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FRONT COVER

AN ABOVE AVERAGE YEAR EMERGING... FOR SOME

This crop of Jurien lupins has established well for Western Australian south coast district



farmers James and Susie Lewis. Many areas of WA and southern Australia are well underway towards potentially above average winter crops. See District Reports starting on page 43. (COVER PHOTO: Quenten Knight)

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Focus Sections

Southern Australia Focus

Covering cropping systems of Southern NSW, Victoria, South Australia, Western Australia and Tasmania

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Covering Northern NSW and Queensland

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SOME very good things just might be coming for those patient growers in Western Australia as well as their eastern cousins in many parts of the southern Australian grainbelt. After a very dry autumn, ANZAC Day came and went with no 'break' to the season in sight. Plumes of dust dotted a lot of horizons as a large portion of the winter crop went in dry. Then finally, the rains came – albeit a little late – but nonetheless welcome. Crops have generally established well and reasonably weed-free given the lack of a knock-down opportunity. This is testament to some very carefully planned pre and post emergent weed control.



Unfortunately, the break didn't arrive for much of New South Wales and Queensland. By mid-July the winter crop planting window in those areas was either about to close or was firmly shut. Saving as much moisture when the rains do arrive – and they will – and keeping fallows as clean as possible will be the main focus for long-suffering growers in those regions.

Qld Department of Agriculture & Fisheries researchers are doing some ground breaking research in this soil moisture preserving space. David Lawrence and Andrew Erbacher are investigating the role of cover crops and how they can potentially increase the amount of plant available water for the following cash crop. We've known for a long time how cover crops can protect top-soil from wind and water erosion as well as improve the nutritional and structural profile of soils. But cleverly managing cover crops to maintain – or in some cases – increase plant available moisture for following grain or fibre crops is exciting stuff (see article page 11).

And how about a soil moisture preserving technique from even further left-field? CSIRO is developing a spray-on biodegradable polymer membrane technology aimed at minimising soil evaporation and suppressing weeds. In pre-commercial release trials, increases of more than 30 per cent in crop water productivity have been achieved (see page 16).

The global grain balance sheet

The USDA and other forecasters are predicting a big year of global grain production – but it looks like we're going to need it! World wheat production for the coming season is predicted to rebound to 771 million tonnes after poor seasons last year in Australia and the EU. This will be an increase of 40 mt on the 2018–19 year. But total global consumption for human, livestock and industrial needs is expected to increase by more than 3 per cent to 760 mt. In other words, the world will pretty much use all of the wheat it will grow this season. But what about the stored wheat mountains around the world keeping wheat prices subdued I hear you cry! Well you'd be right in one sense. There is a lot of wheat stored around the world. In fact the USDA estimates about 275 mt of it – but about half of this is stored in China – a country that does not traditionally export wheat.

It won't take much of a production hiccup in any of the major wheat exporting countries to make the markets very jittery.

All the best for the season ahead.

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AUSTRALIAN GRAIN

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In this issue...

Cover crops: Old ideas reborn

Cover crops are not new. They can protect the soil from erosion, suppress weeds, boost nitrogen levels when legume species are included, and maintain soil organic matter for healthy soils that support greater biological activity.



See article Page 11

Uzina Tractorul Brasov

I concede that possibly not many readers of my tractor epistles will be familiar with the intricacies of the Romanian language. But 'Uzina Tractorul Brasov' renders itself as an easy translation into Universal Tractor Brasov or UTB.



See article Page 18

Grower Group Focus: Lime and liming – managing soil health

Liming to maintain good soil pH levels and avoiding yield losses is just as important as applying fertiliser. If growers let soil pH levels in the topsoil run-down they are at risk of creating soil acidity issues at depth which are harder and more expensive to treat.



See article Page 31

What's the latest in optical sprayer technology?

Can you believe that it's almost 20 years since optical sprayer technology came to Australia? In that time, being able to spray 'green weeds on brown paddocks' has been a game-changer for fallow weed management on many grain farms.



See article Page 36

How sensor technology is helping map soil

Grain growers may one day soon be able to map soil in their paddocks without sending a single sample to the laboratory thanks to the efforts of an innovative young researcher. Edward Jones, who is working on new technology examining how sensors can be used to scan soil for properties such as clay content, water holding capacity, sodicity and pH.



See article Page 39

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Scientists are exploring taking crops out of the field and growing them in warehouses to develop new varieties capable of feeding 10 billion people by 2050.

'Plant factories' needed to feed a growing world population

■ By Kallee Buchanan and Amy Phillips, ABC

AT A GLANCE...

- The United Nations expects the world population will reach 10 billion by 2050.
- Twenty per cent of the world's daily calories come from wheat, but it takes a long time to breed new varieties.
- Indoor 'speed breeding facilities' are growing 1000 plants per square metre.
- Researchers are growing up to six generations of crops in a year instead of just two generations.
- The technology has been used on crops including wheat, barley, chickpea, millet, sorghum and quinoa.

A REVIEW in the journal *Nature Biotechnology* has outlined efforts to harness technology like speed breeding, genome editing, growing crops indoors, and manipulating the temperature and atmosphere to fast-track new varieties of major crops like wheat and corn.

Lead author Lee Hickey, a senior research fellow at the University of Queensland, said a suite of new technologies will increasingly be needed to feed the world as resources dwindle.

"Plant breeders want to deal with thousands of plants, so

we need to find a way to really scale up these technologies and reduce the costs," Lee said.

"What we're trying to do is create a plant factory – growing the greatest number of plants in the smallest space possible.

"Some of these crops, we're growing them at a rate of 1000 plants per square metre and setting up these speed breeding facilities indoors. We're actually creating warehouses."

By taking crops out of the field and growing them in controlled conditions, variables like soil, water, light, and even the carbon dioxide levels in the atmosphere can be controlled.

The technique builds on a speed breeding protocol developed by Lee that allows plant breeders to grow up to six generations of crops in a year instead of just two.

The technology has already reduced time it takes to select traits like disease resistance, drought tolerance and nutrition in critical food crops like wheat, barley, chickpea, millet, sorghum and quinoa.

"But it's still just one tool in the shed for a plant breeder," Lee said.

"What we propose is really that we need to bring all these technologies together and then a real step-change is possible in terms of making these crops more resilient in the face of changing climatic conditions."



UQ research fellow Dr Lee Hickey says speed breeding blends well with other plant development techniques. (PHOTO: QAAFI)

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Plant breeders are hoping that taking wheat out of the field and growing it in warehouses will speed up the development of new varieties. (PHOTO: QAAFI)

The authors hope that by speeding up the generation time for a crop like wheat, genetic improvements can be delivered to farmers quicker, producing more food with fewer resources.

Using all the 'tools in the shed'

Speaking from St Petersburg where plant breeders from around the world were meeting to discuss the challenge of climate change and population growth, Lee said the world needed to produce an extra 60–80 per cent more food.



UQ research fellow Kai Voss-Fels is investigating how root structure impacts drought resilience. (PHOTO: QAAFI)

"It's really important that we're adopting all the tools in the shed when it comes to technologies," he said.

"And I would say that includes technology like GMO."

While his work started in wheat, Lee said it was also important to adapt the technology to less-common crops often used in developing countries.

"As of next year we'll be building facilities in places like India, Mali and Zimbabwe," he said.

"This will help fast-track breeding for crops that haven't had much investment like sorghum, millets and peanuts.

"These crops are so critical to nutrition and global food security in those regions."

Getting to the root of the problem

While Lee is keen to see more investment in a variety of crops, wheat was still one of the most important food sources providing 20 per cent of the world's daily calorie intake.

But last year, wheat yields were down in Australia and Europe, which Kai Voss-Fels from the Queensland Alliance for Agriculture and Food Innovation said reaffirmed the need to quickly find wheat types which are robust and resilient.

"Farmers reported 30 to 70 per cent crop losses and some crop failures in Germany," Kai said.

"So farmers there are also speaking up and asking for better adapted varieties."

Kai was working with international plant scientists to investigate the root structure of drought-tolerant wheat varieties.

He said roots are important as they are the interface for water and nutrient intake.

"Roots are complicated because the plant can only produce so much carbohydrates," he said.

"It's always about resource allocation and how much energy a plant should put into growing roots or how much energy should it put into grain filling."

Kai said an international effort, involving researchers from across Europe and Mexico, was testing some of the best wheat varieties.

"Basically we are taking important wheat varieties and making copy versions of them but with modified roots to then test under specific environmental conditions," he said. ■

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PRECISION PAYS

Debunking the myth about wheat breeding and allergies

AT A GLANCE...

- Charles Sturt research examined allergenicity of 170 Australian wheat varieties.
- One of the most allergenic varieties was one grown in the 1800s.
- It's hoped the research will contribute to the development of low-allergenic wheat varieties.

NEW research has debunked the myth that all early varieties of wheat were less allergenic than the varieties grown on Australian farms today.

Charles Sturt University (Charles Sturt) PhD candidate Mr Chris Florides has investigated 170 wheat varieties as part of his research through the Australian Research Council (ARC) Industrial Transformation Centre for Functional Grains (FGC).

"Wheat allergies or gluten intolerance has become a key talking point, not only for people who have diagnosed allergies or consumers who eat gluten-free, but also for wheat breeders and food processors," Chris said.

"If you search the internet or social media, there's a lot of speculation that early wheat varieties were not immunogenic and that modern genetic techniques have created wheat varieties that are more allergenic.



PhD candidate Chris Florides from the Functional Grains Centre says he hopes his research helps in the development of low-allergenic wheat varieties.

"My research examined the allergenicity of wheat varieties grown in Australia from 1860 to 2015, including some original varieties brought from England that were bred to suit Australian conditions.

"The study found that one of the most allergenic varieties was one grown in the 1800s."

Chris has also developed a diagnostic method and created databases with information on the allergenicity of these wheat varieties.

"I found there is variation in the levels of allergenicity and it's hoped varieties with a low content of immunoreactive proteins can now be used in wheat breeding programs and the ones with high content avoided," Chris said.

"It is not possible to develop completely non-allergenic wheat because the gluten proteins – which are responsible for the immunogenic effects of bread and other wheat products – are necessary for the functionality of the flour used to make these products.

"But I hope that my research will contribute to the development of low-allergenic wheat varieties that could be made into products suitable for people who have mild gluten intolerance."

FGC Director Professor Chris Blanchard said, "This is an example of the research at the Functional Grains Centre that's responding to the interest that consumers have regarding the impact of food on their health.

"Ultimately, developing products to meet consumer demands will benefit the entire grains value chain."

Funded by the Australian Government through the ARC's Industrial Transformation Training Centres scheme, the FGC is administered by Charles Sturt University and is an initiative of the Graham Centre for Agricultural Innovation.

An advertisement for Dinner Plain. It features a large circular image showing a scenic view of a valley with a waterfall. Inside the circle are smaller circular insets showing people at a picnic, a small building, and a person on a motorcycle. To the right of the circle, text describes the area as a place where families can explore trails, meet friends, and enjoy the natural environment. At the bottom, it provides contact information for the Dinner Plain Visitor Information Centre.

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Cover crops: Old ideas reborn for modern farming systems

■ By David Lawrence and Andrew Erbacher, DAF Queensland

COVER crops are not new. They can protect the soil from erosion, suppress weeds, boost nitrogen levels when legume species are included, and maintain soil organic matter for healthy soils that support greater biological activity. They have been most widely used by organic and low input farmers.

But cover crops use water, and storing Plant Available Water (PAW) is 'king' particularly in northern farming systems where dryland crops use only 20–40 per cent of the rainfall; approximately 60 per cent is lost to evaporation and 5–20 per cent is lost as runoff and drainage.

Growing crops that do not produce grain or fibre is understandably considered 'wasteful' of both rainfall and irrigation. But research is now supporting grower experience that cover crops may provide many of their benefits with little or no loss of soil water.

Queensland's Department of Agriculture and Fisheries, the Department of Primary Industries NSW and CSIRO recently joined forces with funding from the Grains (GRDC) and Cotton (CRDC) Research and Development Corporations to assess the impact of cover crops on the net soil water accumulation of fallows for grain and fibre crops.



Photo 1: This photo shows a range of cover crops plots with different 'spray-out' times to assess fallow water storage following a skip-row sorghum crop.

This meant growing a range of cover crops to assess changes in water storage in low cover situations following cotton, skip-row sorghum, chickpeas and drought that leave the ground exposed to erosion and poor infiltration (Photo 1).



Knowledge grows



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Photo 2: This photo shows the stubble effect three days after around 30 mm of rain at Bungunya to the west of Goondiwindi in southern Queensland. A rolled cover crop treatment is in the foreground with the 'control', a low-cover fallow plot behind it. The theory is that stubble reduces evaporation and keeps the soil surface wetter for about 21 days, so if more rain falls in that time, more water will be stored.

The science of stubble and evaporation

How can growing more crops actually increase soil water? We know cover crops will use some of the stored soil water and so make the soil drier. This drier soil can then recharge faster following rain than a moist soil. We also know more crop stubble (e.g. after a cover crop) will protect the soil from rainfall impacts and so improve infiltration to store more water in the soil.

Finally, we know that increased stubble loads can slow down the initial rate of evaporation (Photo 2). Research shows that these evaporation gains are short-lived and lost from accumulated evaporation after three to four weeks. But any

further rain within this three to four week period provides opportunity to reduce total evaporation and so accumulate more soil water.

If the increased cover across the whole fallow can store more water than it takes to grow the cover crop initially, there will be more water to grow better and more profitable crops.

Any extra cover will similarly help infiltration under irrigation for better and more efficient crops.

Trials with commercial cover crop treatment

Trials are underway in both dryland and irrigated systems from Goondiwindi in the north, to Parkes and Yanco in the south. Two trials at Goondiwindi are now complete:

- Pivot-irrigated cotton at Yelarbon; winter cover crops planted in June 2017 on a short fallow between back-to-back pivot-irrigated cotton; and,
- Dryland grain at Bungunya; summer cover crops planted in October 2017 after skip-row sorghum harvested in February that year was long-fallowed into wheat in 2018.

These trials included treatments based on the main commercial options used in the district:

- Cereal cover crops (barley or millet/sorghum) sprayed-out at different growth stages (first node, flag leaf, flowering);
- Legumes (vetch or lablab); and,
- Tillage radish alone or in mixtures with the other species.

Longer fallows need later terminated cereal cover crops to maintain ground cover

The dry matter production levels (biomass) of the cover crops were similar at both sites; 1500–2000 kg per hectare for the early cereal spray-out (first node) treatments; 4000–5000 kg per hectare for the late cereal spray-out (flowering) treatments; and, 8000 kg per hectare for the winter cereal that was taken through to harvest.

This extra biomass will help maintain soil organic matter if the following cotton and grain crops are not smaller as a result.

Biomass declines were small (10–20 per cent) in the short fallow prior to planting the subsequent cotton. While cover levels also remained over 80 per cent for all treatments through to the cereal harvest treatment, they declined sharply by cotton planting for the tillage radish (down to 25 per cent) and the early spray-out cereal (down to 50 per cent). The late spray-out cereal with its more resilient stubble, maintained cover levels over 80 per cent up to cotton planting.

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Photo 3: This photo shows the improved establishment of wheat following a millet cover crop (lower picture) compared to a no cover crop (top picture).

In contrast, biomass declined significantly over the longer summer fallow in the grain systems. Biomass dropped to below 500 kg per hectare and cover dropped below the critical level of 30 per cent at wheat planting for the multi-species (with tillage radish), the legume (lablab) and the early spray-out cereal (millet) treatments.

Longer fallows should therefore include cereal species and use later spray-out times for stronger stem development and cover that is more resilient.

Cover crops can recover more water than they use

The 'water cost' of growing the cover crops, relative to the Control treatment in the early stages of the fallow was about 40–50 mm for the early-termination, about 40–70 mm for the mid-termination and about 60–120 mm for the late-termination treatments. The variations will be different each year, depending on the timing of rainfall before and after the cover crops are terminated (sprayed-out) each year.

The low-cover 'Control' treatments stored an extra 56 mm in the shorter back-to-back cotton system and 42 mm in the long fallow following skip-row sorghum. In both cases, the best cover

crop treatments recovered the water they used to grow, and ultimately stored more soil water across the whole fallow than the Control (low-cover treatment) which was maintained with herbicides (Table 1).

The best treatment in the short fallow between cotton crops was the early spray-out cereal, which finished with an extra 14 mm of water. It used less water to grow and maintained 40 per cent cover over the life of the short fallow. By planting, the mid-spray-out treatment recovered to match the Control and went on to increase infiltration and store more irrigation water in the early growth of the cotton crop.

On the longer fallow following skip-row sorghum, several cover crop treatments were ahead – the best being the late spray-out (+19 mm), the multi-species (+21 mm) and the late spray-out with rolling (+36 mm). These cover crops more than recovered their lost water with the extra cover they provided.

Crop performance

The cover crops cost around \$70 per hectare to establish and then spray-out with herbicides. They recouped some of this cost by saving three fallow sprays that were otherwise needed in the cotton system (about \$60) and two fallow sprays in the grain system (about \$40). But each treatment was more profitable than the low cover fallows, with improved yields of the subsequent cotton and wheat crops measured for all cover crop treatments (Table 1).

The wheat yield increases were largest following the cereal cover crops, especially the late spray-out treatments with their more resilient stubble. The water differences at the end of the fallow explains only some of the observed yield differences. But the establishment of the wheat crop was also dramatically better with cover crops, especially where cereals were used (Photo 3).

The expected yield increases from the higher fallow water storage alone would typically be about 200 kg of grain in wheat (assuming 15 kg grain per mm water) for the mid-terminated millet (worth about \$50 per hectare), about 280 kg of grain for the late millet (worth \$75 per hectare) and about 540 kg of grain for the late + rolled millet (worth \$150 per hectare).

These gains would represent net returns of \$20, \$45 and \$120 per hectare respectively. But the measured yield gains for these same three treatments were 950 kg per hectare, 1461 kg per hectare and 1129 kg per hectare respectively, representing increased returns of between \$250 and \$380 per hectare.

Similarly, the remarkable gains in cotton yields for all treatments compared to the Control fallow represent large returns for the investment in cover crops. The reasons for these big yield increases are not clear. The irrigation schedule for the trial was based on the grower's own crop in the rest of the paddock (wheat grown through to harvest), which was similar to treatment 6 and explains why the treatment overcame its large water deficit at planting.

Continued better infiltration of overhead irrigation with cover crops in the early stages of the cotton crop, and apparent better extraction of soil water in the later stages of the crop may help explain at least some of the results.

These 'initial' results from both trials show that cover crops can increase net water storage across fallows when groundcover levels are low (less than 30 per cent). How often these soil water results will occur across different seasons will be explored with further experiments and simulation modelling. Furthermore, the impacts on the subsequent wheat and cotton yields are dramatic and provide big dollar returns – far beyond expectations from the increases in soil water alone. Improved establishment of the wheat crop at Bungunya and better water extraction by the cotton at Yelarbon are likely contributors to the results.

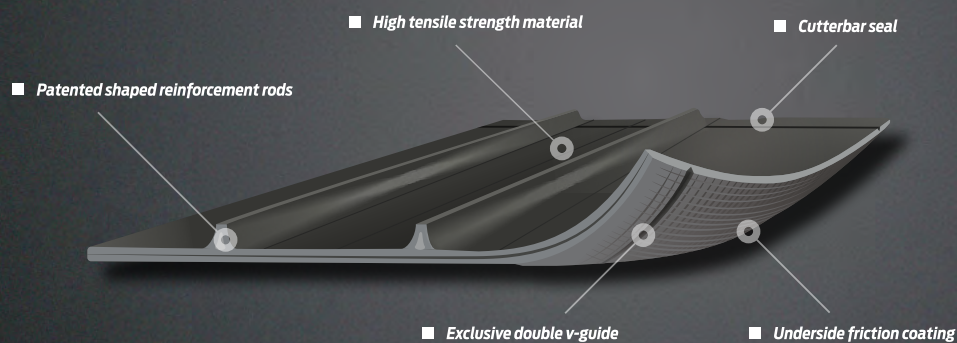
But it's likely that there are other factors that remain to be studied in future research.

TABLE 1: Net change in water storage over the life of the fallow (relative to the Control) and the final cotton and wheat yield for each cover crop treatment

| Treatment | Cover crop | Termination | Water gain (cf control) | Crop yield |
|---|--|-------------|-------------------------|--------------------------|
| Yelarbon (short fallow in back-to-back pivot-irrigated cotton) | | | | Cotton (bales/ha) |
| 1 | Control (Bare) Starting water ~100mm PAW | | 56 mm (fallow gain) | 9.3 |
| 2 | Barley | Early | +14 mm | 12.9 |
| 3 | Barley | Mid | -1 mm | 12.7 |
| 4 | Barley | Late | -14 mm | 11.9 |
| 5 | Barley | Mid + Roll | -2 mm | 12.6 |
| 6 | Barley | Harvest | -111 mm | 14.1 |
| 7 | Barley + Legume | Mid | -16 mm | 11.9 |
| 8 | Barley + Legume | Late | -7 mm | 13.9 |
| 9 | Tillage Radish | Mid | -40 mm | 14.4 |
| Bungunya (long fallow from skip-row sorghum to wheat) | | | | Wheat (t/ha) |
| 1 | Control (bare fallow) Starting water ~120mm PAW | | 42 mm (fallow gain) | 1.44 ^f |
| 2 | Millet (White French) | Early | +5 mm | 2.22 ^{cd} |
| 3 | Millet (White French) | Mid | +14 mm | 2.39 ^{bc} |
| 4 | Millet (White French) | Late | +19 mm | 2.90 ^a |
| 5 | Millet (White French) | Late + Roll | +36 mm | 2.57 ^b |
| 6 | Sorghum | Mid | +17 mm | 2.63 ^{ab} |
| 7 | Lablab | Mid | -4 mm | 1.80 ^e |
| 8 | Multi-species (millet, lablab, tillage radish) | Mid | +21 mm | 1.95 ^{de} |

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Sprayable biodegradable polymer shows promise

CSIRO is developing a sprayable biodegradable polymer membrane technology for use in agricultural crop production systems to minimise soil evaporation, suppress weeds and improve crop water productivity in order to increase crop yields, farm income and farm profitability.

This patented technology is undergoing pre-commercial trials.

The sprayable technology has been demonstrated in laboratory pot experiments and in irrigated field plot trials using melons, sorghum and cotton. These trials have confirmed increases in crop water productivity in excess of 30 per cent compared with bare soil treatments.

Around 3,500,000 tonnes of plastic mulch film is produced worldwide every year for the Plasticulture market, representing a significant opportunity for market disruption via a new technology. The Plasticulture market enjoys an average annual growth rate of about five per cent, and research firm Markets and Markets, projects the global agricultural films market to reach a value of US\$11,744 million by 2020.

"The problem is that plastics don't biodegrade, they fragment," says researcher Keith Bristow. "In the process they produce toxins and heavy metals which remain in the soil. China uses large amounts of plastic mulch and already has huge problems with large areas no longer able to be farmed due to the build up of plastic waste in soils.

Same problem in Australia

"We also have the same problem in Australia with many councils saying they won't accept the waste in landfills any more. The only options for disposal are landfill/burning which can produce nasty toxins such as dioxins or stockpiling/burying the waste – neither option is acceptable," says Keith.

When film fragments it can disrupt the soil pores and you don't get good aeration and water relations. And toxins can disturb soil microbiology and it can find its way to waterways and the water table.

Results to date show significant gains have been made in



Sprayable polymer membrane offers farmers flexibility, helps reduce production costs, and eliminates soil and water pollution (field demonstration of the non-pigmented polymer formulation).



Using multiple spray nozzles to improve uniformity of application (black pigmented polymer formulation that maintains in-field colouration).

crop water use and yield by using plastic mulch films, and that sprayable biodegradable polymer membrane technology offers extensive benefits to farmers and the environment compared to preformed plastic mulch films.

Transitioning to sprayable biodegradable polymer membrane technology will offer farmers considerable flexibility and help eliminate costs associated with installation, retrieval and disposal, as well as eliminating the environmental damage caused by the pollution of our soil and water systems associated with current petroleum-based preformed plastics.

Pre-commercial farm trials are providing valuable lessons regarding:

- Biodegradability and non-toxicity of the polymer membrane and potential risks to soil health;
- Water use, weed suppression, crop yield and the cost:benefit of different product application rates, across full crop cycles under real world conditions; and,
- Finetuning the polymer formulation, its application and impact.

"The trials to date have also demonstrated the ability to apply the polymer with small handheld sprayers and currently available large mechanised sprayers," says Keith. "This makes our product suitable for use by small holder farmers in developing countries and large commercial farm operations in developed countries."

Lab trials have shown the potential for 50 per cent water savings with the technology and small plot trials showed a 25 per cent improvement. Field trials have shown inconsistent results so far because many of the commercial operators couldn't control inputs to the extent required.

"So far we have proved that the system works," says Keith. "That is, the material can be produced and sprayed on as required, so we have a proof of concept."



Installed melon field trial.

"But it is still too costly and needs a bit more refinement to ensure it works the way we want it to. In the meantime we are getting lots of interest from researchers and commercial operators from all round the world to help develop the new sprayable technology."

Acknowledgements: This research is supported by CSIRO and the Science and Industry Endowment Fund (SIEF).

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Uzina Tractorul Brasov

■ By Ian M. Johnston

Brasov

I concede that possibly not many readers of my tractor epistles will be familiar with the intricacies of the Romanian language. But 'Uzina Tractorul Brasov' renders itself as an easy translation into Universal Tractor Brasov. But even this mouthful is thankfully normally reduced to simply UTB.

For those who may be unaware, Brasov is an ancient medieval city located in the Northern Transylvanian mountainous region of Romania. And yes, one associates Transylvania with that evil and heinous character Dracula, who incidentally, was not merely a fictitious individual. His real title was Count Vlad Tepes Dracula The Impaler, and ruled from 1448 to 1476.

His eerie and menacing Bran Castle is but an hour's drive south of Brasov and I suggest should only be visited by those of a strong constitution and never at night!

Brasov is located in a valley, but a few kilometres to the north west is one of the rare areas of Transylvania that can boast a reasonably level plateau. In 1925 an aero club established an airfield on the site. In due course a factory was constructed to manufacture biplane aircraft.

Fast forward to World War 2, when Romania was occupied by the Nazi regime. The Luftwaffe commandeered the aircraft factory for the purpose of assembling the infamous Junkers JU 87 Stuka ground attack dive bombers. Thousands of fleeing civilians across Europe were subjected to the horror of Stukas as they hurtled from the skies with machine guns blazing and

fragmentation bombs being scattered indiscriminately. In order to create further panic, Stukas were fitted with ear shattering sirens which added to the horror and fear of their onslaughts.

The original Junkers plant in Germany was exposed to continual bombing attacks by the RAF, and it was considered the location of the factory at Brasov would be an ideal alternative, as it would be beyond the range of the RAF Wellington and Blenheim bombers. An additional advantage of the site was the fact that ash forests were in abundance on the slopes of the surrounding hills. The Stuka frames were partially constructed from ash timber.

Following the collapse of Hitler's Nazi rule of terror, in 1944 Romania, along with most of Eastern Europe, fell under the brutish control of Stalin's grim Union of Soviet Socialist Republics. The immediate emphasis was the necessity to grow more food, at a time when millions of war ravaged citizens were starving.

Accordingly, scores of East German tractor technicians were forcibly removed to Brasov and ordered to convert the aircraft factory into a high production farm tractor facility.

In 1946 the first UTB tractors left the production line.

A place of fear

When I visited Brasov in 1988, Dracula's Castle was not the only source of trepidation. Romania remained under the desultory control of President Nicolae Ceausescu, undoubtedly the most monstrous and feared communist leader during the merciless Iron Curtin era. (A few months following my perhaps injudicious visit



Bran Castle – the sinister residence of Count Vlad Tepes Dracula. (IMJ archives)



Junkers JU 87 Stuka dive bombers. (IMJ archives)



A 1989 Farmliner 640 DTC Special on display at Wingham Show. (PHOTO: IMJ)



A Universal 850 in the Long livery, observed whilst driving in Alberta in 1995. (PHOTO: IMJ)

to that troubled land, a well aimed bullet through his cranium blessedly terminated Ceausescu's life).

The presence of apprehension in the streets of Brasov was almost tangible. The much feared Securitate (state secret police) were everywhere – including a machine gun toting unsmiling character permanently stationed in the lobby of the Hotel Carpathi, into which I had booked. Food was in such short supply that children were growing up having never tasted fresh fruit or farm produce. Milk was unknown.

Even my initial arrival at the UTB factory created an unanticipated situation. A factory official was appalled when he saw me extracting a camera from the boot of my rental car and rushed to have me replace it urgently back in the boot. He then furtively glanced towards the Securitate chap who had been designated to accompany me on my factory visit, and was relieved to note that the forbidden camera had not been observed.

The purpose of my visit to the UTB factory was to appraise the suitability of a new model for the Australian market. In Australia, UTB tractors were rebadged as Farmliners. They were imported by Inlon Pty Ltd who were also the importers of the Italian Landini tractors. I had a business association with Joe Jardin, the firm's managing director, who had recently experienced cardiac problems and was unable to undertake his planned visit to Brasov to carry out the new tractor inspection. So I volunteered to take his place. But I insisted at my expense, as I wished to be accompanied by my wife and also use the excuse to visit other Iron Curtain countries. (Which nearly ended in a disaster when I was placed under arrest in Bulgaria by an over zealous security official who accused me of being a NATO spy – but that is another story).

The factory was vast, employing around 28,000 workers. But it was a dark sprawling affair, which made me think of the sort of factories one reads about that existed during the Industrial Revolution. Everywhere I was taken by my escorts, I observed hard working men and women offering me a friendly smile, but which was quickly extinguished when they detected the grim faced Securitate individual following behind.

The range of UTB tractor models was impressive. Totally

differing examples were being produced for varying world markets. For example, those destined for Egypt and The Middle East had no correlation with those manufactured for East European farmers, or others for Turkey or the African Continent.

The range included both wheeled and track mounted units, plus an extensive array of earthmoving machinery. Around 70,000 tractors were produced each year for distribution to 115 countries worldwide.

But there was a problem!

The actual design of the UTB tractors was world class. Indeed a Fiat licence had been provided for the construction of certain models. But the standard of individual component production and assembly lingered well below western world standards.

There was an obvious reason for this unfortunate situation. Under the communist dictates, the factory was required to produce a designated number of tractor units by the end of each month. Failure to comply with this imperative resulted in extreme penalties for the senior management officials which in turn filtered down to the wages of the work force. It is therefore perhaps understandable that the philosophy within the factory was to hurriedly complete the build of tractors at any cost!

I personally witnessed endless numbers of tractors, lined up side by side along a railway platform measuring several hundred metres in length, awaiting the arrival of a locomotive hauling flat top trucks, upon which the waiting tractors would be driven cross ways onto the trucks. Also in attendance were a number of tractors fitted with cushioned pusher blades, which were used to push the tractors which failed to start, onto the wagons. A sorry state indeed!

I must hasten to state that the UTB Farmliner tractors destined for Australia did not fall into the above deplorable category.

Those tractor models, previously selected by Joe Jardin, were identical to a range imported into the USA by Long Inc., a company based in North Carolina. In America they were sold under the Long label.

Knowing the UTB production problems, Long had established a hi-tech workshop within the UTB factory boundaries. I enjoyed lengthy and informative discussions with the Long team, which had permanent bookings in the aforementioned Carpathi Hotel. They explained that each individual tractor purchased for the USA



1000 UTB Universal 650 tractors awaiting shipment to Africa.
(IMJ archives)

market was personally selected by their own technicians and was then more or less completely rebuilt and tested, prior to being shipped.

Joe Jardin being aware of this procedure, prudently arranged for the Australian bound tractors to receive this same special treatment by the Americans. As a result, Farmliner tractors in Australia retailed by Inland 4 Wheel Drive Pty. Ltd., Chelmsford Farm Machinery and others, were highly regarded and enjoyed volume sales.

Since the collapse of the communist regime in 1989–90 the factory changed hands and tractor production rapidly declined. In 2007 a shopping centre was planned to be built on the site.

The new Series 3 UTB (Farmliner)

Following a lunch consisting of a mug of black tea and a crusty biscuit, it was time for me to inspect the adequacy of the new model tractor for the Australian market.

Accompanied by a small team of departmental chiefs, I was escorted to an outside compound, into which an example of the new tractor awaited. All eyes were upon me as I slowly scrutinised the smart looking machine. I then pulled myself up into the driving seat and surveyed the layout of the controls and instruments. A few points of disapproval occurred to me, so I beckoned to a technical fellow, attired in a white dustcoat, and through my interpreter explained to him the reasons for my concern. He listened carefully, nodding his head in agreement, before entering the details in a notebook.

He then invited me to start the engine. A bad decision as it turned out! Having ascertained the transmission was in neutral, I inched the rev lever slightly forward and turned the key. The big diesel immediately turned over – but the engine failed to start! Following a further three attempts, the engine refused to start.

I noted the Securitate character frowning.

The white coated bloke suggested I must have the stop lever pulled out. It was my turn to frown at the very suggestion, but refrained from pointing out that I was in fact familiar with correct starting procedures and no, the stop lever was not pulled out!

I alighted from the tractor and invited him to have a go.

He climbed aloft and with a superior smile turned the key. Nothing! He tried again. Nothing! I noted the accompanying executives were obviously concerned and the Securitate guy was furiously writing in his notebook.



The new 1990 Model 643 Farmliner operating a Shearer baler.
(PHOTO: IMJ)

A discussion took place and a mechanic was summoned. The tractor still would not start! I apologetically suggested maybe it was out of fuel. I was greeted with a look of disdain. But I insisted upon climbing up and, upon unscrewing the fuel tank bung, observed the tank was bone dry!

The Securitate cove scribbled rapidly in his notebook and glared at the visibly shaking white coated technician. The executive team all looked embarrassed, and also glared accusingly at the unfortunate individual. I am not sure if he was actually taken out and shot! (Remember – this was communist Romania).

Later in the afternoon I was able to field test the new Series 3 and to declare it was eminently suited to the Australian market.

The following day, together with Margery, I gratefully pointed the nose of our car towards the Hungarian border on the first leg of our journey back to freedom. ■

IAN'S MYSTERY TRACTOR QUIZ

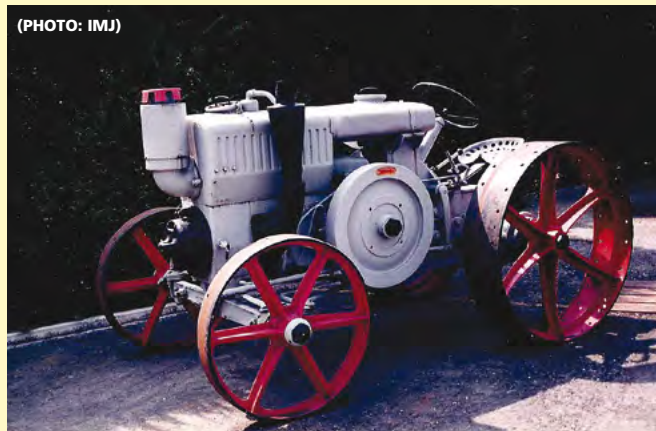
Question: Can you identify this remarkable tractor?

Clue: If you are an elderly Italian farmer, you may be able to identify it.

Difficulty: This is a humdinger!

Answer: See page 48.

(PHOTO: IMJ)



Narrow crop rows, delayed black oats emergence and weed control

■ By Bhagirath S. Chauhan, Associate Professor, QAAFI, University of Queensland

AT A GLANCE...

- Two dominant species of black oats exist in the grain cropping systems of Australia.
- The use of narrow rows (25 cm) in wheat will provide greater suppression of growth and seed production of black oats compared with wide rows (50 cm).
- Irrespective of row spacing, delaying emergence of black oats will greatly reduce their growth and seed production.
- Both components – narrow rows and delayed weed emergence – should be included in integrated weed management programs in wheat.
- Both species of black oats have different seed shattering levels, which have implications for harvest weed seed control practices.

BLACK oats or wild oats are problematic weed species in winter crops. They are highly competitive and can reduce crop yield significantly. Nationally, they are ranked as our number 3 problem weed infesting over 2 million hectares and causing large revenue losses. In the northern grain region of Australia, black oats are ranked at number 1 and infest over 0.6 million hectares. They produce a lot of seeds (more than 20,000 per m²) with differential levels of dormancy, which allows them to emerge in the field at different times.



Bhagirath Chauhan.

There are two main species of black oats that infest Australian grain cropping systems – *Avena fatua* (AF) and *Avena ludoviciana* (AL). AF tends to germinate and shatter earlier. It is difficult to distinguish seedlings of these species; but they can be properly identified at seed maturity.

AL spikelets tend to hold together at maturity while AF spikelets readily break into individual seeds (see Figure 1 photo).

Herbicides are widely used to manage black oats (the name used for both AF and AL) in cereals; but injudicious use of herbicides has been accompanied with the evolution of resistance. In Australia, some biotypes of black oats have already developed resistance to Group A, B and Z herbicides.

These concerns warrant the need to develop cultural weed management programs (for example, the use of narrow crop rows and high crop density) for black oats.

In some regions, wheat is grown at very wide row spacings (up to 50 cm), even in irrigated conditions. The big 'open' space between the rows is prone to heavy weed infestations and black oats in such situations may produce high biomass and seeds.

The use of narrow row spacing may lead to reduced black oats growth and seed production.

Cultural methods, including the use of narrow crop rows, allow weeds to germinate and emerge in the field at different times after crop planting. Black oats emerging at different times may have differential growth and seed production. Seedlings emerging later in the crop are usually less competitive and produce fewer seeds than seedlings emerging with the crop.

Harvest weed seed control practices have the potential to reduce the size of weed seed banks. AF and AL are known to have different seed shattering traits, which may have implications for their management.

A field study was conducted to evaluate the effect of crop row spacing and delayed emergence of black oats on growth and seed production of black oats (AF and AL) in a wheat crop.

FIGURE 1: Spikelets of *Avena ludoviciana* (left two seeds) and *Avena fatua* (right two)



How we did the trial

A field trial was conducted during the winter season of 2018 at the Gatton research farm of the University of Queensland. The trial determined growth, seed production and seed shattering of AF and AL emerging at five different times (0, 2, 4, 6 and 8 weeks after wheat emergence – WAVE) in wheat planted at 25 and 50 cm row spacing. Spitfire wheat was planted at 125 seeds per m² and the plant density was similar in both row spacing treatments. Black oats seeds were planted in small pots and eight seedlings per two m² area were transplanted at the two-leaf stage. Total seeds and shattered seeds per plant were counted.

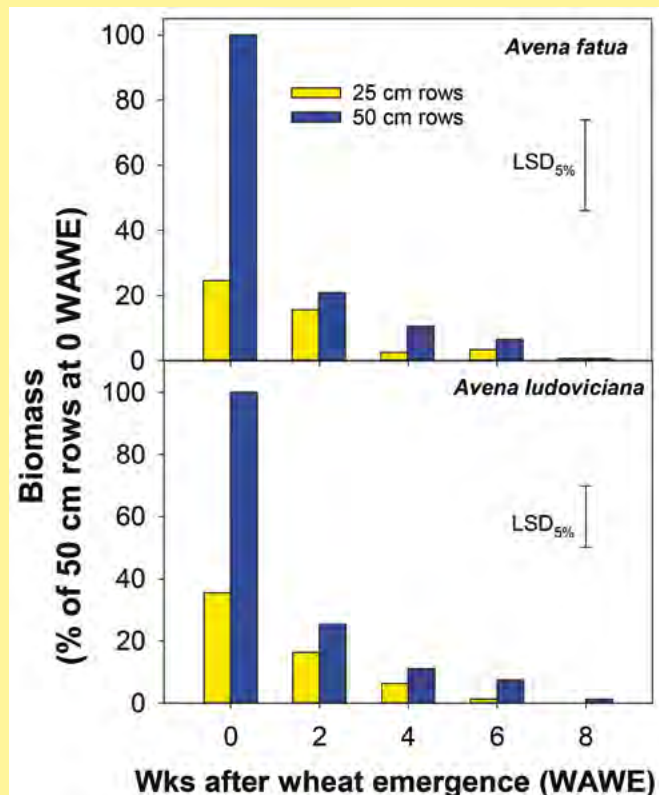
Plants were then cut at the ground level, placed in paper bags and dried in an oven at 70°C for three days and dry biomass determined. As black oats biomass and seed production were maximum at 0 WAVE in the 50 cm row treatment, the parameters are presented as the per cent of 50 cm rows at 0 WAVE.

Seed shattering data are presented only for the black oats seedlings emerging with the crop. GenStat was used to compare the means using the least significant difference test at the 5 per cent level of significance (LSD 5 per cent).

What we found

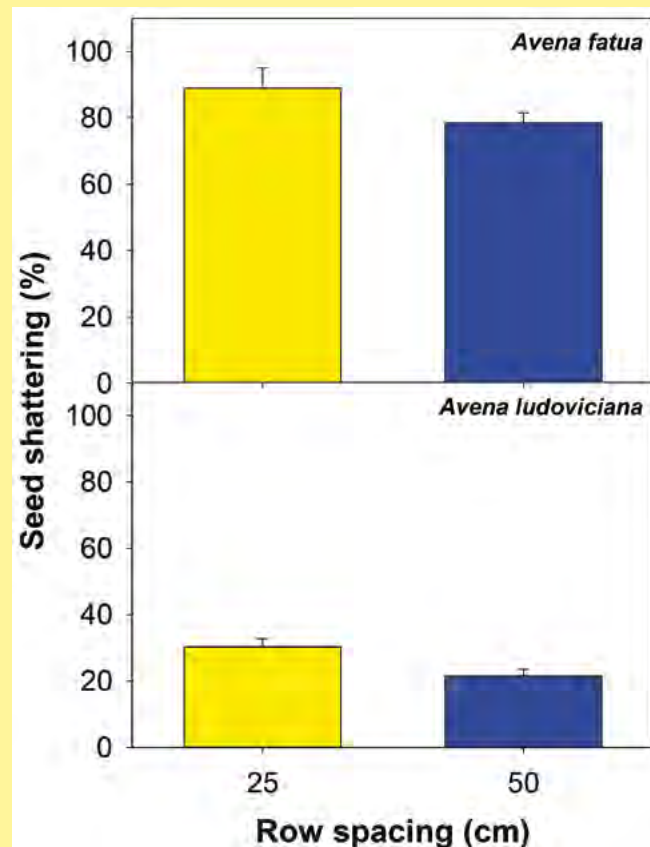
Both species of black oats (AF and AL) emerging with the crop had greater biomass (Figure 2) under 50-cm rows. But row spacing had no effect on biomass of plants emerging later than

FIGURE 2: Shoot biomass of *Avena fatua* and *A. ludoviciana* as influenced by wheat row spacing (25 and 50 cm) and weed emergence time (25 and 50 cm) and weed emergence time



LSD_{5%} is shown for the interaction between row spacing and black oats emergence time.

FIGURE 3: Effect of 25 and 50 cm wheat row spacing on seed shattering of *Avena fatua* and *A. ludoviciana* when emerged with the crop



Error bars are the standard error of the means.

2 WAVE and beyond) in the crop. When emerged with the crop, AF produced only 25 per cent of the biomass in 25 cm rows compared with 50 cm rows. This value for AL was 36 per cent.

Similar to the biomass data, both species emerging with the crop had greater seed production under 50 cm rows and row spacing had no effect on seed production of plants emerging later in the crop. When emerged with the crop, AF produced only 32 per cent seeds in 25 cm rows compared with 50 cm rows (640 seeds per plant). This reduction for AL was 42 per cent in 25 cm rows compared with 50 cm rows (490 seeds per plant).

Black oats plants that emerged 8 WAVE produced 11–14 seeds per plant in 50-cm rows, whereas only two to four seeds per plant were produced by these plants in 25-cm rows.

At harvest, higher seed shattering/dispersal (78–89 per cent) was observed for *A. fatua* compared with *A. ludoviciana* (22–30 per cent) for the plants emerging with the crop (Figure 3).

What does this tell us?

This field trial found that growth and seed production of both species of black oats emerging with the wheat crop were greater in 50 cm rows than in 25 cm rows, demonstrating the importance of using narrow rows for wheat. The seed production data suggest that black oats plants that escape the application of a pre-emergence herbicide may produce about 70 per cent more seeds in 50 cm rows compared with 25 cm rows.

In a wide row crop, some herbicides cannot be incorporated well by sowing operations as the space is very wide between the rows and this may result in the escape of black oats seedlings.

Irrespective of row spacing, delaying black oats emergence until 2 WAVE greatly reduced growth and seed production

compared with the plants that emerged with the crop. Late emerging black oats seedlings might have suffered more from shading than early emerged seedlings.

The results suggest the importance of planting a wheat crop in a weed-free field condition, which could be achieved by using a pre-emergence herbicide. Irrespective of row spacing, black oats plants emerging 8 WAVE produced only 0.4–2.7 per cent biomass compared with the weed plants emerging with the crop.

These late emerging plants may not affect crop yield but they still produced two to four seeds per plant in 25 cm rows and 11–14 seeds per plant in 50 cm rows. These seeds may build up a large seed bank in the subsequent seasons. Black oats seeds are known to spread through farm machinery and these seeds may infest a clean area. The issue may become more serious if the plants are herbicide-resistant. Growers need to aim for a 'no seed threshold', especially in a situation where black oats are not a serious problem.

The seed shattering data suggest that AL could be targeted using harvest weed control practices but most seeds of AF may escape these control techniques. Researchers need to think if there is a possibility of reducing seed shattering in black oats.

This study concludes that narrow row spacing and early black oats control could be important components of integrated weed management programs in wheat. For black oats management, future research should focus on integration of cultural approaches (row spacing, plant density, weed-competitive cultivars, etc.) with herbicide application timing. Although highly unlikely, efficacy of a herbicide may vary on AF and AL. So there is a need to evaluate the performance of different herbicides on AF and AL.

Keep mixing herbicides

AS AHRI researcher Roberto Busi attempted to land a jump on his motorbike recently, the last thing that went through his mind as he approached the ground was “I’ve got this”. Waking up after surgery to reconstruct his elbow several hours later it became apparent to him that no, he didn’t have it!

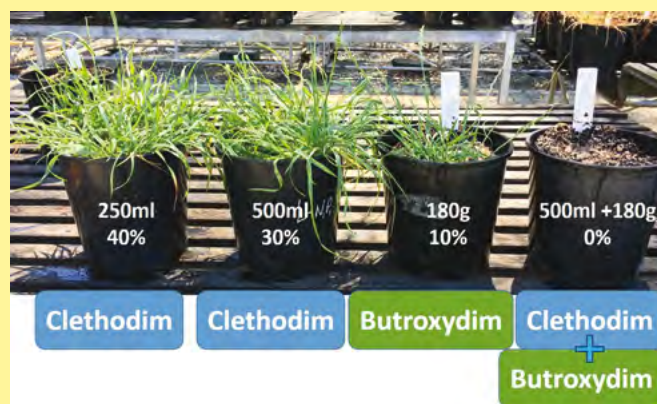
It’s a little like spraying clethodim on ryegrass these days. As the grain grower sprays ryegrass of the right size with a robust rate in good conditions, with excellent application, he could be excused for thinking, “I’ve got this”.

Roberto recently completed a project with GRDC investment where he sampled ryegrass from 17 paddocks across eight farms in Western Australia to see if there are benefits of proactively testing for herbicide resistance. Across these tests, he found ryegrass that was resistant to Clethodim (Select) or Butroxydim (Factor) but no ryegrass that was resistant to the mix of the two. The same went for the pre-emergent herbicides as well – no resistance to mixes.



Recent testing of ryegrass samples from 17 WA paddocks found resistance to two individual herbicides – but no resistance when the herbicides were mixed.

FIGURE 1: A suspected case of clethodim resistance in annual ryegrass



From left to right: Typical dose – response of annual ryegrass resistant to clethodim at 250 ml/ha clethodim with ~40% survival, 500ml/ha clethodim with 30% survival, 180 g/ha butroxydim with 10% survival and no survival (0%) when the 500 ml/ha clethodim + 180 ml/ha butroxydim is applied as a mixture to the same annual ryegrass population.

This is not to say that herbicide mixtures will kill every population of ryegrass, but it does highlight the benefits of mixtures as well as the benefits of testing for these mixtures before using them over the whole farm.

Keep mixing herbicides... and be careful when riding motorbikes!



“I’ve got this!” And the surgeons did a great job reconstructing Roberto’s elbow.



Herbicide mixtures also worked best in pre-emergent situations.

In 2018, a study was conducted to assess herbicide resistance in annual ryegrass seed samples collected from focus paddocks across eight different farms located in the Kwinana West Port Zone. A total of 17 ryegrass seed samples were collected from 17 paddocks. Herbicide resistance status was determined by treating germinating seeds or two-leaf seedlings with a range of herbicide modes of action. Plants were grown outdoors at the University of Western Australia (UWA) during the autumn/winter season.

Clethodim + Butroxydim

For this study, Roberto used the lower end of the herbicide

TABLE 1: Number of samples from WA that were either Susceptible (survival <5%), Developing resistance (survival 6%–19%) or Highly resistant (survival >20 %)

| Herbicide | Highly resistant (%) | Developing resistance (%) | Susceptible (%) |
|---|----------------------|---------------------------|-----------------|
| Clethodim (250 mL) | 6 | 3 | 8 |
| Butroxydim (100 g) | 1 | 3 | 13 |
| Mixture | | | |
| Clethodim + Butroxydim (250 ml + 100 g) | 0 | 0 | 17 |

TABLE 2: Number of samples from WA that were either Susceptible (survival <5%), Developing resistance (survival 6%–19%) or Highly resistant (survival >20%)

| Herbicide | Highly resistant (%) | Developing resistance (%) | Susceptible (%) |
|--|----------------------|---------------------------|-----------------|
| Dargo (Propyzamide) 1 L/ha | 0 | 0 | 17 |
| Trifluralin 1 L/ha | 0 | 3 | 14 |
| Arcade (Prosulfocarb) 2.5 L/ha | 0 | 5 | 12 |
| Sakura (Pyroxasulfone) 118 g/ha | 0 | 2 | 15 |
| Mixtures | | | |
| Arcade + trifluralin 2.5 L/ha + 1 L/ha | 0 | 0 | 17 |
| Sakura + trifluralin 118 g/ha + 1 L/ha | 0 | 0 | 17 |

rates of Clethodim and Butroxydim. He found significant resistance to the widely used clethodim herbicide, and some resistance to butroxydim, but no resistance to the mix of the two.

In another study, Roberto and Mechelle Owen tested ryegrass that was suspected to have high level Clethodim resistance.

This time the ryegrass was tested with the top label rates and once again there were no survivors to the mix of clethodim and Butroxydim, but there were survivors to the individual herbicides.

Hit it hard

Clethodim + Butroxydim is the biggest registered hit that can be applied to ryegrass, although this mix is safe in registered grain legume crops only and is not recommended in canola due to crop safety issues.

Pre-emergent herbicides

And, you'll never guess the result when Roberto tested some common pre-emergent herbicides. That's right, mixtures win again.

There was no resistance detected in ryegrass to propyzamide in this study and there is yet to be a confirmed resistant population anywhere in the world.

But there was developing resistance detected to Trifluralin, Arcade (Prosulfocarb) and Sakura (Pyroxasulfone) in the same 17 populations mentioned above. But the mixture of trifluralin with either Arcade or Sakura was 100 per cent effective in all populations.

To sum up

Test, mix and rotate is the message. There are a number of new herbicides coming to the market soon and we are beginning to see resistance evolving to our current suite of pre-emergent herbicides. Unpredictable patterns of cross resistance are arising between these herbicides.

We believe that in the future, extensive resistance testing, including the testing of herbicide mixtures, will be important to help grain growers get the best result with their herbicides.

Test, mix, rotate, and keep away from crazy Italians riding motocross!

P.S. Roberto is doing well. He's got a very sore elbow that doesn't currently bend, but he's hoping for a full recovery and is already back on the running track.



Prevention is better than having this disease history repeat itself

TWENTY years ago, Fusarium Head Blight (FHB) infamously made headlines in New South Wales when the disease slashed durum wheat yields by up to 100 per cent across the Liverpool Plains region.

Economic losses were extensive, prompting industry to undertake a detailed evaluation of the agronomic and climatic factors that contributed to the devastating outbreak.

Since then, the GRDC and its research partners have invested in research and extension efforts to better manage the disease and minimise the risk of history repeating itself as soon as weather conditions are conducive – that is, wet and humid during flowering and/or grain fill.

Averting an outbreak

To avert a similar outbreak, experts say it's important for industry to recognise the key FHB risk factors and implement preventative agronomic strategies where possible, particularly if the cropping program includes cereal crops and maize within the rotation.

With the rapid expansion of these crops in some irrigation areas of southern NSW, growers are being urged to implement an integrated FHB management program that includes the use of non-grass crops in the rotation as a disease break, and testing of at-risk paddocks and potentially planting seed following seasons conducive to FHB development.

NSW Department of Primary Industries (DPI) senior plant pathologist Steven Simpfendorfer said rotation selection was

one of the most important management tools in minimising FHB infection-risk and recommended avoiding durum/maize rotations as well as back-to-back durum plantings.

"Maize is an excellent host of the FHB fungal pathogen *Fusarium graminearum* and if weather conditions are conducive, the fungal pathogen will release tiny ascospores that can be wind-blown over moderate distances (around one km) to infect heads of surrounding cereal crops," Steven said.

"When conditions are warm and humid, the spores will germinate and infect the plant through the flowers (anthers) which can lead to serious grain yield losses and grain quality downgrading."

Prolonged periods (36–72 hours) of high humidity (higher than 80 per cent), low evaporation and temperatures from 20° to 30°C during flowering and early grain-fill produce the most favourable conditions for FHB infection.



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NSW Department of Primary Industries senior plant pathologist Steven Simpfendorfer says rotation selection was one of the most important management tools in minimising FHB infection-risk. (PHOTO: GRDC)



Experts say it's important for industry to recognise the key FHB risk factors and implement preventative agronomic strategies where possible, particularly if the cropping program includes cereal crops and maize within the rotation. (PHOTO: GRDC)

Yield and economic losses result from sterility of the flowers and grain that is shrivelled, lightweight, low quality and prone to containing toxins such as deoxynivalenol.

Steven recommended that growers:

- Avoid durum crops in areas with known high prevalence of FHB;
- Avoid sowing durum into or adjacent to paddocks that contained maize the previous year;
- Plant the least susceptible varieties available (although this can be difficult with durum);
- Reduce FHB inoculum levels by rotating with non-grass crops, such as sunflowers, cotton, soybeans, mungbeans, chickpeas, faba beans, canola and field peas;
- Vary sowing times and varieties to minimise the risk of the entire crop flowering when weather is favourable for infection; and,
- Use clean seed – if contaminated seed must be used, seek further advice.

In-crop treatment a last resort option

Grain infected with FHB is usually white and, if prolonged wet conditions occurred during grain fill, infected grains will take on a pink appearance. But it should be noted that if any white or pink grains are evident, then the levels of Fusarium infection can be significantly higher than what may be indicated by visual inspection.

Steven said in-crop fungicide treatments should be considered as a 'last resort' management option with the only chemical

registered for use in FHB control in cereals, Prosaro, requiring a well-timed and well-executed application strategy to be effective.

"Research has shown that spraying durum wheat at flowering (GS61) was more effective and had more yield benefit than spraying seven days before flowering," Steven said.

"The anthers (flowers) are the primary infection site for *F. graminearum*, so spraying before flowering provides reduced protection of these plant structures.

"Overseas research has demonstrated the importance of spray coverage in FHB control, with twin nozzles (forward and backward facing) angled to cover both sides of a wheat head and high volumes of water (100 litres per hectare or more) being critical to efficacy.

"Globally, wherever corn has been grown in rotation with cereals (especially durum), add successive rainy days during flowering and more often than not they've ended up with significant FHB issues."

Look out for Gibberella cob rot

Maize growers are also being encouraged to factor Gibberella cob rot into their decisions around hybrid selection, rotations and stubble management given that the disease is caused by *Gibberella zeae* – the asexual state of *F. graminearum* and the same fungus that causes FHB in cereals. The Gibberella cob rot fungus survives from season to season on infected maize residue.

"So that has implications for maize hybrid selection as well as management of maize stubble within the farming system," Steven said. ■



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Valor Brings Flexibility to Summer Weed Control

New residual registrations for Valor® herbicide in fallows and prior to summer crops greatly broadens crop rotation flexibility and boosts efforts in combating herbicide resistance.

Valor herbicide is well known for its effectiveness as a spike with knockdown herbicides, boosting control on difficult to kill weeds, and in controlling Roundup Ready (GM) cotton volunteers.

However, with new registrations received last year, growers can capitalize on its ability to provide effective pre - emergent (residual) control of a broad range of problem weeds in fallow and prior to planting summer crops. Valor offers excellent

residual control (6-8+ weeks) of problem weeds such as **Barneyard Grass, Feathertop Rhodes Grass, Fleabane** and **Milk Thistle**, and even against glyphosate resistant strains.

Sumitomo point out there are no other Group G (PPO mode of action) herbicides registered for this residual use in fallow and prior to summer crops. There is also no recorded resistance in Australia to Group G herbicides, making Valor an excellent option for resistance management.

Summary of the New Residual Uses for Valor Herbicide:

• AT PLANTING

- Peanuts and Soybean. Pre-plant or PSPE (post sowing pre-emergent)

• 1 MONTH PRE-SOWING

- Pigeon Pea, Maize, Sorghum, Navybean

• 2 MONTH PRE-SOWING

- Cotton, Sunflower and Mungbeans

• LONG RESIDUAL CONTROL ON CHANNEL BANKS

Significantly, Valor can be used one month prior to sowing several summer crops including Sorghum. With no new herbicide modes of action being registered in Sorghum for many years Sumitomo see this as filling a key need for Sorghum growers. The ability to apply Valor at high residual rates up to 1 month prior to sowing Sorghum now offers growers a new residual chemistry group that can keep country clean leading into sowing and well into the emerged crop, reducing the need to continually rely on older options like Atrazine and metolochlor.



Sorghum planted minimum till at Pittsworth Qld into country with a history of heavy Feather Top Rhodes Grass. Valor applied at 280g/ha 30 days pre-sowing, photo shows excellent level of residual weed control carried well into the emerged crop.

With the steady increase in herbicide resistance in mixed cropping areas and the need for more flexible weed control strategies, growers and agronomists now have a highly flexible and effective new tool at their disposal with Valor. Ticking all the key boxes for mixed cropping systems, Valor offers the ability to be used prior to a large range of crops, it has short and flexible re-cropping intervals (prior to summer and winter crops), it controls key problem weeds, and controls weeds resistant to other herbicides.

These new registrations are very timely for the industry given the drought conditions many are experiencing and the need for flexibility in crop choices as a result. Valor's short plant-back requirements enable growers to respond quickly to opportunities including salvaging failed crops and being able to quickly plant alternate crops where needed.

No plant-back period is required for Soybeans, Faba Beans and Peanuts. While many other crops only require a one-month plant-back period and just 15 mm of rain prior to planting.

This is in great contrast to some other residual herbicides which can tie-up farming country for years, locking farmers into growing only a narrow set of crops over an extended

period (until rainfall and lengthy time requirements have been met). Valor is a godsend in this regard, allowing growers the flexibility to grow a wide mix of crops whether they are coming out of drought conditions or not.

Conserving moisture is critical any time of the year and a product like Valor that can help remove weed pressure in fallow but also offer carryover residual protection into the emerging crop is a valuable option for growers.

Sumitomo encourage growers to try Valor this coming season so they can see how effective it is for increasing their cropping flexibility while managing resistance and ultimately improving the returns from their farming operations.

FOR MORE INFORMATION:

Jock LEYS Business Development Manager

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A grower's experience with deep applied phosphorus

■ By Ben Taylor – 'Culara', Condamine

AT A GLANCE...

Following is a dot point summary of a presentation by Ben at a series of GRDC Grain Research Updates (North) held in March this year.

- Before considering deep P, the whole farm system needs to be considered.
- You can't expect to see full potential of P (or any input) if the whole system isn't in order to gain maximum potential when the opportunity is given.

Overview of 'Culara'

- 'Culara' is a family operation of 4000 hectares of owned and leased land located south of Condamine consisting of Brigalow/Belah and Wilga tree country.
- Key enterprises: Five year rotation of – wheat, chickpea, wheat, long fallow, sorghum/cotton.
- Main equipment used: Case Rowtrack 400 and 12 metre Excel Stubble Warrior with CR600 parallelogram units on 375 mm spacing.
- Have been applying 100–120 kg of MAP over 500–800 hectares per year for the past five years.

Why give deep applied P a go?

- Sorghum configuration/fertiliser trial.
- Deep spray tracks after laser levelling.
- Articles in grain magazines, practical observations and our agronomists, MCA, led us to the decision of giving deep applied phosphorus a go.

Costs of deep applied P

- MAP at \$740 per tonne on-farm applied at 120 kg of MAP = \$89 per hectare cost.



Deep applying MAP to a depth of 18 cm at 'Culara' in sorghum stubble after rain.



Millet cover crop planted after deep applying MAP at 'Culara' (deep P on left, untreated on right).

- Using 70 litres per hour of diesel covering roughly 10 hectares per hour = \$7 per hectare fuel cost.
- Machine cost = \$20 per hectare.
- Total cost per hectare = \$116 per hectare.

Yield benefits

- Yield advantages of 600 kg to 1200 kg per hectare.
- 900 kg of wheat at \$300 per tonne = \$270 per hectare extra income minus \$116 per hectare cost = \$154 increase in income per hectare.
- Header data only. Not accurate weigh bin data.
- Long fallow/rotations.
- Five year plan – but some research suggest benefits of application could last longer than that.

To sum up

- Before considering deep P, the whole farm system needs to be considered.
- Is good weed control in place?
- Is nitrogen and other nutrition in order?
- Is the profile of moisture managed to give crops full yield potential?
- What equipment do I need to modifying or investing in?
- Apply in good soil conditions to be less aggressive on the equipment.

You can't expect to see full potential of P (or any input) if the whole system isn't in order to gain maximum potential when the opportunity is given.

Contact Ben Taylor, M: 0427 692 175 E: cularafarming@bigpond.com ■

Sorghum takes its place in the world's largest trial network

THE Grains Research and Development Corporation (GRDC) has released the first National Variety Trials (NVT) Hybrid Sorghum Performance Report to enhance variety decision making by growers in northern Australia.

Drawing on data generated from the first two years of NVT sorghum trials in New South Wales, Queensland and Western Australia, the report was released at the 2019 Australian Summer Grains Conference on the Gold Coast in July.

Sorghum was included in the NVT program for the first time in 2017–18 in response to grower requests for independent variety performance data to underpin informed choices around the most appropriate hybrid grain sorghum varieties to plant in their paddocks.

Trials have been conducted at 21 locations in Central Queensland, Southern Queensland, Northern NSW, the Liverpool Plains and at Kununurra in WA.

GRDC Board Chair John Woods, a northern region grain grower, says the release of the inaugural NVT Hybrid Sorghum Performance Report is a significant step in continuing to develop and improve the nation's sorghum production and grower profitability.

"Sorghum is now the dominant summer crop in the northern region, so it is incredibly important that growers of this crop are provided with the data, information, knowledge and confidence required to extract optimum yield and profit from their sorghum cropping programs," John says.

"As a grower of sorghum, I was pleased to see it be the first summer crop added to the types tested through NVT, which will improve our understanding of sorghum's performance in a range of environmental situations.

"And I certainly welcome publication of this report which will no doubt become an important resource for growers and advisers.

"I thank everyone involved in producing this report, including the growers who willingly host trials on their properties and the breeding companies who have participated in the NVT sorghum program over the past two summer cropping seasons," John says.

GRDC NVT Manager – North, Laurie Fitzgerald, says the new report is being mailed to growers and is also available at www.nvtonline.com.au/sorghum/.

Difficult seasons but trial data is robust

"The report captures data from two summer cropping seasons – 2017-18 and 2018-19 – both of which were hot and extremely dry across the north," Laurie says.

"As a result of the harsh conditions, not all sorghum trials over the past two seasons were harvested. Central Queensland (CQ) was among the regions hardest hit by the lack of moisture, with none of the NVT sorghum trials planted in that region in 2019 meeting rigorous NVT standards. But NVT data has been captured from four sorghum trials planted in CQ in 2017–18.

"The overall dataset from the past two seasons of the NVT sorghum program across the northern region has been deemed sufficiently robust to enable publication of the performance report."

Laurie reminds growers and advisers that the predicted yield values that appear in the Hybrid Sorghum Performance Report



GRDC Board Chair John Woods, a northern region grain grower, says the release of the inaugural NVT Hybrid Sorghum Performance Report is a significant step in continuing to develop and improve the nation's sorghum production and grower profitability. (PHOTO: Rural Weekly)

are from only two seasons and should be taken in context.

"These values may not be representative of the long-term seasonal conditions experienced by growers in various regions."

Sorghum has been traditionally used as feed by domestic livestock industries, but more recently there has been an increasing interest in the grain for use in ethanol production and for human consumption.

It is now one of the 10 major crop types in the NVT program – the others being wheat, barley, canola, chickpeas, faba beans, field peas, lentils, lupins and oats.

Largest field trial network

The largest co-ordinated field trial network of its kind in the world, NVT is a 100 per cent GRDC investment that is fully administered by the GRDC on behalf of Australian grain growers and the Australian Government.

A national program of comparative crop variety testing with standardised trial management, data generation, collection and dissemination, NVT seeks to assist growers to optimise the profitability of their farming systems through choosing the most appropriate varieties for their growing environments.

More than 550 near-release or released varieties are evaluated within hundreds of trials across the country each year, generating highly valuable comparisons for variety agronomic performance, grain yields, disease and pest resistance and physical grain quality traits.

NVT accepts lines into the program for testing two years prior to their commercial release. This ensures sufficient data is available for growers on newly released varieties to make informed variety selection decisions.

Data analysis for NVT is conducted by a team of statisticians through the GRDC's Statistics for the Australian Grains Industry (SAGI) program.

More information about NVT can be found at www.nvtonline.com.au

Herbicide resistance: Doing nothing is not an option!

HERBICIDE resistant weeds might not be widespread in Central Queensland yet, but all the indications are that the problem is flying just under the radar. Following the discovery of the world's first population of glyphosate resistant sweet summer grass near Emerald, random weed surveys have since confirmed glyphosate resistance in both feathertop Rhodes grass and fleabane samples collected in the region.

Cotton and grain growers and agronomists who want to stay ahead of this mounting threat are invited to attend the 2019 WeedSmart Week event in Emerald. The 2.5-day program will begin with a one-day forum at Emerald Agricultural College on August 13. The following day will be filled with a bus tour to farms around Emerald where growers have put in place integrated weed management programs to minimise the impact of herbicide resistance on their businesses. The final part of the program is a half-day tour of the SwarmFarm Robotics base at Gindie on Thursday, August 15.

The WeedSmart Week theme 'Diversify and Disrupt – Conquer weeds with the Big 6' says it all! At the forum and on the bus trip growers, agronomists and researchers will have all the options and ideas on the table for discussion.

Vicki Green, GRDC Crop Protection Manager, North is looking forward to attending the event and hopes that CQ growers will make the most of the opportunity to be part of such a focussed and interactive couple of days.

Each region needs different diversity

"There is so much pressure on herbicide use in farming systems and growers all over Australia are rising to the challenge to diversify their weed management programs," she said. "We know the WeedSmart Big 6 principles apply everywhere, but they need to be applied differently in each region and on each farm."

"That's where events like this are so valuable – bringing together a vast array of knowledge and experience from local and inter-state growers, researchers, agronomists, consultants and technology experts."



Vicki Green, GRDC Crop Protection Manager, North hopes that CQ growers will make the most of the opportunity to be part of the first WeedSmart Week event to be held in Queensland. (PHOTO: GRDC)

In August last year, 12 members of the GRDC CQ Grower Solutions Group attended the 2018 WeedSmart Week in Narrabri as part of a six-day fact-finding tour through southern Queensland and northern NSW.

Brothers Justin and Royce Staier, who farm in the Clermont and Kilcummin areas, were part of the tour group and came away from the experience with some new ideas and a resolve to implement some changes in their farming operations.

Justin was impressed with the calibre of speakers and enthusiasm of the growers on the farm tours. "There are so many people putting a big effort into controlling herbicide resistance," he said. "We are just starting to see problems with weeds like feathertop Rhodes grass here and going to WeedSmart Week in Narrabri really brought some important things to mind, like the need to stop survivor weeds and to be careful with residual herbicide use. Machinery hygiene is an on-going risk for spreading herbicide resistance and this is a high priority for us."

At this year's event, attendees will have several opportunities to see and discuss cutting-edge technologies such as optical sprayers, robots and emerging 'green-on-green' spray sensors, and to find out how other growers in the region are implementing the Big 6 weed management tactics.

The growers, agronomists and researchers speaking and participating in expert panels at the Day 1 forum will spark important discussions about herbicide resistance and how the Big 6 tactics can be used to target the weed species and farming systems in the northern cropping region. There's one thing for sure – doing nothing is not an option.

Register for this important three-day event for the 'early bird' single ticket price of \$130, guaranteeing a seat on both the bus tour days as well as the forum, all fully catered, at

<https://weedsmart.org.au/weedsmart-week-emerald/>

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



Attendees at WeedSmart Week in Emerald will have several opportunities to see and discuss cutting-edge technologies and find out how other growers in the region are implementing the 'Big 6' weed management tactics.

Paired-rows give entry level crop competition

■ By Cindy Benjamin, WeedSmart

HIGHER crop yield and less weeds naturally flow from increased crop competition, but the costs involved in changing machinery and farming systems can be a barrier to achieving these benefits.

Narrowing row spacing, while maintaining the same seeding rate, is generally accepted as the simplest way to increase crop competition. But growers who are not ready to change over their machinery can gain much of the weed suppression benefit using paired-row sowing systems. If this is coupled with east-west sowing the benefits are even greater.

Peter Newman, WeedSmart western extension agronomist says paired-row systems such as the Stiletto Boot, which is popular in Western Australian sandy soils, are a cheap way to increase crop density and achieve earlier canopy closure.

Yield maintained in weedy situations

"Generally, there is not a yield response over single row seeding but yield is maintained in weedy situations, taking some pressure off in-crop herbicides without adding significantly to the weed seed bank," he said. "Paired-row systems reduce the

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Peter Aikman, Annuello, Victoria has used a paired-row system to maintain crop competition to suppress weeds while gaining seeding efficiencies through slightly wider row spacing. This crop of Compass barley was dry sown in April 2018 and germinated on 12 mm rainfall on May 4.



Paired-row systems such as the Rootboot (pictured) and Groundhog have improved seedbed utilisation.

'auto allelopathy' effect that suppresses plant growth when the seeds of crops like wheat are planted very close along the row. Spreading the seed out, essentially in a slightly wider band, gives each crop seed more room to germinate and grow without impacting on the growth of neighbouring crop plants."

In southern Australian farming systems there has been steady adoption of paired-row systems – such as Rootboot and Groundhog – to improve seedbed utilisation (SBU), which is a measure of the seed and fertiliser spread relative to the row spacing.

Southern WeedSmart extension agronomist Greg Condon says the paired-row systems help avoid the problems with fertiliser toxicity that can occur in single wide row systems.

"Older paired-row setups moved too much soil and left the seedbed very rough," he says. "They also had poor stubble handling capacity, used more fuel, achieved poor seed-soil contact and growers had problems with pre-emergent herbicide safety in some situations."

"Most of these constraints have been fixed with the newer configurations now available on the market. Growers who might have had bad experiences before will probably find that paired-row boots now move less soil, have narrower openers and fit better with a wider press-wheel setup."

Greg says that although paired-row systems are a good interim option, the best long-term solution is to change to narrow single-row spacing, no wider than 250 mm for tynes or 190 mm for disc planters.

Paired-row system technology options

Dr Jack Desbiolles, senior agricultural research engineer at University of SA has undertaken extensive trials investigating the benefits of increasing the space between seeds in the seedbed. Paired-row sowing is one way to effectively achieve this and can deliver both increased yield and useful suppression of weeds.

"When it comes to paired-row seeding systems, the technology can be categorised into either split or integrated designs," said Jack. "The split designs use a Y-splitter tail located further behind the opener, which delivers seeds into a furrow backfill. While seed spread can be more limited, seed placement can be accurate. But seed is often exposed to diluted furrow moisture and contamination from residue and pre-emergence herbicide, all of which can reduce the rate of crop establishment."

While these Y-splitter design solutions represent easy and low-cost upgrades for compatible single row seeding systems, the newer, integrated paired-row designs are becoming more mainstream.

"The integrated designs are compact and streamlined, sitting closely behind the opener and are designed to deliver seeds onto an undisturbed ledge on each side of the trench that the opener creates," he said. "The accuracy of seed placement depends mostly on the primary furrow shape not affecting the integrity of side ledges. These paired-row configurations are more expensive but often achieve good seed-soil contact without diluting soil moisture or allowing residue or herbicide contamination," Jack says.

One grower's experience

Farming at 'Annuello' in the north-west of Victoria, Peter Aikman started using a Rootboot paired-row system in 2014 as part of their strategy to increase sowing efficiency after buying additional land and doubling their cropped area.

Peter's Horwood Bagshaw seeder had been set up on 30 cm, single row spacing for cropping wheat, barley and legumes in rotation. To cover more area per day at seeding, Peter changed to 35 cm row spacing but did not want to lose the crop competition benefits that he had seen at 30 cm spacing.

"Widening the tyne spacing allowed us to increase sowing speed and add two more tynes to increase the seeder width. Together these changes increased our seeding efficiency from 12 to 16 hectares per hour, which means we save seven days at seeding time and can finish planting the whole area on time," he said. "To keep the crop competition benefits we turned the row direction to east-west where practical, and use the Rootboot opener to seed 10 cm paired-rows on 35 cm tyne spacing."

Peter has found that this paired-row system moves some soil around, but in some instances this can be a good thing as it helps to fix any small areas left bare after a legume crop or slightly eroded after using the self-propelled sprayer on sand hills.

"Brome grass is one of our major weeds and we are trying to reduce its germination and seed set by using the combination of the paired-row system and east-west sowing, together with other strategies such as robust crop and herbicide rotation, monitoring for weeds, acting early to prevent weed blow-outs and using harvest weed seed control."

In August, WeedSmart Week will be held in two locations – Emerald, Queensland and Horsham, Victoria – shining the light on integrated weed management tactics, including crop competition, that growers can use to stave off herbicide resistance in weeds. Register on the WeedSmart website.

For more information about paired-row sowing and crop competition, visit the WeedSmart website: www.weedsmart.org.au

PAIRED-ROW SYSTEMS AND EFFECT ON WEEDS AND CROP YIELD

In 2005 Dr Jack Desbiolles led research into the effects of seedbed utilisation and seed rate on weed competition and wheat yields on a shallow grey Mallee loam near Minlaton in South Australia.

The SAGIT funded research, in collaboration with the Southern Yorke Peninsula Alkaline Soils Group, centred on investigating the impact of seedbed utilisation (SBU), which quantifies the extent of the row spacing occupied by the crop. Low SBU seeding typically makes a uniform seeding job easier to achieve but there is an increased risk for fertiliser toxicity to reduce seedling emergence, and inter-plant competition can significantly limit the yield potential in higher potential seasons.

Two wheat crop seeding rates were tested – ‘Standard’ seeding rate of 88 kg per hectare to establish 180 to 190 plants per m²; and, ‘High’ seeding rate of 125 kg per hectare to establish 250 to 260 plants per m². Three levels of seedbed utilisation (SBU) were trialled and Marloo oats was broadcast at 40 kg per hectare (105 seeds per m²) and incorporated using a prickle chain on the ‘weedy’ plots to simulate weed competition.

A knife blade plus double-shoot rubber seed boot on 25 cm row spacing gave low (15 per cent) SBU. The intermediate treatment was 45 per cent SBU using a double shoot narrow ribbon Anderson opener, also on 25 cm row spacing. Full (100 per cent) SBU was applied using a 20 cm wide share with a 20 cm reach plus Morris spreader boot set on 20 cm row spacing, effectively sowing seed across the full bed area and leaving no inter-row space.

SBU impact on weeds

While crop seeding rate had little effect initially, the 100 per cent SBU had a significant effect on early weed vigour. This treatment reduced weed biomass by 16 to 20 per cent, and reduced weed tillering by 25 to 30 per cent in the early stages of growth.

SBU also had an impact on later weed growth where greater SBU proportionally reduced weed biomass by 11 to 14 per cent (in the 45 per cent SBU system) and 29 to 32 per cent (in the 100 per cent SBU system). A 43 per cent reduction in weed growth was achieved using a high seeding rate combined with 100 per cent SBU.

Weed seed production followed similar trends, with the best results being a 38 per cent reduction in seed weight per weed plant using full SBU and the higher seeding rate. Following a 289 mm rainfall growing season, the full SBU seeding combined with

high seed rate increased wheat grain yield by 0.43 tonnes per hectare (in a weed-free environment) and 0.83 tonnes (in a weedy environment), relative to the low SBU, low seed rate control.

This research confirmed the principles of crop competition and showed that paired-row systems were a practical option to help achieve greater weed competition and higher yield potential through greater seedbed utilisation.

Different soil types

More recently, Jack conducted research on different soil types in the Murrayville district (Vic) in collaboration with Mallee Sustainable Farming Inc, and with DAFF funding, comparing paired-row systems to a commonly-used single row knife point system. In this trial, the paired-row systems gave the highest and most consistent crop establishment across a swale-dune Mallee sandy soil system, with good moisture conditions at seeding and sufficient in-crop rainfall.

The plant establishment benefits ranged from +15 per cent on the mid-slope and sand hill, to +20 per cent on the sandy stoney flats, relative to a district system control, and after a dry season finish, achieved up to 0.15 tonnes per hectare gain in wheat grain yield.

“These results correlate well with the earlier work done in Minlaton which measured crop yield and weed suppression benefits through increased seedbed utilisation,” he said. “Improving crop establishment and gaining the crop competitive advantages relies on correct seeder set-up.”

When to use paired-row systems?

- Recommended for use in marginal soil moisture conditions when seeds can be placed onto undisturbed soil moisture.
- Recommended for effective incorporation of pre-emergent herbicides (IBS) application. Crop safety is best secured using paired-row attachments closely integrated behind the opener.
- Possible use in stony soils if compatible with shallow operating depth.
- Possible use in non-wetting poor fertility soils, where seeding is at furrow tilling depth.
- Possible use under rhizoctonia pressure if coupled with best practice disease management.
- Possible use in high residue situations when coupled with good residue management strategies.



Increasing seedbed utilisation from a common 15 per cent (left) to 100 per cent (right), especially when combined with higher seed rate, effectively suppressed weed biomass and seed production while increasing crop yield.



Dr Jack Desbiolles' research favours the adoption of paired-row seeding systems as a practical way to benefit from higher seedbed utilisation. (PHOTO: Birchip Cropping Group)



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Which 'early break' wheat varieties perform best?

THE National Variety Trials (NVT) program was off to an early start in Western Australia this season with all wheat crops seeded as part of 'early break' trials with emergence timed for no later than Anzac Day.

These Grains Research and Development Corporation (GRDC) NVT trials will provide wheat growers with information about which varieties perform best for yield, grain quality and disease ratings when planted very early in the season.

GRDC manager NVT – west, Peter Bird, said the early break trials had been added to the main suite of WA NVT trials in 2017 in response to growers requiring information about which wheat varieties to grow in order to capitalise on early seeding opportunities.

"These early break trials complement the main series of NVT trials that are seeded around the ideal seeding window in May, reflecting when most of the WA wheat crop is seeded," he said.



GRDC manager NVT – west, Peter Bird at an 'early break' NVT site at Kojonup, where wheat was seeded on April 5.
(PHOTO by GRDC)

"The new series of trials were introduced because growers, often in lower rainfall areas, sometimes have early sowing opportunities in April but might not receive further rainfall until late May or June.

"Wheat varieties that perform well from April sowings are often different to those that produce good results when seeded in May.

"The trials also provide wheat breeding companies with an opportunity to fine-tune the breeding of varieties that suit April seeding dates."

Ten early break trials, assessing more than 20 near-release and released long-season wheat varieties, are being conducted at sites across the WA grainbelt, and not just in lower rainfall areas.

Peter said if necessary, the early break wheat trial sites were watered by mid-April so that crop emergence was achieved on all sites by Anzac Day (April 25).

"Wheat crops had already emerged by mid-April at the Kojonup, South Stirling and Moorine Rock sites, where early rainfall had allowed these trials to be seeded in early April," he said.

Following harvesting and analysis at the end of the season, results from the 2019 early break trials will be available on the GRDC NVT website at www.nvtonline.com.au by searching the 'Find Trial Results' box.

The WA NVT program in 2019 comprises more than 170 trials at more than 60 locations and evaluates wheat, barley, oats, canola, lupin, chickpea, field pea and sorghum. Many locations are at grower group trial sites to better enable growers to view the trials.

Largest field trial network in the world

The largest co-ordinated field trial network of its kind in the world, NVT is a 100 per cent GRDC investment that is fully administered by the GRDC on behalf of Australian grain growers and the Australian Government.

A national program of comparative crop variety testing with standardised trial management, data generation, collection and dissemination, NVT seeks to assist growers to optimise the profitability of their farming systems through choosing the most appropriate varieties for their growing environments.

Peter, who has more than 20 years of experience in grain crop agronomy, trial management and product development, is one of a team of dedicated GRDC NVT staff that has now been appointed – enhancing co-ordination of trials and extending NVT's reach and presence in the regions.

"My aim is for growers to have access to the best possible data about variety choice and to make sure the trials are managed to the highest standard and are in line with changing crop agronomy practices," he said.

"To achieve this aim, I work closely with grower groups, trial service providers, plant breeding companies, agronomists and advisers."

To further support growers and advisers, the GRDC has produced new instructional videos on 'how to navigate NVT's website' and 'how to interpret NVT data (long-term yield results) using the NVT website'. The videos can be viewed via the GRDC's YouTube channel at <https://youtu.be/GbasB-xUIQA>

GRDC podcasts about NVT are available at <http://bit.ly/2G0wSWf> and <http://bit.ly/2Godty4>



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Growers set to 'diversify and disrupt' weeds in the Wimmera

THIS August, Birchip Cropping Group (BCG) is co-hosting the first WeedSmart Week to be held in Victoria. Growers and agronomists are invited to attend the three-day event, beginning with a one-day forum at Horsham Town Hall on August 27.

The following two days will be spent touring farms around the Horsham area to see how growers are implementing the WeedSmart Big 6 tactics to minimise the impact of herbicide resistance on their businesses. The WeedSmart Week theme 'Diversify and Disrupt – Conquer weeds with the Big 6' says it all!

GRDC is the major sponsor of WeedSmart and Senior Regional Manager – South, Craig Ruchs, encourages growers from the Wimmera and beyond to make the most of the opportunity to be part of the focussed and interactive couple of days.

"Weeds frequently drive systems decisions, having the potential to affect flexibility, choice and ultimately profit. Taking a strategic and planned long-term approach, implementing the WeedSmart Big 6 principles, can help put growers back in control," he said. "Pulses are a particularly important element of crop rotations for many growers in the Wimmera and the production of these crops presents both unique opportunities and challenges for weed control."

"Bringing greater diversity in weed control tactics is critical in the ongoing battle against weeds and WeedSmart Week provides a highly effective platform to share research outcomes and on-farm innovation in a very practical and applied way."

WeedSmart Week brings together a wealth of knowledge and experience from local and inter-state growers, researchers, advisors and technology experts – putting the spotlight on herbicide resistance and weed management. Growers can see what is and isn't working first-hand and consider how key principles can be applied directly to their own farming operation.

At the forum and on the bus trip growers, agronomists and researchers put all the options and ideas on the table for discussion. In August last year, three members of the Birchip Cropping Group, Ian Ruwoldt, Tim Rethus and Sam Eastwood, attended the 2018 WeedSmart Week in Narrabri, NSW.

Opportunity to think through the tactics

Farming at Kewell, Ian Ruwoldt and his brother Greg have several strategies in place to manage ryegrass, bedstraw, marshmallow, vetch and bifora. Ian found the WeedSmart event in Narrabri to be very comprehensive and a good opportunity to think through the tactics that could help solve their weed problems.

"We currently use oaten hay, chemical rotation, imidazolinone (imi) chemistry with canola and a chaff deck on the harvester to keep weed numbers low," said Ian. "Thinking about the WeedSmart Big 6 helps to formulate a plan to manage weeds through the year and through the rotation."

"The forum covers a lot of topics and the discussions are very practical and very relevant to the region, so this year's event will focus on the weed issues facing Wimmera and Mallee farmers."

Attendees will have several opportunities to see and discuss cutting-edge technologies such as optical sprayers, robots and emerging 'green-on-green' spray sensors, and will find out how other growers in the region are implementing the Big 6 weed management tactics.

The growers, agronomists and researchers speaking and participating in expert panels at the Day 1 forum will spark important discussions about herbicide resistance and how the Big 6 tactics can be used to target the weed species and farming systems in the southern cropping region. There's one thing for sure – doing nothing is not an option.

Register for this important 3-day event for the 'early bird' single ticket price of \$130, guaranteeing a seat on both the bus tour days as well as the forum, all fully catered, at <https://weedsmart.org.au/weedsmart-week-horsham/>

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



Kewell farmer Ian Ruwoldt is encouraging other Wimmera and Mallee growers to attend WeedSmart Week in August as a good opportunity to formulate a plan to manage weeds throughout the year and through the rotation using the WeedSmart Big 6.



Craig Ruchs, GRDC Senior Regional Manager – South, says WeedSmart Week provides a highly effective platform to share research outcomes and on-farm innovation in a very practical and applied way. (PHOTO: GRDC)

Indonesia walking the import talk

■ By Peter McMeekin

INDONESIA is the world's most populous Muslim nation, the world's third-largest democracy and the fourth largest nation in the world by population. It is also the closest, and one of Australia's most important trading partners.

The most recent estimates put the island nation's population at around 265 million, and it is expected to grow by another 30 million by 2030. That is an increase of more than the entire Australian population over the next 11 years.

With a growing population comes an increasing demand for food. And like most developing countries, the Indonesian population is urbanising. Its people are moving to the cities at a rapid rate in search of better and more secure opportunities.

Rice has long been the diet staple, particularly in the rural areas, but with the migration to the city centres comes a change in diet. The city folk tend to eat more noodles and bakery products such as bread and pastries. And as people get wealthier, they tend to seek healthier food options such as whole grain bread as opposed to white bread. Per capita consumption of wheat has increased from 7 kg per head in 1985 to 22 kg in 2016 as a result.

Indonesia is totally reliant on imports to meet the demand for wheat-based food and as an ingredient for poultry and other livestock sectors. The country's wheat imports are forecast at around 11.5 million tonnes (mt) in the 2019–20 marketing year (July 2019 to June 2020). This compares to imports of less than 4 mt just 20 years ago.

Approximately 9.5 mt of those imports are expected to go into food, seed and industrial (FSI) use, and the balance of 2 mt will be consumed as animal feed. Around 70 per cent of wheat imported for human consumption goes into the noodle market, and the remaining 30 per cent goes into bakery products.

In 2018, there were 25 milling companies in Indonesia operating 27 major flour mills. Those mills had a total installed capacity of 11.5 mt per annum.

Indonesia has traditionally been Australia's biggest wheat customer, buying an average of 4.2 mt of high-quality milling wheat each year. That is approximately 25 per cent of average Australian wheat exports and represents shipments of around 350,000 tonnes per month.

Alarming trade trend continues

The latest Australia wheat export data (May) reveals some interesting numbers and continues an alarming trend regarding wheat exports to Indonesia over the past 12 months. Total Australia wheat exports for the month of May were 1.23 mt. The biggest customer was the Philippines, who accounted for 32 per cent, or 396,000 tonnes, followed by Vietnam with 113,000 tonnes and Japan at 99,000 tonnes.

Indonesia came in fourth, at a paltry 86,000 tonnes.

But one month of data doesn't tell the full story, nor provide a demand trend. Looking at the year-to-date export data (January to May), Indonesia has imported 378,000 tonnes of Australian wheat over the five months, an average of less than 80,000 tonnes per month.

The statistics for the Australian grain marketing year-to-date (October 2019 to May 2020) disclose a similar story with exports to Indonesia totalling 624,000 tonnes for the eight months.



That compares to just under 1.6 mt for the same period in the previous marketing season and is a long way behind the pace required to get close to the 4.2 mt longer-term annual average.

Those days are over!

Indonesia has traditionally paid a premium for the high-quality Australian wheat. But the message from the Indonesian consumer over the past 12 months was that those days were over, and Indonesia would buy on price from whichever origin could offer the quality required.

And they seem to be walking the talk. Indonesia purchased wheat from the Black Sea region in the second half of last year. This year they have purchased wheat from Argentina and Canada, and their most recent purchase was five cargoes for July and August shipment from the Black Sea region.

There seems to be a clear message from the Indonesian consumer. If you want our FSI business, you will need to be competitive with an increasing number of origins who can also offer suitable quality wheat.

In the past, Australia's primary competitors into the Indonesian wheat market were countries who had a similar cost base, such as the United States or Canada. Now, many of the competing origins, such as Russia, the Black Sea region and Argentina, have much lower costs of production.

Add to that, increasing production and exportable surpluses in Russia and the Black Sea region in recent years has tended to make them the weakest seller – and price setter – in an extremely competitive global wheat market.

Historically, the quality available from these origins has not been acceptable to the Indonesian consumer. But as exportable surpluses have increased, so has the quality of the wheat being produced. The Russian and Black Sea producer has recognised the need to improve quality to compete in the global wheat market.

This has made it increasingly difficult for Australia to sell wheat into traditional markets such as Indonesia.

The Indonesian wheat market is big, growing and on Australia's doorstep. In the absence of new markets, it is critical that Australian exporters find a way to reverse the recent trend and at least return Indonesia close to its position as the biggest consumer of Australian wheat.

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

Checking the global wheat balance sheet

■ Based on information supplied by US Wheat Associates market analysts, July 11

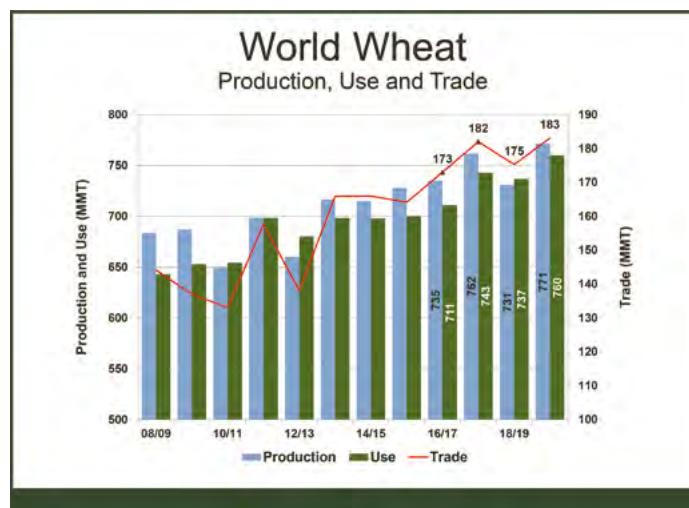
THE mid-June USDA estimate for global wheat production in 2019-20 was for a record 777 million tonnes as several major suppliers (including Australia) rebound from a below average production season. This was the first forecast the USDA had for the coming season. One month on – and although tempered slightly – the USDA forecasts a 10-year high of 771 mt of global wheat production for 2019-20.

Following is a graphical representation of some of the key global grain numbers from the July USDA-WASDE estimates.



In the 2019-20 season, global wheat production is predicted to jump to a 10-year high of 771 mt. This is on the back of a rebound in European Union wheat production to 151 mt, 9 per cent higher than last year.

Black Sea (Russia, Ukraine and Kazakhstan) wheat production is expected to reach 117 mt while US wheat production will increase slightly on last season to an estimated at 52.3 mt.



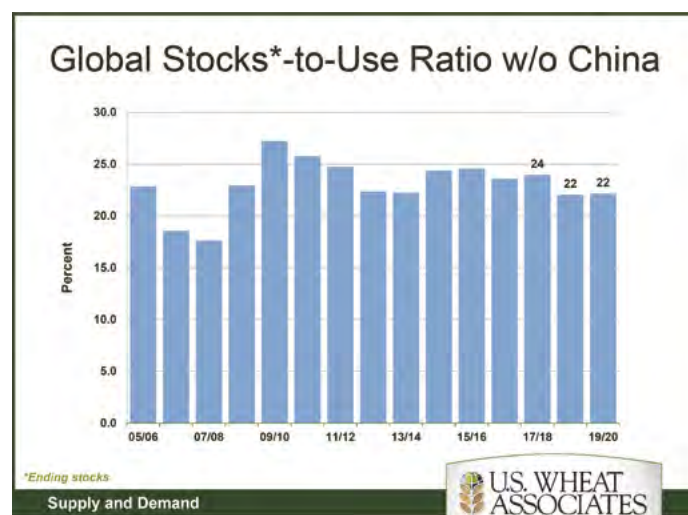
Global wheat consumption (use) is forecast at 760 mt, the highest since 2009. China's domestic consumption is predicted to reach 128 mt (2 per cent more than last year) while EU consumption is expected to reach 128 mt, up 4 per cent. US domestic wheat consumption is forecast at around 32.2 mt – up 4 per cent from the 5-year average.

The USDA predicts world wheat trade to jump 44 per cent year-over-year to 183 mt. This is 4 per cent above the 5-year average of 176 mt.

Australian exports are expected to increase 28 per cent over last year to 12.5 mt in 2019-20, while Russian exports will fall 4 per cent from last year to 34.5 mt. US wheat exports will increase slightly to around 25.9 mt.



Global ending wheat stocks are projected at 286 mt, 4 per cent higher than last year and 11 per cent higher than the 5-year average. But the estimated Chinese ending stocks of 146 mt are up 30 per cent over the 5-year average and account for half of



total global ending stocks of wheat. And in most years, China is not a wheat exporter.

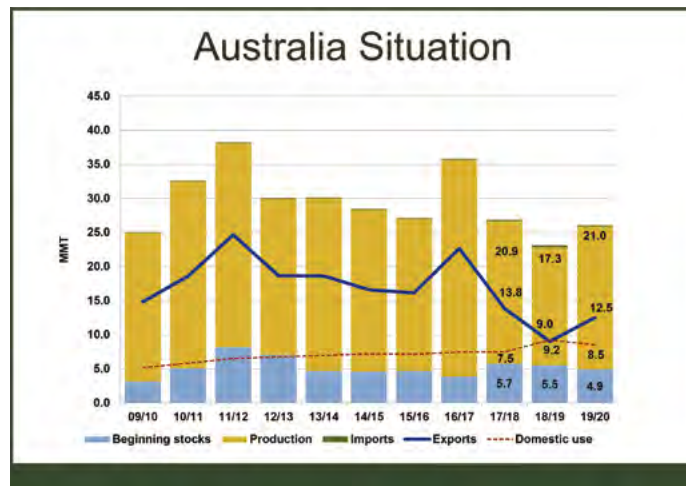
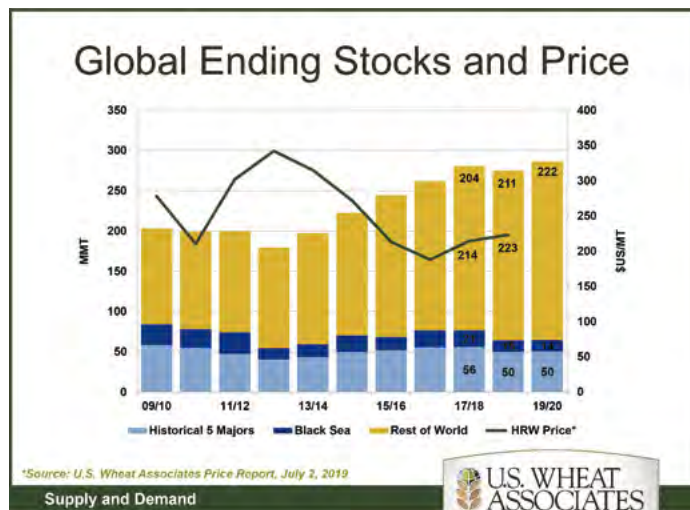
US ending wheat stocks are expected to total 27.2 mt, down 7 per cent from 2018-19 and 2 per cent below the 5-year average of 27.6 mt.

The global stocks-to-use ratio for wheat over the past three years (1917-18, 18-19 and 19-20) has been – on the face of it – at very high levels of 38, 37 and 38 respectively. But if we take China out of the global wheat stocks-to-use calculation, this chart highlights a very different story. The ratio is 24, 22 and 22 respectively for each of these years.

The USDA forecasts that world consumption and trade of wheat this marketing year are both expected to exceed 2018-19

levels. Total global trade is to reach 183 mt, 4 per cent higher than 2018-19 and 4 per cent above the 5-year average.

With total global wheat consumption expected to reach its highest level in 10 years (760 mt), the outlook for wheat price is positive.



The USDA is estimating Australian wheat production at around 21.0 mt in 2019-20 and exports at 12.5 mt (28 per cent higher exports than last year). Australian domestic wheat use is estimated at 8.5 mt for the year.

From an estimated 4.9 mt of wheat in store at the beginning of 2019-20, this will leave Australia with a projected 5.1 mt of ending stocks.

Charts supplied by US Wheat Associates market analysts.

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ALL THE WINTER SPORTS

Summing up the grain storage \$\$

AS coordinator of the GRDC national Grain Storage Project, Chris Warrick is often asked “what’s the cheapest form of on-farm grain storage?” While it sounds like a simple enough question, answering it adequately requires Chris to reply with a few questions of his own about the business’s production, marketing and operational structure.

“It’s important to differentiate between cheap and good value when it comes to grain storage and there’s more to it than a pure dollar figure,” Chris said.

When weighing up grain storage options, some important considerations include:

- What type of grain is being stored?
- How long is the grain going to be stored? Will the storage be short term only as a means of managing harvest logistics? Or will the grain be held for longer requiring the prevention and management of pest incursions through hygiene, aeration cooling and correct fumigation?
- What’s the labour structure of the business? Is there labour stress at harvest time or is there generally adequate labour capacity during the harvest period? and,
- What are the key personality traits of those who will be involved in managing the on-farm storage system? Do they tend to be diligent on routine operational tasks?

“Considering the requirements and nature of the business, and the people involved within it, is key to ensuring that any investment in a grain storage system represents value for money,” Chris said.

“For example, if storage is only going to be required as a short term measure and the business doesn’t experience labour stress at harvest time, bags and bunkers may be a viable option.

“But in instances where there’s no excess labour at harvest and flexibility is required for longer term storage, a better option might be gas-tight, sealable silos with aeration cooling which will allow for grain quality preservation and insect control.

“If growers opt to go down that path, their next decision centres on which silo brand to choose – generally you get what you pay for with grain storage but where the inherent value lies is in designing the whole system well, implementing a best-practice integrated pest management and monitoring program and adhering to hygiene recommendations.”

Is grain storage worth the investment?

On-farm storage capacity has doubled over the past 10 years with growers now able to store 41 per cent of their production capacity on average.

This expansion is likely to continue as growers strive to maximise the quality, marketability and value of their grain.

While storage systems can deliver long-term cost benefits, it’s important to recognise that they require significant infrastructure investment and can add complexity across the supply chain.

Chris said on-farm storage generally required multiple financial benefits to cover costs and urged growers to analyse the costs and expected returns, weigh up all options and make informed decisions. “Like many economic comparisons in farming, the viability of grain storage is different for each grower,” he said.

“Depending on the business’s operating style, the location, the resources and the most limiting factor to increase profit, grain storage may or may not be the next best investment.

“Therefore everyone needs to do a simple cost benefit analysis for their own operation.

“To make a sound financial decision, it’s important to compare the expected returns from grain storage versus expected returns from other farm business investments, such as more land, a chaser bin, a wider boomspray, a second truck or paying off debt.

“The other comparison is to determine whether grain can be stored on-farm cheaper than paying a bulk handler to store it.”

Calculating the costs and benefits

To enable a simple comparison, Chris suggested calculating the benefits and costs on a dollars per tonne basis.

He said the majority of growers would require multiple financial gains in areas such as harvest logistics, timeliness, market premiums, freight savings, cleaning, blending or drying grain to add value, in order to make a return out of on-farm storage.

On the flip-side, grain storage costs can be broken down into fixed and variable. Fixed costs are those that don’t change from year to year and have to be covered over the life of the storage.

Variable costs are all those that vary with the amount of grain stored and the length of time it’s stored for.

“Interestingly, the costs of good hygiene, aeration cooling and monitoring are relatively low compared to the potential impact they can have on maintaining grain quality,” Chris said.

“One of the most significant variable costs – and one that is often overlooked – is the opportunity cost of the stored grain.

“That is, the cost of having grain in storage rather than having the money in the bank paying off an overdraft or term loan.”

Making an informed decision

While acknowledging it’s difficult to place an exact figure on each of the costs and benefits, Chris said a calculated estimate would determine if an option was worth investigating more thoroughly or discounting completely. “Unlike a machinery purchase, on-farm grain storage is a 25 years-plus investment that cannot be easily changed or sold,” Chris said.

“Based on what the grain storage extension team is seeing around Australia, growers who are taking a planned approach to on-farm grain storage and doing it well are being rewarded for it.

“Grain buyers are seeking out growers who have a well-designed storage system that can deliver insect free, quality grain without delay,” Chris said. ■



On average, Australian growers can store more than 40 per cent of potential grain production on-farm.

Keeping Australian wheat number one for Asian noodles

■ By Australian Export Grains Innovation Centre

AS Black Sea wheat increasingly throws its bulk around in Australia's main \$2.5 billion wheat market, AEGIC is taking action to help the Australian industry preserve and increase value for Australian growers.

South East Asia accounts for almost half of all Australian wheat exports – the lion's share of which is used for instant noodles and fresh yellow alkaline noodles.

It is crucial for Australia to understand the wheat quality requirements of South East Asian flour millers, and to continue meeting those needs in the face of mounting pressure from low cost competitors. And when we talk about wheat quality for noodles, we mean 'looking good' (noodle colour and colour stability) and 'feeling good' (noodle texture and mouthfeel).

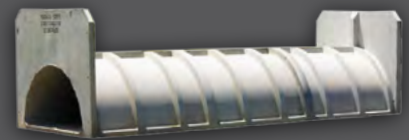
AEGIC Wheat Quality Technical Markets Manager Dr Larisa Cato said previous AEGIC research had already confirmed noodle texture (firmness and elasticity), colour and colour stability were among the major factors that flour millers look for when making wheat purchasing decisions.

This research – a GRDC investment – involved collecting and analysing the wheat quality preferences of more than 250 flour milling staff in 40 flour mills across Indonesia, Vietnam, Thailand, Malaysia, Singapore and the Philippines.



Participants at the 2019 Australian Wheat Quality Technical Seminar in Manila.

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Premium Indonesian instant noodles on display at the Indofood headquarters in Jakarta.

What flour millers look for

"Thanks to this market insight, the Australian industry has a detailed understanding of what flour millers look for when buying wheat," she said.

"We know Australian wheat has the best colour attributes for noodles, better than wheat from any other origin in the world.

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Whilst the noodle textural properties of our wheat are good, there is room for improvement."

In the light of these findings, AEGIC is now focusing on enhancing the noodle textural qualities of Australian wheat.

"Noodle texture is related to mouthfeel – that is, the balance of firmness and elasticity, and is unique to each noodle type and each market. AEGIC's objective is to develop measurable texture targets for each of our wheat classes to support Wheat Quality Australia classification and wheat breeders in new variety development."

Larisa said there was also an opportunity to further improve noodle appearance – noodle colour and colour stability.

"This will help widen the gap between Australian wheat and wheat of other origins and help to maintain the premium status of Australian wheat."

AEGIC is also ramping up in-market technical support and engagement. This year alone, AEGIC has hosted Australian Wheat Technical Seminars in six South East Asian countries: Indonesia, Vietnam, Malaysia, the Philippines, Myanmar and Thailand.

The seminars were presented in collaboration with Wheat Quality Australia, breeding companies InterGrain and EdStar Genetics, the Grains & Legumes Nutritional Council, Chopin Technologies; and Victorian grain producer and GrainGrowers director Julia Hausler.

Larisa said the events were all very well attended, with most major flour milling companies involved.

"This type of technical support and engagement is extremely important in helping customers understand the value of using Australian wheat for noodles and other products, thereby influencing their purchasing decisions," she said.

Back in the lab, AEGIC is benchmarking major APH, AH and APW wheat varieties for their suitability for premium yellow alkaline noodles and instant noodles, and will soon establish a trained sensory evaluation panel to assess noodle quality attributes such as appearance, texture, mouthfeel and taste.

AEGIC's noodle experts are also developing objective ways of measuring noodle texture. ■

WHY AUSTRALIAN WHEAT?

Flour millers across Asia prefer to buy Australian wheat for noodles. The combination of excellent noodle texture and colour attributes is unique to Australian wheat.

White Australian wheat results in high milling yield at low flour ash, meaning more profit for the flour miller. The starch and protein quality of Australian wheat is ideally suited to Asian noodles.

Looking good...

Noodle appearance is very important in Asian markets. Fresh noodles should have a bright, clean appearance with good colour stability. In other words, noodles made today will still look appealing tomorrow. Specks of bran or noodle colour discoloration is a no-no.

Feeling good...

The texture and mouthfeel of noodles is also very important.

While preferences differ between countries, generally speaking, noodles should have a 'clean bite' with good elasticity. Good quality noodles don't go soft too quickly in soup – good textural stability is important.

Noodles should feel good to eat!

Lime and liming – managing soil health

By Lisa Miller – Southern Farming Systems

Results at a glance...

- Liming to maintain good soil pH levels and avoiding yield losses is just as important as applying fertiliser.
- If growers let soil pH levels in the topsoil run-down (pH in CaCl₂ < 5.0) they are at risk of creating soil acidity issues at depth which are harder and more expensive to treat.
- In general, not enough lime has been applied frequently enough to address acidification occurring within the whole soil profile, so soil test to depth and calculate lime requirements for 0–10 cm, 10–20 cm and 20–30 cm, not just the top 10 cm of soil.

Why do the trial?

SFS was fortunate to be involved in a soil acidity project in both crops and pastures which started in 2014 under a GRDC and federal government investment in South West Victoria.

We needed to improve our understanding of soil acidity management with particular regard to lime responses, soil acidity increases in the 10–20 cm layer, lime movement and lime quality.

From this research, better extension messages could be developed for local farmers and graziers.

What we found

Acidity affects plant and soil functions

Soil acidification is unavoidable in productive farming systems, and acidity eventually eats away profits, affecting chemical, biological and physical functions within soils and plants. This makes it difficult to diagnose acidity based on crop symptoms. But soil pH provides a good guide to which functions might be affected and the likely lime response as shown in Table 1.

Do not let soil pH run down

Our cars are serviced regularly so they run reliably and efficiently, and most people do not wait for their cars to break down and then have it fixed. The same applies to maintaining soils.

If topsoil pH is allowed to run down to less than 5.0 – which is common in grazing enterprises – significant production has probably been lost over the past five to eight years and possibly not noticed. More importantly, by letting the soil acidity form in the top 10 cm of soil, the acidity build-up results in leaching downwards of hydrogen ions and this allows soil acidity to increase at depths of 10 cm to 20 cm, where it becomes much more difficult and expensive to treat.

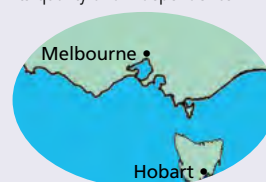
Lime is slowly soluble and often will not work straight away – it takes time to dissolve and move and so some ongoing yield losses will continue. If a subsoil acidity problem exists, lime with no



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Region: Southern Farming Systems (SFS) was formed in 1995 by a group of farmers who came together to find ways of making farming in the higher rainfall zone (HRZ) more profitable. SFS has members in five branches; Geelong, Streatham, Hamilton, Gippsland and Tasmania. While SFS maintains strong partnerships with research and extension agencies and with agribusiness, the information provided to over 600 members, sponsors, supporters and students is highly valued for its quality and independence.



Commercial sponsors:

Class Harvest Centre, Stephens Pasture Seeds, BASF, Malteurop, Premier Ag Consulting Group, Rabobank, Serve Ag, Suncorp and TP Jones & Co. just to name a few of our many valued supporters.

Table 1: Crop symptoms at different soil pH (measured in CaCl₂)

| If the soil pH is: | |
|--------------------|--|
| More than 5.5 | There will be no problems from soil acidity affecting crop growth and yield, and there could be net movement of lime beyond 10 cm depth. |
| Less than 5.2 | The effectiveness and numbers of rhizobia that fix nitrogen (N) on acid sensitive legumes (eg. lucerne and pulses, but not narrow-leaved lupin) are reduced. Liming increases the persistence and effectiveness of these rhizobia, and the amount of N fixed and grain produced of the sensitive legumes. |
| Less than 5.0 | In addition to the effects above, there is a chance of molybdenum deficiency in legumes – check for local advice. Molybdenum is important in the synthesis of amino acids and proteins and a requirement for Rhizobium bacteria to fix atmospheric N. |
| Less than 4.8 | In most soils, aluminium (Al) starts to precipitate from a harmless solid into a soluble form which is toxic to root growth. Aluminium tolerance among plant species varies. Reduced root growth means roots are unable to effectively explore soil for nutrients (particularly phosphorus and trace elements) and access stored subsoil water. Crop yield is reduced significantly. Reduction in root hairs occurs and so infection by rhizobia (nodulation of legumes) is severely affected. |
| Less than 4.5 | The speed of N mineralisation processes (nitrification) slows significantly, resulting in decreased N supply. In most soils Al concentrations increase further and quickly become toxic to most pasture and crop species. There is a chance of molybdenum deficiency in cereals or canola, but check for local advice. The effectiveness of rhizobia in acid tolerant legumes, such as subclover, balansa and arrowleaf clover is reduced. |
| Less than 3.8 | Soil can no longer buffer effectively against pH change and is overcome with acidity which breaks down clay minerals leaving only the sand component. Irreversible soil structural damage is done. |

Source: Table adapted from Fenton, 2003.



Using good quality fine lime at the Rokewood site to ameliorate the acidity at 10 to 20 cm where the pH averaged 4.1.

incorporation will take five years or more to fix the acidity profile beyond 10 cm (depending upon soil type and rainfall), provided enough is applied to move downwards.

Maintaining good soil pH means yield responses to lime may not be immediately noticeable, but they will avoid ongoing acidification and yield declines. A soil pH increase will show that the lime is working and regular soil monitoring is recommended, particularly at 10–20 cm where there may be issues with subsurface acidity build-up.

Soil acidity eats away at yields

SFS replicated research trial data has been used to create lime response curves by calculating the percentage difference in yield of the control (un-limed plots) compared to limed plots for wheat and barley (see Figures 1 and 2). They show the yield reduction at different soil pH levels, especially in barley.

Most of the trial sites had acidity less than pH 4.5 in the topsoil plus acidity issues down to 15 cm or 20 cm. The moderate rates of lime applied and without any significant incorporation did not correct subsurface acidity at the sites and this probably reduced yield beyond what was measured.



NSW Agriculture broadcasting lime onto the soil surface at the Rokewood trial site.

Figure 1: Wheat yield responses to different soil pH levels, 2012–18

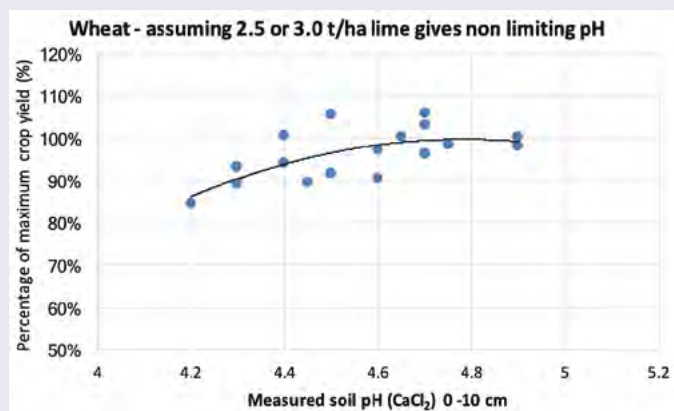


Table 2: Rokewood subsoil acidity trial. Lupin response to liming treatments, 2018

| Treatments | Treatment description | Lupin yield (t/ha) | | Establishment counts (plants/m ²) | | Dry matter cuts at anthesis (kg DM/ha) | |
|---------------------------|---|--------------------|----|---|---|--|---|
| Surface lime Incorporated | Surface liming 1.5t/ha incorporated into 0–10 cm with offset discs to bring pH to 5.5. | 1.24 | b | 8.63 | a | 4084 | b |
| Deep rip only | Surface liming 1 t/ha incorp. + deep rip. Ripped down to 30 cm, tines 50 cm apart. | 1.36 | b | 6.73 | b | 4724 | a |
| Deep lime | Surface liming 1 t/ha incorp. + deep rip + deep lime. Deep lime 1.5 t/ha placed between 8 to 25 cm (acid layer). | 1.44 | ab | 9.07 | a | 4756 | a |
| Lucerne pellet | Surface liming 1 t/ha incorp. and lucerne pellets 7.5 t/ha placed into acid band. (Rate based on providing the same amount of alkalinity). Contains 200 to 300 kg N/ha. | 1.60 | a | 8.3 | a | 4983 | a |
| LSD (P<0.05) | | 0.21 | | 1.43 | | 537 | |
| CV (%) | | 7.46 | | 8.72 | | 5.8 | |

LSD – Least Significant Difference, CV – Coefficient of Variation

The responses are from surface applied South West soft rock lime [Neutralising Value (NV) 90 per cent, Effective Neutralising Value (ENV) 63 per cent] in 2014 with minimal tillage and incorporation.

These lime response curves will become even more robust with the collection of data points from 12 new trials SFS has set up in the high rainfall zone across Tasmania, south west Victoria, Gippsland and South Australia (supported by the National Landcare Program and GRDC).

We expect the responses to flatten out and become steady at pH levels above 5.0 for cereals and 5.5 for pulses.

With the collection of this additional data, lime response curves for canola and faba bean will also be generated.

Lime responses are difficult to predict

The lime responses can be variable as they are influenced by many factors such as:

Subsoil acidity

A trial at Rokewood is investigating subsoil acidity further including incorporating lime and organic amendment (lucerne pellets) to depth (see Table 2). The pH at this site was 5.1 at 0–10 cm, 4.1 at 10–20 cm and 4.7 at 20–30 cm. Relatively acid tolerant lupins were planted in the first year, but nonetheless it was apparent that the subsoil acidity resulted in a 672 kg per hectare reduction in biomass and a 200 kg per hectare yield loss (although yield difference was not significant).

Interestingly, the best response was with deep placement of lucerne pellets, producing an extra 399 kg per hectare biomass and 360 kg per hectare yield. Approximately a 20 per cent significant yield reduction in both wheat and barley was recorded at an acidity trial site near Cootamundra, NSW where the acidity constraint was at 10–30 cm depth.

Season

Acidity and aluminium toxicity reduce root growth which reduces the plant's ability to extract

Figure 2: Barley yield responses to different soil pH levels, 2014–18

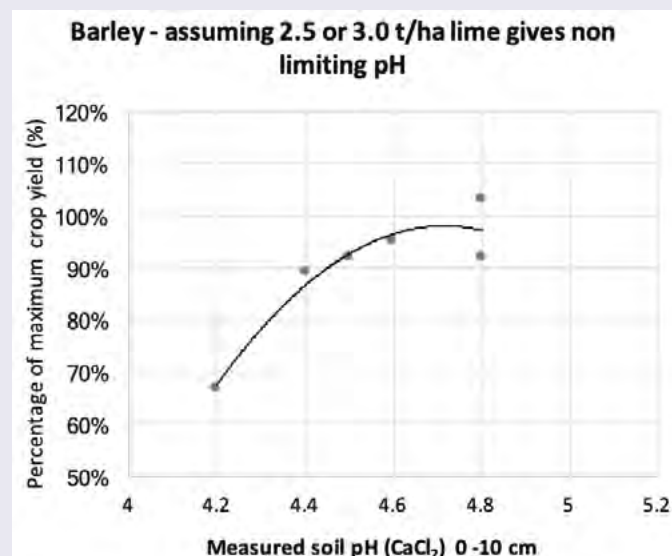


Table 3: Average annual acidification rate measured across Corangamite farming systems at different depths based on pH (CaCl₂) change over four years (2014–18)

| System | Average annual acidification rate of the soil layers (*Application of kg pure lime/ha/year to counteract acidity) | | |
|---|--|--|--|
| | 0–10 cm | 10–20 cm | 20–30 cm |
| Cropping on clay loams | Average pH fall 0.05/year Lime equivalent 180 (Range 85–430) | Average pH fall 0.03/year Lime equivalent 100 | Average pH fall 0.03/year Lime equivalent 100 |
| Grazing on clay loams | Average pH fall 0.04/year Lime equivalent 138 (Range 85–345) | Average pH fall 0.01/year Lime equivalent 45 | Average pH fall 0.02/year Lime equivalent 50 |
| Hay cutting including lucerne on loams | Average pH fall 0.18/year Lime equivalent 350 (Range 300–400) | Average pH fall 0.09/year Lime equivalent 175 | Average pH fall 0.12/year Lime equivalent 230 |

*Assuming 1 tonne of pure lime/ha lifts pH by 0.29 units in a clay loam and 0.5 in a loam.

soil moisture particularly in a dry finish to the season. But if there is ample soil moisture and the crop's nutritional needs are met, there may not be a significant lime response.

Organic carbon

High soil organic carbon (organic C more than 2%) appears to influence lime response by reducing the impact of aluminium solubility and toxicity.

Other soil constraints

If there are other soil constraints to production present, then a lime response may not be seen. This has been apparent in pasture trials in Southern Victoria where nutrient deficiencies over-rode lime responses.

Lime or fertiliser may not have shown significant differences when applied separately, but together they did. This indicates that lime is not a substitute for fertiliser – both are needed.

Other potential constraints may include compaction, waterlogging or sodicity.

Lime reaction

If you are looking for obvious responses in the first season following lime applications, you may be disappointed. Among this project's trials, there were only two with statistically significant lime responses in grain yield in the first year and that was when pH was low (pH 4.2 and 4.5) and acid sensitive crops were grown.

Lime needs acidity moisture and time to dissolve. Incorporated superfine lime has taken up to 18 months to fully dissolve. Surface applied lime without incorporation is likely to drive up soil pH in the top 1 cm to 6.0 or above where lime stops dissolving. Hence, the benefit of incorporation of some kind.

Acidification rates

If you are farming and removing plant and/or animal products from the paddock, then you are acidifying the soil. Soil acidification is caused by a number of processes, for example, as roots take up cations they release hydrogen ions to maintain charge balance.

Also, the cycling of nitrogen is particularly important, with the addition of urea or ammonium

which is converted into nitrate and then leached beyond the rooting zone, leaving behind acidity.

If the agricultural system was closed (that is, products not removed and nitrate not leached), then acidification rates would be zero.

Analysis of trial results and monitoring of 100 un-limed paddocks mainly within the Corangamite catchment, showed that the rate of acidification varies according to the farming system and soil type (Table 3). The measured pH changes varied from 0.05 and 0.18 units per year depending upon the production system.

The decrease in soil pH at 10–20 cm and at 20–30 cm over the four-year period was also found to be highly significant. The equivalent amount of pure lime (100 per cent NV) required to neutralise the annual acidification rate was calculated from the reductions in pH over a four-year period.

Table 4: Acidifying effects of various farm enterprises in the greater than 500 mm per year rainfall zone

| System | kg of lime/ha/year to balance acidification |
|--|---|
| Continuous grain cropping including grain legume | 200 to 300 |
| Grazed pastures | 100 to 200 |
| Lucerne hay | 200 to 700 |

Adapted from Hollier, 1999.

Lime movement occurs if pH is kept above 5.5

Very few of the recent SFS trials saw lime movement beyond 10 cm because there was not enough time for it to move and because rates were not high enough to saturate the surface with alkalinity to allow it to leach. Any change in pH measured may have been through physical lime falling down cracks.

A lime trial run by NSW DPI from 1992 to 2010 (18 years) is one of a number of trials that only found subsoil amelioration when soil pH in the topsoil was kept above 5.5. Micro-fine lime was incorporated into the top 10 cm and soil pH maintained above 5.5 for the trial duration to counteract acidification and leaching.

After four years, lime had moved to 15 cm, but advanced no further for another four years (2004), but in 2010, lime was detected at 25 and 30 cm. Movement was about 1 cm per year.

Variation across the paddock and down the profile

The average paddock pH can be misleading when trying to make decisions about liming. To make informed decisions about liming, it is good to know what you are dealing with. The use of pH mapping or using yield maps to identify low production zones and then taking exploratory cores within them both have merit.

The Rokewood subsoil acidity site provides a good example of how soil acidity changes spatially and vertically down the soil profile. The Rokewood trial is 100 by 140 metres and the variation in soil pH is 2 units in the top 10 cm (Table 5).

Table 5: Average pH (CaCl₂) and Exchangeable Al results for the Rokewood trial site, 2017

| Depth | Average soil pH | Range of soil pH | Average Al % of exchangeable cations |
|----------|-----------------|------------------|--------------------------------------|
| 0–10 cm | 5.11 | 4.1–6.1 | 2.75% |
| 10–20 cm | 4.10 | 3.8–4.4 | 19.33% |
| 20–30 cm | 4.71 | 4.1–5.5 | 3.41% |
| 30–40 cm | 5.76 | 4.8–7.1 | 0.09% |



NSW Agriculture broadcasting lime onto the soil surface at the Rokewood trial site.

Doug Crawford, Ag Victoria, describes four considerations in relation to variable rate liming once the variability in soil pH is known. These are:

- No pH issues and therefore there is no need to lime.
- Marginal soil pH but maintenance liming is needed which can be applied by a blanket rate.
- There are distinct pH zones which make variable rate useful.
- There is too much variability but generally low pH, therefore it makes sense to apply a blanket rate of lime.

Doug describes pH mapping as an insurance policy to make sure lime is applied to where it is needed most and hence, is as cost-effective as possible. Some argue that the money spent on pH mapping (approximately \$65 per hectare) is better spent on additional lime. Having pH maps allows you to identify zones that can be monitored in future, especially if subsoil acidity is likely.

Variation in soil pH across paddocks is caused by management and soil type which makes it hard to predict. Some examples include sheep stock camps, lime spreading inaccuracies, burnt canola swaths, trees and high production grain and hay areas.

Developing a lime program

Once the distribution of soil acidity is spatially and vertically understood, decisions can be made about where to lime, what rates are needed and how to apply the lime. Most growers and advisers only consider the 0–10 cm soil. Lime rates are rarely estimated based on treating acidity at all soil depths – 0–10 cm, 10–20 cm and 20–30 cm – which is why subsoil acidity develops.

Lime rates are determined by knowledge of the pH buffering capacity, which is chiefly influenced by the amount of organic carbon and then clay content. Below is a commonly used method for lime rate estimation which is available through Soil acidity monitoring tools (DPI, 2005) and appears in OptLime and Soil Amelioration calculators from WA. It calculates the amount of lime required to reach a target pH but to maintain it.

The target soil pH for the 0–10 cm is 5.5 to 6.0, if aiming to achieve lime movement or growing acid sensitive pulses, and pH 4.8 deeper in the soil to avoid Al toxicity.

Step 1. Pure lime requirement (t/ha)
= (Target pH – Current pH) ÷ Conversion factor

Divide the desired pH change by a conversion factor for different soil types:

0.26 for clay;
0.37 for clay loam;

Table 7: Costs of soil acidity at the Bellarine trial site where soil pH was 4.2 (0–10 cm), 4.4 (10–20 cm) and 4.9 (20–30 cm) and lime applied at 3 t/ha

| Year | Crop | Average yield of limed plots (t/ha) | Yield reduction compared to lime 3 t/ha | \$Price/t of grain | \$ Calculated cost of acidity |
|------------------------------------|--------|-------------------------------------|---|--------------------|-------------------------------|
| 2014 | Barley | 3.0 | 1.0 | \$278 | \$275 |
| 2015 | Canola | 1.7 | 0.4 | \$531 | \$228 |
| 2016 | Wheat | 7.3 | 1.2 | \$200 | \$230 |
| Total costs of acidity for 3 years | | | | | \$734/ha |

0.47 for sandy clay loam;
0.57 for sandy loam; and,
0.67 for sand.

Step 2. Adjustment for organic matter (OM) – If the soil OM per cent is above 2 per cent, then add an extra 0.4 tonnes per hectare.

Note OM% = organic carbon % x 1.7.

Greater than 2 per cent OM content is likely in most pastures or crop pasture rotations.

Note the calculation is for pure lime which has 100 per cent NV and so lime rates will require adjustment depending on the NV per cent of the lime to be used.

Also, these calculations need repeating for each 10 cm soil layer as shown in the example in Table 6. The 10–20 cm and the 20–30 cm layer will be unlikely to contain OM content below 2 per cent so step 2 can be ignored.

Lime calculation rates for amelioration of acidity are estimates only and so it is important to monitor soil pH change after three or five years so that rates can be adjusted.

Too much lime?

Topdressing large amounts of lime without incorporation may cause micronutrient deficiencies (e.g. copper, zinc, boron and manganese) if these elements are already marginal, especially on poorly buffered sands. High rates of pure lime (NV 100 per cent) are thought to be in excess of 2 tonnes per hectare for a sand, 3 tonnes per hectare for a sandy loam or 4 tonnes per hectare for a loam or clay loam soil.

While these deficiencies can be overcome by the application of appropriate granular fertiliser or foliar sprays, if high rates of lime are required, it is best to split applications over a period of three or four years or incorporate the lime with a tine or disc implement.

Choosing a lime

Choosing a lime should be based on the most cost-effective product. Transport costs can be high so often, the cheapest lime is from the pits located closest to the farm. The price of lime tends to reflect

the level of processing. But you need to know how effective the product is at neutralising acidity.

The typical costs of lime spread are about \$40 to \$50 per tonne depending upon the quality and transport distance.

- Purchase cost \$18 to \$30 per tonne for Victorian Ag lime.
- Cartage rate 10 cents per km.
- Spreading \$8 per tonne.
- Variable rate spreading, extra \$2 per hectare.

Most agricultural limestones are calcium carbonate and can be described as hard rock limes or soft rock limes. Explosives are needed to extract hard rock limes and need to be processed very finely so they react quickly in the soil, which add to the expense. Most of the limes in Victoria are soft rock excavated, crushed and then particles screened to less than 2 mm.

Purity, particle size and solubility

The main factors determining lime quality include purity (i.e. neutralising value NV) particle size distribution and solubility. Pure calcium carbonate (or pure limestone) has an NV of 100 per cent. The higher the NV, the purer the product. Lime products sold in Victoria commonly have an NV of 80 to 90 per cent. Some products can exceed 100 per cent if containing appreciable amounts of magnesium carbonate and/or burnt lime.

The finer a lime product is, the greater the surface area for the neutralising chemical reactions to occur. Therefore, a finer lime will reduce soil acidity more quickly than a coarser lime. The rate of lime dissolution is also affected by its solubility. Lime is regarded as being relatively insoluble, although this varies amongst different types.

NSW DPI compared the pH change of different lime types with the same average particle sizes and found that soft limes created 20 per cent greater pH change compared to a hard calcitic lime over a period of six to 12 months due to differences in solubility. Dolomites contain less soluble magnesium carbonate, and created 15 per cent less pH change compared to hard limes.

Effective Neutralising Value (ENV)

ENV is a calculation that allows for comparison of different liming materials by accounting for both the neutralising value of the lime and particle size. An ENV of a lime product is calculated based on the sum of its percentage of particle sizes (fine <0.3 mm, medium >0.3 mm to 0.85 mm and coarse >0.85 mm) which are discounted according to their potential reactivity. Particle sizes of 5 mm are thought to take about 20 years to dissolve.

Table 6: The calculations of approximate lime rate required at the Rokewood trial

| Depth | Average soil pH | Target | pH changed required | Soil type | Organic C % | Lime requirement (t/ha) |
|--|-----------------|--------|---------------------|------------|-------------|-------------------------|
| 0–10 cm | 5.11 | 5.8 | 0.7 | Sandy loam | 0.8 | 1.2 |
| 10–20 cm | 4.10 | 4.8 | 0.7 | Sandy loam | 0.5 | 1.2 |
| 20–30 cm | 4.71 | 4.8 | 0.1 | Clay | 0.6 | 0.3 |
| Total pure lime requirement for soil pH recovery | | | | | | 2.8 |

A good quality lime from Victoria will have close to 50 per cent of its particle sizes less than 0.3 mm and very little above 0.85 mm and with good screening practices should contain no more than 5 per cent above 1 mm. Having up to date information on particle size distribution is important, even for soft rock limes.

Pelleted limes and liquid limes

There has been interest in the use of pellets containing super fine lime (20 to 40 μm) for ameliorating soil acidity, but the costs of these products are about \$260 per tonne in bulk. Researchers in WA have reported that the lime pellets used in their trials acted like a good quality lime, and that it did not move horizontally in soils as was hoped, only vertically. There is interest in using these products in air seeders to place prilled lime into acidic layers at 10–20 cm at rates of 500 kg per hectare for two or three years and possibly in different orientations to maximise soil coverage.

Liquid lime sources are generally micro-fine calcium carbonate in suspension. In trials conducted by the Woody Yaloak catchment group, recommended rates of liquid limes were shown to be ineffective at creating pH change in comparison to standard rates of agricultural limes.

Profitability of liming

The profitability of liming is generally straightforward because many of the crops are acid sensitive, such as barley and pulses, and liming costs are often recouped within short time frames. Certainly, at one SFS trial, acidity cost was calculated to be \$734 per hectare over the three-year period and liming (approx. \$150 per hectare spread) paid for itself after the first year (see Table 7). This trial provides a good example of how liming can avoid yield losses from acidification.

Timing of lime application

Lime can be applied any time. Lime is normally applied in summer or early autumn to fit the farming schedule. Spring liming of pastures is beneficial to a following cropping rotation as there is time for the lime to start neutralising acidity, particularly if there is summer rainfall.

The factors which affect the time of liming are:

- Paddock trafficability.
- The need to apply lime six weeks prior to sowing to avoid inducing any micronutrient issues.
- Accessing lime, and ability to back-load lime after grain delivery to reduce transport costs.
- Wind erosion risks where the fine component of lime is lost from bare surfaces.

Growers in high rainfall zones often look to spread lime prior to burning stubble. Lime effectiveness is not adversely affected by burning. Agricultural limes are treated at 900°C in kilns to create burnt lime which makes it faster acting for use in the building and horticultural industries. A hot stubble burn might reach 500°C at most. But agronomists raise some concerns with spreading lime before burning stubble. These include:

- Spreading lime over heavy stubble may not give



Soil pit discussions with Lisa Miller at SFS – Agrifocus field day on October 17, 2018.

even coverage compared to spreading on bare paddocks. This may be a visual perception issue as the lime cannot be as easily seen amongst the stubble or could be valid if the spreading height was too low.

- Stubble does not seem to burn as well if lime is spread. This may be a factor if the lime was moist and covered stubble.

Applying lime into paddocks with some stubble cover or prior to burning is likely to reduce losses from wind erosion. Timing application to coincide with rainfall or heavy dews can help wash the lime off any stubble and start to dissolve the lime.

To sum up

Acidification occurs in all farming systems where plant or animal products are removed, and liming will be necessary to neutralise it or else significant losses in yields will occur

Acidification is not just confined to the top 10 cm of soil and the emerging issue of acidity at 10–20 cm indicates that our liming practices (rates, frequencies and lack of incorporation) have been insufficient at addressing it. Therefore attention to the subsurface and subsoil through monitoring, the maintenance of good soil pH and generally incorporation of lime in low rainfall (<500 mm) or heavy clay soils is vital for protecting the soil asset.

This work is set to be expanded in a new GRDC and NLP Smart Farms project across the high rainfall zone in Tasmania, Gippsland and in southern South Australia.

The research undertaken as part of this project (SFS00026) is made possible by the significant contributions of growers through both trial cooperation and the support of the GRDC – SFS would like to thank them for their continued support. Other acknowledgments include the Australian government support through the Corangamite catchment management authority and through a Smart Farms grant. In addition, thank you to NSW DPI and Agriculture Victoria.

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Lime quality and testing PhD opportunity

A PhD opportunity investigating lime quality and developing new tests to reflect performance is now available through SFS.

Soil acidity is recognised as one of the major soil constraints to increased agricultural productivity in Australia. Lime is a key amendment to address the decline in soil pH. This project will explore and develop novel approaches to advance understanding of lime type, quality, variability and spreadability on performance under current farming systems and practices.

Lisa Miller from SFS – the farmer organisation leading the project – says an outcome of the PhD would be to have a way of testing lime quality that we are confident in and is commercially applicable. A reliable methodology will be developed to accurately compare different lime types.

This PhD offers the opportunity to work in the Centre for eResearch and Digital Innovation (CeRDI) at Federation University Australia.

The Victorian Lime Producers Association is a third partner in the project and represents the interests of Victorian limestone producers.

SFS and CeRDI are offering this industry-funded 3-year PhD scholarship in soil science at Federation University Australia's Mt Helen Campus in Ballarat. This is an excellent opportunity to be paid to undertake your PhD in an industry with excellent employment prospects. Further information see www.seek.com.au

This project sits within a broader project: *Building the resilience and profitability of cropping and grazing farmers in the high rainfall zone of Southern Australia*, funded by the Australian Government's National Landcare Program Phase Two.

ASK AN EXPERT – WHAT'S THE LATEST IN OPTICAL SPRAYER TECHNOLOGY?

■ With Jeremy Jones, PA Specialist, Dalby Rural Supplies

CAN you believe that it's almost 20 years since optical sprayer technology came to Australia? In that time, being able to spray 'green weeds on brown paddocks' has been a game-changer for fallow weed management on many grain farms.

What started as a great double-knock tool has since evolved into a multi-purpose weed management tool for driving down the weed bank and regaining control of weeds that are notoriously hard to kill with glyphosate.

Precision agriculture specialist with Dalby Rural Supplies, Jeremy Jones has a long association with optical spray technology. Jeremy sees the adoption of optical sprayer technology across Australia's grain growing regions is testimony to the role the technology can play in an integrated weed control strategy.

"Early on, growers used optical sprayers such as Weedseeker and WEEDit as an efficient way to apply paraquat in the traditional double-knock tactic to control any weeds that were surviving the initial glyphosate application," says Jeremy. "This helped save time and chemical but growers were often left with a changing weed spectrum that was dominated by hard-to-kill species such as feathertop Rhodes grass, sowthistle and fleabane."

"This led growers to look toward more expensive herbicides that have better efficacy on these species and optical sprayers enabled the economic application of these products because product was only applied to such a small portion of the paddock area, typically around three per cent."

The latest use pattern emerging for these sprayers is the option to apply pre-emergent herbicides to known patches of weeds such as feathertop Rhodes grass to reduce germination in the following season.

The whole aim of fallow weed control is to save soil moisture and to reduce the weed seed bank from harvest to planting

ensuring crops are sown into clean paddocks. Optical sprayers have proven their worth as a valuable and cost effective way to achieve both these outcomes.

WeedSmart Week from August 13–15 in Emerald will focus on leading technologies and tactics that make a real difference to effective weed control. Jeremy will be speaking about the opportunities that optical sprayers present and the latest WEEDit sensors will be put through their paces on-board robotic platforms for spraying and on the 'Weed Chipper' at the SwarmFarm Robotics base at Gindie.

To register go to www.weedsmart.org.au/events

How much chemical can I save?

Short answer: The amount of chemical applied is always significantly less. The cost saving may not be as great as more expensive products may be applied.

Longer answer: The greatest savings will not always be in chemical costs. Using optical spray technology usually reduces chemical use by 90 per cent, and consequently, 90 per cent less water. The real savings though are seen in resistance management through the use of more modes of action and maintaining a low seed bank. Frequently a single pass achieves the required level of control, saving hours of time spent in the sprayer. Growers generally find that the payback period for these sprayers is just a few years.

How are growers using optical sprayers to apply pre-emergent herbicides?

Short answer: By mapping the weedy areas and using the sprayer to select these areas for treatment prior to planting.

Longer answer: Soon, the WEEDit will have on-board mapping capability to 'remember' where weeds were sprayed early in the



WEEDit sensors are mounted on the latest SwarmFarm robotic platform, which will feature at the Emerald WeedSmart Week field demonstrations in August.



Jeremy Jones, Precision Ag specialist with Dalby Rural Supplies says the real savings that growers are seeing through the use of optical sprayers are in resistance management through the use of more modes of action and maintaining a low seed bank. (PHOTO: N Lyon)

fallow, enabling the operator to apply residuals to known weedy patches while also applying a knock-down to kill existing plants prior to planting. This capability already exists with SwarmFarm's robotic platforms that currently carry the WEEDit sensors.

Can optical sprayers be used to apply all herbicides?

Short answer: Many products now carry registrations for optical sprayer application.

Longer answer: When the rates used in the optical sprayer are within the application rate range on the label, there is no problem using an optical sprayer or any other. Some labels have an application range specified for optical sprayers.

Some minor use permits are available for use patterns that lie outside the conditions on the product label. For example, APVMA permit number 85049 provides for the control of volunteer and ratoon cotton in fallow using optical spot spray technology using specified tank mixes and application rates. Always read the label to check that the use pattern you plan to follow is legal.

Can optical sprayers help reduce spray drift?

Short answer: Yes, less product is applied to begin with, putting less particles into the air. The new nozzles increase the proportion of coarse droplets, in line with the new 2,4-D guidelines.

Longer answer: Optical sprayers are acknowledged as a useful tool to reduce spray drift. When the optical sprayer is engaged and the coverage area is below the threshold, the required buffer zone is reduced. ■

HOW TO ASK A WEEDSMART QUESTION

Ask your questions about the advances in spray technologies on the WeedSmart Innovations Facebook page WeedSmartAU, Twitter @WeedSmartAU or the WeedSmart website <https://weedsmart.org.au/category/ask-an-expert/>

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

Thermal weed control – just hot air, or site-specific reality?

DID you know that rotary hoeing requires less energy than steaming? Or offset discing requires less energy than microwaving?

Well that's the case when it comes to controlling weeds.

An epic effort to review 170 papers by a team from the University of Sydney (Guy Coleman *et al*) has shown that mechanical weed control options (eg. tillage) can use significantly less energy than thermal options (eg. heat) to kill weeds. Herbicide energy use sits somewhere in the middle.

But what are thermal weed control options?

Basically, they're tools that use heating or freezing to rupture plant cells, which can result in plant death. Lasers, flaming, steam and microwaves are a few examples of thermal weed control, and they've been creating a bit of a stir amongst the ag community lately. Not only do they offer an alternative to herbicides, but just as importantly they offer an alternative to tillage – a word that can send shivers up the spine of many a committed no-till farmer!

There is one slight hurdle for thermal weed control though, in that it has significantly higher energy requirements. Microwave technology to control weeds uses an average 23500 MJ per hectare compared with 192 MJ for herbicides and just 15 MJ for a set of sweeps!

Before we all throw our hands up in the air, the review also found that when thermal weed control options are applied using site-specific technology, eg. similar to that used for 'green on brown' weed control in fallows, energy requirements are reduced by 99 per cent. Thermal options suddenly look much more feasible for broadacre cropping!

Incidentally, site-specific weed control using herbicide and mechanical options also reduces energy requirements by 97 per cent.



Lasered weed. (PHOTO: Guy Coleman)



Guy Coleman with his robot Gordon.

So why compare energy?

Every weed control option – be it mechanical, thermal or herbicide – requires energy for both its production (eg. steel, chemical) and its application (eg. draft force, power take-off, fuel). In the case of site-specific weed control, there are also significant energy requirements for real-time image collection and computer processing.

By calculating the total energy requirements to control a given weed population, the University of Sydney team has been able to compare the energy use between a range of alternative weed control options. This provides an indicative comparison of weed control costs for both broadcast (Figure 1) and site-specific (Figure 2)

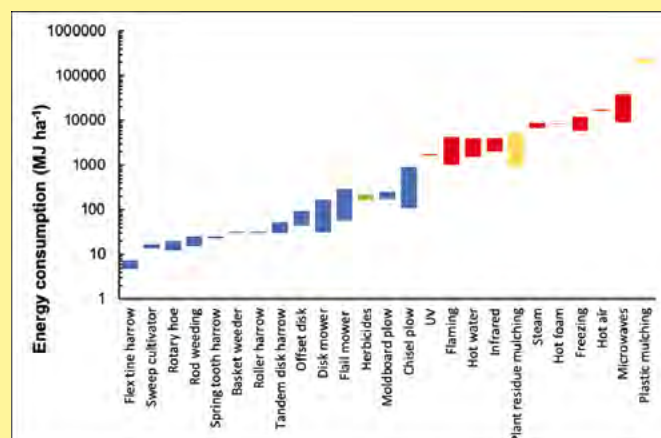
2) applications, including their viability for broadacre cropping systems.

The low energy use of tillage-based weed control means it may still have a role in broadacre cropping as a strategic tool for specific weed species. But thermal weed control options are obviously better suited to no-till farming systems and it now seems they have significant potential in site-specific application. Imagine having an autonomous, optical weed steamer?

The key to this alternative weed control utopia is accurate and consistent weed recognition – something which is currently a limiting factor. But it's a fast-moving space and as processing speeds and detection accuracies increase, it's one that will have a significant impact on broadacre weed management.

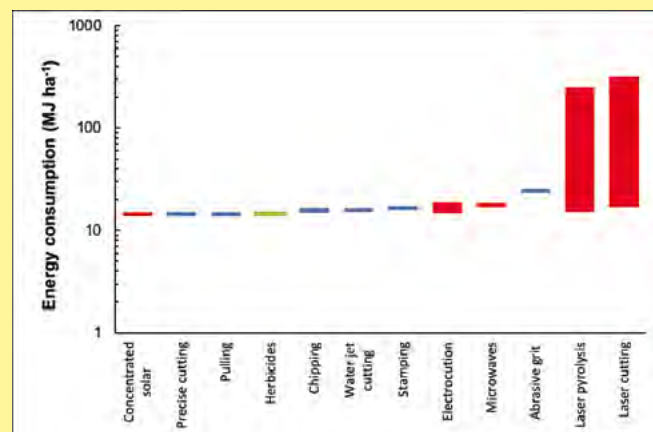
So yes, thermal weed control is definitely much more than just hot air.

FIGURE 1: Total energy estimates required to control two-leaf broadleaf weeds at a density of five plants per m² using broadcast (blanket) application



Mechanical treatments (blue bars) generally had much lower energy requirements than the thermal treatments (red bars). Herbicides (green bar), mulching (yellow bar). Source: G. Coleman.

FIGURE 2: Total energy estimates required to control two-leaf broadleaf weeds at a density of five plants per m² using site-specific application



These values include the 14.4 MJ/ha used for image processing and weed detection. Mechanical treatments (blue bars), thermal treatments (red bars), herbicides (green bar). Source: G. Coleman.

How sensor technology is helping map soil in the paddock

GRAIN growers may one day soon be able to map soil in their paddocks without sending a single sample to the laboratory thanks to the efforts of an innovative young researcher. Edward Jones is a postdoctoral research fellow from the University of Sydney, who is working on new technology with GRDC investment, examining how sensors can be used to scan soil for properties such as clay content, water holding capacity, sodicity and pH.

His work has shown that by using a range of sensors to scan multiple soil samples across a paddock, it is possible to build an accurate digital soil map identifying variation within a paddock.

GRDC Manager Agronomy, Soils and Farming Systems – North, John Rochecouste, said the ability to map soil types in paddocks, without sending samples to the laboratory, would be an invaluable management tool for grain growers and potentially save them significant costs.

“Soil properties do not change rapidly, so once growers have developed a digital map it would become an important tool to guide their decision making and importantly it would not need to be updated annually,” John said.

“Soil properties don’t change significantly for pretty much decades, if not longer, unless there has been major intervention such as incorporating significant amounts of lime or gypsum.

“Things like sodicity and clay content are pretty fixed without intervention. While pH can decrease (acidify) gradually with time, but essentially they are pretty much fixed properties.

“Nutritional element can vary significantly over seasons so that’s why nutritional sampling is treated differently. To 3D characterise a paddock is very expensive in terms of sampling costs, so this work by Edward is looking at significantly reducing this expense.

“Knowing your soil characteristics across a paddock, and the variation within paddocks, is invaluable information and really is the foundation for effective crop planning and management.”

Calculating soil properties

But there is a series of complex steps required to develop sensors which can effectively calculate soil properties.

“To be able to predict properties of a new soil sample you must first build a soil spectral library. Fortunately, the University of Sydney has been stockpiling soil samples from research projects dating back decades,” Edward said.

“So far in the project we have delved deep into this stockpile and scanned more than 8000 samples, primarily from the wheat-sheep belt of eastern Australia.”

The digital soil scientist said when samples were scanned with one of the sensors, they produced a unique response, like a spectral fingerprint. From here he has been able to build models using the samples in the spectral library to estimate the properties of new samples that were scanned.

“The most exciting thing has been the speed at which this technology is developing. One of the sensors I am using is a visible near-infrared spectrometer – the same technology used to estimate grain protein and moisture content at receival depots,” Edward said.

“When I started my PhD in 2014 one sensor was the size of a briefcase and cost around US\$60,000. A sensor that I am currently testing is the size of a deck of cards and costs only US\$3000.”



GRDC Agronomy Soils and Farming Systems – South Stephen Jones with University of Sydney digital soil scientist Edward Jones, who has been working with a range of sensors – including a near-infrared spectrometer – to scan soil samples and develop a map identifying soil variations across a paddock. (PHOTO: GRDC)

He said the next generation sensor was the size of a postage stamp and could be incorporated into a phone case and run using a smart phone. The same sensor could also be used to scan plant leaves to diagnose a range of nutrient deficiencies.

“I am very excited for the day that this technology is widely available to growers and advisers, because getting as much information that you can about your soil is crucial to good crop management,” Edward said.

“Understandably the sensor does have its limitations. Everybody wants to be able to predict plant available nitrogen, but the technology is not advanced enough at this stage.

“Some private companies are saying that they can predict all of a crop’s nutritional requirements from a single scan and this is simply not true.”

Be wary of ‘sensored’ fertiliser claims

Edward advised growers to exercise caution with any organisations claiming fertiliser recommendations could be made using sensor technology.

“At the moment, the sensor technology is not advanced enough to assess fertility management, so for that sort of information growers need to keep sending samples to the laboratory for accurate assessment.”

Edward has been trialling the new sensors and digital soil mapping techniques at the US’s northern NSW L’ara research property at Narrabri. His plan is to showcase these digital technologies destined for broadacre agriculture to growers, farm advisers and industry stakeholders at a field day in early 2020.

In the meantime, growers interested in more information can go <https://bit.ly/2Y7QePp>

Micronutrients needed throughout the growing season

PLANT tissue analysis from recent trials has shown that fertiliser programs relying on micronutrient applications at planting or as early season foliar applications may be falling short later in the growing season.

Yara Australia Agronomy and Crop Solutions Manager, David McRae, says manganese, copper and zinc are essential for plant growth and function.

"The availability of these micronutrients throughout the whole season is important to maximise yield potential.

"Even though the plant's requirements for these micronutrients is small, efficient plant growth and function cannot occur without adequate levels.

"Up to 70 per cent of these essential micronutrients are taken up by cereals after the end of tillering (growth stage GS30).

"Shortages of micronutrients later in the growing season can limit grain yield by reducing grain numbers and weight, protein levels and the plant's ability to tolerate stress."

Plant tissue analysis is an important tool to monitor the nutritional status of crops throughout the growing season.



David McRae.

Targeting plant tissue analysis

"One or two targeted samples taken after the end of tillering can quickly identify how the crop is progressing and what additional nutrients are required," Dave says.

"Our colleagues in New Zealand implemented this approach in the crop nutrition program implemented in Eric Watson's world record wheat crop of 16.71 tonnes per hectare achieved two years ago.

"They used YaraVita Gramitrel as the foundation of the micronutrient program, with YaraVita Zintrac and YaraVita Mantrac as required."

YaraVita Gramitrel contains a guaranteed minimum analysis of N 6.4 per cent, Mg 15 per cent, Mn 15 per cent, Zn 8 per cent and Cu 5 per cent.

"Gramitrel helps to 'unlock' the yield potential of cereal crops by providing a balanced combination of essential micronutrients, thereby maximising your return on investment in all crop inputs," Dave says.

It is applied to cereal crops at one to three litres per hectare from the two-leaf stage to second node detectable (Zadoks GS12–32) and/or one litre per hectare from second node detectable to flag leaf fully emerged (Zadoks GS 32–39).

Micronutrients and water stress

Ongoing trials being conducted by Yara are investigating the important role micronutrients play mitigating transient moisture stress later in the growing season.

"YaraVita Gramitrel was applied at flag leaf stage GS37 and subject to permanent or transient water stress," Dave says.

"Gramitrel increased the plant's tolerance to abiotic stresses and yields when compared to no foliar application in the transient water stress treatments.

"The delayed senescence was attributed to the lower release of oxygen radicals or enhanced detoxification, therefore minimising cell damage and supporting leaf health."

Gramitrel is compatible with many crop protection products for easy, one-pass application.

"But always check the compatibility of all the tank-mix partners before mixing by visiting the Yara website or downloading the Yara Tankmix app," Dave says. ■



Wheat with nitrogen deficiency (left) versus plants with optimum N levels throughout the season.



Trials are investigating the role of micronutrients in mitigating water stress.

Chemical quality should be your priority

■ Supplied by 4Farmers

If you're not into risk taking with farm chemicals – chemical quality has to come first. If there is one subject coming under increasingly heavy scrutiny today, it is farm chemicals for three key reasons:

- The efficacy of the product in doing what the farmer wants it to do;
- The safety of the farmer in applying the chemical; and,
- The safety of consumers in the food chain.

It's for these reasons that farmers must give consideration to what they're applying and not just be governed by what appears to be the cheapest.

Senior chemist, Dr Roger Franklin, head of production at the 4Farmers operation in Welshpool, said that just on the subject of product efficacy – if the boom spray is blocking up or later in the season you find the product hasn't lived up to expectations, the fantastic bargain you thought you had wasn't a bargain after-all.

He says it's a tricky road that farmers are on when buying farm chemicals.

"On the one hand price has to be a consideration and on the other hand the product has to be reliable and safe to use," he said.

According to Roger in the past this had been a quandary for farmers with many believing that the only way to access a reliable product was to stick to products from the major multi-national companies and known tradenames.

He added that this was not true anymore.

"While these companies have set the standard in quality in the past, I can tell you after working for 30 years in the industry that there are some reliable generic brands that can give as good a performance, and in fact sometimes better."

Roger said that 4Farmers, an organisation established by local farmers because they were fed up with price gouging by the multi nationals at the time, has benchmarked its products against leading brands to make sure they perform to the same standard.

He added: "In quite a few cases we have actually exceeded the performance standards of the products we have been emulating.

"But there is more to it than just that, as aside from performance in the paddock, the health [and] safety of the people applying the chemicals and its effects on the environment have to be considered when reviewing formulations.

"I believe that farmers are taking a risk with some of the very cheap imported products that don't go through Australian laboratories before being released," he said.

"For health and environmental reasons some raw materials are being phased out. We are working out new formulations to eliminate these undesirable materials.

"The size of research budgets maybe bigger at the multi-nationals, but a company like 4Farmers is still doing its part in research and innovation.

"People need to understand that the active is just one part of the chemical formulations. What the other ingredients are and how they're put together makes a big difference to chemical performance and the applicator's safety."

4Farmers General Manager, Neil Mortimore said 4Farmers has manufactured most of its range of farm chemicals in WA for the past 10 years.

"It means we meet Australian health and safety standards and, by having the technical skills of chemists in our team, we're able to compare our products with those of the multi-nationals to ensure our products haven't sacrificed quality for the sake of being competitively priced.

"Farmers can be assured when dealing with 4Farmers that the products have been laboratory tested by a bright team of chemists and then field tested by competent agronomists before they're presented to them.

"We're a local company, owned by farmers and I can promise farmers that our products have been put together with integrity and care," Neil said.



There has been one topic coming under scrutiny recently and that is the quality of farm chemicals.

Pacific seeds donation a blessing for drought-stricken farmers

THE donation of hundreds of bags of forage sorghum by Pacific Seed, and its distribution by a group of Rotary clubs, has helped drought-stricken farmers across New South Wales get through what was an especially tough season.

Boggabri Rotary president Malcolm Donaldson said the donation was enough to plant over 400 hectares in both local area and similar farms further south and was a welcome relief for farmers.

"The end result was that some crops fortunately grew to their full potential, which was quite spectacular, whilst others, including our own crops, got to about 1.25 metres high before drying off – this provided some valuable feed for longer than we expected," Malcolm said.

The large donation was distributed over a wide area of the north of NSW in the Boggabri, Gunnedah, Narrabri, and Coonabarabran districts late last year and has allowed farmers to generate carry-over feed and hay, providing resource support amidst Australia's dry summer.

Went to those who missed drought assistance

Pacific Seeds Managing Director Barry Croker said it was important that the company's donation was allocated to those who had missed out on receiving drought assistance.

"As an industry leader it felt like a duty of care to help our farmers during a time when the situation was beyond their control," Barry said.

"We were more than happy to provide hybrid forage seed as a practical donation, and it was fantastic to see that these donations have resulted in a positive outcome for many of the farmers.

"Of course, it is only one single step in the right direction, so we will continue to make sure that we are doing everything we can to support Australian agriculture during these tough times," Barry said.



There's no doubting the drought is not over yet.

In early June some farmers in the area have received up to 50-millimetres of rain which boosted soil moisture and encouraged the planting of winter crops.

"It's been well over a month since this last substantial rain event and so plenty of planting has been happening, but there is no doubt that this drought is not over yet, and it continues to have a profound impact on the region," said Malcolm.

"The effects of the extended drought meant that most of these plantings have been done on sub optimal soil moisture and so will be heavily reliant on follow up rain.

"For a lot of farmers, it's worn them out physically, financially and emotionally, but it's practical donations like this that really make a difference and let us know that true support is available in times of need."

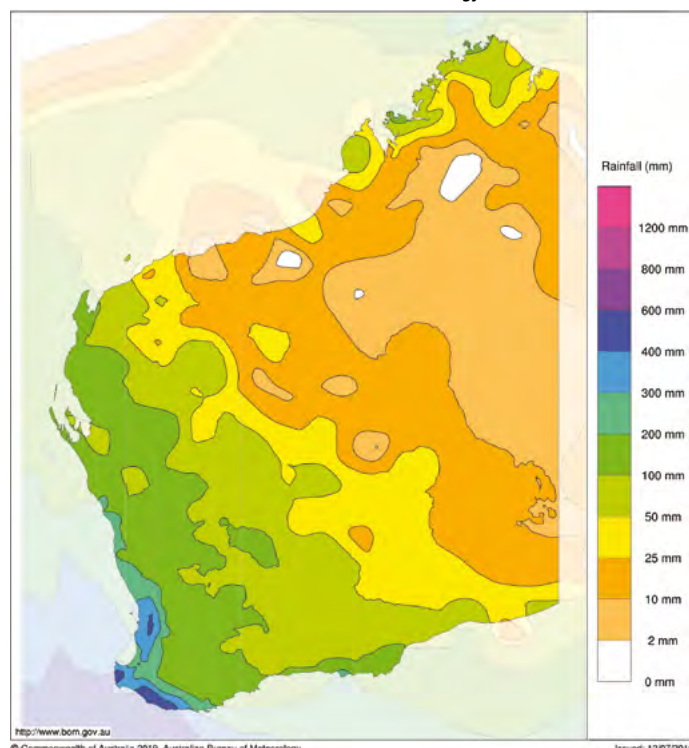


The donated bags of forage sorghum have been distributed by Rotary clubs.

Western region

Western Australia rainfall totals (mm) April 1 to July 11, 2019

Australian Bureau of Meteorology



After an extremely dry start, the season break finally arrived in WA in early June. Timely rainfall since then has set-up a promising yield potential in most districts.

WESTERN AUSTRALIA SUMMARY

The majority of the Western Australian grainbelt is now in good shape and most areas could achieve average grain yields if the rain keeps up. For the northern half of the state it will need to be a soft finish to hit average grain yields as the crops are very late for this time of the year. The southern areas have generally less subsoil moisture and are behind their ideal growth stage, although the chances of a soft finish are greater moving closer to the southern regions, and most growers are looking forward to at least average grain yields.

Crops were very slow to emerge and most cereals that germinated on the opening rains in June are only just starting to tiller. The emergence of cereals has been excellent in most cases and weed control from the pre-emergent herbicides very good for all crops.

Canola crops have really struggled in the central and northern areas and have only just started to pile on true leaves in the last week of June. Crops in regions where there were light rainfall

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events in May, and subsequent crops which sprouted and sat in the ground until the main break in June, came up patchy and are more staggered in growth stage than later sown crops.

This is more evident as you move south to the south coastal regions where some canola is only just emerging and some cereals are flowering with anywhere from early tillering to first node.

Due to the pattern of rainfall events to date, the south eastern areas of the state radiating out from Ravensthorpe are again light on for rain and whilst the crops are up, it is the only area of the state that has not achieved average or above average rainfall since the break of the season in June.

The turnaround in predicted 2019 planted areas from earlier estimates has been greater than expected.

Paddocks that were held back due to little or no rain up until the end of May due to the uncertainty of the season and weed control risk, mostly ended up being planted. The majority of the later sown paddocks have gone to wheat and whilst some of the heavier country was left out to pasture, most growers opted to go ahead with their planned seeding programs.

The drop off in canola area this year looks to be as predicted and the increase in barley looks to have eventuated as well.

Kwinana North Midlands

The North Midlands region of the state received good general rains in early June. The cereal crops on the medium and heavier soils emerged very well and have at least average grain yield potential. Lighter soils were wind-blown prior to the rain and have suffered with furrow fill and some herbicide damage from the soil movement. Crops on the lighter country are patchier as a result and currently have lower than average yield potential.

Canola has below grain yield potential due to being late and suffering slow uneven emergence.

Kwinana West

Whilst crops are late, most growers are faced with at least average cereal yields and the recent rain has improved chances of this significantly. The majority of the region has received another 25 to 30 mm in early July adding to sub-soil reserves. All crops were very slow to get away and even those sown dry in early May, that germinated and sat there until the June break, were initially very slow to get going.

Most crops are more than two weeks behind last year in growth stage, although in this region, crops can make up ground in the spring due to a greater chance of finishing rains than further east.

GIWA Western Australia crop area estimates July 2019 (hectares)

| Port zone | Wheat | Barley | Canola | Oat | Lupins | Pulses | State total |
|------------------|------------------|------------------|----------------|----------------|----------------|---------------|------------------|
| Kwinana | 2,600,000 | 770,000 | 400,000 | 170,000 | 120,000 | 6,000 | 4,066,000 |
| Albany | 520,000 | 680,000 | 210,000 | 160,000 | 40,000 | 8,000 | 1,618,000 |
| Esperance | 500,000 | 380,000 | 165,000 | 10,000 | 10,000 | 35,000 | 1,100,000 |
| Geraldton | 960,000 | 120,000 | 220,000 | 10,000 | 180,000 | 4,000 | 1,494,000 |
| Totals | 4,580,000 | 1,950,000 | 995,000 | 350,000 | 350,000 | 53,000 | 8,278,000 |
| % change to June | 7.0% | 2.1% | — | — | — | — | 4.3% |

GIWA gratefully acknowledges the support of DPIRD, CBH, CSIRO and contributions from independent agricultural consultants and agronomists in the production of this report.

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Kwinana North-East

Cereals in the eastern areas of the Kwinana zone are on track for average grain yields. Most of the region had small reserves of sub-soil moisture when the break arrived and now with average or above average rain in June, the potential is there if the rain keeps falling.

The area of fallow is back on earlier predictions with planted area now up to originally planned hectares. Once growers got going on the remaining paddocks not sown dry following the rain in early June, most elected to complete their planned seeding programs.

Albany West

The region is in very good shape with many growers fertilising for above average grain yields.

Some of the earlier sown cereals have finished tillering and are starting to lift. The emergence of crops was very good with even plant stands across paddocks and good plant density.

There is no waterlogging in the susceptible areas just yet which can be a 'dampener' on yield in the zone. The more growth crops can put on now, the better they are able to handle waterlogging and grow away from it in the spring.

A lot of early nitrogen has been applied since the break and this has assisted with crop growth in the cold growing conditions.

Leaf disease is just starting to get going in barley with most crops being sprayed.

The barley area is up slightly from last year at the expense of wheat while the canola and oat areas are similar to 2018.

Albany South

The west and southern areas of region are in very good shape with crops well advanced with most average to above average yield potential. Rainfall has been lighter in the northern and eastern areas of the region and crop potential really tapers off east of the Pallinup River.

Crops to the north in the southern Lakes District and Western Esperance zone have missed out on the good opening rains that the rest of the state received. Crops in these areas have emerged well considering the conditions, although they will need more rain than what came their way in early July to reach average grain yields.

Crops in the western and coastal parts of the region are well advanced with cereal tiller numbers indicating in excess of six tonnes per hectare yield for barley. Canola crops are starting to flower and most have bulked up well prior to flowering indicating good yield potential.

Albany East (lakes region)

The rainfall in the region has followed a similar pattern as 2018 with a gradient of decreasing rainfall from north to south.

The region has very little stored moisture from rainfall events in April and May and whilst the recent rain in early July will go a little way in filling the profile, the region is going to need a good season from now to reach average grain yields.

Crops are later than growers would like for this time of the year and most cereals are just at the three leaf stage now. Crops

were very slow to get out of the ground. Crop emergence was a little patchy and staggered with weed control from the pre-emergent herbicides not quite as brilliant as further north in WA.

Cereal crops sown prior to the opening rains in June are cleaner than those sown just after the rain as grass weeds got the jump on emerging crops without a knockdown spray.

Barley area is up in the region replacing both canola area and wheat. The pasture area is slightly up as growers opted to keep more country out of crop in this region for stockfeed. As previously reported, the barley area this year will exceed wheat for the first time in history.

GIWA gratefully acknowledges the support of DPIRD, CBH, independent consultants and agronomists in the production of this report.

GIWA Crop Report – July 5, 2019

NORTHERN DISTRICT

The cloud band and cold front that I mentioned in my previous report did show up on June 7 and did deliver significant rain across the region. All areas had a good opening rain at this time and the season is well underway. Rain fell for a few days in most



A well established wheat crop on the Eradu sand.



Jurien lupin crop that emerged with a May rain, north west Mullewa.

areas in the June 7 to 12 period and totals were from around 75 mm in the west to around 40 mm in the east.

We have had a few follow up rain events and in the past four weeks the region has had highs of 250 mm of rain in some western areas down to around 110 mm in eastern areas. It has been a fantastic start to the season but is too wet in the west with around 100 mm being lost in runoff in some areas. Nutrient



Roundup Ready canola crop, south west Mullewa.

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leaching is also a problem in western sand soil areas. What a difference a month (and 10 inches of rain!!!) can make.

Most programs went in as planned. A small number of growers changed their plans and opted out of some canola area and changed it into cereal crops.

There have been some crop emergence problems where heavy rain caused furrow fill. This problem mostly occurred on sandier soil types. This has caused pre emergent herbicides to move into the furrows with the washed soil and reduced crop stand density. There were also problems getting through the root material from big 2018 canola and cereal crops in many areas. These problems were due to root strands wrapping around seeding tines and pushing much more soil than necessary. This resulted in very deep sowing in some soft soils and greatly reduced crop emergence.

Not much crop has been resown but many sand soil paddocks have lower than ideal plant numbers. Canola fared the worst followed by wheat crops.

Nutrient spreading and spraying are the main jobs at the moment. Lucerne Flea have also been very active in many heavy soil areas.

Seasonal rainfall across the grain regions – 25 year averages and year to date

| <div>Brought to you in association with</div> <div></div> <div>JOHN DEERE</div> | | | Summer | | Autumn | | Winter | | Spring | |
|--|-----------------------------------|-------------------------------------|-----------------------------------|---------|-----------------------------------|------|-----------------------------------|-----------------|-----------------------------------|------|
| | 25yr Annual Average (mm) | 2019 rainfall to date (mm) | 25yr Annual Average (mm) | 2018–19 | 25yr Annual Average (mm) | 2019 | 25yr Annual Average (mm) | 2019 to date | 25yr Annual Average (mm) | 2018 |
| Emerald Qld | 564 | 258 | 251 | 52 | 106 | 182 | 67 | 43 | 125 | 113 |
| Toowoomba Qld | 679 | 276 | 276 | 73 | 138 | 232 | 86 | 19 | 180 | 184 |
| Roma Qld | 579 | 150 | 256 | 36 | 119 | 133 | 75 | 16 | 134 | 106 |
| Goondiwindi Qld | 619 | 142 | 253 | 66 | 123 | 110 | 98 | 19 | 147 | 174 |
| Narrabri NSW | 621 | 139 | 217 | 69 | 119 | 111 | 123 | 14 | 162 | 149 |
| Gunnedah NSW | 627 | 189 | 211 | 65 | 108 | 144 | 126 | 24 | 183 | 207 |
| Dubbo NSW | 588 | 170 | 184 | 117 | 125 | 70 | 129 | 17 | 152 | 166 |
| West Wyalong NSW | 437 | 177 | 118 | 84 | 79 | 85 | 120 | 28 | 122 | 86 |
| Wagga Wagga NSW | 531 | 181 | 134 | 110 | 109 | 161 | 147 | 44 | 141 | 149 |
| Swan Hill Vic | 308 | 117 | 69 | 57 | 64 | 58 | 87 | 44 | 88 | 41 |
| Bendigo Vic | 490 | 188 | 100 | 60 | 105 | 78 | 158 | 92 | 128 | 61 |
| Horsham Vic | 365 | 163 | 76 | 41 | 71 | 66 | 120 | 85 | 99 | 47 |
| Lake Bolac Vic | 506 | 282 | 108 | 72 | 103 | 171 | 153 | 90 | 142 | 73 |
| Murray Bridge SA | 358 | 117 | 66 | 30 | 80 | 53 | 120 | 58 | 94 | 47 |
| Kadina SA | 327 | 120 | 60 | 9 | 76 | 70 | 110 | 47 | 82 | 58 |
| Cummins SA | 390 | 211 | 51 | 6 | 89 | 115 | 174 | 95 | 76 | 48 |
| Esperance WA | 618 | 196 | 90 | 37 | 136 | 95 | 251 | 98 | 140 | 146 |
| Wagin WA | 391 | 179 | 50 | 7 | 90 | 51 | 165 | 128 | 85 | 61 |
| Northam WA | 407 | 169 | 61 | 32 | 87 | 30 | 189 | 137 | 80 | 55 |
| Mingenew WA | 347 | 207 | 33 | 0 | 86 | 4 | 171 | 193 | 57 | 40 |
| Moora WA | 385 | 159 | 46 | 6 | 82 | 20 | 189 | 137 | 68 | 65 |
| Mullewa WA | 320 | 145 | 56 | 12 | 90 | 37 | 131 | 107 | 43 | 24 |

Last rainfall reading July 16, 2019.

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Wheat and barley crops are mostly early tillering. There has been some programs that were completed after the rain and the odd paddock is at the 2-leaf stage. There are small areas of crop that are at booting and even head emergence where there were some storms in early May and crop got away at this time.

Canola crops are mostly four to five leaf with the odd crop close to flowering where the May storms fell. Weed and insect control are the main activities on canola at the moment.

Lupin crops have generally emerged well and are mostly at the six to eight leaf stage.

Generally crops look very good but grain fill will be a challenge with the mid June crop emergence timing. September conditions will need to be wet and cool for the region to get average crops from here. Anyway, so far, so good.

Peter Norris

**Agronomy For Profit and Synergy Consulting, Geraldton
July 10, 2019**

SOUTH COAST

Seasonal conditions for the South Coast have improved over the past two months. Some moderate rainfall totals of 20 to 30 mm during late June and early July has put the season back on track.

The South Coast region is still the driest area of the Western



This crop of Jurien lupins has established well at 'Lennoch Park', the Gibson district farm of siblings James and Susie Lewis. (PHOTO: Quenten Knight)



**Chasing rainbows on the South Coast highway at Coomalbidgup, about 60 km west of Esperance – some more rain would be nice to find at the end of them.
(PHOTO: Quenten Knight)**

Australian grain growing belt. The northwestern weather fronts are failing to deliver significant rainfall. The region needs a good southerly front to deliver soaking rain and build up stored soil moisture for a spring-time reserve.

Most crops were sown on time and are developing well with no major insect or disease pressures. Standard grass and broadleaf weed control are the main on-farm activities.

Top-up nitrogen decisions are the most difficult to make at the moment – crops look good but there is very little stored soil moisture.

Quenten Knight

**Agronomist, Agronomy Focus, Esperance
July 11, 2019**

Southern region

SOUTH AUSTRALIA SUMMARY

Average June rainfall and sufficient soil moisture in most South Australian cropping regions, has allowed for generally good winter crop establishment. Additional rainfall in early July has kicked the crops along.

Indian Ocean temperature forecasts indicate that a positive Indian Ocean Dipole (IOD) is expected to be the dominant driver of climatic conditions in Australia for the remainder of winter and spring. A positive IOD at this time of year typically brings drier conditions to much of southern and central Australia.

While this probabilistic forecast indicates that the chance of exceeding median rainfall is quite low across large parts of southern Australia, it does not mean that these areas will not receive rainfall sufficient to sustain crop and pasture production during the next three months.

**ABARES, Weekly Australian Climate, Water and
Agricultural Update, July 11**

VICTORIAN MALLEE

The first round of top-dressing is all-but complete in the region and in some situations – mainly early sown barley – ‘the gate has closed’ on urea spreading altogether. Crops in the southern Mallee area are looking very impressive as follow up rains and showers continue. This is also increasing growers’ optimism with robust rates of nitrogen being applied to match yield potential. Getting your hands on enough urea supply has been the challenge.

A week or two ago, areas in the northern Mallee were in need of a good moisture top up. And right on cue, many areas received some good rain which increased confidence levels.

Growers continue to feed livestock in these northern areas and the Mildura region still needs good rain. Those without subsoil moisture are anxiously looking for the next rain event.

Most cereals have reached the end of tillering growth stage and stem elongation has commenced in canola.

Moist conditions and thick crop canopies are prompting growers to develop their fungicide strategies. Low levels of spot form of net blotch have been detected, particularly in barley on barley paddocks.

Low levels of redlegged earth mite, bryobia mite and blue oat mites have also been detected.

Weed control has been excellent considering many crops were dry sown.

All eyes will be on the Indian Ocean Dipole as we get closer to the crucial September and October months when crops are flowering and reaching maximum biomass.

Louisa Ferrier
Engagement and Member Services Leader,
Birchip Cropping Group
July 11, 2019



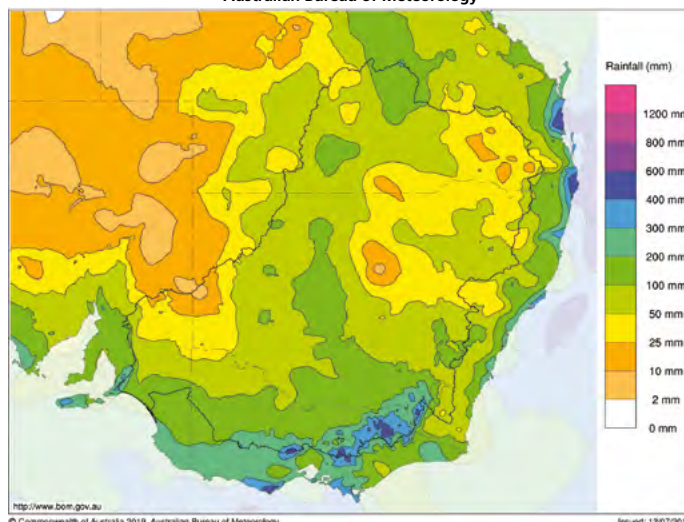
Right on cue, many areas in the Mallee received good rainfall in early July which kicked canola and cereal crops along very nicely.

District Reports...

July–August 2019

Murray–Darling Basin rainfall totals (mm) for April 1 to July 12, 2019

Australian Bureau of Meteorology



The southern states are generally away to an encouraging start to the 2019–20 winter crop while central-west and northern NSW and southern Queensland are still dry.

Northern region

NSW SUMMARY

Drought conditions continued across the majority of New South Wales (NSW) during June and into early July, with signs that the event is intensifying in the northern half of NSW. Low rainfall totals over the past six weeks have been insufficient to provide the widespread follow up falls needed to continue the momentum from the easing of conditions experienced in some regions during May.

Producers and rural communities are expected to continue drought mitigation strategies for the remainder of winter and into spring.

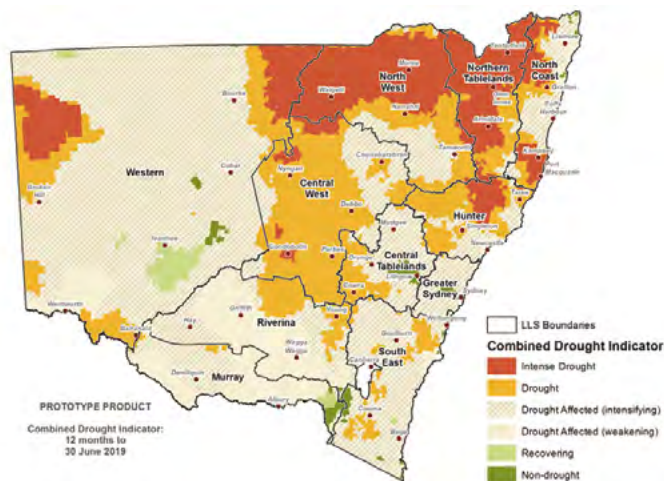
The June rainfall pattern was variable, with only isolated areas of the state receiving average monthly totals. Parts of southern NSW benefited from larger totals, which have aided the establishment and prospects of recently sown winter crops. While this is welcome, winter crop yields in southern NSW remain critically dependant on follow up rainfall over the next few months.

The remainder of the state's wheatbelt experienced the continuation of dry conditions throughout June. Winter crop sowing conditions have been tough, especially in the north and west of the cropping region, where the sowing period is almost closed. The onset of cold conditions and frost is also limiting agronomic productivity in many areas, particularly at high elevations, where feed growth is now typically slow.

The NSW DPI Combined Drought Indicator (NSW CDI – see chart next page) provides a general regional assessment of the complex pattern of field conditions across NSW. Overall the CDI at the end of June shows little change from May in terms of the

District Reports...

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total area of the state affected by drought conditions. There has been an increase in the area categorised as Drought Affected (Intensifying), reflecting the lack of follow up or breaking rainfall that is required to provide longer term relief to agronomic and hydrological conditions. Overall the CDI shows that 97.6 per cent of NSW remains in one of the three drought categories.

The official climate forecast released by the Bureau of Meteorology (BoM) on June 27 continues to indicate a higher chance of drier than average conditions across NSW for winter and into spring. The emerging influence of the Indian Ocean Dipole (IOD) reported last month remains the dominant feature of the forecast, with the IOD still predicted to move into a positive phase over coming months. A positive IOD is generally correlated with dry conditions for central and southern Australia.

The BoM also provided an updated ENSO outlook on June 25, where the El Niño status was downgraded to 'Inactive' – a small amount of positive news despite the IOD situation likely being the dominant influence for rainfall moving into spring.

NSW DPI
July 2019

DARLING DOWNS

Weather conditions

Things have not improved on the Downs with only 5 mm of rain in May and about 20 mm over three falls in June. Consequently, there has been no improvement in soil moisture conditions. Temperatures have been mild during the day with some frosts in short bursts.

ANSWER TO IAN'S MYSTERY TRACTOR QUIZ

The tractor is a 1932 40 hp single cylinder two stroke semi diesel Landini.

Winter crop

The central and western areas of the Downs have a small amount of winter crop that is growing fairly well. The cereals are elongating as they move to the reproductive phase whilst the chickpeas are still in the early growth stages.

On the Eastern Downs the main paddocks planted are those with some irrigation, and these crops are growing well. The lack of June rain meant there was no further winter crop planting and there are very few dryland paddocks sown, with a number turned over to grazing.

There has been an increase in the use of Weedit technology as fallow weed emergence is patchy and growers look to economically keep on top of the few weeds growing.

Many growers have taken advantage of the dry time to fertilise earlier than usual with nitrogen in the hope of a summer crop planting opportunity in a few months time.

Summer crop outlook

There is the prospect of another large summer crop planting with so much area not able to be planted to winter crops. This will create issues with seed availability, as last summer was a difficult season for all growers, including seed producers.

We are potentially looking at a very wide sowing window, with sorghum the main crop being planned.

Irrigation water supplies are down significantly from last summer, and with limited subsoil moisture to date, growers may be changing tactics and crop choice to cope with this.

The current outlook for rain is not showing any significant falls on the horizon.

Hugh Reardon-Smith
Agronomist – Landmark, Pittsworth
July 11, 2019



This photo shows a typical eastern Darling Downs cropping paddock this winter – stubble!

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