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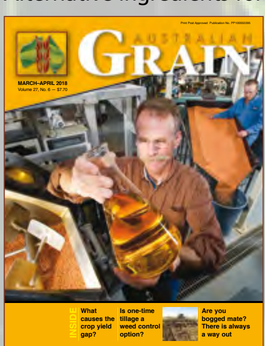
FRONT COVER

Plant-based fish feed

Alternative ingredients for fish feed – based on plants – are helping reduce costs in the worldwide aquaculture boom. Pictured is USDA researcher Rick Barrows infusing fish feed pellets with flax oil. See article page 41. (PHOTO: Stephen Ausmus)



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Southern Australia Focus

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

Northern Focus

Covering Northern NSW and Queensland

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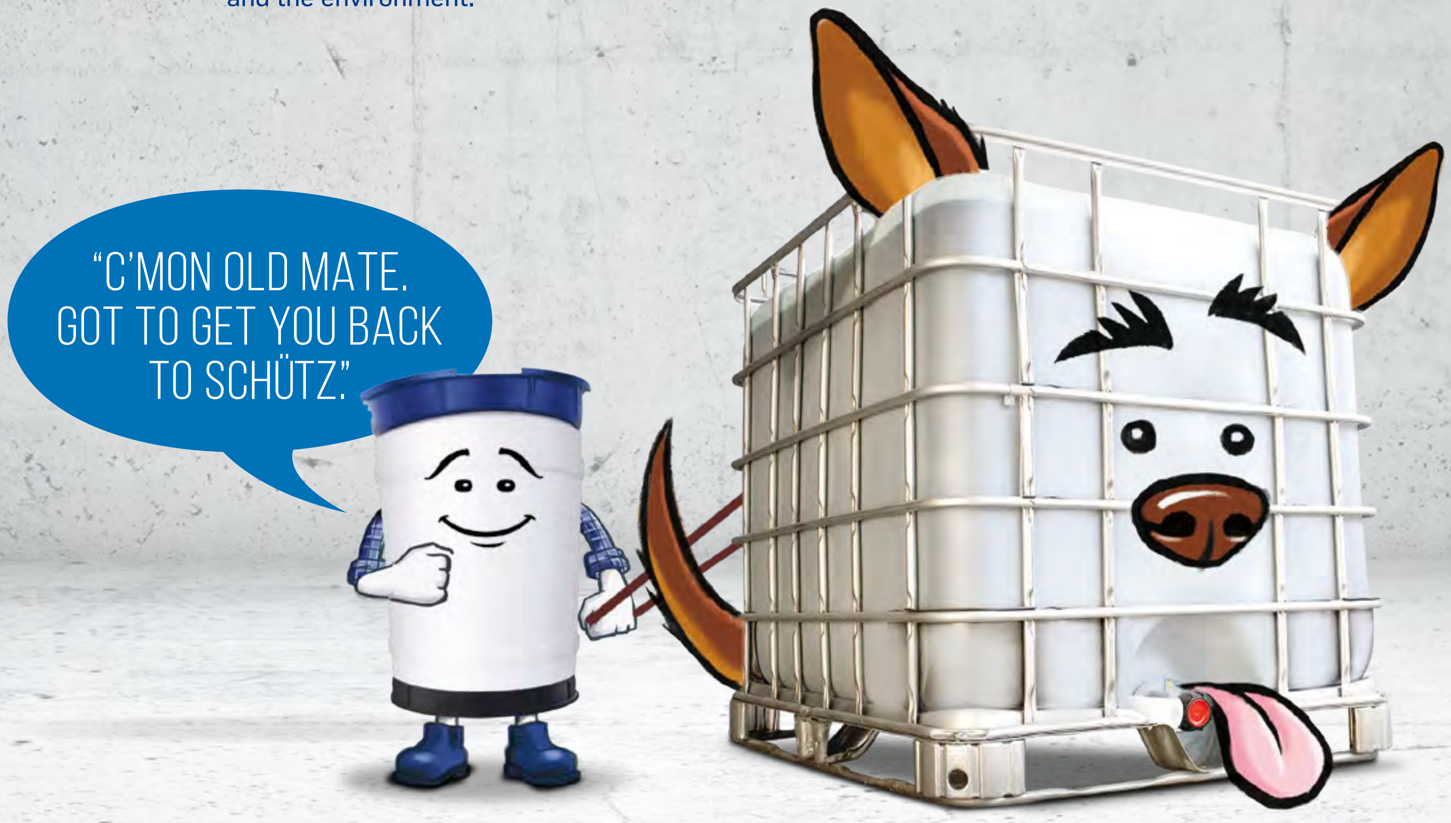

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Editorial... Lloyd O'Connell

OUR national commodities forecaster weighed in recently with crop production estimates for the 2017–18 winter and summer crops. And there's some interesting trends emerging in how we are going about the business of grain production.

ABARES has estimated the past season's Australian winter crop at 37.82 million tonnes – and capital city newspaper headlines were quick to bemoan a 35 per cent drop in production on the previous year. This needs to be put into perspective.

The production results from the 2016–17 season were nothing short of exceptional and tend to distort any comparisons or statistical analyses you want to make. Total winter crop production from the 2016–17 season was 65 per cent above the previous 10-year average and almost 30 per cent more grain production than our previous record season (2011–12).

If we take the 'distortion' of 2016 out of the numbers, the production results from last season present a totally different picture. Winter crop production of 37.82 mt – in a very challenging season in many regions – was 6 per cent above the 10-year average leading up to the exceptional 2016 season. Not a bad result considering the very dry early season and widespread frost damage.

It's also worth noting that the total area planted to winter crops has not moved much at all over 10 years and tends to bobble around 22 million hectares.

But it's the mix of the winter crops we are planting each year where we're seeing some change and you could mount a pretty good argument that it's this change in crop sequencing that may be helping to achieve more resilient yields in tough seasons.

Closing the yield gap

In this issue we look at some results of the *National Paddock Survey* which aimed to determine the size and variation of yield gaps in rainfed wheat and sought to explain the agronomic reason behind the gap. The research found this yield gap varies from 1.0 to 1.3 tonnes per hectare across the national grainbelt.

There's money to be made in bridging this gap as much as possible. The researchers point out (see page 6), there is always a combination of factors causing the yield differences and as a consequence, a variety of agronomic strategies are needed to improve wheat yields. But crop rotation was a major player.

And maybe growers are already onto this. Ten years ago the total area planted to pulses in Australia was around 1.7 million hectares – pulse plantings in the past two seasons have been in excess of 2.5 million. This is a tad under 10 per cent of the total area of national winter and summer crops but both pulse area and production are around 30 per cent more than 10 years ago.

Canola has also become much more prominent in the winter cropping mix and over the past 10 years has increased in area around 60 per cent and now makes up about 12 per cent of the total winter plant.

Notwithstanding ad hoc tariff and other international marketing blimps, the national trend is undeniably towards more productive crop sequencing.

I hope everyone enjoys a wet autumn.

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In this issue...

What causes the crop yield gap?

The yield gap is the difference between the actual crop yield achieved by the grower and the water limited yield potential. The potential exists to help growers increase on farm yields by targeting the key factors that contribute to this yield gap.

Is one-time tillage a weed control option?

Many would say that the widespread adoption of no-till and minimum till farming underpinned the expansion of cropping in many parts of Australia and saved many farming families from economic hardship.

Down to earth

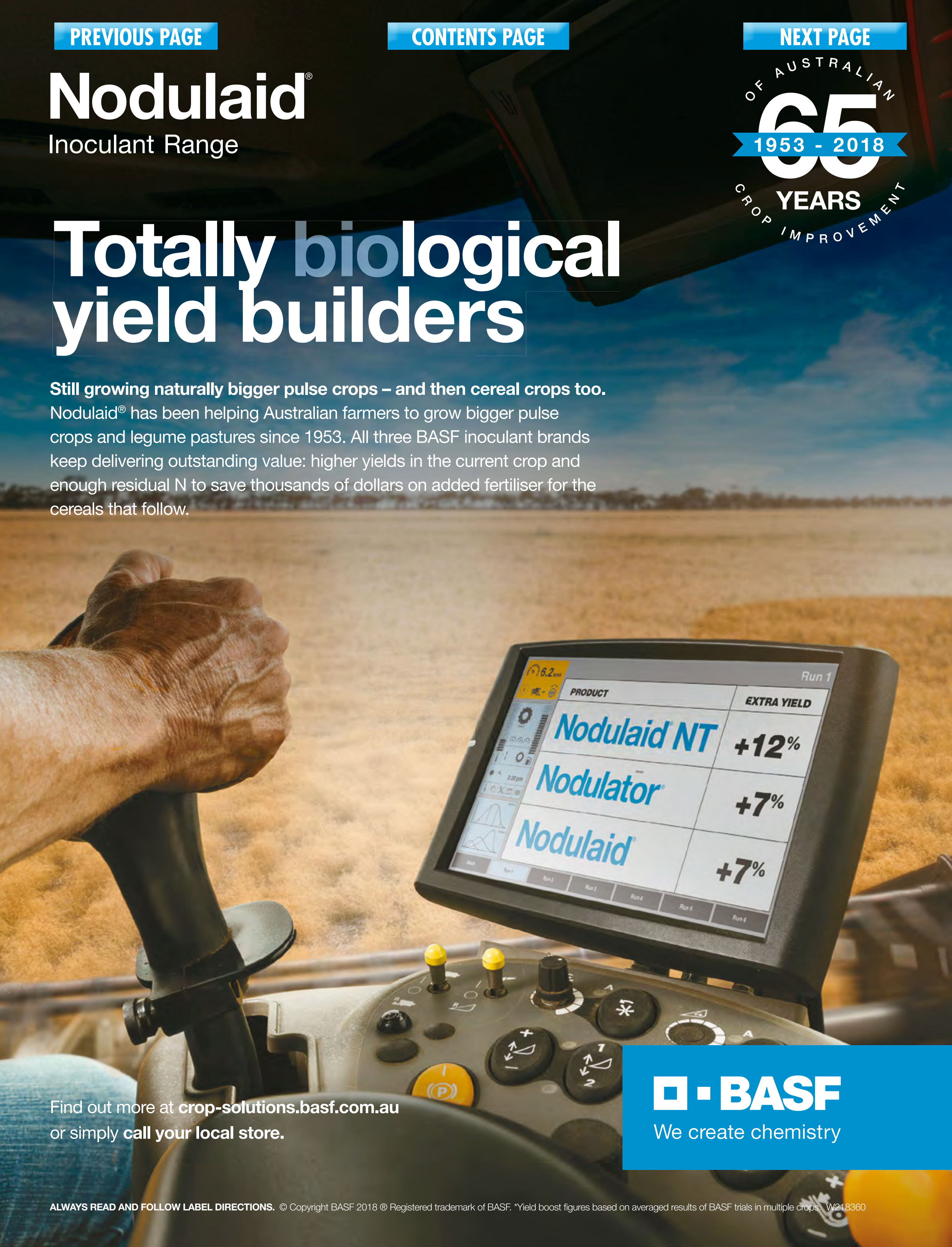
My interest (some say 'obsession') with tractors, also extends to earthmoving and construction machinery. Well after all, bulldozers, loaders and excavators are really first cousins of farm tractors. In fact, back in the mid-1960s I was employed by Lough Equipment Pty Ltd, a firm which imported and marketed an extensive range of earthmoving and construction machinery.

Are you bogged mate? There is always a way out

I spend a lot of time raising awareness about spray drift but recent events have compelled me to talk about something that disturbs me even more than spray drift.

Insecticide resistance is outgunning our current weapons

Pecticide resistance issues in broadacre cropping continue to outpace the availability of novel control options. In this article, we discuss the latest findings on two major pests that have developed resistance to key chemical groups. We also discuss the development of a new Resistance Management Strategy for *Helicoverpa armigera* in grains.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What causes the crop yield gap?

■ Roger Lawes[1], Chao Chen[1] and Harm van Rees[2]

THE yield gap is the difference between the actual crop yield achieved by the grower and the water limited yield potential. The water-limited potential is defined as the maximum possible yield able to be grown with the optimal sowing date, current cultivars and nutrients, pests, disease and weeds not limiting yield. The potential exists to help growers increase on farm yields by targeting the key factors that contribute to this yield gap.

The gap is usually calculated using a crop growth model. Previous studies have shown that well managed commercial crops can reach their potential, showing it is not an unattainable or unrealistic yield.

A previous study using shire-level data showed that the wheat yield gaps average around 55 per cent across Australia, meaning that the current yields growers are achieving is about half what is potentially possible. A small yield gap indicates that management is near optimum. A large yield gap, implies that crop productivity is constrained by abiotic and/or biotic factors, such as nutrient deficiencies, weeds, diseases and insects.

The yield gap is likely a result of multiple causal factors and due to a number of sub-optimal management activities. Identification of the most important factors will allow farmers to prioritise their efforts in improving yield and profit. While we have a much clearer idea of the size of the yield gap across the grains industry, we have little quantitative understanding of the abiotic and/or biotic constrains on the yield gap at the individual paddock level.

In this national study we aimed to determine the size and variation of yield gaps in rainfed wheat and to explain the agronomic reason behind the gap. Yield maps were used to summarise actual crop yield. Crop simulation models such as APSIM have been widely used in yield gap analysis. We used the APSIM model – combined with surveys of soil properties and agronomic practices – to estimate water-limited potential yield.

AT A GLANCE…

- The yield gap, or the difference between actual and potential yield in wheat was 1.1, 1.2 and 1.3 tonnes per hectare across the Northern, Southern and Western Zones of the Australian grain belt.
- The cause of this yield gap is variable. No one factor (nitrogen, disease, weeds or rainfall) causes the gap – it is a combination of factors.
- Growing season rainfall, the previous crop or crop sequence, nitrogen application, levels of disease and weeds were all important factors that were associated with the yield gap.

How the study was done

On-farm data collection

In the Western, Northern and Southern GRDC regions across the Australian grain belt, 250 paddocks were monitored for the growing seasons of 2015 and 2016 (Figure 1). These farms were selected on the basis that they were owned by leading farmers and represent the range of prevailing rainfall and soil conditions across the grain belt.

Paddock monitoring protocol

Commercial wheat crops were monitored by collaborating consultants from pre-sowing to harvest at two transects (zones) selected within each paddock.

The variation in soil conditions and constraints within a paddock may affect crop performance. To consider such an effect, soil types were identified and soil water and mineral nitrogen before sowing were measured in the two selected zones.

Cores were subdivided into depth increments to estimate the water and nitrogen availability down to a depth of 1 m. Agronomic management details including the management of previous crop residues and tillage, cultivar, sowing date, plant density, fertiliser management (type, application rate and date).

The type and number of weeds, plants damaged by diseases and/or insects and root diseases were monitored at Zadoks stage 31 and Zadoks stage 65.

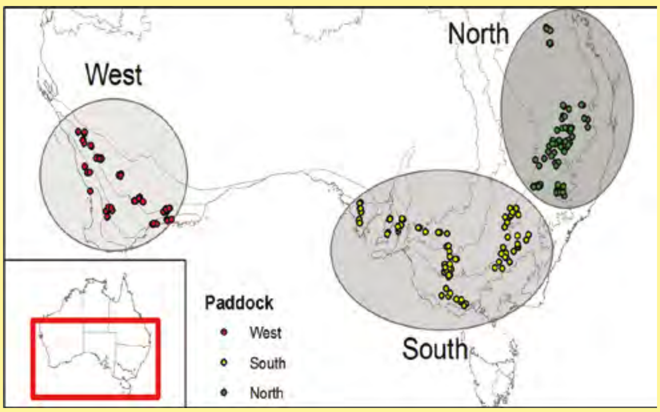
Disease root health score was assessed as a (0–5) score where 0 = not observed and 5 = severe disease level.

At the end of each season, crop yields were measured using a grain harvester yield monitor. The data collected for each season was reviewed at annual project meetings, to allow consultants and researchers to discuss insights and information regarding individual paddock performance.

Potential yield and yield gap analysis

The difference between the simulated water limited yield and actual yield, as measured by the yield monitor, was defined as the yield gap. At the end of each season water-limited potential yields were simulated on both transects within each paddock using the APSIM model. Agronomic practices on each paddock were recorded (crop type, sowing date, plant density, residue and

FIGURE 1: Surveyed paddock locations



fertiliser) and used to initialise the model.

Soil parameter values for the identified soil types in the surveyed paddocks were sourced from APSoil. Measured soil water and nitrogen at sowing was used at the start of the simulation to initialise the model. If initial data were missing, the model was initialised from expert opinion.

Weather data were sourced from the nearest SILO meteorological stations to each farm.

Simulations were run assuming that yield was not limited by nitrogen supply, weeds, pests, disease, frost or heat damage.

Classification and Regression Tree (CART) was used to determine the relative importance of the factors influencing the size of the yield gap including in-crop agronomic factors (weed densities and type, levels of disease severity, nitrogen fertiliser application) and other factors (region, soil type, previous crop).

This analytical approach was chosen because it allows the variables to interact with each other and can identify complex relationships between multiple variables.

What we found

Assessing the survey data (Table 1)

When wheat was grown, the dominant previous crop was usually wheat in the western and southern regions. Conventional break crops, such as canola, chickpea, sorghum, oats or pasture were less common. This was not the case in the north. Growing season rainfall was highly variable across paddocks within and between regions, and between the 2015 and 2016 seasons (Figure 2a). The growing season rainfall was lowest in western region (192 mm) and highest in southern region (296 mm).

The average amount of N fertiliser applied to wheat was 32, 43, 26 kg N per hectare in the western, southern and northern regions, respectively, while it varied greatly among paddocks within each region.

The average weed density at Zadok stage 31 was 10 plants per m² in both Western and Southern regions, with few paddocks with weeds detected in the Northern region.

The incidences of diseases and insects was generally minor in most of paddocks across regions and seasons, with a trend for

FIGURE 2: a) Yield gap of dryland wheat at Western, Southern and Northern regions for the 2015 & 2016 seasons; and, b) The relationship between yield gap and yield potential at the three regions for the two growing seasons

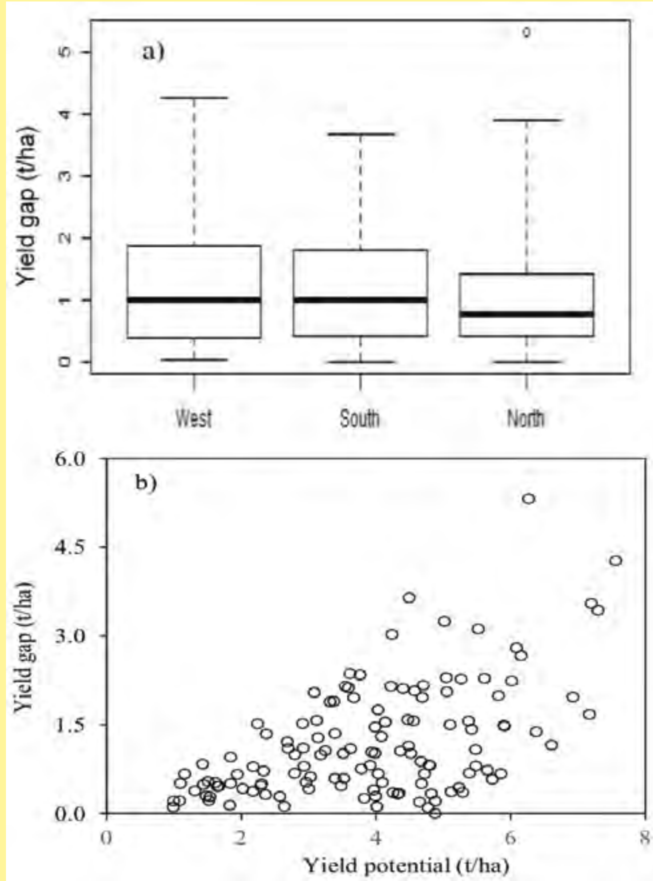


TABLE 1: The average of wheat survey data across the Western, Southern and Northern regions for the 2015 & 2016 growing seasons

	Western region	Southern region	Northern region
No. of paddocks	78	53	38
Previous crop (% cereal/% break crop)	80/20	62/38	36/64
In-crop rainfall (mm)	192	296	230
Nitrogen supply (kg N/ha)	32	43	26
Weeds (plants/m²)	10	10	0
Root health score	1.8	1.7	2.2
Disease (% affected plants)	12	4	8
Insect (% affected plants)	11	7	1

the incidences of disease and insects being higher in the Western region, compared with the Southern and Northern regions.

On average, the root health score was low across all three regions, although there were occasional root health problems detected in some surveyed paddocks.

Average dry wheat yields were lower in the Western region (2.5 tonnes per hectare) than the Southern (3.7 tonnes per hectare) and Northern regions (4.1 tonnes per hectare).

The magnitude of yield gaps

There was considerable variability in the gap between water-limited potential yield and actual farm yield (Figure 2b). For the 2015 and 2016 seasons, the yield gap of wheat ranged from 0 to 4.3 tonnes per hectare in the Western region, with a mean value of 1.2 tonnes (Figure 2a).

It varied between 0–3.7 tonnes per hectare in Southern region and 0–5.3 tonnes per hectare in the Northern region, with average values of 1.3 and 1.1 tonnes per hectare, respectively.

Extremes were statistical outliers (Figure 2a), and could point to problems with data collection or simulation modelling. In general, the size of the yield gap was correlated with the size of the potential yield and growers are unable to capture the extra yield on offer in the high rainfall zones (Figure 2b).

In the Western regions 46 per cent of wheat paddocks achieved between 80 and 100 per cent of yield potential. In the Southern region, 38 per cent of wheat paddocks fell within this range. In the Northern region 43 per cent of paddocks fell with 80 to 100 per cent of yield potential.

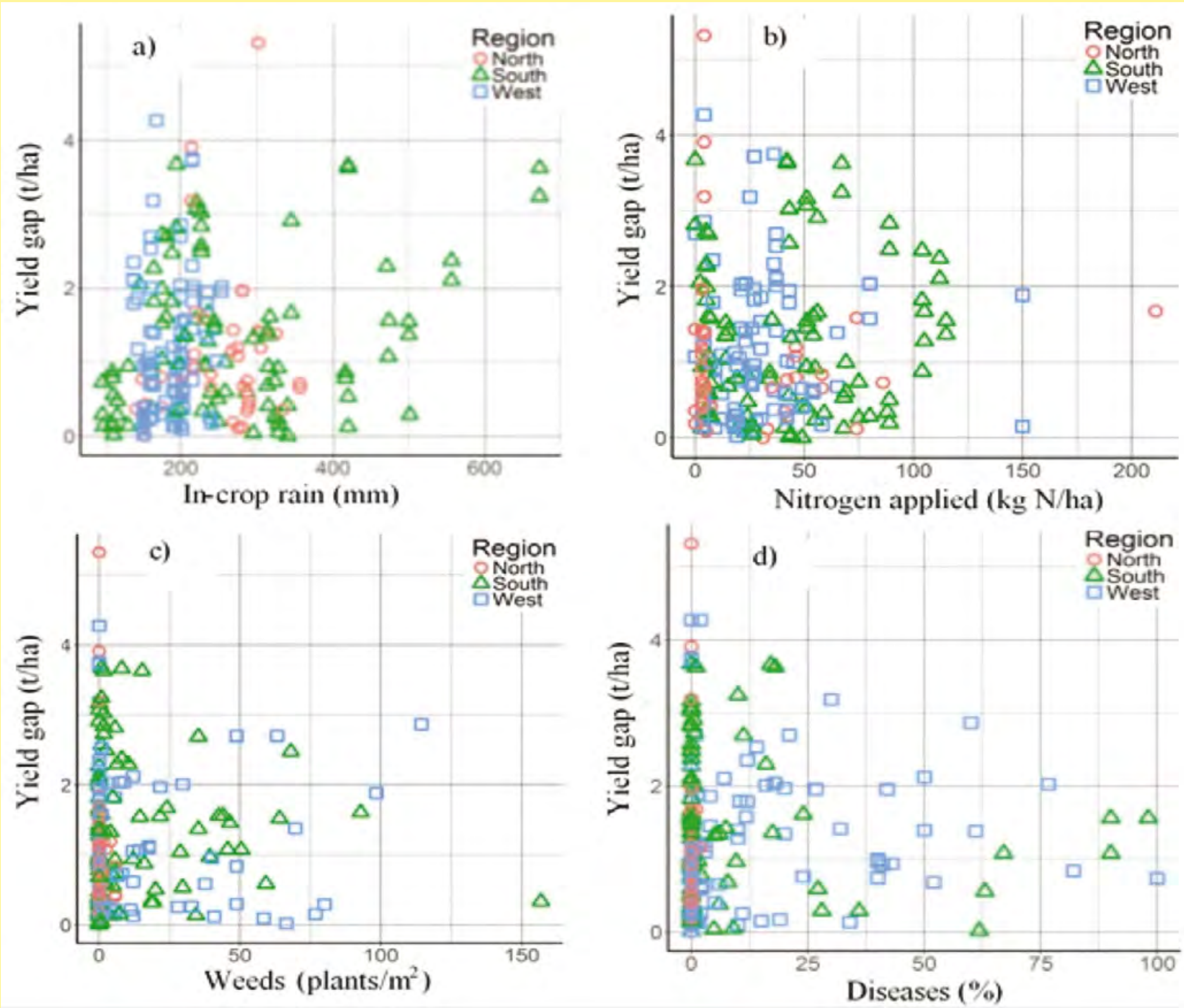
Achieving yield potential is not uncommon and demonstrates that yield potential is achievable for a broad range of farmers, with paddocks on all soil types and rainfalls.

Factors associated with the yield gap (Figure 3)

No significant relationship was observed between yield gap and a single factor (in-crop rainfall, nitrogen fertiliser application, weeds, disease, insect and previous crop). This suggests that the yield gap was caused by a combination of these effects, or the yield gap was driven by the first limiting constraint (Leibigs law), and a lack of a linear relationship is therefore not surprising.

The CART analysis, which copes with such complex data

FIGURE 3: The relationship between wheat yield gap and in-crop rainfall (a), nitrogen applied (b), weeds (c) and disease as a percentage of affected plants (d)



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More targeted nitrogen management and crop rotation are just two interacting factors in reducing the yield gap.

revealed that growing season rainfall, rate of applied nitrogen, the previous crop, disease levels and weed levels all contributed to the size of the yield gap (Table 2).

In the Western region, growing season rainfall was the most important variable to explain the yield gap. This was followed by the amount of nitrogen and the previous crop, with weeds having a minor influence.

It suggests that larger yield gaps occur in the high rainfall zone, possibly because these yields are harder and more risky to achieve.

Nitrogen does appear to be limiting growers' ability to capture these higher yield potentials, while crop rotation is playing a role. Wheat on wheat is still common in the Western region. In the southern region, the amount of applied N, the previous crop and root health score were the three most important variables. Weeds and growing season rainfall were of minor importance.

TABLE 2: The ranking (importance)* of the variables that contribute to the size of the yield gap across the three regions

	In-crop rainfall	Nitrogen applied	Previous crop	Weeds	Root score
West	1 (109.8)	2 (17.7)	3 (6.1)	4 (0.8)	
South	4 (8.5)	1 (25.3)	2 (16.4)	5 (4.2)	3 (8.8)
North	1 (87.6)	2 (18.5)	4 (5.3)		3 (5.4)

*The number in brackets refers to an estimate of variable importance, as an absolute measure. It is used to assess the relative power of one variable over another.

In the Northern region growing season rainfall, applied N and root score were the three most important variables. The implication is that N dynamics, growing season rainfall and crop rotation tend to play an important role in explaining the size of the yield gap. The potential to grow a high yielding crop is complicated because of the high N demands.

These analyses suggest that in high yielding situations, the N demand of the crop is not being met and growers are under fertilising in the high rainfall zones of Australia.

This may be a sensible and rational decision by growers, given the risks associated with targeting high yields.

To sum up

The National Paddock Survey is helping to understand the critical drivers of the yield gap across Australia. There is potential to reduce the size of the yield gap with more targeted N management and crop rotation. Importantly though, multiple, interacting factors all contribute to the yield gap.

1. CSIRO Agriculture and Food, Floreat WA.
2. Cropfacts P/L and Birchip Cropping Group.

The first data stemming from the National Paddock Survey project was presented at the 2018 GRDC's Grains Research Updates.

The research behind this project is made possible by the significant contributions of growers through both trial cooperation and the support of the GRDC. The authors would like to thank them for their continued support. We acknowledge the support of CSIRO staff Jeremy Whish, David Gobbett, Jackie Ouzman and Noboru Ota for contributing to vital components of this research. We also thank the Birchip Cropping Group and Square V Design for hosting the project and developing the database infrastructure. ■

Tillage, stubble and zero till: What have they ever done for us?

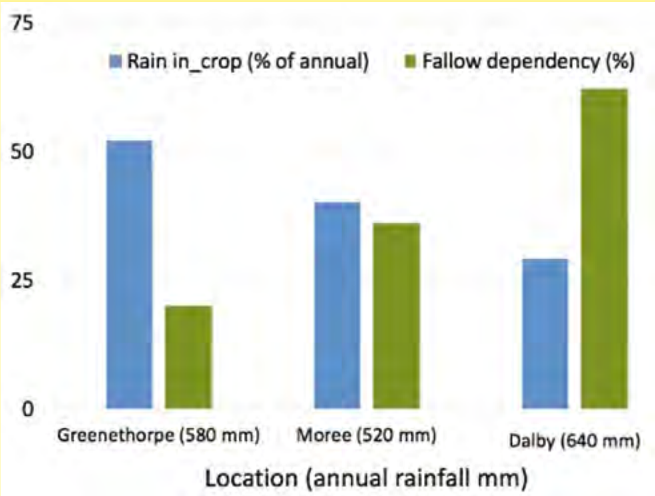
By David Freebairn

AT A GLANCE…

- Stubble cover and reduced tillage improve water storage, with very few exceptions;
- Improved water capture in soils leads to improved crop yields, especially in drier years, but negative responses to stubble are observed in southern regions;
- Negative responses in wheat on wheat systems to practices which store more water are due to lower soil nitrate, higher disease and nematodes;
- Sorghum and pulse crops are better able to use extra water stored in stubble and reduced/no till systems;
- Optimizing compaction (controlled traffic), fallow durations, crop sequences and weed management offers additive improvements;
- Conservation tillage has improved water quality and reduced erosion dramatically;
- An occasional tillage to deal with issues associated with no tillage does not have any long term negative impacts and benefits outweigh negatives;
- The farming community has adopted new practices over wide areas when benefits have been demonstrated; and,
- Rainfall is used inefficiently with only 25–50 per cent going through plants – so there's plenty of room for improvement.

TODAY'S tillage and crop systems have evolved dramatically since the First Fleet settlers. Not knowing the environment and being short of food, James Ruse was set the task of growing crops near Parramatta after it was found that the soils near Sydney Cove were not suited to cropping. Ruse's first attempts at cropping found that corn was the best bet.

FIGURE 1: Percentage of in-crop rainfall and fallow dependency (the proportion of the crops' water supply derived from soil water at planting) for three locations



As cropping expanded across south eastern Australia, cropping systems were strongly influenced by experience from England and Europe. These systems – based on frequent tillage and clean fallows – were found to be wanting, especially in the northern cropping regions. Contour banks were the mainstay of soil erosion control, yet erosion remained an issue.

In the late 1960s farmers began to explore tillage and planting equipment to handle higher stubble loads while machinery evaluation programs were initiated in the mid 1970s. In Queensland in particular, these programs involved importing equipment from Canada and the US and testing them with interested farmers and provided training on appropriate set-ups.

Roundup was released in Australia in 1974 and was the first broad spectrum herbicide that made weed control feasible in prospective no-till fallows. But it cost $20 a litre and in 1976, we used to use 1–2 litres per hectare!

Visionary research

A long-standing agronomy research effort was initiated by Marley and Littler in 1968 comparing water and nitrogen relations associated with tillage and stubble. This was visionary in that stubble burning and disc tillage were the norm.

In the spirit of land development, the Queensland Government set up a catchment study in 1965 to better understand the influence of land clearing on farm water supply. After a calibration period of 17 years, two catchments were cleared with one cropped and one to pasture. These two sites remain active and demonstrate vision and commitment after 50 years.

In the mid 1970s there was conflicting advice coming from government extension agencies – on one hand farmers were being told to burn or bury stubble to reduce diseases and facilitate tillage and planting, while at the same time the soil conservation fraternity were indicating retention of stubble even though tillage and planting machinery was not well suited.

This set the scene for a grand era of research, development and extension across the fields of agronomy, soil science and hydrology.

Herbicide and local machinery manufacturing companies were actively involved in all elements of these studies. This extensive investment in the exploration of conservation tillage forms a foundation for the cropping systems of today.

This article is an overview of this collaborative research and extension effort and for simplicity, demonstrates a northern region bias – but a very similar story played out on the national stage.

Why is fallow management so important?

Figure 1 shows the dependence of winter crops in the northern region on starting soil water. For example, 20 per cent of the water supply of a crop at Greenethorpe in Central West NSW comes from water in the soil at planting. This value increases to 60 per cent for a winter crop at Dalby in southern Qld. All other things being equal, it's hard to see how better water capture cannot improve productivity and profit.

Catastrophic erosion after our typically sharp summer storms

also highlighted the need for a better system to keep soil in place so it can store water for another day!

Figure 2 shows average fallow efficiency values for four tillage treatments at the long term trial near Warwick in southern Qld. An extra 9 per cent of rainfall is captured when stubble is retained and not cultivated.

Similarly, starting soil water over three years at three sites in northern NSW was 30 mm higher in no till with stubble compared to tilled and stubble burnt (Figure 3). Given the "safe" nature of stored soil water, an extra 30 mm could be worth as much as 100 mm of extra in-season rainfall.

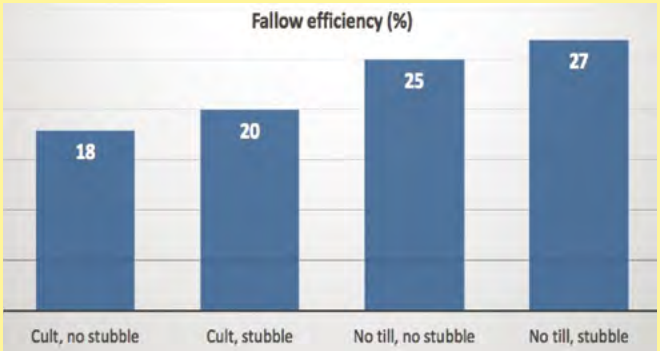
In both these studies, wheat yields did not reflect these gains in starting soil water. Figure 3 provides some of the evidence for this lack of achievement – lower soil nitrate and lower protein.

Additionally, higher root and leaf disease and nematode levels were observed in all stubble and reduced tillage plots.

This result is consistent across eastern Australia, and more so in southern Australia where negative yield responses to stubble are common in research studies.

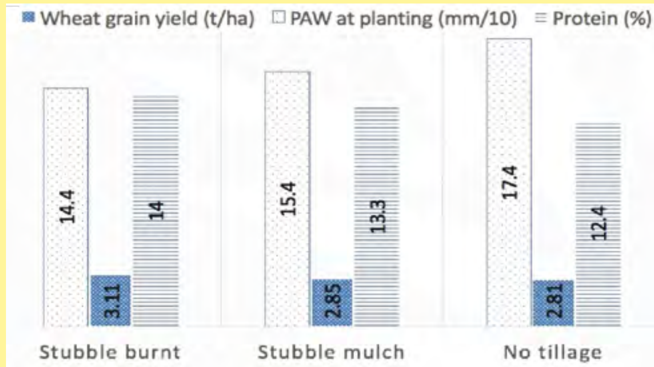
In contrast Holland and Felton (1989) found that when sorghum was sown into no-till cereal stubble, yields were 0.7 to

FIGURE 2: Average fallow efficiency (% of fallow rainfall stored in soil at planting) for four tillage/stubble treatments at Warwick, 1968 through 1979



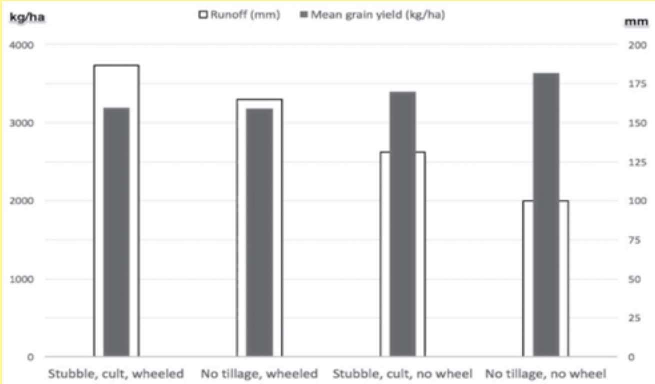
Source: Marley and Littler 1989, Hermitage Research Station.

FIGURE 3: Average yield over three years for three fallow management strategies at Warialda, Croppa Creek and Breeza (northern NSW), 1986 through 1988



Note: All treatments received basal fertiliser plus 50 kg/ha N.
Source: Marcellos *et al* 1995.

FIGURE 4: Mean annual runoff and grain yield from four stubble/compaction treatments at Gatton after six years of opportunity cropping



Source: Tullberg, 2001 Xi *et al.*

1.8 tonnes per hectare greater compared with cultivated, stubble retained fallows. Apparently sorghum did not have to deal with the disease load – which negatively impacted wheat yields – and could use the extra 31 mm of stored water.

One of the more interesting results from these many studies comes from Central Queensland where Radford and Thornton (2011) found that a yield penalty associated with aggressive tillage lasted three years after a zero-till regime was implemented over the whole trial (Table 1).

It is notable that there are no yield differences between the three "stubble retained" treatments and that crop type was varied depending on planting opportunities. Radford and Thornton proposed that the lingering yield penalty was due to disease and nutrition.

Controlled traffic

Controlled traffic is an evolving practice to improve efficiency, timeliness and improved soil conditions leading to better yields.

TABLE 1: Average grain yield over 20 years for four fallow management options and yield when all plots were zero-till managed for the subsequent three years

Treatment	Mean yield for 20 years (t/ha)	Mean yield post-treatment years (t/ha)
Disc/scarifier tillage	2.15	1.43
Stubble mulch tillage	2.66	2.73
Reduced till	2.77	2.83
Zero till	2.79	2.71

Source: Radford and Thornton, 2011.

Jeff Tullberg and other researchers found large differences in water capture and grain yields in Gatton-based trials in the early 2000s. Compaction (from wheeled traffic) had a larger impact on moisture infiltration than soil cover.

This encouraging result is being replicated across the national grainbelt as the package appears to offer other advantages.

One point of conflict that has arisen with controlled traffic is the direction of travel. Should the preference be to cross the slope – similar to cultivating between contour banks – or down the slope?

While this debate will continue, my summary at the moment is that if good stubble cover is maintained, then direction is not important. And if there is little soil protection, it is also of little interest as we can expect the worst when that big rainfall occurs.

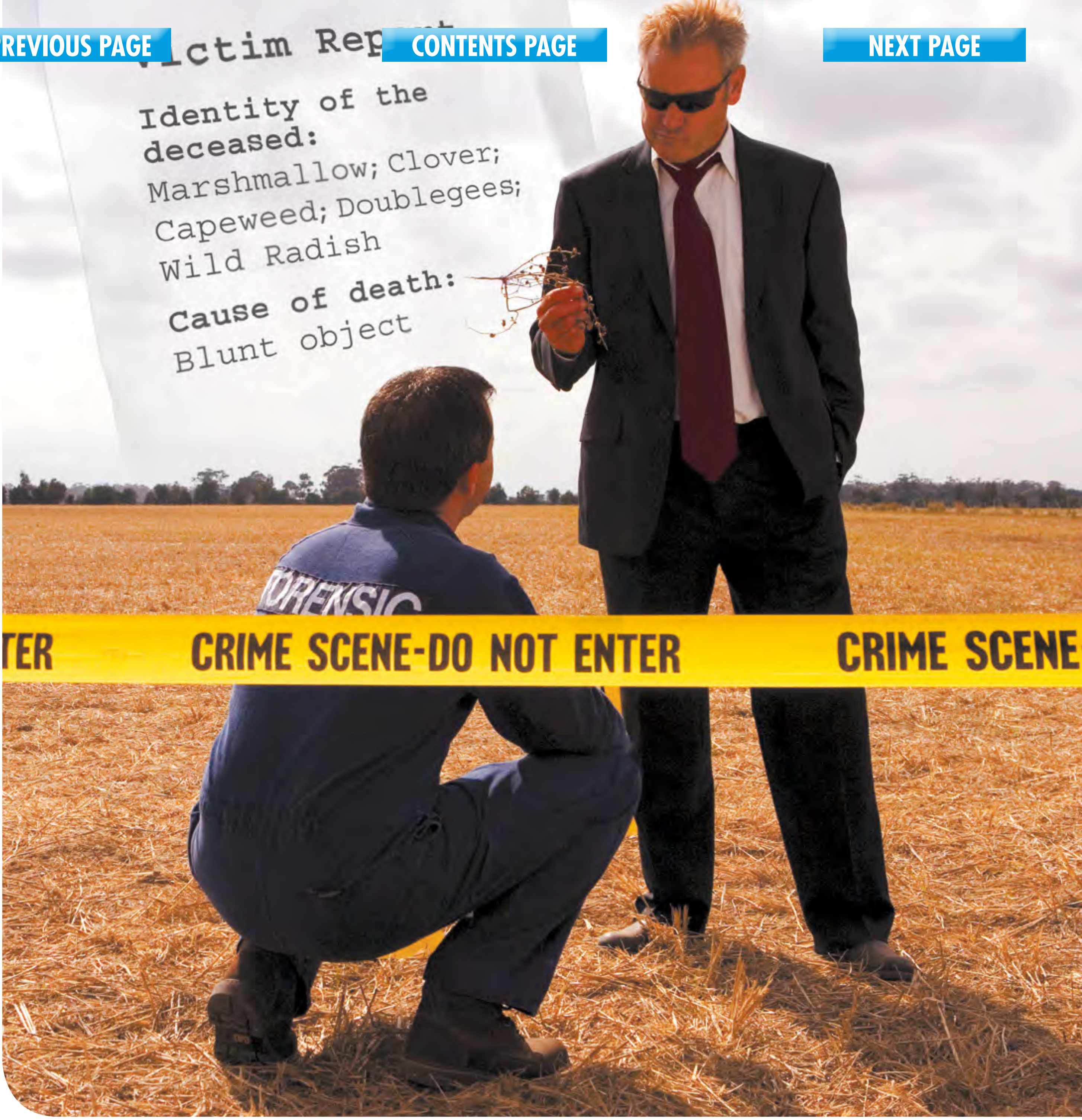
To sum up

Agriculture, like most industries, has its fads and its believers in one system or another. There was/is a belief that no-till systems created cumulative benefits that would be lost from tillage. But Yash Dang and others have recently concluded that the impacts of an occasional 'strategic tillage' did not have any lasting negative impacts and on balance, was a useful strategy to deal with some aspects of not cultivating for long periods.

NSW DPI researcher Graeme Schwenke offers a very good summary of the main results of the vast range of tillage research studies carried out across the northern region since the 1990s:

"No-tillage, in conjunction with crop rotation and N fertiliser use, can be a more productive and economic proposition than a continuous cereal system. Chickpea, faba bean and sorghum crops perform better when sown into cereal stubble (around a 10 to 20 per cent yield gain); Legumes fix more nitrogen; and, Pulses on wide rows (64 cm) retain more stubble, are easier to sow, and increase herbicide options."

Many grain growers have already sorted through some of the negative issues (such as leaf and root disease, N at sowing, stubble loads etc) associated with conservation tillage. And they appear to be implementing conservation tillage systems with better results than most research trials – after all, they are professional farmers. ■



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ASK AN EXPERT – IS ONE-TIME TILLAGE A VIABLE WEED CONTROL OPTION IN A NO-TILL FARMING SYSTEM?

With Yash Dang, Senior Research Fellow, University of Queensland

MANY would say that the widespread adoption of no-till and minimum till farming underpinned the expansion of cropping in many parts of Australia and saved many farming families from economic hardship.

While costs and erosion damage were reduced, the heavy reliance on herbicides has resulted in a significant shift toward weeds that can thrive in this farming system. Weeds that were previously not considered a problem are now making farming unprofitable or impossible on some no-till paddocks.

University of Queensland senior research fellow, Dr Yash Dang says the removal of cultivation has also led to an accumulation of certain immobile nutrients such as phosphorus, zinc and potassium in the dry surface layer of the soil where plant roots cannot access them.

"Cultivation has a role in distributing nutrients, managing soil and stubble borne diseases and controlling certain weeds," he says. "The complete removal of tillage for 15 to 20 years or more on some farms has led some farmers to the conclusion that they cannot continue as no-till farmers."

Yash undertook a four-year project, starting in 2012, to investigate the effect of tillage on a range of soil properties in no-till paddocks throughout the northern cropping region – from Emerald, Qld to Dubbo, NSW.

"We applied tillage using disc and tyne implements and also tested the timing and frequency of tillage operations," says Yash. "On well-structured soils there was no detrimental effect as a result of the cultivation. Even on more difficult soils, such as those with sodic subsoil or with hardsetting tendencies, one-off tillage operation at the correct soil moisture content caused only limited damage to the soil and repair was evident within two or three years."

Dr Yash Dang, University of Queensland research fellow, says 'no-till' does not have to mean 'never till'. Occasional cultivation can be used as a weed control tactic without having a detrimental effect on the soil resource.

The type of implement used for a one-off cultivation had little impact on the soil properties. Non-inversion tine or disc implements provided effective weed control when used before weeds flowered and set seed.

The research also demonstrated that cultivation is a viable weed control tactic within an otherwise no-till system, to prevent seed set of weeds such as fleabane and feathertop Rhodes grass, which flourish in a chemical-dominant control program.

"The positive effect on weed numbers is usually short-lived and has the potential to have negative effects in the years after cultivation," says Yash. "Growers considering the re-introduction of occasional cultivation must consider all the pros and cons. Cultivation is just another tool in an integrated weed management system – not a stand-alone solution."

How often should I use cultivation in my no-till system?

Short answer: As a last resort.

Longer answer: A move to no-till farming has provided significant benefits to the soil resource and to farmer's profitability. This research does not suggest a return to full cultivation, but the trials showed that one-off, occasional tillage does not have significant detrimental effects on the soil. Care is required in terms of timing, type and frequency of tillage on sodic soils and soils with hardsetting characteristics.

There is a soil moisture loss associated with cultivation so this should be taken into account when making the decision to cultivate.

When should I use tillage?

Short answer: Before the weeds flower and set seed.

Longer answer: Cultivation should be a last resort measure to treat patches or paddocks where the weed pressure has reached unacceptable levels and where the species present do not have seed that remains viable for many years once buried.

Weeds such as fleabane and feathertop Rhodes grass are good candidates for occasional tillage as a means of preventing seed set. Numbers of these species can be driven down quickly through a dedication to preventing seed set for just a few consecutive years.

In most situations a single pass cultivation is sufficient to achieve the desired effect of reducing the target weed population. If the problem is severe then this single pass operation may be required for a few consecutive years. Timing is critical to achieve good weed control while not sacrificing a planting opportunity.

What other benefits can I expect from occasional tillage?

Short answer: A possible yield increase.

Longer answer: Cultivation will speed up mineralisation in the soil and the breakdown of organic matter. The distribution of immobile nutrients, such as phosphorus, potassium and zinc, will move deeper into the plant root zone. In a no-till system these nutrients tend to accumulate in the top few centimetres of soil, which is often too dry for plant roots to access. The release of nutrients may support short-term yield response.

Cultivation will also disrupt insect and disease cycles, potentially improving yield and reducing control costs. Pathogens causing diseases such as crown rot of wheat, yellow spot of wheat, ascochyta blight of chickpea and stalk rot of sorghum, can build up in the stubble and soil in a no-till farming system.

Likewise soil insects such as Helicoverpa, armyworms and black field earwigs can proliferate in the surface soil.

What are the risks associated with occasional tillage?

Short answer: Potential nutrient and soil moisture loss, and exposure to erosion.

Longer answer: Tillage is accompanied with a loss of soil moisture, but at most of the trial sites stored moisture improved in subsequent years due to improved infiltration.

If possible, cultivation should be done when there is a good chance of sufficient rainfall before the next planting opportunity. Mineralised nutrients and the soil itself is more exposed to runoff following cultivation.

In situations where weed seed has been buried previously, cultivation may bring these seeds back to the surface and initiate fresh germinations. Paddock history is an important consideration in the decision to cultivate. ■

HOW TO ASK A WEEDSMART QUESTION

Ask your questions about re-introducing tillage to a no-till farming system 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.

Take on board the new spray quality data for nozzles

By Bill Gordon, Nufarm Australia

AT A GLANCE…

- Before you spray, you need to critically evaluate the claims made on adjuvant labels or in technical literature about the products you are about to use;
- Check the spray quality data for nozzles supplied by their manufacturers for legal compliance, efficacy and drift control; and,
- Ensure you select nozzles based on current spray quality information, such as the GRDC *Nozzle Selection Guide*, 2017.

IT'S important that we understand the reasons why we use adjuvants. The primary purpose of adding an adjuvant to the tank mix should be to improve efficacy. This may be achieved through different mechanisms, such as:

- Increasing spread of the droplet on the leaf surface;
- Modifying the leaf cuticle to improve penetration;
- Adjusting the pH of the solution to reduce interactions with cations in the water or on the leaf surface;
- Reducing evaporation to allow more time for the product to enter the target;
- Reducing undesirable interactions between products in the tank mix; or,
- Improving droplet retention by reducing droplet bounce or shatter.

Figure 1 illustrates how spray droplets – with and without the use of an adjuvant – behave on the target leaf surface.

To change the behaviour of the spray solution, or of a droplet on the leaf surface, the physical and chemical properties of the spray solution usually need to be modified in some way. The most obvious effect of adding an adjuvant to the spray solution is a change in the dynamic surface tension (Table 1).

Lowering the surface tension causes droplets to spread on the leaf surface, which can increase contact with the leaf surface, improving uptake.

But reducing surface tension of the spray solution can also modify how the droplets themselves are formed as they leave the nozzle, typically reducing their size (compared to water alone).

Factors influencing droplet size

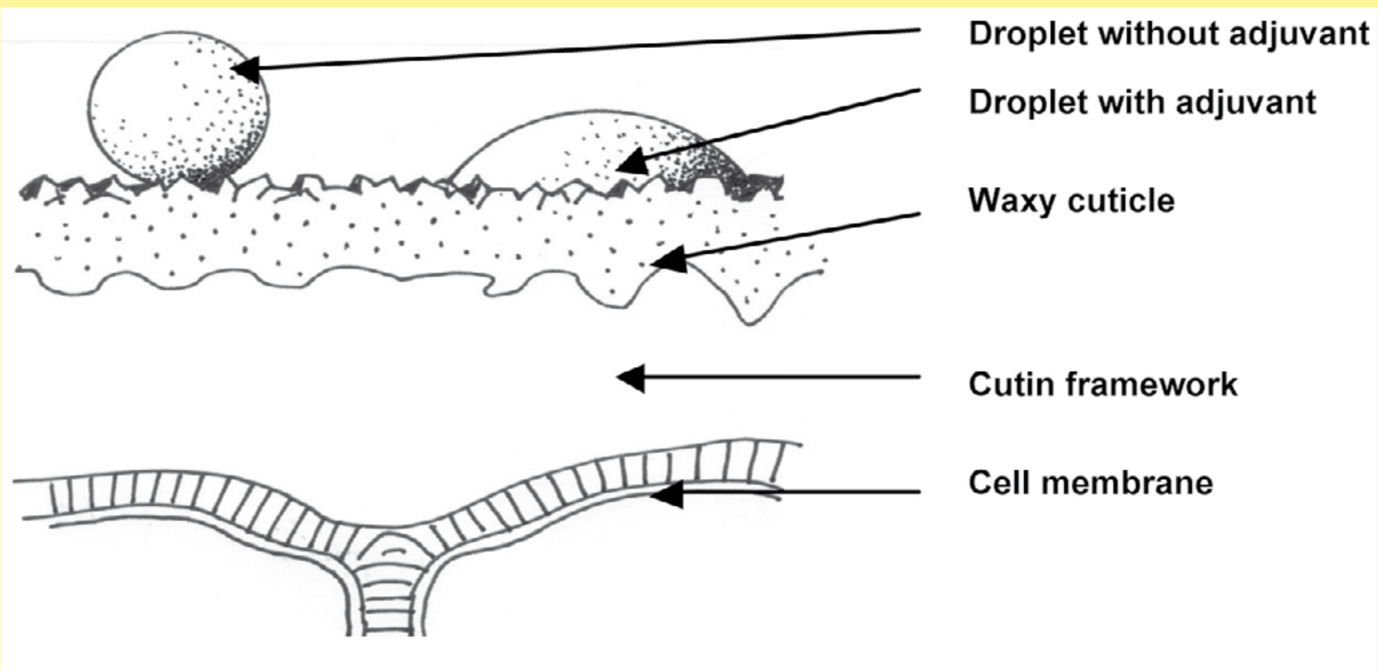
One of the main factors influencing the droplet sizes produced by a nozzle is the nozzle design itself – that is some nozzles are coarser or finer than others.

The spray solution also has an influence, where products with

TABLE 1: Typical dynamic surface tension values (dynes/cm) for some common adjuvant types

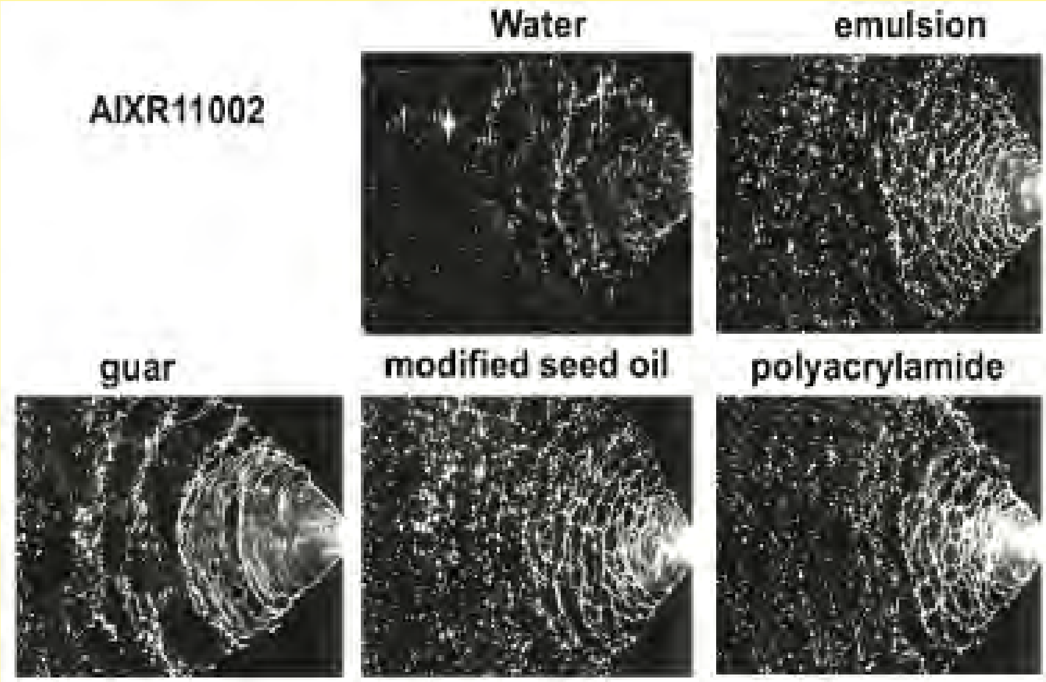
Water alone	72 dynes/cm
Water + Collide 700 / LI 700	48–49 dynes/cm
Water + Wetter 1000 (non-ionic) products	32 dynes/cm
Water + an organosilicone (penetrant)	22–23 dynes/cm

FIGURE 1: Behaviour of droplets on a leaf surface – with and without an adjuvant



Source: *Adjuvants – Oils, surfactants and other additives for farm chemicals*, GRDC 2012.

FIGURE 2: Effect on spray pattern from a TeeJet AIXR11002 nozzle when using various adjuvant types and at the same spray pressure



Source: University of Queensland, C–START

a lower dynamic surface tension tend to produce finer droplets than products with a higher dynamic surface tension.

Other factors including viscosity and solution temperature can also impact on how droplets are made through various nozzles.

Typically, the more uniform the pattern is as it begins to break up, the more uniform the range of droplet sizes produced will be.

Figure 2 compares the uniformity of the spray pattern when using the same nozzle and pressure but with various adjuvant types.

Spray quality and changing standards

Spray quality is not a direct measurement of drift, but a measurement of the range of droplet sizes produced by a nozzle.

Spray quality data may be reported by nozzle manufacturers against a couple of different standards including the British Crop Protection Council (BCPC) or the older American Society for Agricultural Engineers (ASAE) Standard S572. Both standards are mentioned on some Australian labels.

Both the BCPC and older ASAE standards report spray quality based on **water alone** being sprayed through the nozzle.

More recently the ASAE has changed its name to the American Society for Agricultural and Biological Engineers (ASABE) and has adopted a new standard for spray quality known as the ASABE S572.1.

This new ASABE standard requires that testing of pre-orifice and air induction nozzles include the addition of a 40 dynes per cm adjuvant to water as the test solution.

This has been designed to provide data which better reflects the spray quality that a typical tank mix may produce, rather than water alone.

As a result, recent nozzle charts (see Table 2) may show spray qualities which appear to be finer than that indicated on older charts which may still be in circulation. It is important that nozzles are selected based on the best available data.

More information: Bill Gordon, Nufarm Australia. Mobile: 0418 794 514; Email: bill.gordon@nufarm.com ■

TABLE 2: Comparing old and new spray quality data for the same nozzle

OLD	Hypro	**Pressure (bar)**	1.5	2	3	4	5	6	7	8
	Guardian Air 110-025	**Spray quality ASAE S572**	XC	VC	C	C	C	M	M	M
NEW	Hypro	**Pressure (bar)**	1.5	2	3	4	5	6	7	8
	Guardian Air 110-025	**Spray quality ASABE S572.1**	XC	VC	C	M	M	M	M	M

Where spray quality XC = Extra coarse; VC = Very coarse; C = Coarse; and, M = Medium.
Source: GRDC Grownote – *Spray Application for Grain Growers, 2017*.

Down to Earth

By Ian M. Johnston

My interest (some say 'obsession') with tractors, also extends to earthmoving and construction machinery. Well after all, bulldozers, loaders and excavators are really first cousins of farm tractors.

In fact, back in the mid-1960s I accepted the offer of a job as Sales Manager employed by Lough Equipment Pty Ltd, whose premises were based at Artarmon, on Sydney's North Shore. During my period with the firm, which imported and marketed an extensive range of earthmoving and construction machinery, I encountered numerous absurd experiences, four of which I have chronicled hereunder.

The spaghetti gang

Based at Penrith, NSW, there was a group of Italians who were engaged in pipe line connection work for The Metropolitan Water Sewerage and Drainage Board. I recall there was a Luigi (he was the boss), an Enrico and a Giuseppe among them, but I am unable to recall the company name, but it sounded a bit like Spaghetti Constructions – so that will do.

One morning I decided to pay a goodwill visit to the Spaghetti current worksite, as they had recently favoured our company with an order for a Whitlock 60A loader backhoe. Their job consisted of laying a mains water pipeline the length of a suburban street, which involved the digging of a 200 metre trench.

As I wheeled my company Holden into the street, I noticed a parked ute partly blocking the entrance to the thoroughfare with a swarthy faced unshaven fellow leaning on the bonnet. I was obliged to slow down as I edged past the vehicle, during which time I was carefully scrutinised by the fellow, who then proceeded to wave a thumbs up signal to the gang working further down the road.

Archival scene of a Whitlock 60 loader/backhoe, with a Thwaites Nimbus dumper and Lough Equipment ute taken outside the Old Parliament House, Canberra, whilst engaged in the very first excavations to create Lake Burley Griffin.
(IMJ archives)

The Whitlock backhoe was hard at it, tearing out bucket loads of soft shale with obvious comparative ease. Curiously there was also an adjacent Hollman air compressor with its big Gardner diesel engine idling and a couple of jack hammers lying on the ground.

Luigi scrambled out, from whatever he had been doing down in the trench, to greet me. I was about to inquire the purpose of the Hollman and the jack hammers, because it was obvious the backhoe was handling the excavation effortlessly, when there was a frantic sounding of the horn from the ute at the top of the road.

Instantly, Italians rushed to the compressor and grabbed the jackhammers. In the meantime the Whitlock abandoned its excavating, was hastened away from the trench and the engine switched off. Within half a minute of the sounding of the horn, the scenario had completely changed. The Gardner Diesel in the compressor was roaring, two assiduous fellows were deep in the trench furiously working the clattering jack hammers and Luigi was wiping the sweat from a worried brow.

At that moment a Water Board utility pulled up and a stout Project Inspector climbed out and surveyed the scene.

"Still having problems with the shale I see, Luigi," he remarked.

"Yes matey, hard as rock it is, but we are getting through it matey. Thank God for the jack hammers," Luigi added.

"Okay mate. See yis tomorrow." With that the inspector eased himself back into his vehicle and drove off.

Within minutes, the compressor was stopped and the backhoe was back in place, effortlessly hauling out the soft shale.

Luigi turned to me and winked and said "You see matey, we gets triple dollar per cubic metre when we strike the hard material that needs the hand operated jack hammers. Luigi, he no fool! So Enrico, he keep guard at the end of road and when he see inspector bloke he is coming, he honk horn. Clever, eh?"

Panic in the square that is round

The Thwaites Nimbus was a robust diesel engine powered one cubic metre capacity dumper – a versatile addition at building sites and which sold strongly to contractors and Government Departments. Despite its compactness, with the skip fully laden it turned the scales at around two tonnes.

Australia Square is the euphemistical name given to the round 50 floor office tower in the centre of Sydney. Designed by the high profile architect Harry Seidler and completed in 1964, its construction was unique for the period. Basically it featured a centre core with connecting pre-stressed concrete support beams to outside columns, in the manner of spokes in a wheel.

During its construction a contractor was engaged to remove building debris and surplus materials. As each floor, supported on the beams, was completed, he was required to remove the rubbish, which was transported to, and dumped into, one of the several yawning yet to be equipped lift wells, where it tumbled down into an awaiting skip.

What better means of carrying out this task, than with a

Australia Square building. (Photo origin unknown)

Thwaites Nimbus dumper! Accordingly, the dumper was hoisted aloft by a stalwart crane to each level as the construction progressed.

I was quick to grasp the perfect opportunity of seeing at first hand the complexities of such an epic building. Surely it would be a necessary courtesy to call upon the contractor and check the operation of his Thwaites dumper?

So there I was, having been elevated in a special hoist to the 39th floor, chatting to the contractor alongside his loaded dumper, when a frantically worried individual stormed up to us. I identified him as one of the building engineers by the row of pens and slide rules sticking out from his breast pocket and the rolls of blueprints he carried under his arms. The poor fellow was in a blithering state and looked as if he was about to start frothing at the mouth!

It appeared he had just awakened to the fact that the concentrated weight of the dumper was far in excess of the safe bearing loads of the pre-stressed concrete beams, which supported each floor level. Wow! Did that mean the building was about to collapse – and with me on the 39th floor?

Apparently not! But the frantic engineer guy demanded the dumper discharge its overflowing load there and then, and be quietly driven to the crane access and lowered to the ground.

The distraught contractor was obliged to buy himself a wheel barrow to carry out the remainder of his contract.


A Thwaites Nimbus Diesel dumper. (IMJ archives)

Chaos in Carlotta Street

The Australian earthmoving industry entered a period of transformation in the early 1960s with the introduction of hydraulic excavators. JCB – the world's largest producer of loader backhoes – entered the excavator market with its JCB 7 in 1965. This occurred during my period as Sales Manager for Lough Equipment Pty Ltd. We had recently abandoned the Whitlock franchise for that of JCB. Accordingly, I was full of anticipation as the first of the JCB 7 excavators arrived off the wharfs.

Rather cleverly I thought, we had received an order for that first unit prior to it being shipped from the UK. Messrs Tipping Brothers of Chatswood had been so impressed by the specs and photos with which I had presented them, they insisted upon securing the first to arrive. (A marketing man's dream!)

Fast forward to the morning Tippings sent their float to pick up their new excavator…

There the JCB 7 stood outside our premises, all checked over, a full tank of diesel and even polished by Jacko, our resident doer of all the jobs everyone else felt would be beneath them. Even Mr Lough, our tall distinguished and always elegantly attired

Mr Lough watches anxiously as the JCB 7 is up on the float – but facing the wrong way! (Photo IMJ)

boss, must have sensed the exhilaration of the occasion, as he had relinquished the sanctuary of his desk and joined us waiting by the kerbside in the expectation of the arrival of the float, which duly arrived. But to our consternation it was a relatively lightweight side mounting affair.

The JCB weighed in at around 20 tonnes and really required a rear loading tri-axle float for its transportation. But Wally the driver insisted his somewhat diminutive float was up to the job.

I should explain that Carlotta Street is a relatively narrow affair, largely populated by ageing suburban residences. The Lough Equipment premises were at the top end just a mere 50 metres from where it joined the Pacific Highway.

For one hour, Carlotta Street, (which is a through thoroughfare often used as a shortcut to Artarmon station) was completely blocked off by the big excavator as it had to be backed across the road and then wrestled back and forward by Wally to mount and be positioned on the inadequate deck. In the meantime streams of traffic which had entered Carlotta Street, were obliged to back out onto the Pacific Highway. I closed my ears to the profanities that were levelled at us by exasperated drivers.

Finally the JCB was on board the float, BUT owing to the short deck length, the excavator could not be laid out in the normal transport position. Instead the dipper and boom were tucked up close to the cab, which increased the overall height when mounted on the float and suggested that proceeding under a low bridge would be out of the question.

Eventually, Wally cranked up his rig, having securely chained the excavator, and roared off down Carlotta Street. We gratefully waved cheerio.

There were no low bridges in Carlotta Street. But equally devastating, was the fact that each house was connected to electricity overhead power cables by wires slung high diagonally across the road. But not high enough to clear the JCB!

There were around 30 houses, therefore 30 power wires were systematically ripped from each power pole, accompanied by a spectacular display of sparks, which could be likened to a Sydney's New Year fireworks display. And dear old Wally remained sublimely unaware of the chaos and bedlam in his wake as he blissfully continued on his way, possibly with his radio tuned to John Laws. Carlotta Street resembled a snake pit, with rows of hissing and spitting black snakes wriggling across the road.

Somebody rang 000. The rest of us disappeared. Well, it was lunch time!

The fat policeman

Just north of the Sydney Harbour Bridge, the old Pacific Highway passes through the Crows Nest intersection. This is a heavily trafficked area where five roads join. Today, a complex system of multiple traffic lights controls the flow of vehicles. But in the 1960s the task was left to a stout policeman who had the stoicism of a New York cop. He was never flustered by even the mammoth volume of peak hour traffic. When the situation became too chaotic, he simply strolled off and stood in a doorway until the motorists were finished hooting at each other and normality had resumed.

On one memorable occasion I was on my way from the city to Artarmon driving a customer's Ace front end loader (never mind why) and had been waved through the junction by the benevolent stout policeman, when a taxi abruptly, without warning and quite illegally, changed lanes and skidded to a stop in front of me.

An Ace loader mounted on an old Fordson Major, equipped with two wheel super optimistic brakes, is not the most manoeuvrable of vehicles. But even had I been driving a Porsche I would still have been forced to inflict a scratch on the parked car on my left.

Fordson Super Major with Ace loader.

The corpulent enforcer of the law arrived majestically on the scene. He was full of understanding and completely sympathetic to my predicament, happy to leave the conclusion of the event to insurance companies.

He was about to resume his point duties when my boss Mr Lough pulled up in his Pontiac. His reaction was to verbally and loudly assail the policeman insisting that his Sales Manager could not possibly have been in the wrong, even although he had not a clue of what had transpired. The haranguing continued to such an extent that the patient policeman had had enough!

He shook his head, gazed Heavenward, sighed – and booked me for negligent driving!

Gee, thanks boss! ■

IAN'S MYSTERY TRACTOR QUIZ

Question: Can you identify the mystery tractor?

Clue: Yes, it is easy. If you can read the name on the bonnet you will know it is an Allis Chalmers! But – do you know its model type and is it US or UK manufacture? No clue offered.

Degree of difficulty: Easy, only if you know your Allis Chalmers tractors! Otherwise – very hard.

Answer: See page 48.

NORTHERN FOCUS

COVERING NORTHERN NSW AND QUEENSLAND

Horses for courses: Picking a winner in the wheat yield stakes

By Felicity Harris[1], Rick Graham[2], Greg Brooke[3] and Darren Aisthorpe[4]

AT A GLANCE…

- Plant phenology is the study of plant life cycle events and how they are influenced by seasonal and environmental factors.
- In our research, variation in phenology had a significant effect on the grain yield potential of wheat varieties in response to sowing date across growing environments of the northern grains region (NGR).
- The variation in phenology of genotypes is largely due to interactions between genetic responses to vernalisation and photoperiod and growing environment, which determines genotype adaptation.
- High grain yields can be achieved from a range of genotype x sowing date combinations – but there is variation in genotype responses across environments of the NGR.
- Whilst flowering time is important in maximising grain yield potential, the pre-flowering growth phases can have a significant influence on grain yield.

THERE are a range of commercial wheat varieties suited for sowing across the northern grains region (NGR), which vary in phenology from slow developing winter types to fast developing spring types. This range of varieties provides growers with flexibility in terms of the wheat sowing window.

The yield potential of wheat basically relies on matching phenology and sowing time of varieties to ensure flowering and grain formation occurs at the best time. And in most Australian winter crop environments, this involves balancing frost risk with increasing water and heat stress.

The optimal flowering time varies across the northern region. But with a good understanding of the drivers of phenology, NGR growers have a much better capacity to tailor suitable combinations of genotype and sowing date to minimise environmental stresses and achieve better grain yields.

This article discusses the influence of phenology on yield responses to sowing time for wheat genotypes across five environments of the NGR.

The duration of wheat growth stages

The grain yield of wheat is determined by three main components:

- Spike density;
- Grains per spike; and,
- Individual grain weight.

The timing and duration of development phases (phasic development) in wheat is directly related to the formation of specific grain yield components and overall grain yield.

During early vegetative development, leaves and tillers are initiated (spike density), prior to the transition to the reproductive stage, when spikelet development commences.

Spike growth and differentiation continues in conjunction with stem elongation up until flowering (grains per spike).

After flowering, and during the grain filling phase, the embryo develops, producing a viable seed – this coincides with the establishment of grain weight.

Phasic development in wheat is primarily controlled through varied responses to vernalisation (Vrn) and photoperiod

(Ppd) genes. Generally, accumulated temperature accelerates development of all phases, whilst there is an additional effect of vernalisation in some genotypes.

Genotypes responsive to vernalisation require a period of cold temperatures to progress from vegetative to reproductive development. Vernalisation accumulates most rapidly in the range 3–10°C, but can accumulate at a slower rate up to 17°C.

The direct influence of vernalisation is to alter the length of the vegetative phase, but it can also indirectly affect the duration of subsequent phases.

Wheat is a long-day plant meaning the rate of development is increased with longer day-lengths. But individual genotypes of current commercial varieties respond differently to photoperiod, and a large number of Australian cultivars are insensitive to photoperiod.

In photoperiod sensitive genotypes, short-day (SD) conditions prolong the vegetative phase and delay the transition to reproductive development. Conversely, long-day (LD) conditions decrease the time to reproductive phases.

Flowering time is generally regulated by Vrn and Ppd genes. But there is also an additional effect of a third level of genes – the earliness (Eps) genes. These have been identified as having a finetuning effect on flowering time, though these are less associated with regional adaptation of genotypes.

2017 field experiments

In 2017, field experiments were conducted in central and southern QLD, northern NSW and southern NSW.

This article presents results from five sites: Wagga Wagga, Trangie, Edgeroi, Wellcamp and Emerald.

A range of genotypes with varied development (and with different combinations of Vrn and Ppd genes) were sown across these sites from late April through to late May, with an additional early April sowing at the Wagga Wagga site.

The optimum genotype and sowing date combination for maximum grain yield varied significantly across the five sites (Figure 1).

Optimal flowering time was substantially earlier and spanned longer in the northern sites compared to the Wagga Wagga site in southern NSW.

To summarise the results of the 2017 field experiments, grain yields were maximised when the sowing date x genotype combinations flowered:

- Mid to late July at Emerald;
- Late August to mid September at Wellcamp;
- Mid to late August at Edgeroi and Trangie; and,
- Early October at Wagga Wagga.

Wagga Wagga site

The flowering window at Wagga Wagga was directly influenced by early stem frost damage in 2017. This resulted in significant tiller death and late regrowth of tillers in faster developing genotypes. This affected uniformity of maturity in plots.

Faster developing genotypes had lower tiller survival (proportion of tillers which produced a spike) at early sowing dates, whilst the slower developing genotypes, which remained vegetative for longer, were exposed to less frost events and were able to maintain tillers and stabilise flowering time.

Trangie site

The grain yield responses to flowering time at the Trangie site were largely influenced by below average (Decile 1) growing season rainfall. In this warmer environment, winter genotypes flowered much later than the optimal flowering window and yield was severely penalised.

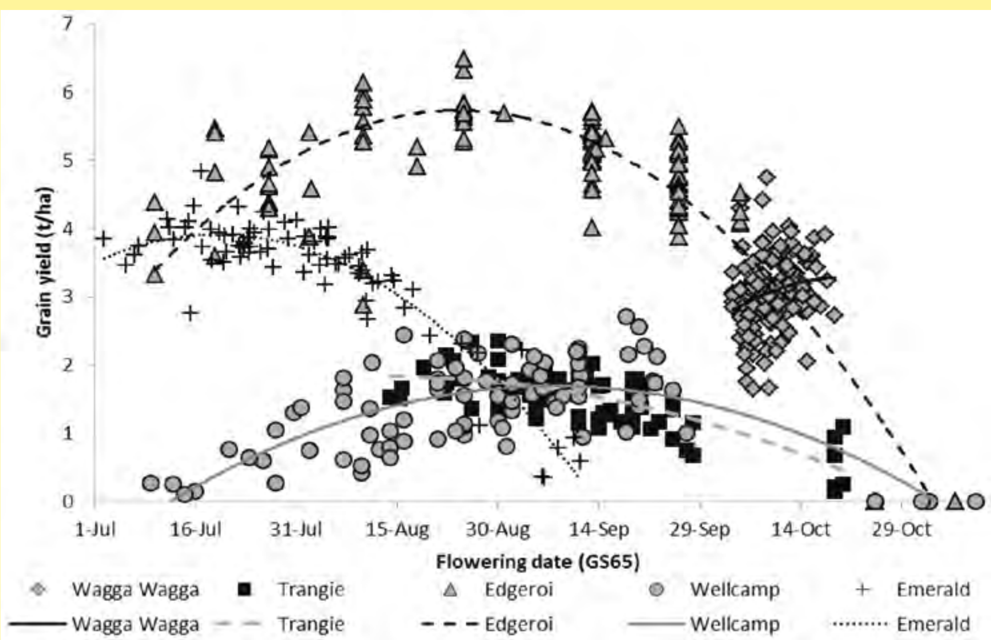
Edgeroi site

The optimal flowering window at Edgeroi (mid to late August, see Figure 1), was broadly representative of this environment, highlighting the potential for frost risk whilst also underlining the impact of heat and moisture stress.

In 2017, there was a combination of stresses including frost in August and early September, below average growing season rainfall (195 mm) and temperatures above 30°C in mid to late September.

Consequently, the highest yields were achieved by combinations of sowing date x genotype which flowered during the mid to late August flowering window. The winter types with strong vernalisation responses (for example, Manning), did not flower until late October – even when sown early – which was too late to achieve grain fill in this environment.

FIGURE 1: Relationship between flowering date and grain yield of genotypes across sowing dates at five sites in 2017



Wellcamp site

The optimal flowering window identified for Wellcamp was late August to mid-September (Figure 1). In 2017, the site was particularly influenced by cooler temperatures and significant frost events in July through September, and high temperatures throughout the flowering window.

Grain yield was reduced by a hail storm on October 24, just prior to harvest. Generally, wheat is sown from late May to June for the Inner Darling Downs region, due to increased risk of frost damage, and later onset of heat risk.

Emerald site

The flowering response observed at the Emerald site in 2017 (Figure 1) was generally representative of the sowing dates in that environment. The optimal flowering window at Emerald (mid to late July) is largely driven by the high risk of heat stress from August onwards, rather than an early frost risk.

The winter genotypes did not achieve harvestable yield across any of the sowing dates. While some slower developing genotypes, such as LongReach Kittyhawk and Sunlamb, did measure very modest grain yields, the Emerald environment favoured mid to fast spring genotypes which flowered within the optimal flowering window and attained the highest grain yields.

Yield responses to sowing time

Across the five sites in 2017, there was genotype variation in the grain yield responses to sowing time (Figure 2).

Generally, the slow developing genotypes favoured southern sites, characterised with a longer growing season and high risk of frost damage. For example, Manning (a winter type with strong vernalisation response) and EGA Wedgetail (also a winter type) had highest yields when sown early (indicated by the negative slope) at the Wagga Wagga site.

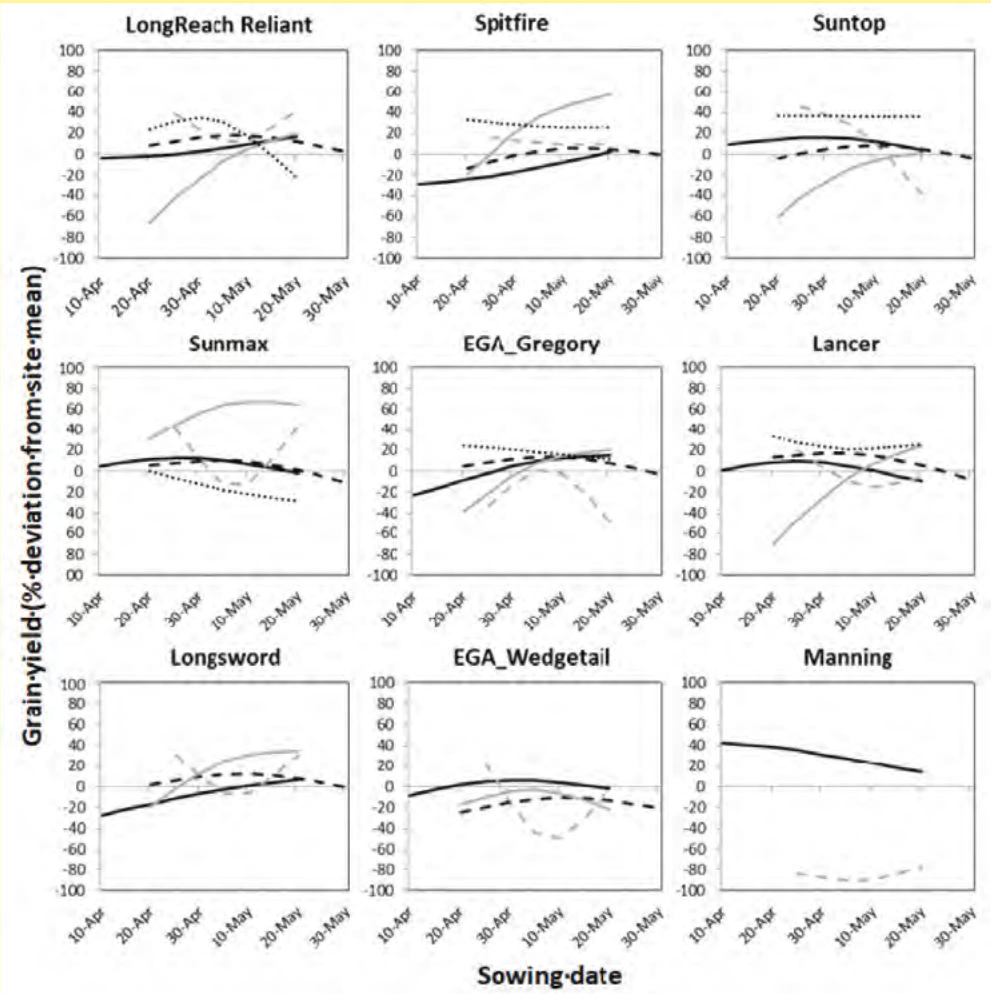
But the vernalisation requirement of these winter types did not suit the warmer environments of northern NSW and QLD, and as such they either had significant grain yield penalties or did not achieve grain yield.

The northern sites favoured mid to fast developing spring genotypes sown late April to early May (indicated by the negative slope). But in contrast, these genotypes were better suited to the late May sowing at Wagga Wagga (indicated by the positive slope).

Despite the variability across environments and conditions in 2017, some spring genotypes such as EGA Gregory and Suntop were able to maintain relatively stable grain yields across many sowing dates at some sites (indicated by a flatter line).

While the general yield responses were similar for some sites, the variability in specific genotype responses across the sites suggests there are differences in suitability of genotypes across the northern region growing environments.

FIGURE 2: Grain yield response to sowing date in 2017 for selected genotypes across the five sites



(Black line = Wagga Wagga; Grey dash line = Trangie; Black dash line = Edgeroi; Grey line = Wellcamp; and, Dotted line = Emerald). Grain yield response is presented as the % deviation from the individual site mean. Site means were: Wagga Wagga – 3.07 t/ha; Trangie – 1.52 t/ha; Edgeroi – 4.98 t/ha; Wellcamp – 1.33 t/ha; Emerald – 2.93 t/ha.

To sum up

Our field experiments showed that genotypic variation in phenology had a significant effect on the grain yield potential of wheat varieties in response to sowing date across growing environments of the northern grains region.

Genotypes varied in responses to vernalisation and photoperiod genes, which influenced early phasic development in addition to flowering time across the sites.

Matching variety and sowing date to achieve an optimal flowering time for each growing environment is the most effective management strategy in minimising the effects of abiotic stresses.

In southern NSW, winter types can be sown early and regulate flowering to minimise effects of early frost damage and later, heat and moisture stress.

But in northern NSW and QLD, winter types are not able to saturate vernalisation requirements and the shorter growing season favours mid to fast spring types which are generally regulated by responses to photoperiod.

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We acknowledge the support of NSW DPI and QDAF and their cooperation at Wagga Wagga Agricultural Institute, Tamworth Agricultural Institute, Trangie Agricultural Research Station and Emerald Agricultural College.

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Diverse management to keep FTR numbers low

AS an early adopter of zero tillage and controlled traffic farming in Central Queensland, Brendon Swaffer is fully convinced of the benefits, and is well aware of the potential impact of weeds like feathertop Rhodes grass (FTR).

Since taking over the family farm near Clermont in 2007, Brendon and his wife Jody have been building a robust cropping program with wheat and chickpea in winter and, if soil moisture permits, dryland cotton and sorghum in summer across their 4000 hectares of cultivation.

"In the summer fallow our main weeds are summer grass, Johnson grass and fleabane but we are most concerned with the small patches of feathertop Rhodes grass that are appearing," says Brendon. "We are using a mechanical and chemical double knock to manage these patches of FTR and it has been very effective for us in preventing its spread."

Targeting patches – keep a hoe in the ute

Early in summer Brendon targets any patches of persistent weeds – mostly feathertop Rhodes that has survived under the winter crop. Starting with cultivation of the affected areas, Brendon then follows up a few days later with an application of metolachlor (Group K) to provide short-term residual control of any new germinations that are triggered by the cultivation.

"We might spend two days ploughing but only cultivate 150 hectares in total," he says. "For the rest of the year we carry a hoe in every vehicle and stop to chip out small areas of weeds when we see them. We have been enjoying the enormous benefits of zero till and controlled traffic since the 1990s – there is no going back to full cultivation, but it is a useful management tool to target weedy patches before they get out of hand."

Preventing seed set for a couple of consecutive seasons is

Planting on 50 cm rows using moisture seeking techniques has established chickpea as the Swaffer's most reliable crop. Brendon has found that a post-plant pre-emergence application of Terbyne (Group C) controls weeds up to canopy closure and no other in-crop herbicide is needed until the crop is desiccated prior to harvest.

Strzelecki wheat has been a mainstay variety in the Clermont district because of its ability to emerge from a depth of 10 cm. A change in classification of this wheat will most likely drive growers to look for a replacement variety.

known to rapidly rundown FTR seedbank as the seed on the surface or even slightly buried only persists for 12 to 18 months.

Adding dryland cotton to their rotation has also helped minimise the spread of FTR. The Swaffers produced cotton in four of the five summers from 2010–11 to 2014–15, which enabled the application of Roundup Ready Plantshield to keep pressure on FTR and reduce seed set.

Brendon has built-in several non-glyphosate weed control measures including cultivation, along with other knock-down and residual herbicides, to take the pressure off glyphosate in their farming system.

"Feathertop Rhodes grass is not a problem in conventional systems but the more area farmed the more difficult it is to keep clean," he says. "It also seems to prefer scrub soils that are a bit lighter textured than the open downs country and alluvial soils we have on this property, giving us a slight advantage."

The fallow starts with spraying out sorghum in June with glyphosate to kill the crop, make harvest easier and kill the weeds. During summer, Brendon applies glyphosate, 2,4–D-amine and a small amount of metsulfuron (Group B) as a tank mix to target weeds when they are small and actively growing after a rainfall event.

The metsulfuron is targeting parthenium and can also provide an additive effect on glyphosate when applied in a tank mix.

Looking for survivors

After each spray application Brendon looks for, and manages any survivors or areas where the sprayer has missed, to minimise the number of weeds that escape and set seed later in the season. In recent years he has moved to more robust rates to ensure efficient weed control and to avoid the need to go over a paddock a second time.

With the variable rainfall experienced in Central Queensland, chickpeas are now the Swaffer's most reliable crop, using moisture seeking planting techniques. "We can plant in April or early May on rain received in February by planting the chickpea seed up to 18 cm deep," says Brendon. "Chickpea is the only crop that has a long coleoptile that allows emergence from such depth."

"Emergence can take three weeks, but we can establish a crop on stored moisture and have it up and away before in-crop rain initiates a fresh flush of weed germination, giving the crop a distinct competitive advantage."

The timing of a moisture seeking planting needs to factor in the frost risk in the district to avoid having the chickpea crop flowering when there is a high chance of frost.

In some years there is moisture higher in the profile, allowing both chickpea and wheat to be planted about 10 cm deep. Wheat is also planted a little later in the Clermont district than in other areas of CQ, to avoid frost. Most growers prefer to accept the small yield penalty for planting later rather than risking a crop failure.

"Strzelecki wheat is a slow maturing spring wheat of semi dwarf habit that is popular in CQ due mainly to its longer coleoptile length that allows us to plant to a depth of 10 cm," he says. "But this variety is about to be re-classified to Hard 2 instead of Prime Hard and so many growers will be looking for an alternative wheat for the future," he says.

Higher levels of crop competition can be achieved in the winter crops compared to the summer crops, with chickpea and wheat both sown on 50 cm rows. Brendon plants chickpea in his cleanest paddocks and uses a post-plant pre-emergence application of Terbyne (Group C) to control weeds up to canopy closure. No other in-crop herbicide is applied except for desiccation for harvest management. Brendon avoids using Balance due to the long plant-back period and the need for a lot of rain to break down the residual.

Sorghum crops are sown on single skip metre rows, with cotton planted in double skip configuration of two in and two out to optimise yield and quality. Brendon previously planted sorghum in solid one metre single rows but has changed to planting a single skip – two in and one out – and increased intra-row plant density. The soil on the Swaffer's property requires about 200 mm of steady soaking rain to fill the profile and initiate a summer crop planting.

"We are concentrating on achieving even intra-row spacing using a double disc precision planter to increase weed competition within the row," he says. "This also promotes even maturity and reduces tillering. The combined effect encourages a shorter flowering period and makes grub and midge control easier, along with reducing the risk of ergot infection."

Sorghum is planted in January and early February following an application of glyphosate, Dual Gold and 2,4–D, provided there is no cotton planted nearby. Brendon also applies atrazine and fluroxypyr to provide in-crop weed control. Metolachlor applied in the fallow ahead of cotton provides some residual weed control but the main in-crop weed control strategy is RR Plantshield.

Brendon puts far greater emphasis on timeliness of weed control than on specific rates and products.

Cleanest possible seed

At harvest, Brendon uses perforated screens in the header to remove as much Mexican poppy, and turnip weed seed and soil as possible out of the chickpea grain sample. He also keeps about 100 tonnes of both chickpea and wheat seed that has been graded hard to ensure the cleanest possible seed goes back in the ground the following season.

Brendon does all his own spraying with a John Deere 4030R self-propelled sprayer and likes to keep their spray technology up to date. He considers the sprayer to be their main tractor now and changes the sprayer unit every five years or so to always have new gear that works well and with minimal downtime.

"Our groundwater is quite hard so we use ammonium sulfate, especially when spraying out sorghum with glyphosate," says Brendon. "Although we now have more access to rainwater, storing water is very costly so we have been assessing the difference between rain water and groundwater this year in terms of cost and efficacy on weeds. We expect to invest more in rainwater storage in the future."

Being in full control of the spray program means Brendon can ensure his neighbours are always informed regarding cotton plantings and he only sprays when conditions are suitable. "When sensitive crops are nearby it is all about working in the right conditions and being careful about product selection," he says.

For more information about managing feathertop Rhodes grass, visit the WeedSmart website: www.weedsmart.org.au ■

How much nitrogen is fixed by pulse crops?

■ By Nikki Seymour[1], Kerry McKenzie[1], Steve Krosch[1] and RCN Rachaputi[2]

AT A GLANCE…

- The amount of nitrogen (N) fixed by pulses varies widely (from 0 to 400 kg N per hectare) and is impacted by crop species, soil nitrate at planting, effective nodulation and agronomic factors such as time of sowing, row spacing, plant population and variety.
- Narrower row spacing in pulses not only improves crop biomass and yield but also the proportion of N in that biomass that is fixed from the atmosphere and hence free for crop use. This allows crops to be produced on lower levels of soil nitrate and gives more opportunity for crop residues to be higher in N that can mineralise for the following crop.
- Time of sowing should be optimised for maximum biomass production and longer time to accumulate fixed N. The proportion of N in plants that is fixed from the atmosphere is significantly greater when crops are sown earlier in the planting window rather than late – particularly in soybean and faba bean crops. If growers are planting late, more N will be fixed if plant populations are significantly increased.
- Some minor varietal differences in N fixing potential do exist and growers can aim for higher biomass varieties to fix more N.
- The actual amount of N fixed depends on the species of legume grown, the site and the seasonal conditions as well as agronomic management of the crop or pasture. The legume crop uses this N for its own growth and may fix significantly more than needed, leaving a positive N balance in the soil for proceeding crops.

AVERAGE estimates of N fixation for the major crop legumes grown in Australia (derived from many research trial studies) are shown in Table 1, but huge variations around these figures exist in practice. Actual per cent N fixed and amounts of N fixed by individual crops are influenced by environment and management effects, including soil nitrate levels at planting.

Importantly, both root and shoot N must be considered when calculating the total amount of N that was fixed and used by the plant for growth.

Root N is substantial for all crops but does vary with species, for example chickpea have equal portions of N in their roots as they do in their shoots whereas faba bean and mungbean have approximately half as much N in their roots as their shoots. N remaining in residues of shoots and roots of the pulse crop after harvest is a slow release form of N for the subsequent crop.

In this form, less is likely to be moved through the loss pathways that lead to loss of inorganic N fertiliser in the short term.

Improving the amount of N fixed

Improving the amount of N fixed in a farming system by changing agronomic practices has been a focus in a recent northern region project. Our results show that altering management practices such as row spacing, time of sowing and variety used can have large implications for the amount of N fixed by that crop. This means better N nutrition for the pulse crop and also potentially for the crop following that pulse.

TABLE 1: Estimates of amounts of N fixed annually by crop legumes in Australia

Legume	% N fixed	Shoot dry matter (t/ha)	Total crop N[1] (kg/ha)	Total N fixed[2] (kg/ha)
Lupin	75	5.0	176	130
Pea	66	4.8	162	105
Faba bean	65	4.3	172	110
Lentil	60	2.6	96	58
Soybean	48	10.8	373	180
Chickpea	41	5.0	170	70
Peanut	36	6.8	268	95
Mungbean	31	3.5	109	34
Navy bean	20	4.2	148	30

[1]Total crop N = shoot + root N
[2]Total N fixed = %N fixed x total crop N; Data sourced primarily from Unkovich et al. 2010
Source: Drew et al (2012).

Row spacing

Field trials with chickpea, mungbean, soybean and faba bean have shown that significant increases in %Ndfa (percentage of nitrogen derived from the atmosphere) occurred when plants were grown on a narrower row spacing (ie. 25 or 50 cm rows compared to 75 or 100 cm rows), keeping plant population the same.

FIGURE 1: Total N fixed in chickpeas (shoots and roots) when grown at three different row spacings but keeping plant population the same at 30 plants per m²

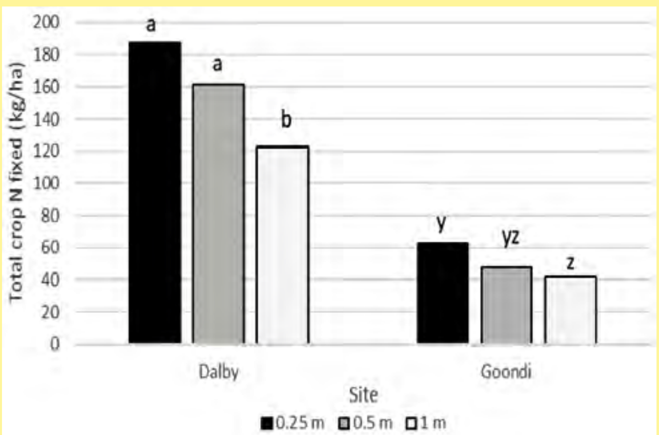


FIGURE 2: Differences in total shoot and root nitrogen for three mungbean varieties, Crystal, Jade-AU and Satin (LSD 5% = 7.65) and for two row spacings of 30 and 90 cm (LSD 5% = 6.24)

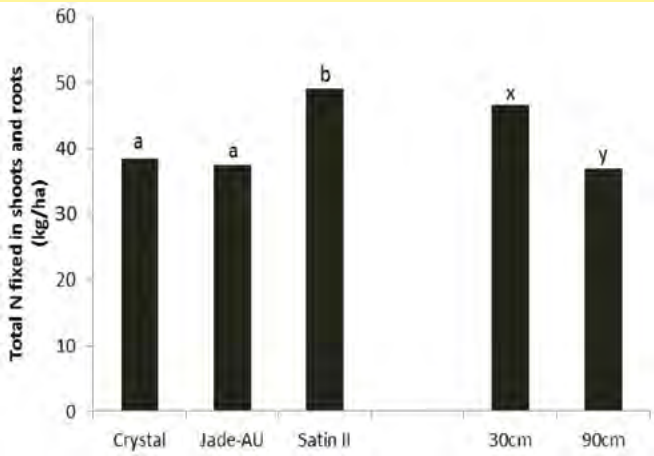
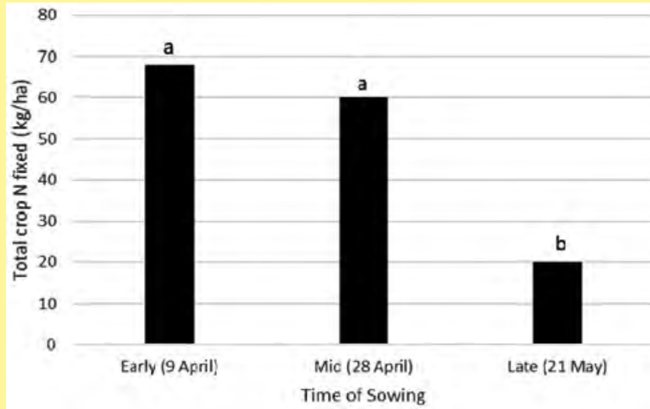


FIGURE 3: Total amount of N fixed by faba bean (mean of two varieties, PBA Nasma and PBA Warda) was much lower when the crop was planted late



NB: Figures are for total N in shoots and roots assuming 40 per cent of N in roots.

This then translated into higher amounts of N (kg/ha) fixed by the plants as biomass was also greater and ultimately more N was left behind post-harvest for the following crop.

Figure 1 illustrates this higher amount of N fixed with narrower row spacing for two chickpea trials – one at Billa Billa near Goondiwindi and one near Dalby. After accounting for the N removed in the grain at harvest, an estimated 59 kg N per hectare was added to the soil by the chickpeas at the Dalby site when grown on 0.25 m rows, while only 23 kg N per hectare was added at the 1.0 m row spacing.

In the trial at Goondiwindi, N fixation and biomass were much lower overall. Just 6 kg N per hectare was added through N fixation at 0.25 m row spacing, but if grown at on 1.0 m rows, the crop actually depleted soil N by 6 kg per hectare.

Reducing rows from 90 down to 30 cm in mungbean also significantly increased both %Ndfa and total amount of N fixed. Differences in varieties in their potential to fix N also was evident (Figure 2).

Time of sowing

Mungbean, soybean and faba bean have all shown significant impacts of time of sowing on N fixation. Not only is biomass of the crop reduced in a late planting for all three crops, so too is the proportion of the N in the plants that is fixed by the rhizobia (%Ndfa).

Higher plant populations are therefore required to try to compensate for this loss in production and reduced amount of free N.

Faba bean varieties PBA Nasma and PBA Warda both showed that sowing late decreased %Ndfa by more than half and this – combined with the reduced amount of biomass produced by the plants from this late May sowing date – meant much less N was fixed by the plants (Figure 3). Increasing plant population partially compensated but did not completely overcome this loss.

Soybean planted in late January rather than December also was negatively impacted, with much lower %Ndfa and N fixed.

One variety from the Australian Soybean Breeding Program, Richmond, fixed half the amount of N (81 kg N per hectare less) in shoots when planted later (January 15, 2014 compared to December 20, 2013).

The variety PR443 fixed only a third as much N (163 kg/ha less) when sown at the later planting time.

Inoculation

Trials focussing on the best form of inoculum for soybean and peanut in particular have shown little differences between peat, freeze-dried and granular inoculum forms. Growers should be able to use either form with confidence depending on available equipment.

The use of liquid Zn fertilisers at recommended application rates and mixed with the chickpea inoculum strain CC1192 did not significantly impact the rhizobia or nodulation.

But mixing of inoculum with concentrated forms of any fertiliser is not recommended and extreme caution must be taken at all times to protect the live bacteria in the inoculum which are extremely sensitive to heavy metals and low or high pH levels.

Further research with rhizobia strain compatibility for soybean, mungbean and faba bean strains is required.

Establishment of good nodulation is vital for N fixation and hence good inoculation practices are crucial for survival of the rhizobia on the seed or in the soil at planting. Manufacturer guidelines as given on the packets should be followed and the correct rhizobia strain must be used.

To sum up

Improving the amount of N fixed in a farming system by changing agronomic practices has been a focus in this project.

Our results show that altering management practices such as row spacing, time of sowing and variety used can have large implications for the amount of N fixed by that crop. This can mean better N nutrition for the pulse as well as for the crop following that pulse.

Field trials have compared the impact of different row spacing, plant population, time of sowing and variety on effective nodulation and N fixation in pulse crops.

This work has shown that narrower row spacing (for example 25 and 50 cm rather than 75 or 100 cm) in pulses can lead to higher levels of N fixed by the crop. This has correlated well with growth of the tops (biomass) and in some cases yield.

Also, importantly, it has translated to greater amounts of N left in the soil.

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The research undertaken as part of this project is made possible by the very much appreciated and significant contributions of growers through both trial cooperation and the support of the GRDC.

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SOUTHERN AUSTRALIA FOCUS

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

Frost effects on cereal species

By Hayden Petty[1], Danielle Malcolm[1], Rohan Brill[1], Felicity Harris[1], Ben Biddulph[2], Jess Simpson[1] & Warren Bartlett[1]

AT A GLANCE…

- Heading and flowering are considered the most sensitive stages for frost damage in cereals, but damage can still occur from the onset of stem elongation and this can be reduced through management and variety selection.
- Winter varieties have a long vegetative phase so have the lowest risk of damage from stem frost and although are not always the highest yielding varieties, may be the most stable across sowing dates.
- Recovery from stem frost can be achieved where there is moisture available to support new tillers.
- Matching phenology and sowing date is just as important for oats and barley as it is for wheat. Oats and barley are not resistant to frost damage.

A COMMON practice to avoid losses from frost is to avoid heading and flowering during the frost risk period. Matching phenology with sowing time is a method used to ensure sensitive reproductive stages of development escape severe frost events, while also aiming not to flower too late as to incur water stress during grain fill (Figure 1).

In frost prone parts of the landscape, this is still relevant and this flowering window typically occurs around early October in southern NSW. The early stem elongation stage is less susceptible to frost than heading and flowering as lower temperatures are required for damage to occur. Stem elongation however, usually occurs in a higher frost risk period so damage can still occur.

Anecdotally, over the past few seasons stem elongation frost damage has occurred across significant portions of the southern production system in South Australia, Victoria and NSW in 2014.

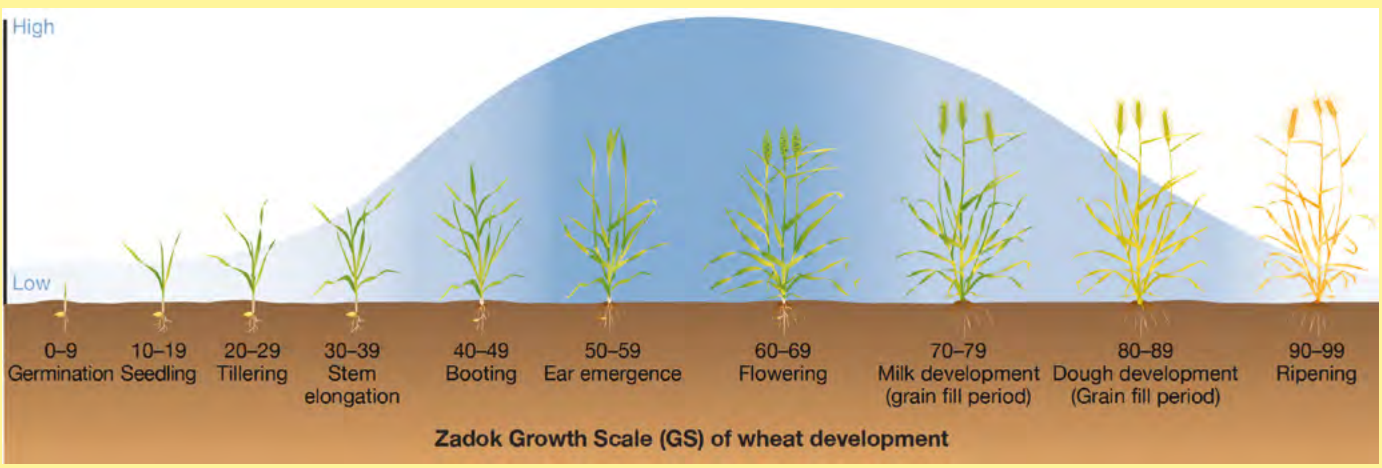
There has been a recent increase in frost severity and duration across southern Australia combined with the widespread adoption of earlier sowing of cereals, which has all contributed to the increased exposure of cropping programs to frost damage.

Of the three main cereal species grown in southern and Western Australian grain production zones, oats and barley have traditionally been categorised as being more tolerant to frost than wheat. But the different phenological traits, overall plant characteristics and locality of where these species are grown in the landscape often make the ability to compare between them for frost susceptibility difficult and there is little data to support this claim.

These claims have been made primarily based on observations of frost events that occur during flowering, but cereals are sensitive to frost damage both before and after flowering (Figure 1) and the final grain yield is the cumulative effects of all the individual frost events throughout development.

To look at which crop type by maturity class combinations are most suitable for frost prone parts of the landscape, an

FIGURE 1: Susceptibility of wheat to frost during the development cycle (GRDC, 2016)



experiment designed by GRDC's *National Frost Initiative* assessed the variability in frost damage between varieties, within species and across four times of sowing.

The 2017 season in southern NSW

The 2017 growing season of southern NSW experienced an above average number of severe frosts. The trial site at Wallacetown (15 km north east of Wagga Wagga) recorded 112 mornings below zero degrees throughout the growing season with 87 of these days having temperatures drop below –2°C (measured at crop height in an unshielded Tinytag).

Screen temperatures were on average two degrees warmer than those measured within the crop canopy.

This emphasises the fact that crops experience colder temperatures than those generally recorded by weather stations. The growing season rainfall (April–October) was 199 mm – well below the average of 321 mm – but there was above average rainfall for the month of October.

How the trial was done

The Wallacetown trial consisted of:

- Four times of sowing: April 11; April 20; May 4; and, May 25.
- Six varieties of wheat: Emu Rock; Scepter; Cutlass; Trojan; EGA Eaglehawk; and, Kittyhawk.
- Three varieties of barley: La Trobe; Commander; and, Urambie.
- Three varieties of oats: Bannister; Mitika; and, Durack.

These selections made up the crop type x time of sowing experiment.

Varieties with reasonable performance across southern Australian and Western Australian production systems were selected to represent the different maturity classes within each crop type.

What we found

Stem elongation

Sowing on April 11 saw quick developing wheat and barley varieties such as Emu Rock and La Trobe reaching the start of stem elongation (GS31) in mid-June, four weeks earlier than winter type wheat and barley varieties such as Kittyhawk and Urambie.

The sheer number and severity of frosts experienced during the 2017 season resulted in all varieties, regardless of maturity type, being exposed to frost during stem elongation

But the faster developing varieties were exposed to a greater number of frost events whilst in the sensitive stem elongation phase and as a result suffered severe yield penalties.

Slow developing winter wheat and barley varieties exhibited stable yields across all sowing times. The vernalisation requirement in these varieties slowed the time to stem elongation (GS31). This allowed the slow developing winter types to avoid some of the stem frost damage (Table 1).

Yield

Delaying the start of stem elongation through varietal selection and sowing time increased grain yields (Figure 2). Yield was stabilised across all sowing times through the use of winter type varieties.

Kittyhawk wheat and Urambie barley with their relatively long vegetative period, achieved similar results across sowing dates, with yields between 4 and 5 tonnes per hectare (Table 1).

In the earlier sowing dates, the yields achieved by the spring varieties such as Emu Rock and La Trobe were due mostly to regrowth. Early formed tillers that developed rapidly to stem elongation were killed by frost (in season observations, samples still being processed).

These plants then relied on grain from regrown tillers which was made possible by rain in late October which filled grain.

Varieties such as Scepter and Cutlass yielded well across all sowing dates, showing some flexibility in the 2017 season; undoubtedly attributed to the capture of late rainfall assisting grain-fill of late formed regrowth.

The poor performance of the oats in the first two sowing dates with yield starting to improve in the latter two sowing dates

TABLE 1: Grain yield (t/ha) of the 12 varieties from the four times of sowing (TOS) at Wallacetown, 2017

Species	Variety	Phenology*	TOS 1: April 11	TOS 2: April 20	TOS 3: May 4	TOS 4: May 25
Wheat	Emu Rock	VF	2.84	2.83	3.43	3.99
	Scepter	MF	4.01	4.31	4.36	5.36
	Cutlass	MS	4.12	3.76	4.67	4.90
	Trojan	M	3.74	3.83	4.60	4.43
	EGA Eaglehawk	MS	3.76	3.63	3.77	3.56
	Kittyhawk	W	4.26	3.96	4.38	4.07
	Mean		**3.79**	**3.72**	**4.20**	**4.38**
Barley	La Trobe	F	2.09	2.49	3.88	5
	Commander	M	3.33	3.66	4.55	5.04
	Urambie	W	4.24	4.90	5.16	5.12
	Mean		**3.22**	**3.68**	**4.53**	**5.05**
Oats	Bannister	M	2.80	2.71	3.50	3.27
	Durack	F	2.35	1.92	2.86	2.53
	Mitika	MF	2.03	2.15	2.79	2.92
	Mean		**2.39**	**2.26**	**3.05**	**2.91**
Yield LSD (P<0.05)	Genotype		0.41	0.47	0.43	0.35
	Wheat		0.27	0.25	0.19	0.35
	Barley		0.30	0.52	0.24	0.15
	Oats		0.46	0.42	0.35	0.24

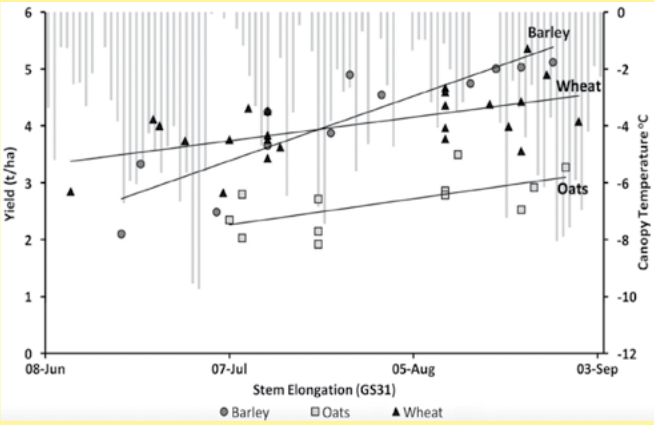
*VF = Very Fast, F = Fast, MF = Mid-fast, M = Mid, MS = Mid-slow, S = Slow, W = Winter

is due to limited phenological differences in the oat varieties used. All three varieties have fast to mid-fast development and hence should be sown mid to late May in frost prone areas to avoid exposure to frost during sensitive development stages.

Despite the regrowth contributing a substantial amount of grain in early sown spring cereal varieties, it caused sporadic and staggered flowering times which could not be precisely measured. This led to delayed maturity as green regrowth continued to develop through to late November and early December for the wheats.

Yield was supported by the regrowth, however, harvest then became an issue as immature spikes and stems resulted in high moisture levels and a delayed harvest. In 2017, late rains favoured yields, but led to a decline in quality and accessibility.

FIGURE 2: The relationship between the onset of stem elongation (GS31) and yield for the three cereal species used in the Wallacetown trial. The incidence and severity of frost events measured at canopy height (shown in light grey bars) provide an indication of the number of frosts experienced by the crop when stem elongation occurs too quickly.



To sum up

It is difficult to predict the environmental conditions a crop will experience in a given season.

Choose a variety that will perform well in the area and can be sown in a timely manner allowing the crop to reach sensitive stem elongation, heading and flowering stages in a post frost risk period.

In light of stem frost events in 2014 and 2017, attention should also be paid to matching sowing date and phenology to avoid early stem elongation.

Winter varieties performed well in this trial having the most stable yields due to their longer vegetative phase.

Faster developing wheats, such as Scepter and Cutlass, showed flexibility in the sowing dates in 2017 as the late rainfall allowed regrowth after stem frost in the earlier sowings to mature.

This is the first year of this trial, and samples are still being processed and analysed, hence further research coming out of 2018 will improve our understanding of how frost interacts with different cereal species

Authors: 1. NSW DPI Wagga Wagga; 2. DPIRD South Perth. ■

Study shows fixing soil constraints can pay the bills

A NEW analysis shows overcoming a severe soil constraint that suppresses crop production and grain yields can be economic in most areas of the Western Australian grainbelt.

Findings from this research, conducted by CSIRO and the Department of Primary Industries and Regional Development (DPIRD) with GRDC investment, were presented to the GRDC's Grains Research Update, Perth on February 26-27.

The CSIRO and DPIRD team used soil moisture probes and amelioration tactics, including deep ripping, at sites right across the WA grainbelt to help quantify the financial benefits of fixing soil constraints.

DPIRD's David Hall, left, with CSIRO researchers Yvette Oliver and Phil Ward in a soil pit with soil moisture probes used to monitor soil water content. (PHOTO: CSIRO)

Soil constraints such as soil acidity, compaction, sodicity and salinity can lead to significant grain yield losses in WA crops.

CSIRO senior research scientist Phil Ward outlined findings from the field trials at Wubin and Dandaragan, where soil water data from seasons 2015, 2016 and 2017 was combined with Agricultural Production Systems sIMulator (APSIM) crop modelling data.

The major findings

The key results from these sites, which were also supported by the local West Midlands Group and Liebe Group, included:

- Crop water use and yield responses to subsoil amelioration vary widely;
- A driving factor for crop response is distribution of rainfall in the growing season;
- Total growing season or pre-season rainfall is not as important as distribution;
- Economic responses are common where a severe soil constraint can be fully overcome; and,
- Partial amelioration (typically achieved by growers on-farm) will provide a one-year positive return in the majority of situations (for severe constraints).

Phil said deep ripping to loosen compact soils and incorporate ameliorants, such as lime or gypsum, to improve fertility and soil structure has become an accepted farming practice in many parts of WA.

But he said research and experience was finding that crop responses to deep ripping could vary depending on the initial level of constraint from subsoil conditions and the seasonal conditions after treatment.

Phil said costs of subsoil amelioration could also vary greatly, depending on the soil type and tactics used.

Determine the level of constraint

"The key to deciding whether to spend money on soil amelioration is to accurately determine the initial level of constraint imposed by the soil," he said.

"Growers can get an indication of the level of their soil constraint by comparing actual yields with potential water limited yields.

"A severe constraint can result in actual yields being less than half of what is potentially achievable, which might provide impetus for growers and advisers to consider tactics that will address the problem."

For its economic analysis, the CSIRO and DPIRD research team used an average cost of $100 per hectare for deep ripping.

"This meant in a one-year period and at a wheat price of $250 per tonne, the crop yield increase after treatment needed to be at least 400 kg per hectare for this tactic to be profitable," Phil said.

"Where the original soil constraint was severe and then fully overcome, this level of yield increase occurred in almost all seasons.

"But where the constraint was less severe, the required yield increase was obtained in 75 per cent of years, according to our modelling.

"Of course, yield increases are likely over more than one year, but a rapid return on investment helps to reduce the risks associated with soil amelioration." ■

Collaboration to drive new crop nutrition research

THE Grains Research and Development Corporation (GRDC) is partnering with multiple organisations from the public and private sectors to invest in a $14.6 million suite of Western Australian soils and crop nutrition research projects.

Involving extensive collaboration between government, universities and grains industry stakeholders, three major new projects have been initiated by the GRDC, which is the major contributor – with an $8.3 million commitment.

Research and development carried out through this investment will focus on:

- Getting a better understanding of soil nutrient supply, leading to more efficient fertiliser use to meet crop requirements for grain production;
- Distribution of nutrients when soils are renovated; and,
- Developing new in-the-field soil sampling methods.

Co-investments, equivalent to $6.2 million, have been committed by the Department of Primary Industries and Regional Development (DPIRD), The University of Western Australia (UWA), CSIRO, Murdoch University, CSBP, Summit Fertilizers and The University of Adelaide (UA).

GRDC chairman John Woods said the GRDC had increased its investment into WA soils and crop nutrition research in response to grassroots feedback that has been gathered through extensive GRDC consultation, including by its Western Regional Panel and Regional Cropping Solutions Network (RCSN) groups.

GRDC chairman John Woods said the GRDC had increased its investment into WA soils and crop nutrition research in response to grassroots feedback.

Grower and adviser feedback

"The GRDC has acted on grower and adviser feedback that improved knowledge is needed about the state's soils and crop nutrition requirements – especially for the most commonly required nutrients of nitrogen, phosphorus and potassium – in order to maximise crop profitability," he said.

"These investments are unprecedented in WA in terms of scale and level of collaboration and involvement with key industry R&D organisations and stakeholders.

"This will allow the projects to draw on the wide range of specialist skills and scientific knowledge available from the multiple organisations involved."

John said the biggest of the three soils and nutrition projects, worth a total of $9.7 million across five years, aimed to improve WA grower profitability through more efficient nutrient use.

He said researchers will investigate soil nitrogen, phosphorus and potassium supply to crops, with a focus on providing a better understanding of fertiliser requirements.

"This investment will be led by UWA – through the SoilsWest alliance with DPIRD – and Murdoch University and UA, with involvement from other grains industry stakeholders," he said.

"The project will improve knowledge about nitrogen cycling and availability, soil phosphorus and potassium storage, sources of nutrient supply and responsiveness of crops.

"Quantifying soil nitrogen supply is crucial for grain growers, given it affects the rate of nitrogen fertiliser required and is one of the few in-season management strategies available to improve returns on all variable and fixed costs."

John said the project investigating soil nutrient supply would involve collaboration with researchers working in other projects that focus on managing crop nutrition on ameliorated soils and improved methods for soil sampling.

Researchers involved in the SoilsWest partnership between UWA and DPIRD will play a key role in this collaboration between projects.

Soil amelioration project

Worth a total of $3.5 million over four years, the soil amelioration project will be led by DPIRD, in cooperation with Curtin University, Murdoch University, CSIRO and industry.

"This investment will improve understanding about how ameliorating soil constraints with strategic tillage changes the availability of nutrients in the soil, the duration of the effects and the implications for fertiliser requirements," John said.

"The area of soil mechanically modified in WA to tackle one or more soil constraints is increasing rapidly and, to date, the effects of ameliorating soil constraints on soil nutrient availability has seldom been measured."

Soil sampling

John said the soil sampling investment, worth a total of $1.4 million over three years, would be led by CSIRO and have input from DPIRD, UWA and industry.

"New ways to collect soil samples are needed by WA growers to boost the accuracy of determining what soil nutrients are available to plants and help them make better, more cost-effective fertiliser decisions – ultimately increasing their profitability," he said.

"Current soil sample collection protocols were developed in an earlier era when farming practices differed significantly from those in current use."

The GRDC's purpose is to invest in research, development and extension (RD&E) to create enduring profitability for Australian growers. It invests in projects and partnerships that drive profitability, productivity within Australia's grains industry. ■

Survey shows herbicide resistance in key weeds is stable

LATEST results about the herbicide resistance status of Western Australia's major cropping weeds was revealed at the recent GRDC Grains Research Update in Perth.

Australia Herbicide Resistance Initiative (AHRI) Senior Research Officer Mechelle Owen unveiled the results which were generated from testing a random collection of weed samples from across the grainbelt in 2015.

Mechelle said preliminary data from the weed analysis suggested herbicide resistance in wild radish and annual ryegrass has not increased dramatically since 2010 for commonly used herbicides.

"Resistance against commonly used herbicides is still evident in key weed species, so growers need to use a range of integrated weed management tactics," she said.

Mechelle Owen, Australia Herbicide Resistance Initiative (AHRI) Senior Research Officer.

The AHRI survey, carried out with GRDC investment, involved visits to 507 WA cropping paddocks and collection of 734 seed samples, comprising seven weed species.

During the 2016 growing season, researchers treated wild radish populations with a range of herbicides.

"We found that, of the 65 populations sprayed with the ALS-inhibiting herbicide chlorsulfuron, 88 per cent of populations had resistant plants," Mechelle said.

"The results showed 70 per cent of the populations sprayed had resistance to the ALS herbicide mixture, imazamox+imazapyr.

"For the synthetic auxin 2,4–D, there were 61 per cent of populations containing resistant plants and 65 per cent had plants resistant to diflufenican (PDS inhibitor).

"Screening with atrazine indicated 17 per cent of populations displaying resistance, although resistance levels haven't changed significantly since the earlier surveys.

"It was positive that no populations exhibited resistance to the knockdown herbicide glyphosate (EPSPS inhibitor)."

Mechelle said, for annual ryegrass, of the 338 populations treated with diclofop (ACCase inhibitor), 96 per cent of populations contained resistant plants and 83 per cent also had resistance to sethoxydim.

"But the knockdown herbicides glyphosate and paraquat (photosystem I inhibitor) provided good control of most annual ryegrass populations," she said.

"No populations had resistance to paraquat, but some populations displayed resistance to glyphosate."

Mechelle said testing in 2017 found that no populations of brome or barley grass had resistance to fluazifop, clethodim, glyphosate or paraquat.

But she said some brome grass populations displayed resistance to the sulfonylurea (SU) herbicides sulfosulfuron and sulfometuron. Barley grass screening for the SU herbicides will be carried out during 2018.

Weed numbers kept low

"In spite of these latest herbicide resistance findings, our survey results since 1998 indicate growers are, in fact, doing a great job at keeping weed numbers low," she said.

"We found there can be such variability that it pays for a grower to get to know the resistance profile for their own paddocks.

"For example, there are some paddocks where there are resistant plants present but 95 per cent control can be achieved with the right herbicide."

Mechelle said the evolution of herbicide resistant weed populations was now widespread right across southern Australia for the major cropping weeds, including annual ryegrass, wild radish and wild oats.

GRDC recognises the importance of managing this problem and invests about $1 million annually into AHRI, which is a research leader in understanding mechanisms of herbicide resistance and resistance management.

Further data from Mechelle's AHRI-led research was presented at the GRDC Grains Research Update, held at Crown Perth on February 26 and 27.

The two-day GRDC Grains Research Update, was complemented by one-day GRDC Grains Research Update events held in Northampton on February 23, Darkan on February 28 and Corrigin on March 1. ■

Conditions create challenges for summer weed control

SUMMER weed germination across southern and western Australia is often staggered on the back of wet and warm conditions and grain growers are urged to ensure the right herbicides are used at the right growth stage to achieve optimal results.

If not controlled at early stages, summer weeds can remove soil moisture and nutrients for winter crops and potentially increase pre-sowing populations of a range of disease pathogens and pests.

The GRDC is investing in several projects aimed at surveying, mapping and managing summer weeds with integrated control measures to reduce costs for growers.

WA Department of Primary Industries and Regional Development (DPIRD) principal research officer Abul Hashem said it was vital summer weed species were correctly identified and at the right growth stage before applying any herbicides.

"Herbicides are most effective when weeds are at the three to five leaf stages," he said.

"This is likely to achieve better results than waiting for weeds to reach the rosette or mature stage.

"Research, as well as on-farm experience, highlights that – in most cases – a single application of glyphosate rarely kills all summer weeds.

"A second application of a paraquat-based mixture, such as Spray Seed, Alliance or Para Trooper, may be necessary to ensure a complete kill and delay the risk for the onset of glyphosate resistance."

With herbicides equating to about 30 per cent of growers' crop input costs, there is strong motivation to adhere to best practice management when treating summer weeds.

Herbicide users should always read the whole product label for guidance about spray quality, buffer (no-spray) zones and wind speed requirements.

"During summer, herbicide application may not be as effective as in the cooler months because plants are stressed and temperatures are high," Abul said.

"We recommend growers assess the local meteorological conditions and make decisions accordingly around whether or not to spray.

"To minimise the risk of spray drift, growers can adjust spray practices, such as application volumes, droplet size and ground speed.

"Never spray during a surface temperature inversion, which typically occurs in the cooler parts of the day."

More information about best practice herbicide use is available in the new GRDC GrowNotes *Spray Application Manual for Grain Growers*.
It is available at: https://grdc.com.au/resources-and-publications/grownotes/technical/spray-application-manual ■

DPIRD principal research officer Dr Abul Hashem, right, and research officer Dr Catherine Borger are inspecting the growth of summer weeds at Northam (WA) as part of a GRDC investment project. **(PHOTO: DPIRD)**

Taking the lead in grains industry research

A RESEARCH scientist who is making an impact in the area of new crop varieties and best practice agronomy has been recognised as one of the grains industry's most influential young leaders.

Andrew Ware, from the South Australian Research and Development Institute (SARDI), a division of Primary Industries and Regions SA (PIRSA), has been presented with the GRDC Southern Region 2018 *Emerging Leader Award*.

The annual award – voted upon by the GRDC Southern Regional Panel – acknowledges, encourages and rewards young emerging leaders of the grains industry in South Australia, Victoria and Tasmania.

Andrew, who is based at Port Lincoln on Eyre Peninsula, leads the New Variety Agronomy group for SARDI and plays an important role in a number of regional, state and national research initiatives.

Andrew Ware from SARDI has been presented with the GRDC Southern Region 2018 *Emerging Leader Award*.

GRDC Southern Regional Panel deputy chair Dr Mike McLaughlin said Andrew was fast becoming a respected agronomic authority, not only in SA but beyond.

"Andrew has an innate understanding of cropping systems, environmental and other agronomic constraints and how to get the most out of the varieties available to growers," Mike said.

"He has already established an enviable reputation, not only for his agronomic knowledge and research skills, but also for his work ethic, enthusiasm and commitment to supporting grain growers as they strive to improve their farming systems."

Farming and research experience

Andrew started his career with SARDI at the Minnipa Agriculture Centre in 1994, and then spent time at CSIRO Land and Water in Adelaide. This was followed by 10 years away from research, managing the family farm on Lower Eyre Peninsula, before returning to SARDI in late 2009.

He recently assumed leadership of SARDI's NVA group which conducts field trials at a number of locations to evaluate a range of new material from field crop breeding programs, including the GRDC's National Variety Trials program. The group also conducts field trials aimed at developing agronomic packages to improve crop production.

Andrew is currently involved in a number of major GRDC research, development and extension (RD&E) investments, including the national *Optimised Canola Profitability Project* which is focused on understanding the relationship between physiology and tactical agronomy management to provide growers with a better understanding of the drivers behind canola's development, to help improve management of the crop and variety selection.

The *National Canola Pathology Program* is another key GRDC undertaking to which Andrew contributes. This project aims to increase stable production and yields of canola in Australia, through the minimisation of blackleg, sclerotinia and other diseases.

He also works with farming systems groups which, through GRDC research investments, are looking at reducing the limitations to farming in retained stubble systems.

Andrew has authored and co-authored a number of industry publications – he is responsible for compilation of the annual *SA Crop Variety Sowing Guide* which is a highly regarded publication – and is a committee member of Lower Eyre Agricultural Development Association and an ex-officio member of Eyre Peninsula Agricultural Research Foundation board.

Mike said the *Emerging Leader Award* was a financial scholarship and could be used for travel or another agreed activity to further the skills or expertise of the recipient.

"The award is designed to encourage the emerging leader to establish linkages that leverage international knowledge and opportunities to assist the Australian grains industry to address gaps in research and skills.

"The award fosters networking opportunities and the development of linkages with leading researchers from around the globe – this will help Andrew in his efforts to identify new paths to profitability for our grain growers," Mike said. ■

A mixed bag for canola growers

By Mark Carter – Canola Trader – COFCO International Australia

THE 2017 season saw a mixed bag for canola production in Australia. High prices at seeding relative to wheat and barley saw a large and broad switch in planted acres across the country. Initial estimates of a bumper crop – brought about by increased acreage – were slowly muted by concerns regarding the dry start to the season.

Predominantly, the dry areas were in Western Australia, which accounts for roughly half of Australia's canola production – and the lion's share of the nation's exports – and in parts of South Australia. While the growing conditions in the traditional canola areas in the south of WA's grainbelt were never as dire as those in the north, market estimates were quickly downgraded. As a result, domestic canola prices pushed well above export parity.

Almost as soon as conditions normalised in Western Australia and it became apparent trend yields were achievable, concerns with dryness shifted to New South Wales. These concerns proved to be well founded as yields ended well below trend. New South Wales commanded a significant price premium due to this, driven by domestic demand, while prices dropped sharply across the rest of Australia.

This drop was due in part from overly pessimistic production estimates which had temporarily priced Australian canola out of its primary market – namely EU port-based crushers where Australian canola has a traditional freight advantage. These crushers increasingly sourced canola from up-country EU growers instead, who enjoyed a better season than the previous year.

This combination of factors has created the slowest Australian canola export pace of the past five years, despite having a reasonable exportable surplus. One saving grace for growers has been record or near record oil content in many zones, with WA harvest receivals averaging around 47 per cent. This has provided a partial offset to lower base prices.

ABARES recently increased their canola production estimate for the 2017–18 season from 2.9 million tonnes to a more accurate 3.7 mt. The national forecaster also revised the prior season production from 4.1 to 4.3 mt. This is more in line with most market estimates.

Europe shivers under a polar vortex

On the international climatic front, in late February a polar vortex pushed exceptionally cold weather into the Baltics (where snow cover remains patchy) and this vortex continued through to Central and Eastern Europe. While some canola yield reduction is expected – and has been priced in – this will be largely offset by

the current pricing in northern Europe which favours the crushing of soybeans over canola. The crushers with the ability to switch from canola, will probably do so.

In Canada, the supply and demand equation remain heavy, despite concerns regarding Argentina's soybean crop. The cold conditions throughout Canada in late February, and competition from energy exports, affected rail logistics from the prairies to the ports of the western coast, which dried up liquidity from that market for some time.

Currently, the seasonally higher prices for wheat and barley – relative to canola and compared to seeding time last season – may result in a reversal in the acreage gain that occurred last year.

This will be especially so for those growers with larger forward selling programs. But, and as evidenced last year, relative prices at seeding can be a poor indication of relative prices come harvest.

Supplied Feb 27, 2018. More information see http://www.nidera.com.au ■

High canola oil content, particularly in WA, helped cushion lower base prices for the 2017 crop.

Indian Pulse Conclave

IN early February a contingent of Pulse Australia members converged on Delhi to participate in the Indian Pulse Conclave. The Conclave is a biennial event aimed at bringing pulse traders around the world face to face with their Indian counterparts for the purpose of furthering trade and better understanding the Indian pulse market.

While there were a number of outcomes from the Conclave, summarised below, one of the more significant was the agreement reached between the industry peak bodies of Pulse Australia and the Indian Pulse and Grain Association (IPGA).

Representatives from Pulse Australia met with IPGA at a side meeting chaired by Austrade to establish ways both organisations can work together for better outcomes for their members. Representatives from Grain Producers Australia (GPA) and the Australian Grains Industry Market Access Forum (GIMAF) were also in attendance.

Both Pulse Australia and IPGA signed an agreement:

- For greater exchange of information about respective pulse crops and longer term trends in quality needs;
- On ensuring consistent messages to respective governments in relation to the implications of market interventions and other trade policies; and,
- Provided joint support for Global Pulse Confederation (GPC) mediations as the preferred form of dispute resolution.

The underlying tone of the Conclave was not surprisingly tempered by the trade disruptions resulting from recently imposed tariffs on most imported pulses, and the uncertainly this has created. It was reported that trade flows are diverting chickpeas and yellow peas to markets such as China, in addition to the established alternate markets of the subcontinent.

As India moves into election mode, (elections May 2019) and rural constituents are a major focus for the ruling Bharatiya Janata Party, there is no great incentive for the government to ease tariffs at this time.

The impact on the Australian trading and production sectors

of these tariffs is very evident – but less evident is the impact of the tariffs on the Indian domestic trade, where importing pulses has become more financially stressful for importers, highlighting the need for Australian exporters to complete due diligence on counterparties and manage payment terms.

India pulses supply and demand

- India produced a record 23 million tonnes (mt) of pulses in the 2016–17 (July–June) crop year and output could be close to that figure in the ongoing crop year as well as on a bigger area, but most likely a lower yield.
- The Indian Government retains a goal of becoming self-sufficient in pulses. Time will tell if this aspirational goal is achieved, but for the foreseeable future, it is clear that India will continue to rely on imports of pulses in order to supplement any domestic shortfalls. The heavy reliance on unpredictable monsoons indicates that domestic shortfalls will continue to be a regular occurrence in India until such time that farming practices and plant genetics improve significantly.
- A rise in output over the past couple of years, record imports, and a large government buffer stock are keeping markets well-supplied and local prices depressed. We must assume that as a result, India will sharply reduce imports of pulses this year.
- India's pulses imports are likely to nearly halve to 2.5–3.0 mt in the financial year starting April due to ample stocks in the country and uncertainty over the government's policy.
- In April–December 2017 around 5.0 mt of pulses had been imported. By the end of March, the figure could be around 5.5–5.7 mt.
- Concerns that the government may take more steps to limit imports of pulses are also expected to keep imports lower. Some participants were suggesting a lift to 100 per cent tariff on chickpeas was likely. This would be the maximum (bound) rate according to WTO guidelines. ■

Nick Poutney (Director, Pulse Australia), Leonie Muldoon (Minister Commercial and Senior Trade and Investment Commissioner, South Asia with Austrade) and Bimal Kothari (Vice Chair, IPGA) after the signing of an agreement to improve the exchange of information on pulse trade to India.

Australia's role in Malaysian food security

■ By Sarah Clarry

MALAYSIA is highly dependent on Australia for wheat. According to the USDA Foreign Agricultural Service report of 2017, Australia exported 873,000 tonnes to Malaysia in 2016, making it Australia's seventh largest export customer for wheat. On the other hand, more than 50 per cent of Malaysian total wheat imports are from Australia alone. It is fair to say that Australia's ability to provide an uninterrupted supply of wheat is critical to Malaysia's food security.

Despite a relatively strong showing, a drop in Malaysia's ranking in the 2017 Global Food Security Index (GFSI) has highlighted the importance of food security as a vehicle of continued economic growth, and a critical factor underpinning a thriving and inclusive Malaysian society.

Food security is defined by the Food and Agriculture Organization of the United Nations (FAO) as "a situation involving all levels which always obtain sufficient food supply, safe and nutritious food to meet the needs and requirements of an active and healthy lifestyle."

Beyond its obvious importance from a human health and wellbeing perspective, there is an undisputed relationship between food security and poverty.

It is therefore an important indicator of a nation's overall economic and social health.

The GFSI measures food security across four categories: Affordability, Availability, Quality and Safety and, most recently, Natural Resources and Resilience.

Deterioration in food security is usually closely tied to conflict and/or climate catastrophes such as drought or flood. But the FAO has observed that even in some peaceful settings, food security has deteriorated as economic slowdowns challenge access to food for the poor.

Malaysia ranks 41 of 113 countries and sixth of the 23 countries that comprise Asia and the Pacific. Despite this considerable achievement, the country experienced an overall drop of six places from 35 to 41 during 2017, and its Global Food Security Index (GFSI) score fell by 3.2 points.

Only seven countries in the world deteriorated more, and none of these were from Asia (see Figure 1).

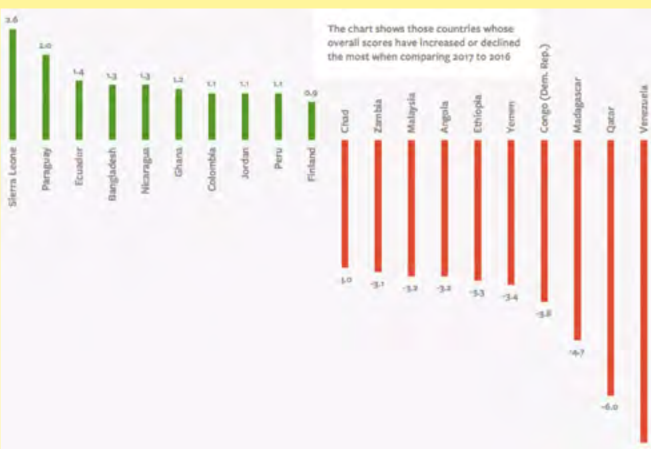
The fall in Malaysia's score and ranking was largely due to a drop in the category of 'Availability', which comprises eight sub-categories:

- Sufficiency of supply;
- Public expenditure on agricultural R&D;
- Agricultural infrastructure;
- Volatility of agricultural production;
- Transport infrastructure;
- Political stability risk;
- Corruption; and,
- Urban absorption capacity and food loss.

'Sufficiency of supply' is a composite indicator that measures the availability of food through the food supply in kilocalories per capita per day and levels of food aid. And Malaysia's drop of 13.1 per cent is the highest drop in the region.

'Public expenditure on R&D' was also below average and the index score in this category dropped by 2.5 per cent.

FIGURE 1: Global Food Security Index (GFSI) greatest increases and decreases in overall scores



Source: http://foodsecurityindex.eiu.com/Index

GFSI improvements

But in spite of these two results and the overall drop in ranking, Malaysia's scores improved on a number of other important measures, most notably:

- 'Proportion of population under global poverty line' (a 24.1 per cent improvement);
- 'Nutritional standards' (a 20.9 per cent improvement); and,
- 'Food safety' (up 18 per cent).

These are measures that reflect both a successfully growing economy and a progressively more inclusive society, and point to a more affluent population overall.

The ability of a nation to be self-sufficient in food production is a worthwhile goal if sufficient agricultural land exists, but it is not essential. Singapore is one of the most food secure nations in the world, despite importing almost 90 per cent of its food.

Rising incomes and the corresponding improvements in living standards have led to shifting consumer preferences in Malaysia – away from basic commodity products such as rice, and towards higher-value imported items such as dairy and grains.

Malaysian wheat grain imports have experienced an annual average growth rate of 4.68 per cent over the past 30 years. This increasing reliance on grain imports in particular requires a sharper focus on the systems that will reinforce the nation's control over its food supply and quality, especially as 'Sufficiency of supply' was the category that recorded the largest loss in the GFSI scores.

From a food security perspective, safeguarding the continued supply of grains needs to take priority to ensure it remains affordable for the population, and this can only be good for the Australian wheat industry in the long run. ■

Are you bogged mate? There's always a way out

By Mary O'Brien

PHOTO: Martin Colbert, Victoria

I SPEND a lot of time raising awareness about spray drift but recent events have compelled me to talk about something that disturbs me even more than spray drift.

I have spent my whole life working in rural and remote Australia and always around country blokes – working with them, for them, and beside them. My father was one, my brother is one, and most of my dearest friends are country blokes. I have always worked in male dominated occupations and that certainly doesn't make me special but I believe it has given me a good understanding of rural men and it has definitely given me a deep and profound respect for them.

So when I see country blokes facing challenges like never before, I need to say something because I know none of them will. I'm talking about rural men's mental health and more specifically, rural male suicide. Yes, that mongrel black dog that sneaks in when you least expect it, grabs all of your rational thoughts, buries them somewhere you can't find them, and without you or those close to you noticing, it gradually pulls you into a hole, a bog hole.

As I recently watched a massive line of four-wheel drives file slowly in and park reverently outside a small country town church, something in my heart changed forever. They emerged,

PHOTO: Gavin Dal Broi, NSW.

PHOTO: Adam Dellwo, NSW.

dressed in their Sunday best – some of these blokes I didn't even know owned a tie. It was a really busy time of year but they stopped all of those important farm jobs to come and say goodbye and pay their respects to a mate who decided to hand in his time sheet way too early.

The minister lamented quotes from the bible about "a time for everything; a time to be born and a time to die, a time to plant and a time to reap", you know the one. All I could think was, these are farmers, no one knows better than this crowd about planting and reaping but I'm stuffed if I could find any reason for this man to die at his own hand in the prime of his life. And judging by the faces on the country men around me, neither could they.

The statistics are everywhere – Australian males between 15 and 45 years of age are the highest risk category for suicide. Men are three to four times more likely to take their own life than women and the further you move from the coast into regional, rural, and remote Australia, the more that figure climbs. Why? Why are my country heroes cashing in their chips early?

The experts will tell you that it's due to reasons like 'the isolation', 'men don't talk about emotions', 'they don't know how to express their feelings'… Well I call that bullshit! I don't have a psychology degree of any kind, I'm not a doctor of any type, I haven't studied mental health at all but I do know

PHOTO: Ryan Milgate, Victoria.

country men. And this is what I do know… country men are the toughest, hardest working, funniest, most sincere, totally dependable, thoroughly genuine people you will ever meet.

So don't sit in your university office in the city and tell me that you know rural men.

No challenge in isolation

As a rule I don't think rural men are challenged by 'the isolation.' I think most actually thrive on it, they enjoy the peace and tranquillity that surrounds them. They enjoy the time they spend tending the earth and its creatures. They are nourished and challenged by nature and all its hardships. Everyone needs interaction with other people but isolation only really becomes a major problem when coupled with depression.

True, rural men 'don't talk about emotions', that's not how they are wired and they never will be. So stop expecting it of them.

True, rural men don't 'express their feelings' in the same way that inner city society expects them to. Let's face it, rural men are never going to be like their soft pink-handed city counterparts (no disrespect to city blokes intended, purely a comparison!). Country blokes aren't going to join a men's group or catch up with mates to discuss their feelings, relationships, or finances over a double decaf latte at some hipster café that has kale on the menu. That's not how they roll.

Rural men let off steam (release emotions) differently. They play footy, go camping, shooting, fishing, ride horses or dirt bikes, go water skiing, have a few beers with mates, they might even throw a few harmless punches with a mate after too many beers or on the footy field. These are just some of the release valves for rural men and they need to be supported and encouraged to do whatever it is that gives them release. Don't let the pressure build inside.

There are multitudes of factors that lead to depression in rural men – droughts, floods, rising input costs, falling commodity prices, pressure from banks, family pressure, feeling compelled to stay on the farm, etc. Today rural men and particularly farmers have additional pressures to previous generations. They are expected to be soil scientists, agronomists, hydrologists, accountants, meteorologists, chemical experts, mechanics, engineers, marketers, environmentalists and the list goes on.

Add to that a society that tells them they need to share 50 per cent parenting of their children, support their partner in her career, share the housework, and all the other gender equality stuff. Before anyone yells at me for dragging women back to the 1950s, I'm merely comparing the dramatic change in just one

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PHOTO: Tristan Baldock, South Australia.

PHOTO: Ryan Milgate, Victoria.

generation. Sorry fellas, you aren't getting out of cleaning the dunny that easily!

The suite of skills needed to live and work in the rural sector has never been greater and yet the divide been city and country has never been bigger. Never before has agriculture been so scorned by city dwellers who view farmers as environmental vandals and poisonous food producers.

And if all that isn't enough pressure for rural blokes, what about adding a sick child, the loss of a loved one or a marriage breakdown into the equation? I don't think we need another study to find out why rural men are struggling.

We've all been bogged sometime

Millions of dollars are spent every year on rural men's mental health, there are endless support services available, and yet the suicides keep happening. I certainly don't have the answers but I know that most rural men will not seek help or talk to someone when they are struggling.

I like to use analogies to explain things so here is my spin on it.

We have all been bogged at some point. It might have been just a sticky patch of the road or paddock where the vehicle just stopped moving. You panicked, threw it into four-wheel drive and got out. Maybe you needed low range, maybe you had to winch yourself out, but you got out, you got through it. But what happens when you get properly bogged? When it's down to the running boards, sitting on the chassis, you are not getting out of this one easily – that's the kind of bogged I mean. So what do you do? Do you burn the vehicle? Hell no!

When you have finished swearing, praying and walking around in circles scratching your head – you know this is as bad as it gets, you are going to have to ask for help. Oh the shame! The whole district is going to be laughing about it, your mates will bring it up for years (probably forever!). You don't want anyone to know but you have to get help.

It's a bit the same with depression, but it's not funny like when you get bogged in mud. Most of the time we get ourselves through the rough patches in life but when depression strikes, you need proper medical care to get you out of this bog hole. The more bogged you get the harder it is to ask for help. In your head, you will justify to yourself with a million excuses why you can't or won't ask for help. None of those excuses are any comfort as I watch a grieving widow, a young family and a whole community grapple to find answers and repeatedly ask "why didn't he tell someone".

You don't want anyone to know that you aren't coping and you don't want to talk to some counsellor that doesn't know you – I get that. But please, for the sake of your family and your precious rural communities, reach out to somebody, anybody, your partner, your mates, or even me. We will support you. You are only bogged, it's ok, we all get bogged but most importantly, you can definitely get out of it. Don't destroy your vehicle just because you are bogged to the ass. Tell someone you are feeling bogged. If your son was struggling, would you want him to ask for help?

I promise you there is always a way out of the bog hole and there are plenty of people ready to help you. Don't choose a permanent solution for a temporary problem. We have already lost too many good men.

#areyouboggedmate ■

PHOTO: Duncan Hill, NSW,

Good canola agronomy made a big difference in 2017

BBy Rohan Brill[1], Ian Menz[1], Rick Graham[1], Leigh Jenkins[1], Colin McMaster[1], Don McCaffery[1], Kathi Hertel[1], John Kirkegaard[2] and Julianne Lilley[2]

AT A GLANCE…

- In 2017, low yielding, unprofitable canola crops grew near profitable crops that had strict attention to the farming system and timely agronomic management.
- Matching the phenology of a variety with sowing date was paramount for grain yield, largely avoiding major frost damage. Yields are optimised where crops flower close to the Optimum Start of Flowering date (OSF).
- Canola responded well to high rates of nitrogen at moderate yield levels, even in a dry and frosty year.
- Hybrid canola generally outperformed OP canola in 2017, but sound agronomic management must accompany hybrids to maximise return on the extra investment.

EXTREME weather conditions experienced in 2017 across much of the national canola-belt, made it difficult to grow the crop profitably. But in regions such as the NSW Riverina and northern NSW – where conditions were particularly challenging – some crops were profitable with canola yields of 1.0 to 2.0 tonnes per hectare even in the same landscape where many crops yielded less than 0.5 tonnes.

There were consistent messages coming from the crops that were profitable in 2017, including:

- Strict fallow weed control that conserved soil moisture from the very wet spring in 2016;
- Even straw spread at 2016 harvest and prudent stubble grazing management to reduce seedbed moisture loss in autumn, and cover maintained at least until sowing;
- Selection of paddocks with relatively high starting soil water and nitrogen;
- Matching phenology and sowing date so that flowering starts close to the Optimum Start of Flowering (OSF) date to minimise environmental stresses and maximise growth;
- Sowing hybrid canola varieties (although this alone did not guarantee success);
- Application of sufficient nitrogen to match grain yield potential; and,
- Some element of luck such as timely rainfall for establishment and high paddock elevation reducing frost damage.

This article will cover the results of research from two projects that have particularly focussed on the agronomic management of canola. The two projects are:

Optimised Canola Profitability (OCP) – a collaboration between NSW DPI, CSIRO, SARDI and GRDC, extending from southern Queensland to the Eyre Peninsula in South Australia; and,

High Yielding Canola (HYC) – a project funded under the new grains and pathology partnership between NSW DPI and GRDC. This project is based in southern NSW with sites in the south west slopes and in the Murrumbidgee Irrigation Area.

Optimum Start of Flowering (OSF) dates

For all grain crops there is a period in the growing season that is most favourable for flowering and reproductive development.

This period will be where the risk of stress (such as frost, heat and drought) is minimised and where resource availability (water and light) is maximised.

Recent enhancements in the APSIM model have enabled OSF (when 50 per cent of plants have one open flower) dates to be identified for major canola growing locations. See https://grdc.com.au/10TipsEarlySownCanola.

This article reports on the results from 2017 in the context of the simulated OSF dates for the three experimental sites in NSW – Condobolin, Ganmain and Narrabri (see Table 1 for site details).

TABLE 1: Experimental sites details, 2017

Location	Region	Nov 16-Mar 17 Rainfall	Apr 17-Oct 17 Rainfall	Available N (sowing)
Condobolin	CW Plains	313 mm	122 mm*	77 kg/ha
Ganmain	Riverina	180 mm	190 mm	123 kg/ha
Narrabri	NW Plains	359 mm	165 mm	211 kg/ha

*Note: 25 mm of irrigation was applied across the whole site at Condobolin on March 8 to stimulate weeds and 15 mm applied on April 13 to ensure even establishment.

Condobolin site treatments and results

The experiment at Condobolin was designed to determine the optimum sowing date, plant type, phenology and nitrogen management to optimise biomass accumulation, harvest index and ultimately grain yield under two contrasting scenarios:

- Irrigated (supplementary water rather than full irrigation); and,
- Dryland.

Four varieties were sown in full factorial combination of sowing date (x2), nitrogen rate (x2) and added irrigation (150 mm).

TABLE 2: Treatments used at Condobolin, 2017

Varieties tested	Sowing dates	Nitrogen rates[1]	Irrigation[2]
Archer (slow hybrid Clearfield (CL)) or	Apr 6 or	50 kg/ha or	Nil (dryland) or
Diamond (fast hybrid Conv.) or	Apr 20	150 kg/ha	150 mm (irrigated)
ATR Wahoo (mid-slow open pollenated (OP) triazine tolerant (TT)) or			
ATR Stingray (fast OP TT) or			

NOTES: 1. All plots had 50 kg/ha N broadcast as urea before sowing. An extra 100 kg/ha of N was applied as urea for the 150 kg/ha treatment at 6-8 leaf stage.
2. Two irrigations of 30 mm were applied to the irrigated treatment in March prior to sowing, one irrigation of 30 mm applied June 20 and four irrigations of 15 mm applied on August 15, September 1, September 5 and September 20.

An irrigation treatment was included to determine if management of sowing date, variety type and nitrogen should vary under different moisture scenarios.

The extreme frost events of 2017 did have a large impact on the outcome. Major frosts occured on July 1 (–6.8°C), July 2 (–5.5°C), July 12 (–4.0°C), July 22 (–5.1°C), July 29 (–4.1°C), August 20 (–4.5°C), August 29 (–5.3°C) and September 1 (–3.9°C). But the success of the crop under these circumstances was still influenced by manageable factors.

From the early (April 6) sowing, the fast varieties, Nuseed Diamond and ATR Stingray, started flowering in late June/early July (Table 3), whereas the slower varieties – Archer and ATR Wahoo – flowered over a month later, starting in August.

From the April 20 sowing, Nuseed Diamond and ATR Stingray flowered about two weeks earlier than Archer and ATR Wahoo sown April 6. Irrigation and the high N rate both delayed the start of flowering by three to four days.

TABLE 3: Start of flowering (50% of plants with one open flower) of four canola varieties sown at two sowing dates, Condobolin, 2017

Variety	April 6	April 20
Diamond	June 28	July 18
ATR Stingray	July 5	July 21
ATR Wahoo	August 6	August 16
Archer	August 9	August 18

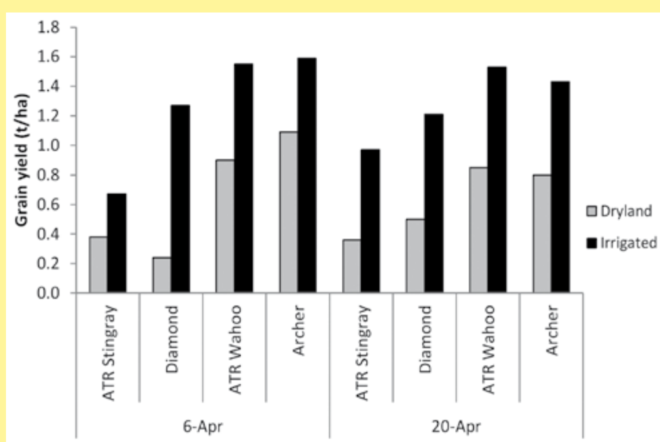
The mid-slow variety ATR Wahoo and the slow variety Archer both yielded around 1.0 tonnes per hectare in the dryland early sown treatment, as their delayed flowering meant they were not too far into podding when the severe frosts occurred. But some frost damage would have been sustained (Figure 1)

The yield of both Archer and ATR Wahoo was reduced by sowing later, as flowering was delayed until mid-August and pod development was limited by higher spring temperatures and greater water stress.

The faster varieties, Nuseed Diamond and ATR Stingray, were heavily penalised by frost at both sowing dates as flowering started (from both sowing dates) before the OSF date of July 25.

It is recommended to sow these fast varieties after April 25 in most environments of southern NSW.

FIGURE 1: Grain yield of four canola varieties sown at two sowing dates, with and without irrigation, Condobolin 2017



Notes: l.s.d. P<0.05 = 0.26 t/ha.
ATR Stingray and ATR Wahoo are protected under the Plant Breeders Rights Act, 1994.

The 150 mm of irrigation doubled the average experimental yield from 0.64 to 1.28 tonnes per hectare (Figure 1). The increase in grain yield of the fast varieties from irrigation highlights the level of recovery that can be achieved by canola despite frost damage where sufficient soil water is available.

While the main message of this experiment is that varietal phenology and sowing date need to be matched to avoid very early flowering of canola (before late July at this site), extra water can help frosted canola recover.

The main ways that dryland growers can reliably provide extra water to their crops is through strict fallow management and crop sequence decisions – such as utilising pulses and long fallow – which may leave behind some deeper soil water that crop roots can access.

Despite the relatively low starting soil N level (77 kg/ha) at the Condobolin site, there was no response to increasing N rate from 50 to 150 kg per hectare in either the irrigated or dryland treatment.

The highest yielding treatment yielded 1.6 tonnes per hectare which would have required 144 kg per hectare N to be available (assuming 50 per cent efficiency), which would have been provided through a combination of mineral N, 50 kg per hectare of applied N plus some mineralisation.

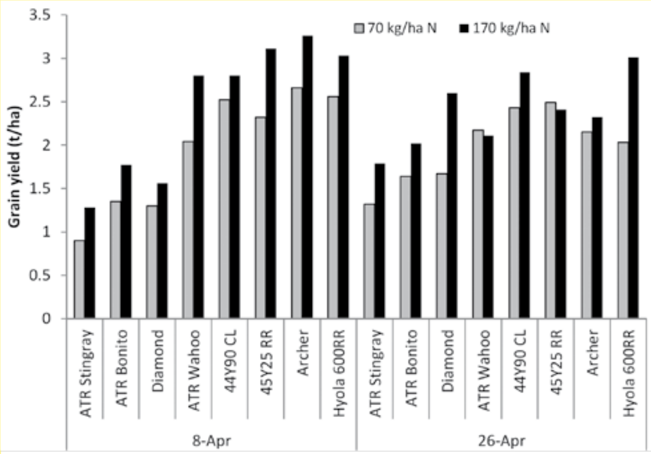
Ganmain site treatments and results

Similar to Condobolin, there were many severe frost events at Ganmain in 2017 including July 1 (–5.5°C), July 2 (–4.1°C), July 22 (–3.5°C), August 20 (–3.4°C), August 26 (–3.1°C), August 28 (–4.4°C), August 29 (–5.7°C), August 30 (–3.5°C) and September 17 (–4.6°C).

Rainfall was also well below average and there was a heat

Rohan Brill (left) and John Kirkegaard are two members of a team of canola researchers who have analysed the challenging 2017 growing season looking for agronomic factors behind varying crop performances. The team found that matching the phenology of a variety with sowing date was paramount for grain yield in a frosty season. (PHOTO: Julianne Lilley, CSIRO)

FIGURE 2: Grain yield of eight canola varieties sown at two sowing dates and fertilised at two nitrogen rates, Ganmain 2017



Notes: (l.s.d. P<0.05 = 0.38 t/ha).
ATR Stingray, ATR Bonito and ATR Wahoo are protected under Plant Breeders Rights Act, 1994.

event of 36.3°C on September 23 – giving a temperature range of 40.9°C in less than one week!

Despite the extreme climatic conditions, average grain yield of the trial (2.1 tonnes per hectare) was still close to average for the region (1.8 to 2.0 tonnes per hectare). And this result was due to deep stored soil water from the spring rainfall in 2016.

A frost scoring system was developed for Ganmain where the number of viable seeds was counted in 20 pods on the main stem in each plot.

There was a strong relationship between flowering date and the number of viable seeds per pod:

- Early sown Nuseed Diamond and ATR Stingray flowered in early July and both averaged less than six seeds per pod.
- From the same sowing date, Archer and ATR Wahoo delayed their flowering until early–mid August and both had more than 10 viable seeds per pod.

This scoring gave an insight into the level of frost damage in each variety but did not completely relate to grain yield as there were differences in the ability to compensate (with new pods) from frost damage.

In the Ganmain experiment, increased yield came from sowing varieties in their optimum window to achieve the OSF date (August 5 for nearby Wagga Wagga) and where they were well fertilised with nitrogen (Figure 2).

The fast varieties – Nuseed Diamond and ATR Stingray – were heavily penalised by frost from early sowing and hence early flowering.

The slower varieties – such as Archer and ATR Wahoo – had reduced yield from later sowing as flowering occurred later than optimal (late August) and pod development was limited by rising spring temperatures.

Importantly, the nitrogen response increased for varieties sown in their correct window.

For example, there was a strong response to N with Archer, Pioneer 45Y25 RR and ATR Wahoo sown early (flowering in early August) but minimal response when sown later (flowering in late August).

Conversely there was a strong response to N for Nuseed Diamond when sown later (flowering in early August) but not where it was sown early (flowering in early July).

Both Pioneer 44Y90 CL and Hyola 600RR responded well to nitrogen at both sowing dates (Figure 2).

There was an overall benefit of planting hybrid varieties – but varietal choice was less important than ensuring sowing date, phenology and nitrogen management were optimised.

For example, sowing the open-pollinated triazine tolerant variety ATR Wahoo (which yielded 2.8 tonnes per hectare) early with a high rate of N yielded 0.7 tonnes above the trial mean yield of 2.1 tonnes per hectare.

But there were several treatments where hybrids, with inappropriate management, yielded less than the trial mean.

Narrabri site treatments and results

An experiment was also sown at Narrabri with six varieties (same as Ganmain but with the exception of the Roundup Ready varieties), two sowing dates (April 19 and May 8) and two nitrogen rates – nil and 65 kg per hectare N.

The frosts were also severe at Narrabri with similar minimum temperatures recorded as Ganmain and Condobolin but with a greater diurnal (ie. the difference between minimum and maximum temperature) variation. On some days the maximum temperatures were much higher (in excess of 20°C) on the same day as a –5°C frost event.

The trial had good early vigour and grew well but the frosts caused significant yield loss and there was little recovery as the season quickly transitioned from frosty to very warm and dry.

Nuseed Diamond and ATR Stingray were the earliest varieties to flower (early July) from early sowing but were the hardest hit by frost and went on to yield less than 0.1 tonnes per hectare.

Later sown Nuseed Diamond – which flowered on August 1 and very close to the OSF date for Narrabri of July 31 – was the highest yielding treatment at 0.9 tonnes per hectare.

There was no grain yield effect of increasing N rate to 65 kg per hectare.

To sum up

Although in many regions 2017 was a tough year for growing canola, there were still profitable crops grown in most environments through effective management – and in some cases – a little luck from timely rainfall and less frost damage.

The main messages from 2017 are:

- It is critical to correctly match sowing date with phenology to target the OSF date for the location. This reaffirms the consistent message from recent canola research;
- Use optimum nitrogen management; and,
- With the above factors in place, choose hybrid varieties particularly in the medium to high yielding environments.

Although frost had a major impact on grain yield in 2017, there were management decisions that significantly affected how the crops recovered after frost.

Matching sowing date and phenology so that crops flowered close to the OSF date ensured that crops were not too far advanced through pod set when the frosts hit – but also not so late that yield was limited by rising spring temperatures.

Hybrids tended to recover better from frost damage but it was still possible to achieve profitable yields with OP varieties. As well as the in-crop agronomic management factors, the pre-crop management also had a major bearing on outcomes for canola in 2017.

The projects supporting this research are co-investments from GRDC, NSW DPI, CSIRO and SARDI. Thanks also to many people for their assistance including Craig Ryan, John Bromfield, Warren Bartlett, Sharni Hands, Daryl Reardon, Danielle Malcolm, Leah Rood-England and Sophie Prentice.

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Insecticide resistance is outgunning our current weapons

By Paul Umina[1,2], Siobhan de Little[1,2], Lisa Kirkland[1], Elia Pirtle[1], Matthew Binns[2] and James Maino[1]

INSECTICIDE resistance issues in broadacre cropping continue to outpace the availability of novel control options. In this article, we discuss the latest findings on two major pests that have developed resistance to key chemical groups, the green peach aphid (*Myzus persicae*, GPA) and the redlegged earth mite (*Halotydeus destructor*, RLEM). We also discuss the development of a new Resistance Management Strategy for *Helicoverpa armigera* in grains.

AT A GLANCE…

- Insecticide resistance issues continue to outpace availability of novel control options.
- The implementation of recently published Resistance Management Strategies (RMS) is vital to maximising the long-term viability of chemical options.

Green peach aphids (GPA)

- GPA has acquired resistance to neonicotinoids.
- Pirimicarb is now mostly ineffective against GPA due to resistance, but remains effective against other crop aphids, highlighting the importance of correct species identification.

Redlegged earth mite (RLEM)

- Resistance in RLEM has been detected for the first time in eastern Australia.
- Synthetic pyrethroids (SPs) are completely ineffective against SP-resistant RLEM populations, while some efficacy remains for organophosphates (OPs) against OP-resistant RLEM populations.

Helicoverpa armigera

- Insecticide control of *H. armigera* is complicated due to field resistances and increased selection pressure to important insecticide products.

Green peach aphid acquires new resistances

Green peach aphid is a widespread and damaging pest of canola and a range of pulse crops, causing damage by feeding and transmitting viruses. Five chemical subgroups are registered to control GPA in grain crops:

- Carbamates (Group 1A);
- Synthetic pyrethroids (SPs – Group 3A);
- Organophosphates (OPs – Group 1B);
- Neonicotinoids (Group 4A); and,
- Sulfoxaflor (Group 4C).

Paraffinic spray oils are also registered for suppression of GPA.

Together with CSIRO, **cesar** has been mapping the extent of insecticide resistance in GPA across Australia for the past few years with strategic investment from GRDC. This ongoing resistance surveillance has continued to show high levels of resistance to carbamates and SPs that are widespread across Australia.

Moderate levels of resistance to OPs have been observed in many populations, and there is evidence that low level resistance to neonicotinoids is spreading.

Despite widespread resistance to the carbamate, pirimicarb, in GPA populations, this insecticide remains important to the control of other canola aphid species of similar appearance (eg. cabbage aphid). So it is important to properly identify aphids before spray decisions are made.

Figure 1 highlights some key features that can be used to distinguish GPA from other similar species found on canola (with a hand lens). If a hand lens is unavailable, GPA will usually be found on lowest, oldest leaves, typically in sparse family groups, while turnip aphid and cabbage aphid are more commonly found in large colonies on flowering spikes.

Neonicotinoid resistance conferred by enhanced expression of the P450 CYP6CY3 gene was discovered in Australian GPA populations in 2016 by **cesar** and CSIRO researchers.

Laboratory bioassays revealed these aphids to be about 10 times more resistant to a topical application of a neonicotinoid to a susceptible population. But overseas GPA are known to carry an R81T gene mutation of the nicotinic acetylcholine receptor that confers around 1000 times resistance to neonicotinoids resulting in field control failures, as well as cross-resistance with Group 4C chemicals such as sulfoxaflor.

For the past decade, pesticide resistance in RLEM was only found in WA. It has now been detected in the eastern states. (PHOTO: cesar)

Australian GPA may acquire this high-level resistance if neonicotinoid selection pressures remain high, or if there is an incursion of overseas GPA carrying the R81T mutation.

Growers and advisors are encouraged to become familiar with the Resistance Management Strategy for GPA in Australian grains. This can be downloaded from the *IPM Guidelines for Grains* website.

Resistance in RLEM spreads to eastern Australia

The redlegged earth mite (*Halotydeus destructor*, RLEM) is an important pest of germinating crops and pastures across southern Australia.

Four chemical sub-groups are registered to control RLEM in grain crops:

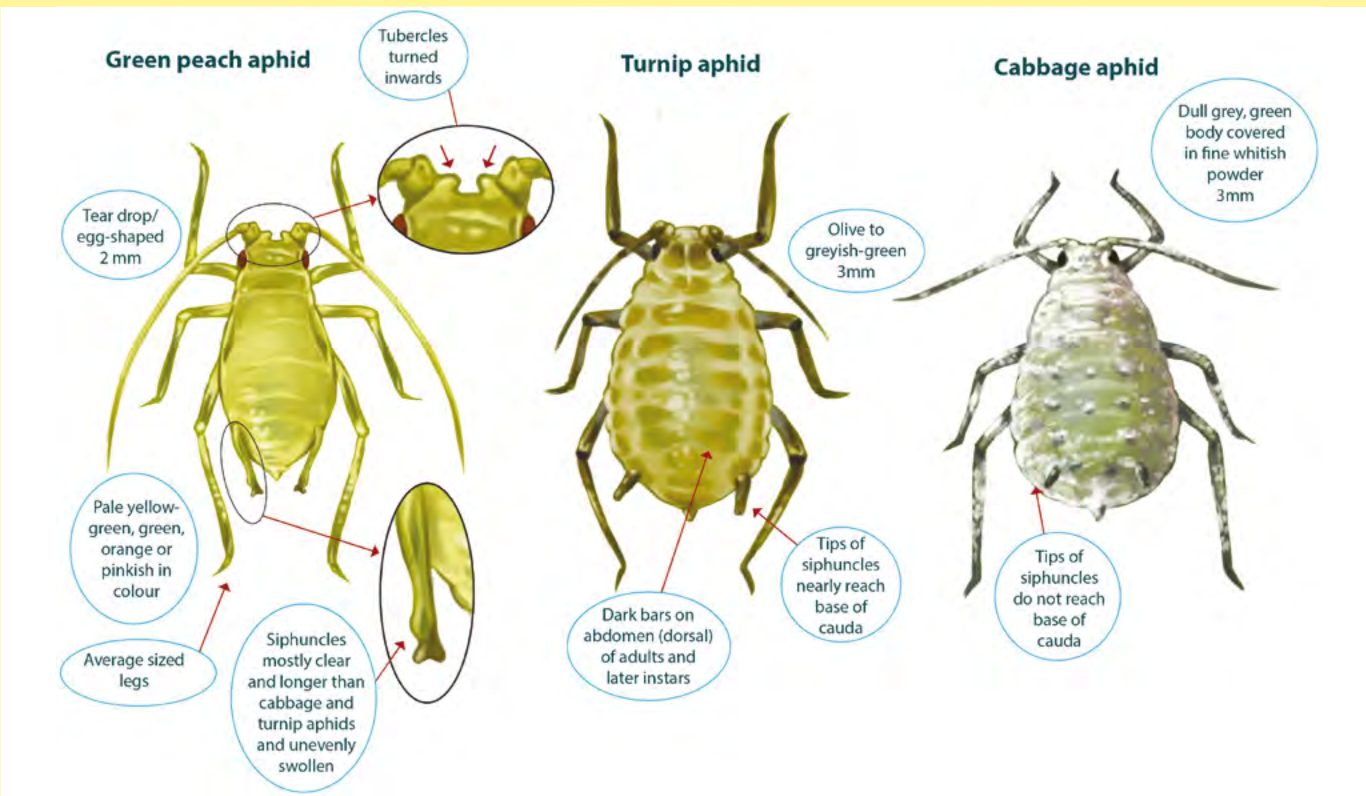
- Organophosphates (OPs) – Group 1B;
- Synthetic pyrethroids (SPs) – Group 3A;
- Phenylpyrazoles – Group 2B; and,
- Neonicotinoids – Group 4A.

The latter two are registered only for use as seed treatments.

After remaining confined to Western Australia for a decade, in 2016, pesticide resistance in RLEM was detected for the first time in eastern Australia.

In WA, resistance to SPs is widespread, while OP resistance is comparatively more restricted (Figure 2). In 2016, following reports of a field control failure in the Upper South East district in South Australia, resistance testing determined this SA population was resistant to SPs and OPs. In 2017, two additional SP resistant populations were confirmed on the Fleurieu Peninsula (about 30 km apart) and 200 km from the 2016 detection.

FIGURE 1: Green peach aphid should be distinguished from other crop aphids before determining the most appropriate management option

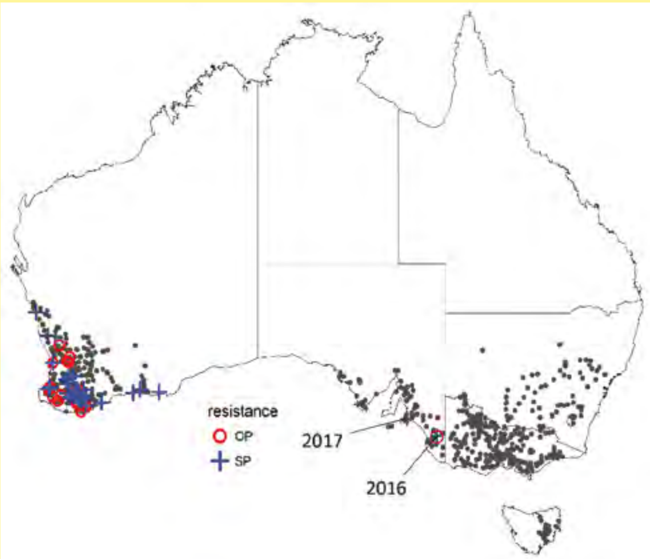


Diagrams by Dr Elia Pirlie © cesar pty ltd.

All SP resistant RLEM populations tested to date have been found to possess a target site mutation which confers very high level SP resistance leading to complete spray failures.

In contrast, the mechanism conferring OP resistance has not yet been resolved, but resistance is comparatively less than SP resistance, giving reduced OP efficacy.

FIGURE 2: The current known distribution of RLEM in Australia shown as full circles, overlaid with the known distribution of SP and OP resistance across Australia, 2017



(Adapted from Hill *et al.*, 2012)

To increase management options for populations with dual resistance to OPs and SPs, trials run by the University of Melbourne and **cesar** are testing the impact of different management regimes on RLEM abundance and chemical tolerance in a dual-resistant population.

Preliminary results have shown that both foliar chemical groups are largely ineffective on populations with SP and OP resistance, but that high rates of omethoate can still provide control in OP-resistant populations – though the long-term sustainability of this strategy is unlikely.

A novel mode-of-action group was also tested as part of this trial and found to be highly effective at suppressing mite numbers, indicating no cross-resistance.

Growers and advisors are encouraged to become familiar with the Resistance Management Strategy for RLEM in Australian grains and pastures. This can be downloaded from the *IPM Guidelines for Grains* website.

New resistance management strategy for *Helicoverpa armigera*

Helicoverpa armigera is a major pest of grains crops. Direct feeding by *H. armigera* reduces yield of pulses, oilseeds, coarse grains and, occasionally, winter cereals. Losses come from direct weight loss through seeds being wholly or partly eaten. Grain quality may also be downgraded through unacceptable levels of chewed grain.

Although widely distributed and recorded in all states and territories within Australia, *H. armigera* is more common in the northern or coastal regions of eastern Australia, particularly

TABLE 1: Products with label claims for *Helicoverpa armigera* (and *Helicoverpa* spp. generally) in Australian grain crops and current resistance status

IRAC MoA group	Insecticide category	Active ingredient(s)	Example trade name(s)	Resistance in Australia
1A	Carbamates	methomyl, thiodicarb	Lannate, Marlin, Larvin	✓ Moderate–high (30-50%)
1B	Organophosphates*	chlorpyrifos	Chlorpos, Lorsban, Chlorpyrifos	✓ Low–moderate (1-10%)
3A	Pyrethroids	alpha-cypermethrin, beta-cypermethrin, cypermethrin, deltamethrin, gamma-cyhalothrin, lambda-cyhalothrin, esfenvalerate, permethrin, bifenthrin	Alpha-Scud, Astound, Trojan, Talstar, Sumi-Alpha Flex	✓ Metabolic resistance is high (50-100%) Target site resistance is low (<5%)
5	Spinosyns	spinetoram	Success Neo	✓ Very low (<2%)
6	Avermectins	emamectin benzoate	Affirm	X
11C	*Bacillus thuringiensis*	B.t. subsp. Kurstaki, B.t. subsp. aizawai	DiPel, Delfin, Costar, Bacchus	✓ Low (<5%)
22A	Oxadiazines	indoxacarb	Steward	✓ Low, but increasing (5-12%)
28	Diamides	chlorantraniliprole	Altacor	✓ Very low (<1%)
No group	Nuclear polyhedrosis virus	nuclear polyhedrosis virus	Gemstar, Vivus Max/Gold	X
No group	Paraffinic spray oils	paraffinic oil	Canopy	X

*Not registered to control *H. armigera* in grain crops.
Table adapted from: Science behind the Resistance Management Strategy for *Helicoverpa armigera* in Australian grains (NIRM, 2018). Data provided by NSW Department of Primary Industries with support from the Cotton Research and Development Corporation (CRDC) and the Grains Research and Development Corporation (GRDC).

in warmer regions. In cooler regions, they are generally only problematic in summer.

There are over 200 insecticide products registered in Australia against *H. armigera* for grains, cotton and vegetable crops. The majority are from three chemical sub-groups with broad-spectrum activity:

- Carbamates (Group 1A);
- Organophosphates (Group 1B); and,
- Synthetic pyrethroids (Group 3A).

But insecticides from Group 6 (emamectin benzoate), Group 22A (indoxacarb) and Group 28 (chlorantraniliprole) have become more widely used in pulses due to high efficacy and low impact on natural enemies. Control is complicated because field populations are resistant to numerous insecticide groups (Table 1). Due to these factors, timing of chemical applications and coverage are critical, and growers need to understand how to minimise yield loss without furthering resistance levels.

A new Resistance Management Strategy (RMS) has recently been produced for *H. armigera* in Australian grain crops and will be available for the 2018 field season. This RMS was developed by the National Insecticide Resistance Management (NIRM) working group of the Grains Pest Advisory Committee (GPAC), and is endorsed by CropLife Australia.

The general rationale for the design of the strategy is that chickpeas and mung beans are currently, and for the foreseeable future, the crops in which the use of insecticides is most likely to have the greatest impact on the management of resistance in *H. armigera* populations. Therefore, the strategy is primarily focused on insecticide modes of action (MoA) rotation in these systems and is built around insecticide product windows.

There are currently two RMS regions in Qld and NSW:

Northern grains region – Belyando, Callide Central Highlands and Dawson; and,

Central grains region – Balonne, Bourke, Burnett, Darling Downs, Gwydir, Lachlan, Macintyre, Macquarie and Namoi.

- The RMS provides window-based recommendations common to southern QLD, central and northern NSW because *H. armigera* moths are highly mobile and have the capacity to move between these regions, potentially increasing the risk of further exposing cohorts of insects previously selected for resistance.
- There has been little formal monitoring of *H. armigera* in the Southern and Western regions (Victoria, Tasmania, South Australia and Western Australia). These regions have very little broadacre summer grain crop production and biological indicators suggest that the risk of *H. armigera* occurring at densities that may result in control failures, is low. If required, the Central grains region RMS may be used for *H. armigera* management in summer crops in the Southern and Western regions.

The new RMS for grain crops is not intended to 'sync' with the cotton IRMS. Recommended windows for use in the two industries do not align, and the level of insecticide used for Helicoverpa control in cotton is relatively small in comparison with the areas of winter and summer pulses potentially treated each year. It is considered that insecticide use patterns in cotton pose little risk to the ongoing management of resistance, relative to the risk posed by year-round, high level use in grains.

Useful resources
https://ipmguidelinesforgrains.com.au/ipm-information/resistance-management-strategies/

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A tiny membrane can make Sydney Harbour water 'drinkable'

SYDNEY'S iconic harbour has played a starring role in the development of new CSIRO technology that could save lives around the world – not to mention the potential for extra water availability for agricultural use. Using their own specially designed form of graphene – *Graphair* – CSIRO scientists have supercharged water purification, making it simpler, more effective and quicker.

The new filtering technique is so effective, water samples from Sydney Harbour were safe to drink after passing through the filter. The breakthrough research was published recently in *Nature Communications*.

"Almost a third of the world's population, some 2.1 billion people, don't have clean and safe drinking water," the paper's lead author, CSIRO scientist Dr Dong Han Seo said.

"As a result, millions – mostly children – die from diseases associated with inadequate water supply, sanitation and hygiene every year. In *Graphair* we've found a perfect filter for water purification. It can replace the complex, time consuming and multi-stage processes currently needed with a single step."

Soybean oil plays a key role

While graphene is the world's strongest material and can be just a single carbon atom thin, it is usually water repellent.

Using their *Graphair* process, CSIRO researchers were able to create a film with microscopic nano-channels that let water pass through, but stop pollutants.

As an added advantage *Graphair* is simpler, cheaper, faster and more environmentally friendly than graphene to make.

A *Graphair* sample. Graphene is the world's strongest material.

Dr Dong Han Seo collecting a water sample from Sydney Harbour.

It consists of renewable soybean oil, more commonly found in vegetable oil.

Looking for a challenge, Dong Han and his colleagues took water samples from Sydney Harbour and ran it through a commercially available water filter, coated with *Graphair*.

Researchers from QUT, the University of Sydney, UTS, and Victoria University then tested and analysed its water purification qualities.

The breakthrough potentially solves one of the great problems with current water filtering methods – fouling.

Over time chemical and oil based pollutants coat and impede water filters, meaning contaminants have to be removed before filtering can begin. Tests showed *Graphair* continued to work even when coated with pollutants.

Without *Graphair*, the membrane's filtration rate halved in 72 hours.

When the *Graphair* was added, the membrane filtered even more contaminants (99 per cent removal) faster.

"This technology can create clean drinking water, regardless of how dirty it is, in a single step," Dong Han said.

"All that's needed is heat, our graphene, a membrane filter and a small water pump. We're hoping to commence field trials in a developing world community next year."

CSIRO is looking for industry partners to scale up the technology so it can be used to filter a home or even town's water supply.

It's also investigating other applications such as the treatment of seawater and industrial effluents. ■

Plant-based fish feeds to help advance aquaculture

By Jan Suszkiw, Agricultural Research Service – USDA

AT A GLANCE…

- In the US over 90 per cent of seafood is imported, creating a $14 billion plus trade deficit.
- ARS develops alternative fish feeds to help US aquaculture expand and compete globally.
- Plant-based feeds could lessen reliance on fishmeal and oil from ocean-caught species.
- ARS nutrition studies include consumption of healthful fatty acids from farm-raised fish.

HALF the seafood that US consumers eat comes from aquaculture – the raising and harvesting of freshwater and marine species in controlled conditions. Over 90 per cent of that seafood is imported, creating a US trade deficit of more than $14 billion.

The Agricultural Research Service (ARS) and its partners are working to close that gap on several research fronts. One such area is the development of cost-effective feeds that will help the aquaculture industry expand and capture a greater share of the world market for fishery products.

Toward that end, ARS researchers are exploring plant-based alternatives to fishmeal and fish oil. These two aquafeed ingredients are made from so-called forage fish caught in the open ocean, like menhaden, herring, mackerel, anchovy, and sardine. Fishmeal and oil are rich sources of amino acids, lipids, and other nutrients that farm-raised species need to grow – especially carnivorous ones like Atlantic salmon, striped bass, and rainbow trout.

But worldwide catches of forage fish are deemed unlikely to sustain aquaculture's long-term growth, experts say. Aquafeed containing all or mostly fishmeal and oil can be costly – US$1500 or more per tonne (AU$1900). In catfish, tilapia, and other farmed species, it's not unusual for aquafeed use to account for over half the farmer's production costs.

Less cost with plant-based fish feed

Supplanting some of that fishmeal and oil with soybeans or other plant-based ingredients can defray some of the costs and alleviate concerns over the presence of ocean contaminants. But plant-based ingredients aren't always as palatable to or as readily digested by fish – some of which require at least 40 per cent protein in their diets.

So-called anti-nutrients are another issue with plant-based feeds. Soybeans, for example, contain phytic acid, a naturally occurring compound that can prevent farmed fish from absorbing phosphorus, iron, and other nutrients from their feed. Instead, these nutrients get excreted into water as waste.

One approach, being investigated by ARS and university scientists in Auburn, Alabama, is to spray plant-based feeds with phytase, a commercially available enzyme that destroys phytic acid and is used with pig and other livestock feeds.

In trials, catfish that ate a phytase-treated commercial diet had higher red blood cell and hemoglobin counts than fish given untreated feed, according to Benjamin Beck, a physiologist in ARS's Aquatic Animal Health Research Unit in Auburn. Catfish in the phytase group also grew faster, suggesting the approach could lead to improved health and productivity in commercially raised catfish.

ARS and university scientists in Stoneville, Mississippi, recently found that giving fish more than 500 phytase units (a measurement of enzyme activity) showed little benefit. This suggests catfish farmers could avoid the cost of using more phytase than is necessary.

In Idaho, ARS scientists and their collaborators are taking a different tack to improve the nutrition of farm-raised fish. Instead

ARS fish physiologist Rick Barrows (recently retired) formulating fish-feed pellets before infusing them with flax oil. (PHOTO: Stephen Ausmus)

of customising the feed to suit the fish, they are, in a sense, customising the fish to suit the feed.

Led by Ken Overturf, an ARS geneticist in the Small Grains and Potato Germplasm Research Unit in Hagerman, the team has selectively bred a strain of rainbow trout that will eat an all-plant, high-soybean diet and grow efficiently on it.

In trout and other members of the salmonid family, a long-term diet of soy or other plant-based aquafeeds can lead to reduced growth and an inflammatory intestinal condition called enteritis, among other complications. But in feeding trials, the soy-tolerant fish strain developed twice as fast as non-tolerant rainbow trout lines and showed no signs of enteritis.

The advance is tied to the team's identification and analysis of multiple genes and physiological pathways enabling the trout strain to digest and metabolise soy proteins for muscle growth. The research opens the door to a strategy that could reduce dependency on fishmeal-based diets for all commercially produced carnivorous fish.

Research into other plant-based feeds

Soy isn't the only potential alternative aquafeed ingredient. ARS scientists, including Ken Overturf and Rick Barrows (ARS retired), are also evaluating the potential of flaxseed, barley protein concentrate, poultry processing remains, and dried distillers' grains with solubles, a byproduct of ethanol-production.

Other candidate ingredients include discarded tree nuts like pistachios, single-celled organisms like yeasts, meals made of insect larvae, and algae. Biodiesel production from algae uses the algal carbohydrates but leaves a protein-rich co-product that was readily consumed by California yellowtail and white seabass in feeding trials.

On a related front, algae-based feeds are being examined as sources of omega-3 fatty acids. Consuming omega-3 fatty acids from fish oil and other foods can offer us health-promoting benefits, like reduced risk of heart disease.

In addition to collaborating with commercial feed manufacturers and others in the private sector, ARS researchers also partner with experts from stakeholder groups, academia, and state and federal agencies, like the National Oceanic and Atmospheric Administration via its Alternative Feeds Initiative.

Established in November 2007, the initiative seeks to "identify alternative dietary ingredients that will reduce the amount of fishmeal and fish oil contained in aquaculture feeds while maintaining the important human health benefits of farmed seafood."

Breeding fish-friendly crops

Genetics also figure prominently in meeting the dietary needs of farm-raised fish and, in turn, the health and well-being of consumers, notes Caird Rexroad, ARS national program leader for aquaculture. This includes breeding "fish-friendly" crops with better feed digestibility and developing new fish lines that are especially adept at using plant-based feeds as healthful sources of protein and oil.

"Aquaculture has tremendous potential to provide healthy protein sources to a growing global population. We need to use our natural resources and agricultural know-how – including genetic improvement technologies – to help make this happen," says Caird.

Source: USDA – ARS *AgResearch* Magazine, January 2018

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Year of the Grower

BAYER CropScience Pty Ltd is launching a major new promotion in the broadacre and horticulture industries in support of its crop protection products. The *Year of the Grower* is a year-long, country-wide promotion, beginning on March 12, and is Bayer CropScience's biggest ever promotion, with a total prize pool of $165,000.

The promotion rewards growers with an entry into a draw for every $100 spent in a single transaction (the Qualifying Spend) on Bayer Crop Protection products. The major prize is the Polaris Ranger 570HD UTV – valued at $16,500. This hard working, smooth riding, side-by-side is the preferred workhouse of Australian farmers, with best-in-class power, towing and payload capacity.

There are 10 Polaris Rangers to be won, across two draws in September 2018 and March 2019. Two Rangers will be won in each of Bayer's five designated regions: Northern Broadacre; South Eastern Broadacre; Western Broadacre; Northern Horticulture; and, Southern Horticulture.

Bayer Crop Science's Gareth Sheehan, Biologics & Fungicides Portfolio Manager, said: "We're committed to giving back to the people who are fundamental to our business – the growers. We believe the Polaris Ranger, with its proven all-round performance and excellent safety record, is not just a highly desirable prize, but a very useful one too. We hope growers will embrace the *Year of the Grower* so that we can to continue to develop our already strong relationships." ■

New ag sprayer unveiled

AUSTRALIAN owned, agricultural spray equipment manufacturer, Croplands unveiled their new dual tank, high capacity trailed last year. The new machine has a 7000 litre main tank, plus a versatile 1500 litre tank which can be used three different ways to suit the farmers' needs.

Croplands Portfolio Manager, Steve Norton is head of the Croplands R&D team and has been heavily involved in the Pegasus 7000 Plus project.

"The R&D team at Croplands focus on being an innovative manufacturer of application equipment. This new versatile Pegasus 7000/8500 has really challenged the way we think about opportunities to maximise efficiency with trailer spraying" says Steve.

The standard model's 1500 litre tank is used for storage or fresh water and has a handy chemical drum rack fitted to the side of the chassis for 20 litre drums. Croplands envision that this model will be useful for farmers to finish off small areas of the paddock.

The first variation has a 1500 litre storage tank for concentrated chemicals to be used with a DCI pumping system. The chemical from the 1500 litre storage tank can also be used to pump into the main tank where extensive travel is required to refill. This sprayer is fitted with two large capacity, centrifugal pumps. The first pump is utilised for self-filling both tanks from a three inch feed line and to maintain agitation in the 1500 litre tank, while the second pump is used to deliver chemical to the boom and maintain agitation in the 7000 litre tank.

The second variation combines the 1500 litre tank with the 7000 litre main tank, for a total volume of 8500 litres. Farmers utilising nurse tanks and pre-batching plants will get the most out of this model with the ability to fill both tanks. This model is also fitted with a dual pump system.

Optional application packages

Croplands is offering a couple of optional application packages for the new Pegasus 7000 Plus to further enhance the spray quality and aid the decontamination process. The one inch boom pumping system has been designed with four major boom feeds to improve chemical distribution from tip to tip, anywhere across the boom.

Croplands 250 mm spacing upgrade is designed to improve penetration of small targets and in heavy stubbles. With twice the standard amount of nozzles, twice the coverage is achieved. ■

Microbial inoculums

THERE are quite a few aspects to biological farming that occur above the ground but Mapleton Agri Biotec is focussed on boosting the fertility of the soil and the efficiency of the root systems to increase yields. A healthy vigorous bacterial and fungal microflora is vital to the productivity of soil as the microbes help with nutrient cycling, micronutrient availability, suppression of root pathogens, increasing soil carbon and water holding capacity, and improving soil physical properties.

Mapelton's Rob Bower says that the scientific understanding of the complex interactions that occur in soil biology lags far behind the understanding of soil chemistry but according to Rob, good farmers are bypassing this problem by using common sense techniques to improve their soil biology and crop productivity.

"Many farmers have soils that have poor soil microflora levels due to past farming practices, prolonged water logging and other factors. Our company believes that two main approaches are appropriate to remedy this problem," Rob says.

- Farming practices that provide a good environment for soil microflora to flourish, such as minimal tillage, avoidance of over-fertilisation etc; and,
- The use of good quality inoculums.

"Farmers who use our products – NitroGuard and CataPult – use them to allow reductions in nitrogen and phosphorous fertiliser rates. But farmers must know that the microbe and fungal species are present in sufficient numbers to allow a lower use fertiliser rate," Rob says. "The use of good inoculums guarantees this."

Good inoculum use can help create the best microbial and fungal species populations. "There is huge variation in what different microbes species do in the soil," Rob says. "Our development trials have identified the microbe species that drive better root growth and nutrient uptake."

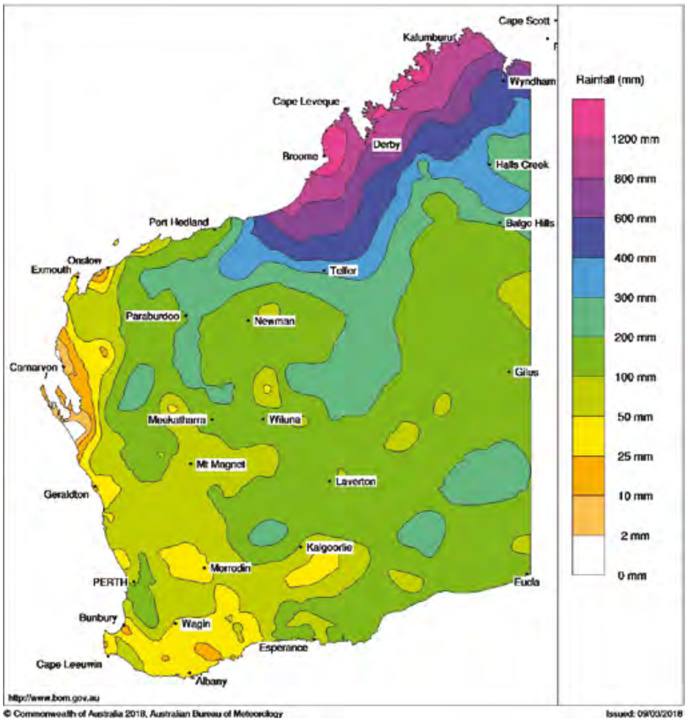
More information Rob Bower: www.mabiotec.com ■

The plant on the left is from a TwinN inoculated wheat crop.

Western region

District Reports…

Western Australia rainfall totals (mm) year to March 9, 2018
Australian Bureau of Meteorology



WESTERN AUSTRALIA SUMMARY

While a long way behind the 2016 total production of 18.20 million tonnes, the final 2017 season production in Western Australia of 14.27 mt for all grains well surpasses predictions mid way through the year. With estimates of around 9 mt in July 2017, the turn-around was unprecedented thanks to spring rains in September and October and a soft finish.

Wheat production was 25 per cent lower than the record year of 2016 due mainly to the poor year in the north and northeast of the state.

Lupin production was down 37 per cent from 2016 reflecting the poor season in the north where the majority of the lupins are grown.

Production of barley and canola in the state was down slightly from 2016. The majority of barley is grown in the southern regions where growing conditions in 2017 were good.

Canola production held up from 2016 due to increased plantings in 2017 and good yields in the southern areas of the state, although seed supply was an issue.

And there was more good news for the Esperance port zone with a record year of just under 3.0 mt production for all grains.

2017 GIWA crop yield estimates (t/ha)

Port zone	Wheat	Barley	Canola	Oats	Lupins	Field pea
Kwinana	1.31	2.74	1.27	2.05	1.69	1.53
Albany	1.70	2.79	1.45	2.53	1.66	1.30
Esperance	2.57	2.92	1.61	2.50	1.78	1.33
Geraldton	1.31	1.40	1.03	0.62	0.83	1.00
Averages	**1.62**	**2.78**	**1.41**	**2.20**	**1.40**	**1.41**

Grain quality in 2017

- Grain weight was high in all regions and screenings low – this was a function of the soft slow finish with minimal frost.
- Very little grain was rain-affected at harvest and/or downgraded from adverse climatic events.
- Protein in wheat and barley was generally low due to dilution from higher than expected yields. It was a difficult year for growers to manage their inputs as most had not experienced such a late start combined with such a good finish.
  The comment from several of the consultants contributing to this report last year was: "You could only get protein off a legume, not out of the bag."
- There was more noodle wheat produced than predicted with increased production from the north and south of the state.
- Canola oil quality was high due to the slow cool finish and contributed significantly to the profit margins of canola crops.
- Lupin tonnage was hit hard by the poor season in the north of WA where traditionally most of the lupins are grown. Some of the newer varieties performed well in the central and south of the state and may in future contribute more to production.
- Milling oats have been steadily increasing in area and depending on price stability, may continue to do so as demand continues to increase.
- Field peas finally had a good year and whilst growers may move into more plantings based on success in 2017, there was a noticeable increase in chickpea, lentil and faba bean test plantings around the state.

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

**GIWA Crop Report
February 14, 2018**

NORTHERN DISTRICT

February was quiet for rainfall over most of the region but the sprayers were rolling due to mid January rain. Falls ranged from 15 mm up to 170 mm with most in the 40 to 60 mm range. This

2017 GIWA WA crop production estimates (tonnes)

Port zone	Wheat	Barley	Canola	Oats	Lupins	Field pea	State total
Kwinana	3,550,000	1,510,000	610,000	305,000	210,000	20,000	**6,205,000**
Albany	1,400,000	1,300,000	580,000	165,000	65,000	4000	**3,514,000**
Esperance	1,450,000	920,000	565,000	5000	25,000	20,000	**2,985,000**
Geraldton	1,200,000	70,000	145,000	5000	150,000	1000	**1,571,000**
Totals	**7,600,000**	**3,800,000**	**1,900,000**	**480,000**	**450,000**	**45,000**	**14,275,000**

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…

has had summer weeds up across the whole landscape. Button grass and tar vine are the toughest to control and growers with these weeds have to go hard and early to keep on top of them. Most of the spraying has wound up or close to it as we get to the end of February.

Outside of spraying, deep ripping and lime applications are the main paddock activities. Moving rocks, soil sampling and tidying up paddocks are also happening at the moment.

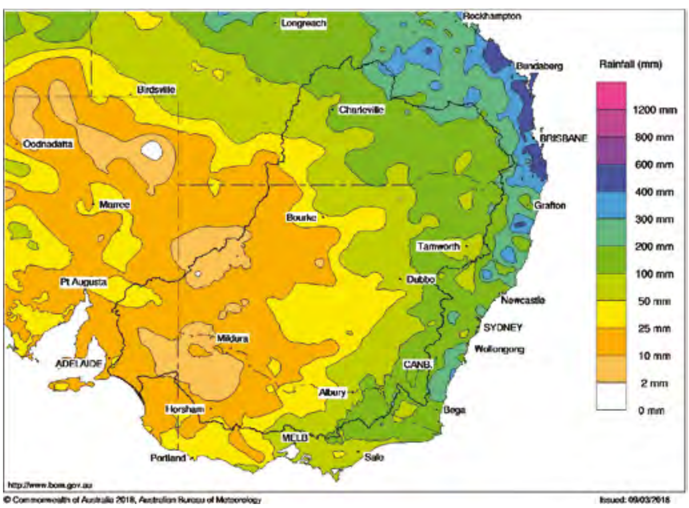
Planning for the 2018 crop and attending the many grower group and research update meetings are the other activities filling in the weeks.

Hopefully rains can hold off in March and arrive with gusto in April. We are looking forward to a much simpler season than 2017. Hopefully 2018 delivers.

Peter Norris
Agronomy For Profit and Synergy Consulting, Geraldton
February 20, 2018

Southern region

Murray–Darling Basin rainfall totals (mm) year to March 9, 2018
Australian Bureau of Meteorology



SOUTH AUSTRALIA SUMMARY

The 2017 winter crop

- Despite below average growing-season rainfall in many districts, total state crop production at 6.8 million tonnes has been only slightly below the long-term average from a smaller than average crop area of 3.6 million hectares.
- A dry finish to the season reduced yield potential in most districts, with crops on deep sands or shallow soils drying off early. Crops on soils with good moisture-holding capacity were able to ripen slowly.
- Where good summer weed control allowed soil moisture to be conserved and where crops were sown and emerged early, crops yielded above average. Paddocks with poor summer weed control, or where crops were sown or emerged late, yielded below average.
- Frosts in late October and early November 2017 severely affected crops yields in the Northern Mallee with average losses of 20 per cent. There was also severe frost damage in areas of the South East and isolated frost damage in a number of other districts.
- Despite well above average rainfall in the South East, crop yields were only average to slightly above average due to frost and waterlogging.
- Harvest was completed in most districts by the end of December. Farmers on Kangaroo Island, Adelaide Hills, Fleurieu Peninsula and Lower South East completed harvest in mid to late January.
- Cool and damp weather slowed harvest in early November and heavy rain in late November and early December halted harvest in many districts.
- Heavy rain resulted in weather damage and down-grading of unharvested wheat and barley crops in some districts.
- Given the seasonal conditions, cereal crops generally yielded exceptionally well, with most districts achieving close to average yields and some districts above average yields.
- Grain harvested before the rain was generally of good quality with low levels of screenings. Higher than expected yields in some districts – and fewer opportunities for nitrogen application during the dry growing season – resulted in low grain protein in some areas.
- Bean crops in Central Hills, Fleurieu Peninsula and the South East yielded average to above average but most crops in other districts were well below average. The area sown to beans is likely to continue declining in a number of districts.
- Canola yields were variable with Eyre Peninsula, Upper and Mid North and Northern Murray Mallee being below average but average to above average in other districts.
- Oil content was highly variable both within and across districts, ranging from 35 to 48 per cent. Frost damage resulted in green seed levels above receival standards in some crops in the South East, which diminishes oil quality.
- Following the November and December rainfalls there was germination and growth of summer weeds and volunteer crops which required spraying.
- Elevated mouse numbers damaged the 2017 crop causing yield losses in the Lower and Southern Murray Mallee areas where hail storms had destroyed crops in 2016. The fallen grain provided a food source for the mice.
- More ‘pasture topping’ and less elimination of grasses from pastures during spring on Eyre Peninsula has increased the risk of certain cereal root diseases in the new season cereal crops.
- High numbers of Russian wheat aphids in 2017 caused some crop damage on Eyre Peninsula before crops were sprayed for the pest.

Rural Solutions SA for PIRSA
Crop & Pasture Report
January 15, 2018

VICTORIAN MALLEE

The 2017 season was a positive one in the Mallee, even though there was a relatively dry spring there was enough moisture at depth (from 2016) to carry crops through, and yield average to above average in most cases.

An early summer rainfall event warranted spraying and in some instances it was straight off the header and onto the

sprayer. Since then, summer rainfall has been minimal meaning little summer spraying has needed to be carried out.

Mice were problematic in 2016 and with a decent harvest in 2017 there is a threat of an outbreak in the 2018 season. Farmers are encouraged to be diligent and clean up grain, graze stubbles and keep grain storage areas tidy. There's been advice to speak to resellers early to ensure there is sufficient stock of bait, especially during the sowing period.

Summer spraying in the Mallee.

Farmers are soil sampling paddocks to get an understanding of nutrient and soil moisture status. Analyses of these results will be done and will provide growers with their nutrient requirement and support fertiliser budgeting.

Seed cleaning and grading is being carried out and there's a push to do germination tests and calibrate seeding rates based on seed size (when retaining seed).

Pulse prices have reduced considerably in recent months while cereal prices seemed to have climbed, which has made grain marketing and storage challenging.

There has already been some vetch sown in the Mallee, and the intense cropping program is only a few short weeks away – fingers crossed for a decent breaking rainfall event.

Ciara Cullen
BCG Extension Manager, Birchip
March 2, 2018

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)	2018 rainfall to date (mm)	Summer 25yr Annual Average (mm)	Summer 2017–18	Autumn 25yr Annual Average (mm)	Autumn 2018 to date	Winter 25yr Annual Average (mm)	Winter 2017	Spring 25yr Annual Average (mm)	Spring 2017
Emerald Qld	561	249	251	330	105	1	69	16	127	190
Toowoomba Qld	675	234	269	302	138	35	88	64	179	177
Roma Qld	581	217	251	208	116	92	78	40	135	163
Goondiwindi Qld	623	100	254	113	122	38	102	54	145	191
Narrabri NSW	631	96	220	95	118	38	130	73	164	126
Gunnedah NSW	634	68	217	118	108	17	129	74	183	185
Dubbo NSW	604	31	190	85	127	0	133	33	157	124
West Wyalong NSW	454	38	119	156	80	0	124	75	131	66
Wagga Wagga NSW	540	74	133	176	111	0	150	105	140	111
Swan Hill Vic	317	16	71	69	65	0	87	68	95	91
Bendigo Vic	504	23	109	60	106	0	159	124	135	106
Horsham Vic	374	17	79	43	71	0	122	114	104	116
Lake Bolac Vic	515	20	114	66	101	1	153	119	148	179
Murray Bridge SA	364	14	70	64	79	0	121	102	97	75
Kadina SA	336	19	63	60	78	0	112	71	85	60
Cummins SA	388	23	55	49	88	0	170	164	78	75
Esperance WA	614	65	88	75	141	2	248	219	138	128
Wagin WA	397	47	50	62	97	1	163	163	87	79
Northam WA	401	82	47	97	88	0	185	169	80	64
Mingenew WA	347	54	30	57	89	0	170	108	58	44
Moora WA	382	73	43	88	85	1	185	200	69	63
Mullewa WA	321	87	53	88	93	24	130	134	45	34

Last rainfall reading March 8, 2018.

District Reports…

March–April 2018

Northern region

DARLING DOWNS

Sorghum, cotton and corn in the one photo illustrates the cropping diversity on the Darling Downs.

Weather conditions

January's weather was brutal with basically no rain and hot and windy days, with temperatures constantly above 35°C. This had a devastating effect on all crops, dryland and irrigated. February started cooler then we had another two week heatwave, before some decent rain started to fall in the last week of the month.

Summer crop

The early sorghum crops have died rather than ripened, with the result that many crops have been direct headed rather than desiccated. Headers started moving in early on sorghum as crops started to lodge, and 70 per cent of the crop has been harvested.

Yields have been very dependent on stored moisture and where any storms fell, and have ranged from two to six tonnes per hectare for dryland. Irrigated yields have also been reduced by the conditions, yielding seven to eight tonnes per hectare.

A fair amount of the harvest has been sorghum 1 quality, but screenings have been an issue.

Pest pressure was light, although there are plenty of Rutherglen bugs at harvest. The crops remaining are now at risk of mould and sprouting where the rain has been good, especially in the Chinchilla area. On the other side, those crops planted in early January are making good use of the current rain.

Corn grown for grain is yet to be harvested, but the silage crops were 10–20 per cent down on yield as irrigation could not compensate for the conditions this summer. These crops also saw a very quick drydown.

As we saw last summer, the later sown mungbean crops will benefit most from the late February rain, with most crops in the pod fill stage now, but with limited yield potential. However, the few soybean crops planted are improving with the conditions.

Cotton defoliation has started in the dryland crops with below average yields expected, as the heat has scorched and split the bolls. Insect pressure though has been very quiet. The yield potential for the irrigated crops depends very much on water availability, but this late rain will help finish the crop off.

Winter outlook

As always, the rain has not fallen evenly, and whilst the Dalby and Chinchilla areas are looking at some full moisture profiles, the eastern Downs is still looking for rain to firm up winter planting intentions.

With the change in prices this winter, the emphasis will move back to winter cereals at the expense of the chickpea area. One advantage from this should be less disease pressure for the chickpeas.

The first crop into the paddocks will be oats, which are already being planted.

Hugh Reardon-Smith
Agronomist – Landmark, Pittsworth
February 28, 2018

This sunflower crop near Felton made it through a very challenging summer.

ANSWER TO IAN'S MYSTERY TRACTOR QUIZ

The mystery tractor is a 1939 Milwaukee manufacture Allis Chalmers Model B. The cast front axle is different to the fabricated straight axle fitted to the UK versions.

ADVERTISERS' DIRECTORY