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FRONT COVER

Chickpea traumas and triumphs

The 2016 season will have mixed memories for chickpea growers across the country. Growers in some areas enjoyed the rare trifecta of high yields, a large planted area and excellent prices while in other regions, too much rain caused crop losses through disease and waterlogging. But in the Victorian Mallee, some chickpea crops filled pods three wide thanks to an extremely favourable season.

(Photo: David Ferrier)
See article Page 39 and District Reports.

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CNH INDUSTRIAL CAPITAL

Editorial... Lloyd O'Connell

FOR any producer of a primary product, one of the best ways to counter low prices is to grow a lot of the stuff. The strategy looks like working a treat for winter crop growers this season. As we roll through harvest the early yield results are generally very encouraging.

In September, our official government forecaster ABARES, was estimating a record winter crop in the region of 46.1 million tonnes – a whopping 29 per cent bigger than the 10-year average of 35.8 mt. Some damaging late September and October frosts, and some waterlogging issues as a result of the wettest winter and spring across Australia for many years, will no doubt trim this figure back. In Western Australia where frost damage has had the most state-wide impact – and where almost half of our winter grain crop is grown – some analysts are reducing WA harvest prospects by around 10 per cent.

Notwithstanding the lower WA result, national winter crop production should still be well in excess of 40 mt.

Add to this around 4.0 to 4.5 mt expected from the 2016–17 summer crop and we're looking at an awful lot of grain working its way through the system.

Tonnes of travel

There's been plenty of volume on the 2016 travel front as well with *Greenmount Travel* farm study tours visiting numerous out-there destinations such as North Korea, Kazakhstan, China, Alaska, the Klondike, Africa, Iceland and the Baltics. See page 27 for a review of these tours.

Greenmount Travel is continuing the 'destinations with a difference' theme in 2017 with an offering of old favourites such as the UK and Ireland, South America, Canada and the US (including Alaska and the Klondike) as well as farm tours to places like Siberia, Mongolia, North Korea, Iran, Jordan, Vietnam and Burma. See www.greenmounttravel.com.au for details.

Here's hoping harvest has been a great one for you. From everyone at *Australian Grain*, all the very best for Christmas and a happy, healthy and bountiful New Year.

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In this issue...

Going underground to beat dam evaporation

The underground storage of water for agricultural and other uses not only eliminates evaporation for long-term storage, it can also replenish groundwater supply and protect ecosystems that depend on groundwater for their very survival.

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Getting the upper hand against fusarium

Kansas State University scientists in the US say they have isolated and cloned a gene that provides resistance to fusarium head blight (FHB) – or wheat scab – a crippling disease that costs farmers worldwide billions of dollars.

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Can herbicide affect weed seed dormancy and viability?

Farmers have been reporting that several weed species seem to be emerging later than usual – evading pre-emergent herbicides – allowing them to establish in-crop. Researchers are investigating whether herbicides applied to the weed populations over summer could have been affecting seed dormancy and viability.

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Greenmount Travel 2016 farm tour reviews

They say that travel broadens the mind. Well, if that's true, there should be some very broad-minded Australian farmers after this year's *Greenmount Travel* tours to many diverse and distant foreign fields.

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Tractors in a hurry!

Farm tractors are by definition lumbering machines. They plod around the paddocks dragging their ploughs, scarifiers, seeders and whatever. But surprisingly, there were a number of 1930s tractors that certainly could not be classified as plodders and were more than capable of testing the testosterone of the most daring of speed freaks!

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Going underground to beat dam evaporation

By Mary O'Callaghan, CSIRO

WHEN the rivers of northern Australia are raging torrents and the floodplains are full and lush, it seems like a no-brainer to store some water for use when the dry season inevitably arrives. But, of course, it's not that simple. Capturing and storing the water is only one part of it. High rates of evaporation and vast distances are just some of the reasons we need to assess the economic and environmental viability of any water storage solution in the region.

An option that warrants further investigation is to store the water underground – not only can it eliminate evaporation and provide long-term storage, it can also replenish groundwater supply, prevent seawater from intruding, and protect ecosystems that depend on groundwater for their very survival.

There are various techniques for storing water underground for use later. The concept of using human intervention to do so, known as 'managed aquifer recharge', or MAR, has two general approaches:

- Infiltration, whereby the water is gravity fed down into the aquifer via seepage; and,
- Injection, whereby the water is gravity fed or pumped into the aquifer via a well.

Schemes that allow the water to filter down into a shallow aquifer are generally much cheaper than those where you need injection wells to replenish, or recharge, the aquifer.

Mapping the opportunities – where supply meets demand

Dr Joanne Vanderzalm, a senior research scientist at CSIRO, is on a mission to find out where MAR might be viable in northern Australia. She and her team aim to map the opportunities for three regions:

- The Fitzroy catchment in Western Australia;
- The Mitchell catchment in Queensland; and,
- The Darwin catchments (Adelaide, Finniss, Mary and Wildman) in the Northern Territory.

The Burdekin Delta scheme is Australia's oldest MAR scheme. This photo is of sand dams in the Burdekin River. These sand dams help direct part of the river flow to deeper sections of the river near the bank where it is easier to pump into 'canals' or natural waterways. The water can then be distributed to various recharge pits across the floodplain. (Image: Keith Bristow/CSIRO)

"You need a suitable aquifer for managed aquifer recharge to be feasible. So first we need to understand the subsurface and the aquifer properties," says Joanne. "Then we need to investigate how much water can be stored before we can decide which technique is best suited."

The real opportunities lie in those places where a suitable aquifer, water source and the demand for water intersect, she says.

"It's a screening process. Once we have identified the potential storage capacity, we will then overlay that with proximity to available water for recharge and demand. We're not advocating any particular end use of the water, other than economic development. But, to be cost-effective, the water needs to be close to where you use it to minimise infrastructure costs."

With at least 16 million hectares of soil potentially suitable for irrigated agriculture in northern Australia, but only enough water to irrigate 10 per cent of that area, access to water is a major constraint for development.

Joanne's MAR project is part of a broader groundwater research program which itself is part of the $15 million Northern Australia Water Resources Assessment (NAWRA), an initiative of the Australian Government's Agricultural Competiveness White Paper. The CSIRO-led assessment is tasked with investigating opportunities to develop water and agriculture in the three regions by June 2018.

The Assessment, says CSIRO's Research Leader for Northern Australia Chris Chilcott, "will enable government, industry and communities to make informed decisions about sustainable development in the north".

A familiar concept in Australia

The oldest MAR scheme in Australia, and one of the largest, is in northern Queensland's Burdekin Delta, near Townsville, where up to 45 gigalitres (GL) a year is stored underground through infiltration basins established in the 1960s, sustaining groundwater levels for agriculture and keeping seawater at bay.

The Northern Territory has Australia's first 'soil aquifer treatment' scheme which stores treated wastewater underground and augments groundwater resources at Alice Springs. MAR has also been used to store shallow groundwater in a deeper aquifer to supplement drinking water supply on Goulburn Island in the NT.

The Cloudbreak iron ore mine in the Pilbara uses an injection technique to recharge more than 20 GL per year of brackish and saline water for mine water management and to protect groundwater-dependent ecosystems.

There are two main types of aquifers – those that are confined by a low permeability layer, which for MAR requires injecting water via a well, and those that are unconfined and allow water to infiltrate through permeable soils, where recharge can be enhanced by basins and galleries (see Figures 1 and 2).

In the southern states, operational MAR schemes abound, particularly in urban centres where they are used to store stormwater and treated wastewater. Perth's groundwater replenishment scheme is Australia's first MAR scheme to recycle wastewater for drinking water. The 14 GL per year scheme is

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FIGURE 1: Confined aquifer

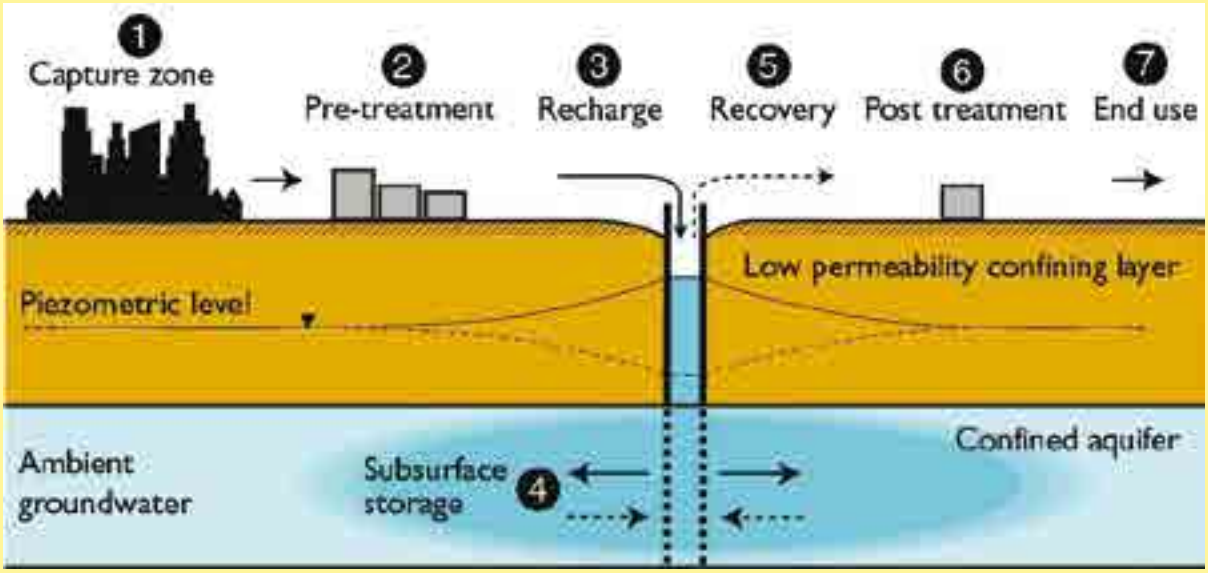
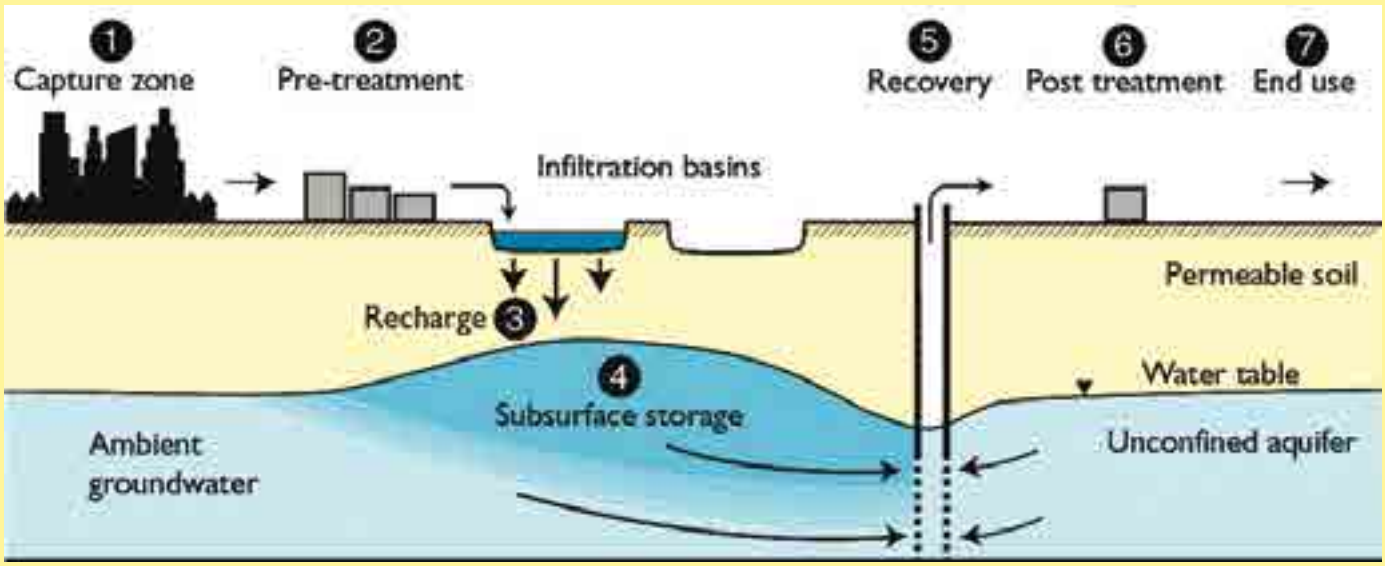


FIGURE 2: Unconfined aquifer



scheduled for operation later this year, with a planned expansion to 28 GL per year in 2017.

Adelaide has a number of schemes that inject stormwater into deep limestone aquifers. A total capacity of about 20 GL per year is available for non-potable use such as irrigating public space. Additional work is underway to support wastewater recycling via aquifers to potentially double this capacity and support an expanded horticulture industry.

Underground dams – a promising technique for the north?

A MAR technique commonly used overseas, especially in Japan, Korea, China and Brazil, is the 'underground dam'. A barrier is constructed to intercept groundwater flow and store water for use during dry periods. It's a technique that looks promising for some parts of northern Australia, says Joanne.

"Picture a nice sandy riverbed and several metres beneath it is hard rock," she explains. "You build a barrier that extends from, say, a metre below the riverbed down to the rock and laterally to the riverbanks. Water can still flow over the top of the barrier, but the remainder is stored underground for use. Think of a weir in a river, but buried, banking up groundwater instead of surface water."

On the Ashburton River in the Pilbara, mining magnate Andrew Forrest has built an underground dam on his family's property, Minderoo Station, to store wet-season flows. The feat of engineering, which Andrew refers to as an 'upside-down weir', is now supplying water year round for cattle and fodder.

"This MAR scheme is the first of its kind in Australia," says Joanne. "Others were trialled but have not met with success."

Because Minderoo Station is operational and is located in a geological setting that is more representative of northern Australia than some of the international examples, Joanne has been granted access to go onsite to understand the site characteristics.

"Our interest is in research", she says. "We want to know what it is about the sediment properties and the river flow dynamics that make it successful. We want to understand the

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physical characteristics of the riverbed and surrounding geology, the impact on the groundwater level and the maintenance requirements. This kind of information will help us gain a general understanding of suitable environments for this technique.

"We think MAR techniques, such as underground dams, have potential promise for use in some areas of northern Australia, but it's crucial to have demonstration schemes that people can learn from. There is naturally some uncertainty for potential investors in schemes that are below ground. Having a demonstration scheme reduces that uncertainty and builds confidence."

A question of economics for irrigated agriculture

Dr Richard Evans, Principal Hydrogeologist with Jacobs Engineering Group, was involved in the Minderoo Station weir and is now investigating opportunities for MAR in the Pilbara and in Katherine in the NT, under the National Water Infrastructure Development Fund.

"We are confident that underground dams will work in a technical sense in the right hydrogeological environment. It still has to be proven and we need to demonstrate it. But the challenge is to demonstrate that MAR schemes will work in an economic sense.

"For irrigation in northern Australia, if it's not cheap it's just not going to fly. The challenge is what does it cost relative to the alternatives? If the alternative is a big dam, that could cost many millions. Can irrigated agriculture pay that back? Usually not. Our thinking is in line with CSIRO's – it's all about cashflow and the ability to pay back the loan on the capital cost of the infrastructure."

The main advantage of some MAR schemes, says Richard, is that they are relatively cheap to run. Then there's the obvious advantage of evaporation being 'practically nil' underground.

Scalability is another advantage of MAR schemes, he says. It's possible, for example, to progressively add underground dams along the same river.

"These are significant hurdles", says Richard. "But if the hydrogeology is right and other factors, we believe it can be economic."

The potential in the three regions

While it's very early days in her research, Joanne is already getting a sense of how viable MAR might be in the three study areas.

"The Darwin region is more suited to injection techniques because of the geology. MAR has the potential to replenish declining groundwater resources in two of the four catchments that are already developed," she says.

The Mitchell catchment, on the other hand, has potential, she says, on some of the major tributaries of the Mitchell River. "We're looking for that intersection between water we can detain for recharge and an aquifer that is suitable for storing water."

For the Fitzroy catchment, it's too soon to say: "There may be some potential in the lower Fitzroy, but the possible impact on groundwater-dependent ecosystems must be assessed."

Internationally renowned MAR expert Dr Peter Dillon has experience with MAR in monsoonal climates in India and Africa. He sees potential for it in northern Australia, but doesn't envisage it supporting broad scale irrigated agriculture.

"I expect MAR would support mosaic-type irrigated farming, as it does in India's upland catchments and in parts of Africa," he says. "It won't transform the landscape into an Ord Valley – we're not talking about that scale of irrigation. It is more likely to be the livestock industry that will benefit, and the mining industry, where water can be very valuable for enabling extraction and processing." ■

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Factoring climate risk into farm planning

WHEAT growers who faced a delayed start to harvest after a wetter-than-average winter and mild spring are keenly aware of the impact climate variability has on profit, but how can weather be effectively factored into farm planning?

It is a question well-known climatologist Professor Roger Stone, Director at the International Centre for Applied Climate Science at the University of Southern Queensland, investigated as part of a 'Risk in Farm Profit' research project funded by the Grains Research and Development Corporation (GRDC).

The project examined how wheat profitability varied across different geographic regions due to a range of climate and market influences, including rainfall, temperatures and larger-scale drivers, such as El Niño-Southern Oscillation.

Roger said the research was focused on identifying the level of influence these factors had had historically, as well as assessing how changes in climate and market environments could impact wheat growers in the future.

"Decision makers in agricultural production need to prepare for a range of possible outcomes, often using very conservative management strategies to reduce the negative impacts of likely climate extremes on seasonal time scales," Roger said.

"Very often, the sheer complexity of managing a whole range of decisions of which climate risk is only one, can become overwhelming.

"But we also know that by understanding how risk varies across the different agro-ecological zones and developing a risk assessment process that effectively assesses the relative influence of factors that contribute to farm profit variability we can still improve these complex decision making needs."

This research revealed that across Queensland and New South Wales, each of the key profit drivers such as climate, yield, cost of production, and market price, exhibited significant variability annually.

While Roger's teams analyses of historical farm production data at 105 sites spread relatively uniformly across GRDC's agro-ecological zones from 1982–2012 and climate data from 1900–2012, indicate that the greatest risk of the impacts of variability is in Central New South Wales.

Roger looks at how risk varies across the different agro-ecological zones and how the regional influence of these drivers varies both historically and in the future due to change in climate and market environments.

In contrast to this season's rainfall, Roger said their research indicated evidence of changing long-term rainfall trends with a decrease in April to September rainfall and increases during the October to December period.

"The changes in pre and post season rainfall are greatest in Queensland and New South Wales, while the number of frosts and the length of the frost season in this region is decreasing," he said.

Roger said long term modeling looking at climate changes from 2010–39 also forecasts a decrease in in-crop rainfall, although the volatility of rainfall will increase in eastern states.

"One of the clear pictures emerging is that although the riskiness of production may decrease in inland regions of Queensland and New South Wales in 2030, the climate drivers of yield are likely to cause a decrease in average yields compared with the 1960–90 period," he said.

Sensitivity of profit to climate change

"But changes in average yield don't tell the whole story. We can use historic cost and price data assessment to gauge the relative sensitivity of profit to climate change.

"The profitability of the highest and lowest 25 per cent of growers responds differently to climate and market environments. Although profits increase for the bottom 25 per cent of growers so does, unfortunately, the volatility. In contrast the top 25 per cent of growers are likely to experience less volatility in their future profit."

But he said farm profit critically hinged on how growers were able to assess and successfully manage the farm risk that came with climate and market change.

"By improving our understanding of the historical variability of climate and market drivers of risk, as well as the response of production to these drivers and how this is likely to change in the future, we can enhance industry preparedness, leading to increased resilience and competitiveness.

"Risk management can provide more stable income streams for growers under increased climate and financial variability across a range of seasons and will also enhance the capacity of grain growers and their advisors to respond and adapt to climate and market risks, and remain viable and sustainable."

Price and cost have most impact

He said understanding and implementing risk management by continuing to monitor research and development in this area and, if possible, build capacity by participating in grower workshops designed to develop enhanced climate risk management using the latest climate science and modelling, was critical to growers' long-term sustainability.

"The relative strength of price and climate drivers varies regionally, but in general the sensitivity of profit to climate change over the next few decades is less in the modelling, than the sensitivity to price and cost fluctuations.

"In general, on a longer time-scale towards the end of the century, climate change becomes the dominant driver of profit." ■

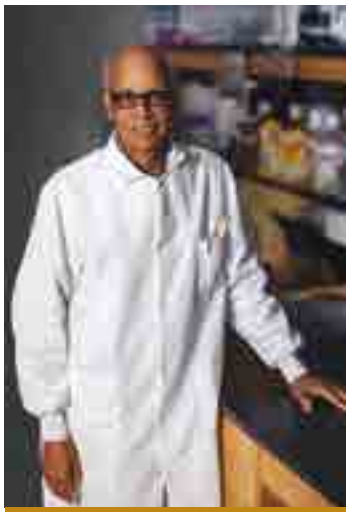
Getting the upper hand against fusarium

By Pat Melgares, Kansas State University

KANSAS State University scientists in the US say they have isolated and cloned a gene that provides resistance to fusarium head blight (FHB) – or wheat scab – a crippling disease that costs farmers worldwide billions of dollars.

"This has been a very difficult project," said Bikram Gill, university distinguished professor of plant pathology and director of the Wheat Genetics Resource Center at Kansas State University. He estimates that nearly 100 scientists, faculty, staff and students have participated in the work.

"The breakthrough that we're reporting is the cloning of a resistance gene," Bikram said. "We have identified the DNA and protein sequence, and we are getting some idea of how this gene provides resistance to the wheat plant for controlling the disease. The cloning of this gene is the key to unlock quicker progress for control of this disease."



Bikram Gill led the research team that has made an important breakthrough in the fight against Fusarium Head Blight.

A disease that shows up periodically in more humid growing regions, FHB caused severe damage in Minnesota and North Dakota in 1993 and subsequent years. Bikram noted that a 1997 epidemic in Minnesota, which ruined 50 per cent of the state's wheat crop that year, caused an estimated US$1 billion in losses.

Fusarium head blight is caused by the fungus *Fusarium graminearum*, which produces a toxin that makes the crop unfit for human and animal consumption. James Anderson, a professor of wheat breeding and genetics at the University of Minnesota, said there are frequent epidemics of the disease reported in the US, Canada, Europe, Asia and South America.

The fungus is also a menace to the barley industry. Bikram noted that since the 1997 outbreak in Minnesota, malting barley is rarely grown in the upper Midwest because the industry implemented zero tolerance for the toxin, Deoxynivalenol, produced by fusarium.

Wheat being harvested in Kansas. Kansas State University researchers have isolated and cloned a gene that provides resistance to wheat scab (fusarium head blight).

DNA breakthrough

Previously, the wheat variety known to best resist FHB was a Chinese cultivar named Sumai 3. But while scientists knew Sumai 3 provided resistance, they didn't know what DNA sequence was responsible for resistance – until now.

Kansas State University faculty and students used sophisticated wheat genome sequencing techniques to isolate the gene. Bikram said that Eduard Akhunov, associate professor of plant pathology, prepared a library of "millions of clones" of Sumai 3 DNA. Lead scientists Nidhi Rawat at the University of Maryland and Mike Pumphrey at Washington State University sifted through the library.

"It's like searching for the proverbial needle in the haystack to find one clone that contained the resistance gene," Bikram said.

"It looks like when the fungus attacks the wheat plant, the resistance gene protein has domains for binding and making pores in the cell wall of the fungus, and stopping it from spreading and infecting the developing grain," he said.

Traditional and molecular wheat breeding will benefit from the finding, Bikram said. Without knowing the DNA source of this resistance, scientists would have to grow wheat in a field, hope for the right growing conditions to test new varieties against the disease, and then reproduce successful varieties for future years.

Instead, processes that would take years to replicate can be done in a fairly short amount of time in a diagnostics lab.

Breast cancer analogy

"An analogy I can think of is in the cloning of the most common gene that causes breast cancer," Bikram said. "A woman can get diagnosed very early and be treated to avoid getting the cancer. We can do the same thing with this gene. Once you diagnose the plant, you can use it in breeding without exposing the plant to the disease."

Among several, Bikram credited James Anderson, whose research team has been working on resistance to Fusarium head blight since 1993 and was the first to genetically map the location of the gene to a small segment of the wheat chromosome. James has worked closely with researchers at Kansas State University and Washington State University to help prove the identity of the resistance gene.

Bikram also acknowledged Mike Pumphrey, an associate professor in the department of crop and soil sciences at Washington State University, for his work leading to the discovery. Mike was a graduate student at Minnesota under James Anderson and later with Bikram at Kansas State University.

The project was funded by the USDA's Wheat and Barley Scab Initiative and the National Science Foundation. The agricultural experiment stations at each of the participating universities also provided support. ■

FHB IN AUSTRALIA

Fusarium head blight can occur in Australian cereal crops, particularly in the northern region, if conditions during flowering are wet and warm. This can result in significant yield losses and quality downgrading.

FHB is a fungal disease that can occur on many grass species, including both crop and weeds. It is a frequent and widespread disease of major wheat production areas of North America, Asia and Europe.

Major yield losses occur mainly from floret sterility. Additional yield and quality losses can occur when damaged and shrivelled lightweight grains are produced as a result of infection. Quality downgrades may also occur from seed discolouration varying from whitish-grey, pink to brown. Fungal infection can sometimes be associated with the production of a toxin (mycotoxins).

If fungal toxins are produced in infected seed the grain is often unacceptable for certain end uses and downgraded in the marketplace depending on the concentration of toxin present. Toxin levels and fungal infection can not be accurately estimated from visual appearance.

FHB can be caused by several species of Fusarium. The most common species causing FHB is *Fusarium graminearum*. This fungus can also cause stalk and cob rot of corn.

The crown rot fungus is a closely related species – *Fusarium pseudograminearum.*

Source: QLD Department of Agriculture & Fisheries

Australian legumes hub to tackle global food, nutritional security

A MULTI-MILLION dollar project spanning government, the private sector and universities was recenty launched as part of an Australian Research Council program – with the ambitious aims of bolstering grain legumes in an environment of global food demand increases, a changing climate and ever decreasing natural resources.

The five-year ARC Industrial Transformation Research Hub – Legumes for Sustainable Agriculture – in partnership with the Grains Research & Development Corporation (GRDC), worth $14.5 million in cash and kind, will position Australia to take advantage of a significant and growing market for these 'future crops' – improving human health while helping address the over-reliance on a handful of staples worldwide.

University of Sydney Deputy Vice-Chancellor (Research) Professor Duncan Ivison said the hub, based at the Camden campus, would help provide a coordinated approach to position legumes as the coming generation's staples of choice.

"We hope that by drawing together the best researchers with leading industry experts, we will play a vital role in addressing complex food security, health and environmental issues, both here and abroad," Duncan said.

Focus on innovative approaches

The hub will focus on innovative approaches to enhance drought-heat, salinity and flooding tolerance and to improve below-ground traits that are naturally linked to nitrogen acquisition for better plant growth.

It will include 13 chief investigators from state government agriculture research departments and universities including the University of Sydney's Centre for Carbon, Water and Food, the Plant Breeding Institute, as well as the University of Western Australia, University of Adelaide, Australian National University and Flinders University – and create 12 postdoctoral roles.

Director of the hub, Associate Professor Brent Kaiser, said the importance of legumes in sustainable cropping systems had been extensively documented; legumes also promised significant untapped potential for genetic improvements.

5 FACTS ABOUT THE HUMBLE BEAN AND PULSES

- Grain legumes are essential in optimal human diets because their seed structure and composition confers a physiologically favourable matrix in the total diet.
- Studies in China revealed all-cause mortality was increased in individuals on a legume-free diet.
- Several meta-analyses of observational studies have associated eating legumes with lower risk of a number of cancers, including bowel cancer.
- Pulse exports alone were worth more than $1b to the Australian economy in 2013.
- It is estimated that Australia needs to double legumes production in order to have a healthy agriculture system; currently, the proportion of legumes is about eight per cent.

Source: C. Foyer Brent Kaiser et al: "Neglecting legumes has compromised human health and sustainable food production", Nature Plants 2016.

"Although the past 50 years has seen an increase in the area planted with grain legumes, the area planted with cereals still outnumbers this fourfold – this lag may be due in part to unstable legume prices because of high variability in their yields," Brent said.

"This lag, particularly in developing countries and despite increasing global demand, if left unchecked, could threaten current and future food security.

"As the world shifts from animal- to plant-based protein sources because of supply and cost issues, legumes are ideally placed to provide people with their nutritional needs.

"Legumes require low inputs and put nitrogen back into the soil, rather than using extensive amounts of expensive synthetic fertilisers that pollute the environment." ■

Grain legume trials and other research will be conducted at a number of sites across Australia including the University of Sydney site near Narrabri, northern NSW. (Source: University of Sydney)

AHRI **insight...**

Harvester set-up – catch weed seeds and grain

ROGER Lowenstein, in his book about Warren Buffett wrote, "Buffett found it extraordinary that academics studied such things. They studied what was measurable, rather than what was meaningful".

When John Broster from CSU and Michael Walsh from Sydney University set out to measure how many weed seeds were entering the chaff fraction in a modern harvester, they were definitely studying what was meaningful, but man was it difficult to measure!

In 2014, John and Michael set up trials with five different harvesters in NSW and found, much to their distain, that all of the harvesters were throwing a lot of weed seeds out with the straw fraction. This does not auger well for Harvest Weed Seed Control (no pun intended!).

Fortunately, in 2015, they tried again with a harvester that was set up to destroy weed seeds with an integrated Harrington Seed Destructor (iHSD) fitted and found, that when set up right, the vast majority of weed seeds were directed into the chaff stream and then into the iHSD mills. They also found that harvest speed had little effect on the fate of weed seeds, but it did have a big effect on grain losses.

If you're using a form of harvest weed seed control (HWSC) that removes just the chaff fraction (eg. chaff cart, chaff deck, iHSD) there's a real art to setting up the harvester to maximise the capture of weed seeds. Difficult to measure, but meaningful.

Maximising weed seed capture by setting up the header

John Broster and Michael Walsh measured weed seed losses on five farms in 2014 in NSW. These harvesters were set up for normal wheat harvest. The harvesters were:

Site 1	**John Deere**	**9660 STS**
Site 2	New Holland	CR 9080
Site 3	John Deere	9660 STS
Site 4	John Deere	CTS
Site 5	Case	8120

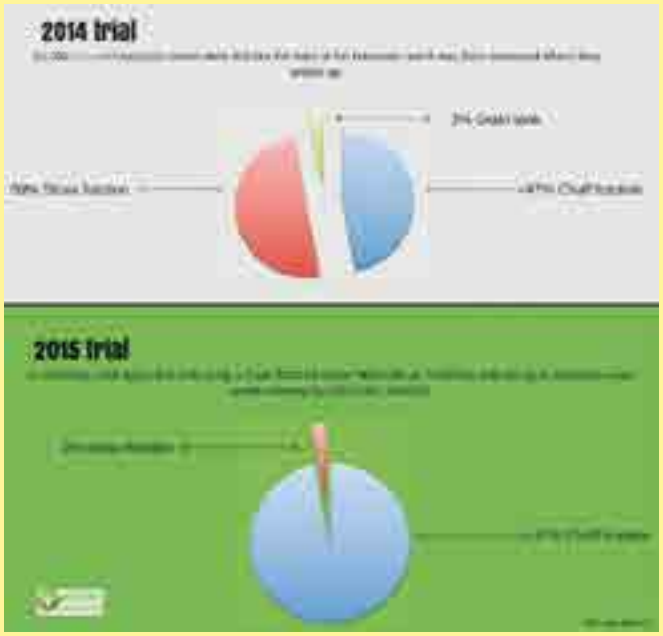
Ryegrass

Ten thousand coloured ryegrass seeds were fed into the front of the harvester and then painstakingly, it was measured where

Harvesting at full engine capacity is likely to result in high grain losses. Research shows slowing down is the best solution.

they ended up (Figure 1). On average, across five harvesters, about 50 per cent of the weed seeds went out with the straw fraction (through the rotor). This was a disastrous result for HWSC. About 3 per cent of ryegrass ended up in the grain tank and 47 per cent ending up in the chaff fraction. The remainder was assumed to exit with the straw.

FIGURE 1: The fate of ryegrass seeds



Back to the ol' drawing board.

In 2015 they tried again (Figure 1), this time using a Case 9120 harvester fitted with an iHSD that was set up to maximise weed seeds entering the HSD mills.

Bingo. This time only three per cent of the ryegrass exited with the straw, meaning that 97 per cent of ryegrass entering the front of the harvester could be captured and destroyed.

The harvester used was a Case 9120 with the settings: Rotor 950; Fan 980 rpm; Concave 10; and, Sieves - upper 18 mm, lower 11 mm.

Harvester settings

It is really hard to specify exactly how to set up the harvester for HWSC, but the 2015 trial shows that it is possible to get it right.

All we can do is speak generally, and we all have a lot to work out together on how to get the best out of these machines to harvest both the crop and the weeds.

To quote Ray Harrington, "We have to get the weed seeds out of the rotor. To do this we have to thresh the grain hard enough to get the weed seeds out of the seed head, and open up the grates of the header to get as much material as possible out of the rotor and onto the sieve".

Does harvest speed affect weed seed capture?

No.

The encouraging thing from this 2015 trial is that harvest speed did not affect the amount of weed seeds exiting in the straw fraction.

Harvesting at 4, 6 or 8 km per hour resulted in only 3-4 per cent of weed seeds exiting in the straw fraction.

Harvest grain losses – slow down!

There is a large body of evidence that suggests new harvesters have more engine capacity than sieve and rotor capacity. They are all hat, no cattle!

The 2015 trial mentioned above found that harvest losses were significant where the harvester was operating at full engine capacity. They harvested a 2.45 tonnes per hectare wheat crop at three different speeds.

When harvesting at 8 km per hour the harvester was at its maximum capacity and rotor losses of wheat were 127 kg per hectare. Rotor losses were just 6 kg per hectare when harvesting at 6 km per hour. So rotor losses increased by 121 kg per hectare or about $30 per hectare by harvesting at full engine capacity compared to slowing down 2 km per hour.

TABLE 1: Summary of canola harvest losses from a New Holland 7090 in Chapman Valley in 2012

	Normal speed (full capacity)	Slowing down a bit
Speed (km/hr)	7.5	5.8
Work rate (t/hr)	15	12
Canola yield (t/ha)	1.8	1.8
Grain moisture (%)	8.5	8.5
Front loss (kg/ha)	17	17
Rotor loss (kg/ha)	73	24
Sieves loss (kg/ha)	66	56
Total (rotor and sieves) loss (kg/ha)	139	80
Total (rotor and sieves) loss ($/ha)	$76	$44

Slowing down makes the difference

A grain grower from the Chapman Valley did a great job of assessing harvest losses in canola a couple of years ago. He said to me, "It is amazing what settings you can change and modifications in the back of the header that you can make, without making any difference whatsoever to harvest losses" (he tried different concaves, grates, wires, sieves, sieve settings etc.). "The only thing that made any difference was slowing down". He used trays on the ground and a sieving technique to accurately measure his losses from a New Holland 7090 harvester. The results are summarised in Table 1.

This grower saved $32 per hectare by slowing down from 15 to 12 tonnes per hour canola harvest. This equates to $222 per hour that the harvester is working. To see how he did it check out this YouTube *https://www.youtube.com/watch?v=HZ-aUHXz4Mo*

Wheat grain loss was a similar story but the losses were lower. In 2012 he also put the New Holland 7090 to the test in wheat with the following results

TABLE 2: Summary of wheat harvest losses from a New Holland 7090 in Chapman Valley in 2012 operated at different speeds

Work rate (t/hr)	Loss (kg/ha)	Loss ($/ha)
20	8	$2
24	8	$2
33	10	$2.50
39	20	$5

Does a bigger, newer harvester fix the problem?

The grower mentioned above (who shall remain nameless) recently had a demo harvester on his farm – a Claas 770 which is a class 8 harvester. He applied his measurement technique above and found the same thing.

When harvesting canola, slowing down reduces grain losses.

TABLE 3: Summary of harvest losses from a Claas 770 in Chapman Valley in 2016 – canola yield 2.6 t/ha, sunny day, 29°C, crop moisture 7–8 per cent

Speed (km/hr)	Work rate (t/hr)	Loss (kg/ha)	Loss – % of crop yield	Loss – $/ha
3.5	11.7	65	2.5	36
4.5	15	87	3.3	48
5.5	18.7	128	4.9	70

To sum up

Harvesting at the full engine capacity of your harvester is likely to result in significant grain losses. Slowing down seems to be the only reliable solution to this problem.

A bitter pill to swallow when you have spent a fortune on your harvester!

To maximise weed seed capture for harvest weed seed control, tools that remove the chaff fraction only will take some harvester modifications and some specific settings to ensure that the majority of weed seeds are in the chaff fraction.

This is difficult to prescribe, but research has shown that it is possible. ■

Breeding wheat for yield improves water and nutrient use

FIVE decades of breeding for yield in Australian wheat has given researchers from The University of Western Australia some interesting insights into root systems, and how efficiently they take up nitrogen and water from the soil.

Improvements in grain yield are associated with higher nitrogen uptake, and thanks to research supported by the Australian Centre for International Agricultural Research (ACIAR), we now know the mechanism of how this is achieved.

Given the worldwide effort to improve nutrient-use efficiency of crops, the findings, published in the prestigious journal *Plant and Soil*, will have a big impact on global breeding programs to develop climate-ready crops for the future.

Better nitrogen capture is the key

Dr Moyassar Aziz, from Mosul University in Northern Iraq, studied the root systems of selected wheat varieties released in Australia between 1958 and 2007, whilst visiting The UWA Institute of Agriculture. He found that the reason modern wheat varieties increased their nitrogen uptake was not associated with increased root length density as was previously thought, but due to increased efficiency by which nitrogen is captured.

UWA Adjunct Professor Jairo Palta who co-supervised the research, said understanding the efficiency of the root system is especially important in areas where water and nutrient content of soils are limited.

"The results are exciting because they show that breeding for yield has resulted in a more 'clever' root system," Jairo said.

"The wheat varieties used in this study are an interesting subset to further investigate the physiology of nitrogen uptake and its genetic basis."

Director of The UWA Institute of Agriculture, Hackett Professor Kadambot Siddique first noticed that modern wheat varieties invested less biomass in their root system compared to old varieties almost 30 years ago.

He conducted an intensive field study at Merredin, in the Western Australia grain belt, to test the root redundancy hypothesis, and published the findings in *Plant and Soil* in 1990.

"The current study builds on the early work which showed that breeding for yield optimises root system architecture," Kadambot said.

"Greater understanding of root system architecture for future yield and quality improvements is a high priority."

Dr Aziz analyses the root system architecture of selected wheat varieties.

The paper: 'Five decades of selection for yield reduced root length density and increased nitrogen uptake per unit root length in Australian wheat varieties' was published in *Plant and Soil* and supported by the Australian Centre for International Agricultural Research (ACIAR) in collaboration with the South Australian Research and Development Institute (SARDI). ■

COMPLEX ROOT TIPS COULD BE THE KEY TO BETTER GROWTH

A new study into the seemingly simple tip of a plant root may ultimately decrease our dependence on crop fertilisers to help grow food, according to researchers at UWA.

Researchers Tim Stuart and Professor Ryan Lister from UWA's ARC Centre of Excellence in Plant Energy Biology worked with scientists from around the world to examine the cells of plant roots.

Tim, who was co-lead author on the study and a PhD student at the Centre, said the ground-breaking research had led to a greater understanding of the way that the underground part of a plant developed.

"Plant root tips are made up of many different types of cells; our work helps show what makes these cells different from one another," Tim said.

"On top of the genetic code within these cells sits another code – known as the epigenome – which can direct which genes are switched on and off.

"While epigenetic patterns across different plant organs and tissues have previously been studied, this is the first finding of differences between individual cell types of the root."

Tim said that when the root was looked at as a whole, as in previous studies, the intricate differences became invisible.

"Columella cells, located at the very tip of the root, were found to be the most epigenetically affected of the six cell types studied as part of our research," Tim said.

"These cells are important in telling the root which direction to grow and for the uptake of nutrients from the soil – knowledge which is incredibly relevant when you're talking about food security."

Tim said the findings had allowed scientists to start to understand how columella cells were formed.

"This is the first step in decreasing our dependence on crop fertilisers because by understanding how the cells work we should be able to improve overall nutrient uptake," he said.

The study was published in *Nature Plants*.
More information: Tim Stuart Ph: 0400 527 003

ASK AN EXPERT – CAN HERBICIDE AFFECT WEED SEED DORMANCY AND VIABILITY?

With Hanwen Wu, NSW DPI Principal Research Scientist

FARMERS have been reporting that several weed species seem to be emerging later than usual – evading pre-emergent herbicides – allowing them to establish in-crop.

This apparent shift in emergence has also caused weeds researchers some trouble when they conduct herbicide resistance testing and find that seed from some populations has greater germination than others.

Hanwen Wu, NSW DPI principal research scientist says he first came across this with fleabane when seeds collected from some populations failed to germinate. He began to investigate whether herbicides applied to the weed populations over summer could have been affecting seed dormancy and viability.

"We have now confirmed that different herbicides sprayed on mature fleabane plants at early and late budding stages definitely affect the seed dormancy and viability," says Hanwen. "Other researchers have previously found that brome grass and barley grass seed collected in cropping fields often have longer dormancy than seed collected from adjacent non-crop habitats."

"Herbicide-induced dormancy could be a problem for growers as it can cause delayed emergence and prolonged seed persistence in the field. Weeds like fleabane that are difficult to kill – especially once they have developed a strong root system – can quickly take advantage of summer rainfall to send out multiple branches bearing large amounts of seed.

"Our field and glasshouse trials have shown that there are herbicides that can be used to reduce the amount of viable seed produced by large fleabane plants, but the timing must be right," he says.

Glyphosate applied at early budding can effectively reduce seed set on the main stem of flaxleaf fleabane – a management tool that could be incorporated into an integrated weed management program over summer.

How important is the timing of herbicide application to sterilise fleabane seed?

Short answer: Spray at early budding for best effect.

Longer answer: There is only a three-week window between early budding and late budding when the fleabane buds begin to open. Spraying glyphosate at late budding or at flowering is generally wasted and is more likely to help the plants produce seed with longer dormancy. Spraying at early budding can effectively kill or stunt the seed heads and more seed will be sterile.

What herbicides are effective for this use?

Short answer: A range of herbicides commonly-used in summer can effectively reduce the germinable seeds and the total viable seeds on flaxleaf fleabane plants, especially when applied at the early budding stage. Delayed herbicide application has a lesser sterilising effect on the seed.

Longer answer: Similar studies around the world demonstrate that herbicides could potentially reduce seed production and viability of many agricultural weeds. While there is potential to use this tactic to reduce seedbank replenishment there is also a risk that herbicide applications could also induce seed dormancy, which could prolong the seed persistence in the field, making weed management more complex in-crop.

HOW TO ASK A WEEDSMART QUESTION

Ask your questions about managing herbicide resistant crop plants that establish in non-crop areas on the WeedSmart Innovations Facebook page *https://www.facebook.com/pages/WeedSmart-Innovations/354441941389122*, Twitter @WeedSmartAU or the WeedSmart website *http://www.weedsmart.org.au/category/ask-a-weedsmart-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.

How can this strategy be used in an integrated weed management plan?

Short answer: Herbicide applied at early budding stage can reduce the amount of viable seed set, but this tactic must not be used in isolation.

Longer answer: Large flaxleaf fleabane plants are hard to kill with herbicides, particularly if soil moisture is limited. They readily regrow after being cut off at harvest, drawing on large root reserves. Over summer, use the double knock technique after rain to treat regrowth while the branches are relatively 'small'. Crop competition is very effective in reducing fleabane populations so choose competitive crops, narrow row spacing and set them up for success to minimise the opportunities for late germinating plants to gain a foot-hold. Strategic cultivation and regular sheep grazing are also effective tactics. Integration of chemical and non-chemical options could minimise the buildup of dormant seed in the seed bank. ■

Dr Hanwen Wu has demonstrated that herbicide applications can induce dormancy in fleabane seeds, enabling seeds to evade pre-emergent herbicides and establish later in-crop when control options are minimal.

BIG TYRE

Tyres, Wheels & Rubber Tracks

AUSTRALIAN MANUFACTURER LEADS THE WAY

At a time when the Australian manufacturing industry appears to be falling apart with the closure of Australia's iconic Ford and Holden production facilities, family owned and operated company, Big Tyre, is stepping up its game. In operation for over 60 years, Big Tyre has weathered many storms and learned many lessons, allowing it to grow into Australia's leading specialist in solid wheels, as well as new and reconditioned agricultural rubber tracks and tyres.

Despite the challenges for Australian manufacturing, Big Tyre has been breaking new ground. This includes the design and manufacture of solid mining wheels for domestic and international clients with exports currently going into China and South Africa. With the success in this area, Big Tyre is the preferred supplier to large multinationals including Caterpillar Global Mining and other major mining equipment manufacturers.

Since the company's inception in 1954, when it was known as Vacu-lug, Big Tyre has maintained a strong focus on the agricultural sector. This began with repairing and retreading tyres and to this day it still remains an economic solution for some tyre types and sizes. For those tyres, that are now best bought brand new, the Big Tyre on-line store provides the most comprehensive catalogue of new tyres in Australia complete with prices, photos and tyre specifications. Even without car and 4WD tyres, which may be added once fitting and wheel balancing services have been arranged throughout the country, Big Tyre lists almost 4,000 different tyres that they can supply throughout the country on **www.bigtyre.com.au**

Over the last 20 years, Big Tyre's main workload has shifted to the reconditioning of rubber tracks and the rebuilding of the undercarriage wheels. Big Tyre has reconditioned over 1,000 tracks and nearly 5,000 undercarriage wheels and it guarantees the results to ensure its clients get the most out of their products. In recent years, Big Tyre has led the

Plus

- **Mid Rollers**
- **Drive Wheels**
- **Idler Wheels**

Rebuilt & Service Exchange

Continental

Big Tyre services industry locally and overseas from its factory at 226 North Street in Toowoomba

way in switching from the use of rubber to polyurethane on rebuilding mid-rollers (to handle the high loading) whilst still maintaining the use of rubber on the drive and idler wheels to maximise grip. The finish on these wheels is as good as new despite the huge savings and due to the use of polyurethane on the midrollers, a rebuild can actually outlast a brand new wheel.

Big Tyre's expertise in the tyre and track industry hasn't gone unnoticed by the leading manufacturers either. Both Continental and Firestone have awarded Big Tyre with the Australian distribution rights for their high quality agricultural tracks, which Big Tyre imports directly from the USA and Japan. Continental and Firestone represent two of the leading three brands and enable Big Tyre to be an effective one-stop shop for tracks and undercarriage wheels. Big Tyre holds new tracks in stock at its Toowoomba factory for Caterpillar, John Deere and Case tractors in all common sizes to ensure that wherever possible farmers can have their needs met without delay. This is backed up by a supply of service exchange mid-rollers and drive wheels to suit most models to enable a rapid turn around and to minimise down-time for farmers.

In an age of global economic uncertainty, it is refreshing to see an Australian manufacturer not only surviving, but leading the charge and seeking to provide the most economic and high quality solutions required to meet the needs of Australian farmers.

Trackman

Spray water: Some things in life are best served warm

IT'S just the way it is. The evening meal, toast, custard, hollandaise sauce, herbicide spray water…

New research by Devkota and colleagues from Purdue University in the US tells us that cold water may not be as good as warm water when spraying weeds.

They found that when they sprayed Giant ragweed and morningglory with a glyphosate plus dicamba mix, weed control was improved anywhere from 6 to 26 per cent by using spray water that was 18° to 39°C compared to 5°C.

This response didn't hold true for all of the weeds in the study. For example, there was no effect of spray water temperature on fleabane (Conyza) control.

It's too early to make firm recommendations to growers based on this information, but this research does raise a lot of questions. Which weeds will respond this way? Is the response big enough to consider warming water or should we simply adjust the rate? Are there other benefits of warm water such as herbicide mixing?

Do we need to consider serving our herbicides warm?

Once in a while a piece of research appears out of the blue that makes you stop and think. The research we're talking about here is one of those!

This research certainly raises a lot of questions that may well be worth exploring further (hats off to the American researchers for bringing this topic to our attention). For now, let's take a brief look at this research and we can consider other possibilities later.

The weeds

Four weed species were tested – Giant ragweed, Horseweed (fleabane), Palmer amaranth, Pitted morningglory.

The herbicides

A mix of glyphosate plus dicamba at a low rate (275 gai/ha plus 137 gai/ha) and a higher rate (550 gai/ha plus 275 gai/ha)

Water temperatures

Five water temperatures were tested – 5, 18, 31, 44 or 57 °C. Herbicides were mixed with water at these temperatures then sprayed immediately.

The results

The low rate of glyphosate plus dicamba applied in water at 31°C provided 14 and 26 per cent improvement in the control of Giant ragweed and Pitted morningglory respectively. There was little effect of water temperature on Horseweed and Palmer amaranth control.

The higher rate of glyphosate plus dicamba applied in water at 31°C provided 20 per cent improvement in the control of Giant ragweed. This herbicide mix applied in 44°C water improved Morningglory control by 20 per cent.

Mixing issues

Anecdotally, many agronomists comment that certain herbicide mixes experience poor physical compatibility under cold conditions. We contacted a number of agronomists about this issue and they all agreed that it does happen, but they didn't point the finger at a particular herbicide or adjuvant.

TABLE 1: Per cent control of four weed species sprayed with a low rate of glyphosate plus dicamba in water at a range of water temperatures

Water temp. (°C)	Giant ragweed	Horseweed	Palmer amaranth	Pitted morningglory
5	61	63	82	72
18	64	66	89	81
31	**75**	65	81	**98**
44	**76**	64	76	92
57	69	65	80	80

Numbers in bold (green) are significantly different from the 5°C treatment.

TABLE 2: Per cent control of four weed species sprayed with a higher rate of glyphosate plus dicamba in water at a range of water temperatures

Water temp. (°C)	Giant ragweed	Horseweed	Palmer amaranth	Pitted morningglory
5	66	73	86	74
18	79	79	92	89
31	**86**	74	95	86
44	78	79	96	**94**
57	74	80	90	95

Numbers in bold (green) are significantly different from the 5°C treatment.

Most agronomists agreed that mixing problems occurred with cold water when there were a number of products in the tank.

Practical solutions

We're sure many farmers are reluctant to heat their spray water as it would be a difficult, energy consuming task. But there may be some simple solutions such as storing water in plastic tanks instead of concrete tanks, not leaving spray water in the tank overnight, or perhaps adjusting the rate of certain herbicides when spray water temperature is low.

We will need more research before we seriously consider adopting some of these practices – but it's food for thought.

To sum up

There's no denying that spray water temperature has had an effect on weed control in this study. The results are not convincing enough to go out and buy a water heater, but there's certainly merit in more research.

Perhaps our herbicides are best served warm to our weeds!

AHRI
AUSTRALIAN HERBICIDE RESISTANCE INITIATIVE

NORTHERN FOCUS
COVERING NORTHERN NSW AND QUEENSLAND

Row spacing more important than seeding rate in suppressing weeds

By Bhagirath Singh Chauhan[1]

AT A GLANCE...

- In Australia, soybeans are generally grown in wide rows with low seeding rates.
- Wide rows and low seeding rates make the crop more prone to weed infestation.
- Narrow rows are more important than high seeding rates in managing weeds.
- Narrowing the row spacing may increase weed suppression and grain yield of soybean.

SOYBEAN is an important oilseed crop to Australian growers. It makes up about 60 per cent of the overall world oilseed production. Soybean has a large number of applications, including a source of vegetable oil for human food and industrial uses as well as a valued protein source in livestock production. In addition, the crop makes a significant contribution to the sustainability and profitability of farming systems as a rotation crop through improving soil fertility and as a disease break.


Bhagirath Singh Chauhan.

In Australia, soybeans have been adapted across a wide area ranging from the northern Queensland to the Darling Downs and inland river valleys south of the NSW coastal hinterland and coastal sugar belt to the inland cropping regions of southern NSW and Victoria.

Soybeans are grown in wide rows of up to one metre. A crop grown in wide rows is more prone to heavy weed infestation. Herbicides are used to control weeds but continuous use of herbicide(s) with similar modes of action may result in the evolution of resistance in weeds. In Australia, several weed species have already developed resistance to commonly used herbicides.

There is a need to develop weed management tactics which can make crops more competitive against weeds.

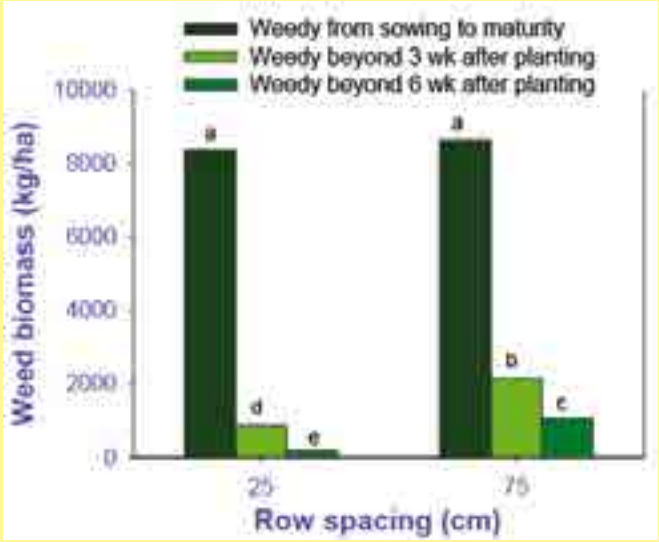
The use of narrow row spacing and high seeding rates are some of the tactics, which can help improve crop competitiveness with weeds. But there is no information available on the impact of row spacing and seeding rate on weed suppression in soybeans grown under Australian conditions.

The research outlined here aims to provide more information on row spacing and seeding rate options for Australian growers.

How the research was done

A trial was conducted in the summer season of 2015-16 at the research farm of the University of Queensland, Gatton, to evaluate the impact of row spacing (25 and 75 cm), seeding rates (40 and 80 kg per hectare), and weed infestation periods on weed suppression and crop yield of soybeans.

FIGURE 1: Weed biomass in soybeans grown in 25 and 75 cm rows

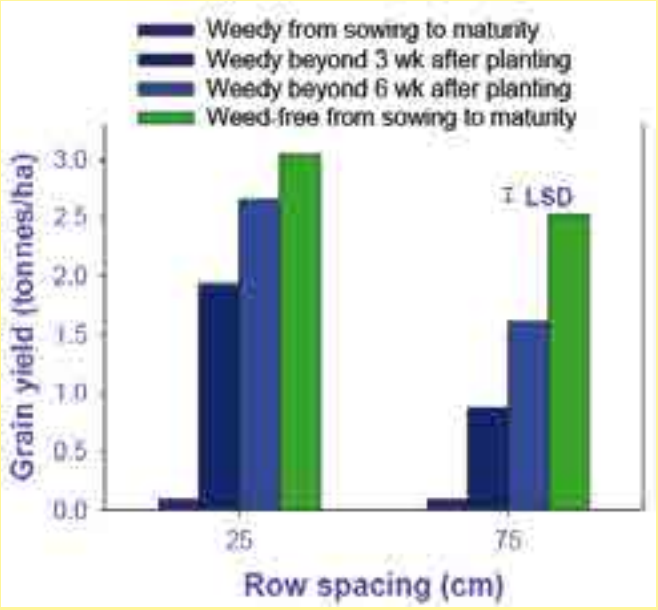


There were three weed infestation periods (weedy from sowing to maturity, weedy beyond three weeks after planting, and weedy beyond six weeks after planting).

The weed infestation scenarios were:

- No weeds (weed-free);
- Weedy beyond three weeks after crop planting (WAP);
- Weedy beyond 6 WAP; and,
- Weedy from crop sowing to maturity.

FIGURE 2: Impact of row spacing and weed infestation period on yield of soybeans



There were three weed infestation periods (weedy from sowing to maturity, weedy beyond three weeks after planting, and weedy beyond six weeks after planting).

The cultivar 'Soy 791' was planted. The experiment was arranged in a split-split-plot design with seeding rate assigned in the main plots, row spacing in the sub-plots, and weed-infestation period in the sub-sub-plots.

There were three replicates of each treatment.

Weed competition was created by spreading Rhodes grass at 300 seeds per m^2 at crop planting (in weedy plots from sowing to maturity), 3 WAP (in weedy plots beyond 3 WAP), and 6 WAP (in weedy plots beyond 6 WAP). These weedy treatments were selected to reflect different levels of weed infestation. No weeds were allowed to grow in the weed-free plots.

Soybean at 25 cm rows under 'weedy' treatment conditions.

Soybean at 75 cm rows under 'weedy' treatment conditions.

What we found

Seeding rate did not influence weed biomass and soybean grain yield. Its interaction with row spacing and weed-infestation period was also non-significant but the interaction effect of row spacing and weed-infestation period was significant.

When weeds were allowed to grow from crop sowing to maturity, row spacing did not affect weed biomass. But 25-cm rows suppressed weeds more effectively than 75-cm rows when weeds were allowed to grow beyond 3 WAP (Figure 1).

There was 58 per cent less weed biomass in 25 cm rows compared to 75 cm rows for the weeds grown beyond 3 WAP. This reduction in weed biomass was 82 per cent in 25 cm rows compared to 75 cm rows when weeds were allowed to grow beyond 6 WAP.

In the completely weedy condition, grain yield was not affected by the row spacing, and it ranged from 0.086 to 0.089 tonnes per hectare (Figure 2). In the other three weed treatments, grain yield was always lower for the crop grown at 75-cm rows.

Maximum grain yield (3.0 tonnes per hectare) was produced in the weed-free plots of the crop grown at 25-cm rows.

To sum up

This trial suggests that narrow row spacing is more important than high seeding rates in suppressing weeds in soybean. The results also suggest that weeds, emerging beyond 3 WAP, can be suppressed more effectively by planting soybeans in narrower rows (25-cm), compared to wider rows (75-cm).

At these levels of weeds as well as in the absence of weeds, the narrower rows provided higher grain yield of mungbeans compared to the wider rows.

Different soybean genotypes, depending on their growth habit, may compete with weeds differently in different management scenarios. Therefore, there is a need to conduct this trial in different genotype x environment x management situations.

[1]The Centre for Plant Science, Queensland Alliance for Agriculture and Food Innovation (QAAFI) Team Leader, The University of Queensland, Gatton. ■

Non-herbicide weed control options put to the test

DIVERSITY in cropping systems and diversity in weeds in the northern GRDC grains region of NSW and Queensland calls for diversity in weed management solutions.

Survey work in the region has identified over 70 different weed species that impact on grain production and over 10 per cent of these weed species have confirmed populations within Australia that are resistant to glyphosate and several other chemical modes of action (MOA).

TABLE1: Confirmed herbicide resistance in weed populations found in NSW and Queensland

Mode of action	Resistant weeds
A (fops, dims, dens)	wild oats, paradoxa grass, annual ryegrass
B (SUs, imis etc)	annual ryegrass, wild oats, paradoxa grass, Indian hedge mustard, charlock, wild radish, turnip weed, African turnip weed, common sowthistle, black bindweed
C (triazines, ureas, amides etc)	awnless barnyard grass, liverseed grass
D (DNAs, benzamides etc)	annual ryegrass
I (phenoxys, pyridines etc)	wild radish
L (bipyridyls ie. diquat, paraquat)	flaxleaf fleabane
M (glycines ie. glyphosate)	annual ryegrass, awnless barnyard grass, liverseed grass, windmill grass, feathertop Rhodes grass, sweet summer grass, flaxleaf fleabane, common sowthistle
Z (dicarboxylic acids etc)	wild oats

Source: adapted from a table prepared by M Widderick, DAF.

A recent survey of common sowthistle determined populations as glyphosate resistant if treated seedlings were surviving and reshooting 21 days after glyphosate application. In this testing, glyphosate was applied at the upper label rate for small sized plants (up to 5 leaf).

While the majority of common sowthistle samples collected from Central Queensland to central NSW were still susceptible to label rates of glyphosate applied to small seedlings, resistant populations were found throughout the study area. This is not a localised problem but rather the inevitable result of over-reliance on a particular herbicide.

Most northern region weeds are self-pollinated so resistant plants will produce resistant seed. To reduce the likelihood of resistance, a key approach is to use multiple tactics to maintain low weed numbers. While weed numbers are low so too is the risk of resistance genes being present in the population.

Strategic burning of early infestations of feathertop Rhodes grass in a fallow can effectively reduce the biomass of the survivor plant and reduce the amount of viable seed present on the soil surface from 7500 seeds per m^2 to less than 500 seeds per m^2.

Summer cover crops such as cowpea, lablab and French millet have the potential to smother summer growing weeds, particularly barnyard grass and feathertop Rhodes grass and return large amounts of organic biomass to the soil.

To keep these 'difficult to control' weeds in check will clearly require other, non-herbicide, tactics to reduce germination and weed seed set. Queensland Department of Agriculture and Fisheries (DAF) researchers in Queensland have been studying common weeds, particularly feathertop Rhodes grass, barnyard grass and common sowthistle, to find weaknesses in each weed's ecology to help identify non-chemical control tactics that could be part of an effective management system.

Dr Michael Widderick and the DAF weed research team are investigating non-chemical options, including various cover crops, crop competition, strategic tillage, strategic burning and harvest weed seed control options.

He says that although growers are making good use of chemical strategies such as double knock, residual herbicides, spot spraying and weed sensing technology to preserve herbicide efficacy, there is an urgent need to investigate non-chemical options that can be added to a weed management program to target resistant weeds in the northern region, as outlined in the WeedSmart 10 Point Plan.

Strategic tillage

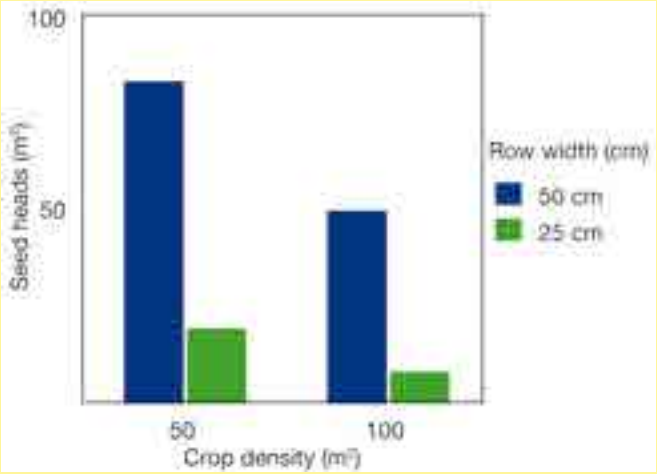
"Most growers are keen to preserve their zero or minimum tillage farming systems that have delivered significant benefits and so are very reluctant to re-introduce cultivation for weed control purposes," says Michael. "We are currently researching ways to use cultivation that will have maximum effect on driving down weed numbers while having least impact on the min-till farming system."

The aim of this research is to investigate the impact of different tillage operations in situations where the weed population has blown out and intensive patch or paddock-scale management is required.

"The key is to understand weed ecology, particularly how seed in the soil seed bank responds to different types of cultivation," he says.

The team used small plots to determine the effect of burial at different depths on weed seed persistence (long-term viability) and emergence. They also conducted experiments to determine the displacement of seed (glass beads were used to represent the

FIGURE 1: Fleabane seedhead production



seed) throughout the cultivated zone using four different types of machine – harrows, gyral, off-set discs and one-way discs – compared to the zero till control treatment.

Sowthistle emergence occurs primarily from seeds close to the soil surface with up to 30 per cent of viable seeds emerging over five months. Seed can emerge from a depth of up to two cm with approximately four per cent emergence after six months. Seed buried below five cm is unable to emerge and can persist at depth.

Seed persistence (the percentage of viable seed after burial) in fleabane was most reduced when seed was buried to a depth of two cm and not disturbed for at least two years. Seed buried to a depth of 10 cm remained viable for over three years. Feathertop Rhodes grass seed persisted for only 12 months regardless of being left on the surface or buried to 10 cm depth. But barnyard grass persisted on the soil surface for up to two years and when buried to 10 cm depth remained viable for over three years.

The Gyral machine placed the majority of weed seed in the 0–2 cm and 2–5 cm zones while the offset discs and one-way discs achieving burial of about half the seed below five cm depth.

"All species responded to increased tillage intensity with reduced germinations," says Michael.

"The message here is that infrequent but intense cultivation can be a useful weed management tool within an otherwise zero tillage farming system. Generally, once a deep cultivation has been done there should be no cultivation of that area or paddock for at least four years to avoid the risk of bringing seed back to the soil surface."

Strategic burning

Feathertop Rhodes grass is known to colonise around mature plants and potentially spread to form distinct weedy patches. Killing the large plant at the centre of the colony is usually not possible using chemical treatments.

Strategic burning of early infestations of this weed can effectively reduce the biomass of the survivor plant and reduce the amount of viable seed present on the soil surface from 7500 seeds per m^2 to less than 500 seeds per m^2.

Growers have made effective use of a flame-thrower to burn large feathertop Rhodes grass plants during the fallow.

Crop competition

Crop competition through narrower row spacing and/or increased planting density provides an effective offensive against common sowthistle and flaxleaf fleabane.

"Our experiment looked at the effect of crop competition on its own, but in commercial situations crop competition would be used in conjunction with herbicide applications," says Michael.

"Narrowing wheat rows from 50 cm to 25 cm spacing had the most marked effect on fleabane seedhead production with an additive advantage if the crop density is also increased from 50 plants per m^2 to 100 plants per m^2."

Project work is continuing to investigate the options for increasing crop competitiveness in sorghum, winter and summer pulses and wheat.

"We are particularly keen to identify ways to improve the competitiveness of sorghum crops, which are often a weak link in northern farming systems," he says. "Highly competitive summer grasses that also have high tolerance and/or resistance to herbicide can gain the upper hand in sorghum crops that often do not achieve canopy closure."

Cover crops

Summer fallow periods are heavily reliant on glyphosate for summer grass control. Preliminary research has explored the potential role of cover crops in place of a chemical fallow for control of summer grass weeds. Summer cover crops such as cowpea, lablab and French millet have the potential to smother summer growing weeds, particularly barnyard grass and feathertop Rhodes grass and return large amounts of organic biomass to the soil.

French millet planted on its own, or in combination with the legumes, increased the amount of biomass produced. The higher the biomass production the greater the suppression of weeds. Cover crops will tend to use fallow stored moisture so the team investigated the effect of two termination dates on both subsequent crop yield and weed numbers.

"Feathertop Rhodes grass germination was minimal after all the cover crop treatments, and the yield of the following wheat crop was comparable to the chemical fallow control and no yield differences were found between treatments," says Michael. "For barnyard grass, late termination of the cover crop reduced weed emergences before and after the following wheat crop, but there was a trend toward slightly reduced wheat yield compared to the early termination treatments that tended to boost yield compared to the chemical fallow control."

"The reduction in barnyard grass emergence and wheat yield are both likely due to reduced soil water following the late terminated cover crops," he says. "Much more work is required to identify suitable cover crops and define the parameters for their use as a weed management tactic."

Harvest weed seed control

Harvest weed seed control (HWSC) is known to be an effective strategy and is widely adopted in Western Australia and increasingly in South Australia, Victoria and southern NSW. The efficacy of the current tools such as narrow windrow burning, chaff carts, tramlining or chaff decks, bale direct systems and the new integrated Harrington Seed Destructor to control weeds found in the northern growing region is largely unknown.

Trial work in winter crops to date have revealed that these tools can effectively collect and concentrate brassica weeds growing in wheat and chickpea crops in the northern region.

The DAF weed research team is conducting further HWSC trials with a focus on collecting wild oats seed. They are also keen to hear from growers planning to plant sorghum this summer where the team will be assessing the efficacy of various HWSC tools against barnyard grass and feathertop Rhodes grass.

For more information visit the Weedsmart website: www.weedsmart.org.au

Michael Widderick: 07 4639 8856 E: michael.widderick@daff.qld.gov.au ■

Bean seeing grubs? – Protect your Mungs!

DURING spring 2016, the northern grain belt has seen significant numbers of *Helicoverpa armigera* and *H. punctigera* in chickpeas, wheat and other host crops. Due to these high numbers, there has been heavy use of many synthetic insecticides causing shortages of both old and new products. Vivus® Max (*Helicoverpa* NPV) was also used widely during this period, providing very good performance under difficult conditions.

AgBiTech has taken steps to ensure that Vivus Max stays in strong supply throughout summer. This means it will continue to be available as a vital tool for *Helicoverpa* management in sorghum, soybeans and other summer crops. With a large mung bean planting expected, and the need to consider control options in a season of tight insecticide supply, consultants and growers are considering using Vivus Max to reduce the risk of damage from *Helicoverpa* in mung beans.

By following a few key recommendations, Vivus Max can provide highly effective control of *Helicoverpa* in mung beans and be a valuable complement to chemical insecticides applied during podding.

Timing – crop stage

Due to the fast growth rate of mung beans and the susceptibility of the "soft" young pods to damage from small larvae, strategic use of Vivus Max should focus on the vegetative or early flowering stages of the crop. Using this strategy, early *Helicoverpa* larvae will be controlled by NPV, and the virus generated by killed larvae can be very effective in suppressing the pest during the critical podding period. Early use of Vivus Max (instead of non-selective options) will also preserve the beneficial species populations.

Oozy does it – even small larvae release huge amounts of virus when liquefied by NPV.

Application rate

When targeting smaller larvae during the vegetative stages, Vivus Max rates of 75 to 100 mL per hectare are sufficient to provide cost-effective control and establish an NPV infection cycle. The addition of Optimol (see right) will also boost performance. Good spray coverage is always important to maximise results from NPV.

Compatibility

Vivus Max is highly compatible in tank-mix with the majority of crop inputs – the key is to ensure mixture pH is below 8. The application of grass herbicides and fungicides offers an excellent opportunity to apply Vivus Max early to "inoculate the crop" with NPV.

Mixtures with chemical insecticides

When applying insecticides against threshold numbers of *Helicoverpa* larvae during podding, the inclusion of Vivus Max in the mix will improve overall control and reduce the risk of poor performance of the chemical insecticide (e.g. due to resistance).

Addition of Optimol

AgBiTech has developed Optimol as a molasses and oil-based additive to enhance the performance of Vivus Max in a range of situations. In mung beans, trials have shown that there is a consistent benefit from Optimol in providing faster control and better performance of NPV, particularly against larger larvae (>10mm).

Give early worms the bird, and profit this summer!

For further information, call AgBiTech on 1800 242 519 or visit www.agbitech.com ■

AgBiTech

VIVUS MAX

Advanced Helicoverpa Biocontrol

Full house – remnants of NPV killed caterpillars produce huge amounts of virus.

ASK AN EXPERT – WHAT ARE THE HERBICIDE OPTIONS FOR THE SUMMER FALLOW?

■ With Mark Congreve, Senior Consultant, ICAN

Mark Congreve.

THE weakest link in weed control programs in most northern region farming systems is the summer fallow. With no competition from crops, uncontrolled weeds can use the abundant water and nutrients to produce lots of seed, putting additional pressure on future weed control programs.

For the past three decades glyphosate, and its tank mix partners, has provided effective summer weed control and allowed the implementation of conservation farming techniques, but with glyphosate resistance affecting more and more paddocks, summer fallow management needs to change.

Mark Congreve, senior consultant with ICAN, says that growers are implementing new strategies, not simply to replace glyphosate but to extend its use in their farming system.

"Glyphosate has been, and continues to be, the most useful knockdown herbicide available to growers in the summer fallow," he says. "While still effective in many situations, resistance to this herbicide is becoming increasingly evident and other options need to be built into the summer fallow program."

Mark identifies two main signs that growers need to look for to detect if their weed populations are becoming more resistant to herbicides:

- The first is to take note of 'survivor' weeds – individual weeds that appear unaffected after a spray event that has killed the surrounding weed plants.
- The second sign is 'rate creep'. This is where a herbicide is still effective but only when higher and higher rates are applied.

Growers should not ignore either of these signs, which could indicate changes in the herbicide resistance status of the weed population. Mark suggests growers should seek agronomic advice and test weeds for their susceptibility to a range of herbicides.

"While waiting for the test results, immediately look for alternative fallow management strategies to those that may have worked in the past but are increasingly less effective," he says.

What should I do as a first step, even if there are no definite signs of glyphosate resistance?

Short answer: Do something different. Double-knock, whenever possible. Implement the 2 + 2 + 0 strategy.

Longer answer: Herbicide resistance is considered an inevitable part of long-term herbicide use but if weed numbers are kept low and all survivors are removed, then resistant weeds can generally be managed. The 2 + 2 + 0 strategy adopted in the cotton industry to support Round-up Ready technology involves using two non-glyphosate tactics in the crop, two non-glyphosate tactics in the fallow and ensuring there are zero survivors. Wherever possible use the double-knock combination of two herbicides or a herbicide followed with a non-herbicide tactic (eg cultivation), particularly while glyphosate resistance levels are still relatively low.

Are there any other knock-down options for grass weed control in the fallow?

Short answer: Consider using Shogun, a recently registered knock-down herbicide for use in fallow situations.

Feathertop Rhodes grass is challenging the glyphosate-reliant summer fallow management program on many grain farms.

Longer answer: Shogun (propaquizafop) is a Group A 'fop' herbicide. Fops are particularly effective on small grass weeds, but resistance is likely to develop faster than has occurred with glyphosate.

When using Group A herbicides in the fallow it is essential to double-knock to remove any survivors and enable longer term use this herbicide option. This strategy is useful for controlling glyphosate-resistant weeds such as barnyard grass, liverseed grass and feathertop Rhodes grass. It provides an alternative mode of action to glyphosate and can increase the diversity of chemical control options used across the farming system.

What knockdown options exist for glyphosate resistant broadleaf weeds such as fleabane or sowthistle?

Short answer: There are a number of Group G and I herbicides registered for these problem weeds. Check product labels for details and timing.

Longer answer: Group I herbicides containing either 2,4-D, fluroxypyr (Starane), clopyralid (Lontrel), or picloram (Tordon) can be effective on one or both of these weeds. If weeds are larger, a double knock will be required for high level control. Clopyralid and picloram based products also give residual control of fleabane.

Group G herbicides containing flumioxazin (Valor) or saflufenacil (Sharpen) are also effective on one or both species. As they are contact herbicides they perform better when applied to very small weeds, ideally when used in a tank mix with either glyphosate or paraquat. ■

HOW TO ASK A WEEDSMART QUESTION

Ask your questions about managing herbicide resistant crop plants that establish in non-crop areas on the WeedSmart Innovations Facebook page *https://www.facebook.com/pages/WeedSmart-Innovations/354441941389122*, Twitter @WeedSmartAU or the WeedSmart website *http://www.weedsmart.org.au/category/ask-a-weedsmart-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.

SOUTHERN AUSTRALIA FOCUS

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

Feathertop Rhodes grass: Don't let it slip under the radar

GROWERS are warned to be on their guard against Feathertop Rhodes grass (FTR), a costly summer weed that has already become a major problem in Australia's northern cropping region. Australian Herbicide Resistance Initiative (AHRI) communications leader Peter Newman said the weed had become more prevalent in the past couple of years but was largely not yet "on the growers' radar".

FTR (*Chloris virgata*) is a tufted annual grass growing up to one-metre tall, and has a distinctive seed head of between seven and 19 feathery spikes.

Peter, whose work at AHRI is supported by the GRDC, said there were currently isolated outbreaks of FTR in different parts of the southern Australian grainbelt, especially on roadsides, and it was important that the weed was not allowed to get a foothold in our cropping systems.

"It is really important that growers know what this weed looks like and that they act straight away to eradicate any populations from their paddocks," he said.

"It is also necessary to find the source – which can often be on roadsides – and notify relevant local authorities so they can control it," he said.

"FTR is problematic as it is difficult to control – it is relatively tolerant to glyphosate, especially after early tillering."

Populations of FTR have been confirmed resistant to glyphosate in New South Wales, Queensland and South Australia.

FTR is quick to mature and can produce seed heads within four weeks if conditions are suitable, and that major flushes

There are isolated outbreaks of feathertop Rhodes grass in different parts of the WA grainbelt, especially on roadsides.
(PHOTO: Andrew Storrie, Agronomo)

occur when good rain falls over consecutive days, particularly in spring.

Glyphosate (Group M) alone may be ineffective on FTR regardless of the age of the weed.

"But if paraquat (Group L) is applied sequentially in a double knock, control is improved, although 100 per cent control is rarely achieved," Peter says.

Roadside weed populations

As part of the GRDC-funded project 'Improving IWM practice of emerging weeds in the southern and western region', conducted with Chris Preston of the University of Adelaide, DAFWA collected seed of several WA FTR populations during a roadside survey of summer weeds in 2015.

Herbicide resistance testing is now being conducted on these populations by DAFWA at Northam.

DAFWA researcher Abul Hashem said that during the roadside survey for emerging weeds, 242 sites were sampled in 2015 and 138 sites in 2016 to assess the prevalence and density of summer weeds and highlight the variation between years.

"Several FTR populations were found in large infestations in the Lake Grace area, eastern grainbelt and Gingin area, including one population in a pasture paddock," he said.

But growers in other parts of the WA grainbelt are also advised to be on the look-out for FTR which has been reported in additional areas including Borden, Albany and Cunderdin.

Abul said the roadside surveys from both years have revealed that African love grass, fleabane, windmill grass and wild radish are the most widely distributed summer weed species in WA.

"Other summer weeds such as couch, sowthistle and stink grass were also found to be common in some regions," he said

Abul said the movement of animals, vehicles, soils, wind and water could potentially spread weed seed from one location to another, and the change in climate was also pushing some weed species from the warmer north to cooler southern agricultural regions.

Resources to assist the sustainable use of glyphosate in Australian agriculture are available on the Australian Glyphosate Sustainability Working Group website http://www.glyphosateresistance.org.au/

Information about managing FTR is available in the GRDC Fact Sheet Managing feathertop Rhodes grass, available at https://grdc.com.au/GRDC-FS-FeathertopRhodesGrass ■

Feathertop Rhodes grass is a tufted annual grass growing up to one-metre tall, and has a distinctive seed head of between seven and 19 feathery spikes. (PHOTO: Abul Hashem, DAFWA)

FOUR EMERGING WEEDS ON RESEARCH HIT-LIST

New research aims to arm Western Australian grain growers with information to help them manage four difficult-to-control weed species emerging in the state's farming systems.

- Feathertop Rhodes grass (FTR) (*Chloris virgata*);
- Matricaria (Oncosiphon spp.);
- Marshmallow (*Malva parviflora*); and,
- Stinking lovegrass (*Eragrostis cilianensis*)

are the focus of the research led by the WA Department of Agriculture and Food's Alex Douglas with funding from the GRDC.

DAFWA researcher Alex Douglas says a GRDC-funded 'Locally Important Weeds' project will provide growers with information about the biology and ecology of targeted weed species and investigate a range of practical management options.

The work is part of the GRDC 'Locally Important Weeds' project which also involves the University of Adelaide and CSIRO carrying out research into emerging weeds in Australia's southern cropping region.

Alex said the four weeds being investigated in WA were selected following consultation with GRDC Regional Cropping Solutions Networks (RCSNs), prominent WA consultants, the GRDC Western Regional Panel and grower groups.

"These weeds are of local importance but have not previously been the subject of major research projects," she said.

"Our understanding of the biology and ecology of these localised weed species is extremely limited and growers have been challenged when it comes to managing them.

"Information on the life of their weed seed-bank (persistence) is critical for growers to be able to develop practices to manage them."

Alex said that as well as providing growers with information about the biology and ecology of the targeted weed species, the project would investigate a range of practical management options.

"A range of experiments will explore the efficacy of herbicide mixtures and knockdowns applied at various times during the growing season and a series of best practice guides will then be developed," she said.

"The weed biology and management information will also be used to update the weed models Ryegrass Integrated Management (RIM) and Weed Seed Wizard.

"Once updated, these tools can be used by consultants and growers to further understand the impact of management decisions on these weeds.

"Better weed management based on weed seed biology will reduce the impact of locally emerging weeds on crop production and increase farm profitability through reduced yield losses, lower costs of control and reduced contamination of grain."

Information about weed management is available via the WeedSmart website http://www.weedsmart.org.au and the GRDC Integrated Weed Management Hub at http://www.grdc.com.au/IWMhub

Further information: Alex Douglas, DAFWA Ph: 08 9821 3246; E: alex.douglas@agric.wa.gov.au

Targeting summer weeds

A SURVEY conducted at more than 200 sites in the Western Australian grainbelt indicates that African lovegrass, windmill grass, fleabane, wild radish and sowthistle were the most common summer weeds in the last two years.

It has also revealed variability in the prevalence of summer weed species from year to year, highlighting the need for growers to carefully consider summer spray programs to ensure they are targeting the correct species.

The survey, which will continue for another year, was conducted by the Department of Agriculture and Food (DAFWA) and is part of a national GRDC project. It is being conducted with the University of Adelaide to provide detailed information about emerging summer weed species and herbicide resistance in southern cropping regions.

"Summer weeds carry disease, impede crop sowing and use stored soil moisture or nutrients otherwise be available to the subsequent crop," DAFWA researcher Catherine Borger said.

DAFWA weeds researcher, Catherine Borger.

The survey was conducted over all main roads in the WA grainbelt during February to April in 2015 and 2016, and sites were selected about every 10 km where weeds were visible.

In WA's northern agricultural region, fleabane, African lovegrass and wild radish were common weeds over both seasons. Couch was common in 2015 and mullamulla was more prevalent in 2016," Catherine said.

"In the central agricultural region, African lovegrass, windmill grass and wild radish were common in both years, but fleabane was common in 2015 and roly poly was more prevalent in 2016.

"In the southern agricultural region, African lovegrass, windmill grass, fleabane and sowthistle were the most common weeds in both years."

Six weeds at high densities

Catherine said the survey identified 91 species in total and that in 2015, only six species (African lovegrass, wild radish, couch, wild oats, capeweed and ryegrass) were at high densities.

"By contrast, in 2016, following more summer rain, 41 species were at high densities at one or more sites, highlighting the variability of summer weeds between years," she said.

The survey reveals that wild radish was a prevalent weed in summer as well as winter making it a severe problem.

"Wild radish will not produce as much seed in summer as it will in winter, but it is still important to control this weed throughout the year as part of an integrated weed management program," Catherine said.

Further information: Catherine Borger, DAFWA: Ph 08 9690 2220, Email: catherine.borger@agric.wa.gov.au ■

Improve yields by increasing organic matter

RESEARCHERS at The University of Western Australia are encouraging farmers in south-western Australia to increase organic matter in soils over the long-term, through a study they published showing it can improve grain yield without substantial increases in greenhouse gas emissions.

Increasing soil organic matter in agricultural soils can increase crop productivity and is a well-known strategy for sequestering carbon dioxide to mitigate greenhouse gas emissions. But it may enhance nitrous oxide emissions.

Dr Louise Barton from UWA's School of Earth and Environment, and Institute of Agriculture led a 2.5 year field study on the Liebe Group's Long Term Research Site at Buntine, WA, to understand how increasing soil organic matter affected greenhouse gas fluxes and grain production in south-western Australia.

As well as the expected improvement in grain yield, the results did show an increase in nitrous oxide emissions, but at low levels compared to international standards.

The study also showed that increasing soil organic matter in cropped soils can potentially increase nitrogen available for plants, thus lowering the need for nitrogen and other fertilisers.

Louise said farmers in southwest WA should be encouraged to employ land management practices such as no-till, reduced tillage or residue retention to increase soil organic matter in cropped soils, and modify nitrogen fertiliser inputs to reflect changes in nitrogen available for plants.

"Better predicting the nitrogen supply from mineralisation will ensure potential fertiliser savings are realised, and adverse losses such as soil nitrous oxide emissions and nitrogen leaching are minimised," Louise said.

"We believe this is critical if the benefit of increased soil carbon storage for the purpose of mitigating global warming is to be fully realised."

The findings were published in the paper Incorporating organic matter alters soil greenhouse gas emissions and increases grain yield in a semi-arid climate in Agriculture, Ecosystems and Environment and was supported by the Australian Government Department of Agriculture, and the GRDC. ■

Tillage treatment plots at the Buntine site.
(Photo: Debra Donovan)

GRDC to review frost research

THE Grains Research and Development Corporation (GRDC) will explore all research and development options to see if there is more it can do to help growers manage the huge impact of frost.

This is the message from GRDC managing director Steve Jefferies who visited frost affected areas of Western Australia's grainbelt earlier this year to view damaged crops firsthand and speak with growers.

He said the tour, conducted with GRDC Western Regional Panel chairman Peter Roberts, GRDC Western Regional Grower Services manager Roger States and local agronomists, aimed to increase his understanding of the scale and impact of the severe, consecutive frosts that have occurred this season.

The group spoke with growers in districts including Brookton, Corrigin, Kulin, Hyden, Lake King, Kukerin and Wickepin.

Steve, who took up his position with GRDC in July and was previously chief executive officer of plant breeding company Australian Grain Technologies (AGT), said he saw examples of very severely damaged crops during the two-day tour in WA.

"In an extraordinary year like this, when there have been so many damaging spring frosts with temperatures as low as –7°C at regular intervals over extended periods covering flowering and grain fill of most crops, it is unlikely any risk management strategy could have had a significant impact on reducing frost damage," he said.

What risk management works?

"But I was keen to get feedback from growers about what they have experienced this year as well as what the impact has been of various risk management strategies they have adopted in the past – in terms of what works, what doesn't and which ones could make a difference in years when frosts are less extreme.

"I wanted to gain information ahead of a review that the GRDC is undertaking of our extensive frost research investment portfolio of more than $24 million in contracted research projects.

GRDC managing director Steve Jefferies, centre, inspects frosted barley south of Kukerin with Glenn Ball, left, and Chris Ramm, both of Dumbleyung, WA.

"We want to identify any gaps or anything that looks promising that could be fast-tracked and the input from growers on this tour will be an important consideration."

Steve said observations from growers and some preliminary research results were suggesting a number of factors were influencing the impact of frost on crops, including:

- Sowing rates;
- Nitrogen application;
- Potassium application;
- Different stubble management techniques; and,
- Some soil amelioration practices.

"This warrants further research to gain an improved understanding of the financial value to growers of various risk management strategies," he said.

National Frost Initiative

Frost is a major research, development and extension (RD&E) priority for the GRDC and its investment is managed through the National Frost Initiative (NFI).

"This initiative combines research into improved levels of crop tolerance through genetics and breeding; assessing the impact of different management practices on frost severity; improved understanding of environmental and landscape variables on frost severity and more," Steve said.

"The aim is to be able to deliver a range of tools that can assist growers in managing frost risk.

"It is unlikely, at least with current technology, that we can achieve spring radiation frost tolerance in our crops to temperatures much lower than –2°C.

"But frost tolerance improvements of –1°C or –2°C would still be very valuable."

A major project in the NFI genetics program led by Tim March from the University of Adelaide (UA) oversees R&D into frost phenotyping and pre-breeding.

Through this program, the grains industry now has a field frost screening method that is robust, accurate and able to be reproduced.

In the first phase of this project researchers have used the data collected by this screening research to rank wheat and barley varieties for relative susceptibility to spring radiation – or reproductive – frost, which occurs in late winter and early spring.

The first relative frost susceptibility rankings were released early this year.

While all varieties are susceptible to frost, some are a little more susceptible than others and this knowledge may assist growers in selecting slightly lower risk varieties for the high-risk areas of their farms.

This could be a component of a more comprehensive plan to manage the risk associated with frost.

In the next phase of this project, the work will be expanded to screen thousands of wheat lines from around the world – initially selected using a focussed identification approach to pinpoint lines from parts of the world that regularly encounter spring radiation frost damage similar to that experienced in Australia.

These will be tested during the next five years, with the aim of identifying the most frost tolerant genetics for future breeding programs.

Information about the GRDC's frost investment, tactics to manage spring frosts and links to useful resources are available at www. grdc.com.au ■

More aphid resistance confirmed

RESISTANCE to neonicotinoid insecticides has for the first time been confirmed in Australian populations of green peach aphid (GPA), a serious broadacre cropping pest.

The discovery means that GPA is known to have resistance to four different chemical mode of action groups:

- Synthetic pyrethroids;
- Carbamates;
- Organophosphates; and now,
- Neonicotinoids.

GPA is a widespread pest of canola and a range of pulse crops, causing damage by feeding and transmitting viruses, including Beet Western Yellows Virus which decimated canola crops in parts of South Australia, Victoria and New South Wales in 2014. It is also a common pest in horticulture.

Resistance to neonicotinoid insecticides – commonly used in seed treatments – was recently confirmed by scientists involved in research undertaken on behalf of the GRDC and Horticulture Innovation Australia (HIA).

The work has been led by Melbourne-based scientific research organisation cesar, in collaboration with researchers at CSIRO.

Entomologist Dr Paul Umina, of cesar, says resistance to neonicotinoids has now been confirmed in a number of GPA populations across Australia. Specimens taken from both canola and vegetable crops tested positive for resistance.

Paul says the discovery – while not unexpected – further limits the opportunities and options for control of GPA and underlines the need for sound management resistance strategies and integrated pest management practices to ensure long-term access to available chemistries.

Still a valuable tool

"Our findings don't mean that neonicotinoids are dead in the water; they are still a valuable tool," Paul said. "But the discovery does serve as a reminder that all chemicals are vulnerable to resistance development, particularly when dealing with a species like GPA which is known to have a high propensity to develop insecticide resistance."

The mechanism underlying neonicotinoid resistance in Australian GPA populations has been identified as metabolic resistance which, fortunately, means that functionally resistance levels are low to moderate.

Paul says there is another mechanism conferring neonicotinoid resistance in GPA, which leads to a very high level of resistance, and complete field failures.

"In good news, this high-level resistance, which is found overseas, hasn't been detected in Australia. By adopting resistance management strategies, we can significantly reduce the likelihood of this resistance evolving in Australian GPA."

Paul says Transform – a sulfoxaflor foliar insecticide – remains an effective means to control GPA in canola crops.

Dr Siobhan de Little, a senior consultant with cesar, says it took researchers some time to establish the methodologies necessary to confirm resistance to neonicotinoids.

"We used a relatively new lab-based method in combination with genetic testing to confirm aphid populations were in fact resistant," Siobhan says. "But it is not a discovery in isolation when you consider it in the context of what we already know in terms of GPA and its resistance to other chemical groups."

GPA has high levels of resistance to pyrethroids and carbamates, and while resistance to organophosphates is broad across Australia, levels of resistance to this group are lower.

Insecticide resistance almost always evolves due to the overreliance on a particular chemical leading to strong selection.

Paul and Siobhan encourage growers to continue to follow the GPA Resistance Management Strategy (see www.grdc.com.au). They also urge growers to keep a close eye on next year's canola crops as they establish. If aphids are seen surviving on young canola plants that have been treated with neonicotinoid insecticide seed treatments, growers are urged to contact cesar.

Further information: cesar Ph: 03 9349 4723. ■

Green peach aphids. (Photo: A. Weeks)

GM REPEAL WELCOMED

The Grain Industry Association of WA (Inc) welcomes the passing of the Genetically Modified (GM) Crops Free Areas Repeal Bill on October 20, 2016 in WA State Parliament.

According to Michael Lamond, Chair of the GIWA Oilseeds Council: "The benefit to WA growers from this repeal legislation is both immediate and long term. It gives growers choice on the type of canola they can grow now, and it gives canola breeders the confidence to continue to breed high yielding canola varieties for WA in the future.

"With GM canola, growers benefit sooner from new higher yielding varieties, coupled with new output traits, than would be the case with conventionally bred canola," Michael said.

"The state will benefit from farmers continuing to be able to grow GM canola because they will:

- Be more profitable from growing higher yielding varieties;
- Have access to quicker releases of varieties adapted to our changing climate;
- Have access to alternative weed control options;
- Be able to grow grain quality traits for speciality markets;
- Be able to use new traits to reduce chemical applications; and,
- Continue to have marketing choice to meet consumer demand by growing either GM or non- GM canola."

A global example of proven GM technology over more than a decade is found in the Canadian grains industry – a competitor to Australia – where over 90 per cent of the canola crop is GM canola.

GIWA believes that with the exemptions granted under the now repealed Act, the grains industry demonstrated its ability to manage co-existing technologies through its supply chains. More than 30 per cent of the WA canola crop is GM canola and this statistic is growing.

Since 2010 WA has sold both GM and non-GM canola into international markets such as Japan and Europe, adding to the state's international reputation as a quality, reliable, clean, safe producer of grains and oilseeds.

Encouraging outlook for double cropping

WITH dams and soil moisture profiles full, as well as low water prices, double cropping silage and hay crops could add value for many irrigated and semi-irrigated dairy farmers in southern NSW and Victoria this summer.

According to Advanta Seeds corn business manager, Rob Johnston, a number of factors point to this as a good summer for double cropping into corn or forage sorghum.

"In addition to the lower cost and availability of water, ongoing benefits on the weed and disease control fronts make double cropping into corn or sorghum a good option this summer," he said.

"Both these crops allow the use of Dual and Gesaprim, and corn only has a 10-week plant back to Balance. There are also high yielding imidazolinone-tolerant (IT) options such as PAC 606IT available for post emergent grass and broadleaf weed control."

Rob said as non-host species for sclerotinia and blackleg, corn and sorghum offer a disease break to two of the key diseases affecting broadleaf winter crops.

"Sorghum has also shown an ability to reduce the numbers of certain species of nematode, in particular *P. thornei* and is a non-host of verticillium wilt."

Sow until late December

Sowing time for corn and sorghum is expected to extend from October to the end of December.

"There are a range of maturities for planting over this time, with early sown, quick varieties such as PAC 301 in corn and Sprint forage sorghum offering early quality feed to make efficient use of the good soil moisture available," Rob said.

"One of the main things to think of when picking a corn hybrid to be planting late in the season is its disease package. Advanta Seeds have an extensive rating system on all its hybrids and it would be worth talking to your local representative. PAC 606IT, for instance, has shown outstanding tolerance to rust and northern leaf blight," Rob said.

As always, factors such as field layout and existing infrastructure are among the factors which need to be considered when looking at double cropping. ■

Advanta Seeds corn business manager Rob Johnston says this summer presents an opportunity for double cropping.

New weapon in war on wild rabbits

AT A GLANCE...

- 418 sites across Australia will participate in the release of a new variant of rabbit haemorrhagic disease virus – RHDV1 K5.
- It's been 20 years since the last rabbit biocontrol was released in Australia.
- A RabbitScan mobile app is now available to enable people to contribute to the national data set to monitor the spread of the virus.

A NEW virus known as RHDV1 K5 will be trialled next year at 418 sites across Australia in an effort to significantly reduce wild rabbit populations and their negative impact on agricultural production and native ecosystems.

Deputy Prime Minister and Minister for Agriculture and Water Resources, Barnaby Joyce, welcomed the 755 expressions of interest received from groups wanting to take part in the national roll-out of the new virus.

Barnaby Joyce.

Barnaby said community organisations, Landcare groups and government land managers will be participating in the national rollout of the virus as part of the Coalition Government's $1.2 million commitment to assist with the research and development of new rabbit control methods.

"Australia has a good track record when it comes to the biological control of rabbits. When we first released rabbit haemorrhagic disease virus in 1995, populations had multiplied to around 600 million, and we managed to reduce this by 98 per cent in arid areas," Barnaby said.

"This built on the massive reductions achieved in the 1950s from the release of the myxoma virus, which killed more than 85 per cent of Australia's rabbit population.

"It gave the environment time to regenerate and our farmers a fighting chance to keep rabbits at bay using traditional pest management techniques like baiting and traps."

Rabbit numbers on the rise

Rabbit populations are on the rise again and Member for Calare, Andrew Gee, said he welcomed the new coordinated effort between governments, researchers and communities to address these pests and reduce the cost to farmers and the environment.

"Calare saw a huge expression of interest and 13 sites have been successful around Dubbo, Wellington, Mendooran and Dunedoo," Andrew said.

"Estimates show a conservative knockdown of the rabbit population somewhere between 10 and 40 per cent, dependent on the location and conditions. It's no silver bullet, but it's our best option to address resistance to existing RHDV strains."

"For the sites not selected as a part of this roll-out, I encourage you – and everyone – to get involved by downloading the RabbitScan mobile app and contribute to the national data set that will monitor the spread of the virus and the impact on rabbit populations," Barnaby said.

RabbitScan can be downloaded from www.rabbitscan.org.au

More details about the RHD-Boost project, see www.healthierlandscapes.org.au

Fast facts

- RHDV1 K5 is a naturally occurring Korean variant of the rabbit haemorrhagic disease virus currently found in Australia.
- RHDV1 K5 is estimated to have a conservative knockdown average between 10 and 15 per cent of the wild rabbit population in Australia, and up to 40 per cent in cool-wet areas.
- RHDV1 K5 was selected for the national program to boost rabbit biocontrol on the basis that it should work better in cool-wet regions of Australia where rabbit populations have demonstrated resistance to the existing RHDV strains.
- The national trials of RHDV1 K5 is the culmination of work undertaken by the Invasive Animals Cooperative Research Centre.
- A vaccine to protect domestic rabbits against RHDV1 has been available in Australia since 1996 and studies demonstrate effective protection against the RHDV1 K5 variant. ■

Australia has a good track record in the bio-control of rabbits.

INNOVATIVE APP TO TRACK RABBIT CONTROL

A function to boost the power of the popular RabbitScan app has given the community the ability to track the spread of rabbit biocontrol agents and viruses from their smart phone or computer, via a digital map.

The innovative tracking function in the RabbitScan app was developed through the Invasive Animals Cooperative Research Centre (IACRC) as part of its rabbit haemorrhagic disease (RHD) virus project, called RHD Boost.

NSW Department of Primary Industries (DPI) researcher and project leader of RHD Boost, Dr Tarnya Cox, said the new tool delivers an innovative approach to understanding rabbit biocontrol agents and viruses in the Australian landscape.

"Farmers, land managers and the community can play an important role in recording evidence of rabbit disease which can be used as scientific data to guide local rabbit management activities," Tarnya said.

"The app takes you through a few simple steps to record details of dead rabbits and includes images of rabbits affected by virus and disease for easy identification.

"A powerful aspect of the new tracker gives people the opportunity to submit tissue samples from dead rabbits with suspected RHD virus.

"When users click to submit a tissue sample our research team sends a free, postage-paid sampling kit with full instructions on how to collect and send the sample.

Evidence-based decision making

"Once the tissue sample is analysed an update on the digital map will record the results and the person who submitted the sample will be notified with accurate information of what virus is affecting rabbits in their area or control site, which is valuable information for their local rabbit management plan.

"The project is giving communities across Australia the power to make informed management decisions based on scientific evidence," Tarnya said.

NSW DPI professional officer and IACRC FeralScan manager, Peter West, said the user-friendly RabbitScan app can be used without mobile phone coverage and is suitable for remote areas.

Farmers can play an important role by recording evidence of disease which adds to the scientific data behind more targeted local rabbit management activities.

"Rabbit details recorded out of phone reception are stored until you are in range. Once in range users can upload records directly to the map with just one button," Peter said.

"The RabbitScan app and website are moving from a tool which tells you where rabbits are to one that can also reveal the effectiveness of local management decisions and actions on a national scale."

"RabbitScan is a tool for the community, led by the community and benefiting the community, which will assist land managers and farmers in making future management decisions."

RabbitScan registered users can update their apps to access the Rabbit Biocontrol Tracker via Apple or Google Play stores or www.rabbitscan.org.au

The 'RHD Boost' research initiative has been delivered through the Invasive Animals CRC, with major financial and in kind resources provided by the Australian government, state governments, and industry and non-government organisations.

Funds dropping their shorts...

By Peter McMeekin, Nidera Australia Origination Manager

THE Australian dollar price of grain is made up of three components – futures, the AUD/USD exchange rate and domestic basis. Up until September, and for many months prior to that, the managed money (funds or speculators) in the US futures markets were holding substantial net shorts in both wheat (a record) and corn futures. In other words, when the positions were established they were betting that the futures market would go down and they have been handsomely rewarded for the risk they have taken.

Peter McMeekin, Nidera Australia.

To put the positions in perspective, the wheat short was equivalent to more than 20 million metric tonnes (mt) and the corn short was around 23 mt.

In mid October, the funds starting buying in their net short positions with the momentum increasing as the month rolled on.

The net reduction over the two week period to October 27, was almost 93,700 contracts of corn (11.9 mt) and slightly more than 48,800 contracts of wheat (6.64 mt).

Has there been a fundamental change?

So what has happened in global grains markets? Was this action driven by a fundamental change?

Grain wires for many months were talking about the large global supplies of wheat and feed grains. As the northern hemisphere winter harvest progressed, save for a few quality issues, the crops generally got bigger.

In the US the corn, sorghum and soybean harvests were progressing well and yields were close to expectations. Basically, we got to a point in this season's production calendar where the southern hemisphere crops were the only unknowns in the global balance sheet with Australia on the cusp of a huge harvest.

On the demand side there had been plenty of action with importers taking advantage of the favourable pricing environment in the second half of October. Egypt, Algeria and Saudi Arabia all bought in tenders with European Union, Black Sea and eastern European exporters the main beneficiaries. Syria also bought Russian wheat.

But none of this is new demand so the impact on the world supply and demand equation was basically zero.

The interesting rumour to surface in the third week of October was India purchasing 100,000 tonnes of Australian wheat.

The prices quoted were US$223 CNF (Cost & Freight landed India) for APW and US$216 for ASW. Freight is obviously dependent on vessel size – but let's call it US$20 a tonne.

The quoted APW sale price works back to a grower bid equivalent of AUD$220 Port Adelaide. When the business was done replacement value was around AUD$5 higher, but the market came back by that amount to be around AUD$220 on October 27 – smack on replacement value.

But don't get too excited as this demand is minor in the bigger picture.

Australia will need to sell four times that quantity every week for the next 12 months, and the carry out may still increase with a huge crop hitting the bins.

What about prices down the track?

From a future viewpoint, corn production in South America is forecast to increase next year with the Brazilian planting pace well ahead of the average. The northern hemisphere winter wheat planting program is progressing well on the whole with total area in the US expected to be down only slightly on this year.

So no significant change on the supply side (increasing if anything), no demand surprises, a big Australian crop about to be harvested and no apparent production concerns on the global horizon.

There needs to be a significant production shortfall in one or more origins to push this market significantly higher. Looks to me like the funds were simply booking some profits in late October and positioning themselves for the next opportunity – whatever and whenever that may be. ■

Global wheat feed use increase

By Stephanie Bryant-Erdmann, USW Market Analyst

IN its November World Agriculture Supply and Demand Estimates (WASDE) update, the USDA pegged global wheat production at 745 million tonnes (mt), up 1.3 per cent from 2015-16 and, if realized, the fourth consecutive record high. The USDA also increased its estimate for global wheat consumption to 736 mt, about 5 per cent above the 5-year average.

In particular, wheat feeding is expected to increase 6 per cent to 147 mt. In the EU and Canada, wheat damaged by excessive moisture this season is bolstering wheat feed usage, but in the US, the Black Sea and even Brazil, the difference in price – or the spread – between corn and wheat is playing a key role.

The USDA expects Canadian wheat feeding to increase 71 per cent year over year to 4.5 mt after excessive rain caused significant harvest delays and reduced wheat and durum quality.

The USDA estimates the EU used 38 per cent of its total wheat production for feed in 2015-16, and this year it expects that to rise to 40 per cent or 58 mt, 6 per cent above the 5-year average.

The corn-wheat price flip in the US

Despite not having a designated "feed grade" for wheat, some wheat feeding occurs in the US every year. It happens for many reasons that include its local availability, protein levels and even the preferences of the livestock rations manager. Price relative to corn is certainly a factor. Normally, wheat trades at a premium to corn but in the US and Brazil that spread has flipped, with corn now at a premium to wheat.

Wheat cash prices to US farmers at US Southern Plains local elevators averaged about 87 per cent of corn cash prices in October. With corn trading at a premium to wheat at local elevators, wheat feeding is much more attractive this year. That is why USDA has increased its wheat feeding forecast in the US to 7.08 mt, up 71 per cent year over year and 28 per cent higher than the five-year average.

It's also reported that Brazilian pork and poultry producers are increasing wheat in their rations because local Brazilian corn prices are US$225 per tonne, compared to wheat at US$178.

This price dynamic is expected to increase wheat feeding by 50 per cent year over year. Brazil typically produces about half of its total wheat consumption. As a result, any increase in wheat feeding should result in an increase in wheat imports.

USDA pegged Brazilian wheat imports at 6.6 mt, which would make Brazil the fourth largest importer in the world this year.

While world wheat production continues to increase, milling quality wheat supply continues to erode.

In countries where rains boosted yields, a reversed corn-wheat spread is encouraging lower protein, milling quality wheat into feed wheat channels, further constraining milling wheat supplies. ■

RECORD WHEAT TRADE

A fact that may be undervalued in a market fixed on supply news is that trade volume in wheat, the world's most traded grain, is on a steady increase. In its latest round of estimates (November), USDA now expects 2016-17 world wheat trade will reach a record large 174 million tonnes (mt). Along with rising global demand and a potential shortfall of milling quality supplies, wheat buyers would do well to watch for any price effects and act quickly to cover their needs at the best value.

If realised, world wheat trade would be almost 9 per cent greater than the five-year average of 160 mt. The trade volume increase represents availability of large supplies and the continued growth of global wheat consumption. USDA expects total consumption will increase for the fourth consecutive year and reach a record 736 mt, compared to the five-year average of 694 mt. That includes estimated feed wheat demand growing six per cent to a record high 147 mt.

While global wheat supplies are large, the quantity of milling quality wheat is tightening – a market dynamic that could push prices higher.

US FARMERS AND THE TPP

Following the signing of the 12-nation Trans-Pacific Partnership (TPP) in early 2016, US wheat grower organisations called on the US Congress to rapidly consider and ratify the agreement. After a long and disappointing wait with no Congressional ratification, these wheat grower organsitions are again calling on Congress to allow an implementing bill to be considered as soon as possible.

With President-elect Trump's anti-TPP position made very clear during the election campaign, US wheat growers are concerned that hard-fought gains offered by the TPP will be lost.

Wheat is the most export-dependent grain commodity grown by US farmers. Since early 2016, average cash wheat prices have dropped from an already unprofitable US$4.90 per bushel (A$240 per tonne) to a devastating US$3.50 per bushel (A$168 per tonne).

"Wheat growers depend on export markets like those in South Asia and Latin America that are growing, but highly competitive," said National Association of Wheat Growers President Gordon Stoner, a wheat farmer from Montana. "When implemented, TPP will help ease the pain of low prices by expanding demand for our wheat in those markets. Now more than ever, we cannot afford to lose even more momentum in these markets from Congress letting this opportunity to ratify TPP slip by."

Competition from Australia

"Asia is a growing region and TPP has the potential to increase economic opportunity and wheat demand even in countries where we already have duty free access," says Gordon. "That is critically important because competitors like Australia are moving ahead with bilateral agreements that eliminate tariffs on wheat imports with countries like Vietnam."

"The high standards in the TPP agreement should help us be more competitive and hopefully lead to even more opportunity for our wheat as new countries join TPP in the future," says US Wheat Associates Chairman (and wheat farmer) Jason Scott. "The Obama Administration has taken strong actions that show trade agreements, when enforced, work for agriculture."

Farmers in foreign fields

THEY say that travel broadens the mind. Well, if that's true, there should be some very broad-minded Australian farmers after this year's *Greenmount Travel* tours to foreign fields. The 2016 tours included some old favourites such as China, Canada and southern Africa; some destinations out of left field such as Alaska, Kazakhstan and Iceland; and one destination way outside the ballpark – North Korea (yes, North Korea).

The Hermit Kingdom

Our media exposure with regard to North Korea is limited and overwhelmingly negative. That's not to say that at the foreign relations level it's not accurate, just that when it comes to our perception of the people, it's not warm and fuzzy.

But we can report that the people are friendly, they're courteous, many are clever, they have a sense of humour and, well … they're people.

Following our induction in Beijing we flew into Pyongyang, the capital of the Democratic Peoples Republic of Korea (DPRK). And – as our induction had warned us – we and our luggage were thoroughly, but not threateningly, inspected.

We were collected by our guides – Miss 'Hung' and Miss 'Oh' – who were to keep us close company, very close company, for the next nine days. Keeping close company with very clever and very personable young women is not necessarily a hardship.

We were introduced to our purple bus and taken directly to the massive Mansudae Grand Monument to Kim Il Sung and Kim Jong Il. This was to set the tone of the next nine days. Impressive

Helping out on a North Korean collective farm. George was concerned that a broken shovel could mean an extended stay.

architecture and landscape coupled with universal veneration of the former leaders. Every hotel, every factory, every public building and every farming co-operative prominently featured images and mementoes of the father and son.

Our study group was given the opportunity to travel to places seldom if ever visited by tourists of any persuasion. And I mean this quite literally – we travelled on massive motorways devoid of motorised traffic and stayed in massive five star hotels devoid of guests.

It's not often that you stay in a luxurious 200 room hotel in a truly beautiful location and your group of a dozen travellers are the only people at breakfast. And no, it wasn't because we came down late – it was because we had the facility to ourselves.

The DPRK was always going to be an intriguing destination and it didn't disappoint – there was a general feeling across the group that this had been a great trip – one of the best. ■

Kropping the Yukon

Except for winter temperatures so low that your lungs can literally freeze – and you have less than 100 days to grow your grain crop before frosts or moose finish the job for you – there's a lot of similarities between Alaskan and Australian agriculture.

From the early days of settlement through to current times, farming in both Australia and Alaska happens in a hostile physical environment. As the *Greenmount Travel* Kropping the Klondike group found out earlier this year, where we have vast distances, difficult soils and extreme climatic conditions to contend with – so do our Alaskan cousins.

This physical environment helps create a farming frontier mentality where success or failure is very much determined by your innovative skills and resilience.

A great Alaskan example of this is the Wrigley family at Delta Junction, southeast of Fairbanks. In 1983 Bryce and Jenny Wrigley and their young family migrated north from 'the lower 48' to grow pigs. They were very soon confronted with a worldwide crash in the price of pork forcing them out of the pig business. But the Wrigleys had learnt how to grow barley – under Alaskan conditions – to feed their livestock. Today with around 700 hectares of farmed land, they are among the biggest barley growers in Alaska.

It took a number of years to arrive at a farming system that enables them to harvest an average of 2.5 tonnes of barley per hectare in a 98 day growing season.

The innovation continues on the Wrigley Farm as the family positions their business to supply barley food products directly into the Alaskan market. With around 95 per cent of the food consumed in Alaska being imported, they are finding great support for their farm-made products. With the help of son Mylo and daughter-in-law Leah, the Wrigley Farm barley is now processed on-farm and sold as a variety of products into Alaskan supermarkets and other outlets.

Alaskan farmers need to be on their toes to be able to grow grain crops in just three months – but the spectacular views over the back paddock are 365 days of the year.

The Wrigleys were just one example of Alaskan farmers adapting to the prevailing and very difficult conditions, and making a go of it.

Not far from the Wrigley Farm is the Delta Meat and Sausage Company. Owned and operated by the McCollum family, meat processing is just part of this farming story. Lured by the homesteading opportunities on offer, Doug and Cathie McCollum packed up their Montana farm and family in 1968 and headed 'North to Alaska'. Hay and cattle raising and a concrete business kept the family busy for the next 30 years or so before they built the Delta Meat and Sausage plant.

Jeannie Pinkelman (nee McCollum) explained to our group that to survive in Alaskan business you have to virtually "create your own markets". To this end, the plant processes meat from their own Galloway/Angus cattle as well as pork, buffalo, yak, elk and reindeer from local farmers. They are also a hub for big game hunters with around 300 moose processed each year.

And in typical Alaskan style, Jeannie said that although the US farm program had some attractions: "There's too much paper-work and other BS involved to be bothered. We've stayed out of it."

Into the Klondike

The spectacular Top of the World highway delivered our group into Yukon Territory (northwest Canada) and the Klondike – a region which captured much of the world's attention in the late 1890s as more than 100,000 prospectors joined the goldrush.

Dawson City was very much the centre of this gold-frenzied activity. In 1896 it was a quiet First Nations camp – two years later it was a thriving city of 40,000 people. By 1899, the gold rush had ended and the town's population plummeted. But today, Dawson City has retained many of its historic buildings and seductive charms... such as Diamond Tooth Gertie's Gambling Hall.

We continued southeast to Whitehorse where we found more intrepid farmers making a living under very difficult conditions. At a local 'dog farm' we learned that you could of course supplement this farm income simply by mushing a team of sled dogs in a race over 1000 miles, in freezing March conditions, and in around 10 days.

Somehow, making a few dollars out of farming – even in the Yukon – seemed an easier option.

We re-entered the US at Skagway, the northern gateway to the famed Alaskan Inside Passage. Whales, seals, salmon runs, glaciers and other spectacular sights made for a memorable boat cruise to Juneau and our flight south to Seattle.

The Pacific North West and the Rockies

The Boeing factory, the amazing Chihuly glass artworks, farmer's markets and a spectacular location are just a few of the ingredients making Seattle a very liveable city. It's just a pity about the traffic jams... but once we crossed over the coastal range we had nothing but diverse farmlands and mighty rivers to slow us down.

Washington state, along with Oregon and western Idaho make up the Pacific North West, home to some of the most valuable and reliable irrigated and dryland farming country in the US.

Recently retired USDA agronomist Frank Young, joined us on the coach and introduced our group to some excellent farming

country, and wonderfully hospitable farming families, as we travelled east and into the rolling hills of the Palouse.

Here, farming on 45 degree slopes is commonplace as are specially adapted 'hillside headers' to ensure the grain is separated on reasonably level sieves.

As we continued east the Rockies quickly put a stop to broadacre grain farming for a while but they did open up spectacular vistas as we followed the ancient Nez Perce Indian trail into Wyoming and the Grand Teton/Yellowstone national park region.

We then travelled north into Montana and the western Canadian rolling prairies where farm size and topography were a little more familiar for us – although we wouldn't have minded also being more familiar with their very good and reliable grain (around 4 tonnes) and canola (2 tonnes plus) yields.

Stampedes and stunning scenery

Our tour wound down with a whoop-up at the Calgary Stampede and then the majesty of the Canadian Rockies – including high tea of course at Lake Louise.

The unforgettable train journey from Banff through to Vancouver – and the incredible human and engineering feats to make the journey possible – provided the perfect setting to reflect on the resilience and innovation of past and present day farmers prepared to 'have a go' in some incredibly challenging environments. ■

The Silk Road – potholes and all

When we set out in early July in search of the farming, trading and history along the old Silk Road, we knew we were travelling some of the most remote parts of the world through which Mongol hordes, adventurers and merchants had travelled for centuries.

In the remote north west China province of Xinjiang, wave after wave of conquest and migration has washed through and each wave has left behind a cultural heritage. The result is a melting pot of local Uyghur people with a hefty mix of Kazakhs, Mongols and every other tribe and culture from Central Asia.

We headed into the countryside, with the first stop at Narat, famous for its mountain grasslands. Thousands of hectares of intense green, rolling treeless country, surrounded on all sides by the snow capped peaks of the magnificent Tien Shan mountains.

The scenery is spectacular, reminiscent of the best of the Swiss Alps, but with the most interesting cultural experiences at every turn.

If we thought it couldn't get any better, we hadn't anticipated Sayram Lake, reached after travelling a road and bridge system which is simply a modern engineering marvel.

Our group was slightly disconcerted to have to chase some stray sheep from inside their traditional yurt accommodation for the night. But the cultural experiences left an enormous impression on everyone. The first cultural experience was typically Australian – beer and wine on the shores of the beautiful lake with regular text message updates from the third State of Origin rugby league match. For once, the NSW people won the bragging rights.

That night, some local singers and dancers gave an open air performance of traditional Kazakh music under the stars on a hastily erected platform near our yurts. The music soon drew every family for miles to come and join us and we had an unforgettable night of singing and dancing with the local people.

Northern Kazakhstan

We flew to Kostanai in the far north of the country and met some of the local farmers and came to terms with the scale of the farming in this part of the world. In a round table discussion, the local farmers described the size of their operations. Twenty thousand hectares... 50,000 hectares... 70,000 hectares. When it came to our turn, we gingerly admitted to farms from 500 to 3000 hectares. We would spend the next few days trying to find the differences which allowed our farmers to make a living on such a 'small' area while the locals were struggling to make ends meet on the big hectares. Needless to say, there remain many unanswered questions.

But we did get a glimpse of some of the logistical problems facing the farmers. The major road we were on was riddled with potholes in the better parts. In the worst part, it took well over an hour to negotiate a 25 km section.

Overall, it was a great trip, full of excitement and unique insights into the local cultures. And we had the privilege of visiting some wonderful farms and meeting some great farming hosts. ■

Back to Africa

We hadn't taken a 'large scale' *Greenmount Travel* tour to Africa for several years, so it was perhaps no surprise that the interest was so strong that we ended up with two tours, travelling in opposite directions. Somewhere in the middle of Botswana, the groups crossed over.

A friendly game of Buzkashi at Bayanbulak. Lots of fun, but no rules.

A road hazard in Zimbabwe.

We were treated to the very rare sight of a lion cub, only weeks old, being a part of the pride. Very young cubs are normally hidden away by the lioness until a much older age.

The whole thing had to run like a well oiled machine, and for the most part, it did. The only remaining mystery was: Why had it taken so long for *Greenmount Travel* to return to Africa?

For both groups it was an amazing experience. While we visited some great farms in South Africa and Namibia and were home-hosted at the fantastic "farming frontier" at Pandamatenga in Botswana, the animals and the scenery were definitely the stars of the show. Much of the savannah country looks a lot like parts of the Northern Territory or the dry tropics of Queensland. But instead of kangaroos hopping out from the scrub, you may see a couple of graceful giraffes, a pride of lions on a fresh kill or a herd of impala – the McDonalds of the bush.

Along the way we gained a new understanding of some of the challenges of farming in this continent – from elephant proof fencing in Botswana to razor wire to keep out other intruders in South Africa. One farmer had a narrow escape a few weeks before our visit after being jumped by some would-be thieves outside his farmhouse. He was saved by the quick thinking of his wife and the forceful intervention of his dogs.

But despite the difficulties, it is easy to see how Africa can get into the blood – from the Cape to the Namib desert, the Okavango Delta and Victoria Falls. The whole place was in the grip of a terrible drought, but the animals at least had found ways to survive.

Our game viewing was exceptional, with about 70 species of land animals and over 100 bird species recorded. But whether for the farming, the animals or the scenery, one thing is certain – *Greenmount Travel* will be back there again in the near future. ■

Northern lights to Baltic burn!

The *Greenmount Travel* weather guarantee (it will be what it will be!) saw our Northern Nomads farm study group enjoy beautiful sunny September conditions from Iceland through to the Baltics. And to really cap off our meteorological luck, the elusive Northern Lights came out to play on our first night in Reykjavik.

This was to herald an amazing three-week tour of Iceland, Scandinavia and the Baltic States meeting intrepid farmers who were not only up against very significant physical challenges, but political hurdles as well.

A great example is the Eggertsson family who have been successfully farming crops and dairy cattle in the shadows of Iceland's Eyjafjallajokull volcano for decades. When the volcano in their back paddock erupted in 2010 covering the farm and buildings in 5 cm of volcanic ash – not to mention closing northern European air traffic for two weeks – the 'disaster' was soon turned into a tourism bonanza with people lining up to visit the Eggertsson's recently constructed on-farm volcano exhibit.

Iceland (pictured), Scandinavia and much of the Baltics have abundant supplies of water. But in many of their agricultural systems too much soil moisture is the limiting factor.

And with around 1.2 million people visiting Iceland each year – or four times the permanent population – there are plenty of tourists to be shared around.

Farms clinging to mountain-sides

Our group took a short flight to the east and into the scenic wonders of the Norwegian fjordlands. Farms dramatically clinging to sheer mountain-sides slowly gave way to agriculture on more even terms... very even in fact. Swedish farmer Per Fimmerstad has found a very profitable niche in the production of turf – hectare upon hectare of very lush and flat fields of the stuff.

A building boom in nearby Stockholm provides an insatiable market for turf while in the warmer months the Fimmerstad family's on-farm castle and cafe (don't we all have one?) accommodates over 200,000 hungry tourists.

The financial advantages of having a farm in high tourism traffic areas is pronounced.

Another short easterly flight and we were in Tallinn the capital of Estonia (bordering Russia), and an historic jewel in the Baltic States. After slowly emerging from under the cloak of Russian suppression, agriculture in the Baltics is becoming much more sophisticated and attracts a lot of investment from western European interests.

There are vast tracts of beautiful soils throughout the Baltics and crop yields are impressive – although a number of our group members often suggested (after regaining the ability to talk) that some more work could be done on refining their local home brews.

All in all, an amazing region of the world to visit... but the secret is getting out!. ■

Genetically modified wheat shows massive rise in yield

By David Jones, *Farmers Weekly* (UK)

GENETICALLY modified wheat crops could see a leap in yields after glasshouse trials showed a massive 40 per cent increase in grain output. UK researchers focusing on making the photosynthesis process in wheat plants more efficient, are hoping to have the first field trial of this new wheat crop drilled next (northern hemishere) spring.

The new wheat plants – with genes added from a grass called stiff brome – have been showed to assimilate carbon dioxide better than conventional wheat which led to a big jump in crop biomass.

Three UK research bodies are joining forces, including the Universities of Essex and Lancaster together with Rothamsted Research, to look at the use of GM technology for the first time to increase crop yields.

"We have seen yield increases of 20 to 40 per cent in greenhouse pots, although this in not a yield indication for the field," said Christine Raines from the University of Essex.

Breakthrough the yield barrier

The researchers said even if they saw half that yield rise they would be delighted, as there is a need to break through the barrier to wheat yields which has been seen in recent years.

"Even a relatively modest increase would be a major advance – even a five per cent increase would be amazing," said Malcolm Hawkesford from Rothamsted.

In early November 2016 the research project applied to the UK's Department for Environment Food & Rural Affairs (DEFRA) for the go-ahead to grow the wheat trial which would amount to just under 100 m^2 of the crop being grown in Rothamsted's fenced GM-dedicated 3.2 hectare growing area.

They are planning to use the technology in the spring wheat variety Cadenza at Rothamsted in 2017 and also in 2018 if the trial is approved.

"This is the only way we can determine whether we can get a yield increase in the field, and this yield increase could be huge," said Malcolm.

The researchers identified that the process of photosynthesis can be limited by the lack of the enzyme SBPase, so they are looking to increase the level by engineering wheat plants by introducing a SPBase gene from stiff brome grass.

Extra gene copies

They have produced two types of plants one in which two extra copies of the SBPase gene are added and another in which six extra copies of the SBPase gene are introduced.

"We are improving photosynthesis to improve the yield of wheat," said Elizabete Carmo-Silva of Lancaster University.

If this technique does work then this trait could be transferred to other crops, while wheat yields could be further increased by looking at other enzyme levels which might be boosted, the researchers said.

GM crops in the EU

Currently, only GM maize is grown commercially in the EU.

This is grown largely in Spain and is used to protect the crop against a weevil pest, called the European corn borer.

Malcolm Hawkesford from Rothamsted Research (UK) says that even a modest 5 per cent yield increase with GM wheat would be an amazing advance.

Such is the level of opposition across Europe to GM technology there have been no other GM crops approved and subsequently grown since 1998.

But UK farm minister George Eustice has hinted that British farmers may be able to grow GM crops once the UK leaves the EU, following the Brexit vote in June.

A recent trial at Rothamsted looking at GM wheat designed to repel aphids disappointed researchers as the crop was seen to be no better protected than conventional wheat.

This trial in 2012 and 2013 was targeted by anti-GM campaigners and the wheat plots had to be protected by a high fence, with the cost of the whole trial subsequently rising to nearly £3m ($5m).

The cost of the current GM trial is about £866,000 ($1.45m), with nearly £700,000 ($1.17m) coming from the UK government funded Biotechnology and Biological Sciences Research Council and the rest by the US Department of Agriculture. ■

Tractors in a hurry

By Ian M. Johnston

Farm tractors are by definition lumbering machines. They plod around the paddocks dragging their ploughs, scarifiers, seeders and whatever. Certainly, a JCB Fastrac would scorch past a 1930s Case Model L, but the Fastrac would be incapable of generating the thrill of speed that emanates from say a Porsche Boxster or even a good old MG TC. But surprisingly, there were a number of 1930s tractors that certainly could not be classified as plodders and were more than capable of testing the testosterone of the most daring of speed freaks!

The Allis Chalmers Model U

Until the mid 1930s, the only wheel options offered to intending buyers of farm tractors, related to the width of the steel circumference and a choice of spuds, cleats or bars. This restricted the speed of a tractor to not more than five miles per hour and required the gripping attachments to be tediously and laboriously removed, prior to each trip – no matter how short – on a public road.

Pneumatic tyres were considered as being suitable for motor cars and trucks, but out of the question for tractors. It seemed obvious that rubber tyres could not possibly exert the same grasp of the ground as rugged steel grips.

But a group of enthusiastic young design engineers at the Allis Chalmers Mfg Co of Milwaukee, had the enterprise to disagree with this philosophy. Accordingly, an Allis Chalmers Model U (launched in 1929 as the 'United Universal') was equipped with truck type high pressure pneumatic tyres. Field tests resulted in disappointing conclusions, as it was found the tyres simply could not obtain an adequate grip.

So it was back to the drawing board.

Exhibiting a considerable degree of ingenuity, the design team acquired a pair of cast off tyres that had been fitted to an aircraft deployed in the ferrying of pineapples from Hawaii to the US mainland (of all things) and fitted them to pressed steel rims adapted to a Model U. Following extensive testing on a Wisconsin farm, it became immediately apparent that these tall baggy low pressure tyres obtained an excellent grip of the soil, without the compacting associated with the traditional steel wheels.

The Firestone Tyre Company was contracted to manufacture similar tyres, specifically for fitting to Allis Chalmers tractors. But farmers are conservatively minded individuals and regardless of the marketing campaigns, failed to be convinced of the advantages of pneumatics over steels, even despite the Ohio State University claiming a 27 per cent increase in traction and a 24 per cent reduction in fuel consumption.

It was obvious a departure from conventional promotional advertising was required, in order to convince the reticent farmers of the advantages of pneumatic tractor tyres.

The world record

In June 1933 at the Milwaukee State Fair, a 39.4 hp Allis Chalmers Model U, fuelled with petrol/kerosene and equipped with pneumatic tyres, was demonstrated pulling a plough. A large group of interested farmers observed the event with at first a degree of scepticism, which rapidly changed to surprised approval as they witnessed the ability of the tyres to grip the loose soil.

As the crowd continued to swell, the driver of the tractor brought his rig to a sudden stop. He clambered down and proceeded to unhitch the plough. Largely unrecognised, the driver was Barney Oldfield, America's most celebrated race car driver of the period. Unbeknown to the spectators, his tractor had been fitted with a special high speed road gear.

Barney manoeuvred the Model U onto the adjacent oval race track. With a roar from the straight through exhaust pipe, he let in the clutch and the tractor dramatically shot off around the track. The startled crowd watched wide eyed with astonishment,

A beautifully restored 1929 Allis Chalmers United fitted with a Continental 30 hp engine. (Photo courtesy David Hawkins)

A 1936 Allis Chalmers U with the updated 34 hp Allis Chalmers engine, which is on display at the Temora Rural Museum. (Photo IMJ)

An early painting depicting the Racing Allis Chalmers.
(Courtesy Western Development Museum, Saskatchewan)

as Barney wrestled the big machine around the oval in true speedway style. At the completion of five electrifying laps, it was announced that the tractor, on its pneumatic tyres, had averaged 35.4 mph.

The American Automobile Association, whose representatives had been present to witness the spectacle, declared the achievement a world speed record for a farm tractor!

Although unquestionably a publicity stunt, the speeding tractor convinced many hitherto cynical farmers that the fitting of pneumatic rubber tyres not only increased the efficiency of tractors, but were obviously also safe.

Requests poured in to Allis Chalmers from State Fair organisers around the Mid West, all wishing to replicate the excitement witnessed at Milwaukee. A team of specially factory prepared Model U tractors was assembled and placed under the control of Barney Oldfield.

Known as The Allis Chalmers Racing Circus, the team toured the major agricultural shows and trade fairs. Over 1,000,000 people flocked to witness these racing tractors as they bounced and broadsided their way around cinder speedway tracks.

The racing tractors

The publicity derived from these shows resulted in a massive increase of sales for the company. Farmers now trusted pneumatic tyred tractors, which Allis Chalmers had pioneered.

Barney Oldfield had been the first man to drive a motor car at more than 60 mph when in 1903 he drove Henry Ford's famous 999 Special. He also became the first person to drive a tractor at speeds in excess of 60 mph when he propelled a Model U at 64 mph at Dallas, Texas in September 1933.

Later in the same year, Ab Jenkins, another record breaking race car driver, eclipsed Oldfield's record by achieving 67.8 mph with yet another Model U, at the Utah Salt Flats.

With great fanfare, a stock standard Model U was driven from Milwaukee to the 1933 Chicago Livestock Exposition, a distance of 88 miles, in five hours. Upon arrival, it was paraded through the centre of the city much to the fascination of the visiting farmers, many of whom regularly transported their produce to distant markets on tractor pulled trailers. Such action was economically sound, as the cost of road registering tractors was much less than that of truck registration.

In 1939 Allis Chalmers introduced its highly successful lightweight Model B. It was the very first tractor offered around the world, *without* a steel wheel option.

By the late 1930s around half of all tractors sold in the USA were fitted with pneumatic tyres. By the early 1950s few manufacturers even offered steel wheels as an option. It was only during World War II and the huge demands for raw materials, that many farmers had no alternative but to revert to steel wheels – replacement rubber tyres had become virtually unobtainable.

A 1948 Friday restored by Steve Rosenboom, Ohio. (Photo IMJ)

Friday

Friday is an unlikely name for a tractor, certainly. But the tractor, the brain child of the Brothers Friday of Hartford, Michigan, was indeed an unlikely tractor. Apart from the first handful released in 1948, which were powered by a relatively lazy Ford V8, when production really got underway a Chrysler six cylinder 218 cubic inch was shoe-horned low into the chassis. But the design guys, either deliberately or perhaps unintentionally, forgot that tractor engines were supposed to be fitted with governors!

The result was a snorting Offenhauser-like tractor, the engine of which could be revved out to 3000 rpm. In theory, with the 10 gears provided, this could propel the tractor at an absurd 96 mph. But obviously, at such speeds the tractor would become uncontrollable.

Not withstanding, this author has personal experiences out on the flat prairie country of Ohio, of a Friday which overtook a Ford F150 while registering 60 mph on its speedometer!! It should be remembered, this was a stock standard Friday, as distinct from a specially tuned factory special.

Doubtless the Friday Brothers were cautioned by their legal advisors of the judicial risks they faced by offering farmers such a potentially lethal vehicle.

Following only one year of production, all Fridays were fitted with governors to their engines! Sanity prevailed.

Tail End Charlie

There was never a more 'Tractor in a Hurry' than Australia's legendary Chamberlain Champion – Tail End Charlie.

The Redex Round Australia Trial was conceived as being possibly the most arduous long distance car trial in the world history of such events. The distance was 11,000 miles (17,700 km) largely involving rugged isolated cattle tracks and desert crossings.

The Western Australian firm of Chamberlain Industries, which was in the throes of introducing a new range of Champion tractors, convinced Redex they should permit one of the Champions to accompany the cars, in the capacity of a recovery and rescue vehicle.

Accordingly, special gearing was fitted to the tractor enabling speeds of 65 mph to be achieved, while heavy duty shock

Tail End Charlie at the 1997 Royal Perth Show. (Photo IMJ)

absorbers, together with leaf springs supporting the front axle, enabled this speed to be maintained continuously over the punishing tracks.

In actual fact, the Charlie team of four alternating drivers traversed considerably more distance than the cars. During the hours of darkness, while the car drivers slept, they kept returning the tractor along the tracks, for the purpose of recovering damaged vehicles and towing them into the shelter of a township or station homestead. Charlie proved to be a real Champion and performed faultlessly throughout.

Tail End Charlie went on to complete three Round Australia trials, and now resides in the Whiteman Park Museum in Perth WA. Despite having been driven around 53,000 km it has in addition completed no less than 3160 hours of farm work and is still in superb mechanical condition!

Author's note

On two occasions I was privileged with the opportunity of driving Charlie. The first was in the late 1950s at the conclusion of the Barellan Show, when I drove it out along the Narrandera Road. While urging it along at 60 mph on a straight stretch, I overtook a shocked elderly farmer driving his Ford Mainline ute.

The second occasion was when I drove it from Auburn, through the centre of Sydney to Artarmon via the Sydney Harbour Bridge. Quite an experience! IMJ ■

IAN'S MYSTERY TRACTOR QUIZ

Question: Can you identify this 1919 tractor pulling an early header?

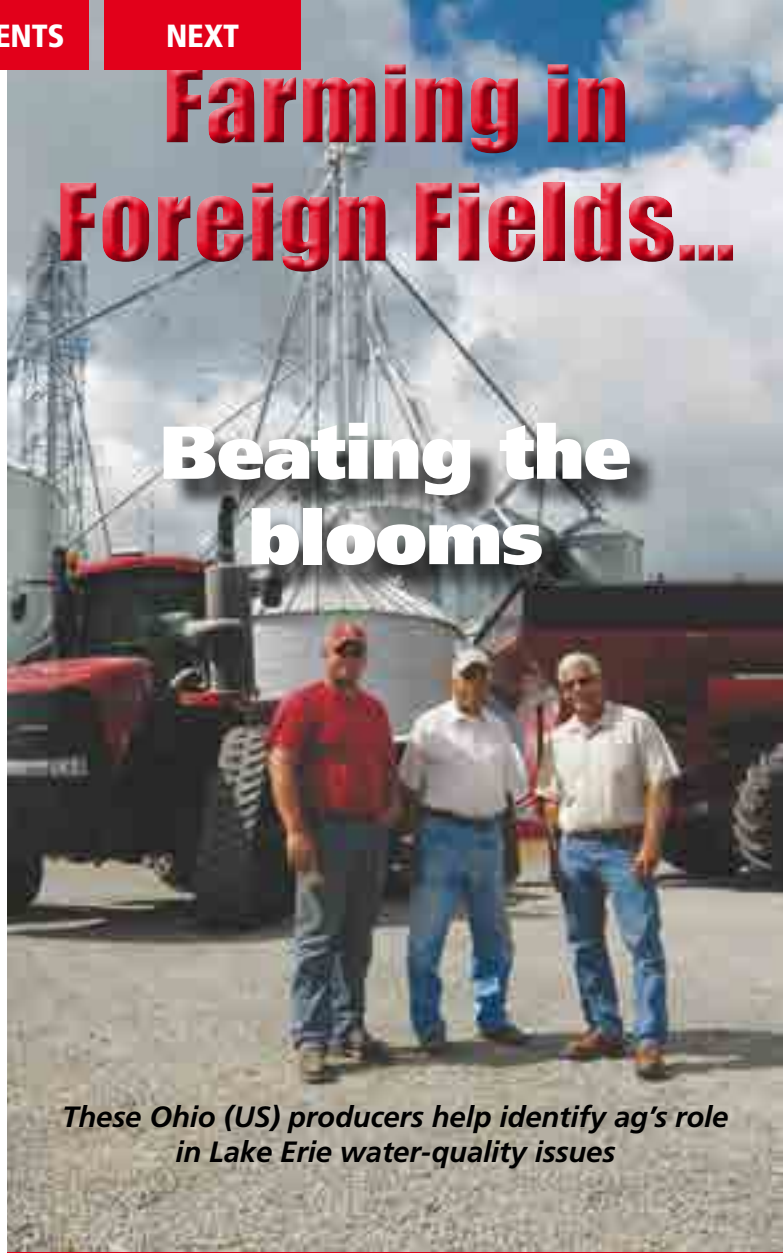
Clue: It is front wheel drive.

Degree of difficulty: The grainy 1919 photo doesn't help.

Answer: See page 48.

Farming in Foreign Fields...

Beating the blooms



These Ohio (US) producers help identify ag's role in Lake Erie water-quality issues

Ryan, Darwin and Terry McClure are long-time users of four-wheel drive tractors. With the recent purchase of two Rowtrac tractors, the McClures are looking for reduced soil compaction and increased tractor versality for planting and sidedressing.

IT'S pretty scary to farm in a watershed that's in the cross-hairs of various environmental interests. That's the opinion of US farmer Terry McClure. But it's the situation he and other farmers in northwestern Ohio faced several years ago as massive algae blooms in Lake Erie had regulators looking hard at agriculture and potential nutrient-rich runoff as a contributor to the problem.

"Ag's an easy target," says Terry of Grover Hill. "And some of the proposed solutions we saw weren't based on an accurate, researched understanding of agriculture's role."

Terry and other individuals, organisations and agribusinesses in the region decided it was better to help ag become part of the solution rather than the problem. Together they raised US$1.2 million and received a matching government grant to help analyse farm field-water runoff.

Through this funding, the United States Department of Agriculture, the Agriculture Research Service and Ohio State University are collaborating to operate 32 water-sampling sites in the western Lake Erie basin, including two sites on the McClures'

farms. The sites measure rainfall and pull water samples from surface and tile drainage at regular intervals every day of the year.

"We're trying to understand what nutrients are leaving the field under different scenarios," Terry says. "We want any regulations to be based on science and a true understanding of what's happening."

Four years in and just beginning

Four years into the project, Terry says the researchers are just beginning what will be a long-term study. Already, he says it's clear that adhering to the '4Rs' of nutrient management (Right source; Right rate; Right time; and, Right place) helps cut nutrient loss.

For their part, Terry says they're planting cover crops behind wheat, applying nutrients in several smaller applications throughout the growing season, rather than all at once, and other steps.

The McClure family which includes Terry, his father, Darwin, and son, Ryan – farm about 4000 acres (1620 hectares) of corn, wheat and soybeans and contract-feed approximately 18,000 pigs a year. Each year they adopt new crop-production practices as they learn more about soil health and managing nutrients.

Hard to be a pure no-tiller on heavy clays

One unique challenge is their heavy clay soils that in ancient times formed the bed of a much larger Lake Erie. "We've been no-till farming since the late 1980s, but it's hard to be a pure no-tiller on this heavy clay," Terry says.

A key tillage step is deep ripping wheat ground after baling straw. The wheat ground, planted for its value as a rotation and for receiving liquid hog manure, injected annually, comprises about 300 acres (120 hectares). So, all their fields get deep-ripped once every 10 years or so.

As they reduce tillage operations overall, they're making more use of a Case IH True-Tandem 330 Turbo vertical tillage tool after corn.

"We'll run the 330 as lightly as we can, just enough to break that root out and get a little bit of soil up. Then we'll plant directly into that in the spring. That 330 is a nice fall (autumn) tool," he says.

In another move to reduce compaction, the McClures are running two Case IH Steiger Rowtrac tractors. Longtime users of four-wheel drive tractors, these Rowtracs are their first tractors on tracks.

"We were looking for more flotation," Ryan explains. One benefit they see is the absence of the 'pinch rows' in corn, stunted by the compaction of the tractor tyres. "Even though the tracks look like they're sinking into the soil, there's not that 'digging' action we see with tyres on the front-wheel-assist tractors."

Ryan says the Rowtrac tractors on 18-inch (46 cm) tracks and equipped with AFS AccuGuide RTK autoguidance, excel at sidedressing with 15-row applicators. "The tractors are very stable, sitting on those tracks. The applicator doesn't move the tractor at all. And with RTK, they perfectly follow the curves.

"These Rowtracs are more flexible," Ryan adds. "We also use them for planting, tillage and pulling the tile plow."

Adding and improving tile is an on-going project for the McClures. They say laying tile 2 feet (60 cm) deep on 33 foot (10 metre) spacings definitely makes their ground more productive and doing it using their own equipment makes for a faster payback.

The changes in crop production practices the McClures have made are helping them be more productive and be better stewards of the land. Making more efficient use of nutrients, both through fertilisers and manure, is critical, which is why they are participating in the water-runoff studies.

"We want any soil-management regulations to be based on solid research," Terry says. "So far, Ohio has managed to have good conversations about water quality, with groups working together. That's what we need to do to preserve our farms and continue to raise crops and livestock." ■

This water-sampling station pulls samples of field surface runoff and tile water. The McClures have two of these stations on their property as part of a long-term study of agriculture's role in Lake Erie water quality.

On track for lower freight costs

By John Picone, Program and Business Manager, GrowerCo

IN the current low price environment, post farmgate costs can amount to around 40 per cent of the FOB price of a tonne of standard quality wheat destined for export. So for grain producers located a long way from port, post farmgate expenses can add up to be the single biggest cost item (Figure 1).

For many years the most significant challenge to Australian grain industry competitiveness on the world stage has been the high cost and poor performance of rail transport. This is now changing.

Coal improving the efficiency of grain on rail

While the coal industry may be unwanted in some prime farming areas it can bring benefits to grain growing regions.

The improvements achieved for the coal supply chain by the below-rail (ie train operator as opposed to track owner) entity, Australian Rail Track Corporation (ARTC), are spilling over to general freight. This includes grain movements to the Port of Newcastle from northern NSW sites.

Upgrades to below-rail infrastructure – which have allowed longer and heavier coal trains to haul much bigger payloads – have flowed through to bigger grain trains also being used.

Once the infrastructure for the movement of coal by rail had been upgraded the next task was to optimise it.

Coal producers in the Hunter Valley and other areas using the same freight corridor, came together in 2009 and established the Hunter Valley Coal Chain Coordinator (HVCCC). The HVCCC now runs the world's largest coal export operation.

GrowerCo Chairman Tim Grellman with Program and Business Manager, John Picone.

GrowerCo's FIRST YEAR

Grower Co-operative Limited has just celebrated its first birthday.

GrowerCo was formed by a group of north west New South Wales grain growers looking to optimise efficiencies in the supply chain for grain, and in so doing, achieve higher farmgate returns for delivering to both export and domestic destinations.

Marius Kloppers, former CEO of BHP Billiton said in 2012, "the cheapest capacity that you can normally find is latent capacity".

When all of the HVCCC member organisations got together they were able to find the latent capacity which resulted in driving costs down while at the same time increasing the volume of coal that could be transported on any given day.

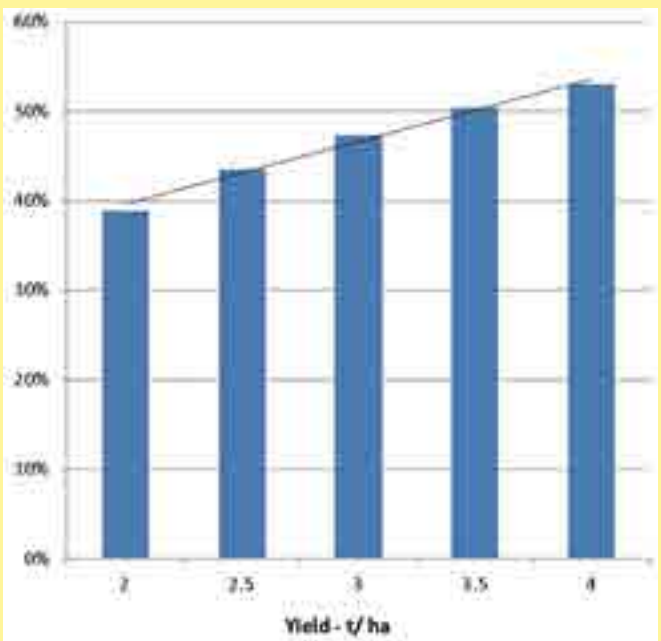
The HVCCC has shown that, through a collaborative approach to supply chain management, additional value is created for individual members. Additionally, the Coordinator has become a marketable comparative advantage within an intense international trading scene. It provides additional comfort to buyers by way of certainty of delivery and reduced risk of demurrage.

Opportunities for the grain industry

There is an opportunity to imitate this model and demonstrate that the existing capacity in rail freight paths far exceeds the grain export demand while also lowering the unit rate per tonne.

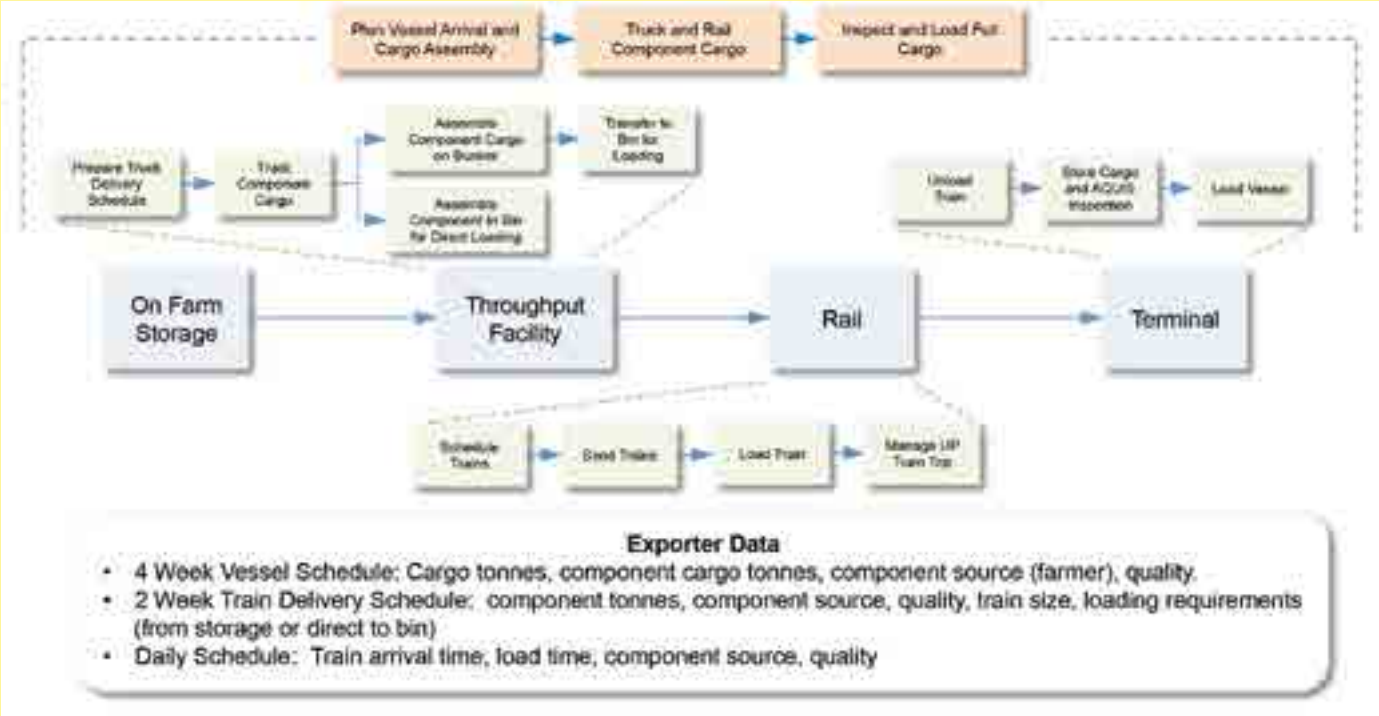
The key is to ensure train cycle times, payload and locomotive requirements are optimised within current supply chain constraints.

FIGURE 1: Farm gate to FOB expenses as a % of total cost per tonne of production



Source: Rimanui Farms, 2016.

FIGURE 2: Data gathering framework



Until recently the rail line heading south from Narrabri in northern NSW had received the main benefit from coal. But now ARTC has increased the maximum axle load on the Moree to Narrabri section of line (the line to the north towards the Queensland border).

This has seen an increase in wagon payloads of 16 tonnes over the past few years along with the ability to run longer trains of up to one kilometre in length. Bigger payloads will improve efficiencies and reduce costs per tonne of grain moved.

Strategic Plan: Stage 1

In the first stage of its Strategic Plan – *Targeting Efficiency Improvement Initiatives* – GrowerCo and ARTC in conjunction with the Australian Logistics Council, will conduct a study aimed at understanding the supply chain interface requirements to further improve efficiencies once the heavy haul Inland Rail project is concluded.

This study has attracted the support and assistance of grain and export terminals, local governments and major grain exporters. This study will be conducted over the next six months with the aim of understanding how a future heavy haul rail corridor can benefit grain and the broader agricultural industry, not just in northern NSW but all of the NSW and Queensland grain production areas.

ARTC has announced it will begin, in conjunction with GrowerCo, a pilot program (see Figure 2) to improve the coordination and scheduling of grain services to better integrate coal and grain planning requirements through a complex common user network.

While the Hunter Valley Network is synonymous with coal, less than 50 per cent of all train movements are coal trains. With over 250 trains per day this network is the third busiest in Australia behind Sydney and Melbourne's passenger networks.

Minimise 'downtime' and maximise payload

The goal is to minimise the time trains are idle and maximise the tonnes per wagon over the year without having to spend big on infrastructure investment. If done correctly this could result in efficiency savings of up to 40 per cent in rail transport charges.

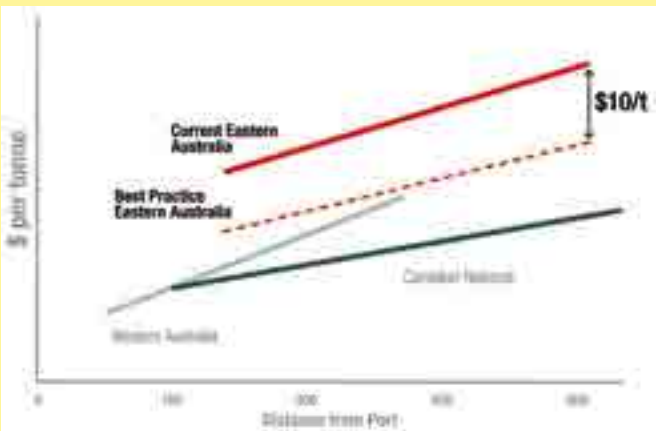
These savings will be shared with all participants in the supply chain with GrowerCo's role focused on maximising the return to farmers.

Other variables impacting rail costs are time taken loading and unloading trains.

Newcastle Agri Terminal (NAT) has a high speed rail discharge at its Newcastle Port facility enabling unloading rates up to 1500 tonnes per hour while at the other end, the best bulk handler can load a standard train in under three hours.

Both these sites have rail loops that can handle large trains without the need to break them up. But not all sites are 'equal' with many unable to load quickly due to slow loading rates from antiquated equipment or short sidings.

COMPARATIVE RAIL FREIGHT COSTS AND DISTANCE FROM PORT



GrainCorp Submission: Rural and Regional Affairs and Transport References Committee July 2014

To achieve lower freight costs for growers located a long way from port, we need to reduce the amount of time trains lay idle while maximising the payload when grain is moved. (Photo: ARTC)

Short sidings means breaking the train into smaller lengths which further slows the loading process.

Various investments from the bulk handlers, in conjunction with NSW Government's Fixing Country Rail Program, are bringing improvements in train loading which over time will see many sites become just as efficient as NAT.

Stage 2: Logistic coordination

The second stage of the strategic plan, flowing from the pilot coordination program, is the development of a fully functional grain logistic coordination model (see Figure 2).

On-farm storage has grown rapidly in recent years to now challenge the bulk handlers' capacity. The increase in on-farm storage has been due to a number of factors such as increased area under cropping and bigger capacity harvesting equipment resulting in much quicker harvests and the subsequent headache of where to store grain in a hurry.

Bulk handling sites have been unable to adequately handle the increase in size and speed of bigger harvests and so farmers have resorted to building their own storage.

This has the added benefit of providing flexibility in growers' marketing decisions post-harvest.

In most seasons Australia produces a large surplus of grain that needs to be exported to find a market.

So a big issue is how to most efficiently get grain from on-farm storage to the export terminal.

The most efficient path to port for grain produced in northern NSW is via train to Newcastle. GrowerCo can add value here by collaborating with stakeholders to coordinate the supply chain.

The GrainGrowers organisation, in a submission to a Government Committee in 2014 stated that "the grain export system requires coordination and oversight which would deliver greater benefits to all but will not be achieved if left to individual companies or sectors of the supply chain".

Stage 3: Coordinating role

GrowerCo has put its hand up to take on the role of coordinator as grain growers are ultimately the ones paying the price for the inefficiencies in the supply chain via reduced prices for their grain. This role will see strategic alliances formed with key industry service providers and falls under the third stage of the strategic plan.

This priority will ensure that the key industry service providers remain focused on continuous delivery improvements.

GrowerCo will work with exporters by coordinating the transferring of grain from farm to train via throughput facilities that can accumulate and load trains quickly and efficiently. The results of the project will assist in the development of a model that may well see the coordination done in the near future on a smartphone app and reduce human involvement to a minimum.

GrowerCo has a throughput agreement in place with an upcountry bulk terminal that will rebate members who use the site to load trains bound for Newcastle.

These sorts of agreements will be more commonplace as sites become more efficient loading trains with savings going back to growers in the form of higher farm-gate prices for their crops.

Grower numbers for extra leverage

The project is ambitious and will require ongoing support from grain growers so GrowerCo is continually seeking new members.

The volume of grain grown by members can be used as leverage to form alliances with bulk handlers to extract rebates for patronage. This season, GrowerCo has agreements in place with two bulk handlers for rebates to be paid to members who use their facilities. These sorts of agreements will help forge alliances that will ensure the facilities are better utilised in dry years when competition is fierce in the provision of bulk storage.

Stage 4: Commercially viable

Income from rebates will assist GrowerCo achieving its fourth stage goal of its strategic plan – becoming commercially viable.

Once a critical mass of members has been reached GrowerCo will be in a much stronger position to cement relationships with other key stakeholders in the supply chain for the benefit of all.

It will be important that GrowerCo remains very much a part of the value chain to keep the benefits of increased efficiencies flowing back to grain growers.

Longer-term goals include using the results of our study to work with governments in planning for 'fit for purpose' infrastructure. The NSW Government predicted rail freight to reach close to 800 million tonnes by 2031 – double its 2011 movements.

The Inland Rail Project promises much more opportunities for produce to be transported quickly and efficiently up and down eastern Australia. It will increase the use of rail for domestic as well as export grain and allow our model to be expanded across all districts that have access to this heavy haulage mainline.

The Federal Government is strongly supportive of the Co-op and pledged $100,000 in assistance to enable it to become a model for other groups to duplicate its success.

GrowerCo is committed to improving supply chain efficiency as its end goal. It will not market grain nor at this stage look to invest in bulk facilities. The opportunities lie in collaborating with existing operators to achieve similar results to those achieved by the HVCCC.

GrowerCo hase recently appointed John Picone as Program and Business Manager to assist the cooperative to the next stage of its development.

More information E: admin@growerco.com.au or www.growerco.com.au ■

Challenging disease season for chickpea growers: But what's next?

NSW Department of Primary Industries (DPI) senior plant pathologist Dr Kevin Moore said while there had been significant chickpea crop losses in the 2016 season due to waterlogging and flooding, many crops had staged a remarkable comeback.

"We had numerous crops that we thought were gone – particularly in northern NSW and southern Queensland – that did go on to develop to a harvestable extent," he explained.

"There were also cases of partial paddock losses, where growers did what they could to hold onto the remaining green crop, because of the high level of investment they had made.

"In general the wetter, cooler conditions during the growing season meant chickpea crops were 3–6 weeks behind where they should have been in terms of pod set and harvest."

Kevin said the high levels of Ascochyta blight, Sclerotinia and Botrytis grey mould (BGM) detected across chickpea crops throughout eastern Australia during winter and spring, were generally brought under control with the arrival of drier, warmer conditions in late October. But growers needed to be prepared to maintain fungicide regimes ahead of any wet weather leading in to November.

"At the start of the season I advised growers and agronomists to have on-farm stores of Ascochyta and BGM sprays. As it turned out, chlorothalonil and mancozeb fungicides were in extremely short supply later in the season," he said.

Be cautious about future crop choices

Meanwhile, Kevin urged those growers, who had lost crops to waterlogging and flooding, to be proactive in disease management and be cautious about summer crop choice amidst an elevated disease risk.

"Growers who have lost a chickpea crop need to be aware of the carry over disease risk of Sclerotinia," he said.

"While Sclerotinia is not usually a major disease of chickpeas it has the potential to impact some summer crops including mungbeans, cotton, sunflowers and peanuts."

NSW senior plant pathologist Kevin Moore said generally, the wetter, cooler conditions during the northern region growing season put chickpea crops three to six weeks behind where they should have been.

He said for those wanting to reduce the potential yield impact from high disease levels post chickpeas, his recommended crop choices this season were sorghum and maize.

Looking further ahead to 2017, Kevin said it was critical growers planned winter crop rotations so chickpeas were not planted into paddocks that had grown chickpeas this season or in 2015.

He said planting chickpea-on-chickpea, especially after the high disease levels experienced this season would put current disease management practices under pressure and could lead to reduced life of chickpea varieties, development of fungicide resistance and problems with weeds and insects.

"Growers need to follow recommendations for current best practice with regard to crop rotation, especially after the challenges of the 2016 season," Kevin said.

For more information, contact Kevin on 0488 251 866 or 02 6763 1100 or visit the GRDC-supported eXtension AUS website. ■

Grain storage – invest today for the system of tomorrow

FOURTH-GENERATION farmer Andrew Freeth and his family have seen their share of fluctuations in seasons, markets and farming practices on their 5000 hectare dryland broadacre cropping and livestock enterprise at Collie, NSW's Central West.

This, as well as a keen interest in changing their approach to improve farming productivity and profitability, prompted Andrew to spend the past two years undertaking a Grains Research and Development Corporation (GRDC) sponsored Nuffield Australia Scholarship.

The focus of his study was investment in on-farm storage taking into consideration future supply chain logistics over the working life of storage built today.

Andrew visited the US, Canada, France, Germany and the United Kingdom and said one of the key things he learned is that when looking at on-farm supply systems, growers need to look to the future.

"When looking at grain storage, I'm talking a 30-years-plus investment, so you need to try and understand what you will need a long way down the track. To me this means looking at your grain supply chain systems, as well as what you are growing and how long you will be storing product," he said.

"I used my research scholarship to look at whole grain supply chain systems in the UK, Continental Europe and North America, as well as the implications of managing storage in their environments so as to reflect on our own.

"One of the key differences you see in North America is mainline rail systems and efficient rail loading hubs, which over time have become more efficient and pay a higher price to the grower.

"Imagine if a typical Aussie grower could get an extra $10 per tonne, say on land producing 3 tonnes per hectare and valued at $2000 hectare – that would generate an extra 1.5 per cent return on investment."

Andrew Freeth used his GRDC-sponsored Nuffield Australia Scholarship to investigate on-farm grain storage and supply chain logistics.

Inland Rail project advantages

Andrew sees potential for better efficiencies and savings for the east coast in the often discussed Melbourne to Brisbane inland rail project.

He said one of the major advantages would be that the rail line would be predominately funded by general freight, not just the grains industry.

"There is potential for properly targeted mainline rail to lift the productivity via heavier axle weights and larger train sets. More productive trains would encourage rationalisation and investment in rail loading and port facilities to improve network efficiency.

"By changing our rail system from state focused networks to a truly national system, Australia could create some great transport efficiencies and cost savings.

"Currently there is flexibility built into the Australia logistics systems, we use a lot of road transport which makes us a bit more expensive, and our export systems are front-ended so a lot of the grain tends to be exported within six months of harvest.

"If you had a more cost efficient mainline rail and shuttle hub system, growers could be storing product for longer and exporting across a 12-month window."

Long term storage implications

But longer storage has some implications for management, and Andrew said that means keeping grain in the silo, like money in the bank, and ensuring it remains in good condition.

"If you get it right from the start, with aeration and hygiene, you are 95 per cent of the way there. In Australia there is plenty of extension funded by the GRDC to learn how to get it right, so it's really important growers upskill and understand best practice storage," he said.

"For example where grain is staying in storage longer term, the ability to use aeration becomes very important. In the event of pest incursion, you must be able to fumigate in gas tight storage to Australian Industry standards.

"On-farm grain storage is growing and will continue to grow in our country, so it is really important that those management skills increase as well."

In the UK grain is only transported by road and Andrew said the key thing he learnt is that for road grain movements, grower operated on-farm storage could be very competitive.

"The UK market provides a window into what the Australian market could look like if rail becomes uncompetitive with road," he said.

"But it is mainline rail that is the driver of whole supply chain efficiency, and one thing that is glaringly obvious is that in Australia we really need a strategic plan to drive this efficiency and achieve the associated gains."

For more information on grain storage, go to the GRDC extension site http://storedgrain.com.au/ ■

Solution is often simple for silo seal failures

WHAT is the most common cause of on-farm silo seal failures? According to Grains Research and Development Corporation (GRDC) grain storage extension team member Ben White – who has tested hundreds of silos – it is empty silo pressure relief valves.

Ben says a gas-tight silo is essential to maintain the fumigant gas concentrations required to kill stored grain insects at all life stages.

"If a silo is not gas-tight, the fumigation may appear successful when the adults die but the surviving eggs and pupae will continue to develop and reinfest the grain," he said.

Ben said that ahead of the 'storage season', growers needed to ensure that silo pressure relief valves were filled to the correct level with light hydraulic oil to maintain their seal.

"A sufficiently full valve allows a controlled volume of air exchange in and out of the silo without excessively diluting fumigant levels," he said.

"Without oil in the valve, the silo will not retain fumigants such as phosphine and fumigation will not disinfest grain.

"If the silo doesn't have an oil valve, it is safe to assume it does not seal and should not be fumigated."

Three minute pressure test

Ben said that once a silo pressure relief valve was filled with oil, growers should check that the silo seal exceeds a three-minute half-life pressure test. For new silos, half-life pressure tests should exceed five minutes.

"A pressure test is a measure of how well a silo will contain fumigation gas," he said.

"Pressure testing silos needs to be part of the annual maintenance and it is much easier to replace seals and carry repairs out when silos are empty.

"But a silo also needs to be pressure tested when full and before fumigating grain.

"This is especially important for silos with slide plate outlets that have been tested when empty – retest when full to make sure the pressure of the grain doesn't compromise the seal."

Ben said that if growers were unsure how to do a pressure test, they could contact him on 1800 WEEVIL (1800 933 845)

More information about grain storage and pressure testing sealable silos is available at www.storedgrain.com.au ■

An oil valve during a standard pressure test on a WA silo.

GRDC grain storage extension team member Ben White says empty pressure relief valves mean that silos will not retain fumigants. (Photo: GRDC)

Adjuvants ain't just adjuvants

MANY grain growers are opting for quality spray adjuvants – and not just any adjuvants – to boost the performance of summer knockdown herbicides. That's the view of senior agronomist at Farmer Johns in Murray Bridge, Tim Harris, who's been advising South Australian farmers on weed control strategies for more than 15 years. And that's also the reason Vicchem products are often chosen – backed by quaity information coming out of its technical division.

"Every year, we see summer knockdown spray jobs that disappoint," said Tim, who studied agricultural science at Roseworthy College.

"This may be due to extreme heat or other stress to weeds but we find if you recommend quality products that have been tested, they're more likely to work – under any conditions.

"There are so many products now entering the market it can be very confusing so at Farmer Johns, we're standardising with just a few core ones including the Vicchem range.

"For me, deciding what to recommend often comes down to the strength of information that comes out of the tech department.

"Australian companies tend to be good at it but with a lot of product these days, you just don't know where it comes from."

Tim believes grain growers are very cost conscious but with weed control, the adjuvant is only a tiny portion of the cost – about 20 to 30 cents per hectare – so they don't focus too much on the adjuvant.

"But in our area, pipe water is getting more expensive each year so many local farmers are using bore water for spraying which can be variable, particularly in terms of hardness.

"So I advise them to test the water before using it and select an adjuvant that's proven to work for that level of water hardness.

"Vicchem offer free water testing as a service to growers, otherwise the commercial rate is about $120," Tim said.

Farmers trial a new adjuvant

Tim said he'd been involved in a local trial aimed at testing Vicchem's new Outright 770 adjuvant designed to enhance performance of glyphosate and other knockdown herbicides under hard water conditions.

"Many farmers in the region have been adding ammonium sulphate to summer knockdown tank mixes because our bore water is so hard.

"Outright 770 has the potential to offer some of these guys a safer, easier, faster alternative to lugging bags into the boom-sprayer hopper.

"Everything is going liquid anyway because it's more popular with farmers. Plus there can be problems with ammonium sulphate – if you get a bit of moisture in the bags it sets like a rock.

"So the Vicchem range of liquid adjuvants is definitely the way things are going longer term," Tim said.

One of the growers involved in the Vicchem trial is Andrew Knight of 'Milrina' in the Murray Bridge region.

According to Andrew, the three in one formulation of Outright 770 makes it easier and faster to use, resulting in less downtime during tank filling.

"With our water being so hard, I felt we needed a lot of ammonium sulphate in the mix so I've been adding bagged ammonium sulphate.

"The guys at Vicchem – Mick Bellenger and Owen Connelly – took samples of our water and tested it to find the ideal adjuvant for our situation.

"They gave us some product to trial – Outright 770 – and the results were fine. I understand Outright is ideal for water at 700 to 1000 ppm. At times, our water can be double that level."

Each year, Andrew and his brother Christopher crop 2500 to 3000 hectares of wheat, barley, oats, triticale, canola, lupins and vetch on 'Milrina' and other farms they have purchased around Murray Bridge over the years.

With so many crop types, they spend a lot of time cleaning the boom-sprayer but believe in doing things right. Andrew also believes having the right adjuvant chemistry for different levels of water hardness is a good idea from Vicchem.

"Vicchem does a very good job on the tech side. They have great product knowledge and are keen to learn from farmers about what spraying issues we have and how they can help.

"Outright 770 is a great product. The three in one formulation certainly makes it easy to use as you don't have to mix it.

"It takes a bit of time getting the bagged stuff to dissolve. With Outright 770, it's very fast and easy to use so less downtime waiting for it to mix. Certainly takes the heavy lifting out of it." ■

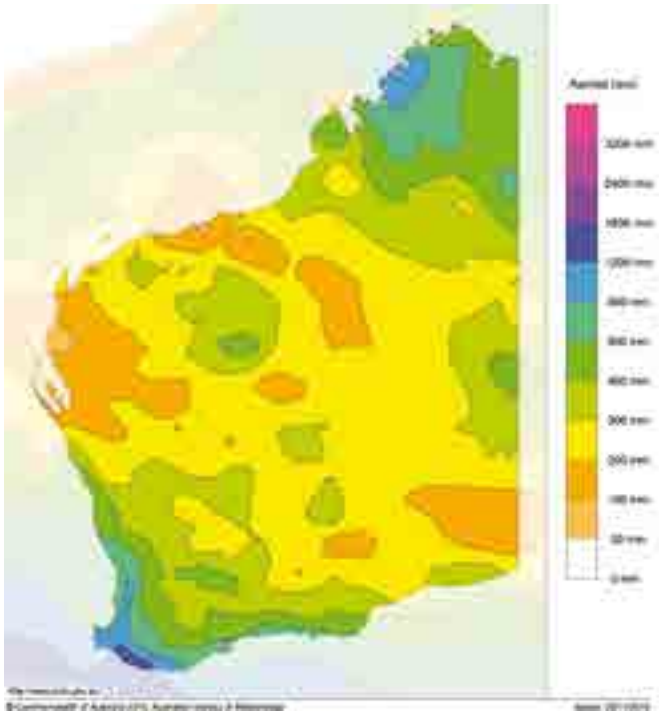
When choosing spray adjuvants, selecting the right chemistry for the water hardness will improve summer knockdown performance

	HOT-UP	OUTRIGHT 770	INFILTRATOR + ASSERT
Water hardness rating	soft – moderate	moderate – hard	hard – very hard
Typical sources	town / mains supply	dams / channels / bores	some bores
Hard water ions (ppm)	less than 300	300-750	more than 750
Use rates	250-500mL / 100L	500mL / 100L	500mL + Assert as per label

District Reports…

Western region

Western Australian rainfall totals (mm) January 1 to November 28 2016
Australian Bureau of Meteorology



NORTH

Harvest is well underway in the WA Northern Ag area with the first few growers finishing their harvest in the last few days. Many growers are around half-way through their harvest programs.

Frost damage is across the entire region with very few areas undamaged. Most growers will finish with 10 to 20 per cent loss from frost with a wide spread around these numbers.

This is the worst frost damage – with the most widespread effects – that I have seen. A small upside on the frost damage for some growers is that the events were early enough to wipe out some grains but leave others to form and fill normally. As a result, many frost damaged crops are still yielding good grain.

With this in mind the cool conditions through grain fill did have an upside and that is that crops which were were not damaged are delivering record (or close to) yields. This will help all growers into a good position with very high yields in all of the region with only a couple of exceptions.

The very east of the region and parts of the northern fringe had lower in-season rainfall and yields are correspondingly lower.

Exceptional canola yields and oil content

Canola yields were exceptional with some paddocks of Roundup Ready hybrids in the 3.0 tonnes per hectare range.

Many growers have had their best canola yield averages ever and some oil percentages are also the highest ever. Insects were not a problem this year with the frequent winter and early spring rain giving very low aphid and DBM numbers across the region.

Lupin yields were also record highs on many farms with the cool spring allowing podset for a very long period.

Barley yields were also record highs with some getting malt quality but most with very low protein and hitting the feed stack.

Wheat yields, where not frost damaged, are close to record highs. Quality is generally low due to high yields diluting protein. Grain weight and screenings are generally very good. Downgrading due to frosted grains is a problem on most farms but the majority will get away with a small amount of lower value grain. Some of the more frosted areas have significant levels of wheat downgrading.

The frost damage to crops has taken some of the shine off this season but most growers are extremely happy with crop yields. One outcome from such a cool spring has been to make us aware of how much heat stress and damage crops incur in most seasons – and the yield reductions from it.

Outside of frost it has been a very good season in our region. Now CBH have to try and deal with all of the bumper yield outcomes. Good luck with that.

Happy harvesting.

Despite widespread frost damage, the WA Northern Ag region has produced excellent crop yields. Harvest was well underway by early November in the Moonyoonooka area, east of Geraldton. (Photo: Peter Norris)

Peter Norris, Agronomy For Profit, Geraldton
November 22, 2016

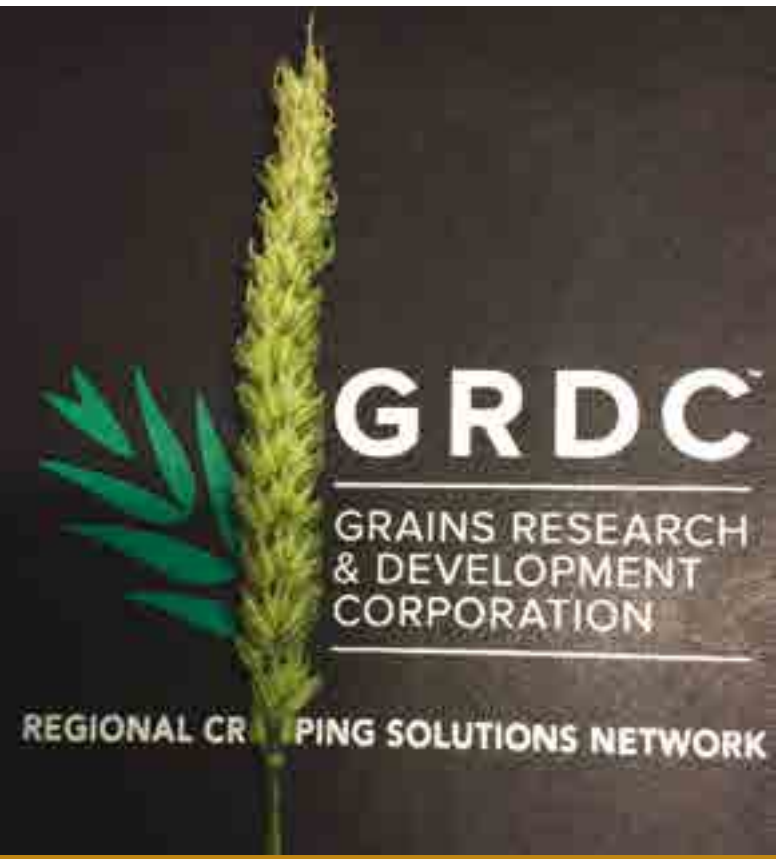
SOUTH COAST

Harvest is well and truly underway on WA's South Coast albeit much later than recent seasons thanks to a long cool spring.

Yields have been mixed with coastal areas having large areas effected by waterlogging while the Northern Mallee has had varying degrees of frost damage.

District Reports...

November–December 2016



Impressive Einstein wheat head from a long season wheat variety trial east of Condingup in WA's South Coast region.

Ryegrass problems in waterlogged paddocks were not uncommon on the South Coast this season. This paddock was swathed, then harvested with a chaff cart collecting the weed seed. The paddock will be 'double-knocked' next for weed seed set control.

For crops not affected by these extreme weather events, yields are very good and above expectations. Grain quality has been mixed, mainly due to low protein. In barley, there has been some germ end staining.

Canola quality has been the shining light with large seed size and high oil percentage – lots of growers are reporting oil between 48–50 per cent leading to a very good final grain price.

To date, harvest weather has been very good. Temperatures have been mild but importantly, the area has not had too much of the normally expected November rain.

Some growers look like completing harvest by the end of November which is testament to the harvest capacity growers have these days – many will finish harvest in less than a month.

Weed control is currently also on the agenda for many growers requiring them to alternate between the header and boomspray.

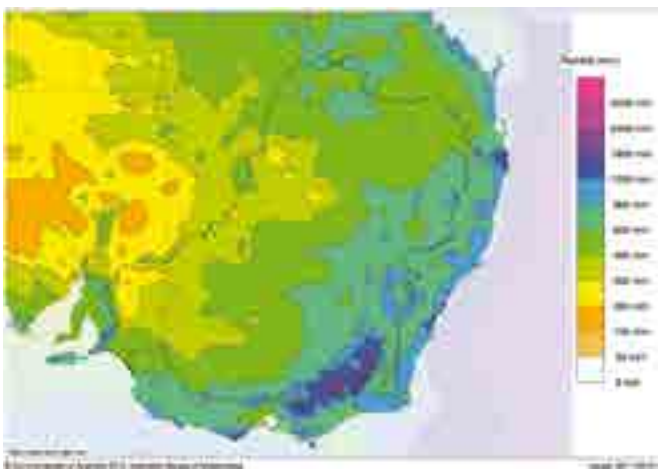
Soil moisture probes throughout the region are showing good levels of residual stored moisture. This will carry over nicely for the 2017 season.

In general the 2016 season looks like it will end up average to slightly below average with waterlogging and frost eroding a huge yield potential.

Quenten Knight
Precision Agronomics Australia, Esperance
November 23, 2016

Southern region

Murray-Darling rainfall totals (mm) January 1 to November 28 2016
Australian Bureau of Meteorology



SOUTH AUSTRALIA

September rainfall was above average to very much above average in most of the agricultural districts, with a number of locations in the eastern part of the South Australia receiving highest September rainfalls on record.

October rainfall varied from below average in the northern

District Reports...

part of the Upper North to very much above average in parts of the Adelaide Hills and Mid-South East.

Severe storms occurred across the state from September 28 to 30, bringing gale force winds, tornadoes, hail and heavy rain.

Several frosts were recorded during October.

(Most cropping districts received 25 to 50 mm of rainfall during November – Editor's note)

Winter crops

Rainfall and growing conditions have been ideal in most districts enabling crops to flower and produce grain under mild, wet conditions.

(In early November) estimates are for a record grain harvest across South Australia. Above average yields should help most farmers off-set low grain prices.

Crops on Kangaroo Island and parts of the South East have been severely damaged by waterlogging and yields will be below average in these districts. Crops unaffected by waterlogging in these areas have well above average yield potential.

Frost during October caused significant damage to susceptible crops in low-lying areas in a number of districts, with the worst affected areas being cut for hay.

Harvest of early sown barley and peas began on Upper Eyre Peninsula in mid-October with barley, peas and wheat being harvested in the Upper North in late October. In other areas of the state harvest will not commence until mid-November or later.

Canola crops have been windrowed in earlier districts. More growers are desiccating crops in preparation for direct heading to enable more even ripening and to control weed seed set.

Leaf diseases including leaf rust and septoria tritici were widespread in many districts with some control necessary to reduce crop damage. Stripe rust developed late in the season in most districts with minimal fungicide application required to control the disease – even in susceptible varieties.

Enormous disease pressure

Constant rain throughout spring has resulted in enormous disease pressure in pulse crops, particularly lentils. On Yorke Peninsula botrytis grey mould has been widespread in all lentil varieties, but in other districts the disease has been at relatively low levels.

Limited supply of some fungicides – together with seasonal conditions – delayed application and resulted in the use of less effective products, weakening disease control in some crops.

Some lupin, chickpea and lentil crops in the Mid and Upper North and northern Yorke Peninsula have been infected by cucumber mosaic virus with losses in infected crops varying from 10 to 100 per cent.

Seasonal rainfall across the grain regions – 25 year averages and year to date

Brought to you in association with JOHN DEERE

	25yr Annual Average (mm)	2016 rainfall to date (mm)	Summer		Autumn		Winter		Spring	
			25yr Annual Average (mm)	2015–16	25yr Annual Average (mm)	2016	25yr Annual Average (mm)	2016	25yr Annual Average (mm)	2016 to date
Emerald Qld	539	656	252	419	100	22	60	262	122	60
Toowoomba Qld	663	620	277	264	127	96	82	205	174	158
Roma Qld	572	510	252	252	117	30	74	132	127	155
Goondiwindi Qld	612	571	254	348	120	52	99	142	136	164
Narrabri NSW	630	682	227	176	118	79	124	266	161	202
Gunnedah NSW	650	485	232	144	112	53	126	172	179	189
Dubbo NSW	603	778	199	186	122	97	128	307	153	248
West Wyalong NSW	443	720	119	95	78	108	119	287	126	254
Wagga Wagga NSW	541	702	130	109	110	155	154	216	145	260
Swan Hill Vic	318	367	73	48	62	82	88	94	95	150
Bendigo Vic	509	648	108	51	102	131	162	230	136	249
Horsham Vic	379	430	77	63	70	87	128	138	106	154
Lake Bolac Vic	519	643	114	100	99	132	157	189	148	258
Murray Bridge SA	369	397	67	40	80	74	124	136	99	155
Kadina SA	339	438	57	38	78	137	116	150	89	116
Cummins SA	391	499	50	83	90	136	171	197	82	93
Esperance WA	614	641	78	112	142	187	248	233	144	152
Wagin WA	395	409	43	88	94	163	168	133	89	64
Northam WA	399	484	38	83	85	184	191	171	84	55
Mingenew WA	354	373	27	22	91	106	175	208	61	39
Moora WA	382	443	41	40	86	113	185	242	70	52
Mullewa WA	326	272	46	34	96	67	135	162	49	18

Last rainfall reading November 25, 2016.

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Chickpeas have been infected with ascochyta blight, with most crops having received at least three fungicide sprays.

Heavy rain in September and early October appears to have washed Russian wheat aphids off cereal crops, with very few crops needing to be sprayed to reduce crop damage.

Dave Lewis, PIRSA
November 4, 2016

VICTORIAN MALLEE

The 2016 season has brought a turnaround for the Mallee grain growers with optimum crop growth driven by wet and mild la nina 'like' conditions. Growers have commented that rarely do all crops look so good – and all season long!

Soil water (for some), a good climate outlook and high commodity prices encouraged some growers to increase break crop percentages sown, including lentils, chickpeas and canola. But this was tempered by recent poor seasons and subsequent tight cash flow.

The growing season has hovered around decile 8 to 9, with exceptional spring rainfall – almost too much for moisture sensitive crops such as lentils and crops sown in low lying areas. But overall, crop growth has been phenomenal.

It's been a tricky year for on-farm decision making as a mindset shift from low to high input farming has been necessary to realise crop growth potential while also juggling the financial budget. Those who were most proactive may see reward with higher yields and grain quality.

Extra spray passes, tight supplies of fertiliser and fungicide, what to do with lodged crops, how to improve harvest efficiency/logistics and strategies for marketing and grain storage have all been front of mind for the past few months.

With such a favourable season, harvest is later but early reports suggest higher canola and lentil yields, longer grains of barley and wider rows of wheat than ever before.

Some chickpea crops in the Mallee have been filling pods three wide thanks to an extremely favourable season.
(Photo: David Ferrier)

The 2016 season has been a great news story for the Mallee. Fingers crossed harvest rain stays away and the sentiment continues. Best of luck to all!

De-Anne Ferrier, Birchip Cropping Group
November 22, 2016

NSW OVERVIEW

Rainfall across NSW returned to a more normal pattern during October after record wet conditions during winter and early spring. About 75 per cent of the state received near-average rainfall during October, with 17 per cent experiencing above average rainfall.

Winter crops

The cool, overcast conditions and slower growth during winter are likely to benefit canola oil content. Winter crop maturity is about one to two weeks later than normal in most areas.

Harvest has commenced in the north of the state for canola and barley. Windrowing of canola is commencing in other areas.

Where crops have not been stressed, waterlogged or inundated yield potential generally remains average to above average. Early sown crops – and those where waterlogging was minimal – generally have above average yield potential, although protein levels in cereals are likely to be lower than normal.

Waterlogging and disease have affected pulse crop yield potential. Around 10 to 30 per cent of winter crop area has been lost due to waterlogging and inundation.

Summer crops

Cotton planting has been mostly completed in the north. In the south, difficulties in ground preparation and weed control may result in the area sown to summer crops being less than expected. Rice sowings have mostly been completed.

Pastures

Relative to historical records, October pasture growth was average across most of western NSW, with some area of high growth. Growth was generally average to above average across the north west, central west, Riverina, far south and the tablelands.

Other temperate pasture growth models indicated generally above average to extremely high relative growth across most of inland NSW during October.

Stock condition is generally very good. Foot problems, bloat and increased worm burdens continue to be issues.

Subsoil moisture levels remain relatively stable and relative to historical records, they are extremely high across most of inland NSW.

Weather outlook

The rainfall outlook for November to January indicates there is a near equal chance of drier or wetter than normal conditions for most of NSW. There is a near equal chance of cooler or warmer than normal daytime and overnight temperatures across most of NSW.

The Pacific Ocean remains in an ENSO-neutral state, with this being likely to continue into summer. The negative IOD event is weakening and returning to neutral. Sea surface temperatures to the north and north west of Australia remain warm, providing potential moisture sources.

But the negative SAM is acting to prevent moisture being drawn from these areas, which is contributing to a drier short term outlook.

NSW Department of Primary Industries
November 17, 2016

Northern region

District Reports...

November–December 2016

DARLING DOWNS

The best way to assess the recent weather is that it has been good for harvesting – warm to hot and dry. The problem is that all the spring-planted crops are really needing good rain to recover from the cool start and then the hot and windy weather experienced since planting. The last decent rainfall was in mid-September, and the countryside has hayed off very quickly over the past three weeks.

Winter crops

Chickpeas are the main crop of interest and (at the time of writing) about 30 per cent of the crop has been harvested east of Dalby and 70 per cent to the west of town. There has been some mould and ascochyta on the seed but so far the levels are just under downgrading specifications.

By late in the season all crops were showing some ascochyta, and it had moved onto the pods – but there was very little botrytis grey mould (BGM) plus the dry weather has helped limit the damage.

The western crops suffered from heavier disease and insect damage. All crops had some very high heliothis infestations.

The barley crops have yielded well, but crops on short fallow or double cropped are weighing light. Most of the barley is now harvested with most yields around 4.0 tonnes per hectare but some crops did yield over 7.0 tonnes.

The wheat was planted after the barley and is yielding well with some crops over 6.0 tonnes per hectare – although in the early stages of harvest, protein is back. Wheat crops have suffered from heliothis damage, as the grubs really attacked the wheat after the chickpeas.

There has been a little white grain disorder.

Overall there will be some good yields but poor prices for the cereals, and although the harvest price for chickpeas is falling significantly, many growers had crops contracted and should have a good return.

This photo typifies the season over the past few months on the Darling Downs – moisture stressed sorghum in the foreground while the dry conditions are ideal for winter grain harvesting seen in the background.

Summer crops

Spring crops are struggling. There was good moisture to plant with, but with the soil drying back and cool temperatures arriving, germination was affected. The recent weeks of warm but very windy weather have taken their toll with dried out plants trying to establish a good root system.

Early corn is approaching tasselling and really needs rain during the next few weeks.

Sorghum was planted later, and although finding it hard to get secondary root growth, is holding on.

Cotton is steadily growing but it is short. Irrigators are flushing their crops to improve establishment, while dryland plantings need at least 60 mm to keep going. There is some evidence of cold shock and crops are also having to cope with heavy insect pest pressure, particularly from thrips, mirids and heliothis.

The winter crop ground is very dry and has cracked open, so the prospects for double cropping are non-existent at this stage.

But there has been ground put aside for the summer plant – mungbeans are planned by many growers.

Hugh Reardon-Smith
Agronomist Landmark Pittsworth
November 23, 2016

CENTRAL QUEENSLAND

The 2016 chickpea crop trifecta

Harvest is finished north of Emerald and about 30 per cent still to go around Orion on the southern highlands. The headers have all but finished in the Dawson and Callide valleys.

It's a deadset rarity but many (and unfortunately not quite all) CQ growers have scored the chickpea trifecta this season.

Most growers planted big areas, achieved record yields and sold their chickpea at high prices.

Farmers have marked this season down as special as they are unlikely to see similar in their lifetime – and maybe not in the next generation.

Big areas: My estimate is about 120,000 hectares of chickpeas were planted. This is up from 30,000 a few years ago and 50,000 and 80,000 hectares for the past couple of years. Pulse Australia's Paul Macintosh suggested the chickpea area for CQ may have even been as high as 200,000 hectares.

Record yields: High yields were achieved across all CQ districts. My guess is the average will be about 2.0 tonnes per hectare. The best patches in some paddocks yielded up to 4.5 tonnes – the best paddocks were going greater than 3.5 tonnes while the best whole farm yields were better than 2.5 tonnes per hectare.

District Reports...

November–December 2016

Only a few farms in the northwest of the Kilcummin district missed much of the rain.

High prices: Much of the crop was sold at $900 to $1100 per tonne. This could inject as much as $200–250 million into the economy. Not only will farmers be able to retire some debt, upgrade machinery and infrastructure, it will also inject significant sums into the local economy.

Farmer's comments

One farmer at Baralaba told his harvest contractor to stop the header and take a photo when the chickpea yield monitor showed greater than 4.0 tonnes per hectare. He wanted a photo to mount on his office wall. He got his photo. His best area yielded 4.2 tonnes.

A farmer from Rolleston said the best of his chickpeas yielded 4.0 tonnes and his best wheat went 6 tonnes a hectare.

A farmer at Theodore said his farm average was 2.6 tonnes for chickpeas and 2.9 tonnes per hectare for wheat.

There were some disease issues

Despite a significant preventative spray program (by CQ standards) ascochyta blight was detected in crops on the Central Highlands (Capella and Gindie) and the Dawson Valley (Theodore). The impact was generally minimal. Dry weather and good soil moisture allowed disease patches to recover and set seed. But this did make harvest a long and drawn out affair.

CQ chickpea growers may well have dodged a bullet as one or two extra rainfall events may have caused significantly greater disease problems. Mould was a significant post-harvest issue causing quality downgrades in some loads.

The imperative for growers is to ensure that best practice is followed during the 2017 season to prevent or minimise disease in our next crop.

Weed pressure

Above average rainfall this winter caused an increase in weeds in chickpea crops in many paddocks – but minimal yield impact. Despite higher a weed population crops still achieved above average yields. While the yield wasn't affected this season a (worrying) seed bank has been created for future seasons.

The 2016 wheat crop

About 100,000 hectares of wheat were planted in 2016 which is down from the long term average area in CQ of around 200,000 hectares. High price on offer for chickpeas, the low price for wheat and very dry conditions during April and early May were major reasons for the reduced area planted to wheat.

Yield of some of the early planted wheat crops were down but most achieved well above average. Some farmers reported best paddocks doing 6.0 tonnes per hectare with average farm yields of around 3.0 tonnes.

Summer crops

Mungbeans: A small area of spring mungbeans has been planted in the Callide and the Central Highlands but most crops are struggling given dry conditions for the past three months.

Sorghum: A dry spring, low prices and a large winter crop are the main reason for very little spring sorghum planted this year.

Cotton: The widening of the Bollgard III cotton window in CQ (August 1 to December 31) is a major reason for an increase in the area of dryland cotton planted – currently about 3000 hectares with more to be planted if the summer rain is sufficient. About 16,000 hectares of irrigated cotton has been planted on the Central Highlands and about 5000 hectares in the Dawson. There is the potential for about 25,000 hectares all up if the season is kind.

Livestock and pastures

Grass pastures are still quite green as a result of fantastic winter rain and the cattle are generally in excellent condition.

Irrigation water

Fairbairn Dam at Emerald is at 46 per cent capacity (600,000 mL) and the weirs on the Dawson River are at about 95 per cent capacity (56,000 mL).

Maurice Conway
Department of Agriculture & Fisheries, Emerald, Qld
November 18, 2016

ANSWER TO IAN'S MYSTERY TRACTOR QUIZ

The tractor is a Moline Universal. This restored version is on display at The Swan Hill Heritage Village.