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focus ON PERENNIALS

Taking saltbush in hand

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EverCrop® offer solutions for low-rainfall areas

Melilotus siculus — rising from a salty grave.

Laying bare the secrets of better lucerne mixtures.

Researchers forge their way forward to grasp the benefits and potential for saltbush

FUTURE FARM INDUSTRIES CRC

INNOVATION IN PROFITABLE PERENNIAL FARMING SYSTEMS

Profitable perennials in mixed systems — the guide

LEFT: Soon to be released, the latest Prospects Statement *provides a guide for farmers to incorporate perennials successfully into mixed farming systems. (Photo: P Lawson)*

By Sarita Bennett
FFI CRC

Rising water tables, increasing levels of soil salinity and acidification were the initial drivers for change from traditional farming systems. The impacts of climate change, alternative competing industries and market forces are now proving alternative drivers for change.

During 2004, the total area of perennial-based farming systems in southern Australia was estimated to be about three million hectares out of a total of 100 Mha of cleared farmland. The remainder being dominated by annual species.

What does it take to persuade a landholder to change their farming system from an annual-based system to a perennial-based one? Understandably, the economics have to be favourable before change is considered, yet will this be apparent if they change the farm one paddock at a time?

Other concerns focus on how much of a farm should be under a perennial-based system for the landholder to reap the maximum benefit.

And how many years will the farm need to include perennials before the landholder will start to see the benefits and returns?

One of the obvious advantages of sowing perennial pastures is the availability of green feed at a time of year when it is scarce. Many farmers who have adopted a perennial-based system have increased their whole-farm carrying capacity, so they can turn off more animals.

Even so, many landholders are reticent to adopt more perennials.

key points

- The fourth title in the FFI CRC's Prospects Statement series is nearing completion
- *Prospects for profitable perennials in mixed farming systems* provides vaulable information for 12 regions across southern Australia
- Research outcomes and species information is supported by practical case studies highlighting successful adoption of perennials on farm.

Supporting change

A critical adoption tool for advisors, extension offers and landholders will be the fourth title in the FFI CRC's *Prospects Statement* series — *Prospects for profitable perennials in mixed farming systems.*

The publication will attempt to answer the questions outlined above according to FFI CRC researcher and publication coordinator Dr Sarita Bennett (UWA).

"Sections are included on the economics of different perennial-based farming systems, what perennials are available, including a summary of our increased knowledge about perennial forages and the potential new varieties that have emerged from research undertaken through the former CRC for Plant-based Management of Dryland Salinity," Dr Bennett said.

"Southern Australia has been broken into 12 regions for this *Prospects Statement* and within each region a table of the suitable perennial grasses, legumes and herbs is presented.

Details on rainfall, soil and other constraints that could limit the suitability of a perennial are provided within tables."

Readers can find further information on each listed species in the publication's appendices, along with a reference to a website which provides guidelines for sowing and managment.

On-farm experience

The publication features five case studies of farmers who have adopted perennials into their farming system. Their decision to include perennials, the issues they faced in changing the farming system to include perennials and their current success are highlights of these case studies.

The final section of the *Prospects Statement* deals specifically with areas where there are few perennial forage options available, including the low-rainfall areas of southern Australia. It also provides details of species identified as having potential in these target areas. The publication also highlights the research areas that FFI CRC plans to target in the future and provides a valuable backdrop to ongoing research under the FFI CRC *Future Cropping Systems* program (see following boxed story).

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Perennial pasture options presented

The upcoming *Prospects Statement — Prospects for profitable perennials in mixed farming systems* provides an overview of the perennial pasture options investigated to date.

A decade ago, lucerne was the main perennial legume option available for most of the medium-to-low rainfall regions of southern Australia. Wide-reaching benefits include its ability to lower water tables with its deep-rooting system. However, lucerne has proven to have limitations — it is intolerant of acid soils, waterlogging and soil salinity, and requires some summer rainfall.

A search for perennial legumes with similar deep-rooting systems would provide further options for the agro-ecological zones where lucerne is unsuccessful. Ideally a suite of perennial options is required that would fit the ecological niches currently filled by annual legumes. White clover is the only other perennial legume currently adopted extensively in southern Australia. However, its use is restricted to permanent grazing regions receiving more than 700 mm of annual rainfall, as it does not persist in lower rainfall regions due to a lack of drought tolerance.

The grass may be greener

More perennial grass options are available including the temperate grasses, such as perennial ryegrass, tall fescue, phalaris and cocksfoot, the sub-tropical grasses, such as kikuyu and Rhodes grass and the halophytic grasses, tall wheatgrass and puccinellia, which are suited to saltland pasture areas of southern Australia. There may be a weed risk associated with the use of tall wheatgrass in Victoria.

The temperate grasses are restricted to the medium-to-high rainfall regions of southern Australia and, other than temperate types of tall fescue, are shallow-rooted and contribute little to water table lowering.

The sub-tropical grasses have more summer activity, therefore contributing more to water use during out of season rains. Other than kikuyu and Rhodes grass their use has generally been restricted to the summer-dominant rainfall zones of Australia, although research is currently underway on expanding their use into winter-dominant rainfall zones with some summer rain or with a shallow or perched non-saline water table.

In discharge areas, with waterlogging and soil salinity constraints to production, the options available are also limited. Puccinellia and tall wheatgrass are tolerant of both soil salinity and waterlogging and will grow successfully, but there is a lack of perennial and annual legume options available. The annual legume balansa clover is productive on waterlogged soils, but is not as salt tolerant as originally thought, particularly during germination. *Melilotis siculis* is well suited to saline and waterlogged environments. However, the search is on to find a hardy rhizobia to match (see story on page 10).

Strawberry clover is also tolerant of waterlogging, but not salt tolerant. Identifying new salt- and waterlogging-legumes that can increase levels of nitrogen in the soil for companion grass species, increasing their nutritive value to livestock, is a high priority.

Perennial legumes also have an advantage over annual legumes as they provide out-of-season feed, increase carrying capacity and reduce the need for supplementary feed during autumn.

Salt-tolerant shrubs, such as saltbush, lower the water table in these environments and can provide a supplement of anti-oxidants, such as vitamin E (see story on page 7).

Researchers ever-ready to investigate

The initiation of two national projects will see a strong perennial research presence in the Victorian, South Australian and New South Wales low rainfall zones during the coming years.

EverCrop® led by Dr Rick Llewellyn and Dr Mike Robertson, CSIRO Sustainable Ecosystems, aim to generate data and develop models to assess the impact of incorporating perennials into exsiting cropping systems.

The projects are part of the larger FFI CRC program — *Future Cropping Systems*, which is exploring options for new cropping systems with sufficient perennial component to be resilient to the multiple challenges posed by declining terms of trade, salinity and climate variability.

Project activities in the low rainfall zones of the tri-state areas will be led by Patrica Hill (CSIRO Sustainable Ecosystems) and will explore how perennial pasture options fit within the context of soil and cropping constraints that exist in the local environments.

"Our aims are to consider how perennials might be used to address production, environmental, economic and seasonal risk aspects of cropping systems," Patricia said.

"The *EverCrop*® Decide component will develop decision support tools to assist local farmers to put perennials in the right places in farm systems for maximum profit and environmental benefit."

Focal sites

Research and extension staff will combine their skills to address local knowledge and adoptions constraints to growing perennials successfully across the region at two 'focal sites' at Werrimull (Vic) and Waikerie (SA).

"At these sites, local farmers and consultants will be invited to guide the research that takes place," Patricia said.

"Other research is also planned around the region, so we can collect enough data to develop models for simulating perennial pasture growth and to assess the whole-farm economic benefit of incorporating perennials into the system."

ABOVE: Project activties will be undertaken across low rainfall zones of the tri-state area shown above. (Source: CSIRO)

The activties will also include spatial analysis of the areas suitable for growing saltbush, assessing performance across a range of soil types, determining the biophysical constraints of fodder shrub species production, options for enhancing lucerne establishment success, and perennial pasture establishment and growth.

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Salinity — a holistic approach leads to successful solutions

By Laureta Wallace
Kondinin Group

Farmers need to take a holistic approach to managing salinity and use a range of tools to combat the problem and, in some cases, making saline land more productive.

This is the message coming from FFI CRC saltland pastures specialist Dr Ed Barrett-Lennard (DAFWA). Dr Barrett-Lennard has been the talk-of-the-town recently due to the help he has given to the groundbreaking work on the continual development of a salt-tolerant wheat species.

The so-called 'salt-tolerant wheat' is an amphiploid - a new synthetic plant containing all the genes from two plant species — in this case commercial wheat and sea barley grass — a highly salt- and waterlogging-tolerant weed. The pioneering work to produce the first generation amphiploids was carried out by Dr Tim Colmer (UWA) and Dr Rafiq Islam of the University of Adelaide. The FFI CRC now has 20 of these amphiploids available for further testing.

While his excitement about the potential new species can't be dampened, Dr Barrett-Lennard cautions that the availability of these new plants will not be the sole solution for farmer's salinity woes.

"These plants will definitely have a role but let's not over spruik it," Dr Barrett-Lennard said.

"They will be most beneficial where salinity is lowest."

Instead, he urges farmers to first diagnose the severity of their salt problem and honestly assess its productive capacity.

ABOVE: Irnam Malik (former PhD student in the Colmer group), Dr Tim Colmer (project leader), Michael Lloyd (farmer), Dr Ed Barrett-Lennard and a Japanese farmer delegation inspect the salt-tolerant wheat plot in December 2008. The salt-tolerant wheat amphiploids (left) have remained green, while the barley (middle of) and wheat (right) have died. (Photo: DAFWA)

"Farmers, agronomists and extension officers need to be able to read the landscape and think about the range of opportunities this variation presents for agriculture, and then invest in the parts of the saline landscape where the greatest benefits will be gained," Dr Barrett-Lennard cautioned.

"The optimal management of salinity, for some growers, might mean changing the way they feel about the use of particular parcels of land.

"For others, it might mean considering new technologies, plant species and farming practices.

"The management of salinity will always require a combination of elements. Nobody should be going to farmers and saying 'I can fix this' with one idea.

"And in the case of severely-affected land, we still advise to not use that ground for farming purposes."

key points

- Salt-tolerant wheat is set to arm farmers with a new tool to manage salinity
- Growers need to diagnose the production capacity of their saline land before deciding on a suitable management strategy
- The *Saltland Genie* website, www.saltlandlandgenie.com.au, helps farmers determine the severity of their salinity problem and, based on the result, advises of the best management option.

Salt-tolerant wheat

So what is all the fuss about the salt-tolerant amphiploids and when and how can farmers take advantage of them?

After years spent developing these new cereals, the results from the first year's research have partly vindicated the original promise of the material.

"In the field, the amphiploid demonstrated better tolerance for salinity during germination and establishment than traditional wheat, it also performed better at harvest," Dr Barrett-Lennard said.

He notes the amphiploids are so new, the manufactured cereals do not even have a name yet. Previous amphiploids have been named based on the Latin names of the parent plants. For example, the cereal triticale (also an amphiploid) was named using a combination of its parents; wheat *(Triticum)* and rye *(Secale)*.

Challenges faced

The main challenge faced by Dr Colmer and his team in developing the amphiploids, is the problem of head sterility.

"Obviously we can't commercialise a cereal that only forms seeds in about 20 per cent of its head," Dr Barrett-Lennard said.

He says the sterility problem in amphiploids has been caused by the way in which the researchers have moved the chromosomes.

"The current family of amphiploids were all created by moving the chromosomes from wheat into the sea barley grass," Dr Barrett-Lennard said.

"We believe this is the major cause of the sterility problem."

There is now a major effort in the project to move the chromosomes from sea barley grass into wheat.

"This is a far harder task," Dr Barrett-Lennard warned.

"But success in this area would be a true breakthrough. It would solve our sterility problem and enable the eventual commercialisation of material from the current range of crosses."

This year, Dr Barrett-Lennard and other CRC collaborators will be running more trials at a site near Canberra.

Glasshouse trials have showed the amphiploid demonstrated a better tolerance for waterlogging than traditional cereals.

"Because of this we will be looking for a test site in WA with more waterlogging than our previous sites, so we can test the real potential of the amphiploid," Dr Barrett-Lennard said.

The new variety is likely to be most effective and productive on moderately saline land prone to waterlogging. Dr Barrett-Lennard estimates the amphiploid will be commercially available in about five years.

In the short-term he recommends farmers need to turn their attention to the other tools currently available to tackle salinity.

Tackling salinity — here and now

"The FFI CRC is promoting a whole suite of tools to help farmers develop a salinity-fighting strategy," Dr Barrett-Lennard said.

"Research carried out during the past five years has revealed there were 11 different solutions farmers could adopt to make their salt-affected land productive. Some of these options, such as the growth of saltbush, puccinellia, tall wheatgrass and salt-tolerant trees, will be relatively familiar.

"However, other options have not previously been widely promoted."

A new website *Saltland Genie*, www.saltlandgenie.com.au, brings all these tools together, allowing farmers to make better decisions on how to productively manage their saltland pastures (*Focus on Perennials*, Issue # 6).

An initiative of the Land Water and Wool program and the FFI CRC, with funding from Australian Wool Innovation, the website has been dubbed Australia's leading resource on saltland management, and after just months of being online, has attracted more than 100 hits per week.

"*Saltland Genie* has all the information farmers need to grow saltland pastures on their properties," Dr Barrett-Lennard said.

"The website provides two different kinds of information; generic information about the principles of production from saltland and more specific information for 11 different options available for saltland revegetation."

Dr Barrett-Lennard says before deciding upon a way to tackle salinity, it is important to determine the severity of the problem. To help, *Saltland Genie* hosts a decision-support tool that guides farmers and their advisers in diagnosing the capability of saltland sites and recommends the best site solution based on the information provided.

Saltbush signals a solution

Saltbush continues to be a plant of interest in the management of saltland and is increasingly becoming valued as much for its offerings as a livestock fodder, as it is for its ability to lower water tables.

Saltland Genie details information about the various ways saltbush can be used to contain salinity, including planting it alone as well as using it to allow the establishment of an understorey of more productive and nutritious but less salt-tolerant annual species.

FFI CRC researcher, Dr Hayley Norman (CSIRO Livestock Industries), and a team of researchers, including PhD student Chelsea Fancote (UWA) featured on page 9, are probing the grazing qualities of the native shrub and the benefits the plant's compound such as Vitamin E and Betaine could have on animal health (See page 9 for more information).

"Feeding sheep grain results in a vitamin E deficiency and so by grazing stock on saltbush, which has 10 times more vitamin E than grain, producers can not only manage salinity, but improve their health of their animals," Dr Barrett-Lennard said.

"Of course, saltbush is also drought tolerant and useful in the control of water and wind erosion. It can also be grazed heavily as long as there is sufficient recovery time.

"The profitability of saltbush is usually low — about $5-6 per hectare but there are low maintenance costs after establishment and they can persist indefinitely."

New plant species hold promise

As well as investigating the potential of established varieties, researchers are looking at developing new plants to bolster salinity management. One promising species is *Melitotus siculis* (See page 10 for more information).

"The profitablity of saltbush-based pastures can be increased by to 10-fold if they are underplanted with salt- and waterlogging-tolerant legumes," Dr Barrett-Lennard said.

Melilotus siculis is easily the most salt- and waterlogging-tolerant annual legume we have, and our research team is currently investigating more than 80 rhizobial accessions to ensure this plant can persist during the years after initial establishment."

The future

At the end of the day Dr Barrett-Lennard and other researchers are focused on finding ways farmers can manage salinity and still make a profit.

"Farmers will adopt new technologies that will put money in their pockets," Dr Barrett-Lennard said.

"And with the tools available now this is quite possible."

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Innovative saltbush research spreads far and wide

By Jill Griffiths
Kondinin Group

Research into the productive potential and nutritive qualities of many saltbush species is showing the enormous opportunity afforded by these well-adapted local species. FFI CRC sponsored research has involved collaboration among research scientists from a variety of disciplines.

Saltbush grows at the end of spring and through summer and autumn. As such, it has signifcant potential to cover summer and autumn feed gaps and to be a soil and water management tool. In a changing climate, with lower winter rainfall and higher summer rainfall, saltbush could have a vital role to play, as it can use summer rainfall – which winter-active annuals cannot.

FFI CRC Program Leader researcher, Dr Ed Barrett-Lennard (DAFWA), considers the recent saltbush research to be 'rather special'. He said the technological methodology used was innovative and the application of the early results to assess saltbushes from around Australia was a further innovation.

key points

- Collaborative research efforts are investigating saltbush for production, environmental and nutritive values
- Assessments sites have been established in Western Australia, South Australia and New South Wales
- A key focus in current research is to expand the range of commercially available cultivars to support producers across different geographical areas.

Plant assessment sites

Three major plant assessment sites were established (at Tammin, WA, Condobolin, NSW and Monarto, SA) with the FFI CRC linking related studies run by the CSIRO Livestock Industries and NSW Department of Primary Industries (see boxed story next page).

Seed for the trial was collected from 600 saltbush plants across Australia – called the 'mother' plants. Plants grown from seed from each of these 'mothers' is referred to as a 'family'. All three assessment sites have 30 plants from each of the 600 families. This has enabled researchers to assess the families in terms of biomass, nutritive quality and sheep preferences. It also allows prediction of heritability of these traits.

All three sites were grazed by sheep during autumn 2008. After grazing, plants were scored on a scale of one to five; with one being not grazed and five being completely grazed. Researchers found clear differences in preference, which were consistent across sites. About 80 per cent of plants were only nibbled but 5-10% were completely grazed.

Above: Researchers, such as Dr Hayley Norman (CSIRO, left) are assessing plants from 600 saltbush families in terms of biomass, nutritive quality and sheep grazing preferences so producers such as Tony York (right) have greater options for the future. (Photo: FFI CRC)

RIGHT: Assessment sites across three states provide opportunities for collaborative research outcomes. (Photo: C Fancote)

Preferential grazing

SARDI researcher Dr Alan Humphries said there was a belief that site factors, such as climate, soil and salinity were responsible for differences in palatability, but the research has been proving otherwise.

"We showed there was good agreeance as to which families sheep grazed and didn't graze across the sites," Dr Humphries said.

The saltbush research shows that grazing preference of sheep is determined by cultivar rather than site specific factors.

During the trial, sheep grazed grass simultaneously with saltbush, and the grass was not eaten out, which is an important factor in maintaining groundcover during summer and autumn.

From a natural resource management perspective, it is important sheep eat saltbush before they eat out all the surrounding grasses and groundcover.

Future research will select saltbush that is palatable and nutritious.

"There is enormous potential to improve the profitability of saltbush by small increases in palatability or nutrient value," Dr Humphries said.

Starved for choice

Currently, Australian farmers have a limited choice of commercially-developed cultivars. The task for researchers now is to increase the number of saltbush cultivars available and to ensure they are palatable and profitable through a process of selection.

Dr Barrett-Lennard said the next step is to select those cultivars that are showing the greatest potential, clone them, test the clones and then develop a commercialisation plan so they can reach their maximum potential in the marketplace.

"Within saltbush is the subspecies *nummularia*, also known as old man salthbush, which is a there are truly exceptional plant," Dr Barrett-Lennard said.

"There are millions of hectares that need to be rehabilitated and the potential market for saltbush is substantial."

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Argentina submits to the saltbush spell

Interest in Australia's iconic shrub, old man saltbush, has spread to the deserts of Argentina.

ABOVE: Atriplex nummularia planted December, 2007 with frost damage INTA Exp Station Chamical 21 October, 2008. (Photo: J Emms)

During a recent visit to share research on the value of forage herbs and shrubs in agriculture at an international conference, (31st Argentine Animal Production Congress), SARDI pasture researcher Dr Jason Emms viewed extensive testing of the shrubs in the Monte Desert region.

Dr Emms said the Argentine Institute of Agricultural Technology had been testing the shrub and comparing its forage value against the natural vegetation in the dry and arid area of the Monte Desert region as forage for goats.

"Argentinians face similar issues to Australian graziers — a shortage of feed quality and quantity at the end of the dry season — and old man saltbush is a means to fill that gap," he said.

Dr Emms said the Argentineans used the saltbush as a 'cut and carry' fodder, mostly in small subsistence-type farms. He saw some saltbush that had been browsed by goats, but the plants had been stripped.

"Goats could graze old man saltbush, but might need some work as far as management goes," Dr Emms said.

In the region Dr Emms visited, the annual rainfall is 250-400 mm, most of which falls in the summer when evaporation is high. The winters are dry and can have severe frosts. This could make saltbush advantageous as can survive frosts, although frost tolerance varies between species and varieties — a potential avenue for research.

In a similar style to that used by Australian researchers in the *Enrich* project, Argentineans may look to their native plants for future fodder species.

"I saw native saltbush in Argentina which may have potential (for Argentinean systems) in the future," Dr Emms said.

Dr Emms said the Argentineans were also keen to try some legume shrub species being used in Australia.

"The systems I saw completely lacked legumes," Dr Emms said. "It's just grasses and (non-leguminous) shrubs."

Dr Emms said although there were no formal agreements currently in place, the opportunities for collaborative research existed, given the similarities in principles and processes.

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Getting a taste for saltbush

By Jill Griffiths
Kondinin Group

ABOVE: Hayley Norman and host farmer Tony York, inspect the old man saltbush site on his property in Tammin, WA. (Photo: FFI CRC)

Collaborative research into saltbush has seen FFI CRC researcher Dr Hayley Norman (CSIRO Livestock Industries) focus her team's efforts on the nutritional value of saltbush for grazing livestock.

Dr Norman and her CSIRO team looked at organic matter digestibility, crude protein and the mineral profile of a subset of 500 plants representing all of the families from the Monarto site, South Australia (see story on page 4).

The team calibrated Near-Infrared Spectrophotometry (NIR) to laboratory methods, then calibrated the laboratory methods to the *in vivo* (animal) data, using penned sheep fed cut saltbush and other native shrubs.

key points

- Some saltbush families have more value as a source of livestock fodder than others
- Researchers are investigating the possiblity that sheep preferentially graze the more nutritious plants over those with lesser nutritive value
- Additional nutritive qualities of saltbush could lead to healthier grazing livestock and meat with a longer shelf-life.

The results show that some saltbush families contain higher levels of nutrients than others. Preliminary results indicate more than 16 percentage units difference between the most and the least digestible shrubs. At this stage, it is not known whether or not the families with the higher nutrient levels are those that the sheep prefer to graze.

"Other studies have shown that sheep will select a diet high in nutritional value and low in anti-nutritional compounds," Dr Norman said.

Dr Norman said that researchers would analyse the data to determine if there is any correlation between the sheep's relative preference and nutritional quality. Establishing any linkage will be of significant benefit in selecting cultivars for further research and breeding.

"This could be the first time animal preferences have been used this early in the plant-selection process," Dr Norman said.

Based on the preliminary data, the families being tested will be narrowed down with further analyses carried out across all sites.

The CSIRO team is also looking at extra nutritional characteristics of saltbush.

"In order to persist in arid and saline environments, saltbushes accumulate minerals and produce a range of secondary compounds such as vitamin E and betaine." Dr Norman said. "These extra nutritional characteristics could lead to healthier animals and a better quality product." (See PhD student story on the following page).

Vitamin E is an antioxidant, which young sheep are often deficient in during autumn. In extreme cases, this deficiency causes animal deaths; in other cases it produces meat of lower quality that browns quickly after processing. An increase in vitamin E content in the animals initially gives a healthier animal, and ultimately produces meat with a longer shelf-life.

Dr Norman said that by broadening the nutritional availability of pastures, animals are better able to balance their own diets, leading to healthier and more productive livestock.

By looking at the extra nutritional characteristics of saltbush, the project aims to increase the profitability of saltbush pasture systems.

"We are aiming to develop systems that are environmentally positive and profitable. If it is not profitable, it won't happen on a large enough scale to make a difference," Dr Norman said.

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Student passion extends saltbush studies

ABOVE: PhD student, Chelsea Fancote working in a sheep pen. (Photo: CSIRO)

As a salinity-fighting tool and fodder for prime lambs, the future of saltbush in Australian farming systems looks bright. FFI CRC PhD student Chelsea Fancote (UWA) has made it her mission to further explore the potential of the native shrub and is hoping to produce some exciting results, including new information about the plant's benefits for animal health and performance.

By Laureta Wallace
Kondinin Group

A passion for increasing the value of saline land and answering questions others can't has inspired one young Western Australian in her PhD endeavours.

Chelsea Fancote, was born and raised on a wheat and sheep property in Brookton, WA and knows only too well the impact salinity is having on producers' bottom lines.

After completing a UWA Bachelor of Science Honours degree in agriculture Chelsea is relishing the freedom to research a topic she is committed to.

"I am passionate about finding ways for farmers to see saline land as productive and encourage them to revegetate and rehabilitate it to reduce the spread of dryland salinity," Chelsea said.

Chelsea's PhD project is entitled *Investigating production of high quality lamb meat from animals grazing saltbush* and is being carried out with the support from UWA, the FFI CRC and CSIRO's Livestock Industries division.

"My PhD project focuses on examining the prospects for producing high-quality lamb meat from saltbush grazing. I will also consider the effects of some of the compounds found in saltbush on carcass composition, meat quality and animal health and performance," Chelsea said.

Saltbush versus unimproved pasture

Chelsea, together with supervisors, Dr Hayley Norman (CSIRO), Dr Phil Vercoe and Dr Ian Williams (UWA) and Dr Kelly Pearce (Murdoch University), is carrying out an experiment exploring how saltbushes planted on saline land can be used in the production of high-quality prime lambs. The experiment compares the grazing of a saltbush-based pasture to an unimproved pasture with no saltbush. The study looks at the influence each scenario has on various aspects of animal health and performance, as well as carcass composition and meat quality.

"The high salt tolerance of saltbush enables these plants to thrive in areas others cannot, while providing a source of green feed for grazing livestock during summer and autumn that has potential to be used in prime lamb production," Chelsea said.

"Saltbush can survive in salty environments because they absorb the salt and other minerals and store them in their leaves.

"It is these minerals and secondary plant compounds that may hold the key to improvements in animal health, performance and meat quality."

The method

The experiment site is at Yealering, WA. There, Chelsea's lambs either graze saltbush or unimproved pastures for a 'backgrounding' period of eight weeks. Following the backgrounding, lambs will be finished in a commercial feedlot and slaughtered.

"The animals backgrounded on the saltbush diet are expected to perform better in the feedlot than those on the non-saltbush diet because of the saltbush compounds," Chelsea said.

Vitamin E is an essential antioxidant that is found in high amounts in saltbush and is important for animal health and productivity. Similarly, betaine has been associated with improved performance in other animal species and may also help lambs in feedlots to cope with heat stress.

"We also hypothesise the saltbush-grazed carcasses will be lower in fat with a higher proportion of lean meat," Chelsea explained.

If Chelsea's hypothesis proves correct, there is the potential for producers to market their lamb in a whole new light.

"Saltbush-grazed lambs could be marketed as a lean, healthy food option, potentially at a price premium compared with lamb grazed on traditional feed sources," Chelsea added.

Joining the battle against salinity

Making the decision to embark on a PhD project was the result of a Chelsea's farming background and her appetite for learning.

"During my initial studies I realised how much I enjoyed researching and trying to answer questions to which people didn't already know the answers.

"I was based at CSIRO's Perth headquarters during my honours project and found the people I was working with had similar research interest to me which led me to pursue further studies and undertake a PhD."

Despite a mile of work ahead of her and many questions still to be answered, Chelsea already knows where her future research interests lie.

"I would love to be involved in the further development of productive and profitable uses for saline land. Identifying the potential for animal production from different or even new plant species that can live in this environment could be really useful."

More information

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Pasture legumes — a test of tolerance

LEFT: The difference between well nodulated (dark green, background) and poorly nodulated plants (yellow, foreground) is profound. (Photo: A Bonython)

By Catriona Nicholls
Kondinin Group

The search for suitable pasture legumes for Australia's harsh saline environment is always going to prove a challenge, but FFI CRC through the experiences of the South Australian Research and Development Institute (SARDI) pasture legume team has proven that its not only the pastures that need to be highly salt tolerant.

In their quest for a hardy legume species well adapted to Australia's more extreme conditions, researchers have searched far and wide. They have sought out genera with reputed tolerance to salt and waterlogging from around the world and put them to the test. One particular species of *Melilotus* — *Melilotus siculus* — has proven a tempting possibility for widespread adoption.

While farmers view the local species of *Melilotus* as little more than a weed, which can taint milk and meat and contaminate grain, FFI CRC researcher, Andy Craig (SARDI), believes *Melilotus siculus* may overcome these challenges and prove a valuable addition to the pasture legume toolbox.

"To date we have field tested 17 *Melilotus* species and *Melilotus siculus* in particular sparked our interest," Andy said.

"Not only does it tolerate salt and waterlogging but it has low coumarin levels."

Coumarins are the compounds researchers believe are responsible for the tainting qualities of the local *Melilotus* species.

"*Melilotus siculus* is the same genera, but a different species altogether," Andy explained.

"Lab tests revealed this species' levels of coumarins were very low — no higher than many other commercially-acceptable plants and indeed lower than many.

"We also investigated other potential nasty attributes, including the weed risk potential, and with a clean bill of health, it still looked well worth pursuing."

Passing the lab test

With promising field results Andy and his team took a range of legume species into the lab for further analysis.

"We did some lab testing to see how the species fared within the larger salt-plant story," Andy said.

Andy explained the characteristics needed for success in a saline environment include:

- A significant level of salt tolerance as a germinating seedling
- Tolerance to waterlogging
- Ability to tolerant a high level of salt not only as a seedling, but also as a maturing plant.

Melilotus siculus ticked all the boxes.

Murphy's law

Having sailed through initial phases with ease, Murphy's law intervened.

"We established the plant in the field and in the first year all went well, but in the second year something quite odd happened," Andy explained.

"The first-generation plants were setting seed and regenerating, but the second-generation seedlings were small, unthrifty, yellow and generally disappointing."

"Regenerating plants lacked vigour to the point where they were overrun by other species — basically they failed when stressed."

"There was much preliminary head scratching and we shared our experience with colleagues, in particular Dr Phil Nichols (DAFWA) who had shared almost identical experiences in trials in Western Australia."

Both Andy and Phil described similar observations, which validated the SA experience across different geographical areas, with different soil types and conditions — the problem was manifest in two different environments.

BELOW: The answers lay beneath the graveyard plots. (Photo: R Ballard)

key points

- *Melilotus siculus* is set to provide a powerful tool to manage salinity and waterlogging if researchers can just solve the puzzle of rhizobial persistence
- Researchers have a hunch the answer lies in finding a suitable rhizobia to match the plant and the harsh saline environments in which it could be used
- Trials of rhizobial strains have been disappointing to date, but a glimmer of hope has appeared in SRDI 554.

Response of *Melilotus siculus* to rhizobial inocula in regenerating saline pasture field trial

ABOVE: A ray of hope - SRDI 554 (top) may provide the solution. (Photo: N Charman)

Enlisting the experts

Andy had a hunch and enlisted the help of SARDI rhizobia experts, Ross Ballard and Nigel Charman, to carry out some preliminary testing.

Together the team investigated the field trial, which showed inconsistencies within the second-generation seedlings — 95 per cent were visibly unhealthy, but patches totalling about 5% remained healthy.

Rhizobial measurements revealed the healthy patches contained about 500 rhizobia per gram of soil and the poor patches contained an average of six rhizobia per gram of soil.

"This fact put forward a compelling argument that the problem was one of nodulation and an unsuitable rhizobia," Andy said.

There was a glimmer of hope. The initial inoculum used was the commercial medic inoculum (Medicago and *Melilotus* are closely aligned genetically), a logical choice, but perhaps not the best option.

"Interestingly, the trial site is not a particularly hostile environment and sowing had taken place, during late May and early June, after most of the salt had gone," Andy said.

"But during the second year the rhizobia had to survive during summer when soil moisture was low and salt levels were higher."

Additional data supported this argument, so the team searched for strains of rhizobia that were better matched for the plant and the environment.

Change of focus

The current hurdle not only prolonged the search for a suitable pasture legume species, but also took the focus away from the plant and onto the rhizobia.

Seeing merit in the argument, FFI CRC provided funding to further investigate different strains of rhizobia.

"Time was of the essence, so Ross quickly isolated some potentially useful rhizobial strains, 20 in the first cut, to test in the field, in Keith, SA, sown during June 2007," Andy said.

A second more targeted batch of 25 strains of rhizobia were then collected from harsh (saline) environments, applied to seed and sown later (late July, early August 2007).

"Although sown late, our hopes lay in this second, more targeted batch," Andy said.

Disappointing performance

As winter 2008 came and the second-generation seedlings from the early-sown plots were emerging, the results were disappointing.

"We had improvements in a biological sense — there was some statistical improvement in seedling health and performance — but from an agronomic viewpoint, the improvement was not enough to see any commercial viability," Andy explained.

Even worse —the late-sown, targeted batch initially gave exactly the same response as the earlier sown plots.

"Yet we weren't totally despondent — an intriguing phenomenon had captured our interest," Andy said.

"Because we sowed the plots of the second batch late and the season had seen high wind levels during summer (after seed set), sand had blow across the plots creating a mounding effect of sterile sand across the top of the plots — eerily reminiscent of a graveyard.

"This became know as our graveyard trial."

Grave concerns

On first inspection, during August 2008, the trial had been a dismal failure, with no rhizobial strains having any greater effectiveness or persistence than the original commercial strain.

"However after a day of walking, talking and thinking in our graveyard, we noticed a higher percentage of 'happy' plants along the bottom edges of many graves at ground level," Andy said.

"Nigel speculated the 'unhappy' plants on the tops of the mounds were trying to nodulate in a heap of sterile soil, containing no suitable background rhizobia, whereas the 'happy' plants growing at the edges of the plot were nodulating reasonably well."

"Nigel's hypothesis was that the plants at the edges of the graves, which hadn't been covered with sterile soil, were tapping into the original rhizobia."

The team got down and dirty at the end of each grave scraping into the soil in which the initial rhizobia had been sown.

With time running out, they sowed sterile (un-inoculated seed) into the scraped foot of the graves (during late August 2008). If the hypothesis was right, they were sowing seed into soil which contained the original rhizobia and where first year establishment took place, the results would speak for themselves.

Visual assessment of seedlings after 4-6 weeks (happy versus unhappy) suggest the hypothesis seemed well founded.

"Plants in the scraped foot of the graves were generally healthy and nodulated and some strains were outperforming those in the control (nil inoculation) and commercial inoculant treatments," Andy said.

"In particular a rhizobial strain, SRDI 554, showed significant promise — much better than the current best practice rhizobium."

The hypothesis will be further tested during the coming season with 80 new, untested strains of rhizobia being trialled at sites in SA and WA.

"It looks promising, but there is still a lot of work to be done," Andy cautioned.

"Even if this does come through, and we are confident we do have a solution to the rhizobial problem, we still have to go back and refocus on the plant, re-evaluate it and ensure it is ready for commercial production." "To avoid disappointment in the commercial arena, we need to provide a rigorous package that delivers sound practices for establishment, growth and management for production and persistence."

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Laying bare the secrets of better lucerne mixtures

By Catriona Nicholls
Kondinin Group

Lucerne may benefit from isolation in a pasture mix by sowing in alternate rows according to preliminary research carried out by New South Wales Department of Primary Industries (NSW DPI) researcher Dr Suzanne Boschma at Tamworth, NSW.

Lucerne is commonly sown in northern NSW, but pastures typically have low groundcover resulting in run-off and erosion. In addition to this challenge, pure lucerne stands often cause bloat in cattle. Sowing lucerne as part of an overall pasture mixture is one way to solve both these issues.

Understanding the relative competitiveness of lucerne sown in a mixture with other species is the first step to identifying the best species to sow in mixtures with lucerne.

key points

- As a seedling, lucerne is more competitive in a mixture when sown during spring than autumn
- Establishment of lucerne could benefit from sowing in alternate rows within a pasture mix
- Competitiveness of species is affected by factors such as seed size, seedling vigour and plant growth habit
- After a seedling is defoliated regrowth rate and cutting height also affect competitiveness.

Investigations to date have shown that lucerne (*Medicago sativa*) is less or equally competitive as a seedling in a pasture mix with temperate pasture species, but more competitive sown during spring in mixtures with tropical pasture species – especially after harvest (or potentially grazing).

In recent trials, lucerne regrew rapidly after harvest, being more competitive than other species in a mixture, particularly during summer. Lucerne produced similar quantities of biomass whether its plant proportion in the mixture was 25 per cent or 100%. This competitiveness suggests it may benefit from isolation in a mixture by sowing in alternative rows.

Getting the right mix

Researchers carried out two experiments investigating the competitive ability of lucerne in both mixtures with temperates and tropicals.

The two replacement series experiments were carried at Tamworth Agricultural Institute, NSW. The temperate mixture experiment carried out from May to October 2007 consisted of the lucerne cultivar, Genesis, sown in a mixture with Puna chicory (*Cichorium intybus*), Eurrabie oats (*Avena sativa*), Atlas PG phalaris (*Phalaris aquatica*), Clare subterranean clover (*Trifolium subterranean*), Resolute MaxP tall fescue (*Festuca arundinacea*) and Taranna wallaby grass (*Austrodanthonia richardsonii*). A mixture of chicory and subterranean clover was also included.

ABOVE: Recent trials investigated the ability of lucerne to grow in a pasture mix with both temperate and tropical species. (Photo: Suzanne Boschma)

The second experiment containing the tropical mixtures consisted of Genesis lucerne sown with Bambatsi panic (*Panicum coloratum* var. *makarikariense*), Floren bluegrass (*Dicanthium aristatum*), Katambora Rhodes grass (*Chloris gayana*), Premier digit (*Digitaria eriantha* ssp. *eriantha*) and Swann forest bluegrass (*Bothriochloa bladii* ssp. *glabra*) was carried out from November 2007 to January 2008.

BELOW: Dr Boschma's co-worker, Ivan Stace, transplants five-day-old seedlings into polystyrene boxes. The species were evenly distributed within each box according to their ratio and boxes were arranged in an un-balanced row-column design with three replicates. (Photo: S Boschma)

TABLE 1 Relative competition between lucerne and a range of temperate species at two harvests*.

Mixture (species 1-species 2)	Harvest 1	Harvest 2
Lucerne-chicory	Competition (chicory)	Over-yielding (chicory)
Lucerne-oats	Competition (oats)	Competition (oats)
Lucerne-phalaris	Equally competitive	Equally competitive
Lucerne-subterranean clover	Competition (clover)	Competition (lucerne)
Lucerne-tall fescue	Under-yielding (fescue)	Over-yielding (fescue)
Lucerne-wallaby grass	Under-yielding (lucerne)	Competition (lucerne)
Chicory-subterranean clover	Equally competitive	Competition

**The species in brackets were more competitive*

ABOVE: At the second harvest lucerne proved as competitive, if not more so when mixed with numerous temperate and tropical species. (Photo: S Boschma)

In both experiments, five-day-old seedlings were transplanted into polystyrene boxes. Seedlings were sown in ratios (species 1: species 2) of 0:1, 1:3, 1:1, 3:1 and 1:0, arranged in five rows, with each row containing eight plants giving a total of 40 plants/box.

The boxes were placed in the field on wooden pallets, and watered and fertilised regularly. Holes in the bottom of the boxes allowed free drainage.

The trials were harvested twice, when the lucerne started to flower.

Temperate results

Chicory was more aggressive in a mixture than both lucerne and subterranean clover (see Table 1).

"This is possibly due to chicory plants being rosettes with large leaves potentially shading other species in the mixture," Dr Boschma explained.

Subterranean clover was also more competitive than lucerne at the first harvest, but less so after the second harvest.

"Subterranean clover has large seeds and seedlings with a vigorous and spreading habit, potentially shading slower growing plants," Dr Boschma explained.

"But when defoliated to 10mm it was slow to regrow as many of its growing points had been removed."

Tall fescue was more aggressive as a seedling than lucerne, although they initially inhibited by each other resulting in under-yielding at the first harvest, while over-yielding resulted at the second harvest.

Lucerne and phalaris as seedlings in a mixture were equally competitive.

"As a mature plant, lucerne is commonly the more competitive species possibly due to its ability to dry the soil profile below the levels at which phalaris can persist," Dr Boschma said.

In a mixture with wallaby grass, lucerne was consistently the more aggressive species. In other work, wallaby grasses was also found to be less aggressive than subterranean clover, annual ryegrass (*Lolium rigidum*) and white clover (*Trifolium repens*).

Tropical results

Rhodes grass was the only tropical grass more aggressive than lucerne, and only at the first harvest (see Table 2).

"The creeping habit of Rhodes grass enabled it to spread and root throughout the box increasing its total proportion during the experiment," Dr Boschma said. Previous investigations have found Katambora Rhodes grass to be more aggressive in grass mixtures than both Bambatsi panic and Premier digit.

Over-yielding at the second harvest was mainly associated with the total herbage mass of lucerne being similar (grams/box), irrespective of its proportion in the mixture.

At this harvest it was also noted that as the proportion of lucerne in the mixture decreased, the number of stems and their thickness increased.

"This may account for its high herbage mass at low plant proportions," Dr Boschma suggested.

This work is being further investigated in the field.

TABLE 2 Relative competition between lucerne and a range of tropical grasses at two harvests*.

Mixture (species 1-species 2)	Harvest 1	Harvest 2
Lucerne-panic	Equally competitive	Over yielding (lucerne)
Lucerne-bluegrass	Equally competitive	Over yielding (lucerne)
Lucerne-Rhodes grass	Over yielding (Rhodes)	Over yielding (lucerne)
Lucerne-digit	Competition (lucerne)	Over yielding (lucerne)
Lucerne-forest bluegrass	Equally competitive	Over yielding (lucerne)

**The species in brackets were more competitive*

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Anti-feed chemicals may provide new mallee benefits

ABOVE: Concentrations of sideroxylonal are strongly correlated both phenotypically and genetically. (Photo: W Foley)

By Bruce Munday
JVAP

Most of us see the wood and the leaves. But if you were an insect or possum looking at York Gum (*Eucalyptus loxophleba* spp *lissophloia*) leaves you might also detect sideroxylonal, a bioactive leaf compound. And chances are that you won't eat many of those leaves.

Sideroxylonal is a formylated phloroglucinol – is a group of chemicals that deters feeding on eucalypts by mammals and some insects – it promotes nausea in feeding mammals; serving as a highly effective antifeedant.

Aside from their properties as antifeedants, these compounds have many other activities including antibacterial agents, antifouling agents and as inhibitors of enzymes involved in disease. However to date they have been available only in small quantities and so cannot be widely tested for biomedical and industrial uses.

The FFI CRC's *FloraSearch* project recognised the potential economic importance of sideroxylonal as a co-product of the large volume biomass feedstocks from the oil mallee industry.

A neat fit with Eucalyptus oil

Research by Professor Bill Foley at the Australian National University (ANU), has found that York Gum has extraordinarily high concentrations of sideroxylonals, up to 15 per cent of the dry weight of the leaf, making it an ideal target for work to extract large amounts of the compound for testing and market evaluation.

Furthermore, Professor Foley has found that concentrations of sideroxylonal and 1,8 cineole (Eucalyptus oil) are strongly correlated both phenotypically and genetically (see Figure 1). So selection aimed at improving the concentration and yield of cineole in oil mallee plantations, will coincidentally select for greater concentrations of sideroxylonals as well – a classic win-win situation.

"Before sideroxylonal can become a product, we need a cheap and environmentally benign method to extract it," Professor Foley said.

"We need a procedure that can be part of the integrated wood processing system planned for the oil mallee industry in WA.

"Most methods for extracting natural products from plant tissue rely on hazardous and flammable organic solvents, such as methanol, petroleum spirit and acetone. An increasing awareness of the environmental problems associated with organic waste, together with the industrial need for cleaner processes, has highlighted the need for research and development into alternative 'green' processing and synthesis methods.

"In our work, 'green' extraction methods showed considerable promise but overall yields were low.

"A hot water method compatible with the industrial processing currently envisaged in WA also produced large amounts of unwanted material."

The ANU team extracted large quantities of pure (95 per cent) sideroxylonal using organic solvents and work is underway to find a more benign extraction processes.

Another card in the oil mallee hand

The viability of low rainfall forestry hinges on utilising all of the resulting biomass, therefore targeting multiple products from an individual enterprise. The opportunity to exploit non-wood products and specifically the natural plant chemicals is an important part of this strategy.

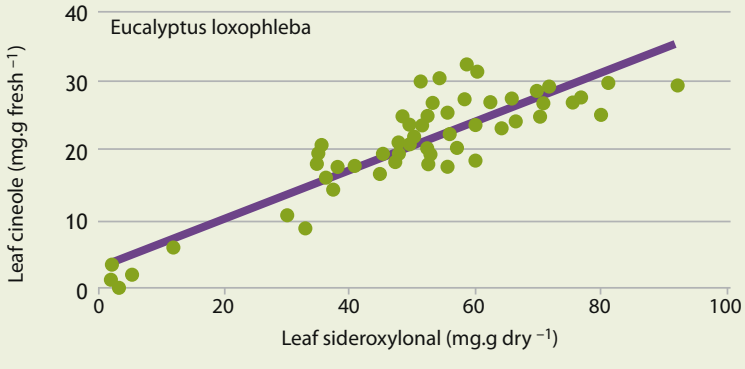
The attributes of York Gum – high yields of sideroxylonal and the close genetic relationship with cineole – have resulted in this species being elevated in ranking as a *FloraSearch* development species.

So far research has not revealed new biological activities for sideroxylon. But the compounds are now available for testing in different scenarios, and given the large biomass of York Gums being planted in WA there is now a prospect that industrial uses will follow.

"Adding value to individual agroforestry enterprises is the best way to encourage their development with the added benefits of salinity control, fixing of CO_2 and possible benefits for biodiversity," Professor Foley said.

Professor Foley's research was funded by the Joint Venture Agroforestry Program (JVAP) which is supported by three R&D Corporations – Rural Industries Research and Development Corporation (RIRDC), Land & Water Australia (LWA), and Forest & Wood Products Australia (FWPA).

FIGURE 1. Relationship between the observed foliar sideroxylonal and predicted values based on 1,8 cineole concentrations.



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LEFT: PhD candidate, Tom Giles puts his media training to the test in a mock interview with journalist, Julia Balderstone (hidden) and cameraman, Simon Hearn. (Photo: Currie Communications)

Lights, camera, action!

The 2009 FFI CRC PhD students left science behind and embraced the world of media during January, 2009.

By Laureta Wallace
KONDININ GROUP

The experience was part of three media training workshops for students from Perth, Melbourne, and Wagga Wagga.

With this year's group of PhD candidates looking at topics such as the animal health benefits of saltbush and the potential for native legumes to rival lucerne, they are sure to attract media attention.

The aim of the workshops was to help the students make the most of their media opportunities. A major part of which was the skill of being able to communicate the often technical subject matter of their projects to a non-science audience.

At the workshop, students were set the task of developing a media release that gave a synopsis of their research, in an easy-to-comprehend manner. Each participant also compiled a mock radio and television interview.

Locally-based journalists were enlisted to carry out the interviews to provide an authentic feeling of what liaising with the media entails. A combination of radio, print and television reporters took part.

Students were encouraged to think about what aspects of their project would be of interest to the mainstream media, a part of which involved asking the question "how will my research impact the lives of others?"

The candidates, who varied in age and interests, all had differing amounts of experience with the media, most were new to the experience of talking to the media.

Part of the workshop was a sundowner get-together with local media. The informal social occasion was a chance for students to talk one-on-one with a variety of media representatives within their city.

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New position will increase FFI CRC presence

Scott Glyde (right) was recently appointed as the FFI CRC Agribusiness Director, a new executive position that will oversee the Centre's national adoption, education and training activities.

With more than 18 years experience involved in research and technology transfer in agriculture, Scott will embark upon his new role within the CRC from his current base at Charles Sturt University, Wagga Wagga, NSW.

Scott's links within research, extension, agribusiness and academia, which cross both the public and private sector, will strengthen the path to adoption approach of the CRC.

"I'm really looking forward to the year, ahead and while I am still getting my head around the enormous scope within my new role, I am particularly excited about the ways FFI CRC can continue to strengthen its links with the agricultural and NRM sector, including at community and farming group levels," Scott said.

"We're very much aware that local networks are powerful agents for exchanging information and encouraging adoption, and supported by training, increasing the adaptability of our farming systems. So building on what's already out there and fostering new communication links will be a really crucial part of our work in the near future."

Scott's appointment highlights the importance the FFI CRC places on adoption and training in achieving effective research uptake. And being located at Wagga Wagga is a strategic decision toward creating a stronger FFI CRC presence in the eastern states.

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About Focus on Perennials

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Focus on Perennials draws on the work of both CRCs, to describe the potential application of Profitable Perennials™ to innovative farming systems and new regional industries better adapted to southern Australian dryland-farming conditions.

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