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CRC FOR PLANT~BASED MANAGEMENT OF DRYLAND SALINITY

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Salinity – its not just in our backyard

By Kevin Goss

Australia may be hosting a second international salinity conference in 2008 thanks to the initiative of CRC LEME and CRC for Plant-based Management of Dryand Salinity.

Salinity is an issue on every inhabited continent, and it was clear from the experience of the inaugural International Salinity Forum held in Riverside California recently that there is a great deal to be gained by sharing science and experience across nations.

Thirty six Australians joined about 320 other delegates from 16 countries to review developments across all forms of salinity. We learnt that salinity worldwide is a larger problem than expected and occurs in many forms, and many of us were certainly surprised at the extent and impact of salinity in the USA.

In Australia we tend to think of the area affected by salinity, whereas in densely populated countries the emphasis is far more on the number of people affected. It is no surprise that the impact of salinity on water resources is attracting a great deal of international attention.

Australia would also do well to understand the diversity of salinity and its interaction with other subsoil properties (such as acidity and sodicity) and think beyond the dryland/irrigation distinction. For instance the Forum reported a lot of work on plant tolerance to these constraints, much of which is applicable to either situation.

Australian participation in the Forum and side events was enterprising, with many opportunities emerging for knowledge sharing and even staff exchanges or sabbatical leave. The training unit of the USDA's Natural Resources Conservation Service was particularly interested in training programs run by CRC LEME and the NSW Department of Primary Industries.

A highlight on the International Salinity Forum's social calendar was the Australia Night hosted by the CRC Salinity. It gave pride of place to Australia expertise, while conference delegates enjoyed Australian food with our wine and beer.

Excellent field tours in Utah were organised by Richard Price (Kiri-ganai Research) and Mark Quilter (Utah Department Agriculture & Food) specifically to suit Australian interests. Clearly there was a synergy between programs there to limit salt mobilisation to the Colorado River Basin and the salinity management strategy for the Murray-Darling Basin.

Other side tours opened the doors to knowledge exchange on catchment scale modelling and economic policy.

For me the whole event underlined the strength of Australian work on salinity. We devote more attention to policy advice and back this with economic and social analysis, compared with the strong biophysical orientation of most other countries' work. I also believe our pursuit of integration is better developed – in farming systems development and in catchment scale programs. At the same time it is always enlightening to move out of our own comfort zone and look critically at how others tackle such relatively intractable problems as salinity.

From a CRC Salinity perspective, 14 high quality oral papers and three poster papers gave an important profile to our work on an international stage.

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The root cause – hydraulic redistribution

By Elizabeth Madden

The theoretical and philosophical framework for the CRC Salinity is that new land use systems should learn from the processes of natural ecosystems. The *Function of Natural Ecosystems* Program is developing this framework by understanding water management in natural ecosystems, so creating the scientific essentials for plant-based solutions to dryland salinity.

Air spade removing soil to allow measurement of rooting patterns

As part of this fundamental Program, Prof Hans Lambers, Dr Erik Veneklaas, Dr Stephen Burgess and Dr Tim Bleby are working on a project entitled *Mechanisms of water-use in native ecosystems*. Burgess and Bleby's sap flow measurements of *Eucalyptus wandoo* and *E. salmonophloia* at their Corrigin field site in Western Australia, are bringing new insights to hydraulic redistribution - the redistribution of soil-water by tree roots.

Burgess and Bleby's results indicate that these two tree species actually equalise patchy soil-water distribution by moving water between lateral roots following rainfall. Just how this water is transported within the plant and the volumes involved are this project's key findings to date.

"The redistribution of water within the root system and the redistribution via root-root pathways is well known," explained Dr Burgess. "However, we were surprised to find that these plants also move water between roots using the stem as a highway interchange route.

"The redistribution of water via the root-stem pathway can account for up to 30 per cent of daytime trunk xylem flow making it a major function of this structure. This finding demonstrates that hydraulic redistribution is more complex than was previously understood.

"Ultimately what we are observing is one of a number of these plants' adaptations to soil-water variability which results in part from variable soils that exhibit strong texture contrasts.

"Hydraulic redistribution equalises water availability among roots by moving soil water through the plant's transport pathways, thus reducing the problem of uneven rainfall infiltration."

Burgess and Bleby are studying the mechanisms that underpin the differing water-use performances of the various native species at the Corrigin site. By isolating 'functional types' that might have a role in managing water in modern sustainable agro-ecosystems, they hope to inform planning decisions involving tree belts that can provide favourable economic and water-use outcomes.

This new understanding of hydraulic redistribution will help the CRC Salinity build salinity management options by:

- Improving groundwater recharge estimations by recognising that some flows recorded in stems during transpiration measurements are due to redistribution, not loss of soil water.
- Understanding the important ecosystem functions that woody perennials can provide when they are added to agro-ecosystems.

■ **CONTACT** Dr Stephen Burgess,
Tel.: (08) 6488 2073
E-mail: ssb@cyllene.uwa.edu.au

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Amongst the less tangible benefits of this conference, the team building, the new collaboration, and the professional development will all be brought back to Australia as important dividends on our investment.

If Australia does indeed host the second International Forum, this will be another opportunity to learn and at the same time demonstrate our international standing.

On behalf of all Australians participating in this conference and field tours I thank sincerely the tremendous support we received from Richard Price who organised and sponsored activities, and to other sponsors – MLA, AWB Landmark, Kirrihill Wines, Coopers and Fosters Beer, and Consuming Passions. Our hosts in California and Utah were most generous and endured a uniquely Australian approach to "learning and fun".

Robust perennial grasses for low rainfall

By Bruce Munday

Perennial pastures offer a huge potential for reducing salinity while at the same time increasing profitability. This is underlined in the low to medium rainfall region of south-eastern Australia and the south-west of Western Australia where about 14 million hectares of grazing land is currently dominated by annual grasses and legumes.

However, for the potential of perennials to be realised graziers need readily affordable, easily established species and varieties. These must then persist in the lower rainfall areas, often where strongly acid soils and low fertility are common.

The CRC Salinity is addressing these issues with an important research project, *Increased water-use with forage grasses*, supported by Meat & Livestock Australia. This project has three major components:

- persistent, summer-active tall fescue managed by NSW DPI
- drought-tolerant cocksfoot managed by DPI Victoria
- warm season grasses specifically developed for southern Australia, managed by Department of Agriculture WA.

The research team, led by Dr Kevin Reed (DPI Victoria), is screening over 400 carefully selected accessions of perennial grasses in low rainfall regions (400-600 mm) where there is an urgent need to reduce recharge and the risk of dryland salinity. Cultivars will be developed and evaluated with emphasis on seasonal yield, ease of establishment, higher water use, nutritive value, and persistence.

In NSW the field sites are at Barraba and Inverell, where the priority is to develop a persistent summer-active tall fescue variety. This will extend its area of adaptation into lower and less reliable rainfall regions where a high proportion of annual rain comes in summer.

In Victoria, field nurseries on strongly acid, high aluminium soils were established in August 2004. These are on farms at Mt. Cole Creek (near Ararat) and at Bealiba (north-west of Maryborough). Here the aim is to select for persistent winter-active cocksfoot with some summer activity and improved nutritive value. All the plants were dormant by early February when a heavy downpour (50-60 mm) saw the plants resume growth and make strong growth through February, using water which would normally contribute to dryland salinity. As the available moisture disappeared the plants returned to dormancy. Most are now active again, however some quite productive cultivars and some accessions failed to recover from the broken dormancy.


Photo: S Clarke

Field nursery at Bealiba

The nurseries contain tall fescue and cocksfoot accessions collected by DPI Victoria from low rainfall sites in north Africa. This material is being carefully screened along with many cultivars as well as experimental varieties developed in the Mediterranean regions of southern Europe.

Warm season grasses

Kikuyu has been used quite widely on the south coast of Western Australia, but it is only recently that other warm season or subtropical grasses have attracted interest in Mediterranean climatic regions. This CRC project is developing several of these for target areas in WA and northern NSW.

Over 150 lines of core, promising and exploratory species have been sown including *Bothriochloa bladhii, B. insculpta, Chloris gayana, Digitaria eriantha, D. milanjiana, Eragrostis superba, Panicum maximum, P. coloratum, Paspalum nicorae, P. simplex, Urochloa nigropedata, U. mosambicensis* and *U. brachyura*.

These have been seed-increased on the Atherton Tableland in north Queensland where soil and climatic conditions are dramatically different from those in WA and NSW. Measurements from the NSW and WA trials will compare production data with that of temperate grass species and lead to the development of better adapted varieties.

■ **CONTACT** Dr Kevin Reed
Tel.: (03) 5573 0911
E-mail: kevin.reed@dpi.vic.gov.au

Meeting online

Many readers will know that the CRC has now established an online forum that can be accessed from its website.

An online forum is just like a meeting. But like a well run meeting it provides an opportunity to focus on a single issue at a time, it keeps reliable minutes, and it involves only those people who are interested.

At http://forum.crcsalinity.com/forum/ there are several Topics underway ranging from treatment of saline water through organic manures for saline land to the merits or otherwise of drains. People attending the Forum can respond to posts or simply browse, and can initiate new Topics at any time.

Rather than me give instructions, why not visit http://forum.crcsalinity.com/forum/ and spend a few minutes at FAQ.

■ **CONTACT** Bruce Munday
Tel.: (08) 85387075
E-mail: bruce@clearconnections.com.au

Comparing the Murray-Darling and Colorado River Basins

By Matt Kendall, Salinity Manager, Murray-Darling Basin Commission

It was Mark Twain who said "Whisky is for drinking. Water is for fighting over". You could be excused for thinking that the famous author must have just returned from an early pioneering trip to Australia's Murray-Darling Basin (MDB), but no – he was apparently referring to the state of water affairs in the western United States.

During the recent trip to these States, I was impressed by the numerous similarities between our own Murray-Darling and the Colorado River Basin (CRB). The similarities range from the geographic dimensions, through to the water sharing and governance and unfortunately to the devastating effects of land and water salinisation.

Both Basins are large (the MDB covers 15 per cent of Australia's land mass) and the rivers long – over 2000 kilometres in both cases. Compared to other great river basins of the world both the Murray-Darling and the Colorado have relatively modest flows, being a product of relatively low rainfall (MDB – 480 mm/yr, CRB – 355 mm/yr). While the Murray-Darling has the slightly higher average rainfall, the high mountains with generous snowfall in the Colorado convert a higher proportion to run-off.

Mark Twain's famous quote no doubt referred to the complex water sharing between farmers, cities and ultimately governments. I thought the six governments of the Murray-Darling presented a challenge to decision making, until I learnt of the complex arrangements in the Colorado involving nine governments, and crossing international borders. Both Basins have long standing governance arrangements that provide for cooperative decision making and investing across jurisdictions.

The salinity problems of both the Colorado and the Murray-Darling stem from the presence of ancient salts, the relatively arid environments and the impacts of human intervention in irrigated and dryland farming. Both Basins have huge agricultural enterprises, some relying on the waters for irrigation, and large urban populations with industrial and household water use. In every case the presence of high salinity levels causes significant economic impacts. (Interestingly both Basins have recently experienced their worst droughts on record, although the drought in the Colorado now appears to have broken.)

The United States has a Treaty agreement that guarantees the quality of water reaching Mexico, and this in turn requires that the US Departments of Agriculture and Interior manage the River's salinity, including that contributed from public lands. In particular the Colorado River Basin Salinity Control Act directs that preference be given to those projects that are most cost effective – that is, obtain the greatest reduction in salinity per dollar spent.

Photo: M Kendall

CRC Salinity Investment Plan 2005–2008

The CRC's Governing Board has agreed on a $28M investment plan for the final three years of its first term. This decision followed an intensive strategic planning and review process involving Board members and management.

The Board's Research Committee led a review process that evaluated most CRC projects by face-to-face or desktop review, each with a component of external evaluation. The review documented a high level of performance across every program, at the same time identifying 15 priority areas for new project development. A number of these responded to strategic gaps and opportunities, while several were part of the successful bid for supplementary funding secured in the CRC's third year.

At this mid-term of the CRC, the Board also took into account the delivery of outputs and harvesting key knowledge from early stage projects, and gave priority investment to activities that would deliver outcomes within the current seven-year term.

The Board budgeted Year 7 as a wind-down year, however if successful in applying for a re-bid this will become the first year of a new CRC and a core of existing activity would transit to the new CRC.

The CRC's *2004/5 Annual Review* provides information regarding current projects and is available from the website.

In both Basins, landholders in partnership with State and Federal Governments have committed significant resources to managing salinity. One notable difference is the approach to salinity management – in the Colorado the primary emphasis has shifted to source reduction through channel lining and piping and on-farm irrigation upgrades (flood to sprinkler), while in the Murray-Darling the majority of salinity outcomes are still through investment in point source salt interception schemes. The change in emphasis in the Colorado has resulted in significant cost reductions for salinity outcomes ($/tonne), and I believe this is worthy of further consideration in the Murray-Darling.

I greatly appreciated the discussions over the similarities and relative approaches in the Colorado and Murray-Darling on the recent trip to the western United States. The hospitality shown during the International Salinity Forum and study tour have set a very high standard, and I sincerely hope that Australia and the Murray-Darling Basin will have an opportunity to repay this to representatives from the USA and showcase our approach to managing salinity in the future!

■ CONTACT Matt Kendall
Tel.: (02) 6279 0132
E-mail: Matt.Kendall@mdbc.gov.au

Snapshot of two Basins

	Murray-Darling Basin	Colorado River Basin
Area (km^2)	1061,469	635,000
Length (km)	2530 (Murray) & 2740 (Darling)	2333
Average rainfall (mm/yr)	480	355
Runoff (GL/yr)	23,500	22,075
Primary water source	Rainfall in Vic & NSW Alps; tributary inflows	Headwater snowmelt
Major dams (GL)	Dartmouth 3906, Hume 3038 Menindee Lakes 1999, Lake Eildon 3390	Glen Canyon 33,304 Hoover 35,200
Population served by water supply	2 million in Basin + 1 million in Adelaide	8 million in Basin + 23 million outside
Large cities relying on water	Canberra, Adelaide	Los Angeles, San Diego, Las Vegas, Phoenix, Tucson
Irrigated area (Mha)	1.5	1.4 in Basin plus 0.2 out of the Basin
No. of governments	4 States – Qld, NSW, Vic, SA, 1 Territory – ACT, Federal Govt	3 Upper States – Wyoming, Colorado, Utah; 4 Lower States – Nevada, California, Arizona, New Mexico; Federal Government; Mexico
Water diversions (GL/yr)	11,576 (NSW 6265, Vic 3975, SA 720, Qld 584 ,ACT 33)	20,500 (Upper States 9500, Lower States 9500, Mexico 1500)
Entitlement flow to downstream (GL/yr)	1850 (SA)	1850 (Mexico)
Drought conditions	2001 to 2004 were the driest 4 years on record	2000 to 2004 were the driest 5 years on record
Basin scale coordinating body	MDB Ministerial Council & Commission	CRB Salinity Control Forum
Average salt loads (Mt/yr)	1.8 at Morgan	8.2 at Hoover Dam
Salinity impacts on water users	Residential, commercial, industrial and agricultural	Residential, commercial, industrial and agricultural
Economic damage of salinity to water users	A $47M/yr	US $330M/yr
Start of coordinated salinity management	1988	1972
Legislative framework	MDB Agreement	CRB Salinity Control Act International Treaty with Mexico
Salinity Targets (mg/L)	End-of-valley salinity and salt load targets for all (21) major tributary rivers. Basin Salinity Target at Morgan < 500 for 95% of time	Flow weighted average salinity target at or below 1972 levels – (Hoover Dam 723, Parker Dam 747, Imperial Dam 879) To Mexico < 115 (+/- 30) above Imperial Dam inflow salinity
Priority activities for salinity management	1. Point source salt interception 2. Improved farming systems (irrigation and dryland) 3. Additional dilution flows 4. Targeted tree planting	1. Channel lining and piping 2. On-Farm Irrigation improvements 3. Vegetation management 4. Point source reductions (saline springs) 5. Yuma Desalting Complex and Wellington-Mohawk Saline Drain Diversion
Salinity reductions to date	500,000 t/yr 120 mg/L	770,000 t/yr 100 mg/L

Forestry – optimising impacts on salt and water

By Bruce Munday

Commercial forestry in the Murray-Darling Basin offers a potentially profitable tool to reduce groundwater recharge, but it can also lead to reduced surface water flow. These are issues confronted by the Commercial Environmental Forestry (CEF) project, a joint initiative of NHT and CSIRO that investigates options for productive forestry with environmental benefits. The CEF uses modelling to optimise catchment outcomes through careful targeting of afforestation projects.

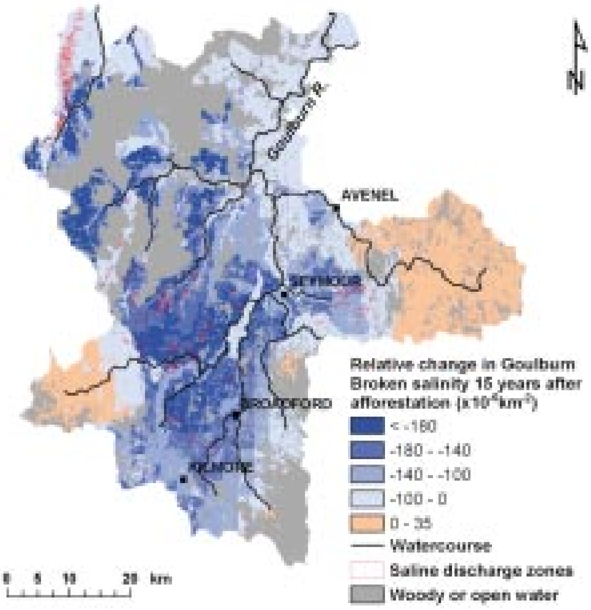

Figure 1. Numbers indicate relative change in salinity of all stream flow from Goulburn and Broken Rivers combined for an average year. E.g $-100x10^{-6}$ km^{-2} indicates that a 1 km^2 plantation in the indicated area would reduce overall stream salinity by 100 millionths (or .01%) after 15 years. Red areas indicate surface outbreaks of saline groundwater mapped in earlier investigations.

Dr Albert van Dijk (CSIRO Land and Water) leads the water and salinity modelling work in CEF and reports that it is being developed as a way of increasing the effectiveness of public investment into environmental services. "Our modelling results show that the impact of new plantation development on stream salinity can be greatly improved by carefully targeting only the most suitable areas.

"Our activities have initially focused on the Southwest Goulburn catchment to the north of Melbourne where the outcomes sought from revegetation are reduced catchment salt yield and stream salinity, but also include enhanced rural economies and other environmental services (increased biodiversity, carbon sequestration, and reduced soil degradation and stream pollutants). An undesirable environmental outcome that must be managed is the reduction in stream flow."

Predicting impact on water and salt

While groundwater flow system models provide a framework for describing salinity processes, the detail of how water and salt travel between two points is often difficult to predict because of the local variability in soil and rock properties, and our limited data to describe this variability.

"Fortunately, as the scale of the salinity models and underlying maps increases, local variations tend to average out," said Dr van Dijk. "Hence we have started at a coarse level and gradually zoomed in on best-bet areas, in that way making efficient use of the available information. In this screening stage we used the BC2C model to identify broad regions that are likely to respond favourably to afforestation."

The Southwest Goulburn was a particularly attractive catchment for this research given the availability of relatively good stream flow and salinity measurements, borehole salinity data, and higher resolution spatial data sets of hydrogeology, topography, land cover and climate.

Targeting new plantings

Screening was very useful to the research team in identifying areas within the Southwest Goulburn catchment that show a more desirable and rapid response to afforestation than others, or areas that do not show the desired response at all and in fact may lead to increased stream salinity when afforested.

The results suggest that on 60 per cent of the potentially available land (i.e. land that is not already under forest), afforestation will lead to reduced stream salinity within 15 years (the blue areas in Figure 1). The remaining 40% of available area would create no change or an actual increase in stream salinity when planted. The area with stream salinity benefits increases when the time horizon is stretched and more sluggish systems start to show a response. The remaining areas fail to produce the desired salinity reductions because they have relatively fresh groundwater (linked to granite areas in this case).

Figure 1 also shows the present extent of mapped dryland salinity areas. "The occurrence of dryland salinity often appears to coincide with areas of predicted stream salinity reduction," said Dr van Dijk. "This result is understandable but not self-evident. It is also encouraging, as stream salinity reduction provides land holders in these sub-catchments with an additional argument for revegetating upslope of salt outbreaks."

Within the 'suitable' (blue) area, the analysis provides further guidance to where the greatest reductions in stream salinity can be achieved, thus enhancing the overall effectiveness of revegetation. Targeting only these most suitable areas shows that half of the maximum achievable reduction in stream salinity can already be realised by planting only 28% of the total suitable area (indicated by the two darkest blue colours in Figure 1), which equates to 17% of the whole catchment.

Reducing stream salinity by any form of revegetation inevitably reduces streamflow. For our example, targeted afforestation of the most suitable area (the dark blue) means a reduction of Goulburn River flow by a model-estimated 1.12% compared with 0.96% for afforestation spread evenly over the entire suitable (blue) area. The dif-

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Toxic ions, spittle bugs and the search for a new perennial pasture legume for saline areas

By Chris Twomey

A species of lotus (*Lotus glaber*) growing in the waterlogged saline flats of Argentina could help Australian farmers to cope with the combined threats of salinity and waterlogging.

CRC Salinity PhD researcher Natasha Teakle has just been awarded the AW Howard Memorial Fellowship to support her international research. This is the third year in a row a CRC Salinity student has received this prestigious fellowship.

Grazing systems based on perennial plants are promising options for tackling salinity if they can both reclaim saline land and provide feed through the autumn feed gap.

Systems based on saltbush can stabilise watertables, but grazing animals need both protein and energy sources to thrive. The holy grail of plant research is therefore a tasty perennial legume that tolerates both salinity and waterlogging - Natasha Teakle hopes that *L. glaber* could be the answer.

However, the path to develop an Australian commercial cultivar is long and complex, and it will probably be three years before we know if *L. glaber* really has what it takes and up to 10 years before commercial varieties are available for farmers.


Photo: M Kendall

This is where smart research based on good experimental design and extensive collaboration comes in. Natasha's PhD research will see her working with world leaders in plant physiology, molecular biology and plant breeding. Collaboration with Professor Tim Flowers at Sussex University will assist Natasha to investigate the physiology of salt tolerance in *L. glaber*, and then a year's research with Dr Anna Amtmann at Glasgow University will help her isolate the gene(s) controlling sodium transport.

Currently the way in which *L. glaber* tolerates conditions of salinity and waterlogging isn't understood, and the variation in the species hasn't been characterised. Natasha hopes to identify genes for these traits in *L. glaber*, allowing researchers and plant breeders to quickly screen plants and greatly accelerate the development process.

Returning with this knowledge and experience in 2007, Natasha will be well placed to screen the best-bet cultivars emerging from the AWI-funded CRC project *Developing new Lotus species for Southern Australia* led by Dr Daniel Real and Graham Sandral. Natasha is also hopeful that molecular markers developed for *L. glaber* can be applied or adapted to screening other *Lotus* species.

So where do the spittle bugs come in?

Understanding mechanisms of ion transport within living plants requires access to the ions without interrupting the process or destroying the plant. Researchers at Sussex University recently demonstrated that xylem-feeding spittle bugs (similar to aphids) do not disturb the natural processes of ion transport within the plant, but their urine gives a direct measure of the levels of different ions at different feeding sites on the plant - a window into the physiological mechanisms the plant uses to regulate ion transport. This is crucial to understanding how salt-tolerant plants cope with toxic ions like sodium and chloride.

Natasha is on a GRDC scholarship and receives operating funds from CRC Salinity. The AW Howard Memorial Trust has provided both a top-up stipend (the Fellowship) and additional travel funds. Natasha is supervised by Dr Tim Colmer (UWA) and Dr Daniel Real – who is undertaking research supported by AWI on secondment to the CRC from Uruguay.

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ference represents about 7 GL/year of moderately saline water.

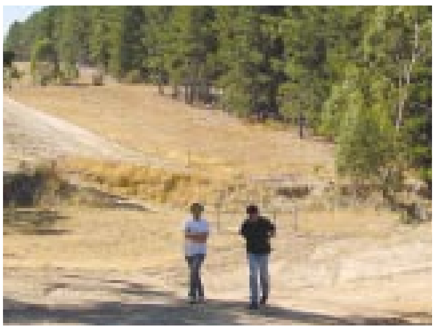
Photo A van Dijk

Ongoing work

Once a target area is selected through screening, alternative options for revegetation can be proposed that differ, for example, in planting density, geometry, species and hill slope position. With this in mind, the CEF project is linking a widely used forest growth and water use model to a finer scale salinity model to compare the predicted water and salinity impacts of different types of plantings and different locations.

Ultimately, however, there are two fundamental constraints to the ability to 'tailor-fit' new plantings to the landscape. Firstly, there will be practical considerations such as the slope and minimum size requirements for commercially viable plantations. Secondly, the uncertainty in model predictions is a direct function of the available local hydrogeological knowledge.

Additional field data collection can reduce uncertainty, but the associated costs will have to be justified by the expected returns.

■ **CONTACT** Dr Albert van Dijk,
CSIRO Land and Water
Tel.: (02) 6246 5780
E-mail: Albert.VanDijk@csiro.au

WA Wheatbelt drainage – acidic groundwater, not just a salt issue

By Steve Rogers, CRC LEME and Richard George, Department of Agriculture, Western Australia

Acid groundwater, that dissolves clays and minerals, has been encountered widely in drains built to counter salinity in the WA Wheatbelt. Acid groundwater has been debated as the main cause of off-site risk as it has the potential to release metals and elements harmful to flora and fauna that inhabit receiving areas.

A research project to assess the causes and risks and to identify management options has been developed as part of the Engineering Evaluation Initiative (EEI) and began in July 2004. This is part of the National Action Plan for Salinity and Water Quality (NAP). The project is led by CRC LEME and involves scientists from CRC LEME, the Department of Agriculture, the Department of Environment, and CSIRO.

Awareness of the presence of acid groundwater has grown over the last few years, and with it awareness of the potential for off-site damage resulting from building drains to remove saline water. It is important that we assess the risk and develop appropriate management strategies to minimise any potential hazards.

The first step in the project was to review historical groundwater records for salinity and pH information in the Agbores database of 2465 records held by the Department of Agriculture and the WIN database of 600 bores. This was undertaken in August-September 2004 to determine the geochemistry of groundwaters in the WA Wheatbelt and in particular the Avon Basin. These data were then analysed according to hydrogeology, geographical location and landform.

Photo: S Rogers

Drain sediments, red iron gels and black monosulfides, form in a matter of months

The review identified two distinct groups of groundwater, one which was clearly acid with pH about 3 to 4.5 (neutral is pH of 7) and a second around pH 6 to 8 (neutral to slightly alkaline). Combined with knowledge of groundwater chemistry from the WA Goldfields and elsewhere, this suggests that:

- Acid groundwaters are a natural regolith phenomenon and existed in agricultural areas well before any drains were installed.
- Groundwaters in the eastern Wheatbelt valleys and other areas with abundant salt lakes, such as north-east of Esperance, tend to be most acidic (affecting up to 70 per cent of bores in such areas).

Photo: S Rogers

Iron precipitates in drain base, source of acidity

Results from the groundwater review contrasted with a stream and lake sampling program in late 2004 which found that surface waters were generally neutral to alkaline (pH 8) especially in the western Wheatbelt. However, naturally acidic surface waters (pH less than 4.5) have been recorded as far back as 1974.

In late October 2004, more than 200 water samples were taken from more than 20 drains in an area between Dalwallinu in the north, Newdegate in the south-east and Williams in the west. Follow-up samples were taken at selected sites in January 2005. The drains were sampled for flow, salinity, pH, major metals, trace elements, rare earth elements and other elements such as uranium. In addition, over 200 soil and sediment samples were taken to determine what geochemical processes were taking place in the drains.

Results again indicated two broad groups of drain pH and salinity. The pH was lowest east of a line from Dalwallinu to Dumbleyung (pH less than 3.5) and highest (pH greater than 6) in the western and central Wheatbelt. Only a few sporadic high pH (alkaline) samples were taken from drains in the eastern areas. Most drains were typically very saline with conductivity in the range 6,000-10,000 mS/m. For comparison, seawater has a conductivity of 5,500 mS/m.

Data show that in most eastern drains with a low pH (less than 4.5), iron, aluminium, cobalt, copper, zinc, lead, uranium and a range of other trace elements and rare earth elements all elevated.

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In summary:

- Acidity is widespread, justifying the initiation of the project by EEI, with more than half of the drains sampled in October 2004 being strongly acid (average pH 3).
- Drain acidity increases during summer, probably due to iron oxidation in sediments.
- Formation of 'new' sediment profiles in drains characterised by iron sulfide minerals occurs over a period of months, and has the potential to generate some additional acid through sulfur oxidation if drain sediments dry out.
- In many cases, metal and trace element levels are 10-100 times higher than in regional surface waters.
- Drains sampled in eastern areas are typically acid and contain large amounts of iron, aluminium, salt, metals, and the rare earth elements, lanthanum and cerium.
- Drains sampled in western, southern and some areas to the north of the Avon Catchment are in general more typically neutral pH.

Drain flows often migrate to receiving areas that are alkaline such as salt lakes and saline seeps.

Transporting acid water to these areas offers the opportunity to 'neutralise' the acidic flow. However while this can occur, it is not true for all metals and trace elements. For example some elements are potentially more toxic under higher pH and an anoxic (oxygen free) sediment environment.

As a result of the data analysis during the first 12 months of this project, the following management and assessment guidelines are suggested:

- Soils, groundwater geochemistry and pilot excavations should be assessed before drain construction to determine the risk of acid groundwater and trace element issues.
- Subsoils that contain calcretes, silcretes and red-brown hardpans are at less risk of erosion, sedimentation, dissolution and related problems than clay-rich, sodic subsoils.

Sampling Elachbutting drain

Elachbutting drain terminus

- Drains need to be kept free of sediments to both sustain their hydraulic effect (water tables) and prevent additional acidification and geochemical reactions within them (making more acids).
- Organic material (such as dead vegetation) should be prevented from entering drains for the same reasons (hydraulic and geochemical impacts).
- Drain designs should prevent erosion and the transport of acids, and related organic and metal-rich deposits (plus sediment) to receiving environments especially during flood events
- An assessment of the impact of acid and trace element-rich drain discharges on receiving environments (lake/river systems, evaporation basins) is critical.

Assessment of discharges on receiving environments and on-ground evaluation of management options will be the major focus of the second year of this project, running from July 2005 until June 2006.

Engineering Evaluation Initiative Steering Committee Chairman, John Ruprecht from the Department of Environment said: "Whilst the project has identified that there is an issue with regard to acid drainage and the presence of metals, rare earth elements, and trace elements, the EEI seeks to evaluate drainage through careful assessment of risk, opportunities and the determination of effective management systems.

"In particular these approaches and regional partnerships will assist NRM regions and interested groups to develop a consistent approach to catchment and regional drainage."

This project is laying the foundation for drainage to be undertaken in a responsible and organised manner. While the issue of acid groundwater is under evaluation, we need to carefully think through managing existing acid drains and developing new drainage systems.

■ **CONTACTS** Dr Steve Rogers
Tel.: (08) 8303 8407
E-mail: Steve.Rogers@csiro.au
Dr Richard George
Tel.: (08) 9780 6296
E-mail: rgeorge@agric.wa.gov.au
John Ruprecht
Tel.: (08) 9278 0461
E-mail: john.ruprecht@environment.wa.gov.au

Travellers' tales

By Ed Barrett-Lennard, Ken Lawrie, Bruce Munday and Anna Ridley

Following the International Salinity Forum 17 of the Australian contingent headed into Utah for a tour hosted by USDA's Natural Resources Conservation Service.

Photo: B Munday

Three of the team reflect on just part of what they drew from the experience. Dr Anna Ridley (DPI Vic; Leader CRC Salinity Program 4: *New Farming Systems*) was particularly struck by the similarities between the farming environment in Utah and many parts of Australia. "Like much of Australia they have recently experienced record drought (now thankfully ended); aside from the snow-capped mountains and breath-taking gorges, much of the landscape could easily belong here in Australia; the rural community is doing it tough, many family farms now dependent on off-farm income; and in the second driest State in the Union, the big issue is water."

Dr Ed Barrett-Lennard (Department of Agriculture WA; Leader of one of the *Sustainable Grazing on Saline Lands* project sites in WA) remarked upon the extent to which the rangeland environment is becoming increasingly dominated by introduced pasture species such as tall wheat-grass (native to Turkey) and intermediate and crusted wheat-grass (native to Russia). But Ed was even more taken by the apparent 'pulsing' of salinity in some of the Utah landscape.

For Dr Ken Lawrie (Geoscience Australia; Leader CRC LEME Program *Salinity Mapping and Hazard Assessment*): "the tour linked us up with many of the end users of R&D - the similarity of many of the scientific, social and economic issues facing the good folk of Utah in their fight to sustain their local communities bore uncanny parallels to much of rural Australia, and again this emphasised the need for the salinity research community to appreciate the social and economic dimensions of the problems faced in tackling salinity in Australia and beyond."

If it is a truism that Australia so often follows the USA, it is then worth noting that the animal welfare lobby is very active in the States and many farmers feel under scrutiny if not pressure. Whist there is a huge movement towards 'industrial farming', particularly in some parts of California, there is also a strong counter-culture spawning organic and locally grown produce, along with the ever burgeoning farmers' markets.

Photo: B Munday

There is nothing quite like getting out of the comfort of home to stimulate critical thinking – Paul would never have reached Damascus had he not travelled that road.

Farming systems - Utah, California, Australia

"The control of water in the Colorado River Basin through engineering means is extraordinary," said Anna Ridley. "Our River Murray is a mere trickle by comparison. However in Australia, the relative scarcity of water and its relatively high price have led us to conservation and efficiency that Utah is only beginning to think about. Extremely inefficient flood irrigation of pastures with large scale nutrient and salt run-off and seepage is only now being phased out in favour of heavily subsidised sprinkler irrigation.

"Nonetheless, the farmers we met are well aware of the causes and effects of both water shortage and pollution, and are embracing the 'new' irrigation technology with enthusiasm.

"Competition between agriculture and the environmental movement appears to be universal, some of the highest value crops in Utah being shared with large populations of protected native deer. In the hilly rangelands, used largely for summer grazing, juniper pine has expanded way beyond its natural boundaries because of the almost total removal of fire as an uncontrolled natural event. Apparently the pines are more iconic than the grasses they have displaced and severe restrictions have been placed on their removal.

"The rich, irrigated soils of the Sacremento and San Joaquim Valleys in California seem to offer farming options with few bounds, save for the widespread concern about water. Industrial style agriculture is becoming almost the norm, and such are the natural growing conditions that crop rotations as we know them scarcely exist.

"Australia appears to be well ahead of the US in terms of understanding and managing salinity – which is just as well, because we appear to have more of it. Understanding irrigation salinity seems to be the main focus in the States that we visited, but with little or no emphasis below the root-zone.

"It is the multi-disciplinary and outcome focused nature of Australian research that seems to set us apart from the US at present. Many of the achievements of the past decade have come from collaboration between hydrologists, economists, modellers, social researchers, plant and animal scientists all working on the salinity problems in partnership with farmers, government and catchment management organisations. This is a model of which we can be proud."

Photo: B Munday

Photo: E Barrett-Lennard

A 'pulsing' saline landscape – an hypothesis

"Salinity presents in many soils in Utah as sulfates of sodium and magnesium rather than the chlorides of sodium commonly found in Australia," remarked Ed Barrett-Lennard. "The vivid white sulfate crystals are highly visible on soil surfaces and contrast with the grey of chlorides we commonly see in Australia.

"Near the San Rafael River we were struck by a close association between shrub and tree vegetation, and salt concentration on nearby bare soil surfaces. However, soils only a few metres away from the shrub/tree vegetation showed no expression of salinity.

"Could this be a seasonal pulsing of salt towards and away from the roots of trees and shrubs? In summer, as the plants use saline groundwater the salt accumulates in the root zone. In winter, the trees and shrubs 'harvest' rain water through canopy interception and stem flow, and salt is leached away from the root zone as water moves into the subsoil through preferred pathway flow down the outside of the roots and through negative hydraulic lift.

"This hypothesis could be important for the sustainability of halophyte growth in Australia. Dr Peter Thorburn and others have previously suggested that perennial plants on saltland will eventually decline and perhaps die from salt accumulation in the root zone. This hypothesis is based on steady-state modelling, but if landscapes do 'pulse' then it may be possible for patchy perennial vegetation to persist on saltland in the long-term. Indeed, we could think of the bare patches that accumulate salt in winter as saltland's waste disposal service – with salt being carried off the site during flood events.

"It might be possible to test the pulsing hypothesis in the one of the SGSL experiments in WA. However, the pulsing would probably be most evident in patchy samphire stands where salt concentrations in the soil profile are high, and plant survival depends on salt export from bare patches in winter.

"In the light of the Utah experience, I wonder if we need to re-examine the hypothesis that water table drawdown by halophytes will decrease salt movement off-site. If saline landscapes pulse, then salt will still move off them. Perhaps the introduction of halophytes into saltland changes the timing of salt efflux from the landscape to times when the river systems are better able to handle it."

Digging deeper

Whereas most of the 'tourists' were interested in what they could see, Ken Lawrie was even more interested in what he could not see.

• ***Continued next page >***

• *From previous page*

"Salinity processes, dynamics and occurrences in the valley landscapes of Utah show both similarities and contrasts with Australian examples. The unmistakable contrast is the significant elevation differences between the adjacent mountains and valley floors. This leads to greater hydraulic drive in groundwater systems compared with most Australian settings. For those of us concerned with understanding subsurface groundwater flow and salt mobilisation, this re-emphasised that the hydraulic conductivity of subsoil regolith materials plays a much more important role in determining the variability in groundwater and salinity dynamics in many of Australia's subdued landscapes.

"Inter-disciplinary, multi-agency efforts to manage salinity in the Upper Colorado Basin have been underway for decades and continue today. Perhaps the greatest differences between salinity research efforts in Australia and the USA lie more in a broader degree of science collaboration between agencies and stakeholders in Australia, the mix and range of science and data inputs being deployed to tackle salinity, and to a certain extent the scales at which we are attempting to manage the landscapes.

Photo: M Thomas

"In the Colorado Basin there is a good regional understanding of groundwater flow within deeper bedrock aquifers. However, as was noted from many ISF presentations, there is commonly a lack of geospatial data on subsoil regolith materials in the top tens of metres.

"The paucity of some key fundamental geospatial/biophysical datasets at finer scales that inform on recharge and deep drainage characteristics, surface-groundwater connectivity, and the links to salinity processes and dynamics often restricts mapping, prediction and management of salinity in many of these landscapes. This has re-emphasised for us the value of some of the fundamental biophysical datasets available for much of the Australian continent."

The hospitality extended and knowledge provided by Mark Quilter and his team from the Utah Department of Agriculture & Food and Department of Natural Resources, the USDA Natural Resources Conservation Service, the USDI Bureau of Reclamation and the Bureau of Land Management was fantastic – far more than we could ever have expected.

■ **CONTACT** Dr Bruce Munday
Tel.: (08) 8538 7075
E-mail: bruce@clearconnections.com.au

Don't separate the wool from the trees

Environmental protection and profitable grazing systems are entirely compatible and need to be core business goals for all Australian woolgrowers.

That's the viewpoint of McKell Medal-winning woolgrower Tom Dunbabin, Chair of the wool industry's Sustainable Wool Advisory Group; a reference committee appointed by Australian Wool Innovation Limited (AWI) and Land & Water Australia which provides advice to the national Land, Water & Wool research initiative.

"As one of the country's largest land-use enterprises and adapted to a wide spectrum of environmental conditions, our wool industry has a unique role in the management of our land and water resources," he said.

"Across the vast area of Australia that supports wool production, the industry faces many environmental challenges. However, within our own business, we know that grazing native pastures can be a profitable activity, providing a low-input system is well planned and managed."

Mr Dunbabin argues that well-managed natural resources are the key to profitable and sustainable grazing systems, resulting in a win-win outcome for woolgrowers and the environment.

Tom Dunbabin

"As part of our grazing operation in Tasmania we manage extensive areas of native grasslands and woodlands, as well as riparian and coastal areas bordering sown pastures," he said.

"Our management strategy is to maintain and enhance the natural biodiversity and the livestock grazing value. Native pastures account for 20 per cent of our total grazing capacity, and are profitable - provided a low input system can be maintained.

"Our 60 off-stream watering points are the key to riparian area management. They remove one of the greatest restraints when designing and constructing fences that enable high utilisation of sown pastures and well-managed riparian and coastal areas."

Mr Dunbabin, together with his wife Cynthia and their son Matt, are fourth and fifth generation woolgrowers on their family's historic, 6000-hectare property 'Bangor' near Dunalley in Tasmania's south-east. They also run Merino wethers on a 2000 ha property 'The Quoin' near Ross in the Midlands.

■ **CONTACT** Tom Dunbabin,
'Bangor', Dunalley
Tel.: (03) 6253 5233
E-mail: tdunbabin@dodo.com.au

Rating winners, losers and 'also rans' in the salt race

By Georgina Wilson

Raised bed technology is being adapted in WA to reclaim waterlogged and mildly saline valley floors in a CRC Salinity project, *Surface water management for waterlogged and saline land*, led by Greg Hamilton.

"Tracking changes in root zone salinity is essential for this project but can be difficult because levels vary over time and space with rainfall, evaporation, soil conditions and plant growth," said Greg Hamilton. "No area is absolutely uniform.

"Long-term, managers can compare land productivity after different treatments, but that can be affected by many other factors besides salinity."

For some time EM38 instruments have been interfaced with GPS technology and contour plotting programs to generate colourful maps of the spatial distribution of salinity to a profile depth of about 0.75 m (see Figure 1).

But Greg Hamilton points out that comparing the technicolour patterns from last year with this year can be confusing. "Maybe one patch of red has declined, but whether it is offset by growth of the yellow band over there, can be very difficult to gauge."

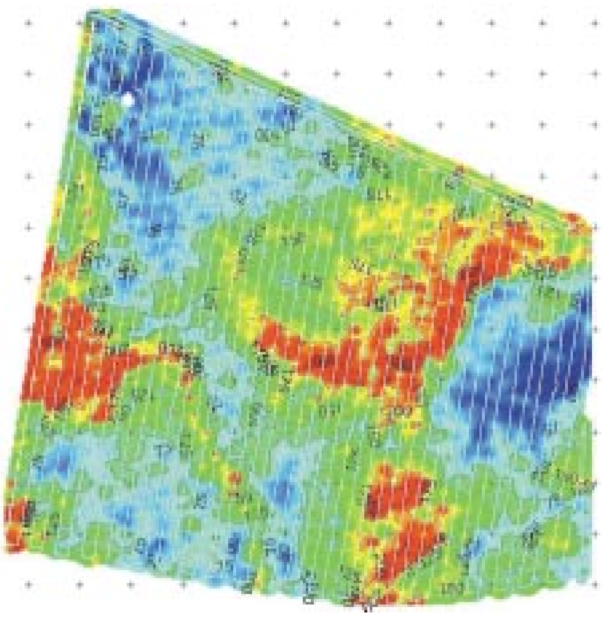


Figure 1. EM38 map of experimental site at Woodanilling, WA showing Apparent Electrical Conductivity (ECa) contours. Twenty four experimental plots are laid out parallel to the survey lines.

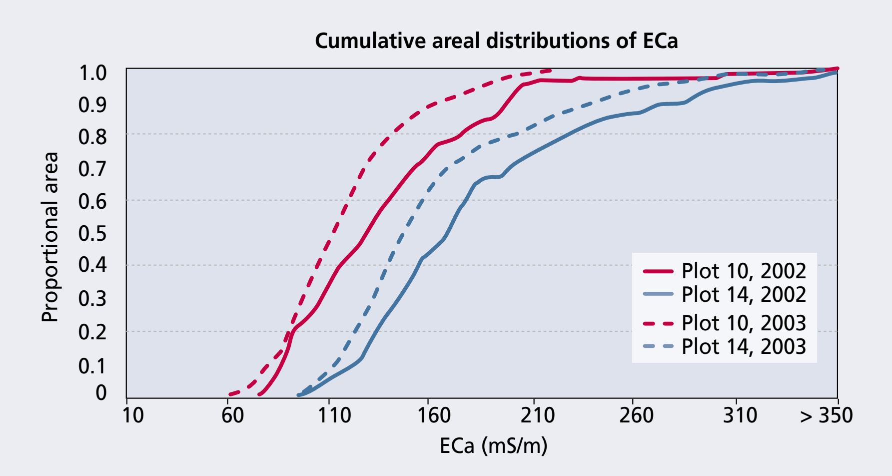


Figure 2. Cumulative distributions of proportions of levels of salinity in two replicate plots at Woodanilling. The general shift to the left indicates reduced salinity.

By computing the total area of land with various levels of salinity from an EM38 map, the proportions with specified salinity levels can be derived and single-line graphs can be plotted. These are called cumulative area graphs (example in Figure 2). Generally these curves take an 'S' shape but their dimensions vary considerably.

The area in each salinity class is easily computed from the geographically-referenced ECa data by using each recording as an average for the area that surrounds it and is equidistant from adjacent records in the same transect and adjacent transects.

This form of presentation has several advantages:

- Multi-coloured images can be reduced to a single line
- Lines for a given sampling time can have their median salinity values compared with other treatments at the same time
- Shapes and slopes of the graphs can be compared to ascertain the range and distribution of apparent EC
- The position of lines from different sampling times and/or treatments allows a quick and accurate appraisal of changing salinity over large areas
- The curves can be described by numbers allowing statistical analysis by scientists and economists of the changing area of certain classes of salinity.

Yield maps and vegetation dry matter maps which are also spatially referenced, can be transformed into similar graphs and the two types of data compared statistically (EM38 versus yield maps for grain or net digital vegetation index (NDVI) images for pastures).

■ **CONTACT** Greg Hamilton,
Department of Agriculture, WA
Tel.: (08) 9368 3276
E-mail: ghamilton@agric.wa.gov.au

Trout harvested in inland aquaculture trial

Rainbow trout are being harvested in the Riverina, as part of a bold experiment to make inland saline areas productive again.

NSW DPI Principal Aquaculture Scientist, Dr Geoff Allan, said scientific trials are being run at the Inland Saline Aquaculture Research Centre at Wakool, in western NSW, to determine the viability of growing marine and freshwater fish in inland areas.

Dr Allan said the research indicates that not only trout, but a variety of marine fish - including snapper, mulloway, black tiger prawns and kuruma prawns - are capable of surviving in degraded inland environments.

"The main difficulty appears to be that groundwater with the same total dissolved salt as sea water contains far too little potassium - about 95 per cent less potassium than salt water from oceans," he said.

"When potassium in the form of potash is added to levels reaching at least 40% of those in seawater, marine species such as prawns and mulloway not only survive - they also grow at rates similar to seawater.

"Of freshwater species, our tests show that silver perch can survive in groundwater containing one-third the salt of seawater; while rainbow trout are able to survive in saline water which is as salty as the sea. Potassium does not need to be added for either of these freshwater species."

Small-scale production of rainbow trout began at Wakool in April last year. The facility contains six 0.05 hectare earth ponds lined with plastic, which are supplied with freshwater and saline groundwater.

Dr Allan said the first run of trout from the ponds yielded about half a tonne. Some of these trout were smoked but most were sold fresh through butchers in Deniliquin, Barham, Wakool and Finley where they were very popular with consumers.

Dr Stewart Fielder and Grant Webster of NSW DPI are running the project with industry partner Murray Irrigation Limited and with support from the Australian Centre for International Agricultural Research and the Fisheries Research and Development Corporation.

■ CONTACT Dr Geoff Allan
Tel.: (02) 4916 3909;
0419 185 510

Managing salinity – still running a business

You need to make some serious decisions about planting trees as a way of managing salinity. But how much of the farm should you plant to trees - how much is enough? What are the long-term benefits? When will you know what they are? How should you implement the planting program over time? How will you finance this new venture and the effect on your cash flow if you choose to go ahead? How will this affect the way you go about the business of agricultural production in an environment where prices and yields vary from season to season? Will you survive commercially to see if trees made a difference?

Well, here is an opportunity to have a go and still live to tell the tale and learn a lot about why farmers do what they do.

A new game called *Salty Business*, designed by the CRC Salinity's Dr Amir Abadi, Professor David Pannell and Dr Stephen Schilizzi, aims to make managing the commercial survival of a farm business under the threat of dryland salinity a little easier and a lot more fun.

Designed to be played by farmers and other agricultural professionals in *Salty Business* workshops, the game will help participants gain an understanding about issues such as the difficulties of incorporating an advocated 'sustainable' farming practice such as tree planting into farm businesses, the practicalities of managing agricultural risk, the stresses faced by farmers managing farms in an uncertain environment and finally why farmers facing similar circumstances respond in different ways.

According to workshop facilitator Dr Abadi, the workshops provide a highly consultative environment in which alternative tree-based solutions to dryland salinity can be discussed.

"It provides the participants with the focus needed to discuss and question some of the commonly held assumptions and beliefs about the role of trees in farming systems. It also helps researchers discuss the implications of their research to farm businesses and develop an appreciation for the key features of perennial plant innovations that may be feasible and commercially viable for farmers to adopt.

"You have 30 years in a day to look at the implications of tree planting decisions on how a farm in the wheatbelt can be managed physically and financially over time and space," said Amir Abadi. "Also, with this game we will be examining various market instruments and policy options for abatement of dryland salinity."

If you are interested in organising or participating in a *Salty Business* day send your name, address, phone number and email address to: Dr Amir Abadi, Department of Agriculture WA; Tel.: (08) 9368 3143; E-mail: aabadi@agric.wa.gov.au

$altland pasture looks great but does it pay?

By Georgina Wilson

Fitting saline grazing into whole-farm economics and ensuring that valid comparisons can be made across States is the challenge facing a new team under the Sustainable Grazing on Saline Lands (SGSL) project.

A group of economists led by Dr Andrew Bathgate (NSW DPI) met in late April to plan economic analysis for both research and producer network SGSL sites.

"The main question is how revegetated saltland integrates with the rest of the farm," Andrew commented. "Saltland pastures not only help to fill the autumn feed gap but can also affect the best enterprise mix, management of other parts of the farm and livestock marketing options. It is difficult to assess the effect of new practices and pastures without considering the effect across the whole property."

The team attended a Saltland for Profit field day at Kellerberrin in the WA central wheatbelt, then discussed plans at the CRC Salinity headquarters at the University of WA.

"Whole-farm models can be helpful in assessing the impact on farm profit and the best enterprise mix. New plant species and management practices can be evaluated to determine how they best fit into farming systems," Andrew said.

Researchers in the four southern mainland States are developing a version of MIDAS, a whole-farm computer model, to assess the viability of saltland pastures. The main modelling task is to ensure that pasture availability, growth rates, digestibility, and energy content are accurately represented in each model - and appropriate for each State.

This information will be used by livestock and pasture researchers to design a grazing system which best suits farms in different regions.

Photo: G Wilson

SGSL economists Felicity Flugge (WA), Jason Kelly (NSW) and Luke Fitzpatrick (Vic) - what do sheep see in this stuff?

Analyses are also being undertaken for a number of sites being managed by members of SGSL Producer Networks.

The main questions being asked by producers getting started on revegetating their saltland are: What are the establishment and maintenance costs and what will they get back for that investment? Economists are now documenting the range of establishment costs and attempting to quantify the value of grazing at different times of the year - in particular during autumn. This information will be used to undertake investment analyses of a number of producer sites.

WA Department of Agriculture senior economist Allan Herbert noted that many SGSL producer sites were still in the establishment phase with some host farmers having little experience of grazing.

"Estimates of future numbers of grazing days are based on the experience of farmers who commenced revegetation programs some years previously," he said.

"At the WA1 site at Tammin, CSIRO researchers are recording stocking rates of 5 sheep per hectare for two to three months on established saltbush stands. It remains to be seen what the range of livestock grazing capacities will be with different plant species across different environments."

The SGSL economists will be progressively releasing results of analyses over the next two years.

CONTACTS Andrew Bathgate
Tel.: (02) 6391 3549
E-mail: andrew.bathgate@agric.nsw.gov.au
Allan Herbert
Tel.: (08) 9368 3680
E-mail: aherbert@agric.wa.gov.au

Know your neighbours

At its regular meetings around Australia the CRC Salinity's Governing Board takes the opportunity to meet with key stakeholders to communicate current activities in the CRC Salinity, plans for the future and any take feedback the guests would like to bring to the CRC's attention. These are informal meetings over dinner, to maximise discussion between individual Board members and key stakeholders.

The CRC Salinity is at the mid point in its seven year life. Its research programs are now realising significant dividends, at the same time as it is commissioning a new round of projects. While now focusing on delivery and communication, the CRC is also starting to shape a re-bid CRC to extend the important work on profitable perennials in agriculture.

These meetings are invaluable to the CRC Board and they have been welcomed by stakeholders.

More information from Natalie Lennon: (08) 6488 1952, E-mail: nlennon@fnas.uwa.edu.au

Salinity information – what's happening in Australia?

A national workshop to develop the standards and protocols for salinity data and information will be held later this year. This will form part of the work-plan for the National Dryland Salinity Data Infrastructure Project, an initiative funded by the Australian Government's Natural Heritage Trust and the National Land & Water Resources Audit (the Audit)

The workshop is part of the Audit's activities to refine the 'indicators' identified under the National Monitoring and Evaluation Framework (NM&EF).

The National Salinity Coordination Committee (Executive Steering Committee for Australian Salinity Information, ESCASI) identified the key aims for the workshop. It will focus on refining and agreeing on:

- salinity indicators identified under the NM&EF
- the data needs required to report on these indicators
- linking current knowledge of groundwater flow systems to this indicator framework
- linking salinity, groundwater, soils and regolith people (to share knowledge on salinity)
- co-ordinating a national view for proposed investments in salinity
- discussing the need to develop targeted salinity hazard and risk assessments.

The Salinity Committee advises the Audit on national information needs. The Audit uses this advice to progressively update information about the status of the natural resources. This information will be used by Australian, State and Territory Governments and regional body decision makers to support the identification of future natural resource priorities and investments.

■ **CONTACT** Peter Baker,
Bureau of Rural Sciences
Tel.: (02) 6272 5609
E-mail: www.nlwra.gov.au

Keeping a tab on watertables

Monitoring often seems to be the Cinderella of natural resource management, but South Australia has made good progress in implementing a strategic approach to monitoring dryland salinity.

One of the four goals of the South Australian Dryland Salinity Strategy is to minimise the area of land affected by dryland salinity beyond the current 326,000 hectares. To enable effective monitoring and reporting against this goal the SA Dryland Salinity Committee oversaw the implementation of the recommendations from the report *Towards a South Australian Dryland Salinity Monitoring Action Plan*.

Mechanisms for monitoring the National Indicators of depth to groundwater and area of dryland salinity in each region have been established and are being implemented on an ongoing basis. Monitoring and benchmarking studies in several key catchments have enabled additional monitoring as a condition of the regional investment strategies.

As a component of the process for monitoring and evaluation the committee initiated a review of the Coorong District Local Action Plan (LAP) in partnership with the LAP Group. The review, completed in December 2004, identified factors that have contributed to the success of the LAP Group and highlighted important issues regarding on-ground works schemes to tackle salinity.

■ **CONTACT** Glenn Gale
Tel.: (08) 8303 9345
E-mail: gale.glenn@saugov.sa.gov.au

Lucerne boost for wheat phase

Research supported by the Grains Research and Development Corporation and the CRC Salinity has shown that WA wheat growers can look to lucerne in ongoing rotations to help boost wheat yields.

Summarising the results of a three year trial at Borden, Perry Dolling (Department of Agriculture) said that lucerne was sown in 2001 in plots that had lucerne in the previous pasture phase, and in 'virgin' lucerne plots following annual pasture to simulate a first-time grower.

Lucerne was removed in late 2003 and then all treatments, including an annual pasture phase, were sown to wheat in 2004.

"The trials found that wheat yields increased by 10 per cent, but protein was slightly lower by 0.5% in wheat following lucerne compared to wheat following subterranean clover," Mr Dolling said.

"There was no difference in wheat yields between one or two phases of lucerne.

"The previous pasture phase has shown lucerne also used 40-100 mm more soil moisture than annual legume pasture to 180 cm depth and therefore reduces the input of water into the groundwater system. This will have benefits in terms of reducing the spread of salinity and waterlogging," he said.

"The lucerne produced similar biomass to annual pasture, or in years of significant summer rainfall was more productive."

Mr Dolling said lucerne controlled weed populations over the long-term due to physical competitiveness and the ability to tolerate some non-selective herbicides, so assisting in reducing the build up of herbicide resistant weeds.

■ **CONTACT** Perry Dolling
Tel.: (08) 9821 3261
E-mail: pdolling@agric.wa.gov.au

Salinity needs more carrots and sticks

By Georgina Wilson

Research into management and reversal of salinity will be largely ineffectual without some tough political reinforcement, a CSIRO scientist has suggested.

Perth-based researcher Tony Schlink, argues that part of the effort in seeking alternative uses for salt-affected land might be better spent in persuading the community, through politicians, that they caused the problem and now must take full responsibility.

"Salinity is rather like fishing," Dr Schlink said. "If individuals take fish stocks beyond the capacity of the fishery, it often goes unnoticed until livelihoods are threatened. Then there is panic to buy back licences or boats and it becomes a major issue. By that stage it can be 50 years too late.

"So it has been with salinity. Governments made it very attractive to clear some land that should never have been cleared. They created the problem and should now take responsibility for solving it."

Dr Schlink pointed to conditional purchase arrangements in WA when settlers were required to clear land completely or lose it despite scientific evidence that this could cause salinity.

"Although watertable trends indicated there was a problem, it was some time before it became visually apparent to the non-technical community. Now we have a big issue and something needs to be done."

By comparison, in SA in the 1860s Surveyor-General George Goyder marked off a line, coinciding with the southern boundary of the saltbush country, which separated lands suitable for agriculture and pastoralism on the basis of reliable annual rainfall. When agricultural land became scarce, combined with good seasons and expected income of land sales, the government was persuaded to disregard the line and allow farmers to crop land to its north. But a return to normal seasons in the 1880s proved Goyder correct.

Tony Schlink, whose SA family farm straddled the Goyder Line, argues that the community can't expect individual farmers alone to sort out the salinity mess but must start paying for solutions.

"Unfortunately economics doesn't value environmental degradation," he said. "Where salinity solutions relate to getting more perennial plants back into the landscape, many landholders say that they will change farming practices when, for example, trees provide the same economic return as wheat.

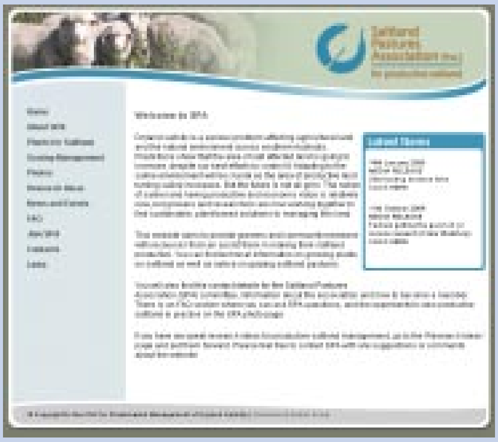
"But realistically, this is not going to happen. Changing from wheat to trees is a complete career change, and how many of us want to do that for marginal rewards?"

Having opened up a landscape in error, the community and the different levels of government should first admit to the error, and then remove the land from cropping or other unsuitable land uses, he suggested. This might be done by buying back the land or by using market-based instruments such as requiring a higher percentage of power from renewable sources, therefore providing a stronger market for oil mallees and reason to change farming systems.

■ **CONTACT** Dr Tony Schlink
Tel.: (08) 9333 6628
E-mail: tony.schlink@csiro.au

Saltland Pastures Association

The Saltland Pastures Association (SPA) is a Western Australian farmer driven group that promotes and assists farmers in making their saltland productive. The group has an overall goal of achieving one million hectares of revegetated saltland in WA by 2015.



It is envisaged that the vast majority of this (~900,000 ha) will be revegetated for forage production, and the remainder for biodiversity. This project, called 1MPULS>, is managed by the SPA's Sally Phelan and is funded by the National Landcare Program's Sustainable Industry Initiative.

1MPULS> provides farmers with on ground assistance as well as an incentive payment to implement saltland pastures and revegetation on their property. Initially revegetation activities will be based on existing knowledge and technology, however SPA is committed to strengthening partnerships with R&D organisations to further refine and develop establishment and management techniques.

In addition to 1MPULS>, SPA is adding to the services it provides to its members, starting with the development of an SPA website. The CRC Salinity is assisting SPA in building a website that provides farmers with good, simple advice on growing and grazing saltland pastures. The website also has information about the Association, and how to be involved and become a member. Go to www.crcsalinity.com/spa/index.htm or look for the link on the CRC website. Check it out!

■ **CONTACT** Sally Phelan
Tel.: 0427 902 126
E-mail: saltlandpastures@westnet.com.au

Search for native grasses

By Jo Curkpatrick

The search is on in Victoria's Wimmera for salt-tolerant native grass species. Already a number of species have been found in surveys undertaken by Department of Primary Industries scientist, Austin Brown.

According to project manager Julie Andrew, very little is known about salt tolerance of native grasses.

"So often we try to solve our problems with an introduced species without realising that an existing native species may be able to do the job. In this work we are going back to areas where remnant grasses remain to explore the local species that had naturally adapted to salinity," Ms Andrew said.

Funded by the National Action Plan, the project is looking for native grasses growing in salinity discharge sites . More than 90 discharge sites were surveyed throughout the upper, mid and lower catchments of the Wimmera River, in the Douglas Chain of Lakes and in the West Wimmera. The survey included grass and associated species identification, specimen collection, soil testing and landscape assessment.

The survey took Austin to a selection of known saline discharge sites, including salt lakes, swamps and creek flats. In the survey, the native species he found showing tolerance of the highest levels of salt included *Puccinellia stricta* (saltmarsh grass inland and coastal forms), *Distichlis distichophylla* (Australian salt grass), *Lachnagrostis filiformis* (common blown-grass), *L. robusta* (salt blown-grass) and *L. adamsonii* (Adamson's blown-grass), although the latter two species are rare in the Wimmera.

At each site, where significant populations of native grass species were present, zones of differing potential salinity and waterlogging were identified, from which surface (0-10 cm) soil samples were analysed for acidity, total soluble salts and soil texture.

"The survey was a welcome opportunity to further my studies of *Native ecosystem function in saline discharge sites*; a CRC Salinity project," said Austin Brown.

One of the outcomes has been a review of research on native salt-tolerant grasses, to provide support for establishment efforts and management techniques employed for the selected species.

As a result of the survey, whole plants of *Austrodanthonia setacea* (bristly wallaby grass), *A.* aff. *caespitosa* (common wallaby grass), *D. distichophylla*, *L. billardierei* (coastal blown-grass), both *P. stricta* varieties, *Sporobolus mitchellii* (short rat-tail grass) and *S. virginicus* (salt couch) were collected by Julie and her team, grown on and replanted into two secondary saline sites for assessment of their salt tolerance, survival and growth.

During the last two seasons, seed was also collected from natural populations of *Austrodanthonia*, *Lachnagrostis*, *Puccinellia* and *Sporobolus* species, *Austrostipa puberula* (spear-grass), *Eragrostis dielsii* (Mallee love-grass) and *Poa labillardierei* (tussock poa). The seed is being tested for germinability under various temperature and salt regimes and will be sown in field trials this spring.

■ **CONTACT** Austin Brown
Tel.: (03) 9742 8728
E-mail: austin.brown@dpi.vic.gov.au

Summary of habitats, means and (ranges) for soil pH in water and electrical conductivity (EC 1:5) for Australian native grasses

Grass Species	Habitat	pHw	EC, dS/m
Austrodanthonia* aff. *caespitosa	Flats	8.5	1.4
Austrodanthonia geniculata	Seepage slopes, peninsula rises, lake beds	6.5 (4.6-8.3)	0.50 (0.10-.90)
Austrodanthonia setacea	Foreshore & seepage slopes, flats, mounds & depressions, creek banks, peninsula rises, lake fringes	7.5 (5.7-9.0)	1.1 (<0.05-4.1)
Austrostipa puberula	Foreshore flats, lake fringes, swamp flats	8.6 (8.1-9.0)	1.55 (0.40-3.1)
Cynodon dactylon*	Foreshore slopes, creek flats, scalds, lake beach, flats	8.0 (7.2-8.6)	0.55 (<0.05-2.2)
Distichlis distichophylla	Foreshore slopes, dunes, flats & hollows, seepage slopes, lake & swamp fringes, beach dunes	3.9 (6.5-9.0)	8.5 (0.08-14)
Eragrostis dielsii	Foreshore slopes, beach dunes, lake beds, flats	8.9	0.22
E. infecunda	Foreshore slopes, gully beds, creek banks, lake & swamp flats	8.2 (7.2-9.3)	0.67 (0.22-2.2)
Lachnagrostis adamsonii	Depressions, flats	8.7 (8.6-8.7)	2.1 (2.0-2.2)
L. billardierei	Foreshore slopes, lake fringes	8.8 (8.6-9.0)	1.9 (0.22-3.9)
L. filiformis	Foreshore slopes, depressions, drainage lines, peninsula rises, lake flats, edges & beds	8.1 (6.6-9.3)	0.79 (<0.05-3.6)
L.* aff. *filiformis	As above	8.2 (7.2-9.1)	3.3 (0.39-16)
L. robusta	Depressions, lake & swamp flats	8.9 (8.1-9.7)	5.9 (2.7-9.1)
Poa labillardierei	Foreshore slopes & dunes, flats, lake flats & fringes	8.7 (8.4-9.0)	0.32 (0.22-0.38)
Puccinellia stricta* var. *perlaxa	Seepage slopes, flats, depressions, scalds, gully beds, beach dunes, lake fringes, swamp flats, edges & beds	8.5 (6.9-9.6)	3.7 (0.10-16)
P. stricta* var. *stricta	Foreshore flats & hollows, creek flats, lake fringes, swamp flats & edges	8.7 (7.2-9.7)	6.1 (0.40-14)
Sporobolus mitchellii	Foreshore & seepage slopes, beach dunes, lake fringes, flats	8.2 (6.5-9.2)	0.16 (0.08-0.22)
S. virginicus	Foreshore & seepage slopes, dunes & hollows, gully beds, creek flats, lake fringes	8.8 (7.4-9.9)	1.3 (0.07-3.1)

* native status uncertain

Workshop support material for people working with land managers

Training the trainers is an important part of spreading any technology, and some widely-used salinity management tools have gained a strong boost from a new series of workshops.

The *A Million Hectares for the Future* project was part of the National Dryland Salinity Program, funded by the Grains Research and Development Corporation and concludes at the end of June.

Its WA team, led by Trevor Lacey from the Department of Agriculture, has produced a series of workshop guides with supporting material that can be customised for local conditions and levels of knowledge. All of the workshops deal with dryland salinity and key management options. Broad facilitator's notes, participants' notes and a series of PowerPoint slides are available for an introduction to salinity plus an initial assessment of where lucerne, perennial grasses, surface water management and drainage may have a role in salinity management.

Each workshop is designed to run from half a day to a full day with an indoor information presentation and hands-on activities followed by local field site visit. Participants then should be able to assess whether the specific management option may be suitable for their properties.

Workshop notes are on the Department's web-site, and can be accessed by searching by title e.g. Lucerne: Is it for me? or by doing an advanced search for salinity management workshops published after 1 January 2005.

"The workshops can be viewed on the web, and if people want to run their own they should probably request the CDs which include material customised to their needs," Trevor suggested.

The CDs contain all of the workshop material plus additional tools such as a salinity calculator and decision tree.

Each workshop was trialled with farmer groups during development and in May the series gained a positive response from about 60 likely users at Dalwallinu and Katanning. These included Department of Agriculture staff, community landcare coordinators, and Landmark and Elders staff.

Some present thought the workshops would be particularly useful for new staff working with salinity. Others noted that as only five salinity management options were included, the concept could be extended to others if demand was strong and funding available.

■ CONTACT E-mail: jbrown@agric.wa.gov.au to order free CDs
Website: http://www.agric.wa.gov.au

What do Aussies do at night

By Bruce Munday

When you have only 20 million people managing the natural resources of a whole continent then collaboration becomes the name of the game.

This was the theme of the Australian Night – the principal social function attached to the International Salinity Forum in Riverside, California.

The 35 Australians played host to the rest of the Forum at a night featuring some of the best of our home grown - wine donated by Kirihill Estates, lamb by MLA, beer by Coopers and Fosters and culinary advice by Consuming Passions while the overall event was sponsored by the CRC Salinity.

By the end of the night I had realised that I am in the wrong game. My fear that nobody would show was dispelled by the queue stretching out to the road; my unease that the Aussies would refuse to wear the sun hats (designed to make them stand out) was unfounded - the Americans would have happily bought them; as for the koalas - well I was warned that the Yanks just lerv them.

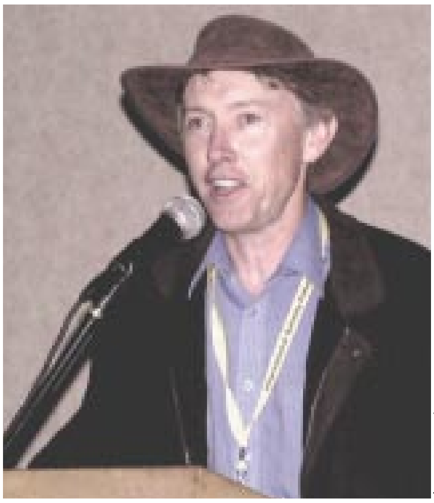


Photo: R Francis

"'We'll all be rooned,' said Hanrahan, 'Before the year is out.'" Dave Pannell demonstrating good old Aussie stoicism about the perils of life.

John Olsen, Australian Consul General in Los Angeles and former Premier of South Australia, directed the show with the deftness of a former politician who had played plenty of unpredictable gigs before. The cast of six Australian scientists who were scripted to talk briefly about collaboration in science quickly went into adaptive management mode when it was clear that the audience had come to party.

In the best Anzac Day tradition the show, scheduled to finish at 9.30pm, was still in full flight at midnight with lots of energetic networking and little regard for tomorrow.

The Australian Night was a great promotion of Australian products, cuisine and culture and all three made a lot of friends that night. It also introduced a lot of in ternational scientists to their Australian colleagues. Dr Richard Price conceived the idea and helped it mature, showing yet again that the innovative style that marked the National Dryland Salinity Program was no fluke.

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

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CRC Salinity Contacts:

CHIEF EXECUTIVE OFFICER
Kevin Goss
T: (08) 6488 2555
E: kgoss@fnas.uwa.edu.au

DEPUTY CEO & WA NODE MANAGER
Assoc. Prof. Mike Ewing
T: (08) 6488 1876
E: mewing@cyllene.uwa.edu.au

SA NODE MANAGER
Glenn Gale
T: (08) 8303 9345
E: gale.glenn@saugov.sa.gov.au

VICTORIAN NODE MANAGER
Dr Tim Clune
T: (02) 6030 4516
E: tim.clune@dpi.vic.gov.au

NSW NODE MANAGER
Peter J. Regan
T: (02) 6391 3185
E: peter.j.regan@agric.nsw.gov.au

COMMUNICATIONS MANAGER & SA
Dr Bruce Munday
T: (08) 8538 7075
E: bruce@clearconnections.com.au

WA COMMUNICATIONS
Georgina Wilson
T: (08) 6488 7353
E: gwilson@fnas.uwa.edu.au

VICTORIAN COMMUNICATIONS
Jo Curkpatrick
T: (03) 9328 5301
E: jo@spancom.com.au

NSW COMMUNICATIONS
Elizabeth Madden
T: (02) 6938 1985
E: elizabeth.madden@agric.nsw.gov.au

CORPORATE COMMUNICATIONS
Chris Twomey
T: (08) 6488 8553
E: ctwomey@fnas.uwa.edu.au

HEAD OFFICE
T: (08) 6488 8559
E: salinity@fnas.uwa.edu.au

CRC LEME Contacts:

CHIEF EXECUTIVE OFFICER
Dr Dennis Gee
T: (08) 6436 8786
E: Dennis.Gee@csiro.au

DEPUTY CEO
Paul Wilkes
T: (08) 6436 8699
E: Paul.Wilkes@csiro.au

HEAD OFFICE
T: (08) 6436 8695
E: crcleme-hq@csiro.au

CRC AUSTRALIA