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FRONT COVER

CHANGING GRAIN EXPORTS

With the increasing domestic grain demand for both livestock and human consumption, Australian exports of cereals, pulses and oilseeds come under extreme pressure, particularly in drought years (see articles pages 25 & 26). Pictured is hand-feeding of sheep at Connemara Station, NSW.

(PHOTO: Carl Davies, CSIRO)

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Sakura® Flow is a convenient 480 SC liquid formulation that offers the same in-field performance as Sakura 850 WG, providing pre-emergent control of annual ryegrass and other key weeds in wheat (not durum wheat), triticale, chickpeas, field peas, lentils and lupins.

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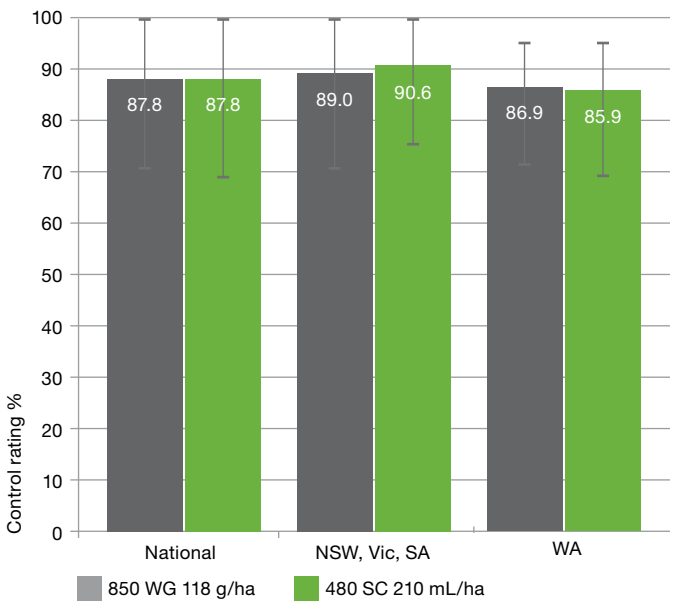
Pre-emergent control of annual ryegrass when applied IBS in wheat*.



*32 trials. 14NW17, 14SA10, 14VB08, 15NW07, 15NW08, 15VA24, 15VB04, 15VC06, 16NA11, 16SB05, 16SB07, 16VD12, 16VD13, 14WA09, 14WA14, 15WA07, 15WA25, 15WA26, 15WC01, 15WC01, 15WC02, 15WC02, 15WE04, 15WE04, 16WA21, 16WA38, 16WA39, 16WA40, 16WE05, 16WE05, 16WE06, 16WE07.
ARG densities between 9 to 1134 plants/m^2

AT A GLANCE

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Herbicide MOA group	K

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Suppression of:	Great brome (*Bromus diandrus*) Wild oats (*Avena fatua*)

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Editorial... Lloyd O'Connell

THE relentless eastern Australian drought has had severe and obvious impacts at the farmgate level on finances and the general well-being of farming families. A less headline grabbing consequence of drought-reduced production is the increased pressure placed on our commodity exports. In particular, we are battling to hang onto hard-won wheat, barley and sorghum customers when there are plenty of international competitors out there happy to fill the export orders we can't.

It's not just the drought putting pressure on the nation's grain balance sheet. For many years leading up to the 2000s, Australia regularly exported about 65 to 70 per cent of the wheat and barley we produced in a 'normal' season. The balance – roughly 5 million tonnes (mt) of wheat and around 2.5 mt of barley – was used domestically each year for both human and livestock consumption. But as Australia's population grows, and a more affluent Asian consumer demands more protein from meat sources, these domestic grain consumption numbers are changing.

Twenty years ago the Australian population was just under 19 million people. Today it's almost 26 million – that's an extra 7 million mouths to feed within Australia. In other words, the domestic demand for our staple foodstuffs such as bread, chicken, pork and grain-fed beef, has increased at least 30 per cent. And all of these foods have a grain, oilseed or pulse ingredient. In illustration, Australia now consumes about 7 mt of wheat each year for domestic purposes. A drought pushes this number even higher as more grain is fed to livestock.

A changing diet, particularly in Asia, is seeing more Australian grain being diverted to the domestic intensive livestock industries to meet growing international demand for meat-based protein. The enormous impact African Swine Fever is currently having on pig herds throughout the world, and particularly in Asia, is only strengthening this demand as pork importers look to ASF-free suppliers or other meat protein options.

The bottom line is that the grain balance sheet for Australia has undergone significant change this century and is predicted to become even more 'squeezed' in the next decade. Some forecasters are suggesting that by 2030, only about one half of our annual grain production will be exported (see article page 26). Under that domestic consumption scenario, keeping our valuable grain export markets supplied with a product of consistent quantity and quality, is made even harder.

From all at *Australian Grain*, we hope that Christmas is a happy, healthy and safe one for you and your family and that the New Year heralds a much wetter and more prosperous 2020.

AUSTRALIAN GRAIN

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In this issue...

Scientists challenge legume N perceptions

Scientists are `mythbusting' a commonly held belief that grain legume crops bolster soil fertility and reduce the need for costly nitrogen inputs.

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The greatest

One of the dubious benefits of being a tractor historian is that fellow tractor enthusiasts tend to challenge me with complex enigmatical questions. I was challenged with "Out of all the great pioneer tractor designers, which one contributed the most to the development of the modern tractor?"

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'Ripping' results from sandy soil trials

Sub-optimal productivity is commonly reported for the deep sands that make up 20–30 per cent of the cropping soils in the low rainfall Victorian Mallee region.

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Livestock feed demand puts squeeze on grain

Australia's grain 'balance sheet' is set to materially tighten over the next decade, with increasing demand for grain to feed livestock..

See article . . . . . Page 26

Maximising the potential of retained seed for next season

Dry and hot seasonal conditions – an all too common situation for grain growers across the country this year – have resulted in small and shrivelled grain from crops making it through to harvest. Growers are reminded of some rules of thumb to adhere to when retaining seed following a tough year.

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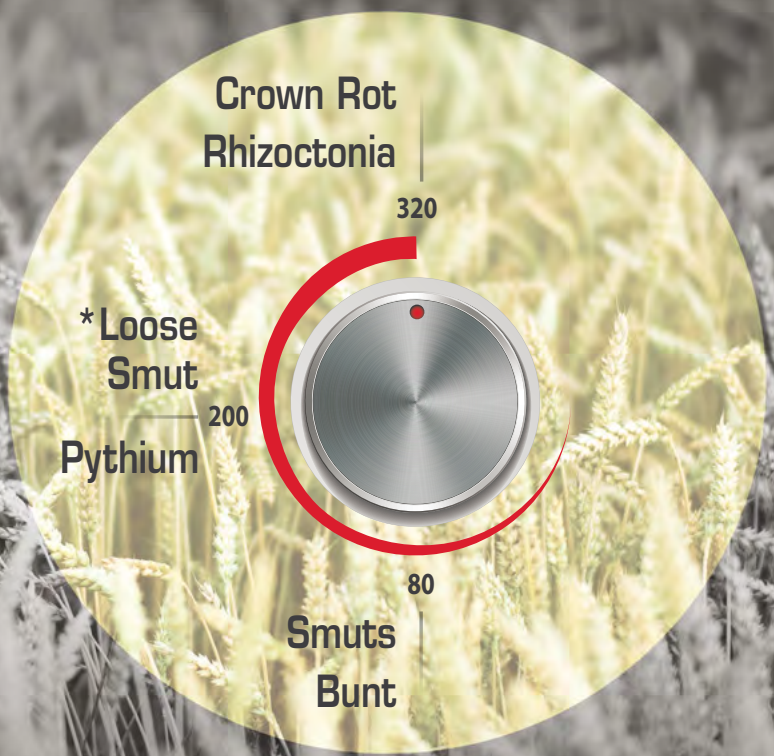

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*Loose smut in Barley rate range is 80-200 mL/100 kg seed, higher rate is recommended for susceptible varieties.

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Cereal killer's deadly touch could lead to new wheat threat

By CSIRO

SCIENTISTS have uncovered the origins of the world's deadliest strain of cereal rust disease which threatens global food security. CSIRO researchers – together with partners in the US and South Africa – have solved a 20-year-old mystery with findings published recently in *Nature Communications*.

Their works shows that the devastating Ug99 strain of the wheat stem rust fungus (named for its discovery and naming in Uganda in 1999) was created when different rust strains simply fused to create a new hybrid strain.

This process is called somatic hybridisation and enables the fungi to merge their cells together and exchange genetic material without going through the complex sexual reproduction cycle.

The study found half of Ug99's genetic material came from a strain that has been in southern Africa for more than 100 years and also occurs in Australia.

Wheat stem rust. (PHOTO: Dr Zacharias)

Drs Narayana Upadhyaya, Rohit Mago, Peter Dodds, and Melania Figueroa. (PHOTO: CSIRO)

The discovery shows that other crop-destroying rust strains could hybridise in other parts of the world, and scientists found evidence of this in their study.

It also means Ug99 could once again exchange genetic material with different pathogen strains to create a whole new enemy. While it was proposed that rust strains could hybridise based on laboratory studies in the 1960s, this new research provides the first clear molecular evidence that this process generates new strains in nature.

Rusts are a common fungal disease of plants. Globally they destroy over $1 billion worth of crops each year. Australian crops have largely been protected for the past 60 years by the breeding of rust-resistant crop varieties.

Group Leader at CSIRO, Dr Melania Figueroa, said Ug99 is considered one of the most threatening of all rusts as it has managed to overcome many of the stem rust resistance genes used in wheat varieties and has evolved many variants.

"While outbreaks of Ug99 have so far been restricted to Africa and the Middle East, it has been estimated that a nationwide outbreak here could cost Australia up to $500 million in lost production and fungicide use in the first year," Melania said.

"But here is some good news, as the more you know your enemy, the more equipped you are to fight against it.

"Knowing how these pathogens come about means we can better predict how they are likely to change in the future and better determine which resistance genes can be bred into wheat varieties to give long-lasting protection."

Stacking resistance genes

Earlier this year, CSIRO worked with the University of Minnesota and the 2Blades Foundation to achieve good results in wheat resistance by stacking five resistance genes into the one wheat plant to combat wheat stem rust.

This latest research is the result of a collaboration between scientists from CSIRO, the University of Minnesota, University of the Free State, and Australian National University.

The breakthrough came as Melania's group was sequencing Ug99 (then at the University of Minnesota) and at the same time a CSIRO team led by Dr Peter Dodds was sequencing Pgt21 in Australia.

Pgt21 is a rust strain that was first seen in South Africa in the 1920s and believed to have been carried to Australia in the 1950s by wind currents. When the two groups compared results, they found the two pathogens share an almost identical nucleus and therefore half of their DNA.

"This discovery will make it possible to develop better methods to screen for varieties with strong resistance to disease," Melania said.

"There was an element of serendipity at play in this work. We never expected that Ug99 and an Australian isolate might be related but only through a multi-continental collaboration was it possible to make the connections needed to achieve this discovery." ■

Scientists challenge legume N perceptions

SCIENTISTS are `mythbusting' a commonly held belief that grain legume crops bolster soil fertility and reduce the need for costly nitrogen (N) inputs.

Recent research comparing the nutrient inputs of different farming systems and long-term impacts on soil nutrient status and cycling has found that most farming systems involving a range of crop species extract more nutrients than are supplied by common fertilisation strategies.

The five-year project is a flagship northern research investment for the Grains Research and Development Corporation (GRDC) and has been undertaken in collaboration with the Department of Agriculture and Fisheries (DAF), CSIRO and the NSW Department of Primary Industries (NSW DPI).

DAF principal development extension officer Jayne Gentry has been involved in comparing the nutrient inputs of different farming systems and long-term impacts on soil nutrient status and cycling as part of a five-year northern farming systems project. (PHOTO: GRDC)

It centres on comparing a baseline farming system (common management in a region) against a number of system modifications including increasing the frequency of legumes in the rotation and increasing nutrient inputs via N and phosphorus (P) fertiliser.

After four years of research, insights have been drawn across the six regional sites stretching from central Queensland to central west NSW and the larger site at Pampas on the eastern Darling Downs of Queensland.

NSW DPI researcher Jon Baird said the higher legume frequency farming systems were generally found to utilise soil mineral N to the same extent as cereal crops and have higher N export which offset potential N fixation inputs.

Consistent results challenge assumptions

"Importantly, these results were consistent across the full range of starting soil N conditions, from locations with very high starting mineral N status to locations with low mineral N status where legumes would be required to fix N to meet their needs," Jon said.

"These results challenge the commonly held assumption that grain legumes will have benefits for reducing N fertiliser needs in the crop sequence.

"As our capacity to grow high yielding grain legumes has increased so too has our harvest index and hence the ratio of N removed in grain to that left in biomass, thereby diminishing the contributions of residual N after the crop."

The research has also provided important data quantifying the impact that the inclusion of more legumes in the rotation has on increasing potassium (K) removal from the soil reserves.

With legumes containing up to three times the concentration of some nutrients compared to cereals, nutrient export tends to be high in spite of comparatively lower yields.

Trial results have demonstrated that K export is proportional to legume frequency within individual farming systems.

The results have implications for modern farming systems which have fostered a substantial increase in the area sown to legumes and the amount of grain being produced.

DAF principal development extension officer Jayne Gentry said the challenge facing industry was how and when to replace this K in the farming system.

"With soil fertility generally on the decline across the regions, there's heightened interest among growers in strategies to halt or reverse this trend," she said.

"Past research suggests that this can be achieved through maximising biomass production, thereby increasing soil organic matter levels and building the natural supply of nutrients such as N and P."

But maximising biomass production relies on an adequate supply of crop nutrition as well as the provision of nutrients to promote soil microbial processes.

The current research targeted strategies to increase crop biomass and yield potential through applying enough N and P to soil for crops to reach 90 per cent of water limited yield potential given starting soil moisture and sowing date. In baseline systems,

fertiliser amounts were formulated for crops to achieve average yield or 50 per cent of the water limited yield potential.

"On average across all sites an extra 83 kg N per hectare was applied between 2015 and 2018 relative to the baseline system. The additional N increased grain N export at seven of the eleven sites," Jayne said.

"The results indicated that applying N fertiliser to aim for a 90th percentile yield potential can reduce the mining of mineral soil N. This was evident in soils with high fertility as significant amounts of applied N fertiliser remained in the mineral N pool available for the use by subsequent crops.

"But it is important to recognise that many of the trial sites were water limited in some years and could not maximise yield potential.

"Before we can draw any definitive conclusions, we'll need to assess longer term trends of underlying soil fertility such as organic carbon or total N pools."

Are some legumes more efficient than others?

The research also challenged another commonly held assumption – that some grain legumes are more efficient than others at increasing N mineralisation during the subsequent fallow period prior to the next crop. There was little difference in soil N extraction or subsequent mineralisation between various grain legumes, challenging assumptions that faba bean or field pea provide greater N benefits to the farming system.

Initial results from across the sites suggest that N benefit for subsequent crops following grain legumes was not as good as expected due to mineral N status being affected by mineralisation rates, denitrification, and microbial tie-up, but Jayne said more sites and seasons are needed to fully understand these interactions.

Grain legumes may not reduce the need for N fertiliser in the cropping sequence.

For more information on the research findings, download a copy of the GRDC Update paper The impact different farming systems have on soil nitrogen, phosphorus and potassium from the resources and publications section of the GRDC website *www.grdc.com.au or click here (https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2019/03/the-impact-different-farming-systems-have-on-soil-nitrogen,-phosphorus-and-potassium)*

Understanding the cause and effect of herbicide carryover on pulses

IT is not uncommon for grain growers to experience negative effects in their pulse crops resulting from carryover of clopyralid or picloram-based herbicides that were applied in previous seasons.

Mark Congreve, senior consultant with Independent Consultants Australia Network (ICAN) says damage to subsequent pulse crops can result from three particular situations.

"Firstly, herbicide close to the soil surface may not have fully degraded before planting of the pulse crop the following winter," Mark says.

"These herbicides are broken down in the soil by soil microbes. Soil microbes benefit from warm and moist soil conditions to build their population. Little degradation occurs during winter as it is often too cold for microbial activity.

"When the following spring/summer is dry, there may be insufficient microbial degradation occurring before planting the following season. In this case, herbicide residues may persist at levels sufficient to cause crop damage at establishment, or growth of the following pulse crop may be compromised."

Secondly, Mark says these herbicides are also relatively mobile in the soil, so some of the applied herbicide may also move deeper in the profile following rainfall after application.

"The amount moving deeper in the profile will depend on soil type and rainfall," he says. "Microbial activity deeper in the profile is significantly less than near the soil surface, so herbicide moving deeper in the profile will take longer to break down.

"Where there are subsoil constraints, such as hard pans or significant change in soil texture/structure, herbicide may concentrate at or above these barriers and be particularly problematic. In this situation, the pulse crop may establish, provided the residues at the surface have degraded, but symptoms may not be seen until later in the crop when roots reach this herbicide at depth."

Typical symptoms of damage in a pulse crop from carryover of clopyralid or picloram-based herbicides.
(PHOTO: Mark Congreve, ICAN)

Mark says the third situation in which damage of subsequent pulse crops may also arise is when herbicide applied post-emergent to a preceding cereal crop, has not been fully metabolised by the cereal crop before harvest.

"In this case, there can be herbicide remaining in the dead cereal stubble following harvest.

"Herbicide trapped in crop stubble is then 'released' back into the soil as the cereal stubble is placed into contact with the soil and starts to decompose.

"The concentration of herbicide in the stubble depends on the application rate and, importantly, when it was applied to the cereal crop.

"Typically, applications made later in the season are more likely to result in higher levels of herbicide in the cereal stubble than applications made earlier in the year.

"Early season applications will have less interception by the crop, more direct application to the soil, and longer for degradation to occur before the crop matures. Availability of herbicide from the crop stubble, and therefore when symptoms appear, depends on when the stubble decomposes."

Residues in harvest stubble

Mark suggested harvest is particularly timely for considering the possibility of herbicide residues in stubble.

"Many clopyralid herbicide labels recommend burning or mechanically incorporating cereal stubble from sprayed crops immediately after harvest. This is to put stubble into contact with the soil and allow time for the stubble to decompose, but this is rarely done in no-till farming systems."

Particular care needs to be taken where harvest weed seed control (HWSC) techniques that concentrate the stubble or chaff are employed, according to Mark.

"This past winter we saw a few examples of herbicide damage in pulses that was only present in old chaff lines, resulting from cereal crops that were treated with clopyralid, in some cases from over two years earlier.

"Where there is concern that residues of these herbicides may be still present in the soil or stubble, the best solution is to plant a cereal crop or canola, until growers are confident that any herbicide residues have dissipated.

"Always read and follow directions of the registered label of the product you have used. Product labels are a good source of information, as are manufacturer representatives."

To help growers better understand the issues involved, the GRDC has produced a fact sheet 'Rotational constraints for pulse crops following the use of aminopyralid, clopyralid and picloram herbicides'. The fact sheet can be downloaded from the GRDC website at *https://grdc.com.au/rotational-constraints-for-pulse-crops.*

Mark Congreve, the fact sheet author, says it is also a useful reference to further understand herbicide carryover constraints for many herbicides.

More information on herbicide behaviour is available at the GRDC webpage, *http://bit.ly/2peRWCp* ■

Microwaves: More bing for your weed control buck?

AN Australian AgTech startup has secured a significant seed investment to commercialise technology that could revolutionise the agriculture industry and wipe out the need to use chemicals to control weeds.

The Growave technology invented by researchers at the University of Melbourne, harnesses the power of microwaves to kill weeds from the inside and rids soil of emergent weeds, dormant seeds as well as reduces pathogens and their impact.

"With the economics of the solution so compelling, the technology has the potential to have an impact on a broad range of agricultural markets," said Paul Barrett, Growave Director and head of physical sciences at IP Group.

The seed investment came from IP Group, Grain Innovate and Artesian and will be used to take the novel, chemical-free weed treatment to a global market.

"This represents the fifth investment by IP Group in Australia and New Zealand with its partnership agreement with the Group of Eight and University of Auckland," said Paul.

Field trials

"While there is strong international interest in the technology, Growave will firstly focus on domestic markets with new trials commencing on farmland at Dookie in Victoria and in southern Queensland in the Lockyer Valley on an organic vegetable farm.

"It is anticipated in 18 months the Growave technology will be

University of Melbourne researcher and co-inventor of the Growave technology, Dr Graham Brodie, anticipates commercial deployment of the modular units is around 18 months away.

ready for commercial deployment," says Paul.

"Herbicide resistance is a growing problem worldwide so people are looking for alternative ways to manage weeds."

The modular design of the technology means Growave can be integrated into existing farming operations.

"This not only means reducing or eliminating the need for herbicides, but also saving labour associated with weed management," said Dr Graham Brodie from the University of Melbourne.

"It can be mounted onto a tractor or trailer, and used in wet or windy weather, unlike herbicides and soil fumigation.

"As no chemicals are used, treated crops and fields do not require isolation. It is environmentally friendly and less expensive per hectare than most alternatives," said Graham.

IP Group is a leading intellectual property commercialisation company focused on evolving great ideas from its partner universities into world-changing businesses. In Australia and New Zealand, IP Group works in close partnership with the Go8 Universities and the University of Auckland to identify ground breaking technologies, rooted in hard science, which have the most promising commercial potential.

Artesian is a leading global alternative investment management company with offices in Sydney, Melbourne, Singapore, Shanghai, New York and London.

GrainInnovate was established by the Grains Research & Development Corporation (GRDC) and Artesian to deliver innovation for the Australian grains Industry. ■

SOME BACKGROUND TO MICROWAVES AND WEEDS

Weed seeds

- As early as the 1970s researchers have been studying the lethal effect of microwave heating on seeds, including weed seeds.
- This early research showed that weed seed damage was mostly influenced by a combination of seed moisture content and the energy absorbed per seed. In addition, both the specific mass and specific volume of the microwaved seeds were strongly related to seed mortality.
- Larger and more rounded seeds focus more energy into their core, which results in higher temperatures at the centre of the seed leading to higher mortality rates.
- Subsequent research on wild oats has demonstrated that the weed seed's susceptibility to microwave treatment is entirely dependent on the surrounding soil temperature.
- In the case of wild oats, when the soil temperature rose to 75°C due to microwave treatment, there was a sharp decline in both oat seed and naturalised weed seed germination.
- When the soil temperature rose above 80°C, seed germination in all weed species was totally inhibited.

Already emerged weeds

- Back in the 1970s, researchers also considered the effect of microwave energy on growing weed plants – bean (*Phaseolus vulgaris*) and Honey Mesquite (*Prosopis glandulosa*) seedlings.
- It was discovered that plant aging had little effect on the susceptibility of bean plants to microwave damage, but honey mesquite's resistance to microwave damage increased with aging.
- They also discovered that bean plants were more susceptible to microwave treatment than honey mesquite plants.
- In the mid 2000s, the effect of microwave treatment on marshmallow (*Malva parviflora*) seedlings was tested, using a prototype microwave system based on a modified microwave oven.
- Based on energy calculations for plants and seeds on the surface of sandy soil, the energy needed to kill dry seeds is an order of magnitude higher than the energy needed to kill already emerged plants.

Costs and benefits?

- In a 2016 field experiment at the University of Melbourne Dookie campus (Victoria), researchers looked at the economic impacts of microwave soil irradiation on farm profitability.
- The researchers estimated that the direct and indirect (ie loss of crop yield) costs of chemical weed management is around $150 to $200 per hectare averaged across Australia's cropping regions.
- In their Dookie field experiment, the researchers estimated that pre-sowing soil irradiation using microwave to kill dry weed seeds had a direct per hectare cost of $400 to $500. But there was a wheat yield increase of almost 40 per cent compared to the 'control' (ie non-microwaved plots). This gave a profit of around $450 per hectare on the pre-sowing microwaved area.
- There were also additional benefits of the microwave treatment in terms of better soil nutrient availability and its long-lasting effect (up to three cropping seasons).
- The researchers concluded that, in general, Australian dryland wheat farmers could potentially realize an additional $370 per hectare using microwave treatment for weed management.

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ASK AN EXPERT –

WHAT'S THE BEST WAY TO OUT-COMPETE RESISTANT ANNUAL RYEGRASS IN CEREALS?

■ With Chris Davey, Agriservices Agronomist, YP AG

OFTEN regarded as the 'poor cousin' to herbicides, crop competition is making a come-back as a simple way for growers to increase crop yield and reduce weed seed set, without breaking the bank.

Chris Davey, partner and director of YP AG at Kadina has worked with growers on the Yorke Peninsula of SA for over 20 years in an on-going battle with weeds such as annual ryegrass, brome grass and bifora, and mounting resistance to herbicide.

"Working with our grower group we have demonstrated that stacking crop competition tactics at sowing really does make a difference," he says. "When you add an effective pre-emergent herbicide to the top of the stack to provide early weed suppression, the resulting increase in yield and reduction in weed pressure definitely puts money in the bank."

In the 2018 trial, two cultivars of wheat (Scepter and Emu Rock) and barley (Compass and Spartacus) were sown into lentil stubble. The trial compared the performance of these four cultivars when sown east-west v north-south, and with a range of pre-emergent herbicide packages.

"The result was clear – when you plant a competitive crop like barley in fertile soil – such as following lentils, row orientation doesn't make much difference, but if you plant a poorly-

YP AG agriservices agronomist Chris Davey says several Yorke Peninsula growers have adopted east-west sowing after seeing the benefits of competitive crops combined with pre-emergent mixes in a recent trial.

In the trial, the package of competitive crops and cultivars plus east-west sowing plus a premium pre-emergent herbicides mix combined to make an impressive difference in annual ryegrass numbers while also producing more grain.

competitive crop like wheat, it really pays to stack as many things in its favour, including east-west sowing and an effective pre-emergent herbicide," says Chris.

"In wheat we measured a consistent 0.5 tonnes per hectare yield gain through east-west sowing across the two cultivars and pre-emergent herbicide packages. In barley, stacking a premium pre-emergent herbicide mix onto an already-competitive crop boosted yield by 1.1 tonnes per hectare and reduced ryegrass plant numbers ahead of the following seeding by over 80 per cent, compared to the least competitive, nil pre-emergent barley treatment."

With harvest weed seed control already adopted by many growers on the Yorke Peninsula, the results of Chris' trial has prompted the adoption of even more WeedSmart Big 6 tactics to tackle herbicide resistance head-on.

What is the effect of crop competition on weed seed production?

Short answer: Crop competition makes a massive difference to weed seed production in-crop.

Longer answer: Ahead of this trial in 2018 the weed seed potential of the site was calculated as 87,000 annual ryegrass seeds per m^2. The annual ryegrass population was known to be 100 per cent resistant to trifluralin (eg. Treflan), 50 per cent resistant to triallate (eg. Avadex) and 30 per cent resistant to prosulfocarb + s-metolachlor (Boxer Gold).

Applying crop competition plus pre-emergent herbicide drove this number down to around 4000 seeds per m^2 leading into the 2019 cropping season. The owner of the trial site chose to cut the surrounding crop for hay to prevent further blow-out of the annual ryegrass population. Although the crop competition plus pre-emergent herbicide package made a vast difference to weed seed production, it is not a one-year fix for a ryegrass blow-out. It is important to keep the pressure on.

After seeing the results of the trial, several members of Chris' grower group immediately adopted east-west sowing on paddocks where the change was practical. It is understood that it is often necessary to sow according to land type, such as on dune swale paddocks, or other constraints, such as established CTF systems that run north-south. Where changing row orientation to east-west is not possible there are still many other ways to boost crop competition.

Where did the reduction in weed seed production come from?

Short answer: Stacking competition tactics and pre-emergents in barley reduced ryegrass weed seed set by over 80 per cent.

Longer answer: Changing from a less competitive (Spartacus) to more competitive (Compass) cultivar reduced ryegrass plant numbers at seeding in 2019 by 13 per cent on north-south orientation and 24 per cent on east-west orientation, with no pre-emergent applied. Keeping the cultivar the same and changing row direction reduced weed numbers by 26 per cent in Compass and 16 per cent in Spartacus.

This suggests that changing to east-west sowing will not achieve much in barley unless a more competitive cultivar is chosen.

Changing both the competitiveness of the cultivar and the row orientation achieved a very useful reduction in weed numbers of 34 per cent (without using any pre-emergent). The result may be even greater in a more common rotation where barley is planted after wheat and the initial soil nutrient status is less than after lentils.

When you add a standard pre-emergent mix (trifluralin plus triallate) to the east-west sown Compass, weed numbers are driven down by 50 per cent. Using a premium mix of (Boxer Gold plus triallate) achieved an 82 per cent reduction in annual ryegrass plants going into the 2019 season. This is particularly impressive given the field's known resistance to the applied pre-emergent chemistry and highlights the value of stacking pre-emergents together and growing a competitive crop.

What impact did the treatments have on yield?

Short answer: East-west sowing increased wheat yield in this trial, probably due to extra competition at a very weedy site.

Longer answer: In wheat there was a consistent 0.5 tonnes per hectare yield gain through east-west sowing across the two cultivars and pre-emergent herbicide packages. In barley, stacking a premium pre-emergent herbicide mix onto an already-competitive crop, boosted yield by 1.1 tonnes per hectare compared to the nil pre-emergent, north-south treatment.

Why worry about crop competition if there are new pre-emergent herbicides coming to market?

Short answer: The new herbicides will provide another useful tool for growers but are not the answer on their own.

Longer answer: The choice of pre-emergent herbicide should be the final decision after you have stacked as many crop competition tactics as possible.

Look for the most competitive combination of crop species/cultivar, row spacing, seeding rate, row orientation, sowing time for early vigour and healthy soil, then add a pre-emergent that is known to be effective. If the crop competition is strong then the pre-emergent just needs to provide the early weed suppression that gives the crop a head start.

Strong competition plus a current premium pre-emergent package (Boxer Gold plus triallate) performed as well as the 'experimental' pre-emergent products in this trial. ■

HOW TO ASK A WEEDSMART QUESTION

Ask your questions about crop competition on the WeedSmart Innovations Facebook page WeedSmartAU, Twitter @WeedSmartAU or the WeedSmart website *https://weedsmart.org.au/category/ask-an-expert/*

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The greatest

By Ian M. Johnston

The question

One of the dubious benefits of being a tractor historian is that fellow tractor enthusiasts tend to challenge me with complex enigmatical questions. For example, some months ago I was asked to name the best tractor ever produced. My ambiguous response appeared in a recent article.

Last week I was challenged with "Out of all the great pioneer tractor designers, which one contributed the most to the development of the modern tractor?"

The inquirer, named Billy Duncan, was the highly intelligent teenage son of a grain farmer, whom I would describe as having an uncommonly prodigious knowledge of modern tractor technology – and was therefore entitled to a well considered response.

Accordingly, I informed Billy his question required a degree of contemplation on my behalf and I would convey to him my response in due course. This of course dictated that I had no option but to endeavour to stimulate my inadequate grey cells into some sort of motivation. (Never an easy undertaking!)

I was obliged to dismiss a number of names that initially occurred to me. These included Jerome Increase Case, Heinrich Lanz, Daniel Massey, Cyrus Hall McCormick, James Oliver, John Deere, all of whom were giants during the pioneering days of farm mechanisation. But (and a big 'but') they each had ascended to the big paddock in the sky, long before tractors bearing their names were evolved!

I then directed my focus upon a number of the amazingly talented design engineers, many of whom are relatively unknown or forgotten by today's generations.

The inventors

It probably would be eminently appropriate to refer to these geniuses as inventors, as It should be remembered they had no precedents from which to learn or copy and there certainly were no computers around to assist with their technical experimentations. Even metallurgy, as we know it today, was in its infancy. As a consequence, these gifted engineers commenced their cogitations by sitting down in front of a blank sheet of paper!

Names of considerable significance include the following:

- Herbert Bamber – designer of the first British Marshall range.
- D. M. Hartsough – US creator of the giant four cylinder Big 4 in 1904.
- Alfred Henry McDonald – Australian tractor pioneer.
- Dan Albone – Englishman who produced the world's first lightweight tractor.
- William Guthrie – Scottish designer of the revolutionary three wheeled Glasgow.
- John Froelich – in 1892 designed the world's first tractor.
- International's Bert Benjamin – Farmall initiator.
- Herbert Morrell – Oliver Corporation's design genius.
- H. Leavit – Creator of Waterloo Boy, Deere & Co's first volume selling tractor.
- Dr. Fritz Huber – Designer of the German Lanz Bulldogs.
- Eugene Farkas – Hungarian designer of Henry Ford's Fordson Model F.

There are of course others who would also qualify as being tractor inventors.

But one individual not yet mentioned, who in my mind and in response to Billy's question, would qualify as the greatest contributor to the development of the modern tractor. I refer to no less than the great Harry Ferguson who, not surprisingly, became a legend in his own lifetime!

So why, in my estimation, have I ranked Harry Ferguson as the 'greatest'?

Three point linkage has been a benchmark requirement on practically all tractors for as long as most farmers can remember. Yet the very first production tractor to be so fitted became

A rare 1910 photo of Harry Ferguson (left) beside his monoplane.

Harry Ferguson demonstrating a 1936 Model A, built by David Brown Ltd.

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A Model A showing the linkage.

1939 Ford 9N on display at The Temora Rural Museum.

available in 1936. Named the Ferguson Model A, it was actually manufactured for Harry Ferguson by David Brown Tractors Ltd. of Huddersfield, England, but totally designed and developed personally by Ferguson and his dedicated staff.

It is important I digress here, to alert tractor enthusiasts, that it is totally incorrect to refer to the Ferguson Model A as a Ferguson Brown, despite the lamentable fact that numerous publications refer to the tractor by that erroneous title!

So I reiterate that David Brown tractors Ltd were merely manufacturing contractors to Harry Ferguson Ltd and Harry Ferguson personally took responsibility for the marketing and distribution of his tractor.

The young Ferguson

Ferguson first came to fame when, as a young man, working on the family farm in Ulster, he became fascinated with aviation and the embryo aircraft being conceived in America, France and Britain. His information and knowledge were obtained solely from newspaper articles and the few publications that were available.

In 1909 Ferguson, who had never actually seen an aircraft, amazed his colleagues by designing and building a monoplane in a loft, located above his brother's workshop. He first flew his fragile machine in late December of that year and thus became the first Britisher to build and fly his own aircraft – a seldom recognised important element of early British aviation.

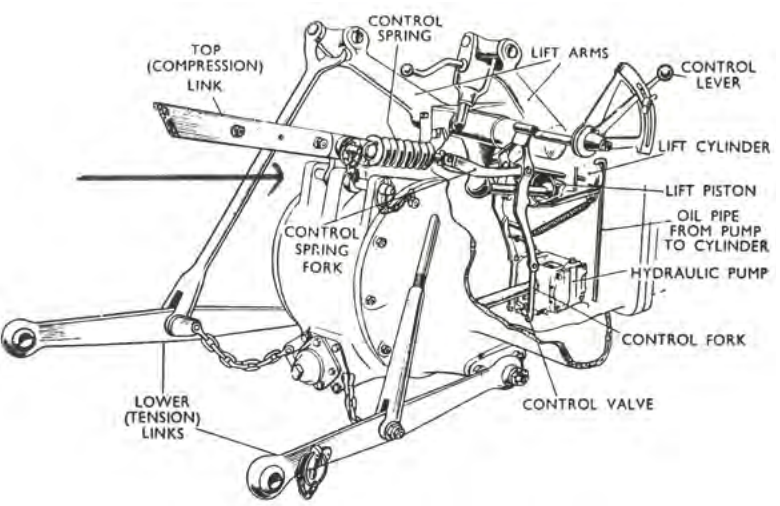
Ferguson also developed an interest in the increasingly popular, but highly dangerous sport of motor cycle and car racing. In the 1920s he became Northern Ireland's most recognised race car driver and is credited as being the main motivator behind the establishment of the famous Ulster Tourist Trophy.

During his dare-devil involvement with aviation and motor racing, Ferguson still found time to take an interest in the family farm. This agricultural interest became an obsession, which developed to the stage where he commenced a business for the purpose of importing and distributing throughout Ireland the American built Waterloo Boy tractors, which he renamed 'Overtime'.

The Overtime tractor was a typical machine of the era. When dragging a plough, its drawbar pull capacity was limited by the horse power of the engine and the tractor's ability to obtain traction over the soil.

Ferguson applied his fertile mind to how greater efficiency could be implemented.

In 1917 he commenced experimenting with (of all things) a Model T Ford, to which he attached, by means of a series of links, struts and cranks, a specially designed plough, which in effect



The Ferguson system.

The familiar Ferguson TEA 20, built by Standard Cars Ltd.

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A rare historic photo of Winston Churchill (seated) with Sir Anthony Eden standing alongside, viewing a Fergy. The man at the rear is a police security officer.

became a mounted component of the tractor, as distinct from a separate trailed implement.

The tractor/plough system, for which he obtained a patent, maintained the plough at a level depth position owing to the innovative hydraulic system employed to raise and lower the plough, whilst transferring considerable weight to the rear wheels of the tractor, thus greatly increasing its traction capabilities. Additionally, the weight transfer enabled a tractor of modest horse power to operate a plough which normally would require a more costly larger and heavier unit.

His patented plough was designated The Belfast Plough. He subsequently adapted it to mount on the Fordson Model F, which at the time was the world's top selling tractor. This was well suited, as the Model F had earned a reputation as being a highly dangerous tractor when dragging a conventional plough. If a stump or other obstruction was encountered, the Fordson had a tendency to wrap itself around the worm drive differential and flip over backwards! The three point linkage method of attachment eradicated this possibility.

In 1933 Ferguson designed a prototype tractor tailored to his Belfast mounted plough. It became known as Ferguson's Black Tractor, on account of its colour which, according to Ferguson, was an indication of its simplicity.

The Ferguson tractor

Following many months of field testing, modifications to the hydraulics, the inclusion of a draught response control, and approaches to several manufacturers, the Ferguson Model A was finally launched in 1936, initially powered by a Coventry Climax engine. The model continued until 1939, and was discontinued largely on account of personal and business disputes between David Brown and Harry Ferguson. Around 1300 examples had been built.

Harry Ferguson transferred his business associations from David Brown to that of the American vehicle magnate Henry Ford. An agreement was entered into, whereby Ferguson's patented three point linkage system would be incorporated in Ford's new 1939 Model 9N. The tractor proved to be a huge marketing success, with a few even finding their way to Australia, until WW2 halted their export. A wartime economy model was released in 1942 know as the Ford 2N.

A legal brawl over patents erupted between the two tycoons, resulting in Ferguson suing Ford for $340,000,000, the largest civil law suite in legal history at that time.

Harry Ferguson then entered into an arrangement with Sir John Black, Chairman of The Standard Motor Company of Great Britain, to manufacture a range of Ferguson tractors, based upon and similar to the Ford 9N, the first of which were released in 1946.

The rest is history. The little grey Fergusons – complete with their Ferguson System three point linkage and hydraulics – became a marketing phenomenon and set the standard for all future tractor designs. Eventually the little lightweights morphed into a range extending to high-powered broadacre tractors.

It is not an exaggeration to say that from 1950 onwards, every make of agricultural tractors manufactured around the world, included in their specification, a version of Ferguson's three point linkage and hydraulics.

Accordingly, in reply to young Billy Duncan's stimulating question, my answer is – Harry Ferguson. ■

IAN'S MYSTERY TRACTOR QUIZ

Question: Can you identify this tractor?

Clue: It was produced by a well known English car manufacturer.

Difficulty: It might be easier to take up chess!

Answer: See page 48.

'Ripping' results from sandy soils trials

By Michael Moodie[1], Lynne Macdonald[2] and Ray Correll[3]
Research team: Mick Brady[1], Todd McDonald[1], Chris Davies[1], Jack Desbiolles[3], Therese McBeath[2] and Chris Saunders[4]

Why do the trial?

Sub-optimal productivity is commonly reported for the deep sands that make up 20–30 per cent of the cropping soils in the low rainfall Victorian Mallee region. Un-used water is evident despite an apparent absence of constraints commonly associated with sandy soils (e.g. non-wetting, acidification). Diagnosis studies of local constraints have pointed to low abiotic and biological fertility in the subsoil layers and the physical restriction of rooting depth as the most likely constraints to production on sands in the Victorian Mallee.

To explore this further, four replicated trials were established across two sites; Ouyen (2017–18) and Carwarp (2018). These trials have investigated the interactions between crop water use, physical disturbance (deep-ripping and/or rotary spading), and the incorporation of organic and in-organic amendments.

The trials are a collaboration between Frontier Farming Systems and Mallee Sustainable Farming, CSIRO and University of South Australia.

Results at a glance…

- Deep ripping resulted in a significant increase in yield at the Ouyen site for a second consecutive season
- At Ouyen, annual ripping treatments resulted in a yield increase of 0.6 tonnes per hectare while treatments which were only ripped in 2017 still yielded 0.4 tonnes per hectare better than the control.
- At Carwarp mechanical disturbance to 30 cm by spading or deep ripping provided a yield boost of 0.5 tonnes per hectare but deeper ripping to 60 cm did not provide any significant yield benefits.
- Second year yield increases following spading of organic amendments in 2017 were evident for chicken litter (+0.5 tonnes per hectare) but not for home grown hay sources (vetch, oaten) and Ouyen (2018).
- Over the two seasons, spaded chicken litter has doubled the yield achieved compared to the non-spaded controls.

How we did it

Two research sites were established in the Victorian Mallee, at Ouyen which commenced in 2017 and at Carwarp which commenced in 2018. The sites have similar soil properties but the Carwarp sand is red while the Ouyen sand is yellow. The annual rainfall at Carwarp is 280 mm per year while the Ouyen district receives on average 25 mm more rainfall per year.

The sands were both wettable and with low fertility. Organic carbon generally ranged from 0.3 per cent in the 0–10 cm layer to 0.1 per cent at 40 cm and deeper.

At each site two separate trials sites were established to investigate both mitigation and amelioration strategies to overcome constraints and improve root growth and water extraction from the sub-surface layers.

Ouyen

Fertiliser placement trial

The trial is comparing surface banding (7-8 cm deep) of nitrogen (N) and other nutrients to deeper nutrient placement using a pre-drilling (20 cm) or deep ripping (30 cm) operation ahead of seeding (Table 1). Nitrogen (N) was applied as urea alone or urea plus a wider nutrient package (P, K, S, Zn, Cu, Mn). Furthermore, nutrients were applied at an annual (30 kg N/ha) or once in three-year (90 kg N/ha) rate. Therefore, annual treatments are applied each season while the 1 in 3 year treatments were applied in 2017 only.

All treatments also received an additional 20 kg N/ha through a combination of starter DAP and top-dressed ammonium sulphate fertiliser.

So each treatment will receive a total of 150 kg N/ha over three seasons.

Table 1: Key factors in the fertiliser placement trial at Ouyen, incorporating physical disturbance with pre-drilling or deep ripping, nitrogen rate, depth of N placement (banding) and the addition of a nutrient package (P, K, S, Zn, Cu, and Mn) applied with N fertiliser

Description	Physical disturbance	[1]Nitrogen rate (kg N/ha)			Fertiliser placement			Nutrient package (P, K, S, Zn, Cu, Mn)
		2017	2018	2019	7.5 cm	20 cm	30 cm	
Control	Nil	30	30	30	✓			+/-
Pre drill control	Pre drill	30	30	30	✓			+/-
Pre drill N (annual)	Pre drill	30	30	30		✓		+/-
Pre drill N (1 in 3)	Pre drill	90	0	0		✓		+/-
Deep rip control	Deep rip	30	30	30	✓			+/-
Deep rip N (annual)	Deep rip	30	30	30			✓	+/-
Deep rip N (1 in 3)	Deep rip	90	0	0			✓	+/-

[1]All treatments receive an additional 20 kg N/ha per year through basal and top-dressed fertiliser inputs

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Region: Mallee Sustainable Farming Inc. (MSF) is a farmer driven organisation delivering research, development and extension services to the less than 350mm rainfall Mallee cropping regions of New South Wales, Victoria and South Australia. MSF operates across 4 million cropping hectares, extending beyond Balranald (NSW) in the east to Murray Bridge (SA) in the west. Our 800 subscribed members receive regular communications and opportunities to attend field days and events across the region.

MSF in partnership with research provider Frontier Farming Systems has recently launched Immersive Ag, a virtual trial extension platform https://msfp.org.au/virtual-trials/

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Spading organic matter trial (amelioration)

Six different types of organic matter were incorporated in 2017 to a depth of 30 cm depth using a one pass spade and sow operation at 4 km per hour (Table 2). Each organic amendment was applied at a rate which supplied 2.5 tonnes per hectare of carbon, but varied in carbon:nitrogen (C:N) ratio.

Spaded organic matter treatments were also compared to spading only, spaded urea (supplying equivalent quantity of N as vetch hay) and a non-spaded control.

Carwarp

Deep ripping x rotation trial (Mitigation)

Eight different three-year rotations were established in 2018. Deep ripping to 60 cm was conducted on one half of each plot prior to sowing to create with or without deep ripping comparison (Table 3).

All treatments received 40 kg N/ha through fertiliser inputs except for the cereal (high N) treatment which received 80 kg N/ha and lentils which received 20 kg N/ha through starter fertiliser inputs and top dressed ammonium sulphate.

Organic matter input incorporation x placement trial

This trial is comparing the incorporation and placement of organic matter inputs (six tonnes per hectare lucerne) through deep ripping, spading or combinations of the two operations (Table 4). Where organic matter inputs were surface applied, lucerne meal was used.

Where organic matter inputs were direct injected into the subsoil during the ripping process, the lucerne was pelletised.

Trial management

Low and infrequent rainfall delayed the establishment of trials at both sites in 2018. The Ouyen site was sown to Kord wheat on May 31, 2018 while Carwarp was sown on June 7 to Spartacus barley except for treatments where canola or lentils were to be established (Table 4). PBA Hurricane XT and Pioneer 43Y92 (CL) were the varieties used for the lentil and canola treatments respectively.

All trials received DAP S Z (16:17:0:8; 0.5 per cent Zn) at 62.5 kg/ha at seeding and 47 kg/ha of ammonium sulphate and a foliar application of copper, zinc and manganese was applied during tillering.

A total of 50 kg N/ha was applied to the Ouyen trial site.

Table 2: Treatments included in the spading organic matter trial at Ouyen

Treatment	Application rate (t/ha)	C:N Ratio	Treatment N input (kg/ha)
Spaded vetch hay	6	16:1	156
Spaded oaten hay	5.9	72:1	35
Spaded vetch + oat hay	3.3 + 2.7	25:1	102
Spaded chicken litter compost	6.8	16:1	218
Spaded compost	15.8	10:1	252
Urea	0.34	N/A	156
Spaded control	Nil	N/A	—
Non-spaded control	Nil	N/A	—

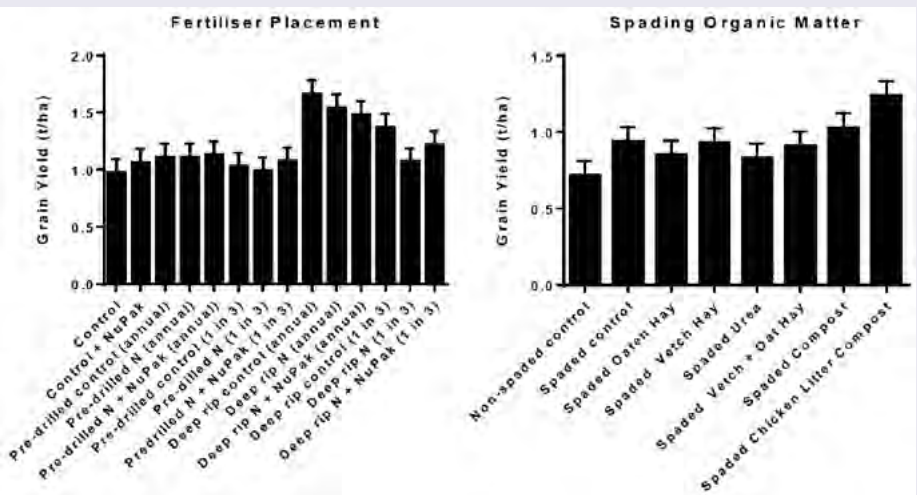
Table 3: Rotations which commenced at Carwarp in 2018 with and without ripping

Description	2018	2019	2020	Deep rip (60 cm)
Cereal (Low N)	Barley	Wheat	Wheat	+/-
Cereal (High N)	Barley	Wheat	Wheat	+/-
L – W – W	Lentil	Wheat	Wheat	+/-
B – L – W	Barley	Lentil	Wheat	+/-
B – W – L	Barley	Wheat	Lentil	+/-
Can – W-W	Canola	Wheat	Wheat	+/-
B – Can -W	Barley	Canola	Wheat	+/-
B – W – Can	Barley	Wheat	Canola	+/-

Table 4: Organic matter input incorporation x placement trial at Carwarp

Mechanical operation	Depth	OM Placement	OM Placement
Nil	Surface	+/-	Surface
Spade	Surface	+/-	Surface
Deep rip	30	+/-	30cm
Deep rip	60	+/-	60cm
Deep rip	60	+/-	30+60cm: Split (50/50)
Deep rip + spading	60 + 30	+/-	Surface + 60cm: Split (50/50)

Figure 1: Wheat yields of treatments in the fertiliser placement and spading organic matter trials (Year 2) at Ouyen in 2018



Error bars are standard error of the means.

University of SA researchers Jack Desbiolles and Chris Saunders talking about machinery specifications for deep ripping

MSF Research Agronomist Michael Moodie presenting deep ripping trial results to growers.

What we found

Seasonal conditions

Growing season rainfall was very low and sporadic at both sites with only 48 mm of in crop rainfall at Carwarp and 105 mm of growing season rainfall received at Ouyen during 2018. Following a very dry September, 10 mm of rainfall fell during October at Carwarp while Ouyen received 20 mm which provided good conditions for grain fill.

Grain yield

Deep ripping resulted in a significant increase in yield at the Ouyen site for a second consecutive season.

In 2017 deep ripping led to a grain yield increase of 0.85 tonnes per hectare relative to the control which yielded 1.9 tonnes. In 2018, annual ripping treatment (i.e. deep ripping in 2017 and 2018) resulted in a yield increase of 0.6 tonnes per hectare relative to the control yield of 0.97 tonnes while treatments which were ripped in 2017 still yielded 0.4 tonnes better than the control in 2018 (Figure 1).

Figure 1 also shows that there were fewer second year benefits in 2018 from the spading and organic amendment treatments which were implemented the year before (2017). Only the spaded compost and chicken littler treatments significantly increased yield relative to the non-spaded control (0.7 tonnes per hectare).

Chicken litter provided a yield boost of 0.5 tonnes per hectare this year, with a cumulative yield of 4 tonnes per hectare over two seasons compared to only 2 tonnes per hectare of grain from the non-spaded control.

On-farm organic matter input sources such as vetch and oaten hays did not provide a yield benefit in 2018.

At Carwarp, disturbance through deep ripping and spading significantly increased grain yield but there was no positive impact of the addition of the lucerne (Figure 2).

There was a negative response to the addition of organic matter in the spading treatment, possibly due to enhanced early crop growth depleting scarce water resources in a season with minimal in-crop rainfall.

Mechanical disturbance to 30 cm by spading or deep ripping provided a yield boost of 0.5 tonnes per hectare relative to the control treatment which yielded 0.55 tonnes per hectare.

Deeper intervention to 60 cm did not provide any significant yield benefits over working to a depth of 30 cm.

Both canola and lentil production were adversely affected by the poor seasonal conditions at the Carwarp site with controls of these crops yielding 0.45 tonnes per hectare and 0.04 tonnes respectively.

Deep ripping increased Canola yield by 25 per cent while the yield of lentils was increased fourfold with ripping – but context is required here as the lentil + deep ripping treatments still only yielded 0.16 tonnes per hectare.

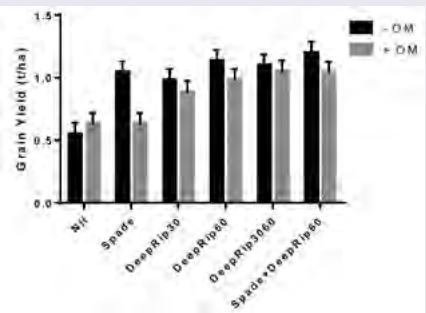
There was no additional benefit of higher N inputs to barley with or without deep ripping at Carwarp in 2018.

To sum up

Alleviating physical barriers to root growth through practices such as deep ripping and rotary spading are providing the most consistent yield increase on sandy soils in the Victorian Mallee.

Thus far, the responses to physical intervention have generally been more consistent than responses to organic inputs. The exception to this is gains from the application of chicken litter at Ouyen which has led to a cumulative grain yield response of 2 tonnes per hectare across two seasons.

Figure 2: Barley yields of treatments in the organic matter input incorporation x placement trial (Year 1) at Carwarp in 2018



Error bars are Standard Error of Difference.

Lameroo Field day 2018 – Investigating the results from the spade and sow machine on a Mallee seep area. Improving production on sand hills helps to reduce the incidence of Mallee seeps forming in the landscape.

The responses to chicken litter demonstrates the potential to improve gains through increasing the nutrient fertility of sandy soils.

But the addition of home-grown biomass – such as vetch and cereal hay – did not provide significant yield responses on sandy soils in 2018.

In other words, addressing physical constraints through deep ripping or rotary spading appears to be a good place to start for farmers who are looking to increase production on underperforming sands in the Victorian Mallee. It is recommended that one pass spade and sow operations are conducted where subsoil moisture is present to best manage soil erosion following spading.

1 Frontier Farming systems, Mildura.
2 CSIRO, Waite Campus.
3 Rho Environmetrics.
4 University South Australia, Mawson Lakes.

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Thank you to the Hastings and Nulty families for provision of the trial sites. The in-kind support from Groocock Soil Improvements for use of the spader and Peats Soil and Garden Supplies for supplying chicken litter and compost treatments are gratefully acknowledged.

Project Title: ***Increasing production on sandy soils in the low-medium rainfall areas of the southern region*** ■

Mitigation or amelioration to overcome soil constraints?

Opportunities for increasing crop production on Mallee sands exist through a range of management strategies that can be broadly categorised as:

- Mitigation Approaches: Lower cost, annual strategies that aim to minimise the impact of a particular soil constraint on crop water use; and,
- Amelioration Approaches: Higher intervention, higher cost approaches that aim to have greater, longer-lasting impact, through changing the properties of the soil profile

Two concurrent long-term MSF trials were established at Ouyen in 2017 aiming to improve productivity through enhanced nutrient supply in the root zone to increase plant rooting depth and water extraction.

The trials were located near Ouyen on a sand 'dune' which is typical of an underperforming sandy soil in the region. The yellow coloured sand layer was approximately one metre thick and was characterised as having high penetration resistance and poor fertility in the subsurface layers.

Two separate trials sites were established to investigate both mitigation and amelioration strategies to overcome constraints and improve root growth and water extraction in the sub-surface layers.

- The mitigation approach was to build up subsoil fertility with deeper placement of fertiliser using pre-drilling or deep-ripping ahead of seeding.
- The amelioration trial aims to build longer-term subsoil fertility by incorporating organic material with a spader to 30 cm depth. The trial is particularly focused on evaluating farm grown sources of organic material such as vetch and oaten hay. The trial compares these farm-grown residues to a wider range of organic inputs to assess whether the quality/complexity of organic matter is important for multiple years of impact.

What happened?

Fertiliser placement trial (Mitigation)

Deep ripping had a positive impact on penetration resistance, significantly reducing resistance in the 15–40 cm soil layer compared to the control. But disturbing the soil using the pre-drilling approach had little impact on reducing penetration resistance. Deep ripping resulted in a significant increase in yield of 0.85 tonnes per hectare. Pre-drilling did not alter yield and therefore.

This indicates a clear link between reducing the penetration resistance of the soil and increased grain production.

Fertiliser treatments did not impact on yield, but applying urea at the 1 in 3-year rate (90 kg N/ha) resulted in 3 per cent increase in protein compared to the annual rate (30 kg N/ha).

There was no impact of either the differing depth of fertiliser placement or the addition of the nutrient package on either grain yield or protein.

Spading and organic matter quality (Amelioration)

Incorporating N rich organic matter such as vetch hay, chicken litter compost and compost significantly increased yields by up to 1 tonne per hectare. All treatments increased yield relative to the non-spaded control except for spaded oaten hay.

Establishment was variable in the spaded treatments which were sown using a spade and sow system and establishment in the spaded treatments was 50–60 plants/m^2 while the non-spaded control established 110 plants/m^2.

Grain protein was also significantly increased in the spaded vetch, urea and chicken litter compost treatments.

We were unable to find any evidence that the organic matter treatments resulted in "haying off", which is often a concern of applying high fertility treatments. All organic matter treatments significantly improved harvest index (ratio of grain yield to biomass) by 5–8 per cent relative to the control which had a harvest index of 38 per cent.

Loxton Field day 2019 in a soil pit with CSIRO Researcher Lynne Macdonald discussing the GRDC Sandy Soils project. The drought year has highlighted benefits of deep ripping sands to access extra moisture at depth and significantly improve crop yields.

What does this mean?

The early results have shown that there is potential to significantly improve production on Mallee sandy soils using both mitigation and amelioration approaches.

In this first year of the trial, deep ripping alone resulted in a 0.85 tonnes per hectare increase in yield, while benefits of up to 1 tonne per hectare were measured with higher cost treatments where N rich organic matter was incorporated using a spader.

Both trials will continue aimed at measuring the longer-term benefits of the treatments and to determine the most economic options for improving production on Mallee sands.

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ASK AN EXPERT – HOW CAN I IMPLEMENT THE 'MIX AND ROTATE' STRATEGY TO COMBAT HERBICIDE RESISTANCE?

With Tony Lockrey, Consulting Agronomist, AMPS Agribusiness

MIXING and rotating herbicide modes of action is a key strategy in the WeedSmart Big 6 – but it's a herbicide response to a herbicide problem. So, while it's critical, it must be implemented within a diverse weed management program.

Tony Lockrey, senior agronomist with AMPS Agribusiness at Moree has seen herbicide resistance get out of control on some farms while other growers have responded early and managed to maintain a broader spectrum of effective herbicides in their program.

"It has to start with herbicide resistance testing," he says. "And this has to include testing for susceptibility. Knowing what does work is very important as you've probably already got a fair idea about what doesn't."

Once all the effective actives are 'on the table' it's time to look at what crops can be grown to allow the use of the widest range of herbicide groups in the rotation, and where you might be able to find synergistic mixes that can further delay resistance and potentially allow the use of actives that are no longer effective on their own.

"When we sit down to plan out an integrated weed control program we want to make sure there is rotation and mixing going on in each phase – in the fallow, pre-sowing, in-crop and for desiccation, where required," says Tony. "When this is done in conjunction with a determination to stop seed set and remove survivors then it is possible to keep weed numbers low."

With an increasing number of proprietary herbicide mixes coming onto the market, and the broad spectrum of synergistic and antagonistic interactions between potential mixing partners, it pays to be well-informed and to seek advice.

AMPS Moree consulting agronomist Tony Lockrey has seen good results when herbicides are rotated and mixed in each phase – the fallow, pre-seeding, in-crop and desiccation.

If I already rotate modes of action why do I have to mix too?

Short answer: Rotation buys you time; mixing buys you shots. Mixing and rotating buys you time and shots.

The fleabane on the right was unresponsive to glyphosate on its own but mixing picloram with triclopyr or 2,4–D to the glyphosate application was effective (left).

Longer answer: Rotation of effective modes of action can significantly delay the onset of herbicide resistance and needs to be built into your crop rotation plan. Herbicides in Group A and Group B are particularly susceptible to multiple exposure resistance with as few as six exposures being enough to select for the resistant mutation.

By mixing MOA groups, either in the same tank mix or applied separately to the same population (like a double knock), those plants that survive one MOA are often killed by the second.

How does testing for susceptibility help when there's a weed blow-out?

Short answer: Knowing what will work against a resistant population helps drive down the seed bank and helps you regain control.

Longer answer: One real-world example is a paddock near Moree where Group A resistant wild oats were discovered in 1998 following a history of repeated use of Topik (Group A – fop), Verdict (Group A – fop) and, later, Axial (Group A – den). Testing of this population showed the wild oats was very susceptible to Group B sulfonylurea, so Atlantis was used to drive down the weed numbers.

A new plan was then put in place with Groups B, A, C and M used across the winter cropping program, but there was still too much reliance on Group B. The current plan for the farm now includes pre-emergent herbicides from Groups K, J and D used individually and in mixes.

How do I integrate more mixes into my herbicide program?

Short answer: Look for opportunities for complementary mixes throughout the fallow and cropping seasons.

Longer answer: Many growers are looking for tank mixes to improve control of glyphosate-resistant seedlings. Knowing which mixtures are beneficial and which are antagonistic is important.

In the fallow, there are often opportunities to use the mix and rotate strategy to great effect in a double-knock application, such as:

- Group M (glyphosate) + Group I (2,4-D or fluroxypyr or picloram) followed by Group L (paraquat)
- Group M (glyphosate) followed by Group L (paraquat) + Group G (Sharpen or flumioxazin)
- Group M (glyphosate) followed by Group L (paraquat) + Group K (Dual Gold)
- Group A (Shogun) followed by Group L (paraquat) + Group K (Dual Gold)

Pre-plant examples include paraquat plus a triazine herbicide (Group C) or paraquat plus an imidazalinone (Group B), which are commonly used to provide broad spectrum knockdown and residual control. Dual Gold (Group K) is another common fallow residual option which is very compatible with glyphosate, triazines and paraquat.

An example of an in-crop mix is the addition of clethodim to haloxyfop (both Group A) to improve control of fop-resistant grasses in broadleaf crops where both are registered.

At the end of the season there is also some opportunity to mix desiccants for some crops.

None of these mixes are provided as recommendations – seek advice for your own situation and always read and follow the label.

What about application set up for mixtures?

Short answer: Some herbicides require better coverage. In many instances the most important mixing partner is more water.

Longer answer: Suitable product and water rates, droplet size and the right adjuvant, are critical for optimising herbicide efficacy.

For example, while a fallow mix such as glyphosate plus a Group A, or a Group G (depending on the target weed), is physically compatible, the components have different requirements for optimal performance.

Seek advice about the best water rate to use, the potential impact of an oil-based adjuvant (required for most Group A and Group G herbicides) of glyphosate efficacy on some summer grass weeds, and other possible risks.

How do I avoid generating multiple and cross-resistance?

Short answer: Implement as many different weed control strategies as possible. The WeedSmart Big 6 is a practical foundation for an integrated program of herbicide and non-herbicide tactics.

Longer answer: Rotating and mixing herbicide groups can give you room to move in holding off resistance or getting more out of some marginally effective products.

The only way to stave off herbicide resistance completely is to have low weed numbers and to be vigilant about preventing survivors from setting seed. Have a diverse cropping program, use herbicides to provide early weed control, set your crops up to compete strongly and monitor and remove survivor weeds. ■

HOW TO ASK A WEEDSMART QUESTION

Ask your questions about mixing and rotating herbicides on the WeedSmart Innovations Facebook page WeedSmartAU, Twitter @WeedSmartAU or the WeedSmart website *https://weedsmart.org.au/category/ask-an-expert/*

'WeedSmart' is an industry-led initiative that aims to enhance on-farm practices and promote the long term, sustainable use of herbicides in Australian agriculture.

Research assesses soil water strategies

THE desperately dry conditions affecting large tracts of Queensland and New South Wales highlight all-too-well the plight of cropping in a highly variable climate.

Although having stored soil moisture this year has proven akin to winning the lottery, northern growers have long recognised the value of efficient storage and use of soil moisture in driving farming system productivity and profitability.

Fallow efficiency is the proportion of rain that falls during the fallow that becomes available to plants and it's a key decision-making tool when weighing up crop options and planting opportunities.

It's well known that fallow efficiency can be influenced by a range of factors including ground cover, timing and intensity of rainfall events, the length of the fallow and residual water left at the end of the preceding crop.

But questions have lingered over how much the type, mix and intensity of crops grown affects this accumulation and utilisation of water.

Scientists have begun to address these issues as part of a flagship five-year research investment by the Grains Research and Development Corporation (GRDC) examining the key limitations, consequences and economic drivers of farming systems in the northern region – assessing the potential of different farming systems and crop sequences to meet emerging challenges; and

Department of Agriculture and Fisheries (DAF) research agronomist Andrew Erbacher (pictured here with MCA Goondiwindi-based agronomist Stuart Thorn) has been involved in a GRDC farming systems research investment that's delivered some key messages regarding the likely efficiencies of higher and lower intensity cropping systems, the retention and availability of soil water following legume crops, and the importance of starting soil moisture reserves. (PHOTO: GRDC)

testing the impacts of modifications of the farming system on attributes such as nutrients, water, pathogens, soil health, yield and economics.

The trial work has been conducted at a core site at Pampas near Toowoomba and six regional centres across central and southern Queensland (Emerald, Billa Billa, Mungindi) and northern NSW (Spring Ridge, Narrabri and Trangie).

Key messages unearthed

Department of Agriculture and Fisheries (DAF) research agronomist Andrew Erbacher said the research had unearthed some key messages regarding the likely efficiencies of higher and lower intensity cropping systems, the retention and availability of soil water following legume crops, and the importance of starting soil moisture reserves.

"Overall the farming systems experiments have shown that systems with less time in fallow increase system water use and rainfall use efficiency (RUE) through higher fallow efficiencies," Andrew said.

"That said, one of the more important observations of the research was that despite the inefficiencies of long fallows, accumulating more water prior to sowing crops is a significant driver of profitability.

"Stored water acts as a buffer against variable rainfall patterns, so sowing with more stored water typically increases crop water use efficiency (WUE) and can achieve higher returns per mm on an individual crop basis.

"The trade-off between opting for higher or lower intensity systems will be further influenced by the cost structure and risk appetite of the farming enterprise and the availability of labour, since higher intensity systems will increase inputs of labour and machinery and increase risk of crop failures.

"What this means from a practical perspective is that it's more critical to optimise management and inputs for crops following long fallows in order to convert the extra water efficiently into yield outcomes."

Over four experimental years, data has been collected on residual soil water and final soil water for over 306 fallows following different crops, to compare how different crop types impact on subsequent fallow efficiencies.

This data clearly showed that higher fallow efficiencies can be achieved from a winter cereal crop compared to winter grain legumes and canola.

Andrew said this signalled the importance of considering the impacts of a particular crop on the accumulation of soil water in the following fallow, when making management decisions pertaining to the cropping sequence.

"For example, a fallow receiving 400 mm of rain after a winter cereal would accumulate 108 mm on average, while the same fallow after a grain legume would have only accumulated 56 mm prior to a planting opportunity," Andrew said.

"This difference could have a significant impact on the opportunity to sow a crop and/or the gross margin of the following crop in the cropping sequence."

While lower fallow efficiency was observed following grain legumes in the farming system, it's a commonly held belief that one of the major benefits of legume crops is the residual soil water at harvest and the accumulation of water until the sowing of the following crop.

In a number of instances, researchers observed higher residual soil water at harvest after pulse crops (chickpeas, fababeans or field peas) compared to after wheat.

This was often associated with rainfall later in the crop's development where the winter cereals were able to extract this water while the pulses were finishing and did not utilise this additional water.

"On average, chickpea had 41 mm more soil water post-harvest compared to wheat, but chickpea stubble achieved lower fallow efficiency. At the end of the subsequent fallow the difference in soil water was greatly reduced so that on average only 10 mm more water remained in the soil profile after chickpea compared to wheat or barley," Andrew said.

"What this means, is that you shouldn't bank on the additional moisture after a grain legume translating into additional soil water available for subsequent crops."

For more information on the fallow efficiency findings from the northern farming systems project, download a copy of the GRDC Update paper Impacts of crops and crop sequences on soil water accumulation and use from the resources and publications section of the GRDC website *www.grdc.com.au* or (*https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2019/02/impacts-of-crops-and-crop-sequences-on-soil-water-accumulation-and-use*) ■

Research has highlighted the impact of a particular crop type on the accumulation of soil water in the subsequent fallow. But don't bank on the additional moisture after a grain legume crop translating into additional soil water available for the subsequent crop.

Successful dryland cotton crops need attention to detail

AT A GLANCE…

With an average summer rainfall of around 350 mm, John 'Cowboy' Cameron has been successfully growing dryland cotton for many years at 'Kendale' on Qld's Darling Downs. Cowboy's experience and skill is well known in the Bongeen district but he recently received wider recognition as the winner of the FastStart Establishment Award for dryland cotton supported by Cotton Seed Distributors and Syngenta.

The following article has been extracted from a FastStart interview with Cowboy, and is an insight into his cropping strategies and his belief that attention to detail – in all aspects of the production of dryland cotton – is essential.

- Good establishment starts with the destruction of the previous crop.
- Attention to detail is key when setting up planting equipment – modify machinery to suit your needs.
- Planting depth is the most important factor in ensuring good establishment. CSD trials in the region have found that planting at a more shallow depth has better results.
- Planting just into moisture gets the better emergence, so try to time this as best you can.
- Attention to the emergence and depth has to be done properly – it's important to get off the tractor seat and check this regularly.

Preparation

Describe your field preparation prior to planting

Attention to detail in the field is most important, starting with the destruction of the previous crop. We set up fields to be even and equal, and this all starts with planting a cover crop (wheat, barley or millet). We make sure the guidance of the tractor and planter is right so the crop will be planted into the right plant line. We also leave a soft area for the establishment of next year's cotton crop.

Following our rotational cropping plan, a field which was planted to millet on a 50 cm row spacing, would be mulched and in the following summer, the cotton planted between the rows of stubble.

What weed control tactics do you employ prior to or post planting?

Weed control at Bongeen is a glyphosate based program but with a mixture of chemicals and tactics that vary year to year, depending on which weeds are becoming a concern. We have a 'zero survivor' policy for weeds which is enforced to reduce resistance.

The general tactic is to control difficult weeds with short term residual herbicides; for example, the use of Atrazine in the millet to control the fleabane for when the cotton is planted. Dual Gold, Stomp and Diuron herbicides have been used in the past and worked back into the weed management as needed.

In the 2018 season the farm was sprayed for weeds for weeds pre-plant, post plant/pre-emergence, and post emergence (though not all in the same field). It is also important to control weeds along the fence line and road side to keep the seed bank down and we have found that by doing so, leads to reduced weeds on the field.

What is your fertiliser application strategy? Do you soil test?

Yes, there is a soil test and this is the basis for the fertiliser regime. If needed, nitrogen is added to the field at pupae bust for the cotton crop, and additional fertilisers are added to the field in the early stages of the fallow crop. The fertilisers are water injected into the soil off-centre from the plant line (approximately 50–100 mm). The reason for the timing and placement is to ensure the rain drives the nutrients deeper into the soil and to reduce the chance of seed burn from the chemicals.

How do you prepare your planter/machinery?

It's all about the attention to detail. The machinery is modified to suit the needs on the farm, with every row unit inspected before use, and any bearing is replaced as necessary to ensure everything is running the same.

The planting unit has been modified to inject liquid starter before the seed, then place the seed two cm in depth before a seed firmer is dragged over the plant line to ensure the seed sits in the moisture. If we didn't use seed firmers, the soil will collapse and we won't achieve good establishment.

There are no modifications to the planting plates, and instead, the vacuum pressure is set at the lower end of the recommended pressure to ensure better singulation. This usually achieves 90 per cent singulation.

When planting, it's important to keep all wheel tracks in the right place (using guidance technology) as you don't want to plant cotton on the side of a wheel track. We also ensure we have fertiliser placement right, at three to four inches off the cotton line.

John 'Cowboy' Cameron, Bongeen Queensland, winner of the FastStart Establishment Award for dryland cotton.

John Deere MaxEmerge planter, set out at one metre spacing, used for planting single skip dryland cotton.

Disc openers, showing the black seed tube which has an orange seed firmer at the back of the tube for seed placement. At the front is a tube which applies the insecticide and the starter fertilser as a liquid.

Decision making

Why did you select your chosen varieties for your farming system?

We choose the varieties (75 per cent Sicot 746B3F, 25 per cent Sicot 748B3F) based on the yield and fibre quality from the results of a cotton trial that had been conducted on the farm previously.

What seed treatments did you use, and why did you select these?

We used the standard D2C (Dynasty Complete plus Cruiser) treatments that were used in the trials and carried it over, and we also used Talstar via a water injection to help eliminate insects.

Do you use a lubricant to assist with seed flow?

Yes.

Timing

When did you plant, and how did you make this decision?

We aim to plant at the end of October into early November. This is the preferable time for us to start planting, but the main factor was that there was a significant rain event in 2018 that allowed for adequate planting moisture for our dryland crops. ■

Researchers go to extra lengths to deliver research outcomes

IT is one of the only patches of green on the Darling Downs this season and researchers admit they have gone to extra effort to keep trial sites alive, so they can continue to deliver critical information back to grain growers.

The crop competition trial site at the Hermitage Research Station, just east of Warwick, is part of a research investment by the GRDC and the Department of Agriculture and Fisheries (DAF), led by the University of Sydney.

DAF principal weed science researcher Michael Widderick said simply speaking, crop competition was about using broadacre crops to deprive weeds of sunlight and space, to take the pressure off herbicides as the 'heavy lifters' of in-crop weed control.

While defeating weeds through crop competition isn't new, trials at the Hermitage over the past three years have shown that crop density and narrow row spacing could suppress the

GRDC Senior Manager Crop Protection Manager Emma Colson, Toowoomba, with DAF Principal Weed Science researcher Michael Widderick, DAF, Toowoomba.

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For farmers with ground rigs, ViVUS Max can be effectively applied in bands to keep costs low. For aerial application, AgBiTech has registered a low water volume recommendation (with Optimol®) to reduce application costs. Early use of ViVUS Max is also compatible with other approaches, such as lower application rates (ViVUS Max is registered at 75 to 150 mL per hectare in sorghum) and double swathing, to help further reduce the cost of managing Helicoverpa in sorghum.

Using a low cost ViVUS Max strategy and based on $200 per tonne sorghum prices, Helicoverpa thresholds are generally below 0.5 larvae per sorghum head.

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These recommendations are all geared toward encouraging the early application of ViVUS Max. Experience has shown that large acreages of flowering sorghum around Christmas can cause significant challenges for farmers and operators being able to apply ViVUS Max on-time, especially if there is some rain about. Taking the low-cost, pre-emptive approach avoids delayed sprays, and reduces tillering for maximum earliness, meaning more grain is delivered into the early market and moisture is conserved for the next crop.

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It was a serious topic, but a chance to compare notes made the field day a social affair for well-known agronomists Paul McIntosh, Toowoomba, John Kerlin, Pilton and Hugh Reardon-Smith, Pittsworth. (PHOTO: GRDC)

problem weeds, common sowthistle and fleabane in the northern cropping region.

"Weed management has historically been heavily reliant on herbicides, but increasing issues with resistance combined with public concerns about the wider impact of herbicides is driving investigation of other weed control options," Michael said.

"Crop competition is one of these options. As part of research being conducted at three sites – the Hermitage, Narrabri and Wagga Wagga – we are investigating the influence of crop species and cultivar, row spacing and plant population on the impact of in-crop weeds.

"Narrow row spacing has so far shown the clearest benefit in limiting weeds."

Growers, agronomists and industry stakeholders turned up to see firsthand the trial plots at the Hermitage Research Station where faba beans and chickpeas' competitiveness against the problematic winter crop weed common sowthistle (*Sonchus oleraceus*) was being assessed.

"Results from the first years of trial work have shown that growing a competitive crop can significantly reduce weed numbers, biomass and seed production in crop while providing increases in grain yield," Michael said.

"These results found growing faba beans and chickpea at a narrow row spacing of 25 cm and a high plant density of 30 plants per square metre respectively significantly reduced sowthistle biomass and seed production while increasing crop yield."

Michael said to date the results had been encouraging but data from this year's harvest would provide greater clarity.

"This trial work is in its third year so we were determined to do what we could to ensure results from this season were available," Michael said.

In a year, where no rainfall fell in-season and water sources at the Hermitage Research Station were limited – and then non-existent – keeping the trial site alive required considerable effort.

"We ended up having to buy and then truck in 15 loads of water – that was 26,000 litres per load – to simulate rainfall on the site and ensure that the data from this year was useable," Michael said.

A total of 120 mm of water per hectare was applied to the trial site from establishment through to final watering.

GRDC Senior Manager Crop Protection Emma Colson said the GRDC understood the pressure growers, advisers and researchers were facing as the drought continued across much of the northern region.

She said the GRDC worked closely with research partners and the challenging seasons emphasised the importance of those relationships, and the value of all parties working together to learn from the tough times.

"The GRDC understands and empathises with grain growers, advisers and researchers who are struggling with the very dry conditions" Emma said.

"For many this is the second or third season they have had to battle tough conditions and we are keenly aware that many of our researchers have gone over and above in their efforts to ensure trials are kept alive and on track.

"This extra effort will ensure there are minimal gaps in our research data and for that we are very grateful." ■

University of Queensland sustainable agronomy students Marijke Hartman, Redlands, and Mia Bowen Osmond, Samford, caught up with GRDC Crop Protection Manager – North, Vicki Green at the crop competition field day at the Hermitage Research Station.

Tony Anderson, Landmark, Pittsworth, caught up with Luke McInnes, Vary Agricultural Services, Brookstead, at the crop competition field day.

SOUTHERN AUSTRALIA FOCUS

COVERING CROPPING SYSTEMS OF SOUTHERN NSW, VICTORIA, TASMANIA, SOUTH AUSTRALIA & WESTERN AUSTRALIA

Revealing canola's super powers

By Cindy Benjamin for the Australian Herbicide Resistance Initiative

WEED control doesn't get more 'site-specific' than this! Bioherbicide plant-factories that bounce out of the ground, monopolise the sunlight and produce allelopathic chemicals to stave off weeds in-crop and in the following summer fallow.

This article is a follow-up on an earlier AHRI Insight – *Crops are doin' it for themselves* – where we investigated the complex interactions of competitive crops and their weed suppression powers.

While that paper focused on cereals, in this one we will consider the mechanisms at play in canola – a crop from the mustard family, long known for its allelopathic ability and yet the exact mechanisms are still shrouded in mystery.

Weed suppressive cultivars

PhD candidate James Mwendwa was part of a project team conducting field trials in 2014 at Wagga Wagga comparing the weed-suppressive effect of six hybrid and one open-pollinated canola cultivars, both in-crop and post-harvest.

The experiment was repeated in 2015, a drier year with much lower weed pressure, using the same cultivars plus two new cultivars.

In 2015 and 2016, another site at Condobolin was added to test the same cultivars in a lower rainfall environment (see "Bullet points for canola").

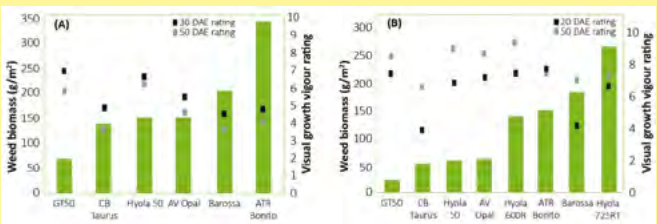
In-crop weed suppression in canola is clearly driven by early vigour and high crop biomass. GT-50 was the most weed suppressive canola cultivar in both years while Barossa, ATR Bonito and Hyola 725RT were least weed suppressive in-crop.

In the drier season (2014), weed pressure was lower and the suppressive effect of the crop was not significant although weed growth was adversely impacted (Figure 1). In the wetter year (2015), with 10-fold greater weed pressure, the suppressive effect of early vigour cultivars truly shone, driving down weed biomass. Low weed biomass before crop flowering is typically associated with reduced weed seed production and seedbank replenishment.

The cultivars used in the field trials at Condobolin were:

- Hyola 50 – Conventional spring hybrid;
- CB Taurus – Conventional winter hybrid;
- GT-50 – Roundup Ready spring hybrid;
- AV Opal – Conventional spring OP;
- Barossa – Conventional spring OP;

FIGURE 1: Canola cultivar visual growth and weed biomass at Wagga Wagga in 2014 (A) and 2015 (B)



A) The canola cultivar visual growth vigour rating (0 = poor, 10 = excellent) in 2014 at 30 and 50 DAE and weed mass at 130 DAE B) The canola cultivar visual growth vigour rating (0 = poor, 10 = excellent) in 2015 at 20 and 50 DAE and weed biomass at 180 DAE

- ATR Bonito – Triazine tolerant OP; and,
- Hyola 600 RR – Roundup Ready spring hybrid;
- Hyola 725 RT – Dual herbicide tolerant spring hybrid.

For example, the Hyola 600RR cultivar exhibited only moderate weed suppression, despite having high early growth vigour and biomass. In comparison, AV Opal and Hyola 50 had similar early vigour to Hyola 600RR yet were far more weed suppressive, and, CB Taurus did not produce high early biomass in either year but demonstrated strong weed suppression ability. This suggests that there are other factors at play – not just crop competition.

Note that the poor performance observed in ATR Bonito in 2014 was likely associated with its susceptibility to blackleg and other pathogens.

'Bioherbicide factories' in the field

Brassicas produce glucosinolates, which can be enzymatically degraded to isothiocyanates in their seeds, roots and foliage. In fact, glucosinolate-containing seed meals have been intensively investigated as biofumigants for weed control.

Charles Sturt researcher Md Asaduzzaman has previously noted the reduction in annual ryegrass root and shoot growth as the density of canola seedlings increases. Additionally, he found that the Australian cultivar Av-Opal and the breeding line Pak85388-502 suppressed root length of ryegrass more than other genotypes, even at low densities.

This suggests that enhanced weed suppression is potentially associated with the production of bioactive secondary metabolites, or allelochemicals including over 120 different glucosinolates produced by brassicas, some of which are exuded by certain canola cultivars. This is a potentially useful trait that could receive additional consideration within the plant breeding framework.

The by-products of glucosinolates include nitriles and isothiocyanates, some of which are toxic to livestock, are also volatile, rendering them difficult to study. Others are more resistant to degradation in soil, with potential bioherbicidal effects evident, even post-harvest.

Post-harvest weed suppression

The weed-suppressive effect of canola stubble is also two-fold. Firstly, high biomass crops produce higher stubble load and secondly, the release of bioactive substances varies over time and by cultivar and their release is clearly impacted by environmental conditions.

Detailed examination of the allelopathic power of canola stubble was beyond the scope of this body of research, but some interesting observations can be made from the ranking of cultivars against summer weeds.

The canola cultivars CB Taurus and GT-50 were consistently more weed suppressive, but results were not always significant, depending on weed evaluated and time of rating.

In-crop weed suppression in Hyola 50 plot (left) and ATR Bonita (right). Both photos were taken on September 27, 2016.

Differences in summer weed suppression between GT-50 canola residue plot (left) and Barossa (right) at Wagga Wagga, January 12, 2015.

Interestingly, ATR Bonito, which was poorly weed-suppressive in-crop in 2014, ranked as the most weed suppressive stubble in-fallow that year following harvest. In 2015, its in-crop weed suppression was moderate, but the in-fallow weed control was poor.

Confirmed in more seasons and other environments

This experiment was repeated in 2015 and 2016 using the same eight cultivars, this time at a similar site in Wagga Wagga and also at a lower rainfall site at Condobolin.

Very similar results were achieved, demonstrating that the competitive ability of canola during the cropping phase and in post-harvest stubble is associated with biomass production and canopy architecture in-crop and rapid growth exhibited by newer cultivars such as Hyola 600RR.

But canola allelopathy or residue phytotoxicity potentially occurs independently of such competitive traits, and deserves further study, particularly now that intensive metabolic profiling of plant and soil extracts is possible.

Enhancing Integrated Weed Management

Selecting for enhanced competitive and bioherbicidal traits in canola plant breeding lines is recognised as an aspirational goal for plant breeding programs in Canada and the EU, and the use of brassica seed meals for weed suppression has received considerable attention by organic producers.

While canopy architecture and growth traits are able to be routinely evaluated, assessing the production and release of allelopathic metabolites, which are often influenced by environmental factors remains challenging. Getting a better understanding of the factors influencing weed suppression in crop and in fallow is a priority for future development of the IWM toolbox.

With new canola cultivars regularly rolling into the marketplace growers can look for and choose cultivars that exhibit competitive traits, regardless of the herbicide tolerance of the cultivar, while also producing high grain yields.

More information:

Evaluation of selected oilseed rape cultivars for early vigour weed suppression: **By James M. Mwendwa, William B. Brown, Paul A. Weston, M. B. Baghereih-Najjar, Christopher Preston and Leslie A. Weston. Under review. Weed Research Journal.**

The weed suppressive ability of selected Australian grain crops; case studies from the Riverina region in New South Wales: **By James M. Mwendwa, William B. Brown, Hanwen Wu, Paul A. Weston, Jeffrey D. Weidenhamer, Jane C. Quinn, Leslie A. Weston, Crop Protection 103 (2018) 9–19**

This work is part of a larger project investigating several aspects of crop competition led by Professor Leslie Weston at Charles Sturt University and Associate Professor Dr Chris Preston at The University of Adelaide. ■

New research targets common oat disease

INTEREST in growing oats has increased in recent years and there is now a greater research focus on how to manage diseases including Septoria leaf blotch – one of the crop's most prevalent diseases.

Initial trial results have highlighted the need to match fungicide programs to infection levels of this stubbleborne disease, which in high rainfall areas commonly causes yield losses of about 10 per cent and staining in some varieties such as Bannister.

Grain growers are well advised to look ahead to next year and which oat varieties to grow for best Septoria resistance levels and management.

The Grains Research and Development Corporation (GRDC) has increased its investment in research that aims to provide growers with best practice management guidelines to reduce losses in yield and grain quality caused by Septoria and other oat diseases.

Western Australia's Department of Primary Industries and Regional Development (DPIRD) plant pathologist Geoff Thomas says oat diseases are now being specifically addressed as part of the broader GRDC-invested project *Integrated disease management (IDM) in western region (WA) grain crops*.

"This project aims to deliver growers new information on the impact and causes of major oat diseases and guidelines on how to manage them," Geoff said. "The first year of dedicated oat disease trials under the IDM project have been located at Highbury, Northam and Wongan Hills in WA.

"Dry seasonal conditions and low disease levels mean that yield impacts and fungicide responses of Septoria have been limited in 2019."

Previous Septoria trial work

With previous GRDC investment, farm consultancy ConsultAg investigated Septoria in oats as part of a 2014 project initiated by the Kwinana West Regional Cropping Solutions Network, and again in 2017 and 2018 as part of a DPIRD oat agronomy and industry development project.

In 2019, ConsultAg has conducted further trials at Highbury and Lake Grace as part of the DPIRD IDM project – to further the understanding of potential management tactics for Septoria.

"Our trials aim to determine the best fungicide and timing strategy to reduce staining in Bannister oat grains, and to evaluate the economic returns from foliar fungicide application on oats," ConsultAg consultant Trent Butcher said.

"To date, this trial series has shown that foliar fungicide applications can reduce the severity of Septoria in Bannister oats and result in a profitable yield response when spring rain is sufficient to achieve high yields.

"It has also demonstrated that fungicide application can reduce the amount of grain staining but cannot provide complete control.

"Grain staining therefore is likely to remain a potential risk, but fungicide may increase the chances of growers meeting delivery standards."

Trent said the trials had shown fungicide applications during head emergence were most effective in reducing grain staining, but this was not the most economic approach as these later timed fungicide applications did not maximise yield responses where the disease was present at damaging levels on leaves.

Best time to apply fungicide

"The trials show that, in order to both maximise yield gains and reduce staining, it is best to apply fungicide when Septoria is present at the full flag leaf to mid-booting stage," he said.

"Growers in medium to high yielding should consider a two-spray strategy if growing Bannister, or other varieties susceptible to Septoria, on oat stubble."

Trent said the trials had demonstrated the importance of carefully inspecting oat crop plants for disease – including at the bottom of the plant canopy – for better fungicide decisions, as the disease could develop rapidly during warmer temperatures above 20°C.

More information: Geoff Thomas, DPIRD; geoff.j.thomas@dpird.wa.gov.au
Trent Butcher, ConsultAg; tb@consultag.com.au

Additional information about Septoria is available in the GRDC's Western Oats GrowNotes publication (*https://grdc.com.au/GN-Oats-West*) and on the DPIRD website. ■

Septoria leaf blotch commonly causes yield losses of about 10 per cent in high rainfall areas. (PHOTO: GRDC)

Improving soil health with manure and cover crops

DRYLAND farmers looking to ensure ongoing profitability amid challenging terms of trade have an opportunity to improve their soil's health, water holding capacity and water use efficiency through the strategic use of manure and greater crop diversity.

That's a key finding of a report released by Nuffield Scholar and South Australian farmer, Grant Pontifex. Grant is a fifth generation broadacre farmer, operating a cropping enterprise across 7000 hectares on the Yorke Peninsula and Kangaroo Island.

With support from Nufarm Australia, Grant travelled throughout the Netherlands, United Kingdom, United States, Canada, Mexico, Brazil, France, Ireland and New Zealand, researching approaches to improving soil health and profitability for dryland grain production systems.

His report reveals insights into production systems which are more resilient and ultimately more profitable than many of those implemented in Australian broadacre farming enterprises.

"Currently, most agricultural soils do not have the capacity to sustain continuous cropping and high yield production, without depending on extensive synthetic inputs," Grant said.

"Agricultural practices have become simplified with large scale mono-culture cropping and little rotational diversity. We need to adopt a more regenerative approach to farming into the future, and I wanted to better understand what that approach could look like."

Nuffield Scholar and South Australian farmer, Grant Pontifex.

The importance of maintaining soil cover

Grant's report outlines the importance of maintaining soil cover to improve overall soil health, and travelling through Brazil and the US, he observed two different approaches to this practice.

"Whether soil cover is more effective when it's in contact with the soil or left standing is still debated," Grant said. "In high rainfall regions of Brazil, surface residue is seen as the best option. The cover lowers evaporation and suppresses weeds, while improving water infiltration and reducing erosion in heavy rainfall events."

Conversely, in the US Midwest State of Kansas, Grant observed the practice of 'stripper headers' using fast rotating fingers to remove grain from stalks, while leaving straw residue standing.

"I met with a Kansas farmer who reported he could capture and utilise 25 mm more rainfall annually with the use of a stripper header," Grant said.

"In areas like this where heavy rains are rare, standing residue can be a better way of capturing rainfall. If wind is common, it can also create a microclimate for young plants to be protected and reduce wind velocity at the soil surface level, which also reduces evaporation."

Manures and composts

Grant's report also explores the use of manures and compost to improve soil health.

"In France, I met with an organic farmer who only used manure for his crop nutrition. He would spread four tonnes per hectare of chicken manure on his cover crop, and use 2.5 tonnes per hectare in pellet form on his cash crop," Grant said.

"Pelletised manure is more efficient to freight, handle and use, albeit more expensive up front due to manufacturing costs. The ability to direct drill the pellets during planting also means application rates can be substantially lower."

Grant's report concludes that regardless of soil type, rainfall, rotation, elevation and climate, the principles of improving soil health are the same.

"Farming practices, crop species and combinations will vary, but soil health can be improved through increased carbon, use of manure and compost, increased plant diversity and soil cover and reduced compaction," Grant said.

"Ultimately, if we can improve our soil health, we can ensure a sustainable future for the grains industry by continuing to produce safe, nutritious foods with greater water and nutrient efficiency and reduced variable input costs."

More information: Grant Pontifex; gjponty@bigpond.com

Grant was supported by Nufarm Australia

Final Nuffield Report Link: https://nuffieldinternational.org/live/Report/AU/2018/grant-pontifex
Final Video Link: https://www.youtube.com/watch?v=UgN-5IS6Q1A

To keep up to date with the latest from Nuffield Australia see: www.nuffield.com.au; Twitter: @nuffieldaust, #nuffieldag; Facebook: Nuffield Australia

Nuffield Australia is building capacity for Australian food and fibre industries to be world leading in adoption of technology, best practice and innovation. Nuffield Australia has been selecting scholars from Australian primary industries for over 60 years. ■

30 years of udon noodle sensory evaluation

By Australian Export Grains Innovation Centre

THE official 2019 udon noodle sensory evaluation program is underway at AEGIC, as Western Australia and Japan celebrate the 30-year anniversary of the unique noodle wheat segregation.

Since 1989, 13 highly-trained Japanese noodle specialists have visited Australia to help assess unreleased wheat varieties that have been purpose-bred for Japanese udon noodles.

AEGIC Wheat Quality Technical Markets Manager Dr Larisa Cato said sensory evaluation was a core pillar of the special noodle relationship between Western Australia and Japan.

"AEGIC runs the sensory program in collaboration with the Japan Flour Millers Association," she said.

"Australian breeding companies submit their advanced, unreleased noodle wheat varieties to the panel to see if they're up to scratch for the discerning Japanese market.

"We mill the wheat samples into flour and then make the noodles in-house here at AEGIC before putting them through rigorous assessment for quality."

A visiting noodle expert from the Japan Flour Millers Association was with AEGIC for a month this October to help with noodle sensory evaluation. Larisa said sensory assessment was largely about mouthfeel and appearance.

WA noodle wheat growers Steph and Barry Clarke (Bolgart), Dr Graham Crosbie and Shunsuke Otsubo. Mr Otsubo is holding a sheaf of Ninja noodle wheat, bred by WA-based company InterGrain.

Since the late 1970s, Japan has recognised that Western Australian growers could deliver the wheat which met their strict and unique quality requirements for udon noodles.
(PHOTO: Peggy Greb)

"The perfect udon noodles should have a 'mochi mochi' mouthfeel," she said.

"Mochi mochi is a unique balance of softness and firmness, combined with good elasticity and a slight stickiness.

"As for appearance, udon noodles should have a creamy, bright slightly yellow colour which is stable, so noodles made today will look similar tomorrow."

Larisa paid tribute to Dr Graham Crosbie, the WA Department of Agriculture cereal scientist who successfully lobbied for the noodle wheat segregation back in 1989.

"Building on pioneering research by Jack Toms and others, Graham recognised that there was a rare opportunity to build a unique, high-value market which would benefit not only Japanese consumers, but growers as well," she said.

"Without Graham's vision, the highly successful and mutually beneficial udon noodle relationship between WA and Japan may never have happened."

On behalf of the WA noodle wheat industry, AEGIC (Australian Export Grains Innovation Centre), CBH and GIWA (Grain Industry Association of WA) leads the relationship with Japan and provides technical support, crop reports and resources to address any seasonal issues that arise.

AEGIC has run the noodle sensory evaluation program since 2013, having taken over from the Department of Agriculture and Food Western Australia (now DPIRD). ■

SEGREGATION

During the late 1970s and 1980s, Japan realised that wheat from Western Australia was excellent for traditional Japanese udon noodles, which have unique and strict quality requirements.

This was due to a wheat variety called 'Gamenya'.

Gamenya became popular with Western Australian growers in the mid-1960s following a devastating epidemic of stem rust. Gamenya had the best rust resistance at the time and was well-suited to WA conditions.

Gamenya was a leading variety for 20 years until the mid-1980s, when growers began planting higher-yielding varieties. Gamenya production dropped drastically.

By this time, Japan had come to rely on Western Australian shipments of the wheat class "Australian Standard White" (ASW) to make udon noodles.

The reduced amount of Gamenya in ASW exports from Western Australia meant lower quality noodles in Japan.

At the same time, a new variety "Eradu" was released with similar qualities to Gamenya.

In March 1989, at a wheat industry seminar, Dr Graham Crosbie, a cereal chemist with the WA Department of Agriculture, publicly called for a brand-new noodle wheat segregation to be immediately established.

The noodle wheat spark

This would go down in history as the spark which led to the noodle wheat segregation.

The new segregation would concentrate the dwindling supplies of the key noodle wheat varieties to ensure shipments to Japan contained the right types of wheat for udon.

Importantly, the segregation would return guaranteed price premiums to growers to support their profitability and encourage the production of noodle wheat.

While controversial at the time, this ultimately proved to be highly successful. Noodle wheat production increased, value was increased for growers, and Japan had their udon noodles.

The ongoing success of this special relationship between WA and Japan is down to the fact that it is mutually beneficial and each partner is prepared to invest resources to ensure its success.

Western Australia continues to invest in new, improved noodle wheat varieties. Japan regularly sends visiting experts to help assess unreleased varieties.

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Australian grain-fed beef exports on the rise with focus on China

GRAIN-FED production is set to play a larger role in Australia's beef sector, with the opportunity to triple the nation's exports of grain-fed beef to China by 2030, according to recent industry research.

In its report, *Opportunities for growth in Australian grain-fed beef,* agribusiness banking specialist Rabobank says while the backbone of the Australian beef industry will remain a grass-based production system, grain feeding is forecast to play an increased role in the country's overall beef production over the coming 10 years.

Continued growth in beef consumption in Asian countries, particularly China – along with Australia's strong market access and competitive supply chain – will provide the opportunity for the nation's total grain-fed beef exports to increase 65 per cent to more than 500,000 tonnes by 2030, according to the research.

Exports of Australian grain-fed beef to China alone could triple in the same period – from the current 50,000 tonnes to close to 200,000 tonnes.

"Rabobank believes there will be strong growth in the global demand for grain-fed beef, fuelled principally by China," the report said.

Report author, Rabobank senior animal proteins analyst Angus Gidley-Baird, acknowledges Australia's vast areas of pastured land – and limited and volatile feed-grain production – suit a grass-based beef production system. But at a time where China is the centre of global beef demand, there is an opportunity to capitalise on the growing need for grain-fed beef for part of the Australian industry, he says.

Angus Gidley-Baird.

"Since the opening of the Chinese market more widely to Australian beef imports in 2013 – and with a growing appetite for beef among Chinese consumers – there has been an increasing demand for grain-fed beef," he said.

"Chinese beef consumption will continue to grow over the next decade and, with limited growth in local Chinese beef production, imports will play a much larger role in meeting this demand. At the same time, consumers in Asian markets, including China, have a strong affinity with highly-marbled grain-fed beef as it suits their palate and cuisine, fuelling a demand for grain-fed beef imports that has the potential to grow at a faster rate than overall beef imports.

"Given projections in Chinese income growth, per capita consumption of beef and food service trends – it is reasonable to expect Chinese grain-fed beef imports to grow to represent 20 per cent of China's total beef imports by 2030 (from an estimated six per cent today)."

But the report says, while increasing Australia's focus on grain-fed beef production is an opportunity worth pursuing, it comes with risks and challenges.

Enough room for everyone

While Australia is in a strong position to capture a sizeable portion of the growing global demand for grain-fed beef, particularly in China, the report says, it will not be on its own.

Other major grain-fed beef exporters – primarily the US, Canada and also likely South American countries in the future – are also expected to increase their export volumes.

But the good news is, says Angus, with the Chinese market forecast to require close to 500,000 tonnes of grain-fed beef exports by 2030, "there will be enough room for everyone".

"Rabobank believes that the other suppliers of high-quality grain-fed beef would not fill more than 300,000 tonnes of this increased Chinese demand," he said.

"Given the potential size of the Chinese grain-fed beef market and, provided Australia is competitive on price, the opportunities for Australia will likely outstrip the production growth of grain-fed beef in Australia."

Competitive position

Although Australia's grain-fed system is faced with higher feeding and processing costs than the US and Brazil, the reports says costs of cattle, reduced freight costs and free trade agreements "balance out the equation" when it comes to being competitive in export markets.

As such, Rabobank believes Australian grain-fed beef – with its own particular characteristics – can be competitive in the global market for grain-fed beef.

If Australia is to compete successfully with the US and Brazil, the report says, the local industry will need to increase the number of genetically-suitable cattle and the number of cattle that spend a longer time on feed.

"The real value of grain feeding cattle destined for a higher-end Asian export market is in the ability to more consistently deliver a high degree of marbling," Angus said. "Australia lags the US in terms of higher marbled beef production. Generally speaking, Australia's grain-fed beef production is less focussed on marbling, with less time spent being grain fed and lower marbling scores."

Maximising chances

Maximising the chances of growing grain-fed beef exports to meet increased global demand will require adjustments to the Australian beef system, the report says.

"Producers, backgrounders, feedlots and processors will all need to work together – a challenge in the current system which is heavily influenced by the availability of grass," Angus said.

"Producers and backgrounders will need to deliver consistent volumes of high-quality feedlot-performing animals. And choosing cattle genetics that perform under a feedlot environment and produce the desired quality traits will be essential.

"Feedlots will need to manage feed-grain supplies and encourage crop farmers to focus on feed-grain production while processors will need to play an active role in incentivising and providing market information to encourage the supply of appropriate animals for the system."

External challenges

There are also a number of challenges outside the sector itself which need to be considered and managed, the report says.

These include social and environment issues (such as concerns about animal welfare and environmental impacts of feedlot production), the use of Australia's valuable grain supply for animal production and an increasingly volatile global trade outlook. ■

Barley, China and sleeping giants

By Peter McMeekin


Peter McMeekin.

THE news in mid November that the Ministry of Commerce (MOFCOM) of the People's Republic of China had decided to extend the anti-dumping investigation into Australian barley imports, while disappointing, came as no surprise to most market pundits. Citing the complexity of the case, MOFCOM announced that the probe would continue for an additional six months and will be completed by May 19, 2020.

The extension comes despite full cooperation by the Australian government, its agencies, industry bodies and exporters with the ministry's investigation over the last 12 months. By all reports the detailed information sought by Beijing in the course of the investigation has been provided in accordance with their guidelines and timelines.

The ministry launched the probe in November last year, accusing Australia of dumping barley into the Chinese market at prices it considered below fair value.

World Trade Organization (WTO) rules state that anti-dumping probes should be completed within one year, though the investigating country does have the option of an additional six months under special circumstances. It seems that 'complexity' qualifies as there appears to have been no attempt by the WTO to intervene.

And our's is not the only agricultural trade stoush involving China at the moment. Early this year Beijing halted purchases of Canadian canola alleging inspectors found pests in several shipments. This has led to a slump in Canadian canola exports and has left growers battling lower prices and holding silos full of unsold seed.

And the US-China trade war continues. The on-again, off-again negotiations have been excellent fodder for the world press. But its impact on world trade and the global economy is growing rapidly.

According to the US negotiators, the two countries held further constructive discussions (whatever that means) in mid

GLOBAL MARKETS LOOK FOR DIRECTION

The November 8 release of the USDA's *World Agricultural Supply and Demand Estimates* (WASDE) failed to get the global grain trade – or futures markets – too excited. The wheat production numbers were basically a juggling act, the result being a small global increase of around 0.3 million tonnes (mt). Australian production was decreased by 0.8 mt to 17.2 mt, similar to last year's final number. But this is still around 1.5 mt above many domestic trade estimates.

Argentine wheat production was decreased by 0.5 mt to 20 mt. The US was the other major wheat producer that saw production fall compared to the previous WASDE report. The USDA pegged 2019–20 production at 52.3 mt – a decrease of 1.1 mt, but still 1.0 mt higher than last season.

On the positive side of the equation, Ukraine, Russia and the EU all saw increases to their final wheat numbers for the 2019–20 season compared to the October report. Ukraine production was increased by 0.3 mt to 29 mt. This represents a significant year-on-year increase of 4 mt – or 16 per cent.

The USDA increased Russian production by 1.5 mt to 74 mt or around 2.3 mt higher than 2018–19 production.

The most significant increase to global wheat numbers in Friday's WASDE report came in the EU. Production was posted at 153 mt, an increase of 1.0 mt compared to October and an increase of 16 mt compared to last season. But the USDA number is 3.0 mt lower than the most recent European Commission wheat forecast of 156 mt.

In France – the EU's biggest wheat producer – planting of the winter wheat crop was delayed by wet weather.

With global wheat demand remaining static, the wash-up of all of the production changes was an increase in world wheat ending stocks to a record 288.3 mt – but over half of these stocks (145.7 mt) are held within China.

Bullish on barley and corn

On the barley front, the report was slightly bullish. The USDA cut Australian production by 0.2 mt to a forecast 8.4 mt. While this may be achievable, it appears to be on the high side based on the hard finish experienced in almost all barley production regions.

Elsewhere, Argentine production was decreased slightly to 4.7 mt (5.1 mt last year), the EU was raised slightly to 61.8 mt (55.9 mt last year), and Ukraine was increased to 9.5 mt (7.6 mt last year).

The USDA increased global barley demand by 0.8 mt, predominantly in Russia, Ukraine and EU and world ending stocks were decreased by 0.8 mt, mostly in Russia and Saudi Arabia.

There were several decreases to global corn supply, but most had already been factored into trade calculations, hence the subdued futures market reaction.

US corn demand was down by 1.2 mt, but world demand was increased by 0.8 mt compared to the October WASDE report. World ending stocks of corn are forecast to decrease by 6.6 mt, predominantly in Brazil, China, EU and the US.

The market needs new news

The grain market needs news, and the November WASDE report provided nothing that wasn't already known and factored into global thinking. From a wheat and barley perspective, 2019–20 production is basically known.

A resolution, or otherwise, to trade disputes involving China is a key driver in the near term. The big one, of course, is the US standoff, with Trump seemingly dousing the most recent positive news with his usual Twitter diplomacy.

November. Completely different rhetoric was reported in China, with officials there saying the two sides are not even on the same page. Plenty of work to do, it seems, before a deal is inked.

Australian barley and China

In recent times, Australia has been China's largest supplier of barley with the grain going into both the brewing and stockfeed markets. In the 2017–18 marketing year (October 2017 to September 2018) China imported almost 6.5 million tonnes (mt) of Australian barley. This was valued at more than AU$2.2 billion and accounted for around 75 per cent of China's barley imports in that year.

Though still significant, that dropped substantially in the 2018–19 season, to a tad under 2.4 mt. To put that in perspective, Japan, Thailand and Vietnam were the next biggest importers of Australian barley at 653,000, 205,000 and 112,000 tonnes respectively.

What does this mean for exports of Australian barley over the 2019/20 marketing year? If past actions are a fair indicator of future intentions, it certainly doesn't mean that there will be no barley trades to China.

While a significant proportion of last season's export business to China would have already been on the books when the anti-dumping investigation was announced, there was 730,000 tonnes shipped in the second half of the season. Most of this business was probably concluded after the investigation commenced.

But any new crop sales are more likely to be malting barley as opposed to feed barley. Feed grain demand is falling as the African Swine Flu epidemic continues to decimate the pig population in China.

On the other hand, Chinese brewers prefer Australian malting barley over French on the basis of quality, and malting barley prices in Canada make that origin uncompetitive at the moment. In fact, market rumours are suggesting that as much as 500,000 tonnes of new crop Australian business may have already been concluded.

The expectation is that barley exports to China will be down again this year. Those exporters that are willing to accept China as a trade counterparty are likely to trickle barley onto the Chinese mainland but will minimise risk by doing so one, or maybe two, cargos at a time.

Where to for Australian exports?

Outside of China, Saudi Arabia, in particular the port of Dammam in the Arabian Gulf, increases in significance as a destination for Australia's exportable surplus in the first half of 2020. Australian exporters would certainly be hoping to do more than the one cargo shipped to the Gulf state in the 2018–19 season.

The Saudi Arabian Grain Organisation (SAGO) announced a tender in mid November for 1.02 mt of animal feed barley for February and March arrival. The results were released on Monday with offers received from Australia, the European Union, the United States, Argentina and the Black Sea region.

In the end, SAGO booked 17 individual consignments of 60,000 tonnes, with 13 (780,000 tonnes) destined for Red Sea ports and four (240,000 tonnes) to be delivered to Arabian Gulf ports. The average price of US$216.62 was an increase of US$6.67 (approximately AU$10) on the previous tender for an identical quantity on September 30.

With Australia's freight advantage over the Black Sea and Europe, domestic exporters will also be looking to other traditional Asian consumers such as Japan, Thailand and Indonesia to step up to the plate and increase their imports of Australian barley over the next 10 months.

Call your local Grain Brokers Australia representative on 1300 946 544 to discuss your grain marketing needs. ■

Livestock feed demand puts squeeze on Australian grain

AUSTRALIA'S grain 'balance sheet' is set to materially tighten over the next decade, with increasing demand for grain to feed livestock – coupled with growing human consumption – well outstripping projected supply, according to a recently-released industry report.

This will see the proportion of the nation's grain harvest exported annually decline from the current 60 per cent to 53 per cent by 2030, and may also increase the likelihood of further grain imports into the country over time.

In its report The Australian Feed Grain Squeeze, agribusiness banking specialist Rabobank says by 2030, the domestic market for cereal grains (wheat, barley, oats and sorghum) will soak up an additional six per cent of Australia's annual production, leaving available supply for exports down by two million tonnes (or 10 per cent under the current five-year average)

Report author, Rabobank senior grains analyst Cheryl Kalisch Gordon says the bank is forecasting domestic demand for cereal grains to grow by 2.3 per cent per annum over the next 10 years (to above 17.5 million tonnes a year by 2029/30), well exceeding projected annual supply growth of only 0.4 per cent per annum over the same period.

Rabobank senior grains analyst Cheryl Kalisch Gordon.

More mouths to feed

Livestock feed will take an increasing proportion of Australia's domestic grain supply, the report says, driven by a rise in the number of stock being fed grain to satisfy local and international demand for animal protein.

Increased human consumption of food products containing grain will also fuel part of the rising demand.

"Despite changing diets, which have seen people's consumption of wheat and other coarse grains fall on a per capita basis, Australians will still consume more grain due to population growth," Cheryl said.

"Overall, this will see an increase in demand for cereal grains in Australia, due to both direct consumption of grain in products – such as breakfast cereals, bread, cake, biscuits, pasta and beer – and also derived demand for grains to feed livestock that supply animal protein products, including beef, lamb, chicken, pork, eggs, milk and fish."

This domestic appetite will also be augmented by a strongly-growing demand for Australian beef and lamb in export markets for at least the next five years, she said, as "the global protein market resets as a consequence of the African swine fever epidemic in China".

Cheryl said a higher level of growth in feed-grain demand – compared with human consumption – forecast over the next decade meant the share of cereal grains going to feed in Australia would approach 70 per cent by 2029–30, up from 64 per cent (the five-year average to 2018–19).

"As such, we will not only see increased demand for grains in Australia, but an increase in the relative importance of feed grain as an end use compared with milling, malting and processing for human consumption," she said.

Supply

On the supply side, the report says, production growth will not be able to keep up with the forecast increase in demand over the coming decade.

"We expect Australian cereal grain supply to increase by just 0.4 per cent annually over the next 10 years," Cheryl said.

"In the absence of any new technologies that offer step change improvements in yield growth – and in the face of a drying climate and challenges to crop management, such as herbicide resistance and potential limits on the use of glyphosate – we do not expect future yield growth to exceed historical growth trends."

Cheryl said with a "southerly contraction" already occurring across Australia's cropping belt due to climate challenges, as well as relative commodity pricing, the bank was not expecting cropping area growth in the forecast period.

"And while genetic modification and new plant-breeding techniques offer the potential for step change increases in yield that would offset the feed grain squeeze, we consider the likelihood of development, adoption and end-market acceptance low within the coming decade," she said.

As such, the report says, Rabobank expects average Australian cereal grain production to be at around 37.5 million tonnes by 2030, up from the current five-year average of 35.8 million tonnes.

"But Australian production will continue to be prone, and possibly more vulnerable, to year-to-year variation, so a range of 20 million to 52 million tonnes must be considered part of the outlook," Cheryl said.

Exports and imports

The report says the expected low rate of production growth, together with the forecast increase in domestic demand, will reduce Australia's annual export surplus – from an average of 22 million tonnes of wheat, barley, oats and sorghum (2014–15 to 2018–19) to an export surplus closer to 20 million tonnes by 2030.

A higher level of growth in feed-grain demand – compared with human consumption – forecast over the next decade meant the share of cereal grains going to feed in Australia would approach 70 per cent by 2029–30.

"This will result in the proportion of Australia's grain production going to exports reducing from typically being 60 per cent of annual production to 53 per cent by the end of the next decade," Cheryl said.

And, while Australia would "remain a net exporter of cereal grains", she said, there was increased potential to see further grain imports coming into the country over the next decade.

"Feed grains may be imported if the basis (price) reaches sufficiently high levels to cover freight and compliance with import biosecurity measures. But the import of food-grade grains for milling, malting or other processing will be more likely."

East/west divide and price

The Rabobank report says grain 'balance sheet' tightening will be particularly focussed on Australia's eastern states "where supply growth will be lowest and demand growth highest".

"The highest forecast growth in cereal supply will be in Western Australia and South Australia," the report says. When it comes to demand though, growth will continue to be concentrated on the east coast of Australia.

"Together, Victoria, NSW and Queensland account for close to 80 per cent of Australia's population and have the highest forecast population growth over the coming decade," Cheryl said. "They also have more than 90 per cent of the country's feedlot capacity, more than 65 per cent of its milling capacity and more than 70 per cent of poultry sector capacity."

This tightening is expected to see the average underlying east coast basis rise by as much as five per cent per annum, she said.

"For WA and South Australia, higher supply growth will put downward pressure on the basis between local grain prices and global prices, though prices are expected to be supported more often by demand for their grain from the eastern states."

The growing demand for livestock feed will also narrow the premiums for food-grade grain and improve the profitability of growing feed grains in Australia, especially in Queensland, NSW and Victoria, the report says. ■

Prices paid for grain farms outstrip other rural sectors

PRICES for Australian cropland have been increasing at a much faster rate than other farm land – far exceeding price growth of country used for dairy and pastoral grazing – with close to double-digit average annual growth rates since 2014, a recent report has found.

This is limiting expansion opportunities for crop farmers, leaving many essentially land-locked, the report says.

Rabobank agricultural analyst Wes Lefroy.

In its recently-released report, *Unlocking Opportunities to Buy Australian Cropping Land*, Rabobank said while prices for dryland cropping land have risen by a compound annual growth rate of 9.1 per cent over the past five years at a national level, price growth has varied significantly between regions (Figures 1 and 2), making interregional purchases "more compelling for farmers".

"Demand for cropping land has been particularly intense over this period, which has accelerated the increase in cropping land prices, relative to other commodity sectors", says report author, Rabobank agricultural analyst Wes Lefroy. "This compares to a 5.1 per cent compound annual growth rate in dairy land values and two per cent for pastoral grazing land.

"Initially, we saw demand for cropping land swell as a result of a string of favourable seasons, which enabled farmers to expand.".

More recently, Wes says, a lack of properties on the market has primarily driven price growth, particularly in drought-affected regions – with overall rural property listings estimated to be down by more than 50 per cent on 2014 in many parts of the country.

"The lack of purchase opportunities is one of a number of drivers that are now tipping favour toward growers purchasing land outside their existing region, more so than we have seen in the past," he says.

Looking inside, then out

Wes says for those farmers looking to expand, the 'inside, then out' approach is a way of "unlocking" opportunities to buy cropping land.

"Farmers have always had incentives to buy land beyond their home region, but there are now more compelling reasons for farmers to consider this strategy as a means to expand," he says.

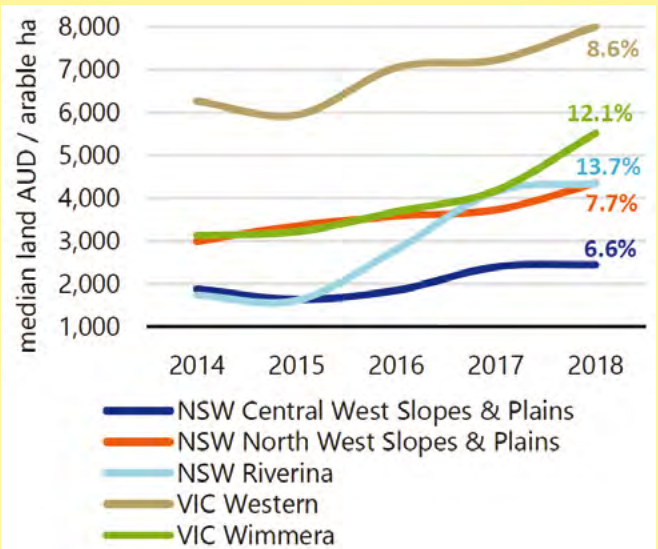
"For example, lifestyle is a larger consideration as well as variability of rainfall, as many cropping regions are expected to continue to face lower winter/spring rainfall and warmer temperatures in light of a changing climate."

For those looking to expand into other regions, Wes cautions farmers to ensure the cost of not expanding outweighs the extra operational cost and complexity of interregional purchases.

"In some situations, economies of scale will be dampened by the travel times and costs between places or if the production practices significantly differ between properties," he says.

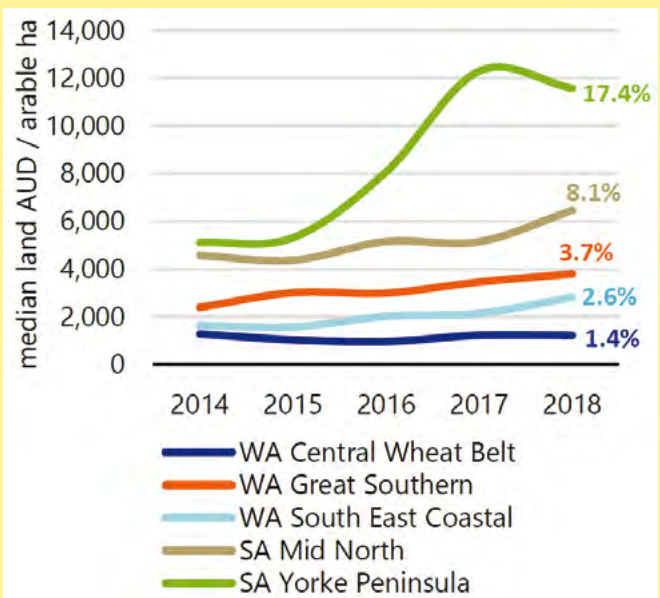
"But where overhead costs can be shared across more production units and the numbers between potential output and return on investment stacks up, interregional land purchases are certainly a way of unlocking opportunities to buy more cropping land." ■

FIGURE 1: Select NSW and Victoria regional median crop land prices*, 2014–18 and five year compound annual growth rate



Note: *Excluding improvements/arable hectares. Source: Rabobank 2019.

FIGURE 2: Select South Australian and West Australian regional median crop land prices*, 2014–18 and five year compound annual growth rate



Note: *Excluding improvements/arable hectares. Source: Rabobank 2019.

Well planned grain storage makes for a trouble-free harvest

GRAIN growers are encouraged to consider upgrading and improving their storage infrastructure to help achieve trouble-free harvest.

"Those improvements don't need to be complicated or expensive – simple tweaks and adjustments can make all the difference in ensuring successful and trouble-free storage of grain," says Chris Warrick, who co-ordinates the GRDC Grain Storage Extension Project.

Chris Warrick. (PHOTO: GRDC)

"Ultimately, we should aim for best practice storage management for safer and easier to use systems."

Chris has provided growers with straightforward, practical advice on what they can do to improve their storage via a GRDC webinar that is also now available through the GRDC's YouTube channel at *http://bit.ly/2mLgjWy*.

The grain storage upgrades webinar was the third in an ongoing series providing growers with convenient, timely and relevant information and advice about all aspects of storing grain on-farm.

Regular maintenance

In the latest recorded webinar, Chris – who is also a consultant with Primary Business – states that regular maintenance of storage is essential.

"Make use of the weeks before harvest to fix damaged hatches, repair rust and other damage, check the seals, and conduct a three-minute half-life pressure test if the silo is gas-tight sealable.

"As part of that pressure test, check the oil levels in the oil relief valves. And if you need to replace the valves, consider replacing them with a larger valve that lets more air through."

Chris advises that while retro sealing can be applied to existing storages, the cost of doing so can be high and the success rate low.

"Rather than retro sealing, I would suggest investing the money in additional storages that are gas-tight sealable to the Australian Standard 2628."

Aeration cooling and maintenance

Adding aeration cooling to existing storages is a common form of upgrading infrastructure, providing considerable benefits in terms of grain quality and insect pest control.

Grain storage systems can be inherently hazardous so any measures to increase safety are highly recommended. (PHOTO: Paul Jones)

Chris suggests installing one or two small fans per silo for efficient and effective cooling, and venting should be considered.

He says a small investment in monitoring equipment is justified given the amount of valuable grain stored on-farm these days.

"Insect traps and sieves, thermometers and moisture meters can greatly assist in monitoring grain in storage. And it's also worth setting up and maintaining a system of keeping record of what you have detected and what you did in response," Chris says.

Safe and easy access

Ladders and walkways should also be reviewed: "It's important to be able to get to the top of the silo via safe and easy access so you know what's going on within the grain stored in respect to mould and insects.

"Existing ladders can be improved with a cage, platform and handrails, and a walkway across multiple silos is a safe way to monitor grain. When working at heights, a safety harness is also advisable."

Chris says grain storage systems can be inherently hazardous so any measures to increase safety are highly recommended.

"Safety is about identifying potential hazards, the likelihood of those hazards coming into play and the potential severity of incidents and accidents," he says.

Tips to reduce hazards include:

- Installing danger signs to advise of overhead powerlines, especially if tip trucks and augers operate nearby;
- Installing danger signs to advise of phosphine fumigation being undertaken;
- Removing any obstacles that pose a trip or head knock hazard;
- Blocking off child access to ladders;
- Considering guards on augers, belts and conveyers;
- Levelling gravel bases under augers to reduce movement; and,
- Installing lighting for safe use of storage at night.

More information on all aspects of grain storage can be found on the GRDC's Stored Grain information hub at *http://storedgrain.com.au/*

Combining good hygiene, well managed aeration cooling along with regular grain inspections provides the best foundation for successful grain storage. (PHOTO: GRDC)

PARTNERSHIP TO COMMERCIALISE A NEW INSECTICIDE FOR STORED GRAIN PEST CONTROL

Bio-Gene Technology is a small Australian biotech company focused on helping to solve some of the world's most pressing health and agriculture problems.

Two of the biggest problems are:

- Growing resistance to insecticide by crop pests and disease-carrying insects – and no new modes of action coming on to the market; and,
- Public concern about some of the commonly-used insecticides.

Bio-Gene has just turned the corner in its development of a new insecticide – Flavocide. This is the first new mode of action to be identified since 2008.

The company has announced a partnership with global heavyweight BASF to continue research on the active ingredient of Flavocide, with a view to commercialise the new insecticide for stored grain pest control.

What is it?

Bio-Gene developed Flavocide from a compound found only in a sub-species of the humble Gympie Messmate, a eucalypt found only in a small part of Queensland.

Flavocide has significant trial data demonstrating efficacy, but importantly, it is 5000 times less impactful on bee populations than current insecticides.

Following successful trials and studies, BASF is now funding field trials with Queensland Department of Agriculture and Fisheries, which is the next step to commercialisation – but the biggest step so far.

Peter May, Bio-Gene Executive Director, Research and Development and Dr James Wade, Bio-Gene Program Manager, inspecting Gympie Messmate, the source of the compound in the new insecticide.

This partnership with BASF will further develop the Flavocide compound for use in stored grain, including identifying the optimum application rates for insect control and resistance management.

Maximising the potential of retained seed for next season

DRY and hot seasonal conditions – an all too common situation for grain growers across the country this year – have resulted in small and shrivelled grain from crops making it through to harvest. Growers are reminded of some rules of thumb to adhere to when retaining seed following a tough year.

This grain can be susceptible to poor germination and low vigour (ability to push through the soil following germination) so extra care is needed and sowing rates in 2020 may need to be adjusted.

Frost may have also affected grains in some areas, causing a lower hectolitre weight and higher screenings – the material that is removed when grain is cleaned.

Josh Johnson, GRDC manager agronomy, soils and farming systems – west, advised growers to select their cleanest paddocks from which to retain seed, from both a weeds and seed purity standpoint.

"Paddock selection for a seed crop is generally determined before the season and, barring any crop failures, should not change during harvest," Josh said.

"If you are grading seed, take the largest seed size possible to get the required amount for seeding."

Simple on-farm test for viable seed

Josh said that while a laboratory seed test for germination and seedborne diseases should be carried out before sowing, growers could also conduct a simple on-farm test after harvest to ensure they retained enough viable seed to achieve acceptable plant populations the following season.

"This on-farm test involves collecting and counting seed from each lot to be planted, putting the seed between moist paper towels placed in a sealed plastic bag, leaving them for five to seven days in a warm place and then calculating the germination percentage after counting the number of seeds that have not germinated," he said.

If on-farm tests reveal poor germination rates, growers could decide to pay to buy in seed.

Factors influencing how much seed needs to be retained for sowing include:

Josh Johnson, GRDC manager agronomy, soils and farming systems – west, says following some rules of thumb can maximise the potential of retained seed following a difficult season. (PHOTO: GRDC)

Wheat being tested for moisture and protein, and screened, before the load is stored. (PHOTO: Evan Collis Photography)

- Germination rate tested at harvest;
- Further decline in germination between harvest and sowing;
- Screenings, foreign and small seeds lost at cleaning;
- Allowance for seeds that germinate but don't emerge;
- Seed weight (grams per 1000 seeds); and,
- Buffer to allow for change of plans in planted area.

Correct storage of retained seed

Josh said that once seed had been graded, correct storage was needed to ensure the viability of seed for the following season.

"This includes ensuring storage temperatures are cool, using aeration in the silo and making sure the seed has low grain moisture content," he said.

"Monthly monitoring of the stored seed is advised, as is prompt fumigation if any pests are detected."

Information about factors affecting grain crop seed germination, how to carry out on-farm tests and laboratory testing services is available on the Department of Primary Industries and Regional Development website. Helpful tips are also available on the GRDC Stored Grain Information Hub.

Further information: Josh Johnson, GRDC manager agronomy, soils and farming systems – west: josh.johnson@grdc.com.au

WHERE TO FIND MORE INFORMATION

More information about correct storage for retained seed is available in a GRDC Storing planting seed video. There is also information about frost damaged crop salvage options and seed retention in a GRDC podcast.

The GRDC Updates paper – *Testing of farm-retained and carryover seed* – also contains further information. The paper stresses that while next season's planting seed is a relatively low-cost input on a per hectare basis, its quality is fundamental in setting up a paddock for profit... or loss.

Trends in HWSC – the days of doing nothing are over

By Cindy Benjamin, WeedSmart

A SIMPLE online survey of 147 farmers from around Australia has added weight to the observations that growers are rapidly adopting harvest weed seed control methods that best suit their farms.

WeedSmart has previously conducted a similar survey in 2017 (269 respondents) and 2018 (95 respondents). And in 2014, a GRDC funded grower practices survey led by Rick Llewellyn from CSIRO, 600 growers answered questions related to the adoption of harvest weed seed control methods.

Peter Newman, WeedSmart and AHRI extension agronomist in Western Australia has been following the adoption trends closely.

"We know that these surveys are biased and are not statistically rigorous, but together they are showing trends that we are also seeing in the field," he says. "As growers invent, modify and trial different harvest weed seed control tools there is a rapid move toward actively managing survivor weeds at harvest and the adoption of tools that don't involve burning."

The most important and encouraging finding is that the percentage of growers 'doing nothing' to capture and destroy weed seeds present at harvest has declined dramatically since 2014 harvest – from almost 60 per cent – down to around five per cent predicted for 2022 harvest (Figure 1).

Peter Newman, WeedSmart and AHRI extension agronomist is thrilled to see more evidence of growers adopting harvest weed seed control tactics to their farming systems.

"This is a significant change in attitude and suggests that growers are taking the opportunity to tackle herbicide resistance head-on. When it comes to choosing the best tool for the job, growers can be assured that each of the tools available are equally effective at capturing and destroying weed seeds," says Peter. "Some tools have a particular fit for certain situations. For example a chaff cart might be chosen for a mixed farming operation, or chaff tramlining chosen to help manage dust and erosion risk in a controlled traffic system."

Around 10 per cent of growers are using and expect to continue using chaff carts and there is steady adoption of chaff tramlining, with almost 20 per cent of respondents planning to use a chaff deck this harvest.

Windrow burning now superseded

"It is clear that narrow windrow burning has been superseded and few growers will be disappointed about having better options that conserve nutrients and involve less risk," he says. "Less than five per cent of growers expect to still be doing narrow windrow burning in the 2022 harvest."

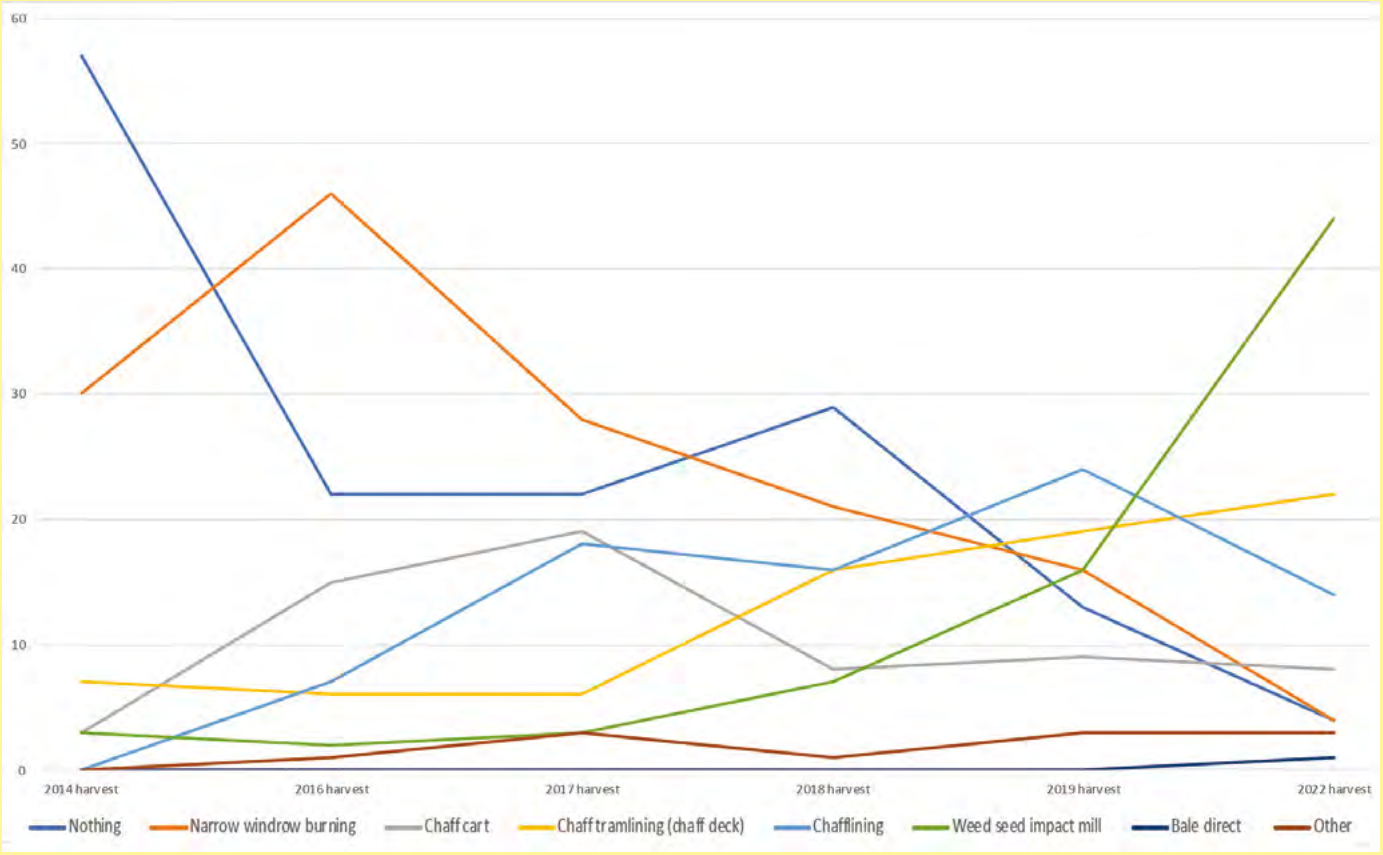
While chaff lining has been rapidly adopted as a simple and cheap alternative to narrow windrow burning, many growers indicated that they would not be using this method in 2022. The trends indicate that many of these growers will be looking carefully at recent developments with weed seed impact mills.

"With three weed seed impact mill manufacturers now offering machines in Australia, growers are the beneficiaries of increased competition and many see this as the ultimate solution to weed seed, stubble and nutrient management at harvest," says Peter.

Harvest weed seed control is one of the WeedSmart Big 6 suite of tactics to contain the threat of herbicide resistance in weeds.

For more information about harvest weed seed control tools visit the website: *www.weedsmart.org.au*

FIGURE 1: Adoption trends for harvest weed seed control tactics on Australian grain farms



Microbial marauder of crops worldwide has an accomplice

By Jan Suszkiw, Agricultural Research Service – USDA

DESCENDANTS of the fungus-like pathogen that caused the Irish potato famine in the 1840s – *Phytopthora infestans* – may have had a 'helping hand' in recent US outbreaks of the costly blight disease.

Reporting in the September 2019 issue of *Virus Research*, a team of Agricultural Research Service (ARS), Cornell University (CU) and Rutgers University scientists announced they had identified a virus that infects *P. infestans* and appears to increase the pathogen's ability to cause the disease, known fully as 'late blight'. Late blight attacks on tomato and potato crops worldwide inflict more than $US6.7 billion annually in yield losses and control costs.

In susceptible potato and tomato varieties, late blight causes lesions and other disease symptoms that rapidly destroy the plants' leaves, stem, fruit or tubers. The pathogen perpetuates its disease cycle by forming masses of spores that spread elsewhere to devastating effect, notes Guohong Cai, a plant pathologist with the ARS Crop Production and Pest Control Research Unit in West Lafayette, Indiana.

Historically, late blight researchers focused their attention on studying the pathogen's virulence, disease cycle, host plant responses, capacity to resist fungicide and the environmental factors that favour it. But little attention has been paid to a virus called PiRV-2 known to reside in some late blight strains including US-8. The latter was first detected in New York state in 1992 and four years later had spread to other potato-producing states and parts of Canada.

Potato infected with late blight. (PHOTO: Scott Bauer)

International search

In collaboration with William Fry and Bradley Hillman, with CU and Rutgers, respectively, Guohong used molecular methods to detect for the virus in 73 samples (or 'isolates') of late blight collected from North America, Mexico, The Netherlands, Estonia and South Africa.

They also used high-throughput sequencing and mapping techniques to identify late blight genes that were either 'up-' or 'down-regulated' by the virus, finding 848 of them. Up- or down- regulation of genes refers to their role in either increasing or decreasing cellular activity (like making proteins) in response to external stimuli – in this case, PiRV-2.

Based on their analysis, the researchers found PiRV-2 in 11 of 13 (85 per cent) isolates of US-8 and three of four isolates of another common North American lineage, US-22. PiRV-2 was harder to find in late blight isolates from the other countries, including Mexico – the pathogen's centre of origin and greatest source of genetic diversity.

The researchers also conducted a series of petri dish experiments using potato leaves from a susceptible variety to compare the virulence of late blight with and without PiRV-2, determining that cultures of the pathogen with the virus produced nine to 125 times more spores and caused larger lesions on the leaves.

"The number of spores produced by a late blight lesion is an important factor in late blight epidemics," Guohong explained. "More spores could lead to more transmission and infection" – a boon, in turn, to the virus's own survival and spread.

PiRV-2's prevalence in the majority of US-8 late blight isolates tested suggests it could have contributed to the lineage's dominance and persistence in US potato and tomato crops compared to others that have come and gone since being introduced in the late-1980s.

Further study is needed to determine how prevalent the virus is among all populations of late blight worldwide, and whether this holds any implications for new ways to control the disease or to predict its severity in crops.

The Agricultural Research Service is the US Department of Agriculture's chief scientific in-house research agency. ■

BENEFICIAL NEMATODES EMERGE FROM AN INFECTED INSECT HOST

By Sandra Avan – ARS – USDA

Beneficial nematodes are used as biological control agents to fight a variety of insect pests that severely damage crops. But in many cases the nematodes don't measure up to other control methods such as certain chemical pesticides.

A recent Agricultural Research Service (ARS) study, published in *The Journal of Invertebrate Pathology*, shows that beneficial nematodes (also called entomopathogenic nematodes) treated with pheromone extracts are more effective at killing an economically important insect – the pecan weevil – as well as the black soldier fly.

The pecan weevil is a major pecan pest in the Southeast of the US as well as in Texas and Oklahoma, said David Shapiro-Ilan, an entomologist at the ARS Southeastern Fruit and Tree Nut Research Laboratory in Byron, Georgia. If left uncontrolled, it can reduce crop production up to 70 per cent.

Safe and targeted control method

An advantage of using beneficial nematodes is that they are safe for humans and the environment and target only specific insects, David said.

In earlier research, David and his colleagues discovered that pheromones produced by beneficial nematodes direct their behavior – telling them to disperse or infect insects. With that in mind, they sought ways to use pheromones to enhance nematodes' behavior to kill more insect pests.

Since then, ARS has established a cooperative research agreement with Pheronym, an ag-biotech pest control company that develops and produces nematode pheromones that can be used to direct beneficial nematode behavior.

David and his colleagues – ARS post-doctoral research associate Camila Oliveira-Hofman, Pheronym CEO Fatma Kaplan and Ed Lewis, head of the Department of Entomology, Plant Pathology and Nematology at the University of Idaho – tested the efficacy of Pheronym's beneficial nematodes exposed to pheromone extracts.

The research showed that pheromone induced nematodes were 28 to 78 per cent more effective in controlling pecan weevils and black soldier flies in greenhouse soil than non-exposed nematodes. In addition, a higher number of pheromone-treated nematodes invaded insect larvae compared to the non-treated nematodes.

This research is believed to be the first time a parasite's – the nematode – own pheromone was used to improve its effectiveness in attacking its host – the pecan weevil and black soldier fly, according to David.

The study's paper, titled "*Pheromone extracts act as boosters for entomopathogenic nematodes efficacy*," was recently selected as a Research Highlight of 2019 by the Nematode Division of the Society of Invertebrate Pathology.

High cost of water dries up profit

A SIGNIFICANT increase in temporary water prices in the Murray-Darling Basin is placing permanent crops like almonds, wine grapes and citrus under considerable pressure, with water costing up to 40 per cent of the per-tonne average value of commodities in some instances.

A recent NAB report highlights the impact persistent drought across eastern Australia is having on both water storages throughout the Murray-Darling Basin and how subsequent skyrocketing temporary water prices are impacting producers.

NAB Agribusiness Economist, Phin Ziebell, said permanent plantings were in a particularly tricky position due to their need for constant water.

"The temporary water price in the Barmah Choke – South Australia border area has increased 138 per cent in the past year, to $950 per megalitre," Phin said. "Upstream of the Barmah Choke, temporary water prices have increased 55 per cent over the same period.

"Our modelling shows that for a temporary-water reliant wine grape producer in the Sunraysia region, the $550 per megalitre uplift in price equates to roughly $180 per tonne of grapes, or nearly 40 per cent of the per-tonne average value of warm climate wine grapes."

Water price beyond the reach of annual crops

With most general security entitlements across NSW at zero per cent, the report details that elevated temporary water prices are beyond the reach of annual crops like cotton, with production volumes tipped to be low again this season.

"Based on current prices and average application rates and yields, neither cotton nor rice are overly profitable at a temporary water price of $800 per megalitre," Phin said.

Despite the challenges presented by low water availability, the NAB Rural Commodities Index recorded an overall gain of 2.5 per cent in October.

NAB Agribusiness Customer Executive, Neil Findlay, said resilience in livestock markets was a key driver of the increase.

"The National Trade Lamb Indicator stands at $7.41 per kg, which is a very strong spring price, and we expect prices to remain strong on the back of tight supply," Neil said.

"The wool price has stabilised somewhat with the Eastern Market Indicator at around $15.74 per kg.

"Tensions between the United States and China appear to have cooled, although we doubt this will lead to much of an increase in the wool price."

The Eastern Young Cattle Indicator reached its highest level in several months, at 517c per kg.

"While there is still considerable weakness in the store cattle market, processor demand for finished cattle runs hot amid strong export market performance," Neil said.

Wheat export concerns

NAB's winter wheat forecast remains on hold, at 15.5 million tonnes, with eastern states predicted to face another season of international and West Australian grain imports.

"West Australian producers have benefitted from the high prices associated with strong eastern demand, but south-east Asia has swung heavily away from Australian grain," Neil said.

"Recapturing this south-east Asian market from Black Sea and South America grain could be a challenge for the sector in 2020." ■

The price of temporary water this season has made it almost impossible to make money from irrigated annual crops such as rice or cotton.

Underground oases could save ailing Murray floodplains

By Andrew Spence

UNDERGROUND bodies of freshwater could hold the key to the health of the fragile floodplains of Australia's Murray Darling Basin.

Flinders University researchers in Australia have discovered freshwater 'lenses' that float on the saltwater aquifer below floodplains that run adjacent to the River Murray for most of its length.

The researchers say the lenses could potentially be expanded and play an important role in sustaining the floodplains that are under threat because of reduced inundation, salinity and increasing irrigation pressures.

The Murray-Darling is Australia's largest river system and runs through south eastern Australia from New South Wales and Victoria and into South Australia where it meet the Southern Ocean. The river system, which is used extensively for irrigation, is managed by the Murray-Darling Basin Authority.

Flinders University Hydrogeology Professor Adrian Werner said the reduction in flooding events in recent decades was having a major impact on floodplain and wetland vegetation, forcing the Murray-Darling Basin Authority to look at ways to save the fragile ecosystems.

Professor Adrian Werner says the discovery of fresh water lenses in the Murray River floodplains could potentially help maintain vegetation along the river. This vegetation helps prevent salts from rising to the soil surface.

Groundwater salinity

"One of the factors they now consider to be important is the salinity of the groundwater under the floodplain," Adrian said.

"If you have a tree on the floodplain that's taking considerable amounts of fresh water and it's not being flooded then it's going to start drawing on the deeper water and if that water is salty then it's going to have a considerable impact on the vegetation.

"What we discovered was that in the River Murray floodplains there are freshwater lenses that float on the salt water that extend underground out from the river into the floodplain."

Adrian, who was recently described as Australia's research field leader in Hydrology and Water Resources, has also spent considerable time studying the underground water resources of Kiribati, an island nation in the central Pacific.

He likened the freshwater lenses floating on the Murray floodplain aquifers to the freshwater lenses found floating on underground seawater in islands.

Reduced flooding events in recent decades are having a big impact on floodplain and wetland vegetation.

Floodplain vegetation is important as it uses groundwater in the soil profile, preventing water and salts rising to the surface or being transported to the river.

"On an oceanic island, if you drill deep enough you'll hit seawater but above the seawater you'll have freshwater and it floats because the freshwater has less density than the seawater," Adrian said.

"In the Murray River the aquifers around the river in many places contain ancient saltwater, which is basically rainfall that's concentrated through evaporation to levels that in some cases where the salinity is even higher than seawater.

"When the floodplain aquifers also contain saltwater that can have a significant impact on the vegetation because if the groundwater is salty it can make the soil salty and if the soil goes salty the evaporation can concentrate that salt and kill the vegetation.

"But if the aquifer has a freshwater lens floating on top of it, this can maintain vegetation because now they have a freshwater supply under their roots."

Floodplain vegetation is important as it uses groundwater in the soil profile, preventing water and salts rising to the surface or being transported to the river.

But irrigation can increase the height of the water table, dissolving salt in the soil and bringing salt into the root zone of crops or into aquifers that flow into the river.

Flooding is the natural process by which excess salts are periodically removed from the floodplain and the river system. But the practice of floodplain harvesting – where irrigators divert overland flows into irrigation stores after rain events – is thought to be a contributing factor to increasing salinity, dropping river levels and mass fish kills earlier this year.

Ray of hope

Adrian said the presence of freshwater lenses under the floodplains and wetlands offered a ray of hope for the under-threat ecosystems.

He said the freshwater lenses were kilometres wide in some areas under the floodplain but spanned only tens of metres in other places.

"Until we did our analysis no one had any idea about the physics of those freshwater lenses or even thought they could be there.

"The intuition was that there shouldn't be freshwater there but we showed using a lot of the theory from the (Pacific) islands that in fact there should be freshwater lenses there, we have seen it in our measurements and we can explain it using the physics and numerical models we've used on islands to show that those freshwater lenses are real."

The South Australian researchers from Flinders have visited some of the floodplains to take samples from the freshwater lenses in a collaboration with researchers from Monash University and the South Australian Government.

Adrian said the freshwater lenses were not just a critically important underground water source for vegetation, they also played a role in regulating river salinity levels.

He said the freshwater lenses could also reduce the amount of salt flowing to the river.

"We're also looking at ways to potentially insert materials into the floodplain aquifer to artificially grow the freshwater lens without having to pump water or change the floodplain hydrology.

"Knowing and being able to predict where those freshwater lenses are and what the relationship is between them and vegetation is a critical part of the story of protecting the Murray River floodplain ecosystem.

"It's mostly about protecting the floodplain vegetation and looking for ways to keep those ecosystems healthy among other methods like artificial inundation and various techniques being proposed by the Murray-Darling Basin Authority."

Adrian presented his research in November at the Australasian Groundwater Conference in Brisbane.

Freshwater under the sea

His other research has been exploring freshwater aquifers under the sea, which has led to the recent publication of seven papers that cover a range of issues from improving methods of obtaining offshore freshwater estimates to better understanding how onshore events influence and affect subsea freshwater aquifers.

The research has focused on major offshore aquifers in South Australia's south east and near Perth, Western Australia.

Several severe recent water shortages in coastal cities around the globe – including Cape Town during 2018 – and concerns about Christchurch's emergency supply raised the possibility of accessing offshore freshwater, even if only as an emergency measure.

But Adrian warns that current knowledge of the extent of offshore freshwater is limited, and questions already exist whether humans are already drawing on offshore freshwater reserves while pumping fresh groundwater from coastal aquifers.

"Since the late 1960s, groundwater scientists have been intrigued by evidence of freshwater beneath the sea, and in the following decades, understanding subsea fresh groundwater has advanced and is now understood to be a global phenomenon," Adrian said.

"Our research is addressing whether we are already accessing offshore freshwater or whether this is a largely untapped resource that is yet to be exploited." ■

Why plants panic when it rains

By the ARC Centre of Excellence in Plant Energy Biology

AT A GLANCE…

An international team of scientists has made the surprising discovery that a plant's reaction to rain is close to one of panic. The research revealed complex chemical signals are triggered when water lands on a plant to help it prepare for the dangers posed by rain.

AN international team of scientists involving The University of Western Australia's School of Molecular Sciences, the ARC Centre of Excellence in Plant Energy Biology and Lund University has made the surprising discovery that a plant's reaction to rain is close to one of panic.

The research, published in *Proceedings of the National Academy of Sciences*, revealed complex chemical signals are triggered when water lands on a plant to help it prepare for the dangers posed by rain.

UWA Professor Harvey Millar said after spraying plants with water and observing the effect, the researchers noticed a chain reaction in the plant caused by a protein called Myc2.

Leaf to leaf warning signals

"When Myc2 is activated, thousands of genes spring into action preparing the plant's defences," Harvey said. "These warning signals travel from leaf to leaf and induce a range of protective effects."

"As to why plants would need to panic when it rains – strange as it sounds – rain is actually the leading cause of disease spreading between plants."

"When a raindrop splashes across a leaf, tiny droplets of water ricochet in all directions. These droplets can contain bacteria, viruses, or fungal spores. A single droplet can spread these up to 10 metres to surrounding plants."

Evidence also suggests that when it rains, the same signals spreading across leaves are transmitted to nearby plants through the air.

"One of the chemicals produced is a hormone called jasmonic acid that is used to send signals between plants," Harvey said.

"If a plant's neighbours have their defence mechanisms turned on, they are less likely to spread disease, so it's in their best interest for plants to spread the warning to nearby plants.

"When danger occurs, plants are not able to move out of the way so instead they rely on complex signalling systems to protect themselves."

Harvey said it was clear plants had an intriguing relationship with water, with rain a major carrier of disease but also vital for a plant's survival.

The study was conducted in collaboration with SLU Umeå, The Salk Institute for Biological Studies, Ghent University, VIB Center for Plant Systems Biology, La Trobe University and CSIRO.

Acknowledgments: From proceedings of the National Academy of Sciences. Organisations involved: ARC Centre of Excellence in Plant Energy Biology, The University of Western Australia, Lund University.

Funder: Australian Research Council.

(L to R) Researchers Martyna Broda, Dr Owen Duncan and Prof. Harvey Millar spraying water on Arabidopsis plants used in the study. (PHOTO: UWA)

Precise sprayer delivers precision and efficiencies

THE RoGator C Series from Croplands has changed the game in professional-grade application. Designed to deliver more precise application, the RoGator C Series has croppers from around Australia reporting extensive fuel savings, with an average of 23 per cent on the new model when compared to the previous RoGator B Series.

Key to this is the revolutionary SmartDrive system which not only enables the C Series to burn less fuel, it also makes life easier for the operator.

Long-time RoGator owner Scott Smith from Baboo Pastoral Company, Green Range WA has recently taken delivery of a new RoGator C Series and he is already seeing positive impacts for his operation.

"The new C Series uses noticeably less fuel and lower engine revs mean a smoother drive and a lightweight feeling in the cab," says Scott.

Engine RPM in the RoGator C Series is managed automatically to deliver drive and system performance – even in changing soil and terrain conditions resulting in fuel savings – reduction in wear and minimised operator fatigue.

Each wheel is monitored by a speed sensor, meaning that if any of the wheels start slipping the power to the ground is adjusted at the individual wheel motor. Like a continuously variable transmission (CVT) in a tractor, the tractor management system (TMS) controls the engine in conjunction with the transmission to adjust RPM automatically as required. This feature of the SmartDrive enables the engine to run at the ideal RPM resulting in a cooler system that burns less fuel and reduces wear on the engine.

Further adding to the comfort of the ride is turn compensation. The speed sensors register that the machine is turning on the headland and cause the inside wheel motors to operate at a different RPM to the outside wheel motors – reducing the soil disturbance on corners.

Scott crops a combination of canola, barley and wheat on his property located 80 km from Albany. Depending on summer rainfall and weed and pest pressures, he averages between five and six spray passes each year at an application rate of 80 litres per hectare.

"We are averaging 1000 hours a year in the RoGator. In the first two months with the new machine, we've done 300 hours," says Scott.

With large hectares to cover, making daily spray operations more productive is key.

Advanced liquid-system technology

The RoGator C Series LiquidLogic system – arguably the world's most advanced liquid-system technology – is designed with productivity in mind. It has a full boom recirculation system with E-Stop valves on each nozzle body, enabling on/off control at the nozzle body. The LiquidLogic system also keeps chemical in suspension – enabling the operator to prime the boom on the way to the paddock, eliminating downtime.

The one-piece boom allows for product recovery, which can be performed by the operator from the cab. This feature is a real money saver when weather conditions suddenly change and any unused product in the pump, manifold or boom can be returned to the tank until weather conditions improve and the operator can prime the boom again and resume spraying.

The LiquidLogic system also features auto-agitation which is especially important when applying powders or granular chemical products. It automatically agitates product in the tank as the tank level increases/decreases which eliminates foaming.

This will be Scott's fourth RoGator having previously owned B Series models.

"RoGators are tough and reliable sprayers with minimal mechanical issues," says Scott, "Technical support and service provided by the service agents is also excellent." ■

The new RoGator C series is fuel efficient and operator friendly.

Product recovery can be performed from the cab.

Regenerating agriculture: Pacific Seeds' new chapter

PACIFIC Seeds has unveiled a new vision for its 57th year in business, with an even greater focus on agricultural innovation, research and adapting for climate change.

The company's new direction follows a long history as an industry-leading seed provider and will drive the development of new seed processing technology and advancements in plant genetics to benefit Australian farmers and the industry.

At the helm is Pacific Seeds Managing Director, Barry Croker who says the goal is to provide growers with the best products, to challenge conventions and consistently add value within the agricultural and food industries.

"Growers, retailers, agronomists and other industry participants might notice the branding refresh, with a new logo being rolled out from August, but the changes run deeper," Barry said.

"Pacific Seeds has a long history of delivering value through its significant investments in research and innovation and this will only increase as we continue to expand our technical development capabilities."

Key point of difference

"Our technical development teams are a key point of difference in our industry, they conduct the research and provide information on how growers and consultants can use Pacific Seeds products to their best potential in a changing climate.

"Pacific Seeds will continue to invest in its people, facilities and technology to improve product standards.

"We have an unyielding belief that the future is bright, which is reflected in our investment this year in a new $2.6 million seed processing line in Toowoomba," Barry said.

Staying relevant in a competitive global market is vital according to Barry, with more than 1.6 million jobs in Australia dependent on the agricultural industry.

"In our experience, farmers are resilient, pragmatic optimists and we are building our business around catering to them."

Pacific Seeds continues to invest in its own plant breeding programs but is also partnering with other institutions to bring new technology to Australian farmers.

The launch of Pacific Seeds' world-first herbicide tolerant sorghum technology and two new herbicide resistant hybrid canola varieties to the Australian market in the past 12 months alone demonstrates its commitment to innovation.

Offering latest technology

"In 2018, we launched our premier imidazolinone-tolerant grain sorghum line, which features our proprietary 'igrowth' trait. In canola, our new TruFlex hybrids offer canola growers a wider spraying window, extending beyond the current six-leaf stage up to first flowering."

Barry said farmers are always searching for the next innovation and Pacific Seeds is excited to offer them the latest technology.

"The company is also offering a dual-herbicide tolerant non-GM canola hybrid combining Clearfield and Triazine Tolerant technologies – Hyola CT. This technology will be useful for all growers but especially for those in South Australia who have been asking for a product such as this for many years.

"There are many more canola stacked traits in the pipeline to benefit growers in years to come," Barry said.

"While the industry has been struggling with drought, Pacific Seeds has been investing in developing traits and exploring management techniques that can help deliver more dependable outcomes in these harsh environments."

Barry said Pacific Seeds is also engaged in sorghum heat tolerance research in collaboration with other industry bodies.

Pacific Seeds, the University of Queensland and Queensland's Department of Agriculture and Fisheries have together received $605,000 from the Australian Research Council for a project to look into identifying sorghum genes with improved heat tolerance and incorporating them into new varieties.

Pacific Seeds is also expanding its wheat breeding operations in WA through its breeding arm – LongReach Plant Breeders – employing a breeder to deliver improved wheat varieties to Western Australian growers.

"We've been supplying seed to Australian farmers for well over 50 years, and we see the new direction as an important way of ensuring Pacific Seeds continues to be a valued partner to Australian growers for many more generations to come." ■

Technical development teams provide information to growers to help get the most out of their seed products.

Pacific Seeds operates a seed production farm in the Ord, WA.

WeedSeeker 2 demonstrations hit the target for growers

THE launch of the new generation WeedSeeker 2 spot sprayer from Trimble has quickly captured interest across the broadacre industry, with growers from Queensland through to South Australia recently converging on New South Wales to attend a series of demonstrations with the system.

The paddock demonstrations were coordinated by national distributor, McIntosh Distribution, at Narrabri in NSW over several days and highlighted all the new developments and benefits with the latest system.

Growers attended the events from as far as Dalby in Queensland and from the Nyngan, Dubbo and Forbes areas in NSW, while several SA growers on a visit to a dealer in the state also took the opportunity to view a demonstration.

Small weed sizes

Scott Jameson with McIntosh Distribution said water sensitive paper was used with the demonstrations to highlight the small weed sizes that could be targeted by the WeedSeeker 2, despite not operating at its maximum sensitivity.

Scott said the lighter, more compact design of the latest WeedSeeker 2 units was one of its leading features, helping to reduce the overall weight of the system on spray booms.

He said the new sensors were 50 per cent lighter and their spacing along booms had widened from 38 to 50 cm, effectively reducing sensor numbers by 30 per cent.

"This has further reduced the weight on booms and the components required for fitment. The lighter sensors have also opened up the opportunity for the system to be used on wider platforms," Scott said.

Compared with other similar products that have sensors spaced at every metre along booms, the 50 cm spacing also provides for double the resolution when targeting weeds, which is especially valuable in situations with heavy stubble burdens.

Scott said a new quick-attach bracket kit allowed quick removal of the sensors from booms and an easy return to other spraying activity.

"Unlike alternate systems, the WeedSeeker 2 also does not need to be fitted to ground-following booms. It suits most existing sprayers."

Scott said the latest system could now operate on most ISO-capable screens, again unlike other spot sprayers.

"Rather than having to put another controller in the cab, WeedSeeker 2 integrates with existing systems, allowing cost savings for growers."

Section control

Another feature that captured significant interest was the ability for the WeedSeeker 2 to run section control.

"Growers can have up to 18 individual sections at whatever size they want. They can manipulate the number of sensors per section to suit the type of program they are running, like tramlining," Scott said.

"Weed mapping provided with the system also maps the weed presence in paddocks. A weed map ISO XML file can then be processed in desktop mapping software, effectively helping growers with their resistance management. It shows where sensors have been turning on and off and, therefore, where weeds are more dominant. Growers can then monitor resistant populations and possibly treat areas differently in future to help fight resistance."

Self-learning sensors

WeedSeeker 2 also features intelligent, self-learning sensors, which Scott said was another big advantage that impressed growers.

"It means the sensors take into account a number of background readings, including the soil background, light, air temperature and other factors. Each sensor individually adjusts itself to work at maximum efficiency all of the time. It adjusts itself to the background it is working in."

He said the self-learning feature was one of the big attractions for growers, along with the ISO capability and lighter weight of the WeedSeeker 2 sensors.

Scott said despite the dry conditions in northern NSW, spraying was still being carried out, particularly in cases where storm events sparked weed germinations, and spot spraying remained a hot topic in these situations. ■

Scott Jameson, McIntosh Distribution, takes growers through the workings of the new Trimble WeedSeeker 2 spot spraying system.

Water sensitive paper was used with the WeedSeeker 2 demonstrations to highlight the small weed sizes that can be targeted by the system, in this case despite not operating at maximum sensitivity.

New self-propelled sprayers

JOHN Deere has launched its next generation of self-propelled sprayers, manufactured at the company's Horst factory in the Netherlands. With the new R4140i 4000 L capacity and R4150i 5000 L capacity machines, engineers have further increased performance, precision, safety and operator comfort.

Improved sprayer output

The focus of these latest developments has been on improving sprayer output while ensuring that the highest possible application quality is maintained and also delivering an improved operator environment. The premium design cab offers a new generation operator interface with fully integrated technology, such as the John Deere universal 4640 display mounted on a new armrest.

JDLink telematics for wirelessly transferring data both to and from the sprayer is available as standard, including free activation for five years. An upgraded lighting package improves visibility at night, both when working in the field and filling the sprayer with chemicals, to ensure maximum productivity in all conditions.

The new cab is available at two specification levels depending on customer requirements, as well as with optional Category 4 operator protection to meet the latest safety regulations.

The R4140i is available with a choice of carbon fibre or steel booms, the R4150i is available with carbon fibre only. Both are available from 24 to 36 metres wide and continue to use John Deere's leading PowrSpray solution system, with direct rate control for fast filling and highly accurate application rates. Combined with the innovative, automated AirRinse system, this reduces the solution system's dead volume to as low as 5 litres for maximum cleaning performance.

Smart nozzle management

New for the R4140i and R4150i sprayers, ExactApply is an 'intelligent' solution that combines the ability to change spray nozzles manually from the cab or automatically depending on application rate and speed. It can also maintain droplet size while changing speed through the use of pulse width modulation (PWM) technology up to 30 Hz.

With ExactApply, each nozzle is controlled individually via GPS based section control. Furthermore, with PWM enabled, turn compensation ensures that application rates remain consistent across the full boom width even when turning the sprayer.

ExactApply technology enables savings in crop protection products, while at the same time yield can be increased by up to three per cent by reducing under/overdosing to a minimum.

To reduce non-productive time on the road, the sprayers also feature a new 50 km per hour transmission option.

Production has started of the John Deere R4140i and R4150i, with the first units due to arrive on our shores early in 2020.

For more information on these new products from John Deere, visit JohnDeere.com.au or see your local John Deere dealer. ■

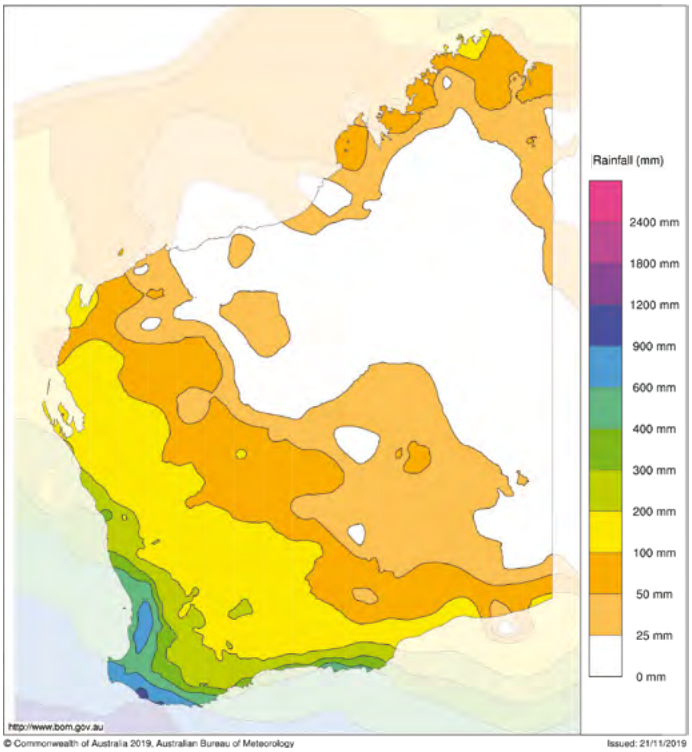
The new John Deere R4140i (pictured) and R4150i sprayers will arrive in Australia in early 2020.

District Reports...

November–December 2019

Western region

Western Australia Growing Season Rainfall totals (mm)
April 1 to November 21, 2019
Australian Bureau of Meteorology



A promising start to the season turned to disappointment for many growers as a hard spring finish set in across WA.

WESTERN AUSTRALIA SUMMARY

Since reporting the hard finish to the Western Australian grain season in the October 2019 GIWA Crop Report, harvest is now travelling too quickly for most with grain yields in the northern half of the state lower than was estimated a month ago. Grain yields for all crops in the north of the state – where harvesting is 50 to 70 per cent complete – are up to 50 per cent below recent averages.

In the central eastern regions of the state grain yields are 25 to 30 per cent below recent averages.

Further south and west where harvesting has only just begun, grain yields are higher, although in most cases still below average.

In the Esperance port zone it is a very mixed bag due to the compounding influence of the frost events in spring.

Wheat quality is variable and grain yields so far are a little less than predicted. Grain protein is higher than in previous years due to the low yields.

Barley grain yields are in most cases lower than they look, with high to very high screenings. Few deliveries are making malt grades due to screenings and/or protein being too high.

Ten years ago when barley was around 20 per cent of the total cereal production, 50 per cent of deliveries were malt. Last year, barley was 50 per cent of cereal production and 20 per cent of that was malt. This year, the state will struggle to produce the usual historical amount of malt barley of one million tonnes.

Total grain tonnage is going to be around 25 per cent lower in the state than the more recent eight-year average of around 15 million tonnes (mt). A return of between 11 and 12 mt of total grain will be a good result considering the low growing season rainfall, higher than average temperatures in spring and virtually no rain in September.

Crop grain yields will pick up as harvest gets going in the southern regions and these areas will make up a bit of ground on the low yields returned so far – especially from areas north of the Great Eastern Highway.

Canola is yielding more than expected and total canola production could exceed one million tonnes. To achieve this, canola yields in the southern regions would need to continue the trend from the north and central regions of the state i.e. being 10 to 20 per cent higher than pre-harvest estimates.

Lupin grain yields are coming in higher than pre-harvest estimates. The short lupin crops have made harvesting difficult although recent higher prices are compensating for the effort.

Oat grain and hay yields are well down on last harvest, although current high prices have negated some of the downside in tonnage for growers.

GIWA gratefully acknowledges the support of DPIRD, CBH, independent consultants and agronomists in the production of this report.

GIWA Crop Report – November 15, 2019

NORTHERN DISTRICT

Very little useful rain fell anywhere in the region since my previous report on September 14. This meant most crops finished prematurely and some died off without filling much grain.

Harvest is well underway and some growers are very close to finishing their program. Most are around half done. Cool damp conditions in the west mean progress has been much slower and many growers are around one third done.

As usual, crop performance has mirrored rainfall with some soil type influences. The areas with annual rainfall tallies around 160 mm have failed crops on heavy soil, and okay crops on medium and sand soils.

2019 GIWA November WA crop production estimates (tonnes)

Port zone	Wheat	Barley	Canola	Oats	Lupins	Pulses	State total
Kwinana	3,400,000	1,700,000	380,000	220,000	140,000	8,000	**5,848,000**
Albany	750,000	1,100,000	270,000	210,000	65,000	5,000	**2,400,000**
Esperance	720,000	900,000	200,000	10,000	15,000	18,888	**1,863,888**
Geraldton	980,000	80,000	110,000	15,000	120,000	4,000	**1,309,000**
Totals	**5,850,000**	**3,780,000**	**960,000**	**455,000**	**340,000**	**35,888**	**11,420,000**
% change to October 2019	-6.6%	-6.7%	-9.1%	15.2%	9.7%	9.1%	-4.3%

Note: The grain totals reported are for whole farm production. This includes on-farm seed and feed requirements as well as trade outside of the CBH network.

District Reports...

The other extreme is areas with around 270 mm in the west, with most of it in a few weeks in June, have good crops on heavy soils. There are okay crops on medium soils and very poor crops on washed out sand soils.

Grain quality has been a surprise. The very dry finish had growers expecting high screenings levels in cereals across the landscape. Most were surprised at how good grain quality is with very high grain weights and very low screenings. There are exceptions to this in some areas.

Wheat – as stated above, has mirrored rainfall and soil types. Best crops are on heavy soil in the west or, strangely, on fallow in the very eastern areas where early thunderstorms gave seeding opportunities. The very best are above 2.5 tonnes per hectare with many above 2.0 tonnes. Most of the landscape is in the 1–2 tonnes per hectare range but some dry, heavy soil areas are under 0.5 tonnes.

Barley – similar to wheat above with yields in similar ranges.

Canola – surprised everyone by staying green right into October on many farms. The area planted was down a little due to the June break and crop performance is down as well. Most growers were expecting less from their canola than what they did harvest. Yields are in the 0.25 to 1.5 tonnes per hectare range with most between 0.5 and 1.0 tonnes. Oil levels have been okay given the very dry spring conditions the crops endured.

Lupins – very similar crop performance to canola with most crops between 0.5 and 1.0 tonnes per hectare. There will be exceptions to this with some western crops still to be harvested with higher yields likely.

Generally, 2019 has been a very challenging year with very dry conditions early and a moderately late season break. To be any good we needed September rain this year. It did not come. So as expected, crop performance has been well below average on most farms.

The best farms and areas have average crops at best and may just get into the black. For many growers it will be a loss making year. Most are already looking forward to changing the calendar!! Roll on 2020.

Peter Norris
Agronomy For Profit and Synergy Consulting, Geraldton
November 10, 2019

SOUTH COAST

Season conditions on the South Coast have remained dry over the past two months – consistent with the entire 2019 season. Harvest began in mid October with many growers now approaching the halfway mark.

Yields have been variable. In the Northern Mallee, yields are some of the worst ever recorded. This is largely due to the extreme frosts of September 5 and 6 where temperatures dropped below -3.5 to -5.5°C for over 10 hours. Where crops were not frosted, yields are remarkably good for year to date rainfall between 140 to 170 mm. Yields in the Northern Mallee are ranging from 0.3–2.5 tonnes per hectare for cereals and 0.2 to 0.8 tonnes for canola and 0.1 to 0.8 tonnes for pulse crops.

In contrast, areas within 40 km of the coast are experiencing an average to above average season in spite of only receiving half their annual average rainfall. The well-timed 250–350 mm has resulted in good even crop establishment without the usual areas of water-logging. Canola yield in these areas is ranging from 1.5 to 3 tonnes per hectare, whilst cereal yields are ranging from 3 to over 5 tonnes with good quality.

With a run of good weather, harvest should be complete by early December. Growers will then be hoping for good summer

Agronomy Focus agronomist Nicky Tesoriero assessing 44Y90CL for swathing timing at Quintarra Farms, around 30 km east of Esperance.

Darcy Gorman from Warakirri Cropping in an impressive crop of Acrocc winter wheat at Lobethal east of Condingup.

District Reports...

November–December 2019

James Buttle, harvest contractor, and Laura Bennett of Warakirri Cropping, checking yield data and machine performance on the *Farmers Edge* app whilst harvesting Bonito TT canola.

rains to build stored soil moisture and importantly, get some water in dams and tanks for spraying and livestock.

Quenten Knight
Agronomist, Agronomy Focus, Esperance
November 11, 2019

Southern region

SOUTHERN AUSTRALIA SUMMARY

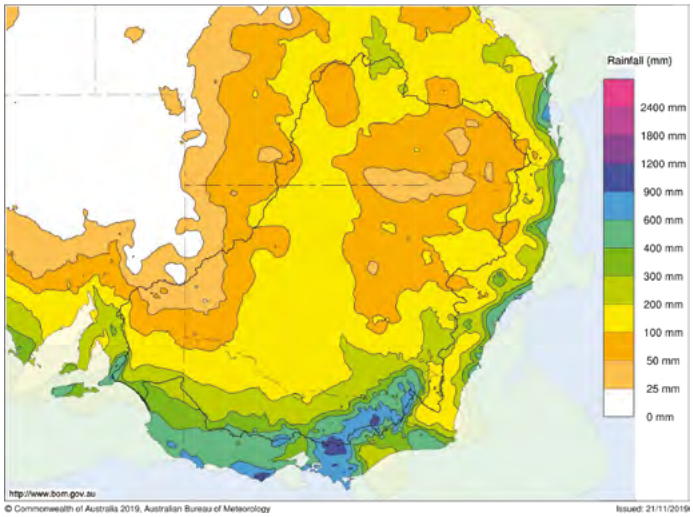
Rainfall for October 2019 was well below average across large areas of Australia, ranking October as equal fifth-driest out of the 120 Octobers the Bureau of Meteorology has on record.

Much of southern Australia recorded well below average rainfall during October, with rainfall totals less than 25 mm across most regions. These low rainfall totals – along with above average temperatures and evapotranspiration rates in October – have adversely affected yield prospects.

These very dry conditions have extended into November. Up to November 19, any very limited falls have been restricted to isolated areas.

ABARES
November 19, 2019

Murray–Darling Basin Growing Season Rainfall totals (mm) for April 1 to November 21, 2019
Australian Bureau of Meteorology



Growing season rainfall totals tell a very graphic story. Many regions in the south of the Murray Darling Basin managed near average totals for the growing season while central and northern NSW and Queensland endured some of the driest conditions on record.

VICTORIAN MALLEE

Most of the Mallee had a Decile 1 growing season rainfall and, topped off with a dry spring, crops are ripening in quick succession.

Following those dry conditions in September, the October cropping activities included mowing, baling and preparations for harvest. Hay contractors were in high demand, as farmers across the Mallee have incorporated hay crops into their regular rotation and have been constructing hay sheds throughout the year.

Harvest began in late October, before being held up by rainfall and cool conditions in the first week of November.

Early reports indicate barley yields (in the northern Mallee) are around 1.6 to 1.9 tonnes per hectare. The rest of the Mallee

BCG's main research site at Birchip in October this year.

will really get into harvest from mid-November onwards. Strong winds in early November caused concerns in terms of yield loss from shattering in canola, pod-drop in lentils or lodging and head loss within some cereal crops.

But what is lost in production could be recovered in marketing as grain, sheep and wool prices remain strong. Oaten hay prices are one example. They remain well above average, despite dropping from very high levels early in the year.

High lamb prices throughout the year put mixed farming enterprises in a good position to manage their cash flow and spread their income. Although those needing to buy supplementary feed were less pleased about the high hay prices.

The big story of cropping in the Mallee in 2019 continues to be the massive rainfall event in December 2018, topped up by low to average rainfall throughout the growing season. It kept crops in the southern Mallee looking good throughout the year and going into harvest.

Meanwhile, the northern Mallee struggled with warmer than usual temperatures and a dry growing season. As a result, a lot of crops were cut for hay or not harvested at all.

Rain in early November has sparked some early summer spray programs in the northern Mallee. There is always something to do no matter what time of the year.

Growers in other areas in the Mallee will need to remain vigilant to prevent summer weed issues.

As baling wraps up and harvest continues, we'd like to wish everyone a safe and successful end to 2019.

Amy Harwood and Louisa Ferrier
Engagement and Member Services,
Birchip Cropping Group
November 13, 2019

District Reports...

November–December 2019

Northern region

DARLING DOWNS

Weather conditions

Just add water appears to be the solution – but is impossible to fulfil at present. September's rain was under 10 mm, October's was generally around 20 mm with a few patches to 50 mm over a two week period, and November is yet to open the account.

Rainfall for the year is sitting at about 35 per cent of the average and the Downs are 270 mm of rainfall behind where we should be to the end of October. The rainfall outlook is grim for the rest of 2019 and we are heading towards one of our driest ever years and we are definitely in our driest ever 48 month period. The other critical factor is the general lack of soil stored moisture.

Winter crop

The irrigated barley has now been harvested, cut or silaged, with yields directly related to the amount of irrigation. The best barley silage yielded 38 tonnes per hectare with most irrigated

District Reports...

crops around 25–30 tonnes per hectare. The best dryland silage is around 17 tonnes per hectare.

On the grain side, the best irrigated barley was seven tonnes per hectare, with four to five tonnes more common. Dryland barley that went through to harvest yielded one to 1.5 tonnes. Hay yields have been two to four tonnes per hectare.

Irrigated wheat is starting to be harvested with some crops producing four to six tonnes per hectare, but dryland crops are around 1.2 tonnes.

Dryland chickpeas closer to Dalby on long fallow ground have yielded up to two tonnes per hectare, and a crop east of Dalby produced 1.5 tonnes on just 9 mm of in-crop rain.

But, at the other end of the scale, any double cropped chickpea yielded 0.35 tonnes per hectare or less. There has also been a few faba bean crops west of Dalby which on long fallow, have yielded to 2.5 tonnes per hectare with good quality.

Summer crop

There has been no opportunity for dryland planting at all, and only a few irrigated crops have gone in, due to lack of water. The main crop is maize with most destined for silage for the feedlots. There has been a small area of cotton planted.

To the east of Dalby there is no sorghum planted, which is very rare for early November. And to the west, only the odd irrigated paddock of sorghum, sunflowers, maize and cotton can be found.

To sum up

Overall, the winter crop depended totally on moisture – both stored soil moisture and the amount of irrigation water available. And because these crops needed more water than expected, many irrigators now do not have enough water to plant the summer crop.

There is plenty of discussion about the summer options from a rotation point of view, and as to how late each crop can be planted. Sorghum and corn could be planted to mid or even late January, but after that, mungbeans and sunflowers may be the only options.

In the fallows, hard to kill weeds have still managed to establish. So camera sprayers have been the sprayer of choice this spring with the ability to target small but sporadic weeds. This has been quite effective despite the average growing conditions. But when the rain does finally arrive, plenty of weeds are expected to emerge.

Hugh Reardon-Smith
Agronomist – Landmark, Pittsworth
November 7, 2019

ANSWER TO IAN'S MYSTERY TRACTOR QUIZ

The tractor is a 1922 Austin, restored by Ron Grosser, on display at The Gunnedah Rural Museum.

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The limited amount of irrigated cereals on the Darling Downs this exceptionally dry winter season, has produced some very much in demand hay and straw. (PHOTO: Hugh Reardon-Smith)


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