AUSTRALIAN GRAIN
www.ausgrain.com.au
September–October 2017

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Published by Berekua Pty. Ltd.,
40 Creek Street, Brisbane
Registered by Australia Post Publication No. PP100002295. ISSN 1449–2970.

Published bi–monthly.
Grain Yearbook published in April

FRONT COVER

In what is shaping up as a very good season in the Victorian Mallee, flowering pea crops have added a splash of spring colour to the landscape. This issue covers a range of pulse topics with articles on marketing prospects through to seed inoculation trials.

PHOTO: Birchip Cropping Group

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

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Editorial... Lloyd O'Connell

IT doesn't matter if it's walking nonchalantly across an impossibly busy road teeming with assorted modes of transport travelling in equally assorted directions – or developing a fledgling economy – around 90 million Vietnamese people tend to get there. With patience, appropriately applied innovation, not to mention liberal doses of perseverance and tenacity, the job gets done. That is the conclusion our *Greenmount Travel/Australian Grain* farm study tour group has made after 10 days of travel through this intriguing and 'can do' country.

Along with Indonesia and China, Vietnam is in the top three of Australia's biggest export wheat customers. In 2017, Vietnam's total wheat import demand is tipped to surge by more than 60 per cent to around five million tonnes. WA-based farmer cooperative, CBH Limited, is one grain company ensuring they get a big slice of this increased demand.

Milling and malt joint ventures across Asia

Established in 2005, the Interflour Group is owned in a 50:50 joint venture by CBH and the Singapore-based Salim Group. Interflour now operates flour mills, malt plants and port facilities across Southeast Asia and Turkey and is a company well positioned to meet the projected growth rates in flour and malt demand in key Southeast Asian markets. Around 60 per cent of the wheat milled by Interflour each year is sourced from Australia.

More affluent Asian consumers are demanding higher quality food with a known and trusted provenance. Vietnamese consumers are also part of this dietary change sweeping Asia while Vietnamese exporters of intensively fed pork, fish and prawns are cashing-in on increased regional demand for their products.

Beer sales and production in Vietnam – read barley imports – are also booming. It is the fastest growing beer market in Asia, with beer sales in Vietnam accounting for around 95 per cent of all alcoholic beverages consumed in the country. And Interflour owns and operates the largest malt plant in Southeast Asia. Based near Ho Chi Minh City, Intermalt opened earlier this year and is gearing up for rapid malt sales growth (read again, barley imports) in the coming years.

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In this issue...

Cracking the code of megapests

For the first time, CSIRO researchers have mapped the complete genome of two closely related megapests potentially saving the international agricultural community billions of dollars a year.

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Getting to the nuts and bolts of machinery investment

Investment in technology-enhanced machinery has provided significant productivity gains for grain growers over the past 10 years. But determining the appropriate level of machinery investment for an individual farm business can be a challenge.

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Trade-in your horse team on a NEW TRACTOR?

Our rural journalist, Mr Ian M. Johnston, urges farmer's with vision to step up to the Twentieth Century, by at least considering the purchase of one of these modern-day mechanical marvels, now referred to as 'tractors'. We have entrusted Mr Johnston with the responsibility of undertaking the hazardous trip to the U.S.A. – by ocean steam boat – for the purpose of studying the dramatic interest in replacing their horse teams with tractors.

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Legume inoculant comparison

On-seed application of peat slurry versus in-furrow has provided the best nodulation, grain yield and nitrogen fixation in experiments comparing different methods of inoculating legumes.

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Unravelling what genomics can do

It took nearly 10,000 years of breeding to take maize from a tropical crop with thumb-sized ears to the high-yielding crops of today. But thanks to genomics, in just the next decade, new corn varieties will likely have higher levels of vital nutrients, handle drought and temperature extremes better, and produce yields more efficiently.

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Cracking the code of megapests

FOR the first time, CSIRO researchers have mapped the complete genome of two closely related megapests potentially saving the international agricultural community billions of dollars a year.

Led by CSIRO, in collaboration with a team of renowned experts, the researchers identified more than 17,000 protein coding genes in the genomes of the *Helicoverpa armigera* and *Helicoverpa zea* (commonly known as the cotton bollworm and corn earworm, respectively).

They also documented how these genetics have changed overtime.

This level of detail makes it easier for scientists to predict both the caterpillars weak spots, how they will mutate and even breed plants they will not want to eat.

***Helicoverpa armigera* is the single most important pest of agriculture in the world.**

The bollworm and earworm are the world's greatest caterpillar pests of broadacre crops, causing in excess of US$5 billion in control costs and damage each year across Asia, Europe, Africa, America and Australia.

The bollworm, which is dominant in Australia, attacks more crops and develops much more resistance to pesticides than its earworm counterpart.

Humanity's greatest competitor

"It is the single most important pest of agriculture in the world, making it humanity's greatest competitor for food and fibre," CSIRO Scientist Dr John Oakeshott said.

"Its genomic arsenal has allowed it to outgun all our known insecticides through the development of resistance, reflecting its name – armigera which means armed and warlike."

In Brazil the bollworm has been spreading rapidly and there have been cases of it hybridising with the earworm, posing a real threat that the new and improved 'superbug' could spread into the US.

In the mid-90s CSIRO assisted Australian cotton breeders to incorporate Bt insect resistance genes in their varieties to try and tackle the bollworm.

'Bt cotton' plants dispatch an insecticide from a bacteria – *Bacillus thuringiensis* (Bt) – that is toxic to the caterpillar.

In the following 10 years, there was an 80 per cent reduction in the use of chemical pesticides previously required to control bollworms.

But the bollworm soon fought back with a small percentage of them building resistance to BT cotton and scientists introducing further strains of insecticides to manage the problem.

CSIRO Health and Biosecurity Honorary Fellow Dr Karl Gordon said while a combination of BT and some insecticides was working well in Australia, it can be costly and it was important to comprehensive studying the pest themselves to manage the problem world-wide.

Huge step forward

"We need the full range of agricultural science," Karl said.

"Our recent analyses of the complete genome, its adaptations and spread over the years are a huge step forward in combating these megapests."

Identifying pest origins will enable resistance profiling that

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reflects countries of origin to be included when developing a resistance management strategy, while identifying incursion pathways will improve biosecurity protocols and risk analysis at biosecurity hotspots including national ports.

As part of the research, CSIRO and the team updated a previously developed potential distribution model to highlight the global invasion threat, with emphasis on the risks to the US.

The findings further provide the first solid foundation for comparative evolutionary and functional genomic studies on related and other lepidopteran pests, many of considerable impact and scientific interest.

The genome project was undertaken by the CSIRO in conjunction with the University of Melbourne, the Baylor College of Medicine in Texas, the French National Institute for Agricultural Research (INRA), the Max Plank Institute of Chemical Ecology in Germany and the US Department of Agriculture – Agricultural Research Service (USDA-ARS). ■

CONFUSING INSECTS SO THEY CAN'T MATE, AND DIRECTING EVOLUTION FOR GREENER FUELS

Chemical engineer Professor Frances Arnold (Caltech) is using nature's own designer, evolution, to improve and invent new enzymes.

Professor Frances Arnold.

These enzymes are allowing us to catalyse new reactions not yet known in the natural world, to make fuels and chemicals from plant sugars and develop non-toxic methods to control agricultural pests.

Frances is considered a pioneer of this process, known as 'directed evolution'.

She holds more than 50 US patents and has co-founded two companies (Gevo and Provivi) to commercialise her research.

Provivi market a pheromone-based alternative to insecticides, which confuses insects so they can't mate – reducing pest populations and minimising crop damage.

Gevo has developed bio-based alternatives to petroleum-based products. Their product isobutanol can be used as a solvent, or with gasoline to can help refiners meet their renewable fuel and clean air obligations. It can also be further processed into jet fuel, or precursors to synthetic rubber, plastics, and polyesters.

"Biology is a great way to re-engineer the chemicals industry to be based on renewable resources, and use clean, efficient biological processes to make the things we need in our daily lives," says Frances.

"I'm trying to bring new chemistry to life, synthetic chemistry that humans invented but can be better done by biology.

"This will impact agriculture, materials, medicines, consumer products, everything."

More at http://www.scienceinpublic.com.au

Be prepared for potential mouse problem in spring

GRAIN growers should be prepared for a potential issue with mice in spring this year. The latest reports from the Grains Research and Development Corporation's (GRDC) regular mouse monitoring program investment indicate that mouse populations remain at moderate levels – for this time of year – in grain-growing regions of Victoria and South Australia.

While mouse numbers were expected to decline over the remainder of winter, particularly if conditions are cold and wet, there is concern amongst scientists monitoring the situation that the sizeable background population and potential stored food reserves will enable a rapid increase in numbers when breeding recommences in spring.

To prepare for such a potential scenario, growers are being advised by the GRDC-supported National Mouse Management Working Group to continue actively monitoring mouse activity and look for signs of mouse damage, such as chewed tillers and nodes.

If mouse populations are high (more than 200 mice per hectare, when they cause economic damage), growers should consider baiting before crops flower, as flowering crops are highly vulnerable to damage from mice.

If mouse populations are low (10–20 mice per hectare) to moderate (50–100 mice per hectare), growers should remain vigilant until the start of spring. Trapping in June near Mallala in SA revealed densities of 30–50 mice per hectare, and at Walpeup in Victoria densities were 30–60 mice per hectare.

Growers are encouraged to communicate with their local bait supplier to be informed of supply timeframes and to determine

CSIRO researcher Steve Henry checks a trap on a property near Mallala on the Adelaide Plains.

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whether pre-purchasing of bait is required. Crops cannot be treated with bait within 14 days of commencement of harvesting.

CSIRO researcher Steve Henry, who has just completed another round of surveying mouse activity for the GRDC investment, says vigilance is critical as crops cannot compensate for heavy damage should it occur.

"If numbers build up significantly over spring, crops could be at serious risk of damage and the problem could continue after harvest and ahead of sowing next year's crops," Steve says. "Even if growers don't think they have a mouse problem, they should continue to monitor for activity."

What level of activity is a problem?

He recommends growers look for evidence of active burrows: "I suggest farmers walk about 30 metres in from the edge of the paddock and set a 100 metre (one metre wide) transect through a crop, following the furrows.

"They should walk slowly along the transect scanning for evidence of mouse burrows, taking note of any burrow that looks active and recording the number of burrows per 100 metre transect, and then repeat across two or four transects.

"If there are more than two to three active burrows per 100 metres, then they have a mouse problem."

Steve says corn flour can be used to mark potentially active burrows, but the transect will need to be inspected the next day for observation of signs of activity.

Baiting guidelines

In terms of zinc phosphide baiting, Steve recommends the following:

- Apply bait according to the label.
- Allow at least four to six weeks before re-application of baits to minimise the chance of bait aversion. This allows mice that have previously tried the bait to try it again and also targets new animals in the population that are susceptible to the bait.
- Bait over large areas. Encourage neighbours to bait at the same time if they also have a mouse problem. The larger the area treated, the lower the chance of re-invasion post treatment.

Steve's recent survey took in areas such as the northern Mallee and Wimmera in Victoria, and the Mallee, Adelaide Plains and Yorke Peninsula in SA. He says paddocks supporting heavy stubble loads, particularly barley, as a result of last year's bumper harvest were most notably affected by mice as they offered ideal habitat.

"Some farmers have been hammered by mice this year, while others have experienced little or no issues. It has been a highly variable situation, and that has even applied from one paddock to the next on some properties."

Steve encourages growers and advisers to report and map mouse presence, absence and level of activity using MouseAlert (www.mousealert.org.au) so others can see the scale and extent of localised mouse activity. MouseAlert also provides access to fact sheets about mouse control and forecasts of the likelihood for future high levels of mouse activity in each grain-growing region.

Meanwhile, the GRDC is proactively investing in research and development so that growers will have new management tools and strategies for mouse management in the future.

The current GRDC mouse monitoring investment is a collaborative project involving CSIRO Agriculture and Food, and the Centre for Invasive Species Solutions.

For information about monitoring mouse activity, contact Steve Henry from CSIRO on 0428 633844 or email steve.henry@csiro.au. Observations can also be directed to Steve via Twitter, @MouseAlert. Information about mouse control is available via the MouseAlert website, www.mousealert.org.au, or the new GRDC GrowNotes Better Mouse Management Tips and Tactics fact sheet, https://grdc.com.au/tt-better-mouse-management. ■

KEEPING PESTS AT BAY THE HI-TECH WAY

With pest animals estimated to cost the Australian economy up to $1 billion a year, CSIRO scientists have developed a humane new technology that could help save Australian farmers' crops and livelihoods.

After successfully scaring away elephants from farms and crops in Africa, scientists are trialling the Vertebrate Pest Detect-and-Deter (VPDaD) technology in Australia against pests such as ducks, cockatoos, rabbits, wild dogs and more, starting in south east Queensland's Lockyer Valley.

"Ultimately we want to scale-up the technology and roll it out across Australia," CSIRO scientist Dr Ash Tews said.

"The idea here is that we can adapt as necessary."

How it works

The technology works by detecting and identifying animals as they come close to farms or crops, and emitting a tailored series of sounds and lights to humanely scare them away before they cause damage.

In Australia, vertebrate pest animals can cause many thousands of dollars' damage in a single dining experience, causing real problems for farmers' orchards, vegetable and cereal crops, and potentially for livestock during critical periods of development or birthing events.

In addition to the feasibility study underway in the Lockyer Valley, CSIRO is looking to partner with local agribusinesses to continue testing and trialling the technology in Australia, aiming to help primary industries facing problems with an array of animals including ducks, cockatoos, rabbits, feral pigs, wallabies, foxes and dingoes.

Works with elephants

The previous trial was conducted in Gabon, Africa, where elephants can present a significant problem for villagers and agricultural communities, capable of destroying a community's entire season's worth of crops overnight.

In collaboration with agribusiness company Olam International, the VPDaD technology was successfully used to prevent elephants from destroying fruit crops.

"One of the interesting issues with existing deterrent technologies is that, not only do animals become de-sensitised to them, but smarter ones can even learn to use the deterrents as an indication of a food source, which is the opposite of their purpose," Ash said.

"Our autonomous technology allows the system to recognise animal behaviours in response to deterrents and modify the deterrent strategy until the desired effect is achieved. This allows the system to be more effective over long periods of time such as the key threat times during crop growing."

The VPDaD technology consists of two systems: a motion sensor device, and a collection of cameras that can pick up images and heat signatures of an animal, with lights and sounds which function as the deterrent for pests.

CSIRO technology specifically developed for the camera program allows the computer to recognise and classify animals based on the images captured. In addition to looking at how animals respond to perceived threats, the scientists are also looking at longer-term aspects, such as analysing deterrent effectiveness and animal movements over seasons.

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Growers weigh up risk of 'driverless' tractors

DRIVERLESS tractors may be the ultimate grain grower fantasy and a new research investment by the Grains Research and Development Corporation (GRDC) shows they are already a global reality.

The research project (USQ00022) led by the University of Southern Queensland (USQ) has investigated international developments in autonomous tractors and found technology that forms the basis on driverless machinery is well advanced.

USQ National Centre for Engineering in Agriculture (NCEA) director Professor Craig Baillie said while it may be some time before growers were controlling their machinery from outside the paddock, autonomous tractor base technology like GPS auto steer, machine optimisation and sensors for process monitoring were already in use on-farm.

Speaking at recent GRDC Grains Research Updates across Queensland and northern New South Wales, Craig said despite many technologies still requiring more testing before they were 'paddock ready,' there were already automated tractors operating under commercial farming conditions.

More precise crop management

"The development of autonomous and intelligent technology is of considerable interest to growers and the agricultural industry, because it provides a mechanism to improve the precision of crop management," Craig said.

"In other words the right machinery can ensure the right management strategy is implemented in the right place, at the right time, which will allow growers to lever and enhance developments in cropping systems and agronomy."

He said Australia had already proved an effective testing ground for major tractor companies to refine technology ahead of commercialisation.

"This has allowed Australia to become 'relatively advanced' in comparison to North America and Europe in the practical application of precision agriculture technologies," Craig said.

"There is definitely an opportunity for more early releases of autonomous tractors in Australia if we engage with leading tractor manufacturers to incubate technology before it is released worldwide."

He said all six major international tractor manufacturers (John Deere, CNH, AGCO, CLAAS, SAME Deutz-Fahr and Kubota) had developed key technologies that provided a 'pathway to autonomy'.

Professor Craig Baillie said while growers say they want to go the 'full monty' in terms of driverless tractors many were not utilising the on-farm technology available in their farm machines now. (PHOTO: USQ)

Features already available

These features had been designed to improve on human operations and were already commercially available to Australian growers. They include:

- Hands free tractor/implement guidance;
- Variable rate control;
- Machine optimisation via varying transmissions;
- Auto-turn and auto-control functions;
- Sensing and perception; and,
- Telematics and infield communications for remote control of tractor operations.

Craig said the next step was to assess grower interest and ultimately uptake of technology.

Technology uptake

In a survey conducted as part of the presentation at the GRDC update at Jondaryan on Queensland's Darling Downs, 65 per cent of growers in the audience would use an autonomous tractor on their farm.

When asked the minimal level of autonomous tractor system they would adopt 47 per cent of growers said they would be comfortable with no driver at all, while 39 per cent admitted they would prefer a person in the cab.

As for adopting new technology 95 per cent of growers said they already utilised machine guidance technology. But when it came to auto end turns and machine implement control, 71 per cent said they did not use the technology.

"These figures reflect the responses we have had from wider research into grower interest and potential use of automated technology," Craig said.

"There are still issues around risks for growers, even when it comes to those technology features that are already available.

"People say they want to go the 'full monty' in terms of driverless tractors, but they are not using the technology they have now. So as with any new technology there will be early adopters and that will be what drives development in this area." ■

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Getting to the nuts and bolts of machinery investment

By ORM and the Grains Research & Development Corporation

AT A GLANCE

(Based on Southern Region surveys)

- Investment in better machinery can offset the need for additional labour.
- On average, farming businesses have a 1:1 machinery income efficiency ratio.
- Machinery costs, including the use of contractors, are, on average, one third of farm income and are higher than fertiliser and chemical costs combined.
- Machinery replacement can be delayed until there are sufficient surplus funds in good years. But the trend towards financing machinery over three to five years results in machinery capital being a fixed overhead cost in all years, and averages 11 per cent of farm income.

INVESTMENT in technology-enhanced machinery has provided significant productivity gains for grain growers. But determining the appropriate level of machinery investment for an individual farm business can be a challenge.

Improvements in machinery capacity and technology have been responsible for substantial gains in farm productivity and efficiency in recent years. The increased capacity of farm machinery has allowed many growers to meet the challenge of increased scale without the need for increased labour. But higher machinery investment and costs have the potential to erode farm profits.

The level of investment in machinery is driven by factors such as changes to farming practices, farm scale expansion, labour skills and availability, family and lifestyle needs, the importance placed on machinery relative to other aspects of the business, and the competing investment and personal demands for capital.

To understand the impact of machinery cost on business profitability, all machinery related costs need to be captured. This includes tractors and vehicles. Machinery costs often work out to be a similar percentage of farm income regardless of whether machinery is owned or contractors are used. (PHOTO: Brad Collis)

The role of machinery

Machinery is an essential tool of the trade for grain production. It can be accessed through direct ownership, outsourced through contractors, hired machinery, syndication or by sharing with neighbours.

The contribution of machinery to a farm business can be measured through:

- Timeliness of operations;
- Labour efficiency; and,
- Lifestyle and operator comfort.

The value of machinery in specific operations can be measured as:

- Seeding and crop establishment accuracy and timeliness;
- Efficiency and timeliness of chemical application;
- Maximising grain quality through timely harvest; and,
- Soil health through stubble retention and no-till practices.

Increased machinery capacity can improve operational timeliness and if crops are planted, sprayed and harvested on time, productivity gains and reduced losses can be realised. For example, a four to seven per cent yield loss occurs in wheat for each week of delay after the optimum sowing time (NSW DPI Primefact 913, *Guide to machinery costs and contract rates*).

Rules of thumb can provide some guidance on the level of machinery capacity and productivity required, as outlined in Table 1.

How much capital should I commit?

As a measure of affordability, investment in owning machinery can be compared with farm income, as seen in Table 2.

'Machinery income efficiency' is an indicator that reflects the ratio of machinery assets to farm income. It is a whole-of-business benchmark that provides a guide to the typical amount a farm business can invest in owning machinery.

TABLE 1: Some rules of thumb about machinery capital investment in the Southern Region

Machinery should be capable of sowing the crop in	21 sowing days
Machinery should be capable of harvesting the crop in	21 harvest days
Harvester capacity per annum	250 rotor hours
The seeding tractor should have	6 to 8 horsepower per sowing tyne

Source: ORM Pty Ltd

TABLE 2: Machinery income efficiency benchmark indicator for a sample of Victorian Wimmera Mallee cropping businesses, 2009–12

Indicator	Average	Range
Machinery income efficiency	1.0	0.7-1.2

Source: Ag Profit

A business's machinery income efficiency should fall between 0.7 and 1.2.

$$\text{Machinery income efficiency} = \frac{\text{total machinery assets}}{\text{farm income}}$$

Note that total machinery assets are determined by current market or clearing sale value for all machinery and vehicles owned. Farm income should be based on a four year average, assuming a steady state of business.

The most profitable farms tend to run, on average, a machinery income efficiency around 0.7. Those with the highest total debt levels tend to be around 1.1. If a farm business outsources some operations to contractors, then they should expect to be at the lower end of the range (see Table 2).

This indicator is useful when assessing the capital value of owned machinery. In addition to the capital costs, all farms have operating expenses relating to a combination of owned and hired machinery, contractors and labour. To analyse the full picture in relation to machinery affordability, businesses should understand more about all the costs associated with machinery and the factors influencing these cost structures.

Understanding the cost of machinery

To understand the impact of machinery cost on business profitability, all machinery related costs need to be captured. This includes tractors, vehicles, implements and so on.

Capital costs

Machinery capital costs are referred to as fixed – or ownership – costs. They are the annual costs incurred regardless of whether machinery is used or not. Capital costs include:

- The change in capital value of the machinery over time;
- Opportunity cost of capital invested in machinery; and,
- Insurance, registration and shedding.

When machinery is financed, the capital cost is reflected in the principal component of machinery finance repayments.

Tip: Finance repayment costs can be structured so that principal repayments are similar to the average change in value of the machine.

The real cost of owning machinery is calculated as:

$$\text{Annual change in capital value} = \frac{\text{cost at start (\$)} - \text{end value (\$)}}{\text{years owned}}$$

Note that the end value is equivalent to market value, which is often different to the trade-in value.

The opportunity cost of capital reflects the return that could be achieved by alternative investment of that capital. As a general guide, the opportunity cost is associated with the cash or bank deposit rate.

Operating costs

Machinery operating costs, also known as variable costs, differ depending on the amount of use. Operating costs include:

- Repairs;
- Fuel and oil; and,
- Tyres and batteries.

TABLE 3: Machinery and labour costs for a sample of family farm businesses in the Victorian Wimmera Mallee

Indicator	% of farm income (4 year average)	
	Average	Range
Machinery costs	**26**	**23–29**
Fuel and oil	7	+/- 2
Machinery repairs	6	+/- 2
Machinery capital (annualised)	11	+/- 3
Other	2	+/-1
Labour costs	**15**	**10–20**
Family labour adjustment	12	+/- 3
Employed labour	3	+/- 1
Contracting, freight and other costs	**6**	**2–10**
Total machinery and labour costs	**47**	**36–58**

Note: Machinery costs include fuel and oil, machinery and vehicle repairs, machinery hire costs and machinery capital costs. Employed labour costs include wages, superannuation, training and other employment costs. Family labour adjustment includes allowance for family labour equivalent and superannuation. Contracting, freight and other costs include hired contracting, cartage and freight, harvesting, sowing and fertiliser spreading. Source: Ag Profit

Labour costs

It is important to put a value on all labour that is used to maintain and operate the business, including employed and family labour. Generally, 15 per cent of farm income is required to cover labour costs, see Table 3.

Tip: The labour required to operate machinery includes travel time as well as time spent carrying out the activity, such as sowing or spraying. It also includes downtime where labour is retained and deployed on-farm to be available for peak work periods.

Contracting costs

If a farm business outsources machinery work to contractors, then machinery capital and operating costs should be lower to offset higher contracting costs.

Tip: Contracting and freight costs need to be included in the overall machinery and labour costs as they are a cost undertaken to perform the task instead of incurring capital, operating and labour costs.

Benchmarking machinery and labour costs

Machinery and labour costs can be expressed as a percentage of farm income, which enables benchmarking and comparison between farm businesses. Table 3 shows a recent analysis of these costs, indicating that the combined cost of machinery labour and contracting is, on average, 47 per cent of the four year average income.

Machinery and labour costs tend to be around half of average annual income.

The ranges in Table 3 indicate the variation from average. Businesses on the higher side of the range for one indicator typically offset that by being on the lower end of the range for another indicator. Some examples of the variation within businesses are:

- A business with higher labour costs has an average level of machinery investment but lower capital costs. They have adequate machinery, but machinery is kept longer. Fuel and repair costs are also typical, which indicates the business does not spend extra to maintain or run their older machinery.
- A business with high use of contractors offsets this with reduced labour, fuel and repair costs. This results in their total machinery and labour cost being similar to the overall average.
- A larger scale business, measured by farm income, has a less than average level of capital invested in machinery, lower

REASONS FOR VARIATIONS IN MACHINERY INVESTMENT AND COSTS

The following questions may prompt you to think about reasons why your machinery investment and costs might vary from the benchmarks.

Income

- Is your past four year average farm income similar to your expected or budgeted income going forward?
- Will farm scale or enterprise mix change or remain similar to current levels?

Costs

Have operating costs, such as fuel and repairs, been unusually low or high?

- Have there recently been one-off or abnormal repair or fuel bills, or are they likely to stay at current levels?
- Have contracting costs been low or high?
- Have freight costs been low or high?
- Are higher machinery costs offset by lower labour costs or vice versa?

Capital

- Is farm profit sufficient to cover machinery replacement, including technology upgrades?

Farming system

- Does your business have sufficient machinery to farm at your current business scale?
- Are you missing productivity and income opportunities because machinery is limiting?
- Are all operations timely and with no impact on production or quality?
- Do you have the machinery to achieve the farming system you prefer?

Stage in the business cycle

- Are you a new, growing or stable business?
- Would future changes in business lifecycle influence your need for machinery?
- What is surplus or a priority – labour or machinery?

Adapted from: Business health indicators for professional farmers, Farm Management 500.

capital and labour costs. This indicates they are achieving cost savings through efficient production and/or economies of scale.

- A business with higher debt also has a higher machinery value, as well as a higher labour cost. As a result of these higher costs, it has lower profits.
- In contrast, the highest profit businesses (top 20 per cent) are typically on the lower end of the range for machinery income efficiency, labour and contracting costs.

Variation between businesses

While it is important to have a set of guidelines and benchmarks for machinery investment and costs, variation might occur due to differences in business circumstances, lifestyle choices and risk profiles. If your business operates outside the benchmarks, it is important to reflect on whether there are valid reasons for doing so.

For example, growers will often upgrade machinery in preparation for growing business scale in the future. In such cases, it is common to use current profit to invest in machinery and therefore exceed current machinery needs in anticipation of an opportunity to expand the land base. During this period, the farm business may have a weak machinery income efficiency in order to position the business for the upcoming opportunity.

If a grower chooses to maintain a higher level of investment in machinery, then the business needs to have significantly lower costs in other areas, such as lower financing costs, or increased income, to counteract the investment.

If a business operates outside the guidelines for an extended period of time it can impact on the business's overall profitability. Each business has a different cost structure and a different set of resources available, therefore individual situations need to be analysed carefully before making investment decisions.

Tip: If you have higher costs in one area, aim to offset this with lower costs in other areas. An example is higher machinery investment, but significantly lower labour or financing costs compared to benchmark figures.

More information
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FREQUENTLY ASKED QUESTIONS

What is a common level of machinery investment for a cropping farm?

On average in south-eastern Australia, farms invest in machinery at a ratio of 1:1 to farm income. That is, for every dollar of farm income (as an average of the past four years), they have a similar amount invested in machinery assets (at current market value).

Is it a problem if our machinery asset income efficiency ratio is higher than average?

There may be a number of valid reasons why a farm business can have a high level of machinery assets, increasing the ratio to farm income above average. Consider whether you have a high level of machinery investment because you are planning to increase farm scale in the future or whether income has been weaker than normal due to adverse climates or low prices. Also consider whether you can generate more income from your machinery, such as contracting, in the short term to bring your ratio closer to the guidelines.

WA SURVEY REVEALS SPENDING SNAPSHOT

Crop machinery investments vary according to a combination of strategy, attitude, business phase and economics.

This is a key finding from a survey exploring how growers in western areas of Western Australia's Kwinana port zone make machinery investment and replacement decisions and divide up capital expenditure budgets.

Ben White says machinery replacement and operating costs – including the use of contractors – can be more than a farm business' combined spend on fertilisers and chemicals. (PHOTO: Kondinin Group)

The project was initiated by the GRDC Kwinana West Regional Cropping Solutions Network (RCSN) – with the aim of increasing knowledge about how much growers are investing in machinery; ownership models; and triggers for and frequency of replacement.

Carried out by agricultural engineer and Kondinin Group research manager Ben White, and farm adviser Chris Warrick, the survey interviewed growers across the WA central grainbelt.

Ben said increased farm machinery capacity had enabled the WA's grain growers to lift scale and productivity without necessarily employing more labour.

"But there is always a trade off in potential efficiency gains from machinery investment versus erosion of business profits," he said. "Machinery replacement and operating costs, including the use of contractors, are estimated to make up about one third of farm income and can be more than the combined spend on fertilisers and chemicals."

The project results showed there was an average $1.35 million invested annually in farm machinery by the 27 growers surveyed in depth, with the amount ranging from $350,000 to $3.37 million.

"The resulting average total machinery investment per hectare was $381 but ranged from $113 to $813," Ben said.

This represented about 65 per cent of average gross income potential (GIP) based on an assumed wheat price of $250 per tonne and long-term wheat yields.

How the machinery investment is split up (WA central grainbelt survey)

- 31 per cent of total machinery investment on seeding equipment;
- 26 per cent on spraying equipment;
- 25 per cent on harvesting equipment;
- 9 per cent on trucks; and,
- 9 per cent on other machinery.

Triggers for machinery replacement were highly variable, but commonly included maintenance costs and number of machine hours.

"Ownership models included: running machinery for longer periods; leasing versus owning; and, having two or more pieces of similar equipment," Ben said.

Research weighs up economics of CTF systems

THE costs of adopting Controlled Traffic Farming (CTF) systems are often lower than growers expect, but the benefits are varied in scope and scale. But a CTF system does not need to be perfect to gain benefits of soil compaction management.

These are findings of economist James Hagan, of the Department of Agriculture and Fisheries Queensland (DAF), who recently addressed the National Controlled Traffic Farming Conference, of which the Grains Research and Development Corporation (GRDC) was the major sponsor.

James's research resulted from investments by the GRDC and DAF, along with previous research conducted by organisations including the Department of Primary Industries and Regional Development (DPIRD) – formerly the Department of Agriculture and Food (DAFWA).

The principle of CTF is to create permanent wheel tracks which are clearly separated from the crop zone. The key aim is to reduce compaction and improve soil conditions in the crop root zone to encourage root growth and increase the uptake of soil moisture – to improve grain yields and quality.

James told the conference unclear costs and benefits of CTF adoption were one reason for variable CTF adoption rates across Australia, including in WA where adoption rates were relatively low.

He said broadacre cropping businesses were now using machinery capable of causing compaction at depths of 30 cm or deeper but CTF systems provided a way to manage this.

"Trials by the then DAFWA in the early 2000s across a variety of soil types in WA found traffic yield penalties ranging from 15 per cent (0.5 tonnes per hectare) to almost 50 per cent (1.8 tonnes per hectare) in a single season," James said.

"The costs of moving to CTF are often seen as a barrier to adoption. But case studies of growers who have adopted this system show the initial cost is typically less than $50,000, with benefits greatly exceeding this.

The perceived costs of moving to a CTF system can be seen by growers as a barrier to adoption. (PHOTO: GRDC)

James Hagan, of the Department of Agriculture and Fisheries Queensland (DAF), says a CTF system does not need to be perfect to gain benefits of soil compaction management. (PHOTO: GRDC)

"Machinery replacement is an ongoing activity for any business, and it is misleading to attribute all machinery capital costs against the CTF system."

On the other hand, James said it was possible for CTF to have considerable opportunity costs.

"Timeliness remains key in farming operations, and while small trade-offs may be worthwhile, significant delays are likely to overwhelm any other observable effect," he said.

"For example, reducing the machinery seeding width from 13.7 to 12 metres – as part of machinery conversions to a commonly used 3:1, 12 m CTF system – could cost about $14,000 annually due to seeding delays."

CTF compromises

But James said compromises existed which allowed farms to reduce the percentage of their paddocks which were trafficked while also allowing them to make use of wide scale machinery.

"A common compromise is the use of wider planting equipment moving from a 36:12 m system, with about 12 per cent of the paddock trafficked, to a 36:18:12 m system in which about 18 per cent of the paddock is trafficked," he said

James said the benefits of adopting CTF would vary by soil type; rainfall; potential yields; cropping enterprise size; and the difference between the percentage of farm which was trafficked – with and without system adoption.

"It is typical for growers to report a 20–30 per cent reduction in fuel use as firm tramlines improve traction and – while yield benefits may vary by season and location – they have been definitively measured across Australia's cropping regions," he said.

The National Controlled Traffic Farming Conference was held on August 22–23. For details visit http://www.nationalctfconference.com.au/

The conference was supported by organisations including the Australian Controlled Traffic Farming Association, the Western Australian No-Tillage Farming Association, the GRDC and DPIRD.

The GRDC Western Regional Panel recently released a booklet featuring insights from WA growers about their CTF experiences – including during flooding events last summer. Controlled Traffic Farming – Case Studies of Growers in Western Australia is available at http://grdc.com.au/ctf-case-studies-wa ■

Nitrogen benefits of CTF

UNCOMPACTED soils, which can be achieved through Controlled Traffic Farming (CTF), can increase the amount of nitrogen available to crop plants when combined with a well-balanced farming system that promotes soil biology.

This was the message from Precision Agronomics Australia (PAA) agronomist Quenten Knight to the recent National Controlled Traffic Farming Conference, of which the GRDC was the major sponsor.

"Uncompacted soils encourage deeper and more extensive root systems that can intercept and recover more nitrogen, and CTF is integral to achieving this, as is crop rotation, good pH levels and stubble cover," he said.

The principle of CTF is to create permanent wheel tracks, commonly called tramlines by Western Australian growers, which are clearly separated from the crop zone. The key aim is to reduce compaction and improve soil conditions in the crop root zone to encourage root growth and increase the uptake of soil moisture - to improve grain yields and quality.

Quenten told the conference soil test data from the Mallee district of Western Australia's Esperance region showed CTF growers' soils had up to 60 per cent more nitrogen (N) – in the form of nitrate and ammonium – compared with soils of non-CTF growers.

Numerous earthworms in uncompacted soils

His observations and those of local growers showed earthworms were much more numerous in uncompacted soils, and that they were a significant contributor to plant-available N.

Precision Agriculture Australia agronomist, Quenten Knight.

Earthworms can contribute from 10 to 100 units per year of plant-accessible nitrogen.

"Earthworms can consume 4 to 10 per cent of the top 15 cm of the soil annually and their contribution to plant-accessible N can range from 10 to 100 units per year," Quenten said.

"As well as N, their castings are high in other nutrients including phosphorus, potassium and calcium, and have a high cation exchange capacity (CEC), which influences the soil's ability to hold onto essential nutrients.

"Earthworms multiply and spread beneficial bacteria throughout the soil and there is a symbiotic relationship between them and fungi, including mycorrhiza, which can help create a larger root system."

Compacted soils needed more applied nitrogen

Quenten said compacted soils often needed much more applied nitrogen than uncompacted soils to produce the same amount of crop biomass.

He said trial work by the South East Premium Wheat Growers Association (SEPWA), funded by the GRDC, had shown an increased grain yield of 18 to 46 per cent in zero trafficked areas (around power poles) compared with trafficked areas when the same amount of nitrogen fertiliser was applied.

More information:
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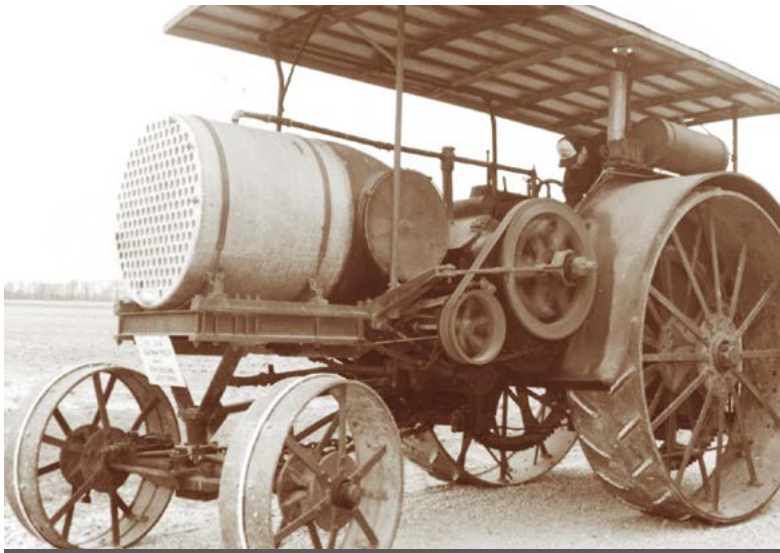
Trade-in your horse team on a NEW TRACTOR?

This report is from our rural journalist Mr Ian M. Johnston (pictured), who urges farmer's with vision to step up to the Twentieth Century, by at least considering the purchase of one of these modern-day mechanical marvels, now referred to as 'tractors'.

Our editor entrusted Mr Johnston with the responsibility of undertaking the hazardous trip to the U.S.A. by ocean steam boat, for the purpose of studying the dramatic interest, being exhibited by mainly younger progressive America farmers, in replacing their horse teams with tractors. Hereunder is his summary.

I have just returned to Australia, having spent three months of 1910 travelling around the American Grain Belt by train, horse and buggy, and (when lucky) automobile, confabulating with farmers on the subject of tractors. Accordingly, I can now report that a growing number (already around two per cent) have either invested in a tractor or are seriously considering so doing.

It is true that many farmers, and not just the old timers, are convinced that tractors will never replace their traditional and reliable horse teams. They consider new fangled tractors as being an extravagant passing phase and predict, by the year 1915, these clattering machines will have totally disappeared from the landscape.



AULTMAN AND TAYLOR 30–60. This unit incorporates the gear and cog final drive design, which can become worn due to the splattering of mud or the grinding of abrasive dust. A close inspection of the photo will reveal the exposed gear built into the rear wheels. Note, the clutch is built into the flywheel. The four cylinder engine produces 30 horse power at 500 rpm.

AVERY 18-16 is a lightweight small farm tractor powered by a two cylinder opposed engine of 18 horse power. Its narrow width enables it to operate in vineyards and orchards originally laid out for tilling using a single horse.

The arguments against tractors are certainly persuasive and include the following:

- They use motor spirit therefore are a parlous fire hazard, particularly if or when the engine blows apart.
- They are unreliable and on each occasion they break down, have to be towed by at least two horses into town and then into the confines of the local blacksmith's shop for repairs.
- Unlike a horse team, they frustratingly do not respond to spoken commands.
- Motor spirit fuel is not readily available and has to be purchased from the local store in four gallon tins, providing they have stocks.
- The roaring din of their engines disturbs the tranquillity of the countryside and can cause men to become impotent.
- The constant jolting when sitting upon the iron seat is likely to cause rickets and mental disarray.
- Horses have been known to die of heart failure when a tractor engine starts up.

Further, operating a tractor on The Sabbath would be sacrilegious in the extreme and likely result in a visitation from an incensed Reverend.

But of course the opposite view is adopted vigorously by the afore

RUMELY OIL PULL 30–60. The term 'OIL PULL' is used to describe the fact that Rumely uses oil, as distinct from water, as an engine coolant. Accordingly, the engine is able to operate at a much higher temperature, which results in more efficient combustion of the kerosene fuel. The 30–60 weighs around 12 tons and its two cylinder engine develops 60 hp, at 375 rpm. Photo shows the tractor pulling an eight furrow plough.

INTERNATIONAL MOGUL TYPE C is powered by a single cylinder horizontal petrol engine with a bore of 8 7/8 by 15 inches and produces 20 horse power. Undoubtedly one of the most reliable tractors available. One example is already operating in The Central Highlands of Queensland. Note the position of the steering gear which rotates the windlass drum with its chain to the front axle.

mentioned younger progressive farmers. It is their belief that these arguments, as itemised above, represent the thinking of biased old fashioned land owners, who are likely to be religious bigots, probably out of favour with their bank manager, plus possibly constantly nagged by a grouchy wife!

Upon contemplation and following the consumption of endless gallons of corn chowder whilst sitting around scrubbed kitchen tables and listening to the cogitations from long gangly grain farmers on the subject of tractors, there is no doubt in my mind that the destiny of modern agriculture might well revolve around the evolution of the farm tractor!

I have taken the liberty of including with this report, a few pictures of some of the better tractors available, and following consultations with a leading export company, whose reputation is well known – Messrs S. Laurel and O. Hardy Inc. of Los Angeles – any of these tractors could be ocean freighted to Australia.

Don't frighten the horses – or ladies

In order to assist Australian farmers with arriving at a conclusion regarding the suitability of a tractor for their agricultural applications, I beg to offer the following comments:

It is not appropriate for a lady to be in the vicinity of tractor, as they are inclined to be noisy, hot and smelly. (I refer here of course to tractors and not the ladies!)

A male operator should be fit and not aged, ie. not over 45 years. In this regard I respectfully draw your attention to the fact that a robust ladder is required for him to carry the dozen or so four gallon tins of gasoline aloft, from which to pour the contents into the fuel tank. Also, the chain and windlass steering device requires considerable muscle power and around three acres in which to negotiate a 180 degree turn. This manoeuvre involves around 20 rotations of the steering wheel!

Horses, mules and beasts should never be in the same paddock as a working tractor, as they will take fright and abscond through fences. A hen house must be located at least half a mile from a tractor, else the hens will be put off laying and fall off their perches.

Each tractor has a water cooling system capacity of between 50 and 100 gallons. It is necessary in frosty weather to completely drain the system every night or risk the contents freezing and thus cracking the iron cylinder walls.

A tractor must never be started on The Lord's Day. The wrath of

the church would likely result in excommunication for the worthless offender!

An important consideration is the imperative of having a local blacksmith invited to inspect and become acquainted with a newly arrived tractor. This is necessary so that on each occasion the unit fails to proceed, he has a prior knowledge of how to rectify the problem and if necessary beat out on his anvil new parts to replace those damaged.

If it's good enough for a horse…

There is a trend among tractor manufacturers to equip their machines with the complexity of two or even three forward gears. I consider this frivolous, as obviously a single gear is all that is required. After all, a horse when ploughing requires only one gear!

It is important that a good quality grease is used to lubricate axle bearings. My research indicates that beef fat mixed with goose oil is the best choice. Mutton fat and lard are not as durable.

The design of a tractor's rear wheel drive is an important consideration for an intending buyer. A ring gear built into the wheel and driven by a cog will be subjected to dust and/or mud, which causes premature wear. But chains can be readily removed and cleaned quite effectively by inserting them in a tub containing either cabbage soup or Ceylon tea. That is a well known fact!

Strange sounds emitting from a tractor gearbox can be easily rectified by inserting there-in four pounds of soft mashed bananas.

Several kettles of hot water, plus a scrubbing brush and a block of pig's fat and nettle juice soap (with added caustic soda) should be on standby at the end of a day's work, enabling a weary tractor driver to climb into a hot bath and be scrubbed by his wife, to remove the layers of oil and soot from his person. Conversation will not be possible for at least half an hour, owing to temporary deafness.

Neighbours within a radius of five miles should be acquainted with the fact that you own a tractor. This is common courtesy, or else an ailing elderly person lying in a sick bed in a homestead that is within earshot, could well imagine that the raucous sound bellowing from your tractor's exhaust stack, heralds doom and finality!

Finally, I respectfully suggest that a new tractor owner allows at least a 12 month settling-in period before finally selling off the horse team, just in case incompatibility with the tractor ultimately eludes his earlier aspirations.

Note: An unwanted tractor can be safely and discretely abandoned at the bottom of a deep farm dam. But it is a good idea to first drain all oils and fuels! ■

IAN'S MYSTERY TRACTOR QUIZ

Question: Can you identify the tractor by its unique patented wheels?
Clue: It is a licensed British version of an International 15/30.
Difficulty: TOUGH!!!
Answer: See page 52.

Better on-farm storage for a stronger grain supply chain

GRAIN growers considering an investment in on-farm storage options should establish clear goals, consider future needs and plan with potential expansion in mind so as to maximise value, says a new Nuffield report recently released by 2015 Scholar Andrew Freeth.

Andrew Freeth standing in a wheat crop on his property, 'Quandong Park', Collie.

Andrew works on his family's 5500 hectare dryland broadacre cropping and livestock enterprise near Gilgandra, New South Wales, and has spent the past two years studying effective on-farm grains storage and supply chain logistics, from around the world.

Funded by the GRDC, Andrew's report has unveiled a suite of recommendations for moving grain to market in an efficient, cost-effective manner, whilst considering future trends affecting the industry.

As a passionate advocate for the grains industry, Andrew said growers have seen unprecedented structural change over the past 25 years, including the need to increase storage capacity on-farm and improve sophistication of existing infrastructure.

"The competitiveness of Australian grain growers rely on an efficient supply chain into domestic and export markets," Andrew said.

"But in order to capitalise on these opportunities, growers are looking at newer, more innovative ways to reduce their supply chain costs and boost their profitability.

"One of these is investing in on-farm storage (OFS), a growing trend being driven by harvest logistics and capacities, upcountry grain storage networks, increasing production of pulse and specialty crops, amongst a range of other industry and government incentives."

On his Nuffield study tour, Andrew visited Hill and Hill Farms in Varna, Ontario, Canada.

OFS continues to gain momentum in the grains industry as growers look to expand their cropping enterprises, but Andrew says there is no strict formula for the optimal mix of OFS options.

"It's not a one size fits all approach," he said.

"Factors such as build quality, cost, ease of management and segmentation will play a key role in determining which OFS model works best for your business.

"Doing your homework and building a strategy which looks at how economically viable OFS is to your business, and aligning this with a broader marketing and management effort is absolutely critical.

"As some of these storage options can have working lives in excess of 30 years, it's important to take a long-term view about how OFS may be affected by the micro and macro operating environment – and build that into your strategy accordingly."

Once growers establish which OFS system they would like to proceed with, Andrew suggests a robust pest management strategy, so as to reduce input costs and risks on-farm.

"Simply building OFS and filling it with grain does not guarantee success," he said.

"For instance, good hygiene and aeration is important when growers are storing grain in an unsealed environment, alternatively gas tight storage that meets standard, AS2628, is a must for growers fumigating grain storage pests.

"With the amount of Australian grain crops stored on-farm likely to grow, it's vital that best practice is followed, which means grain remains in good condition for long periods of time or when the time is right to on-sell.

"Through my Nuffield scholarship, I was able to see some of the advancements in grain storage on farms overseas, and if we can achieve those same gains here, there is no reason we can't see OFS reach levels of up to 50 per cent market share, as seen in countries like the United States.

The right government policy

More broadly, Andrew said that government needs to provide the right policy settings to meet the needs of a modern grains industry, its consumers and the companies that operate within the supply chain.

"A modern and cost-effective freight network will be a game-changer for Australian agriculture," he said.

"The Federal Government's announcement of the Melbourne to Brisbane Inland Rail line funding has been welcome news for growers, with productivity gains expected across the rail and port operations of Australia's east coast.

"It's anticipated the Inland Rail will accelerate the rationalisation of the 'upcountry' storage network, so as to reduce transportation costs and improve profitability of supply chain operators.

"Further to this, new partnerships between grain growers, trading businesses and supply chain operators will be critical to ensure productivity improvements from mainline operations follow through to higher prices at farm-gate." ■

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ASK AN EXPERT –
CAN I RETAIN STUBBLE AND KEEP WEEDS UNDER CONTROL?

With Tony Swan, Senior Experimental Scientist, CSIRO Agriculture and Food

THERE are many benefits associated with retaining stubble, but zero till seeding into high stubble loads can be problematic, particularly in wetter seasons.

Tony Swan, Senior Experimental Scientist with CSIRO Agriculture and Food says growers can manage stubble without compromising weed, disease and pest management or the timeliness of the seeding operation.

"Decisions at harvest, post-harvest/pre-sowing and at sowing influence the success of a seeding operation into stubble," he says. "With a flexible approach, growers can manage stubble loads to suit their seeding operations, weed control tactics, herbicide choice and profit."

"As a rule of thumb, the stubble load after harvest is 1.5 to 2 times the grain yield for wheat and two to three times the grain yield for canola," says Tony. "A high stubble load can create issues for all types of seeding systems by restricting herbicide choice, effectiveness, contact on the soil or weed target and even reduce crop emergence."

In 2014 an experiment was established at Temora, NSW in a paddock with high levels of Group B resistance in annual ryegrass. The trial compared the yield, profit and annual ryegrass (ARG) population status in three management strategies in a no-till (tyne opener) or zero tilled (disc opener) farming system.

Tony Swan inspecting the stubble management trial plots, looking at the 'Conservative (lower input)' second year wheat treatment sown with a tyne seeder (left) compared to the 'Conservative' second year wheat treatment sown with a disc seeder where trifluralin could not be applied (not on label for disc seeders).

Tony Swan, Senior Experimental Scientist with CSIRO Agriculture and Food says crop sequence, including a double-break, is an effective way to manage weeds, improve profit and manage stubble residues, with or without livestock.

Introducing more crop and herbicide diversity into the farming system generated a higher average net margin over three years while reducing the seedbank from 1864 plants per m^2 to 351 plants per m^2 in just 24 months.

Following the wet 2016 season, with a soft late finish, three years of the diverse strategy (which included a double break) reduced the ryegrass seed bank by 70 per cent compared to the aggressive (high input) strategy (145 cf 573 seeds per m^2), while the conservative (low input) strategy increased the seedbank by 600 per cent to above 4000 seeds per m^2.

"Crop sequence is an effective way to manage weeds, improve profit and manage stubble residues in southern grain farming systems, with or without livestock," says Tony.

Tony presented his research into double-break cropping at the WeedSmart Forum on August 21, in Wagga Wagga.

Does choice of seeder type influence weed control?

Short answer: In our experiment, after three years ARG seed numbers were generally lower when crops were sown with a tyne seeder.

Longer answer: Averaged across the three management strategies, ARG seedbank populations were lower in tyne seeded plots in 2016 (650 seeds per m^2 in tyne cf 1080 seeds per m^2 in disc) and 2017 (384 seeds per m^2 in tyne cf 944 seeds per m^2 in disc).

But the use of expensive pre-emergent herbicides eliminated any significant difference in ARG seedbank populations in crops sown with a disc or tyned seeder. In the conservative strategy where trifluralin can not be used with a disc seeder (not on label), the result was a higher ARG seedbank population (4045 seeds per m^2) with a disc seeder compared to 1840 seeds per m^2 with a tyne seeder.

By February 2017, following the 2016 decile 9 season the lowest average ARG seedbank population was found in the diverse cropping strategy sown with a tyne seeder (82 seeds per m^2). In the conservative strategy weed populations continued to increase when sown with a tyne seeder (2322 seeds per m^2) and with a disc seeder (7631 seeds per m^2).

What options do I have if stubble is too thick to sow through?

Short answer: Reduce stubble load by grazing, baling, mulching, incorporating with nutrients, or use a strategic late burn.

Longer answer: Tyne seeding systems will struggle to establish crops into large stubble loads over six tonnes per hectare. While disc seeders may penetrate the stubble more easily and plant crop seeds into high stubble loads, patchy crop establishment and ineffective herbicide application can result in any seeding system sown into high stubble loads.

Retaining stubble, with all its benefits, should not be allowed to compromise effective weed control. Mulching, incorporation and grazing all potentially retain more nutrients *in situ* but mulching or incorporation are likely to lead to nutrient tie-up in the soil unless additional nutrients are added.

Grazing and late burning both improve in-crop nitrogen availability, and often the yield of the following crop. It is not recommended to grow wheat after wheat unless the stubble from the first wheat crop is burnt or grazed, or supplementary nitrogen is applied to offset N immobilisation.

To try and avoid burning at all costs, the best option is to sow a diverse crop sequence and use the legume crop to reduce the cereal stubble.^ ■

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ASK AN EXPERT – HOW CAN I TAKE THE PRESSURE OFF GLYPHOSATE ACROSS THE CROP ROTATION?

With Eric Koetz, Weeds Research Agronomist, NSW DPI

NOW is the time to take pre-emptive action to reduce the incidence of glyphosate resistance in weeds. Eric Koetz, NSW DPI weeds research agronomist, says the majority of agronomists and a growing number of farmers recognise the need to implement management practices that help protect the efficacy of glyphosate in farming systems.

"We know that it takes between 14 and 19 years of routine use of glyphosate to evolve resistance," he says. "We have now had Roundup Ready cotton for 15 years and there are many instances of glyphosate resistant populations of weeds such as fleabane, windmill grass and barnyard grass."

"The 2 + 2 + 0 strategy developed in the cotton industry to protect glyphosate and Roundup Ready technology is also applicable to other farming systems," says Eric. "When planning an integrated weed management program, the Cotton RDC recommends including two non-glyphosate tactics in-crop, two non-glyphosate tactics in the fallow and ensuring zero survivors."

This is where the use of residual herbicides can play a part, along with non-herbicide tactics, such as strategic tillage in both summer and winter crops and in fallow situations. Including residual herbicides in both the fallow and crop phases increases the diversity of herbicide modes of action and places downward pressure on the weed seed bank.

Eric Koetz, NSW DPI weeds research agronomist says residual herbicides need to play a part in the control of glyphosate resistant weeds in crop and in the fallow.

"Roundup Ready technology has been of great benefit to the cotton industry, and has a fit in other farming systems too, but it can not stand alone. It must be supported and protected through an integrated weed management strategy," says Eric. "To preserve glyphosate it is necessary to reduce the total number of applications across the crop rotation."

What are the non-glyphosate options for in-crop weed control?

Short answer: Residual herbicides applied at sowing, inter-row cultivation, crop rotation, maintaining ground cover and increasing crop competition.

Longer answer: Residual herbicides that require incorporation

Residual herbicides applied at seeding or soon after harvest help reduce the number of glyphosate applications across the cropping cycle.

are best applied at sowing. There are some older herbicides that have not been used for several years that are still quite effective and could make a come-back to farming systems that have come to over-rely on glyphosate.

There are also new use patterns being registered for a number of different products that can be used to add diversity to control weeds at different growth stages or to control later in-crop germinations.

Increasing crop competition and promoting rapid canopy closure has a significant impact on in-crop germination. Diversifying the crops grown automatically makes more herbicide options available to use against weed populations that may be evolving glyphosate resistance.

What are the non-glyphosate options for controlling weeds in the fallow?

Short answer: Residual herbicides applied soon after harvest, strategic tillage, double knock, optical sprayer, cover cropping.

Longer answer: Choose residual herbicides carefully. Some products have long plant back periods and will reduce the grower's options for the following season.

Tillage is widely practiced in irrigated cotton and is an effective way to eliminate weeds. In dryland systems tillage operations may be best suited to low crop residue situations such as following a chickpea crop. The cultivation operation may be done across the whole paddock or in small patches and can be coupled with paddock renovation, the incorporation of soil ameliorants or deep banding of nutrients.

Several research projects are currently investigating the usefulness of cover cropping and brown manuring on weed numbers.

What can be done to ensure zero survivors?

Short answer: Scouting and chipping, optical sprayer, patch tillage.

Longer answer: Actively looking for survivors must become a key management practice. A few large plants that have survived all control tactics can generate a huge number of seeds that are very likely to carry some level of herbicide resistance. If these plants are physically removed before they set seed they will not contribute to the seed bank for future germinations. ■

HOW TO ASK A WEEDSMART QUESTION

Ask your questions about the affect of soil pH on weed management on the WeedSmart Innovations Facebook page WeedSmartAU, Twitter @WeedSmartAU or the WeedSmart website http://www.weedsmart.org.au/category/ask-a-weedsmart-expert/

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

What growers need to know to land the 2017 chickpea harvest

CHICKPEA growers and consultants are being advised to 'monitor closely and act promptly' to reduce the disease risk in this year's crops and land the 2017 harvest safely.

New South Wales Department of Primary Industries (NSW DPI) senior plant pathologist Dr Kevin Moore said the risk of Ascochyta, Phytophthora, Sclerotinia and Botrytis diseases was high this season in the wake of wet conditions during 2016.

Speaking at the Grains Research and Development Corporation (GRDC) Updates across Queensland and northern NSW recently, Kevin warned growers to be vigilant about checking crops and where necessary implement in-crop management strategies to reduce disease.

His Update presentations attracted significant interest from growers and consultants with many asking for disease management advice for a drier-than-average winter season.

"It may well be a waiting game for many growers at the moment, but fungal diseases like Ascochyta blight are largely influenced by seasonal conditions, so while growers need rain they won't have disease problems," Kevin said.

"So in some ways the dry conditions have worked in growers' favour by reducing the disease risk, but rain events between now and harvest could change the situation in paddocks rapidly.

"Growers need to have management strategies in place and they need to monitor crops closely and consult with their advisors ahead of any significant forecast rain events to assess the economic benefits of a fungicide treatment."

Ascochyta blight has already reared its head in chickpea crops in parts of northern and north central New South Wales and southern Queensland this season. These detections in May and early June included paddocks planted to Kyabra and the recently released PBA Seamer variety.

Although the outbreaks could have involved seed borne Ascochyta, Kevin said many paddocks planted to chickpeas in 2017 already contained the Ascochyta fungus because they were chickpea-on-chickpea or because they were inoculated with wind borne infected chickpea residue during harvest in 2016.

For years Kevin has warned against planting back-to-back chickpeas, saying growers risked up to 100 per cent crop losses if conditions favoured disease development.

"These cases highlight the risks of planting chickpea back into its own residue. Other risks are Sclerotinia and Phytophthora, which unlike Ascochyta, cannot be controlled in-crop," he said.

Costly, long-term implications

If serious disease outbreaks were to occur, they would pose costly and long-term implications for the entire grains industry according to Kevin.

- The first implication is the increased risk of the pathogen becoming more virulent and aggressive;
- Secondly, it places increased pressure on the resistance genes in new varieties as crops are subject to earlier infection and potentially more disease cycles within a season; and,
- We could see an increased risk of the pathogen developing resistance to fungicide.

Kevin said the best practice recommendations for disease control in chickpea crops were to maintain a 1-in-4 year rotation; avoid planting next to last year's chickpea stubble if possible; ensure all planting seed is pickled and follow the recommended in-crop Ascochyta fungicide strategy for the variety being grown.

This season where Ascochyta blight infection is suspected, growers are advised to have the disease positively identified. Kevin said they should then apply a registered fungicide based on chlorothalonil or mancozeb before and as close as possible to the next rain event.

The Grains Research and Development Corporation (GRDC) has released a Know More video to help growers with Ascochyta blight identification and management, which is available on the GRDC's YouTube channel or by visiting grdc.com.au ■

NSW DPI Plant Pathologist Kevin Moore said the dry conditions have reduced the disease risk in northern chickpea crops, but the situation in paddocks could change rapidly with a significant rain event.

Wheat research is 'al dente'!

By By Jan Suszkiw, Agricultural Research Service – USDA

AT A GLANCE

- Durum wheat has hard, amber-coloured kernels;
- Durum wheat is mainly grown for making pasta and couscous;
- An ARS-led team bred the first soft durum wheat; and,
- Soft durum flour can be used to make breads and pizza crusts.

ITALIAN pasta is cooked to perfection when it is 'al dente' (firm to the tooth). A coarse meal called 'semolina' is used to make pasta, and the primary source of it is the hard, amber-coloured kernels of durum wheat.

Producing semolina requires specialised mills, which limits durum wheat's food uses to pasta, couscous, and a few other products. Certain Mediterranean breads are also made from it. But by and large, durum wheat accounts for only 8 to 10 per cent of all wheat types produced globally, notes Craig Morris, an Agricultural Research Service (ARS) chemist with the USDA.

In the US, durum comprises three to five per cent of America's total wheat crop – in Australia the amount of durum produced is around two per cent of the total wheat crop.

Soft Svevo durum wheat growing in an Idaho field.
(PHOTO: Craig Morris)

Broaden the range of durum products

Craig, though, has a soft spot for durum, which, despite its rock-hard kernels, is better adapted to hot, arid growing regions than the more commonly grown bread wheat varieties. Over the past 20 years, he and colleagues have delved deep into the genetics of wheat kernel development for clues that could broaden the range of products made from durum wheat.

And find clues they did – one quite surprising.

"Turns out, the hard kernel texture has no relationship to the quality of the pasta," says Craig, who is in ARS's Wheat Health, Genetics, and Quality Research Unit in Pullman, Washington. What makes durum the go-to wheat for pasta is its yellow colour and high-protein content, which gives pasta its firmness. Additionally, "the key features of good pasta – bright yellow colour and firm 'bite' – have nothing to do with the particle size of the semolina made from the kernels," he asserts.

Based on that premise, Craig and a team of university and industry scientists set out to create a soft durum wheat whose kernels could be easily milled into a fine flour, rather than a coarse semolina.

The flour would be suitable not only for pasta and spaghetti but also for pizza crust, bread, and other baked goods.

Breakthrough gene discovery

The breakthrough came with their discovery of two genes that control kernel texture in soft bread wheats, namely:

- Puroindoline a (Pina); and,
- Puroindoline b (Pinb).

Using classical plant breeding methods, the researchers moved the genes into a prized Italian durum variety called Svevo. The

eventual result – released in 2016 – was Soft Svevo, the first soft durum wheat of its kind.

Tests show that flour made from Soft Svevo is similar to that of soft bread wheats. It also outscored traditional durum flour on processing and handling evaluations, thanks to its smaller particle size, improved water uptake, and lower levels of damaged and broken starch granules.

Importantly, Soft Svevo's high-protein flour imparted an appealing aroma, flavour, and yellow colour to pizza crusts, baguettes, pan breads, and other baked goods the researchers made. In milling tests, Soft Svevo's easily milled kernels translated into energy savings of 75 per cent and water savings of 15 per cent.

Three US firms are now conducting precommercial trials of Soft Svevo under license from ARS. Requests for it have come from Japan, South Korea, and Morocco.

Other soft durum varieties are in the works. But even with diverse new uses for them on the horizon, one will remain a priority – making a premium pasta that's 'molto bene' (very good), says Craig.

Further information:
Craig F Morris, Supervisory Research Chemist
Director, Western Wheat Quality Laboratory – ARS
craig.morris@ars.usda.gov

■

Artisan bread made with ARS-developed Soft Svevo durum wheat. (PHOTO: Jessica Murray)

Corn variety helps manage weeds and yields

AN initial aim to clean up areas of Johnson grass on the southern Queensland property he manages has resulted in an award-winning corn crop for Wayne Frank.

Wayne, from Melrose Station at Killarney, grows around 600 hectares of summer crop, which for the last few seasons has been predominantly corn, as well as mung beans and soybeans.

River flats on the property have struggled with outbreaks of the damaging Johnson grass weed, which can cause significant yield losses. The problem prompted Wayne to turn to Pioneer brand P1813-IT hybrid corn four years ago.

"On these river flats, Johnson grass can really take hold, you can have it cleaned up for a couple of years and then you get a flood and you've got the problem back again," he explains.

"The weed can cause significant losses of yield in our cropping program as it's very competitive, and without an option like P1813-IT, you'd have to bring in a winter cropping program to get on top of it."

The technology in P1813-IT allows certain chemicals to be used to control Johnson grass without affecting the corn crop.

Alongside weed control, an extra benefit to the P1813-IT has been its outstanding performance in terms of yield and quality, ranking as one of the highest yielding crops Wayne Frank has grown.

In 2016 Melrose Station won the Royal Agricultural Society of Queensland dryland corn competition with their P1813-IT crop, yielding 11.843 tonnes per hectare, before following it up with a similarly impressive result in 2017.

"Last summer we had 40 degree-plus temperatures when the P1813-IT was tasseling and it still performed well, producing around 11 tonnes per hectare of corn at 28 per cent moisture for Whyalla Feedlot," Wayne says.

"I had other varieties here this year growing beside the P1813-IT and they just couldn't match it, plus on top of that performance, it's also helped us clean the Johnson grass up really well – we've got it all under control now.

"We'll definitely keep using P1813-IT. I've also used it for cattle silage and it's performed very well, it just seems to suit the area and our system."

■

Wayne Frank uses corn in his rotation to help keep on top of Johnson grass.

Spring rain will dictate mungbean opportunities

By Cindy Benjamin

WITH the El Niño–Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD) remaining neutral, the Bureau of Meteorology suggests parts of southeast Queensland could see above average rainfall in September through November.

If adequate rain falls in September or early October, Blue Ribbon Group export manager Graham Tancred said growers are very likely to embrace the opportunity to plant a large area of summer crop, especially in areas such as the Liverpool Plains, North West NSW and the Darling Downs where the winter crop has been disappointing for many.

Attractive prices

"Mungbean and sorghum are likely to compete strongly for planting area," he said. "Prices for machine dressed mungbean remain attractive and are expected to be in the vicinity of $1000 per tonne for processing grade product."

Although the outlook for rain is positive, day and night temperatures are expected to be warmer than average across northern Australia through spring. Given the experience of last season many growers and agronomists are expected to favour the summer plant mungbean window rather than the early plant option in spring.

"The 2016–17 mungbean growing season presented growers and marketers with many challenges to quality and supply, especially with the early season crop, which was badly affected by hot dry conditions. Cyclone Debbie then decimated crops in some areas, bringing total production down by about 40 per cent on the more favourable 2015–16 mungbean season, in which quality was also generally much higher," said Graham. "The later summer planted crop benefitted from Cyclone Debbie's rain and generally yield and quality were much better for these crops."

With several new countries, such as Brazil, South Africa and Uzbekistan, now entering the global mungbean market to compete with traditional suppliers such as China, Myanmar, Indonesia and Argentina, Graham said Australia will need to maintain its reputation as a consistent supplier of quality mungbeans larger than 3.5 mm in size.

These new players, and the size and quality of crops grown in each country, will impact on the global price and the premium that may be paid for the high quality Australian product.

Australian Mungbean Association (AMA) seed committee convenor, Geoff Birch said the $245,000 royalty cheque recently presented to DAF and the GRDC was testimony to the effectiveness of the National Mungbean Improvement Program, which has been delivering new mungbean varieties to meet the needs of the industry. Plant Breeder's Rights royalties are collected by the AMA through seed sales, ensuring that the plant breeding program can continue to deliver new varieties such as the new black gram due for release to industry in December 2017.

Geoff said there are good supplies of Jade-AU, Crystal, Satin-II and Celera II-AU available to growers for the 2017–18 season and encouraged growers to arrange their seed, fertiliser and crop protection products early. The seed price for these varieties is set to remain unchanged from the past two seasons.

AMA president Mark Schmidt said growers and agronomists wishing to hone their mungbean management knowledge and skills are invited to attend Mungbean Agronomy Training and Accreditation course that will be held on October 10, 11 and 12.

Pulse Australia's industry development manager, Paul McIntosh is coordinating the training course and also reminds growers and agronomists of the importance of reviewing past applications of residual herbicides and the impact of low rainfall on herbicide breakdown.

More information: www.mungbean.org.au

A positive seasonal and market outlook for mungbeans is likely to see the 'small green bean' compete strongly for acreage in the coming summer cropping phase.

Tillage strategy controls one of the world's worst weeds

By Dennis O'Brien, Agricultural Research Service – USDA

AT A GLANCE

- Palmer amaranth is an aggressive weed;
- ARS researchers found that combining tillage methods helps control Palmer amaranth; and
- The tillage strategy can save about US$26 per acre (A$80/ha).

AN onslaught of the weed Palmer amaranth in the southeastern US has left many farmers with a difficult choice: Should they keep using environmentally friendly cover crops and conservation tillage – allowing Palmer amaranth to cut into their yields – or should they switch to conventional tillage?

Conventional tillage may better control the pernicious weed, but it also increases soil erosion and threatens long-term soil productivity.

Palmer amaranth is aggressive and drought tolerant, a prolific seed producer, and resistant to glyphosate.

Because of that, thousands of acres in Alabama and elsewhere are at risk of being converted to conventional tillage, reversing years of environmental progress.

Agricultural Research Service (ARS) scientists at the agency's National Soil Dynamics Laboratory (NSDL) in Auburn, Alabama, are showing the region's cotton farmers how to control the weed and save their soil while still generating a profit. They can conventionally till weed-infested fields for one year and then use conservation tillage for at least the next two years.

Previous NSDL studies showed that the strategy effectively controls Palmer amaranth and produces sufficient yields. Recently, ARS economist Leah M Duzy and her colleagues analysed the financial implications of the weed-control strategy. "If we can show a financial benefit to a strategy, it's more likely to be adopted," says Leah.

She calculated the net returns for cotton under different scenarios.

For three years, she compared production costs and yields for two tillage systems:

- One year of conventional tillage followed by two years of conservation tillage; and,
- Three years of conservation tillage.

There were also three different cover crops and three different herbicides applications – just before the cotton emerged, just after it emerged, and before and after emergence.

Tillage profitable due to high weed pressure

Results showed that in cotton fields infested with Palmer amaranth, there was a financial advantage to tilling during the first year because of the immense weed pressure.

But in the second and third years, there was little difference in net returns. And with the higher costs of conventional tillage – having to make three passes with a plough versus not ploughing at all – returning to conservation tillage made more sense financially.

Leah estimates that a farmer could save around US$26 per acre (A$80/ha) per year in the second and third years by switching back to conservation tillage. That would represent a US$15,000 (A$20,000) savings each year on a typical 600 acre (240 ha) Alabama cotton farm.

"We know that if a Palmer amaranth infestation is intense, conservation tillage alone may not be sufficient to control it during that first year. But if farmers decide to plough, then they should consider adopting a high-residue cover crop and immediately return to their conservation system in subsequent years. They don't have to plough the soil year after year," says Leah.

More information: Leah M Duzy, Soil Dynamics Research Economist, USDA
E: leah.duzy@ars.usda.gov

Palmer amaranth (tall, yellowish plants) infesting a cotton field. (PHOTO: ARS)

A cotton field free of Palmer amaranth. (PHOTO: ARS)

New GRDC northern panel heads south

THE new Grains Research and Development Corporation (GRDC) northern panel recently took to the paddocks in southern New South Wales for an insight into innovative crop research trials, growers' production challenges and opportunities for future research investment.

The tour will traveled to Wagga Wagga, Yanco, Griffith, Jerilderie and Howlong visiting important GRDC research investments into crop yield optimisation, thermal response, heat stress, nitrogen fixation, crop nutrition, nitrogen management and irrigated faba bean production.

Progressive mix of panelists

It's one of the first engagements for the new northern panel which commenced on September 1 and comprises a progressive mix of industry knowledge and experience, involving growers, consultants and researchers from across NSW and Queensland.

Joining the tour will be incoming panelists Liverpool Plains senior agronomist Peter McKenzie, central Queensland senior agronomist Graham Spackman, Riverina district grower Roy Hamilton, Parkes district grower Bruce Watson, West Wyalong grower Roger Bolte and southern Queensland research pathologist and private consultant Jo White.

They will be accompanied by returning panelists Forbes grower Tony Hamilton, Lake Cargelligo agricultural consultant Andrew McFadyen, Chinchilla grower Arthur Gearon, northern panel chair, grower and agricultural consultant John Minogue, GRDC's General Manager for Applied R&D Brondwen MacLean, Western Australian GRDC Board member Kim Halbert, GRDC Senior Regional Manager – North Jan Edwards, GRDC Integrated Content Manager Julian Fox and GRDC Team Assistant North Linda McDougall.

GRDC northern panel chair John Minogue said the tour offered local growers and consultants an opportunity to directly express their research priorities and have valuable input into the future direction of research and development (R&D) in the region.

"The northern panel plays an important advisory role in the GRDC's regional investment process, helping refine and prioritise research needs," John said.

"Tours like these are a critical touch-point with industry and an opportunity to `ground-truth' existing GRDC research investments against industry needs and priorities to ensure that we identify any R&D gaps.

GRDC northern panel chair John Minogue visited trial sites and research centres in southern NSW during early September as part of the GRDC northern panel's spring tour. (PHOTO: GRDC)

"Importantly though, it's a two-way conversation and we welcome questions from growers and consultants about the GRDC's investments in areas like varietal performance and management, crop nutrition, pest and disease management, soil management and herbicide resistance management."

The itinerary included visits to the NSW Department of Primary Industries Bilateral trial sites near Wagga Wagga, CSU, Yanco Agricultural Institute and Managed Environment Facility, AgGrow Agronomy & Research trial sites near Griffith, Southern Growers Inc. trial site near Jerilderie and Riverine Plains trial site near Howlong. ■

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ASK AN EXPERT – HOW CAN I TAKE THE PRESSURE OFF GLYPHOSATE ACROSS THE CROP ROTATION?

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What can be done to ensure zero survivors?

Short answer: Scouting and chipping, optical sprayer, patch tillage.

Longer answer: Actively looking for survivors must become a key management practice. A few large plants that have survived all control tactics can generate a huge number of seeds that are very likely to carry some level of herbicide resistance. If these plants are physically removed before they set seed they will not contribute to the seed bank for future germinations. ■

HOW TO ASK A WEEDSMART QUESTION

Ask your questions about the affect of soil pH on weed management on the WeedSmart Innovations Facebook page WeedSmartAU, Twitter @WeedSmartAU or the WeedSmart website http://www.weedsmart.org.au/category/ask-a-weedsmart-expert/

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

Microbial degradation of propyzamide – is it a problem?

■ By the Australian Herbicide Resistance Initiative

SOMETIMES we worry about things that might happen in the future, and it never happens, like the millennium bug. The anti-climax was overwhelming. We also thought that daylight savings would fade our curtains, but lo and behold, no problems there either.

Other times we worry about things that might happen, like Trump being voted in, and it does actually happen.

Should we be worried about enhanced microbial degradation of propyzamide bringing about the downfall of this excellent herbicide?

Perhaps.

Some excellent research conducted by Stephen Hole, under the watchful eye of Professor Steve Powles at the University of Adelaide in the mid-1990s investigated the microbial degradation of propyzamide and another similar herbicide, carbetamide.

What is enhanced microbial degradation?

Enhanced microbial degradation is where the soil bacteria which can eat a particular herbicide build up to very high levels so when the herbicide is applied it is broken down very quickly, effectively reducing the half-life of the herbicide.

What the researchers found was ...

Where carbetamide or propyzamide were used twice in the same winter growing season, the second application was roughly half as effective.

In another study carbetamide efficacy was reduced from one growing season to the next when it had been applied to a field for five to seven consecutive years prior to the field research.

Four years without carbetamide returned soil bacteria levels to similar levels as untreated soil.

What has *not* been found so far is ...

Any evidence of enhanced degradation of propyzamide that persists from one year to the next.

Could it happen? Sure. Are there things that we can do to minimise the risk? Yes.

The pasture seed industry of south-eastern South Australia is a melting pot of herbicide resistant weeds. Pasture seed is grown in the same field for many consecutive years, often with the same herbicide treatment every year. It's a place where herbicides cop a hammering and as a result, many unique cases of herbicide resistance are found.

When a pasture seed grower contacted Steve Powles in the early 1990s to tell him that carbetamide had failed to kill ryegrass, Steve naturally suspected that resistance was at play. When he sampled seed from survivors and tested for resistance in the lab, he found only susceptible weeds. Why was that so?

Stephen Hole then stepped up to the plate to investigate as a part of his PhD studies.

Study 1: Carbetamide applied twice in the same growing season is a bad idea

Stephen compared carbetamide efficacy at two fields.

Field A – no prior history of carbetamide application. Sandy clay loam at pH 4.8.

Field B – Carbetamide applied commercially for three consecutive years (1990–92). Sandy loam at pH 4.9.

In 1993 he compared a single application of carbetamide and two applications of carbetamide 103 days apart (carbetamide pre-treatment).

Carbetamide as a single application achieved 88 to 89 per cent control of ryegrass in both Fields A and B.

Field B had been treated with carbetamide for three consecutive years leading up to this research and this appears to have had no effect on enhanced microbial degradation.

One application of Carbetamide in June of 1993 was enough to cause significant enhanced degradation of carbetamide that was applied 103 days later – even in Field A where there was no history of carbetamide use.

Study 2: Propyzamide applied twice in the same growing season is also a bad idea and bacteria are fussy eaters

Further field research by Stephen confirmed that propyzamide is also prone to enhanced microbial degradation.

Applying propyzamide twice in the same season – 77 days apart – led to a significant reduction in control of ryegrass with the second application.

While propyzamide and carbetamide are similar herbicides it seems that they are very different in the eyes of the degrading bacteria.

Pre-treatment with one herbicide did not reduce the efficacy of the other.

Study 3: Carbetamide applied for five to seven consecutive years reduced the herbicide half life

Stephen's research also showed that applying carbetamide every year for five to seven years reduced the half-life of the herbicide in the soil from approximately 30 days to four days.

In this study, the last carbetamide application was made 12 months before sampling, so this proves that the soil bacteria levels required to rapidly degrade carbetamide can persist for at least 12 months in the soil.

The good news is that where the soil was left untreated for three to four years, the enhanced degradation effect appears to 'wear off' and the half-life of carbetamide appeared to revert towards more normal levels.

TABLE 1: The half-life of carbetamide (days) in soil for three different levels of carbetamide application history

Years of sampling	Nil carbetamide history	Treated with carbetamide annually from 1989 until 12 months before sampling	Four applications of carbetamide (1989–92) then nil from then on
1994	23	4	5
1995	44	4	10
1996	28	4	10

Further measurement of the number of carbetamide degrading bacteria numbers supported the half-life measurement.

The control plots had just seven carbetamide degrading organisms per gram of soil compared to 29,000 per gram of soil where carbetamide had been applied for seven consecutive years leading up to sampling.

Where carbetamide was applied for four years then no applications were made for the following four years, there were just 14 carbetamide degrading organisms per gram of soil.

Anyone for 9 holes?

In some other unpublished work, Steve Powles visited a golf course in Victoria where propyzamide had failed. He managed to show that there was enhanced biodegradation of propyzamide which was responsible for the herbicide failure.

In the broadacre scene, Steve also recently checked a couple of paddocks from Kojonup (WA) with propyzamide history and in which propyzamide efficacy was only so-so.

He didn't find enhanced biodegradation.

Thus far, no one in Australia has observed enhanced propyzamide biodegradation from its current use patterns in canola.

Enhanced biodegradation of propyzamide has been found to cause herbicide failure in a golf course situation – but not in broadacre applications.

To sum up

There is evidence that propyzamide is prone to enhanced microbial degradation, but at this stage we haven't seen this persisting from one growing season to the next in broadacre cropping. The only evidence we have at this stage is where two applications were made within the same growing season.

But we have seen that carbetamide degrading bacteria can last from one season to the next, and there is no reason that this could not be the case for propyzamide degrading bacteria.

What can we do to look after propyzamide?

- Avoiding applying propyzamide in consecutive seasons is a good start.
- How many years should we leave between propyzamide applications is really anyone's guess. Common sense would say that the more that we can spread it out in the rotation the better.
- A three to four-year break between applications would be great (we must disclose that this is purely speculation), and this would slow the evolution of resistance to this herbicide at the same time.

Should we be worried about enhanced microbial degradation of propyzamide? Yes. But if we do the right thing, and rotate to other herbicides, we can go a long way to looking after this herbicide for many years to come. ■

New approach to fertilising crops in-season shows promise

TRIALS of a relatively new approach to fertilising dryland cereal crops during the growing season have entered their second year, following promising results in 2016.

Mid-row banding of nitrogen (N) in-season increased uptake of nitrogen fertiliser in wheat by more than 50 per cent – when compared with other methods of in-season N application – in Victorian trials last year.

Agriculture Victoria's regional research agronomist Ashley Wallace, who has undertaken the work as part of the GRDC and Victorian Department of Economic Development, Jobs, Transport and Resources (DEDJTR) Bilateral Research Agreement, describes the outcomes from the trials as encouraging.

"Trials of mid-row banding of N in-season have produced promising results, including increasing fertiliser uptake by an average of 46 per cent and up to 52 per cent in wheat when compared with other methods of in-season N application," Ashley said. "The method also boosted grain yield by up to 0.5 tonnes per hectare."

Results from mid-row banding trials in 2016 – an exceptional year in terms of rainfall and yields in many parts of the southern region including the Wimmera and Mallee where the trials were conducted – are being validated this year, with further trials currently underway at Ultima, Horsham and Telangatuk.

Swing to in-season N management

Ashley said there had been a significant swing towards in-season management of N fertiliser in southern dryland cropping regions as growers looked to improve management amid variable seasonal conditions. The crop's demand for N is largely determined by its yield potential, which is strongly related to growing season rainfall.

"The time when crops are sown is a period when seasonal forecasts and hence yield predictions have limited accuracy," Ashley said. "This makes decisions around N application up-front difficult and risky. Applying N during the growing season better matches the timing of application to crop demand.

"Unfortunately, surface application of N fertilisers such as urea during the growing season increases the risk of N loss through volatilisation.

"Mid-row banding of fertiliser, where N is applied below the surface of every second inter-row, has the potential to reduce this risk, where the current research has focused on application during the growing season, rather than up-front at sowing," Ashley said.

Last year's trials at Longerenong and Quambatook were undertaken in collaboration with BCG (Birchip Cropping Group) and aimed to compare mid-row banding with other forms of in-season N application, including top-dressed, liquid foliar and mid-row surface applications of N.

Mid-row banded treatments of liquid N were applied using a purpose-built three-point linkage mounted fertiliser banding gear which used twin disc openers to place fertiliser at a depth of 30 millimetres below the soil surface. Each pair of discs was followed by a press wheel to assist with furrow closure.

Fertiliser treatments were applied at one of two times between the start of stem elongation and second node growth stages.

At each trial site, the first timing of application coincided with forecast rainfall in the days following, while the second timing of application coincided with dry weather forecast in the days following. This approach was used to examine the effects of rainfall following application on potential losses of N and fertiliser use efficiency of the crop.

"Results from 2016 indicated that the benefit of mid-row banding to crop uptake of N was greater where rainfall was limited soon after application and the surface applied urea was not washed into the rooting zone," Ashley said.

Mid-row banding

"This indicates that mid-row banding could be a more effective way of applying N under drier seasonal conditions."

GRDC Manager Soils and Nutrition – South, Stephen Loss, says it will be important to test mid-row banding in a range of seasons and situations to work out when and where growers will get the biggest bang for their buck.

"With 2017 looking like a more typical season, this year's trials will provide another layer of data to inform industry about the potential benefits of applying N in-season through mid-row banding," Stephen said.

He said that even if results from this year's trials are again positive, any future adoption by growers will require careful consideration of economic and practical factors, such as the availability and the cost of mid-row banding machinery, the speed with which operations can be undertaken, and potential crop damage in comparison with existing methods of spreading N fertilisers.

Such changes may also have impacts on other elements of the farming system that should be considered, such as the effect of inter-row disturbance and fertiliser application on weed germination and growth.

A report of the 2016 trial results, co-authored by Ashley, is available for viewing and downloading via the GRDC website grdc.com.au ■

Agriculture Victoria's regional research agronomist Ashley Wallace says work is continuing this year to validate the benefits of mid-row banding demonstrated in 2016 trials. (PHOTO: Piotr Trebicki)

Green light for redlegged earth mite pesticide resistance test

A SCREENING service to test for insecticide resistance in redlegged earth mite (RLEM) is again being made available to grain growers and their advisers this year.

Through a GRDC investment, cesar is screening RLEM populations across South Australia, Victoria, Tasmania and southern New South Wales.

Dr James Maino from cesar says growers and advisers suspecting a chemical control failure against RLEM are encouraged to contact cesar to access the service. The service is available at no extra cost to growers through a national GRDC investment led by the University of Melbourne, in collaboration with cesar, the Department of Agriculture and Food Western Australia and CSIRO.

"The service will help to identify the best control options for growers, and detect any resistance before it becomes more widespread," James says.

Earlier this year, resistance was confirmed in multiple RLEM populations from SA to both synthetic pyrethroids (SPs) and organophosphates (OPs). This was the first detection outside of Western Australia where many RLEM populations have shown high levels of insecticide resistance for more than a decade.

"Further sampling this year will enable more detailed mapping of the extent of resistance in the southern and northern cropping regions," James says.

RLEM is a threat to the profitability of a range of Australian crops and pastures, with canola, lupins and legume seedlings the most susceptible to attack. Mite feeding can lead to distortion or shrivelling of leaves and affected seedlings may die at emergence when mite populations are high.

Few options

There are few options available to growers for control of RLEM and resistance to OPs and SPs will only increase the dependence on the remaining major chemical group of neonicotinoids. Although limited in options, experts say it is still crucial to minimise chemical use and rotate chemical groups to curb the spread of insecticide resistance.

To guide growers and their advisers in their efforts to control RLEM and reduce the risk of resistance occurring, a Resistance Management Strategy (RMS) for SA, Tasmania, Victoria and southern NSW has been developed (in addition to a separate strategy for WA).

The RMS for the Redlegged Earth Mites in Australian Grains and Pastures, developed through the National Insecticide Resistance Management (NIRM) working group and endorsed by CropLife Australia, has been published by the GRDC and is available for viewing and downloading at https://grdc.com.au/FS-RLEM-Resistance-strategy-South or at http://ipmguidelinesforgrains.com.au

For more information about the resistance testing service, please contact Dr James Maino at cesar by phoning 03 9349 4723 or emailing jmaino@cesaraustralia.com ■

A screening service to test for insecticide resistance in redlegged earth mite is again being made available to grain growers and their advisers this year. (PHOTO: A. Weeks)

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Automated image analysis helps deliver higher quality rice

AN innovative image analysis system developed by NSW Department of Primary Industries (DPI) scientists has given the rice industry an accurate and time-saving procedure to identify grain suitable for sushi and popular puffed rice products, including breakfast cereals.

NSW DPI researcher, Mark Talbot, said the automated system detects the potential of rice to crack during cooking, speeding up the process and saving labour to deliver high quality grain.

Heavily cracked rice turns into mush during cooking for sushi and puffed rice.

"Heavily cracked rice will turn into mush during the cooking process for sushi and puffed rice, so it's very important the industry identifies the potential for rice to crack before grain goes to market," Mark said.

"Now in use at SunRice, the technology has replaced manual assessment to help to keep consumers happy and protect premiums for growers.

"Rice which cracks during the milling process is downgraded, with producers receiving higher payments for grain with low cracking percentages.

"In the past, cracked grain was assessed by eye – clearly a painstaking and subjective test for thousands of rice grains.

"Automated image analysis allows thousands of grains to be analysed in minutes, instead of hours by eye, reducing human error and labour and a boon for industry and consumers."

Good indicator of rice quality

Measuring cracks in soaked rice was recently identified as a good indicator of cooking quality.

Known as the Hanasaki test, rice is soaked for 60 minutes before processing through the automated crack detection and counting system to determine cracking percentages.

NSW DPI scientists based at the Yanco Agricultural Institute are working closely with SunRice to fine-tune the system as a quality test for the rice industry. ■

Don't forget the record carry out...

By Peter McMeekin, Nidera Australia Origination Manager

A RECENT crop tour of Western Australia followed by a visit to the New South Wales ski fields certainly emphasised the poor season being experienced by precipitation dependent industries across many southern parts of Australia this past winter.

Whilst the correlation is not always precise, the lack of rainfall across Australia's prime cropping regions was reflected in the mountains by way of below average snow falls.

The amount of snow in the Australian Alps is a big determinant of the amount of spring runoff into the water storages in the upper reaches of the Murray and Murrumbidgee River systems which, in turn, will impact on irrigation water availability for the summer croppers feeding off the two longest rivers in Australia.

One thing that water and grain stocks have in common is that they can be carried forward from season to season, to be consumed when demand dictates.

Even though the pace of grain exports has been quite impressive since harvest, last year's record wheat and barley production, combined with our more recent lack of competitiveness, means this season's national carry out will be huge.

Location is critical

The location of that carry out is the critical point to note. Come October, the Western Australia cupboard will be quite bare. But a drive around Victoria and the western parts of NSW reveals fences lined with silo bags and bunker after bunker still brimming with grain from last year's harvest.

Peter McMeekin, Nidera Australia Origination Manager.

This means that the carry out in Australia from this season into the next will be exactly where it is needed most – behind the majority of Australia's domestic consumption – in the eastern states of Australia.

The international markets were on fire in June and July as production issues emerged in the northern hemisphere winter crop. After four consecutive years of record global wheat production, and the subsequent building of world stocks as supply exceeded demand, the tide had turned somewhat and the funds (speculators) were spooked.

The market ran up as short positions were liquidated. But the market is now reassessing, realising world stocks are still quite healthy and the futures markets may have been a tad overcooked.

Being a major exporter of grain into the world market place, the production issues here in Australia are also starting to attract attention globally. It is not a disaster yet, but production of wheat and barley will certainly be less than last year. Better than average rainfall over the next two months and mild finishing temperatures will be required to keep that decrease to less than 40 per cent nationally.

This is where the size and the location of the carry out from last season comes back into the discussion. As mentioned

earlier it is well positioned to satisfy domestic demand in eastern Australia in a lower than average production year.

Despite the rally in global markets, it will also temper any rally in domestic basis, as there will most likely be an exportable surplus on the east coast of Australia.

Spring has sprung...

THE sun-kissed days blend into warm evenings and the cold winter months are cast aside. The deciduous trees break their winter dormancy with glorious displays of colour. Spring has arrived and with it comes much anticipation and optimism as the crops (in most regions) move into their critical reproductive phase.

The major exception to this is Central Queensland where harvest commenced late August. It is very early days and far too early to see any yield trends. Nonetheless, reports to date from the early chickpea and wheat harvests are quite promising, considering most producers have had very little rain since cyclone Debbie drenched the region in late March.

As we know, this season is nothing like the last and the "very little rain" story is not limited to Central Queensland. Growers in southern Queensland and many areas of northern and central New South Wales are also suffering the same fate.

For many in these parts of Australia, summer brings a second cropping opportunity. The deteriorating winter crop optimism has given way to summer crop hope. Hope that the dry winter will turn into a wet spring and a possible summer crop plant will come to fruition. And hope that a summer production bonanza will replace a winter crop failure.

Of course, most regions of Australia do not have the luxury of a sorghum, cotton, corn or mung bean cropping option over the hot summer months. Their weather pattern is characterised by winter dominant rainfall and summer drought. Their only alternatives are the traditional wheat, barley, canola and pulse rotations common to many of the world's temperate cropping regions.

In these areas, with the exception of Victoria and the Esperance zone in Western Australia, the lack of rain across autumn and winter has also dominated Saturday night pub talk. The bumper yields of last season have been replaced by average or below average expectations this season. In the northern districts of the Western Australian wheatbelt many of the crops have already failed. If they germinated, they will barely return seed and the focus for many has now turned to footy finals or the upcoming cricket season.

But across the southern most reaches of Australia's winter cropping zone a wetter tone emerged in late July and through the month of August, replacing the dryer than average autumn and winter conditions experienced in many regions.

On the Eyre Peninsula (EP) in South Australia the start to the season had been extremely dry. Many areas were dominated by bare paddocks where the crop hadn't been planted, or if it had, the germination was extremely poor.

Spectacular transformation

The transformation following these recent rains has been spectacular. The outback hues have been replaced by a landscape of green, as dormant seed germinated and struggling crops gratefully accepted a new lease on life. That said, the crop is very late and patchy in many areas and below average production is the most likely outcome at this stage.

Elsewhere, the recent rains have added some production certainty to the rest of South Australia, the Albany zone and southern parts of the Kwinana zone in Western Australia and southern New South Wales. The caveat here is that the crops are nothing like last year. They are patchy and/or late in many areas and the August rains have not always been general. Average, or even above average yields are a possibility for some and a dream for others.

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The Long and Short of the global pulse trade

By Ron Storey – Chair of Pulse Australia

THE market outlook for pulses needs to be seen from two aspects: Long term (10 years plus) and short term (the next 12 months).

Long term – to 2025 and beyond is positive

- The theme is very positive for pulses – it is a consumer story and about changing behaviours.
- There is a transformation taking place in the way we think about food.
- There is a focus on health, nutrition, affordability, sustainability, provenance, environment – these themes plays perfectly into the pulse story. The pulse message is simple and believable.
- The western world millennials (18–34) are foodies, on social media, and are fans.
- The key drivers for food change are: Must taste good, nutrition benefits; health benefits; and, also deal with their fears (obesity, cancers, affordability, sustainability).
- The IYP 2016 legacy will be World Pulse Day and "Half Cup Habit" (campaign for diet to include half cup per day of pulses, somewhere in the diet, either cook and eat or as an ingredient).
- In addition, there is growth in animal and pet food requirements for plant protein and other industrial and food ingredient uses of pulse fractions.
- The sense is that we are at the start of a longer term global trend and change in consumer habits.
- It's an exciting prospect for pulses.

Shorter term – 2017–18, is expected to see some price volatility

- We are coming out of two poor seasons in both India and Pakistan, which are the major buyers of Australian chickpeas and lentils.
- The coming 2017–18 season looks more normal with average monsoons to date and therefore likely lower import demand.
- New exporters from Russia and Ukraine are emerging.

Market direction by commodity

At the Global Pulse Convention (GPC) in Vancouver, the roundup of market direction by commodity was:

Lentils

- Lentils have been one of the star performers for Australian farmers in 2016–17.
- While area planted in 2017 is steady to higher, the yields are expected to return to normal with exports falling in line with lower production.
- Canadian red lentil 2017 production is under pressure with hot weather, with production estimated at 1.8 vs 2.5 million tonnes (mt) in 2016.
- Expect a better quality Canadian crop in 2017.
- The Australian crop to decline from 2016 of 700–800,000 to around 400–500,000 tonnes.
- Possible lower Indian rabi plantings in late 2017 (wheat prices more attractive to Indian farmer).
- Prices stable to slightly lower, largely dependent on outcome (August–September) of Canadian crop and the speed of importers to work their way through current pipeline stocks.

Chickpeas (Desi and Kabuli)

Another star performer for farmers and exporters in 2016–17.

- Area planted in Australia is steady to higher in 2017, but average yields, if achieved, will see a crop more in the region of 1.3–1.5 mt.
- India Desi production will depend on monsoons and their planting in October–November, but under 'normal' conditions, we could expect lower imports in 2017–18.

- Pakistan imported 400,000 tonnes from Australia in 2016–17. Subject to an average local crop in Pakistan, this could be expected to drop to 100–200,000 tonnes in 2017–18.
- If these 'average' conditions do eventuate in Australia, India and Pakistan over the last half of 2017, we can expect Desi chickpea prices to ease as we approach the Australian harvest – remembering that we have seen decile one chickpea prices in the A$700–1100 range over 2016–17.
- Kabuli chickpeas have had very tight supplies, and record high prices in 2016.
- Expect production to respond in 2017, but at faster pace in 7–9 mm – larger size may take longer.
- Supply to grow from Mexico, India, US, Turkey, Russia and Argentina.
- Demand is steady from South Asia, EU, Middle East and North Africa.
- US (a Kabuli exporter) 2017 production is under pressure with the extreme hot weather in July in Montana/Dakotas.
- CIF prices to India were quoted at USD1300, with no-one prepared to predict when these levels might ease.

Field peas

- Major production increases over 2012–16 period in Canada, US and Russia.
- Major Indian production fall in 2016 (weather).
- Recent growth in 2016 demand from India (weather), China, and Bangladesh.
- 'New' demand appearing from petfood trade for plant protein and pea fractionation for flour ingredient.
- Pea prices have stayed low to date in 2017, but likely to be dragged up by recent wheat price surge and some switching of feed protein demand to peas.
- Current Canada values sees pea protein at 50 per cent cost of soybean meal.
- Australia 2017–18 production estimated at 300–350,000 tonnes, with expected strong domestic demand from feed industry due to rising prices of protein soybean meal.

Faba beans

- Australian domestic demand in 2016 estimated at 100–120,000 tonnes.
- Expect 300–400,000 tonnes 2017 crop, but like field peas, the demand for protein in the local feed market is expected to flow over to faba beans and see prices firm to higher in 2017–18.

A word of caution

- The above market and price direction comments are the 'combined wisdom' of those at the GPC held July 10–13, 2017.
- As always, the nature of pulse markets with so much dependent on weather in both exporting and importing countries still to play out, means we should expect volatility as these events unfold over the balance of 2017.
- Notwithstanding the normal seasonal variability, the underlying long term structure of pulse markets looks strong. Look out for the "Half Cup Habit" to hit your kitchen in the coming 12 months!

Real time protein mapping could aid on-farm fertiliser decisions

REAL time protein mapping technology may provide the missing link for growers looking to better identify the causes of lost revenue in their paddocks and capture protein premiums with grain sales more frequently.

Developed by Australian company Next Instruments, The CropScan 3000H On Combine Analyser was one of the key presentations to growers and agronomists at the Grains Research and Development Corporation (GRDC) Updates at Pallamallawa, in northern New South Wales recently.

Developer Phillip Clancy said protein mapping will complete the story on soil and plant performance that is only partially provided by yield mapping.

"Yield mapping has provided significant improvements in productivity and profitability, but by combining yield mapping with protein maps, growers can more completely understand the variations that occur across the paddock," he said.

"They can then use variable rate fertiliser applications to achieve the optimum yield across fields. Real-time protein data can then help to determine where in the field nitrogen should be applied and at what rate.

"High yield and high protein indicates that the plant has reached its full potential – the 'sweet spot'."

One grower in South Australia has combined yield mapping with a protein map to show that the problem with yield was there was insufficient nitrogen available in the emergence and tillering stages, but there was enough nitrogen for the growth stages of sections of the crop.

"In other sections of the same paddock, the yield was high but the protein map shows that the average protein level was lower than expected," Phil said.

"As a result of the analysis, it was found the grower was leaving approximately $10,000 value in the paddock because he did not achieve the optimum yield and protein grades."

Real time protein mapping works whereby near infrared (NIR) light passes through a sample of grains as they are being harvested, and is transmitted to a NIR spectrometer located in the cabin. Data is then sent to a cabin mounted touch screen personal computer where calibration models are applied for protein, moisture and oil.

As the harvester bin fills with grain, the bin protein averages are displayed in real time so that the operator can make decisions about segregating grain or selectively stripping different parts of the paddock.

Phil said the second major use of real time protein mapping is as a tactic to maximise protein grade payments and is already generating significant profit gains for many grain growers.

"One grower using the technology for in-paddock blending noticed a variation of up to five per cent in protein levels across one paddock," Phil said.

"He was able to monitor protein levels as the bin filled and switch to a lower or higher protein section of the field until the bin average reached 13.5 per cent. He reported that every load was accepted as APH1 grade which at the time attracted a $30 per tonne premium.

"This practice generated an estimated additional $40,000 in grain payments across the farm.

"In a slightly different application, another farmer in NSW is using real time protein data to segregate grain by protein level before it is stored on farm. The protein, moisture and weight of every truck load that is stored into each silo is recorded by the system and is made available to their grain marketing consultant.

"Grain is then marketed from each silo with confidence that the protein will meet the buyer's requirements. This system has led to higher prices received per tonne and no costly rejected loads for the grower."

Phil Clancy says farming is about converting water into grain and this can be helped by combining yield and protein mapping.

In summary Phil said the technology had two major application streams on-farm:

Tactical

- In paddock blending of grain to maximize protein grade payments.
- In paddock segregation and storage to maximise protein grade payments.
- On farm segregation and storage into on farm silos.

Strategic

- Protein/nitrogen/yield optimisation to find the 'sweet spot'.
- Reduction in nitrogen fertiliser or better use of nitrogen fertiliser.

"Farming is about converting water into grain. When there is sufficient water available, then the grower's task is to optimise the yield and to get the best price for the grain," Phil said.

"By combining yield and protein maps, growers can more completely understand the variations that occur across the paddock."

He said growers are then able to use variable rate fertiliser applications to achieve the optimum yield across paddocks with real-time protein data able to help determine where in the paddock nitrogen should be applied and at what rate.

For more details go to https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2017/07/on-the-go-protein-sensors-using-real-time-protein-data-for-more-profitable-marketing-aggregations-and-nitrogen-decisions ■

How a new wheat variety could compete with weeds like Jonah Lomu did on the field

Picture yourself on the rugby field, and you're the only thing between All Black Jonah Lomu and the try line. He stood at 6'5", weighed 120 kg, and ran the 100 metres in a lazy 10.7 seconds. It's hard to imagine a more frightening sight. He could play the power game, the speed game, and he could step. He was the ultimate competitor.

Mace wheat, on the other hand, is agile, dependable, and can play the yield game, but its ability to compete with weeds is limited. But yield is king, and hence Mace has been an extremely successful variety where weeds are under adequate control.

What if we could have a wheat variety that could play the yield game and the competition game? What would that look like? Perhaps a dwarf wheat, with a long coleoptile, prostrate growth habit (like barley), early vigour, leaves like solar panels, and of course, high yield.

Well, that's exactly what wheat breeder, Dr Greg Rebetzke from CSIRO, is attempting to develop as part of a GRDC-funded high vigour wheat project. High vigour kinds of wheat are not only good for competing with weeds; they also serve to shade the soil to reduce evaporation and ultimately increase water-use efficiency.

If he is successful, Greg might like to name the first high vigour wheat variety Jonah!

To find out how this breeding program is progressing, and what difference high vigour wheat makes to ryegrass seed set, read on...

Why is crop competition with weeds such a big deal these days?

Back in the day, when the herbicides all worked, we didn't need to focus on crop competition with weeds. If weeds were present they were sprayed and they died. Things have changed a little now and herbicide-resistant weeds are an everyday part of farming life. Now we need to make every post a winner, and we need to do everything we can to reduce the seed set of the weeds.

There are two aspects of crop competition. There is the effect of the crop on the weeds and there is the effect of the weeds on the crop:

- Competitive crops reduce the seed set of the weeds, primarily by shading the weeds, and generally doing a better job of competing for moisture and nutrients as well; and,
- Competitive crops have less yield loss from high weed pressure.

In addition to these factors we also know that:

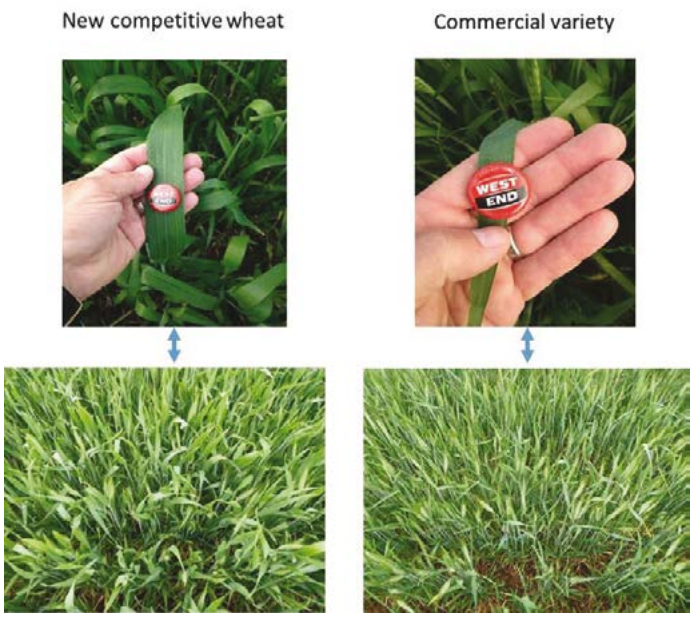
- Some resistant weeds have a fitness penalty (life has to be great to survive and reproduce!), meaning that a competitive crop can have a much bigger impact on the weeds;
- Herbicides generally give improved efficacy when combined with a competitive crop; and,
- Several weed species are now more dormant and emerge later than they used to. The weeds have adapted to avoid the knockdown and pre-emergent herbicides. Late emerging weeds will suffer at the hands of a competitive crop.

Elite wheat varieties with high vigour

Reduced row spacing, east-west sowing and higher crop density are all valuable tools to increase crop competition against weeds. Growers are also prioritising early vigour when selecting crop types and varieties for weedy paddocks. But the most competitive varieties aren't always the best for yield and other agronomic traits.

Enter Greg Rebetzke and team including Gurjeet Gill and the Australian wheat breeders…

Through a pre-breeding program, Greg is producing 'weed competitive elite wheats' with desirable agronomic traits by crossing selected high vigour (HV) lines with favourable commercial varieties. Importantly, the HV lines have been bred using 28 overseas high vigour wheat varieties for more than 20 years at the CSIRO in Canberra. These lines also incorporate new dwarfing genes that reduce plant height (minimise lodging) but maintain coleoptile length for deeper sowing.



The journey...

2009–10

There were 68 'HV' spring wheats developed by CSIRO from high vigour sources which were evaluated for weed tolerance (yield loss in presence of weeds) and suppression (of weed-seed production) against 18 commercial cultivars in South Australia over two seasons (source: Zerner, Rebetzke & Gill, *Genotypic stability of weed competitive ability for bread wheat genotypes in multiple environments, Crop & Pasture Science 2016*).

They found

- Mature crop height (taller genotypes) and early crop vigour were both closely associated with suppressed weed seed production and tolerance to weed competition. But taller stature was associated with lower yields under weed-free situations, so unlikely to be an acceptable trait for plant breeding and release of new varieties;
- Many of the HV lines were significantly higher yielding than commercial cultivars under weedy conditions (18 HV lines produced 10–20 per cent higher yield than the highest yielding commercial cultivar, Derrimut); and,
- Some of the HV lines provided over 50 per cent greater weed suppression than the commercial cultivars.

Michael Zerner and Gurjeet Gill from Adelaide University assessed some of the early lines from this breeding program and found that ryegrass really didn't enjoy growing amongst these triffids of plants! This and other research shows that at least a 50 per cent reduction in ryegrass seed set is common when comparing high vigour wheat and barley lines with current commercial wheat cultivars (Table 1).

TABLE1: Annual ryegrass seed head production in selected wheat lines at Roseworthy in 2009

Cultivar	Ryegrass seed heads/m²
Wyalkatchem	153
Janz	153
Espada	131
Barley	51
HV line WCD2-280504	84
HV line WCD2-400203	77

Source: GRDC Update paper Gill & Zerner 'Progress in developing weed competitive wheat' July 2010 https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2010/07/progress-in-developing-weed-competitive-wheat

2013–18

The GRDC project led by Greg Rebetzke is continuing to further develop HV lines, and with support from colleagues Gurjeet Gill and Bob French, use selected lines to breed elite spring wheats with the competitive trait for use in commercial plant breeding. Many hundreds of crosses have been made in consultation with Australian commercial wheat breeders, and over the next two to three years the project will identify and release to breeders potential competitive breeding lines with the objective of hopefully developing a high vigour, high yielding variety, complete with all of the other desirable traits that modern varieties must contain.

Such long-term and risky research requires dedicated funding support and hence the willingness for GRDC to partner and provide support for the research.

The project is also assessing HV lines used in conjunction with other competitive tools, including seeding rate and row spacing, and how HV lines perform against different weed species. These trials commenced in 2015 at Roseworthy (SA), Condobolin (NSW) and Yanco (NSW). Unfortunately, the 2016 trials were seriously affected by flooding. We'll follow up results at the conclusion of the project.

To sum up

Instinctively all growers know that crop competition is desirable, and it can be hard to achieve through adjustments in seeding rate, row spacing and orientation. While there's still considerable work to do in this research, we look forward to the future release of the high vigour line, 'Jonah' (and a few 'Wallaby' lines as well)! ■

Backcrossing HV + dwarf gene to commercial parent (April 2017).

Increasing 'crop per drop' aim of genetic research

THE delivery of new genetics to help produce wheat varieties that make better use of precious and increasingly variable rainfall is the aim of long-term Australian research.

This includes the development of genes that increase the length of the coleoptile, a protective sheath enclosing the shoot tip and first leaves of wheat.

Seed which germinate with long coleoptiles can be sown deeper in the soil to make use of residual moisture left over from summer rains. This means plants with long coleoptiles are potentially better suited to capturing yield benefits associated with early sowing than plants with shorter coleoptiles.

Wheat geneticist Greg Rebetzke leads this work for CSIRO Agriculture and Food, with investment from the Grains Research and Development Corporation (GRDC).

In his role with CSIRO, Greg, who is also a GRDC Western Regional Panel member, is committed to research into delivering traits and germplasm for improving crop variety water productivity.

He works closely with commercial plant breeders to understand the relative benefits of one trait over another and how to integrate new genetics more efficiently in the development of higher-yielding, more robust cereals.

"Our group at CSIRO focuses on the delivery of improved water productivity, or increasing the amount of 'crop per drop', so growers can get better mileage out of precious rainfall," he said.

CSIRO wheat geneticist Greg Rebetzke is leading research focused on the delivery of water productivity, or increasing the amount of 'crop per drop'.

Greg said many growers had received good rainfall during summer in 2017, but had experienced dry conditions since – meaning many crop seeds had been unable to access moisture from summer rain located deep in the soil.

He said given increasingly variable rainfall in Australia, technologies and crop varieties that made better use of summer rain would need to become a more important feature of our farming systems.

Dwarfing genes

The CSIRO researchers have identified alternative dwarfing genes that could potentially reduce crop stature without reducing coleoptile length and early growth, as well as genes that actively promote coleoptile length.

The dwarfing genes are associated with reduced lodging when grown under conditions of higher nitrogen fertilisation.

Plants with the desired combination of genes have been passed on to wheat breeders to validate in their own programs, and then in the development of new long coleoptile varieties.

"Australian wheat breeders have been delivered the new genes that can produce a wheat plant the same height as varieties such as Mace or Yitpi, but have a longer coleoptile of up to 12.5 cm in length that can access water stored deeper in the subsoil," Greg said.

"Australian-adapted wheat lines incorporating these genes have undergone field testing at the GRDC's Managed Environment Facilities, including in Merredin, WA.

"We hope to learn more about these genes and be able to identify and release new wheat lines with the capacity to be sown as deep as 10 cm – or even 12.5 – deep if these new genetics are combined with improved technologies around planting equipment."

Greg said researchers were also striving to identify the best genes to incorporate into wheat varieties to maximise growth and facilitate flowering at times of the season least impacted by frost, drought and heat.

"CSIRO and other organisations in Australia are seeking to understand, with GRDC investments, what flowering genes are out there and how they are best assembled in a package and delivered to breeders for testing, with the aim of producing new, longer season wheats targeting improved water productivity for the Australian grainbelt," he said. ■

Farming in Foreign Fields...

Profiling US wheat sustainability: Justin Knopf, hard red winter wheat farmer

By Elizabeth Westendorf, US Wheat Associates Assistant Director of Policy

JUSTIN Knopf's family has been farming land in central Kansas for five generations – starting with their original homestead in the 1860s. Now, Justin farms 4000 acres (1620 hectares) with his father and brother, growing Hard Red Winter (HRW) wheat, alfalfa (lucerne), grain sorghum, soybeans and corn.

"I feel like I have been given a gift to be able to work with the land, and that comes with responsibility," said Justin. "What I do impacts consumers, so it is important to take time and energy to be transparent with them and share the bigger story of what is happening in our landscape."

The location of the Knopf's farming interests.

Justin is always learning new farm management skills and how he can apply the latest technology. After attending a no-tillage farming conference, he learned that an evolving no-till system includes having a crop growing and living in the soil at all times. After experimenting with cover crops in his rotation, the results show this boosted biological diversity in his soil and at times allowed him to reduce pesticide use where cover crops are grown.

Three areas of sustainability for ag to thrive

To Justin, sustainability involves stewardship of resources in three areas – environmental, economic and human.

He uses tools, research and continuing farm education opportunities to implement agronomic practices to protect natural resources such as soil, water and air, while also optimising his production per unit of resources.

This is environmental sustainability.

Justin also works to make economically responsible decisions for the farm because if it cannot survive as a business, he will not have a long-term ability to positively affect the environment down the road – which is economic sustainability.

And finally, Justin feels there is a human element to the sustainability conversation. He spends time focusing on the health and happiness of his family, his town and his neighbours while also working to educate consumers – which is social sustainability.

All three of these are necessary for agriculture to thrive.

The Knopf family farm is operated under the overriding principle of sustainable stewardship of the land for future generations.

The bigger story

"The land will go on for much longer than I will be here, and it's a much bigger story outside of myself, so I feel a responsibility to share that bigger story of what is happening with other people as a part of our stewardship," said Justin.

Justin works to share his story by being involved in consumer outreach programs and sustainability research.

Two years ago, in a partnership with Kansas Farm Bureau, he hosted a family on his farm for the day to show them how wheat is produced. Last year, Justin was featured in the book *Rancher, Farmer, Fisherman: Conservation Heroes of the American Heartland* by Miriam Horn, which talked about his focus on improving soil health on his farm.

A documentary film by the same title, narrated by award-winning journalist Tom Brokaw, and directed by Emmy-winning and Oscar-nominated Susan Froemke and Emmy-winning filmmaker John Hoffman, premiered on the Discovery Channel in late August 2016.

Justin's emphasis on soil quality and increasing organic matter is particularly impressive. He does this by using no-till methods, carefully calibrating his crop rotations to maximise organic matter and experimenting with cover crops.

These practices have improved his soil health, increased soil moisture and improved fertility, allowing him to reduce inputs like fertiliser and fuel and ultimately increase yields.

As part of this constant effort to improve, Justin experiments with new ideas on his farm to make sure that he is being a responsible land owner and manager.

"We see our soils as a fundamentally essential natural resource that is irreplaceable – and it takes a long time to build that soil up again if you lose it," said Justin. "And one of the foundational ideas of our family and our farm business is to be a steward of those natural resources and do everything we can to leave them in a better shape for the next generation."

Justin Knopf is one of six farmers – each of whom are growing one of the six main classes of US wheat – that USW has featured in a series to highlight how their production practices are dependent on local factors and how they each address the goal of sustainability on their farm. ■

Legume inoculant comparison: On-seed trumps in-furrow

ON-SEED application of peat slurry has provided the best nodulation, grain yield and nitrogen fixation in experiments comparing different methods of inoculating legumes.

The research, conducted as part of a GRDC investment, concluded that on-seed inoculation was 'consistently superior' to in-furrow inoculation in terms of nodulation and crop productivity.

Eight field experiments were conducted over two years at four different locations in south-eastern Australia to quantify the response of lupin and faba bean to three inoculant methods:

- On-seed application as a peat slurry;
- In-furrow peat inoculant delivered as a liquid suspension at seeding; and,
- In-furrow peat granules delivered at seeding.

Uninoculated treatments were also included in the experiments which were located at Mininera, Rutherglen and Boorhaman North in Victoria, and Culcairn in New South Wales.

Research leader Matt Denton, from The School of Agriculture, Food and Wine, The University of Adelaide, said the aim of the study was to determine whether inoculation application methodologies altered the patterns of nodulation on roots, and if so, whether this influenced nitrogen (N) fixation, crop growth or grain yield.

Testing inoculants

"The experiments were conducted to test the hypothesis that granular and liquid inoculants increase nodulation on lateral roots, with subsequent positive impacts on legume productivity," Matt said.

"But in our study, peat slurry inoculation on the seed, which increased nodulation around the root crown, had generally higher grain yields than other treatments. In contrast, in-furrow granular and liquid inoculants had more varied yield patterns."

Matt said the benefits of deeper, lateral nodulation may in fact be dependent on other factors such as soil water availability, protection of the inoculant from adverse conditions, and seasonal environmental conditions.

Symbiotic N fixation is a key biological process in legumes that supports plant growth and the production of high-protein seed and forage. The establishment of legume root nodules with a functioning N-fixing symbiosis requires that an appropriate root nodule bacteria (rhizobia) is already established in the soil, or that rhizobia are supplied at sowing by inoculation.

On-seed inoculation is the conventional form of legume inoculation and has served legume growers well for more than 100 years. This procedure ensures that inoculant rhizobia are delivered into the soil in the immediate vicinity of the emerging root. But the procedure is somewhat time-consuming, especially with larger-seeded legumes, and it may represent a bottleneck at sowing.

In recent times some Australian growers have drilled liquid and

solid granule formulations of rhizobial inoculants directly into the furrow. In-furrow inoculation has potential to mitigate against certain drawbacks of the traditional peat inoculant applied to the seed. In-furrow inoculation provides greater flexibility in sowing logistics and separates the inoculant from seed-applied fungicides and insecticides that may be hazardous to rhizobial survival.

Matt said until now, gaps in knowledge existed in terms of how each of these different inoculation application methods performed in the field, under different environments and farming systems.

To assist in answering some of those questions, the GRDC invested in a study that was activated in 2008, involving researchers from The University of Adelaide, Agriculture Victoria, La Trobe University and CSIRO. Nodulation, peak biomass production, seed yield, N content and N fixation were measured for all treatments in 2008 and 2010.

On-seed inoculant consistently superior

"The evidence from our experiments was conclusive – in terms of most parameters of nodulation and crop productivity, on-seed inoculation was consistently superior to in-furrow inoculation," Matt said. "But there were few differences between the two forms of in-furrow inoculation – liquid and granules."

Total N fixed was measured at an average of 180 kg N per hectare for peat compared with 110 kg N per hectare for in-furrow granules and 104 kg N per hectare for liquid. Faba bean yields were the most notable in terms of difference, being an average of 2.40 tonnes per hectare when inoculated with in-furrow granules compared to 2.22 (in-furrow granules) and 2.06 tonnes per hectare (liquid).

In the study, all three methods of inoculation generally increased nodulation, N fixation and grain yield, relative to uninoculated treatments. Matt said data from the experiments at Culcairn also illustrated the large economic benefits derived from using a quality inoculant, in any form, at an approximate cost of $10 per hectare when soil rhizobia numbers are either low or absent.

"Under these conditions, the contribution of the additional N fixed and net N returned to soil in legume residues was equivalent to an input of $95–$115 per hectare of urea fertiliser, and the increase observed in faba bean grain yield of 1.94 tonnes per hectare (relative to uninoculated treatments) was worth over $500 tonnes per hectare, based on grain prices at the time," Matt said.

Cost-efficient form of N

GRDC Manager Soils and Nutrition – South, Stephen Loss, says legume crops and pastures deliver an incredibly cost-efficient, alternative form of N, as well as acting as weed and disease breaks for cereal crops and generating income and enterprise diversity benefits for growers.

Research comparing different methods of inoculating legumes has been led by Matt Denton (pictured) from The School of Agriculture, Food and Wine, The University of Adelaide.

"For many years the GRDC has recognised the importance of adequate nodulation in maximising the benefits of growing legumes and its investments in targeted research, development and extension activities have delivered considerable insights and information on inoculating legumes and nodulation," Stephen said. Practical GRDC resources include the popular *Inoculating Legumes* guide and a new GrowNotes *Legumes and Nitrogen Fixation Tips and Tactics* fact sheet.

Meanwhile, in other related research activities, the influence of pesticides on inoculants is being investigated and an assessment of farmer inoculation practices in Australia is being undertaken.

Improving pulse options and the survival and viability of rhizobia in current farming systems is an issue identified as a high priority by the GRDC's Southern Regional Cropping Solutions Network. ■

Unravelling what genomics can do

By J. Kim Kaplan, Agricultural Research Service – USDA

AT A GLANCE

- The term 'genome' refers to all of an organism's genes.
- 'Genomics' is the science of connecting genes with the traits they control.
- Improving an organism with genomics is much faster than traditional breeding.
- Scientists use genomics to solve agricultural and environmental problems.

IT took nearly 10,000 years of breeding to take maize from a tropical crop with thumb-sized ears to the high-yielding crops of today. But in just the next decade, new corn varieties will likely have higher levels of vital nutrients, handle drought and temperature extremes better, and produce yields more efficiently.

How will these changes happen so quickly? The short answer is genomics.

Genomics is today's buzzword when it comes to scientific progress – but what does it really mean?

To answer that question, we need to take a few steps back.

Most people recognise the term DNA – the iconic double helix in the cells of all living things. DNA makes up an organism's genes. All of an organism's genes together comprise a set of instructions – a 'recipe' for making that particular species or variety. This is the genome.

Genomics is also the science of connecting genes with the physical traits or processes they control.

Genomics is also the panoramic view of an organism's entire DNA landscape, not only how DNA works, but also how the genome interacts with its environment and how environment acts on the genes.

Scientists are studying all types of genomes to unlock the codes to specific traits and to use this genomic information to help solve fundamental agricultural and environmental problems.

ARS scientists helped identify genes that allow corn to adapt to different latitudes and elevations. (PHOTO: Doug Wilson)

Genetic markers

Sometimes, rather than figuring out a whole genome, it is easier to identify stretches of DNA known as genetic markers that are associated with particular physical traits. A genetic marker is not necessarily part of the gene controlling a trait, but it is always associated with the trait.

Finding a genetic marker can be faster than sequencing a genome, since it only requires identifying a short DNA sequence rather than millions of genes and their functions.

Before use of genetic markers and genomics became practical, researchers and breeders trying to breed in improvements were mostly working in the dark – or at best working with indirect physical evidence. They could only select parents that exhibited, or expressed, the desired trait and then hope the trait would pass to the next generation.

Usually, researchers bred thousands of combinations for every one or two successes.

"What genomics really means is having a powerful spotlight," explains Jack Okamuro, ARS national program leader for plant genetic resources, genomics, and genetic improvement. "It shines a spotlight of precision so a scientist can get a much better fix on what genes need to be in the offspring."

For example, ARS scientists found markers for a valuable gene that gives wheat resistance to the hessian fly. To ensure that the resistance trait is successfully bred into new wheat plants, researchers need only to look for the genetic markers. This cuts years – if not decades – off the process of conventional breeding.

Similarly, when ARS vegetable researchers wanted to breed broccoli that could be grown in warmer temperatures, they identified genetic markers associated with heat resistance in a test group of broccoli plants. These markers will speed the development of heat-tolerant broccoli cultivars.

In the case of maize, ARS geneticist Edward Buckler has developed an encyclopedic amount of information about the crop's 40,000 genes and the nearly 2.3 million pieces of genetic information about specific physical traits, such as flowering time, yield, and cold tolerance. And the knowledge base continues to expand.

Edward is part of a team that recently analysed 4,500 maize varieties bred and grown by farmers across the Americas to find the genes that let corn adapt to different latitudes and elevations.

"We found that there are a thousand genes attuning a maize plant to a particular latitude and elevation," Edward says. "But we found them."

"Genomics provides us the knowledge and precision to combine the best genetics, whether from the tropics or the US Midwest, to get a new variety with exactly the traits to do the job we need it to do – and to do the combining in just a couple of years, rather than in a decade," he adds.

Big data, big results

Sequencing a genome spawns an enormous amount of data. As technology's power to produce genomic information grows, ever more data is generated, and new approaches are needed to manage all of it.

In the case of insect genomics, research is further complicated by sheer numbers. There are millions of insect and arthropod

Corn has thousands of genes that influence traits like flowering time, yield, and cold tolerance. (PHOTO: Peggy Greb)

species, many of them with profound importance to people and to Earth's ecology.

Insects pollinate a third of our food crops, yet some can cause considerable damage to crops and livestock – and big revenue losses for producers. Pesticide resistance is an evolving problem too. Understanding an insect pest's biology is essential to finding ways to combat it without harming other species.

Better solutions to these problems are to be found in the genomes of pests and their hosts. Yet, the vast diversity of insect species means fewer scientists and resources to unlock their genomic secrets. Developing and maintaining genomic databases is often beyond the financial and technical reach of those smaller scientific communities.

i5k initiative

In answer, an international group of scientists, co-chaired by ARS national program leader Kevin Hackett, organised the "i5k Initiative" to sequence and analyse the genomes of no less than 5,000 important insect species. The initiative leverages resources by virtually bringing together scientists from all over the world and from different disciplines, such as molecular biology, genetics, physiology, bioinformatics, and database management.

It has fostered discussions about how to reduce redundant research efforts and provide feedback about funding priorities.

Far from being ivory tower exercises, i5k insect genomics efforts are leading to advances that play right into today's headlines. A big spike in cattle tick numbers in the summer of 2017 put ticks high on the season's list of media topics, and ticks are also among the successes associated with i5k.

When ARS insect physiologist Felix D. Guerrero and his team sequenced the cattle tick genome, which is about 2.5 times the size of the human genome, they identified genes they are now using to develop a new vaccine against cattle fever ticks.

This vaccine may protect cattle from several fatal diseases spread by the tick.

The proteins these genes control are also being tested by ARS entomologist Andrew Li for control of ticks harbouring bacteria that cause Lyme disease. Li hopes that when these ticks bite mice and rabbits given the proteins, the ticks will die. White-footed mice and rabbits are hosts for early stages in the tick life cycle.

Parallel with the i5k initiative, ARS's National Agricultural Library (NAL) has organized the "i5k Workspace@NAL" to provide a common online area where researchers can work together on genomes, piecing together data using internationally standardised genomics software.

This ensures the widest possible access to the data and more long-term stability for genome databases.

"Scientists – and others – see i5k Workspace@NAL as neutral ground. We have been able to draw together groups into broad international collaborations working on common data sets, efforts that would be more difficult, if not impossible, with smaller databases, each focused only on a single species, at risk of disappearing every time someone retires or changes positions," explains computational biologist Christopher Childers, one of the project co-heads.

Genomics today lets scientists 'play poker' with more cards turned face up instead of betting into the complete unknown.

And that greatly increases the odds of success in solving today's most pressing agricultural problems. ■

Spring has arrived – so why do we have seasons?

By Bernie Hobbs, ABC Science

SPRING is in the air! But only for those of us below the Tropic of Capricorn. Only a few parts of the world experience the classic four seasons of spring, summer, autumn and winter. Many parts of the world get only two or even one. So, what's going on?

Every day, the Earth spins once on its axis.

But our planet isn't perfectly upright when it spins. Thanks to a few collisions during its formation, the Earth is tilted at an angle of 23.5 degrees.

This means that as the Earth takes its annual trip around the Sun, different areas of the planet face the Sun more directly during their daylight hours at different times of the year.

The tilt also affects the daily amount of light – without it the whole planet would have 12-hour days and nights every day of the year.

Summer and winter

Australia has summer at the end of the year when the southern hemisphere is tilted towards the Sun.

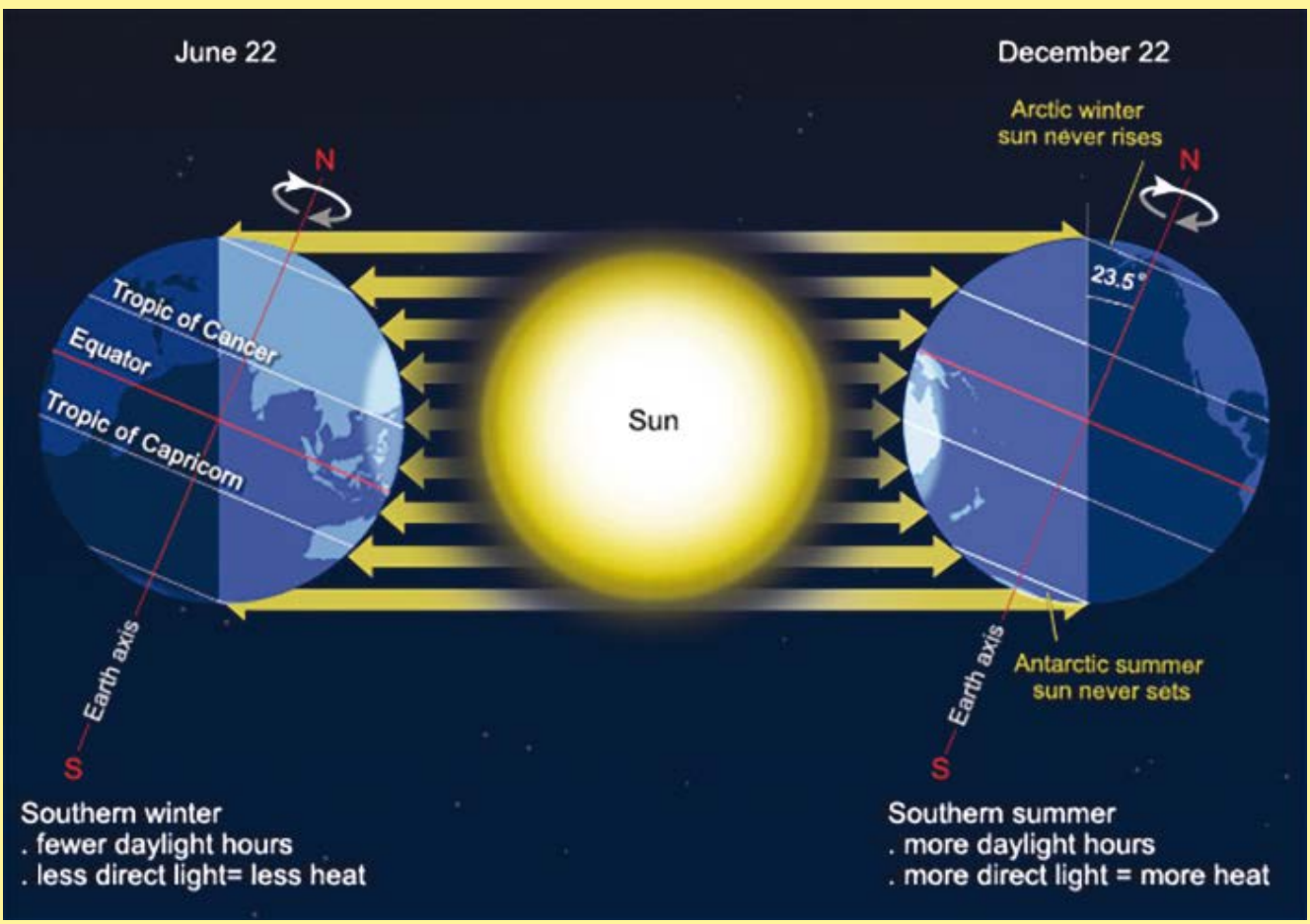
In summer, days are longer because more hours are spent facing the Sun. And they're hotter because we're facing the Sun more head-on – so we get hit by more rays of sunlight than if we were on an angle.

The summer solstice in Australia – about December 22 – is when we have our longest day of the year. On this day the Sun is as far south in the sky as it gets – it passes directly above the Tropic of Capricorn, roughly over Rockhampton.

But while we're busy planning Christmas barbecues, the northern hemisphere is tilted away from the Sun. That means there are fewer daylight hours up there and the light is spread out over a greater surface area, so it doesn't get as warm. Their shortest day – the winter solstice – happens on our longest.

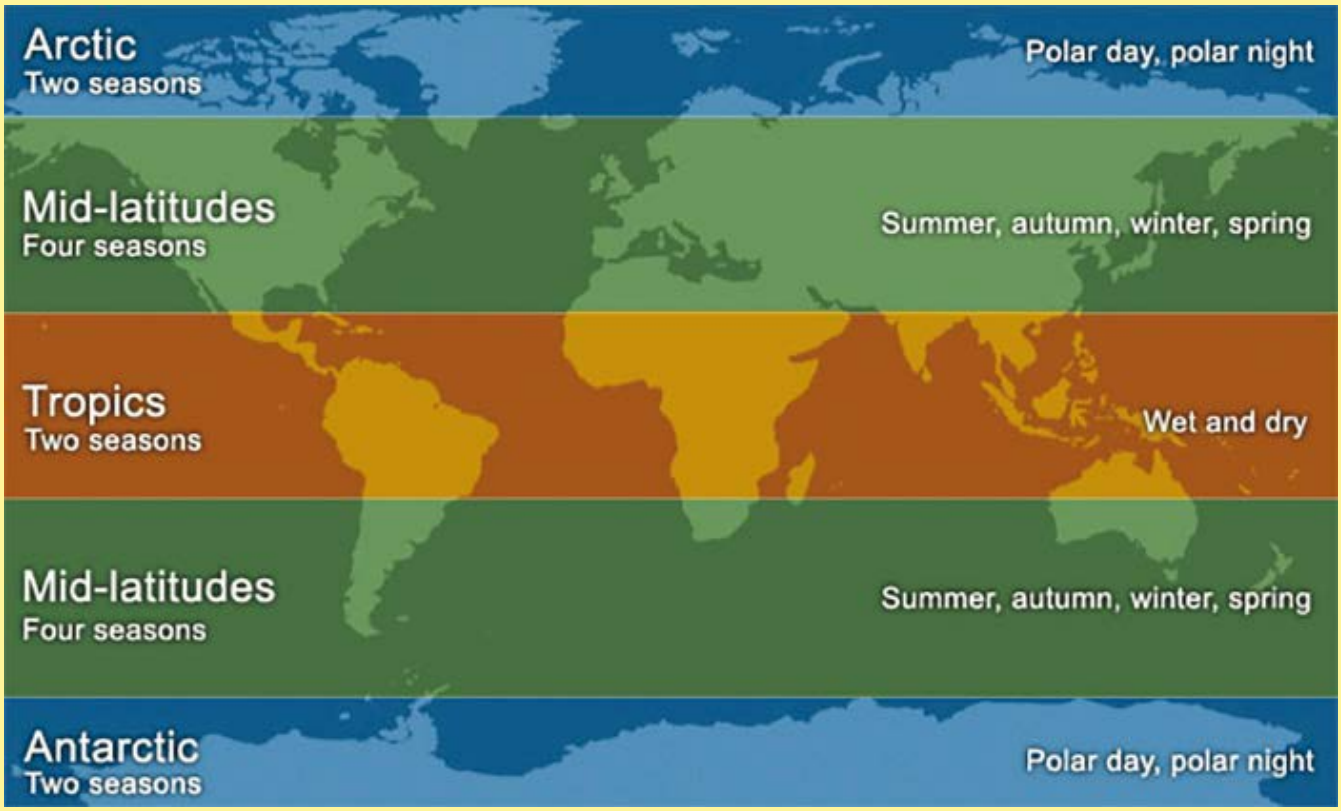
The tables turn six months later, when the Earth is halfway around its orbit of the Sun. The northern hemisphere's summer solstice (longest day) matches our winter solstice around June 22, when the Sun is as far north as it goes – above the Tropic of Cancer.

FIGURE 1: The seasons are a function of the Earth's tilt



(CREDIT: Julie Ramsden, ABC)

FIGURE 2: Only the mid-latitudes experience four seasons



(CREDIT: Julie Ramsden, ABC)

Spring and autumn

In spring and autumn the planet isn't tilted towards or away from the Sun – it's roughly side-on.

And for two days each year the Earth's tilt is exactly side-on to the Sun. The two days are called equinoxes (equal nights), and they fall in the middle of spring and autumn, usually on September 22 and March 22.

On an equinox, night and day are equal length everywhere on the planet.

But spring and autumn only happen in mid-latitude areas of our planet. It's a different story in the tropics and at the frozen ends of the planet.

Tropics and poles

Some parts of the polar regions are so consistently cold – and the tropics so hot – they could pass for having only one season.

Even the sunniest Antarctic day is as cold as winter in most places. This is because the light reaching the bottom of the planet is at such a low angle it doesn't carry much heat.

On the other hand, the tropics are consistently hot. It doesn't matter if they're tilted towards or away from the Sun, they're still closer to it than anywhere else on Earth and they get plenty of direct light and heat.

But both places have two distinct seasons.

In the polar regions, the main difference comes down to the amount of daylight. During 'summer', the whole area is tilted towards the Sun and flooded with sunlight. Daytime at the poles lasts for half the year.

And the polar night lasts almost as long – making for one very long, dark winter.

In the tropics, the difference between seasons is due to rainfall.

The wet is caused by a permanent belt of storm clouds around the middle of the planet that dumps huge volumes of rain on the land or sea below. Thanks to the tilt of the planet and some super-sized sea breezes, the storm belt doesn't stay in one place. During the northern summer, the hot air over the land rises, sucking the storm belt as far north as the Tropic of Cancer, doling out monsoons wherever it goes.

As the northern summer ends the storms are dragged down towards the Tropic of Capricorn, driving the southern tour of the monsoons.

The belt travels across the equator twice a year, once going south and once on the way back up. If they've got the right combination of mountains, wind and sea temperature, some equatorial areas – such as Kuala Lumpur – can score two wet seasons each year.

Fortunately, the Top End is far enough from the equator to just have the one wet season – imagine how crazy Darwin would get with two build-ups each year…

Thanks to Dr Blair Trevin from the Bureau of Meteorology. ■

Spring is only a mid-latitude phenomenon.

RECORD WINTER TEMPS

Winter in Australia this year was hot and dry with the average maximum temperature up nearly 2°C above the long-term trend according to the Bureau of Meteorology.

The average maximum daily temperature recorded across all Australian recording locations for June, July and August, 2017 was a record 23.7°C (these national temperature recordings began in 1910). The previous record of 23.4°C was set in 2009.

The 2017 winter average was 1.9°C degrees above the baseline 1961 to 1990 average of 21.8°C.

The nights were still cold

The warm weather was most pronounced in the north of Australia.

It was the hottest winter on record for Western Australia, Queensland and the Northern Territory, while New South Wales and South Australia made the top three.

Daily minimums were also warmer than average in most of northern Australia but not as far above average as the maximums.

In contrast, inland NSW and northern Victoria had notably cold nights with many areas 1°C to 2°C below average.

NSW had its coldest average winter nights since 1997.

Meanwhile nationally, it was the ninth driest winter on record.

Skies stay clear

Andrew Watkins, manager of extended and long-range forecasts at the Bureau of Meteorology, said the real reason for the warmth was the persistent high pressure seen particularly during early winter.

"But you also have to add to that the long-term warming trend," Andrew said.

Evaporative cooling is the same process that cools you down when you sweat, taking energy from the surrounding air to convert liquid water into gaseous water vapour, leaving the surroundings cooler.

Without a lot of water on the ground this year, large scale evaporative cooling could not happen.

The clear skies also explain the low minimum or overnight temperatures in the southern states.

Without a blanket of clouds, the heat from the day is lost to space, and temperatures drop overnight.

High pressure prevented cold fronts

"We've also seen fewer cold fronts able to penetrate inland due to the slow moving and more southerly highs acting as a barrier to their normal northward progression," Andrew said.

So not only has high-pressure prevented rain in the north but it has also prevented the cold fronts which normally bring rain in the south during winter.

According to the climate scientists at the Bureau of Meteorology, the story behind the heat in northern Australia is more about what has not been happening.

In a standard winter there would be several south-easterly surges, bringing cold air into the tropics.

This year these surges were almost completely missing – blocked by that high pressure – until very late in the season.

New era for Celli and Farmgard in Australia

SINCE 1955 Celli Spa, Italy has been manufacturing quality tillage equipment and now export to 30 countries around the world. The development of Celli equipment has followed that of the agricultural and horticultural sector, in which the name Celli has become synonymous around the world for quality, innovation and reliability.

Celli today manufactures a range of rotary hoes and power harrows from one to six metres (20–450 hp), seeders up to four metres wide, bedformers and stone buriers from 0.95 to 7.0 metres, heavy duty rippers and subsoilers, spading machines and a comprehensive range of fixed, offset and folding mulchers.

Celli Spa CEO, Stefania Celli says: "If we had to sum up in few words what we want to be, we would say that, first and foremost, we want to be recognised as specialists."

"We believe that trying to make too many things at the same time (which is often too common nowadays) prevents companies from achieving good results in terms of product development and quality.

"We have always aimed at building a serious, solid and dynamic commercial presence and creating long term partnerships, because we know that working with professionalism and patience will always pay off."

Farmgard appointed as exclusive distributor

With the above in mind, on September 11, 2017 Celli Spa announced the appointment of Farmgard Pty Ltd as the exclusive Australian distributor for the complete range of Celli manufactured products.

Farmgard Managing Director, Mark Capper says: "We are a third generation Australasian business which has had a presence in the Australian market since 2007.

"To support the ongoing growth of our Australian business unit, in early 2017 we opened a dedicated assembly, parts and distribution centre in Melbourne. This centre will future proof our expansion plans and provide an efficient and effective way to support our rapidly growing customer base.

"Farmgard has been distributing Celli equipment throughout New Zealand for over 30 years and we are looking forward to bringing that experience to Australia along with meeting the new challenges the Australian market will provide," Mark said.

As well as the full range of Celli equipment, Farmgard also currently represents Abbey feed mixers, slurry tankers and manure spreader, RZ rippers and discs, Farmgard grader blades and Stanhay precision seeders.

For all enquiries please phone 1800 farmgard (1800 327 642). ■

Celli Spa specialises in quality and innovative tillage equipment.

Protecting stored grain from insect pests

UNDERSTANDING the options for protecting stored grain from insect pests – as well as knowing the condition of your on-farm silo – is important information if grain growers are to make the right insect control decisions.

"Fumigation in-silo using phosphine would be the most common form of insect protection used by farmers, but many silos are not suitable," says Rod McLean from Bayer.

Market research conducted by Bayer earlier this year showed almost 90 per cent of cereal growers have on-farm grain storage. Many had a combination of different types of storage but the most common was unsealed.

"Of those silos described as "sealed" in the survey, 60 per cent were over 10 years old and it is doubtful if they are gas tight," Rod says. "Many silos are sold as "sealed" but after a few years fail the Australian Standard.

"You need to maintain the level of fumigant above a minimum for several days. If it is not gas-tight this is not possible and the fumigation is not going to be successful," Rod points out. "There is plenty of evidence showing Australia has insect resistance to phosphine. This will be due to it being in use for many years and poor fumigation practices, including poorly sealed silos."

If a silo is not gas tight the only option for good insect control is to use a liquid grain protectant like K-Obiol. These liquids can be used in unsealed silos as well as sheds.

Some grain protectants have been in use for over a decade and insect resistance to them is also becoming a problem. There are several types of insect pests which infest stored grain and they are found throughout the grain growing areas of Australia.

"When we have examined infested grains we often find two or more insect types," Rod says. "Different insects have developed resistance to the various grain protectants. If you want to get good protection you need to use a combination of grain protectants with different modes of action. K-Obiol – in combination with either fenitrothion or chlorpyrifos-methyl – gives effective control of all types of insects."

"Growers spend about $120 per tonne to grow their grain and get it into the bin," says Rod. "The additional cost of protecting the grain in the bin is around $0.50 to $3.50 per tonne depending on the storage system. It seems a pity to risk your valuable stored grain by not choosing the correct method of insect protection."

Farmers who want to use K-Obiol must complete the training. See https://www.environmentalscience.bayer.com.au/K-Obiol/Training ■

RoGator C-series spraying smarter

WHILE the new RoGator C series doesn't look so different from the exterior, it offers plenty of innovation to enhance application and driveability.

It features a new Smart Drive system that is intuitive and smooth. Smart Drive links the tractor management system (TMS) and drive functions, so no operator input is needed. The TMS controls both engine RPMs and hydrostatic drives for efficient operation in even the most undulating of country.

Croplands Area Sales Manager, Steve Ross attended the launch in Jackson, Minnesota.

"To drive it was very user friendly, almost CVT like. The SmartDrive system doesn't create burms on headlands, proving a better boom ride and making it more comfortable for the operator," Steve said.

"The ABS was fantastic and the machine didn't lurch in extreme braking. Having baffled tanks there was no rocking backwards and forward – very car like in its response. The flexible chassis provides even ground distribution and with the addition of the traction control – this is the ultimate combination. This machine would perform amazingly in the most challenging paddock conditions," says Steve.

If the system senses a wheel slipping, it diverts power to the wheels that still have grip to keep the sprayer moving.

Folding the boom is made easy for the operator too. A single lever control provides comfort and improved day to day operation.

The LiquidLogic plumbing also improves spray accuracy and efficacy by creating consistent pressure across the boom which maintains a consistent droplet size across all nozzles.

"There is only one psi, plus or minus across the boom, which is a huge advantage in the plumbing system and makes the accuracy in spraying so exact. It's by far the smartest applicator on the market," Steve explains.

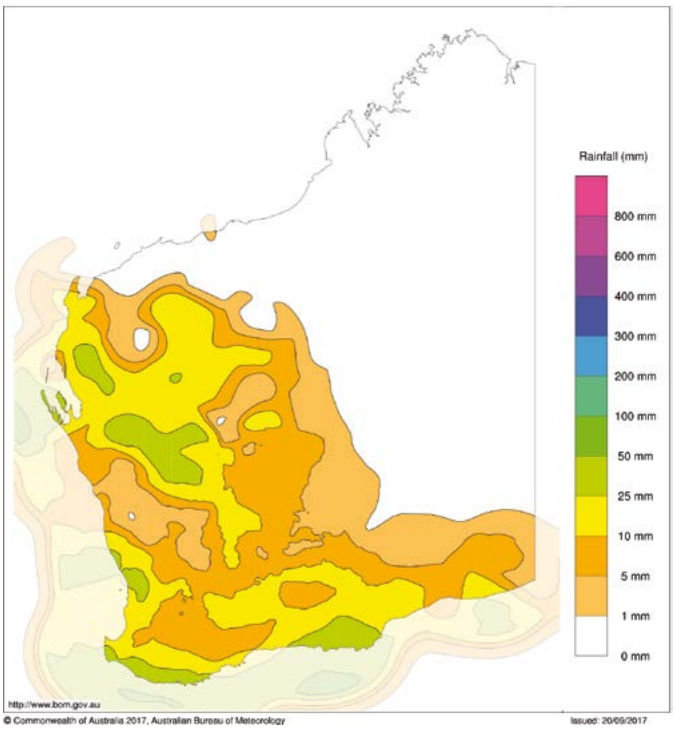
It also has a full recovery system, known as ClearFlow recover. ClearFlow is another industry first that uses air to force chemical from the boom lines back into the tank to minimise waste and contamination. This process is done from the cab which makes life easier for the operator.

Optional 48.5 metre Pommier aluminium booms will be available with the RG1300C model, ideal for those contractors and farmers who want extra width. ■

The Croplands RG1300C is available with an optional 48.5 m aluminium Pommier boom.

Western region

Western Australia rainfall totals (mm) – September 1–20, 2017
Australian Bureau of Meteorology



Most grain producing areas of Western Australia had an extremely dry start to the 2017 winter crop but August and September have brought improved conditions.

WESTERN AUSTRALIA SUMMARY

Most grain growing regions of Western Australia continued to receive rain and favourable growing conditions during August. But due to the lateness of the season and variable crop growth from the patchy start, it is still too early to tell whether these more recent favourable conditions will have a significant impact on final tonnages.

To achieve current estimated tonnages (million tonnes of winter crop) the mild conditions of the season over the past few months will need to continue along a similar path and with more rain needed for most regions.

Overall, barley grain yield potential is looking better than wheat, as many of the early wheat crops 'ran up' during the dry period in May–June and do not have the same density as barley.

Canola and lupin crops are being sprayed out for weed control where grain yield potential is too low to continue within the northern and eastern regions of the state.

Grain quality concerns are emerging with crops being late for this time of the year. Wheat and barley could be low in weight and protein as fertiliser has been modest and top-up applications have been late.

Grain yield potential has improved in the Lakes region, and the Esperance zone is still on track for at least above average grain yields.

The Department of Primary Industries and Regional Development reports that projections from climate models from September to November are indicating below median seasonal rainfall, though the probabilities are not strong.

It appears most likely outcomes will be near-normal or drier rainfall, and models are not indicating the likelihood of a wetter than normal spring for southern WA.

Geraldton Zone

The rain in the north of the state was extensive during the last week of August. The rains gave crops that had struggled all year a chance of returning more than just seed – as was the case a few weeks ago. There are still areas where there will be either no crops or very low yielding crops, but this area is decreasing slightly. The rain was more concentrated north of Carnamah with a dry strip between Wongan Hills and Carnamah only receiving light falls.

The rainfall in August resulted in earlier crop production estimates to remain around the same or slightly increased.

The majority of lupin and canola crops in the north and eastern areas have been sprayed out to control weeds. Lupins in the western areas could potentially return 80 per cent of average yields but the total tonnage for the zone will be down significantly from last year.

Canola crops in the western areas of the zone that have not been sprayed out are now requiring spraying for aphids and diamond back moth.

The Midlands

Crops in the western areas of the Midlands region are continuing to be on track for grain yields of around 80 per cent of average or close to average but central and eastern areas of the region still have very low grain yield potential.

SEPTEMBER 2017 GIWA WA CROP PRODUCTION ESTIMATES (TONNES)

Port zone	Wheat	Barley	Canola	Oats	Lupins	Field pea	State total
Kwinana	2,500,000	970,000	300,000	248,000	146,000	18,000	4,182,000
Albany	1,200,000	890,000	390,000	180,000	58,000	4,000	2,722,000
Esperance	1,150,000	652,000	430,000	10,000	24,000	20,000	2,286,000
Geraldton	750,000	150,000	65,000	3,000	100,500	900	1,069,400
Totals	5,600,000	2,662,000	1,185,000	441,000	328,500	42,900	10,259,400

Note: the grain totals reported are for whole farm production. This includes on-farm seed and feed requirements as well as trade outside of the CBH network.

District Reports...

September–October 2017

There are large areas of the major noodle growing locations that will harvest little more than grain for seed.

Canola and lupin crops around Dalwallinu are being sprayed out for weed control. Cereals east of Moora on the good sandplain are starting to struggle for moisture and the next few weeks will be critical in determining their final potential.

There were a few frost events during August, but as most crops are later than in previous years, there is not expected to be any major impacts on grain yield from these events.

Disease levels are low in cereals but the higher potential yielding canola crops are being sprayed for sclerotinia in the western areas of the region.

Kwinana West

The western areas of the zone are still on track for average grain yields for most crops. Cereal crops in these higher potential yield areas have had top-up applications of nitrogen to ensure grain protein does not fall away.

Sub-soil moisture is adequate to assist in finishing crops if these areas have average rainfall and mild temperatures during grain fill. Noodle crops in the western areas of the zone have been managed to meet specifications although tonnages will be down on last year.

The central/eastern and northern areas of the zone are where most of the states' noodle wheat is grown, and it is these areas that have suffered the greatest impact from the dry season.

The crop yield potential for all crops drops off as you go east with estimated potential 70 to 80 per cent of average. There are pockets of higher potential yielding crops around Kellerberrin and Corrigin but crops become variable in their yield potential further east.

Cereal diseases are low and at this stage barley generally has higher grain yield potential than wheat.

Canola is still flowering and there is some spraying for diamond back moth and aphids – particularly in the lower rainfall areas – to protect what grain yield potential there is. Sclerotinia leaf lesions are showing up in canola but the incidence is low and most canola will not require spraying.

Oat crops for hay are close to being ready to cut and oats for grain in the western regions of the zone have picked up in the last month and look to be on track for average yields.

Kwinana East

In the Kwinana East zone, not much has changed for the lower rainfall regions over the last month. Recent rainfall events will not have much impact on grain yield as most crops are late with very low potential.

Some late radish spraying in cereals is being carried out to keep paddocks clean for next year.

Canola and lupin crops that are late and too patchy to be worth harvesting are being sprayed out to keep paddocks clean.

Production of all grains in this region will be significantly down on last year.

Western Albany

The western areas of the Albany port zone are continuing to be on track for at least average grain yields for all crops. There have been good growing conditions during August with adequate rainfall to keep crops going well. Areas that normally suffer from waterlogging are less this year and this will help keep tonnages up even though the season is later than in recent years.

Disease levels in all crops are relatively low for the region and top-up nitrogen continues to be applied to keep protein levels up.

There are no major insect threats in this region at present.

Southern Albany

Good conditions are continuing for crop growth. Grain yield potential for all crops is still on track for at least average grain yields and if the season continues to be favourable over the next month, grain yield potential could be above average.

Crops are being managed for an average year with pests and diseases being controlled and top-up nitrogen being applied to those crops in need.

Waterlogging has not been a major problem in the region – as it often can be – and this will help in keeping whole paddock grain yields up.

Lakes Region

The Lakes Region continues to be on track for an average harvest result with some areas even predicting above average grain yields.

Good rainfalls in August and mild temperatures for most of the region have benefited all crops and the few frosts have been minor and are not expected to have significant effects on grain yield. Some of the areas from Pingaring to Varley that were struggling, have picked up in the last month and some crops that were going to be sprayed out will be kept and will continue through to harvest.

Most of the region has a good profile of soil moisture and is well placed to handle warm days and a drop off in rainfall during spring. There will be significant areas of the region where wheat will have the potential to reach 2.0 tonnes per hectare.

There is some powdery mildew and yellow spot in wheat but levels are low and not expected to have an impact on grain yield.

Barley is the pick of the crops and will generally outyield wheat at this stage of the season. There is some leaf rust in barley crops but it has come in late and is not expected to impact on yield.

There has been a lot of re-tillering of wheat crops after they bolted earlier in the season making it difficult to predict grain yields.

The noodle area has dropped off as delivery sites were reduced in recent years. This year is still in a re-building phase for noodles where growers are mostly bulking up seed for their own plantings rather than intending on delivering the grain.

Canola is in full flower and even though a bit thin and patchy from the variable start, most have filled in and have reasonable grain yield potential. There is some border spraying for aphids going on and diamond back moth numbers are building up to levels that may require spraying.

Lupin grain yield potential has increased over the last month and most will now be worth harvesting.

Esperance Zone

The season is continuing to track well for most of the region with crops bulking up in August following regular rainfall and mild temperatures.

Most crops look good and have above average grain yield potential, but the season will need to continue to track as it has for the last few months to push grain yields higher.

A large contribution to the estimated tonnages is from dryer areas of the region where they are experiencing a very good season to date. There have been some frost events recently in these areas and rainfall has dropped off so grain yield estimates for wheat, barley and canola have been reduced slightly from last month.

District Reports...

Some cereal paddocks may end up with 30 to 50 per cent losses from frost depending on the time of flowering at the time of the frost events.

Leaf disease has been a major problem for some growers in the area, depending on variety and density of the crop canopy.

There has been significant areas of wheat sprayed at least once for powdery mildew and some crops sprayed multiple times.

Spot type net blotch and leaf rust in barley has generally been kept under control with fungicides and as is the case with areas of the grainbelt further north, barley looks to have higher grain yield potential than wheat.

Canola grain yield potential is looking good and there has been little sclerotinia control needed.

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

GIWA Crop Report – September 8, 2017

NORTH

What a year! From around the time of my last report the region has had significant rainfall. Coastal areas have had 150 mm since mid July and tailing down to around half that for the driest inland parts. This has given a massive turnaround in crop prospects in most areas. But there is still the hurdle of temperatures to get over due to late June – or in some parts – early July crop emergence.

Canola crops are at the mid flowering to just finished stage. Some have been sprayed out in eastern and northern parts due to low stand densities. Roundup Ready hybrids have generally looked better than TT varieties for tolerating the dry.

Aphids and diamond back moth (DBM) are posing a problem in western areas and a few more inland crops are being sprayed for DBM as well. Almost all crops will be sprayed for aphids.

Sclerotinia has been less of a problem this year due to the dry conditions.

Canola yields will be around 0.3 to 1.8 tonnes per hectare with most in the 0.5 – 0.8 tonnes range.

Variable prospects for cereals

Barley and wheat crops are from the booting to haying off growth stage. Some crops – and sections of paddocks where the moisture allowed an early May germination – are now haying off.

But some areas of cereal crops did not emerge until late June and into early July. These crops still have a long way to go.

Most crops should make grain given the soil moisture available, but high temperatures will be a problem and if they do occur, this will result in lower yields and screenings.

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

Brought to you in association with JOHN DEERE

	25yr Annual Average (mm)	2017 rainfall to date (mm)	Summer		Autumn		Winter		Spring	
			25yr Annual Average (mm)	2016–17	25yr Annual Average (mm)	2017	25yr Annual Average (mm)	2017	25yr Annual Average (mm)	2017 to date
Emerald Qld	553	342	255	165	99	224	70	16	122	0
Toowoomba Qld	667	528	277	148	129	348	88	61	177	1
Roma Qld	574	353	254	179	113	183	78	40	131	1
Goondiwindi Qld	615	324	256	185	119	148	103	54	140	1
Narrabri NSW	628	424	226	145	112	231	130	73	165	2
Gunnedah NSW	638	307	224	186	106	138	129	74	181	4
Dubbo NSW	615	292	198	155	122	237	135	33	160	5
West Wyalong NSW	461	227	120	85	80	109	125	75	135	0
Wagga Wagga NSW	554	244	132	116	115	87	153	104	152	7
Swan Hill Vic	321	238	71	37	64	132	87	68	99	6
Bendigo Vic	514	390	108	102	106	187	160	124	143	7
Horsham Vic	379	303	77	86	71	120	122	114	108	15
Lake Bolac Vic	524	370	113	101	102	143	156	119	152	33
Murray Bridge SA	374	246	67	102	81	83	122	103	103	14
Kadina SA	347	212	56	165	82	43	114	71	91	22
Cummins SA	400	328	50	124	94	25	172	164	83	43
Esperance WA	622	536	80	201	146	107	250	221	143	30
Wagin WA	396	430	43	230	98	77	166	163	88	4
Northam WA	399	466	40	262	89	41	188	169	83	9
Mingenew WA	354	203	27	87	93	29	175	64	60	0
Moora WA	383	396	41	165	88	32	185	200	69	9
Mullewa WA	325	325	47	181	97	11	133	134	48	2

Last rainfall reading September 15, 2017.

District Reports…

September–October 2017

Lupins are generally from last flower to haying off. Some crops have been sprayed out in the lower rainfall areas. Crops where there has been higher rainfall are looking very good with average yield prospects for many of these.

We need a kind September to get crops to finish well – particularly with the late emergence of many of them. The mid-term rain forecast does not look like we are in for too much more moisture but every cool day will help.

Even with a 'dry ish' September, compared to the grim outlook eight weeks ago, crops now have around four times the yield prospects in the east and two to three times in the west!

With the driest May and June on record for many areas, we will gladly take that improvement.

Keep rain dancing until October…

Peter Norris
Agronomy For Profit and Synergy Consulting, Geraldton
September 12, 2017

SOUTH COAST

Seasonal conditions in the WA South Coast region during the past two months have remained favourable with good rain during August to keep stored soil moisture levels high. September rainfall has been below average, but temperatures have remained mild.

Growers have been busy applying fungicides in cereals. Powdery mildew has been troublesome in wheat, with some crops requiring two fungicide applications at flag leaf emerged and again at full head emergence. Wheat crops treated with flutriafol in-furrow at seeding seem to be much cleaner and have only required a flag leaf fungicide.

Swathing canola commenced on September 14 in a Stingray TT canola crop sown in late March. This is very early for the region and could see harvest start by the end of September.

Some frost occurred in the Northern Mallee in early September but at this stage damage seems minimal and confined to the usual low lying areas that suffer yield loss on a regular basis.

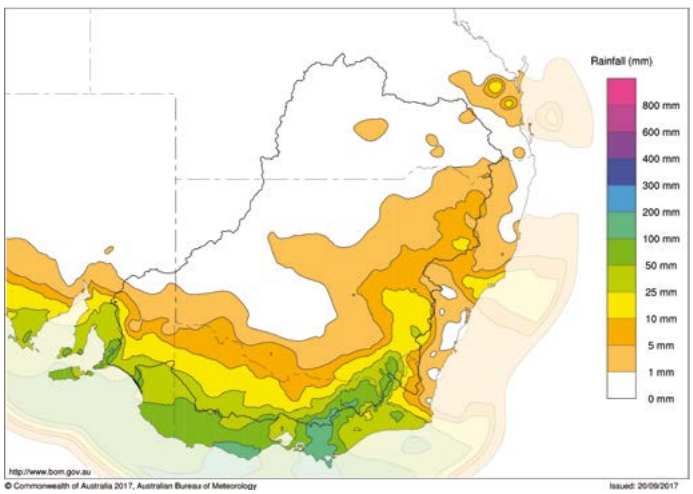
In general, the Esperance Port Zone is looking very good with crops consistent from the coast to the inland Mallee. If the next four to six weeks stay mild – and with a couple of well-timed rainfall events – yields will be very acceptable.

Quenten Knight, Agronomist
Precision Agronomics Australia, Esperance
September 17, 2017

The national Controlled Traffic Farming (CTF) conference Southern Tour inspected some CTF faba beans at Mark Wandel's Scaddan farm as well as CTF lentils at Mick Schutz's Grass Patch farm.

Southern region

Murray–Darling Basin rainfall totals (mm) – September 1–20, 2017
Australian Bureau of Meteorology



SOUTH AUSTRALIA

A dry June across South Australia further delayed seeding in the western and central parts of the state.

Crops in the Mallee and South East generally established well but the dry and frosty June slowed growth.

Farmers in the west and central areas waited until July for adequate rains to continue seeding.

The July rains were too late for some farmers and they did not complete seeding their intended crop area or replaced longer growing season crops like canola and pulses with the shorter season crop, barley.

Crop area sown is estimated at 3.6 million hectares – the smallest winter crop area since 2001 – but with later seeding during July this may be reviewed up.

Crop production is estimated at 6.4 million tonnes – off the lowest area since 2008–09.

Rural Solutions SA for PIRSA
Crop & Pasture Report
July 7, 2017

VICTORIAN MALLEE

The season in the Mallee is looking equally as good, if not better, than that of 2016. Good starting rain provided the ideal kick start, and in-season rain events have been well-timed, resulting in a lot of yield potential if the season continues in our favour.

Wheat is at late booting to head emergence and lupins, canola and field peas are all flowering. Soon we will begin to see vetch and lentils flowering.

Mice have been quite problematic throughout the season, particularly in wheat, lupins and canola crops. They have completely decimated Scepter wheat in BCG early sown wheat trials at Curyo (southern Mallee) by nipping off the heads and eating the grain, this is despite sufficient baiting. Damage is also evident in lupins and canola. Chew cards have been very useful for monitoring and aiding with baiting decisions, and plane baiting has occurred in canola to avoid crop damage.

Nitrogen opportunities have now passed, and the focus has shifted to disease management. The season will probably advance crops far enough so that they will outrun Septoria, but being proactive is better than being reactive. Some incidences of stripe rust and powdery mildew have been identified but are not widespread. In pulses, fungicides were applied prior to canopy closure, especially in chickpeas where ascochyta resistance has been broken down in recent seasons.

Russian wheat aphids (RWA) are apparent in crops, even if the seed was treated with imidacloprid. Imidacloprid has done its job

Mice have completely decimated Scepter wheat in BCG early sown wheat trials at Curyo, despite sufficient baiting.

District Reports...

to this point in the season, but follow up control is necessary. We need to be cautious with follow ups to maintain beneficials.

There have been frost events with mostly vegetative and some stem frost damage in cereals in parts of the Mallee. Frost damage in canola and pulses results in flower loss and the abortion of young pods or blistering – some of which we are now witnessing. Farmers are assessing the severity of damage and starting to make some strategic decisions, for example baling for hay.

Peas across the Mallee are in full flower.

Flowering wheat at the BCG main research site, Curyo.

Those with a livestock enterprise as part of their farm business would have capitalised on grazing dual purpose crops earlier in the season, and consideration is now being given to vetch termination and the beginning of the (planned) hay season.

Some farmers took advantage of the grain price spike and cleared some grain during July which has now freed up some storage in preparation for (hopefully) a high yielding year.

There is high yield potential in the Mallee and there is a lot of anticipation for decent rainfall events to 'bring it home'. If farmers are able to manage any remaining challenges to the end of the season, farmers may experience another excellent season.

Ciara Cullen
BCG Extension Manager, Birchip
September 18, 2017

NSW OVERVIEW

The main points

- During August, areas of the north east received the lowest rainfall and the far south the highest. Rainfall was variable and patchy.
- The outlook to November indicates there is a near-equal chance of drier or wetter than normal conditions across most of NSW. Daytime temperatures are likely to be warmer in areas of the south, south east, some central areas and the Hunter valley. Overnight temperatures are likely to be warmer.
- Global climate models surveyed mostly favour a near-equal chance of drier or wetter than normal conditions through to November.
- The Pacific Ocean remains in an ENSO-neutral state, with this likely to continue throughout 2017.
- Pasture growth was limited across much of inland NSW during August, being below to well below average in many areas, but was maintained across areas of the south.
- Limited rainfall across many cropping areas during August combined with continued frosts, saw winter crop prospects continue to decline. In western areas, many crops have been abandoned.

Crops

Limited rainfall in August and multiple frosts saw winter crop prospects continue to decline. West of the Newell Highway across north western and central western NSW and areas of the Riverina, many crops have been abandoned. In eastern areas, a combination of warm daytime temperatures and multiple frosts put pressure on crops, progressively reducing the yield potential of winter cereals and canola.

Severe frosts in mid-late August and early September in many areas caused stem and head frosting in cereals, with flower and pod abortion occurring in pulse and canola crops.

Areas of the eastern Riverina, south west slopes and the Murray valley received sufficient rainfall during August to maintain crop yield potential.

Prospects for dryland summer cropping across many areas of northern NSW are poor.

Pasture growth

Pasture growth remained limited across much of inland NSW due to the lack of topsoil moisture, heavy frosts and grazing pressure.

Relative to historical records, *AussieGRASS* modelled pasture growth was well below average across large areas of western, north western and central NSW as well as the Hunter valley and

District Reports...

north coast. Growth was average to slightly above average across areas of the south.

Other pasture growth models indicated extremely low growth across most of NSW, with near-average growth for areas of the far south and south west.

Seasonal growth outlook

For September to November the *AussieGRASS* pasture growth outlook suggests that near-average to slightly above average growth is possible for most of NSW, with slightly below to below average growth for some areas of the far south and north west.

But this outlook is based on the *AussieGRASS* SOI phase system indicating a wetter than normal rainfall outlook for most of NSW between September and November.

In comparison, the Bureau of Meteorology's September to November rainfall outlook suggests a near-equal chance of drier or wetter than normal conditions across NSW.

Potential growth may therefore be very different from the pasture growth outlook.

Soil moisture

Modelled topsoil moisture remained low but mostly stable in areas of western and central NSW, but declined across the north and the central to north coast. Particular declines occurred across the north coast, Hunter valley and northern tablelands.

Topsoil moisture improved across areas of the south, eastern and central Riverina, southern tablelands, Monaro and south east.

Relative to historical records, topsoil moisture was below average across most of northern, north eastern and central NSW as well as areas of the coast, far west and western Riverina.

Streamflow and run-off

Run-off during August was below average across the north coast, northern tablelands and slopes and the Hunter valley, above average in areas of the south but near-average in most other areas.

The Bureau of Meteorology's streamflow forecast indicates low to near-median streamflows are likely at most NSW monitoring stations during September to November.

NSW Department of Primary Industries
Seasonal Conditions Report
September 13, 2017

Northern region

LIVERPOOL PLAINS

The past two months have seen all winter crops planted on the Plains with a larger amount of chickpea hectares than normal – and most has been planted into sorghum stubble.

A few rainfall events have helped with establishment. Across the district it seems that if crops have been planted into a full moisture profile they seem to be holding on. But double-cropped paddocks are starting to show signs of moisture deficiency leading to stunted growth. Crops on the lighter soils in the area are suffering.

Grazing country is also struggling to maintain good stocking numbers with the large amount of heavy frosts.

On our farm the chickpeas have been hanging in albeit with little rainfall and a recurring number of frosts. The warmer days ahead will see them to start to take off.

Let's hope a decent rainfall event is just around the corner for the Liverpool Plains.

Lauren McGavin
Precision Seeding Solutions, Premer
September 18, 2017

DARLING DOWNS

August and September are known as dry months – but to have just 1 mm of rainfall since mid-July has been devastating.

There has also been an unusually high number of frosts this winter – 50 and counting in Clifton on the Southern Downs. These have caused some severe crop damage, so overall, the winter crop has been left struggling.

District Reports...

September–October 2017

Winter crops

The very early planted cereal crops are now at grain fill, but the majority are in the boot stage. The late sown crops are somehow still alive and growing on just the primary root. At this stage, the only cereal crops with a good yield outlook are the few paddocks being irrigated.

The record area of chickpeas has the advantage of tap roots growing down into the stored moisture left by Tropical Cyclone Debbie in March – but that moisture is rapidly running out.

All crops have suffered frost damage at some stage with levels of severity ranging from 20 to 80 per cent damage with some patches having been killed. Crops planted in May to early June are more heavily affected in the Western Downs.

There is about 40 per cent of the overall chickpea crop now podding; 40 per cent flowering; and, 20 per cent struggling to survive.

Helicoverpa pressure is moderate at this stage.

It is very difficult to predict any yields, but hopefully some rain will arrive in time to get some winter crops through.

Outlook for the summer crop

The sorghum area is expected to be larger than originally anticipated. Many growers will turn to this crop as it can handle stress better and it is one with a better price than last season.

But a planting rain is not yet in sight, and as a consequence, there is no dryland spring planting at this stage.

Allocations of irrigation water from bores has already been reduced – and coupled with some irrigation water being diverted to winter crop – the irrigated area has already shrunk.

Overall, it's a rather gloomy outlook – let's hope the BOM predictions for at least average rain this summer are right.

Hugh Reardon-Smith
Agronomist – Landmark, Pittsworth
September 12, 2017

Wheat and chickpeas growing side by side on the Darling Downs.

These wheat plant samples have been taken from the crop pictured to the left. Note that there has been no secondary root development because of the lack of moisture.

ANSWER TO IAN'S MYSTERY TRACTOR QUIZ

The mystery tractor is a 30 hp 1930 Vickers.

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