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FRONT COVER

With an early start to the winter crop in many regions, there is the opportunity to cash-in on some sheep grazing. But there are rules to follow to avoid harming grain yields. See article P8.



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THE west and southeastern regions of our vast continental grainbelt are away to a flyer. If you're a winter cropper from Gilgandra through to Geraldton, you shouldn't have too many complaints at this stage of the season. A few grizzles about hauling bogged planting gear out of freshly planted paddocks really doesn't cut it.

But not every region is away. Most growers in northern NSW and Queensland are patiently waiting for that break to arrive. With frost damage a constant worry, June is not such a bad time to be planting winter crops in the sub-tropical latitudes – but a bit of rain would be nice ... very nice.

Managing frost in the context of Australian cropping systems is one of the more complex challenges facing us. To add to this, in the past 50 years a changing and slightly warming climate has paradoxically also occurred during a period when, depending on your farming region, the frost season has lengthened by between 10 to 55 days.

Through the National Frost Initiative, our GRDC is supporting research and the development of customised strategies to manage frost. Key to this is gathering knowledge about the region, farm and crop for growers to build their own frost management tool kit (see articles commencing on page 18)

When you've got a spare \$62 billion sitting around

Rumours have been rife but in late May the German-pharmaceutical and agrichemical company Bayer, confirmed an all-cash US\$62 billion bid for American-based Monsanto. Apparently these days, low interest rates make it more attractive to buy something rather than build it – hence this massive bid. There's a long way to go with the negotiations but there are reportedly merger and buyout talks also underway between Dow and DuPont as well as Syngenta and ChemChina.

If these three deals do go ahead, industry analysts reckon that the combined entities would have over 75 per cent of the global market. Watch this space but it's hard to see how this consolidation down to three huge companies – when once there were 12 of them – is going to increase competition and reduce farm input costs.

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In this issue...

Season away early? A good opportunity for crop grazing

There is an ideal opportunity this year for grain growers to successfully graze early sown grain crops with sheep, according to a WA-based farm consultant. ConsultAg's Steve Curtin has in the past helped coordinate crop grazing trials.



See article Page 8

How big is BIG?

Here on the Mid North Coast of NSW, tractors range from light to medium seldom exceeding 100 hp. When neighbours returned from a trip 'Out West', they were astonished by the dimensions of the broadacre tractors working on Western properties. But if you think these are big, have you heard of the McDonald Castles?



See article Page 14

Building a customised frost management tool kit

Knowledge is power. It's a catch phrase that has been used for centuries but when it comes to making complex cropping decisions the more knowledge you have the better informed your decision. How to manage frost in a cropping system is one example of a complex decision to be made by many grain growers in regions across Australia.



See article Page 18

Why consider sowing east-west?

In winter, when the sun is travelling at a lower angle the additional shading of the inter-row that occurs when crops are sown in rows running east-west can help suppress weeds growing in-crop. This effect is most noticeable in southern latitudes.



See article Page 23

Scouting the Hermit Kingdom

At *Greenmount Travel*, we often come up with ideas of new places to visit and adventurous farming areas around the world. But all the reading and Googling doesn't answer all of the questions. So, in late February, I bravely set out to do some 'ground truthing' for our tours to North Korea and the Silk Road.



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Graze and retain stubble for profit

GRAINS Research and Development Corporation (GRDC) trials are answering growers' questions about stubble management in no-till and zero-till controlled traffic farming systems.

Part of the GRDC flagship stubble initiative – Maintaining Profitable Farming Systems with Retained Stubble – the past six years of trials conducted by FarmLink Research and CSIRO at Temora in southern NSW, have shown that grazing and retaining stubble (not burning) is the most profitable treatment, conserving water, speeding up nitrogen (N) cycling and reducing N tie-up by the stubble.

Outgoing research lead and La Trobe University lecturer Dr James Hunt says when the amount of N available is dictating the yield they've seen a positive change in yield and quality by manipulating the N available.

"The reason we did this trial was because farmers were wondering if the full potential of no-till and controlled traffic could be realised if sheep are grazed on cropping country," James said.

"Sheep remove residue cover and trample soils, but there was little contemporary research to show what affect that might have on crop yields.

"By averaging results across the six years that the trial has run, we see that the grazing and then retaining without burning stubble treatment had the highest gross income.

"Even if no value is placed on grazed stubble, the stubble-graze stubble – retain treatment still grossed \$45 per hectare per year more than the nil graze stubble retain treatment. Assuming



Outgoing research lead and La Trobe University lecturer Dr James Hunt says grazing stubble can be of big benefit to growers.

grazed stubble is valued as a feed source, this economic advantage can be raised to \$178 per hectare."

Consistently higher yields

Since 2013 the trials show that the graze and retain treatment consistently delivered higher yields, whereas burning was only of benefit due to frosts in 2013 and the wet growing season of 2015.

"Burning stubble decreased the amount of water stored over the summer fallow that was used by crops by 8–21 mm, but this didn't always decrease yield due to frost damage, N limitation or adequate subsequent recharge," James said.

"There are several benefits to mixed farming systems, including diversification, offsetting production and price risk and increasing resilience.

"Nitrogen fertiliser inputs may be able to be reduced and grain yields increased if measures are taken to ensure that stubbles are grazed thoroughly and evenly down to threshold levels.

"Our research shows that a well-managed livestock enterprise can complement conservation farming practices such as no-till seeding with stubble retention and controlled traffic to increase crop yields and water-use efficiency."

Rules to follow

James says while the results show mixed farmers can safely continue grazing stubbles under these practices, there are some basic rules that should be followed in order to avoid yield penalties.

"This includes controlling all summer weeds promptly with herbicides prior to grazing as weed control by livestock is unreliable, and not grazing below 70 per cent ground cover to prevent water run-off and soil erosion," he said.

"About 70 per cent cover is equivalent to two to three tonnes per hectare of cereal stubble cover, and to estimate initial stubble load, for every one tonne per hectare of grain yield about 1.5 tonnes per hectare of cereal stubble will be left as residue.

"Ultimately the message is that grazing stubble after harvest will have benefits which far outweigh any negative effects in a well-managed mixed farming enterprise."

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Season away early? A good opportunity for crop grazing

THERE is an ideal opportunity this year for grain growers to successfully graze early sown grain crops with sheep, according to a Western Australian-based farm consultant. ConsultAg's Steve Curtin has in the past helped coordinate crop grazing trials instigated by the Grains Research and Development Corporation (GRDC) Regional Cropping Solutions Network (RCSN) initiative.

He said many long-season crop varieties had been sown early this year in WA, were growing well and were good candidates for crop grazing.

"The early season will allow for good recovery from grazing, resulting in minimal yield loss," Steve said.

"The window of opportunity for grazing canola crops in WA this year has already passed for most growers but there will be many cereal crops at or approaching the right stage of development.

"Grazing crops will allow growers to give pastures a spell and enable them to control grass and broadleaf weeds, without compromising sheep feed.

"It will also delay crop flowering, reducing frost risks associated with early sowing.

"WA trials in recent years have shown that if crop grazing is carried out within recommended guidelines, the maximum yield penalty incurred is eight per cent, although any yield loss is usually negligible."

Don't be too late or too long

Steve said his main message to growers was not to put sheep on crops too late, not to leave them there too long, and to only graze long-season varieties.

"The key to success is early crops, early grazing and sheep early out," he said.

"Local trial results show that cereals should be grazed at the three to four-leaf stage (GS13-14 or earlier) and are best grazed hard and only for a short period of time – up to two weeks."

Steve said a Kwinana East RCSN-supported trial at Merredin in 2015 confirmed a rule-of-thumb from his previous research that for every one day of grazing, the flowering window was pushed back by half a day.

In his previous research, all plots were frosted several times in spring and plots which were grazed produced higher yields than those which were ungrazed.

"This ranged from \$46 to \$92 per hectare in additional yield, not including the value of the grazed crop for sheep feed," he said.

Steve said that if growers had seeded wheat early, they could predict the flowering date for the variety using the online diagnostic tool Flower Power, available on the DAFWA website at <https://www.agric.wa.gov.au/frost/flower-power>.

"If the flowering date is predicted to fall in the main frost window, growers may opt to graze the crop to push the flowering date backward," he said.

More information about crop grazing is available in the GRDC Wheat and Canola GrowNotes at www.grdc.com.au/GrowNotes or in the GRDC Hot Topic Grazing dual purpose crops in Western Australia at www.grdc.com.au/GrazingDualPurposeCropsWA.

Contact Steve Curtin, ConsultAg, 08 9865 1616, sc@consultag.com.au



To retain crop yield potential, don't put the sheep on too late or for too long.

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Analysing pasture biomass and helping the following crop

AT A GLANCE...

Muchas Gracias is a small group of mixed farmers in the medium rainfall zone in Western Australia's wheatbelt. Together with Grain & Graze 3 and WA's statutory authority responsible for property and land information, Landgate, they have been conducting an analysis of biomass data to determine where 2016 sits in comparison to previous seasons.

Their analysis currently shows that 2016 is sitting in a 'similar space' as 2005, which was a great year for pasture growth.

But it is still early days and as everyone knows in farming, there's never any guarantees!



Once the seasonal potential is determined, the stocking rate can be adjusted if required.

actually nodulating, this is taken for granted, when in fact simple testing is now available (from Murdoch Uni) to test the strain and effectiveness of the clover nodules. This ultimately determines how much organic nitrogen will be produced by the pasture this season for use by next season's crop or pasture.

The reality is that the reduction in pasture density for the mixed farming enterprise with a reasonable stocking rate (maybe even higher due to the early break and extra paddock(s) of late sown crop!) can lead to a mid winter feed gap when clover growth naturally slows significantly.

Muchas Gracias adviser Paul Omodei from Planfarm says: "The decision to reduce pasture density is one that needs to be based on sound reasoning and done with a projected green feed budget that takes into context the farm system as a whole. Manipulating pastures of fast growing grasses now could result in a significant deficit in feed when the stocking pressure is at its greatest during lambing."

Instead of pasture manipulation, application of early nitrogen on paddocks coming out of crop (generally with good ryegrass and low nitrogen) will respond while the weather is warm. Then deferring while crops go in, can see the feed situation in mid winter reversed.

This strategy can grow more

AN early break creates the potential for a great pasture biomass year by maximising the leaf area which assists Pasture Growth Rates (PGRs) while the weather is still warm and before day length shortens. An early break can also create complacency that will see this opportunity missed.

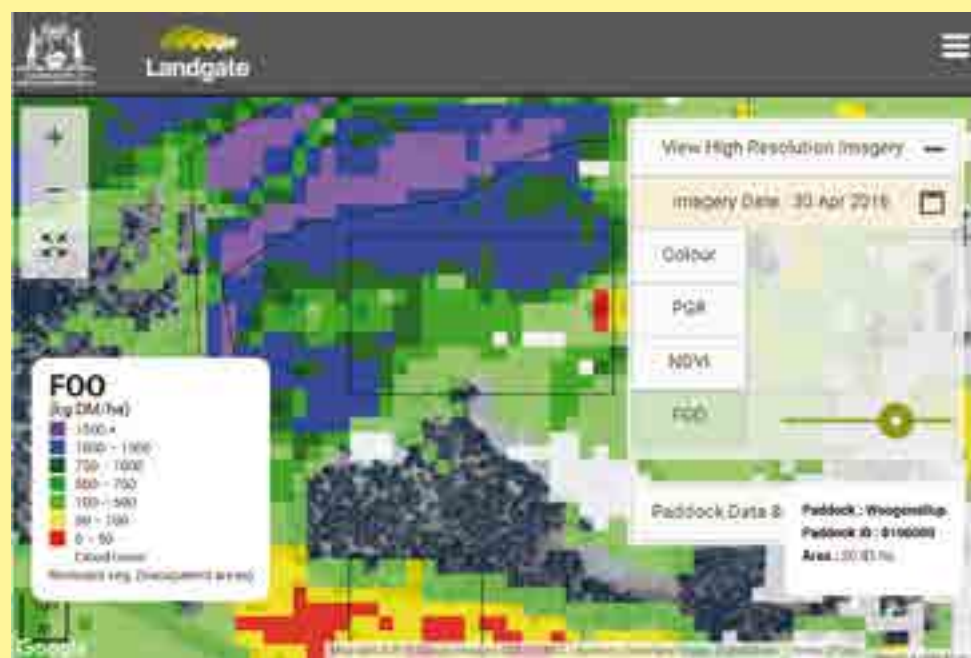
In this complacent mindset, spraying out all the faster growing feed and weeds to leave pure clover – that looks great for a week in September – becomes appealing.

While this also has an end goal in mind (eg weaning paddocks and reducing root disease carry over for next year's grain crop), little or no focus is put on what the next six to eight weeks of paddock feed will look like.

How much nitrogen for the next crop?

In most cases we also don't know whether or not the clover is

FIGURE 1: Landgate's *Pasture from Space* software plus high resolution imagery allows targeted nitrogen applications to the most responsive areas of pastures



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feed in pasture paddocks in one day than deferring pastures by grazing crops in mid winter for 10 days when feed is tight.

Pastures this year in WA may be low in nitrogen after repeated summer rains that will have first mineralised it, then leached it past the root zone.

"Without careful management the potentially great feed year can become just an average season with average results from the livestock enterprise," says Paul.

By using Landgate's *Pasture plus* software – <https://pfs.landgate.wa.gov.au/> – each farming system can view production over the past 10 years and select similar (or analogue) years to estimate seasonal potential for Total Pasture Production.

On-farm testing

Dr Norm Santich from Landgate and farmer Brad Wooldridge have tested this method since 2006 and it has proved invaluable

in matching stocking rate to predicted feed supply.

The prediction is based on a sound knowledge of the software and of the management required to meet the target pasture production.

This potential will vary widely from one farm management system to another and from one season to the next.

The low hanging fruit

Remote system analysis by Paul Omodei, Brad Wooldridge and Norm Santich showed management can double total pasture production in tonnes per hectare year on year. This is predominantly driven by matching the feed requirements of the livestock to the pasture production curve of the farm – or more commonly referred to as 'taking advantage of the low hanging fruit in a livestock enterprise'.

Figure 2 shows data for a representative deferred pasture paddock on the Wooldridge's farm. The 2016 season started very similar to 2005, but is slowing to be more similar to 2008 with a final Total Dry Matter (TDM) of 9 tonnes per hectare. The red line is the 10-year season average TDM for this paddock.

It must be stressed that individual farm production will vary greatly depending on management and location and could be half this figure.

So the updated *Pastures from Space Plus* tool powered by Landgate is a very valuable tool that producers can use to help plan ahead for livestock/cropping enterprises, particularly by being able to match the current season against similar years.

The poor finish to 2015 and summer storms have in some cases reduced pasture density and the recent cooler weather has meant slower growth rates than in 2005. The 2005 year also had had a reasonable 'seed set' season preceding it in 2004 to set up pasture density.

Once the seasonal potential is determined, the stocking rate can be adjusted if required and the season monitored as it unfolds. ■

FIGURE 2: Landgate's *Pasture from Space plus* seasonal Total Dry Matter comparison graph tool – Wooldridge farm

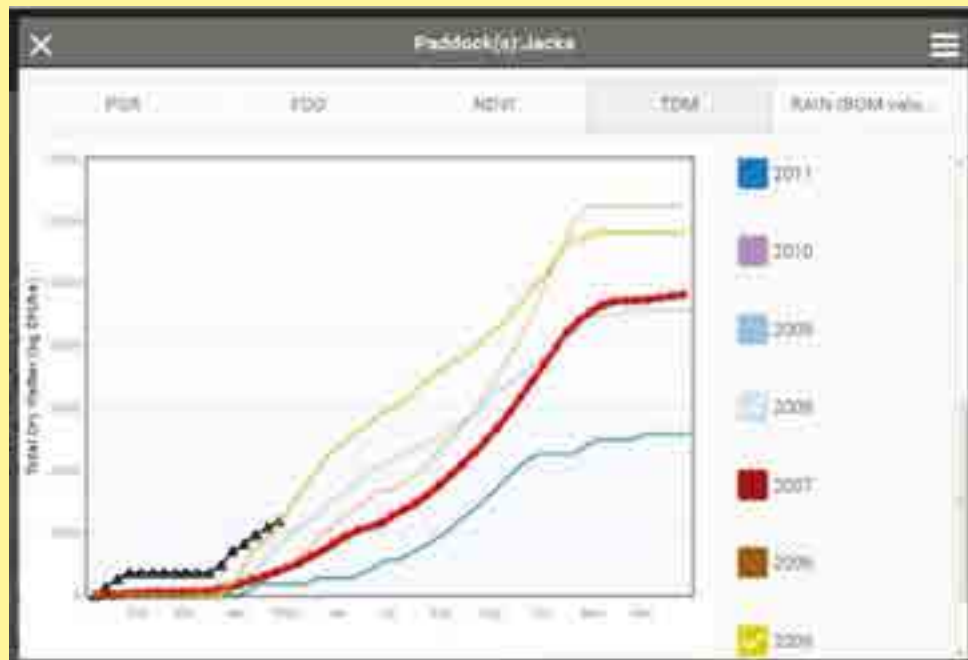
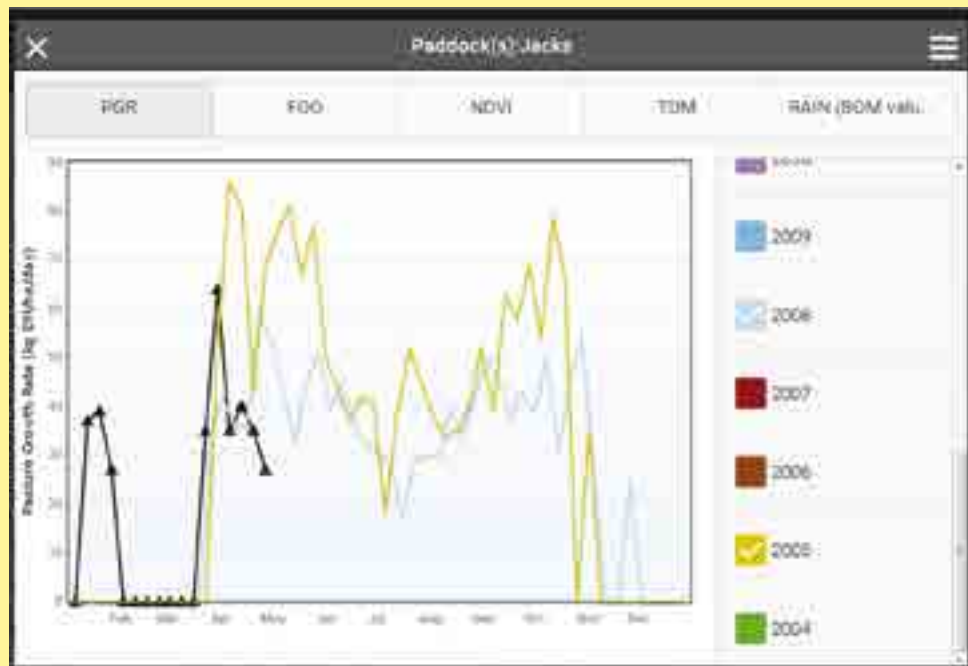


FIGURE 3: Landgate's *Pasture from Space plus* seasonal PGR comparison graph looking at PGRs in similar seasons of 2005 and 2008. Note that many seasons hit 0–10 PGRs in mid winter, but the season is off to a good start in this paddock.



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How big is BIG?

■ By Ian M. Johnston

Here on the temperate Mid North Coast of NSW, tractors largely range from light to medium weight machines. They seldom exceed around 100 horse power.

Accordingly, when my coastal farming neighbours return from a trip 'Out West', it is obvious from their comments, they have been astonished by the dimensions and power of the broadacre tractors they have observed working on western agricultural properties. Certainly, one cannot fail to be impressed by the design and size of tractors such as the current range of Versatile 620 Quadtrac, Claas Xerion 5000, New Holland T7, John Deere 9R, etc.

But if you think these are big, have you heard of the McDonald Castles?

McDonald – the early days

Alfred Henry McDonald was only 20 years of age when he established the firm of A. H. McDonald & Co. in rented premises located in Flinders Street, Melbourne. The year was 1903.

Remarkably – as this was a time when there was little knowledge of internal combustion engines and even less of electricity generation – together with his younger brother Ernest, this 20 year old designed and built a range of generators powered by McDonald petrol engines.

The integrity of design of the products resulted in volume sales. Indeed within 12 months McDonald was obliged to re-locate to larger workshop facilities at Hawthorn. By 1908, with the sales of petrol powered generators becoming self-generating (if you follow me) the young entrepreneur was able to focus his design skills towards another area of expanding opportunities – agricultural tractors!

This proved to be the first step to his firm becoming one of Australia's most prestigious indigenous tractor manufacturers.

The first of the McDonald tractors – the Model EA – was introduced to Australian farmers in late 1908 and exhibited at The Royal Melbourne Show the following year. Comparable to the majority of early tractors emanating from North America and Europe, it was large and heavy, yet by today's standards,

grossly under powered. Its cross-mount kerosene fuelled two cylinder power plant was capable of developing a mere 20 hp. But this rating was typical of the few tractors being imported into Australia, and indeed adequate for the job of pulling the only available implements, which were originally designed specifically for horse teams.

In 1910 the company yet again required larger premises and this time re-located to a large industrial block at Richmond, where an extensive manufacturing complex was built, including a modern foundry.

Wesley Castles

Later that year McDonald was approached by a visionary inventor named Wesley Castles, with a view to constructing a massive leviathan tractor, custom built to excavate irrigation channels.

Its design incorporated a patented excavating plough attached adjacent to each of the two 3.35 metre diameter driving wheels. As the machine slowly progressed along its course, the ploughs scooped out the water channels and turned the excavated soil into the inside of the wheel rims, to which a system of buckets had been fitted. As the wheels rotated, the soil was carried aloft by the buckets and then finally tipped into an endless belt conveyor. This transported the material some feet from the tractor, where it was discharged to form the bank for the channel being excavated.

The simplistic concept was brilliant, considering the normal practice was to dig the channels by manual labour utilising picks, shovels, draft horses and drays. But it was a challenge for McDonald to construct the monster and also to design and build an engine capable of providing the necessary power.

The machine took over a year to build. Its dimensions were gargantuan! A comparison with modern high horse power tractors would be likening a Clydesdale to a Shetland pony – the McDonald being the Clydesdale.

A one-off engine was created for the big machine. Weighing in at around three tons, it featured four water cooled cylinders



A historic print, taken from a glass negative, of a 1908 McDonald 20 hp EA Imperial, delivered in 1908 to J.H. Dardel of Batesford, Victoria. (IMJ archives)



A rare remaining photo of the McDonald Castles giant tractor taken in 1911. (Photo courtesy Neil McDonald son of A. H. McDonald and W.W.2 RAAF fighter ace. IMJ archives)

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John Kirkpatrick carried out this superb restoration of this 1912 McDonald EB Imperial. (IMJ archives)

and developed 120 hp – an amazing capability, at a time when 20 hp was considered powerful.

Without the benefit of power assistance, steering the rig must have required the muscles of an Irish navy, despite being geared down and taking many turns of the steering wheel to alter course.

A few of the dimensions follow and are worthy of contemplation.

- Length: 31 feet (9.45 metres)
- Width: 16 feet (4.88 metres)
- Height: 16 feet (4.88 metres)
- Rear wheel diameter: 11 feet (3.35 metres)
- Front wheel diameter: 6.5 feet (1.98 metres)
- Weight: 20 tons (20 tonnes)

Disaster!

Upon completion, it was decreed by the state government it should be tested at the government Werribee Research farm. But there was a problem. The dimensions of the tractor were such that there was no exit doorway large enough for it to pass through! Only one thing for it – knock down the end wall of the building!

It was imperative that the route to Werribee be carefully planned and surveyed. The majority of bridges were not designed to stand the weight of a 20 ton vehicle, or were of sufficient height under which the 16 feet tall contraption could pass. For after all, in 1912 the traffic consisted almost entirely of horse traffic. So a circuitous course was mapped out. But – hills could not be avoided!

While descending a steep grade in the suburb of Clifton Hill, the operator eased back on the throttle, but was immediately alarmed when there was no response from the big engine. It continued its progress on full power! The speed increased at a terrifying rate. Newton's theory of gravitational pull applied. The Sound Barrier had not been discovered, but it may well have been experienced that day had not a deep drain, two paling fences and a brick wall interrupted the bolting runaway and brought it to an abrupt stoppage, literally centimetres from a cottage belonging to a petrified Mrs Ruffin.

The precise details of the horrifying incident were graphically reported in *The Leader* newspaper. Apparently an errant throttle linkage was responsible for the trauma.

Little more is known of Australia's largest tractor, despite research and perusal of official records. But it does appear that



A 1916 McDonald EAA operating a Massey Harris header. (Photo courtesy Neil McDonald. IMJ archives)

the unit eventually arrived at a South Australian overland railway work site, somewhere west of Port Augusta. It makes interesting pondering to imagine how it would have achieved the 1600 kilometres from Melbourne.

Perhaps the Alfred Henry McDonald and Wesley Castle creation now lies abandoned near the railway line it undoubtedly helped construct, somewhere deep in the Nullarbor, where likely a century of sighing wind would have gently entombed it in the desert sand. ■

IAN'S CLASSIC TRACTOR QUIZ

Time to exercise the little grey cells again. I realise that a few young(ish) farmers may have difficulties with some of the questions. So if you don't know an answer – just ask your Grandpa!

A score of 8 or above would be considered excellent and reveal an indepth knowledge of classic tractors. Five or over is still a good result. Good luck and have fun – *Ian M Johnston*.

1. The first Massey Harris to be powered by a 4 cyl. Perkins diesel was the model — **Pacemaker, 744D or 745D?**
2. The HOV was a model of a 1950s — **Nuffield, Ferguson or Lanz?**
3. The 1938 McDonald Imperial engine had — **1, 2 or 4 cylinders?**
4. The Hanomag Schneeschleuder was a — **beach cleaner, front end loader or snow plough?**
5. Name the Swedish tractor imported into Australia in the 1930s which featured a vertical 2 cylinder 2 stroke crude oil engine — **Volvo, Saab or Munktells?**
6. The tractor model with the longest production run (30 years) was — **John Deere D, Fordson Major or International W6?**
7. Which of these 3 wheeled tractors was all-wheel drive — **Glasgow, Ivel or Wallis Bear?**
8. Harry Ferguson was a — **Yorkshireman, Cornishman or Ulsterman?**
9. The colour of the David Brown 30D was — **Flambeau Red, Burnt Orange or Hunting Pink?**
10. The Steiger Bearcat Diesel, which appeared in the early 1970s, was powered by which make of engine — **Cummins, Caterpillar or Perkins?**

See answers on page 56.



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Building a customised frost management tool kit

■ By Nik Callow (UWA), Ken Flower (UWA), Bonny Stutsel (UWA) and Mick Faulkner (Agrilink)

KNOWLEDGE is power. It's a catch phrase that has been used for centuries but when it comes to making complex cropping decisions the more knowledge you have the better informed your decision.

How to manage frost in a cropping system is one example of a complex decision to be made by many grain growers in regions across Australia. To add to the challenge, in the past 50 years the changing climate, although becoming warmer, paradoxically has also seen the frost season lengthen by between 10 to 55 days depending on the region.

What causes frosts?

In the Australian grains belt, frosts occur when nights are clear and calm and follow cold days. In elevated regions, frosts are often experienced after mild or even warm conditions. These conditions occur most often during winter and spring with the passage of high pressure systems following a cold front. The clear calm conditions encourage loss of heat from the earth and the crop itself, during the night, decreasing the temperature at ground level and within the crop canopy to below zero.

The extent of frost damage is determined by how quickly the temperature takes to get to zero, the length of time it stays below zero and how far below zero it gets.

Often frost will be more damaging when there is little soil moisture, as soil moisture adds to the heat storage capacity of the soil. Wind and cloud reduce the likelihood of frost by decreasing the loss of heat to the atmosphere and turbulent mixing of air to stop a cold inversion forming that causes a radiative frost event.

Cereal crops are most susceptible to frost damage during and after flowering but the window of susceptibility can extend from stem elongation to the grain fill period (see Figure 1). Frost damage may be sporadic across a crop within a paddock. Not all plants may show obvious symptoms and symptoms may not be evident until five to seven days after the frost event.

Damage to a crop can be in the form of aborted grain when

frost occurs during flowering through to light shrivelled grain at the later grain filling period. Yield losses with severe frosts at flowering can be quite devastating.

National Frost Initiative

The Grains Research and Development Corporation has long acknowledged the complex constraint that frost exerts on Australian cropping systems and in 2014 renewed its approach to managing this constraint through the formation of the multidisciplinary National Frost Initiative (NFI). The initiative integrates genetic, management and environmental approaches to frost management to develop solutions to managing frost.

The variability in the incidence and severity of frost means that growers need to adopt a number of strategies as part of their broader farm management plan, encompassing pre-season, in-season and post-frost strategies. Earlier this year the NFI released a Frost Management Tips and Tactics which presents a framework to develop customised strategies to manage frost. Integral to these strategies is the requirement to gather knowledge about the region, farm and crop for growers to build their own customised frost management tool kit.

Two key aspects in devising a customised plan are:

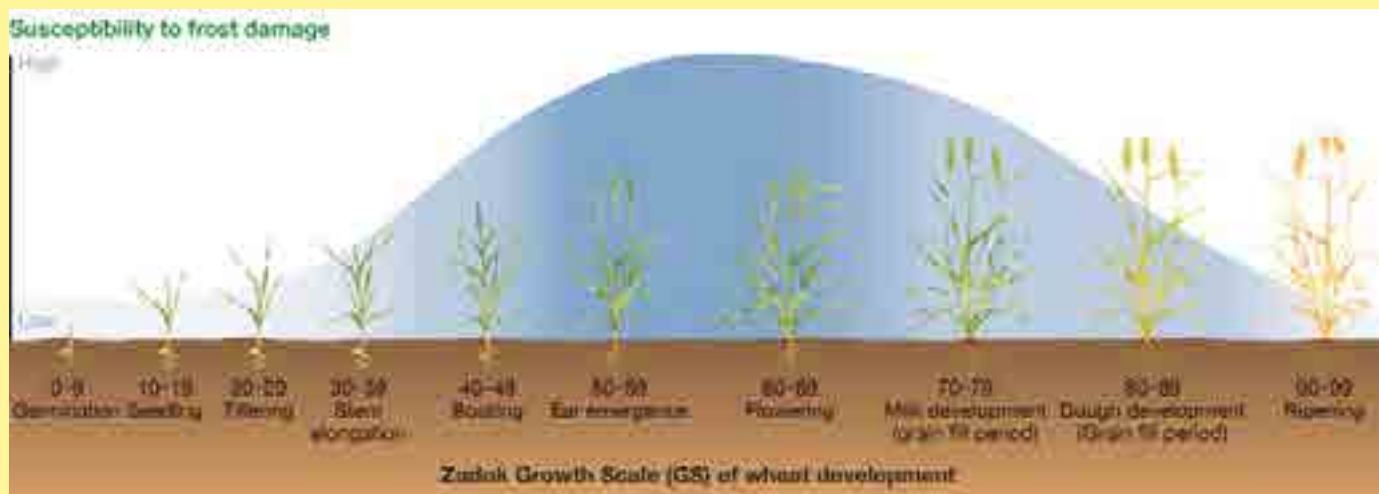
- Knowing the incidence of frost in the region; and if a frost occurs,
- Knowing the extent of the damage to make a timely and informed decision as to how to manage the crop.

Knowledge of the region

As part of a frost management plan, growers are encouraged to consider the risk of their property incurring frosts due to the geographic location and using historic seasonal records and forecasts. Spatial variability across the landscape should also be considered as cold air will flow into any lower regions.

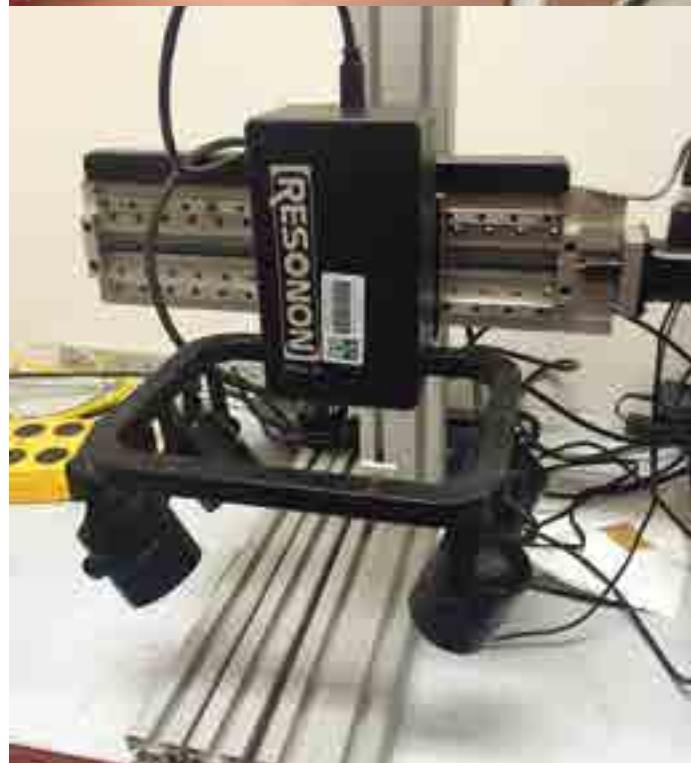
Temperature monitoring equipment, such as Tinytags, iButtons and weather stations are currently commercially available for

FIGURE 1: Susceptibility of wheat to frost damage during the various growth stages



on-farm determination of temperature variability at points across a landscape (see chart page 20). But fully understanding the impact of a frost event in a region can be more complex than this equipment allows growers to measure.

New research is underway within the NFI, with a team based at the University of Western Australia (UWA) who aim to provide a better understanding of the frost events and assessing damage



These photos are of the same camera in two different modes – one for imaging the top of the frosted plant (top) and the other is for imaging parts that have been removed from a frosted plant, for example, leaves or the peduncle. The Pika III is a line-scan hyperspectral imager, capable of imaging across 240 channels with a spectral range of 400–900 nm, and spectral resolution of 2.1 nm.

post-event. While traditionally people have relied on regional weather stations or weather stations close to the farmhouse or workshops, there is a growing recognition of the benefits in monitoring temperature within a paddock for frost-prone areas.

Where to measure temperature?

But the key question here for growers is:

Where should I measure temperature within the crop?

Based on work in the 1970s and from other paddock monitoring data, we know that the temperature can vary by as much as 2°C or more between the soil and the plant canopy. The temperature gradient increases from the soil which releases stored heat at night and is lowest at or around the flagleaf. The temperature then generally increases into the lower atmosphere during a radiative frost event where the cold air settles at the surface and around the plant canopy.

A critical question the team is working on is to better understand the vertical temperature profile, and how this changes as the plants mature and the canopy develops.

This is all about trying to understand where to monitor temperatures that will give growers data that reflects the temperature that critical parts of plants have been exposed to and the likely damage profile. Unfortunately, it is not just as simple as putting out a temperature logger and downloading the data when a likely frost event has occurred.

Because of the potential for the canopy to trap heat released by the soil, monitoring temperatures well below the canopy or close to the soil may give temperature readings that are warmer than what the plant's reproductive organs are exposed to during a frost event. This in turn may underestimate the actual damage to a crop, particularly during marginal frost events.



**Is resistance driving
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Using new technology

The UWA team will be utilising an emerging technology of fibre optic cable to conduct distributed temperature sensing (DTS). By measuring the travel of light and the way the incident light is scattered along the fibre optic cable, temperature can be measured at many positions along the cable. The fibre optic cable will be strung throughout the paddock, covering several plot trials and vertically from the soil to above the canopy.

The advantage of this technique is that it allows spatially-continuous temperature data to be collected, rather than relying on a limited number of point based measurements.

The DTS unit can resolve temperature to an accuracy of 0.01°C, every 25 cm of cable for up to 10 km of cable. The team will also use vertical spirals of cable through plot trials that will allow profiling of the temperature gradient every 2.5 cm.

Whilst this technology is too cumbersome and costly to use in normal farming systems, this work will answer some of these critical questions and allow us to make better recommendations on the deployment and placement of loggers for on-farm determination of temperature and likely frost damage.

This work will be ongoing through the 2016 and 2017 growing season and we will be reporting back on the results.

Our best current recommendation is to use a limited number of relatively accurate temperature sensors like the Tinytags (see Temperature Sensor Chart). Ideally, the logger would be moved through the growing season to be just above the canopy

height, particularly when the head is emerging (booting to milk development or GS40 – 80). As this is the most sensitive growth stage for the plant, accurately measuring temperature experienced by the head is critical. Loggers should be moved every few weeks to maintain their height at just above the canopy.

Where possible, monitoring should be done in a few locations that take into account factors that affect frost in that paddock or on that property.

These factors include landscape gradient (monitor on the flat, break of slope and a short distance up a slope in areas affected by cold-air drainage) and different soil types (particularly from darker loamy soils to lighter sandy soils).

While this is the most accurate method to collect data on the temperature that the plant has been exposed to – and subsequent likelihood for frost damage – data from sites further away such as fence lines or other weather stations may be still useful. But this may require experience to adjust the temperatures from what the logger measures to what the plants at various locations on the property are likely to have experienced.

What damage has a frost done?

Once a frost has occurred the first step is to determine the extent and severity of damage. Currently the methods available are quite labour intensive as monitoring needs to occur for up to two weeks after the event and needs to be done by hand by way of randomly sampling heads.

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Disadvantages

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Removed from location by animals
Short life span
Requires download in paddock

For more information visit: <http://www.maximintegrated.com/products/ibutton/>



Tinytags

Advantages

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Easy to operate
Easy to download data
Accuracy of +/- 0.01°C
Robust and long lasting

Disadvantages

Requires download in paddock
Battery replacement yearly
Requires approx. \$200 worth of software and cables to run

For more information visit: <http://www.geminidataloggers.com/data-loggers/tinytag-plus-2/tgp-4017>



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Disadvantages

Expensive (~\$2000)
Extensive time associated with setting up

For more information visit: <http://mea.com.au/soil-plants-climate/weather/weather-stations>



Nurturing Mace wheat seedlings to be artificially frosted, project members Dr Bryan Boruff and Mary Murphy, UWA.

The UWA group and partner researchers in this NFI project – Agrilink Agricultural Consultants (SA) and the Department of Economic Development, Jobs, Transport and Resources (Vic) – are also working on post-event detection methods. This includes evaluating the use of spectral and thermal cameras.

- Spectral cameras measure the wavelength of light reflected from plants, and is the basis of indices like Normalized Difference Vegetation Index (NDVI), which compare light in the red and near-infrared and indicates the growth vigour of a plant. By collecting detailed spectral data the researchers are hoping to understand whether there are parts of the light spectrum that can be analysed to give a specific indication of post-event frost detection. By using data from the non-visible spectrum it may allow frost damage to be assessed using specific frost indices well before the visual signs of damage appear from in-field assessment. Spectral data can be collected from handheld sensors or rapidly mapped across paddocks using Unmanned Aerial Vehicles (UAVs or 'drones') and satellites. The research teams will also evaluate these assessment options.
- Thermal cameras can measure plant stress and potentially frost damage after events. Because the ability of a plant to regulate temperature can be impacted by frost damage, taking thermal images of crops from handheld and UAV thermal sensors may provide an alternative – or a complementary approach – to spectral sensing for assessing and mapping post-frost damage extent.

The project is working through the NFI to communicate the results of this research over the next few years to growers, extension specialists and the spatial sciences and UAV industries.

A major focus is to provide improved understanding on methods to monitor frost events and map post-event frost damage to specifically enable growers to customise their own frost management tool kit.

Further information:


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On the National Frost Initiative Juan Juttner GRDC Ph: 02 6166 4500

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The Frost Management Tips and Tactics is available from www.grdc.com.au/ManagingFrostRisk






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Grains industry welcomes frost susceptibility rankings

AUSTRALIAN grain growers are now able to factor frost susceptibility of wheat and barley varieties into their cropping programs. Through the Grains Research and Development Corporation (GRDC) National Frost Initiative, most commercial wheat and barley varieties have been ranked for their relative susceptibility to spring radiation or reproductive frost, which occurs in late winter to early spring.

The rankings for frost susceptibility are being made available to growers and their advisers through the use of an interactive tool on the National Variety Trials (NVT) website at www.nvtonline.com.au.

With frost costing the Australian grains industry about \$400 million annually in direct and indirect yield losses, particularly in the southern and western cropping regions, development of the rankings has been welcomed by growers and the broader industry.

Details about the new rankings have been delivered to growers and their advisers at recent GRDC Grains Research Updates.

Speaking at the Updates, Dr Tim March from the University of Adelaide said benchmarking current wheat and barley varieties for sterility at flowering under frost conditions in trials over recent years had enabled researchers to develop a ranking system in which varieties can be compared for their susceptibility to frost during the reproductive phase of development.

Tim said the three years of data from the trials at GRDC-

funded frost screening nurseries in Loxton (SA), Wickpin (Western Australia) and Narrabri (NSW) had shown that overall, barley was more tolerant to frost than wheat and that variation in susceptibility levels did exist between varieties under mild frost events.

Ranking based on sterility impact, not yield loss

"It is important to note that no varieties are completely frost tolerant," he said.

Tim said the new rankings were based on sterility measurements and not yield loss.

"So until we can get that data you should first select varieties for local adaptation, yield, optimal flowering time and other key target traits and criteria important for your farming system, and then use the frost rankings to fine-tune your risk management of the selected varieties.

"In some cases, it may be that the more frost susceptible varieties are your best option. You don't want to be on the back foot with yield before you get hit by frost."

Tim pointed out that the data used to determine the rankings was based on each variety's relative susceptibility to reproductive frost at flowering, and not stem frost which occurs early in the growing season.

Assessment of the frost susceptibility of 72 wheat and 48 barley varieties has been carried out under the collaborative Australian National Frost Program (ANFP) which is a key component of the GRDC's National Frost Initiative – an integrated program addressing genetic, management and environmental approaches to mitigate the effects of frost.

Tim said breeding new cereal varieties with improved frost tolerance will be one of the solutions to minimising the economic losses resulting from frost, and ongoing research was focused on this goal.

"The GRDC's investment in the ANFP is an example of a significant pre-breeding project which is developing industry capacity and methodologies that will enable not only the independent screening of newly-developed cultivars from commercial breeding companies, but also introduced germplasm to identify increased levels of frost tolerance for Australian growers," Tim said.

Tim said it was important to combine genetic, management and environment strategies to overall reduce risk to frost.

"As frost exerts a complex production constraint in cropping systems, it requires a package of risk management strategies."

To support growers and their advisers in their frost risk management efforts, the GRDC has released a *Managing frost risk – tips and tactics* publication which is now available via www.grdc.com.au/ManagingFrostRisk.

The publication offers advice on pre-season management tactics, management tactics within season, post-frost event management tactics, harvesting and marketing frosted grain, retaining seed from frosted crops and recovering from frost. It also provides links to other useful resources.

More information on GRDC's National Frost Initiative and the new frost susceptibility rankings can be found via Ground Cover TV www.grdc.com.au/GCTV15-FrostRatings, the Ground Cover Frost Supplement www.grdc.com.au/GCS109, at www.grdc.com.au/GRDC-Video-NationalFrostInitiativePlaylist and the NVT website www.nvtonline.com.au.



Dr Tim March (left) from the University of Adelaide and Dr Ben Biddulph from the Department of Agriculture and Food, Western Australia (DAFWA), pictured at the GRDC-funded frost screening nursery in Loxton (SA).

Why consider sowing east-west?

In winter, when the sun is travelling at a lower angle the additional shading of the inter-row that occurs when crops are sown in rows running east-west can help suppress weeds growing in-crop. This effect is most noticeable in southern latitudes.

In Western Australia, Department of Agriculture and Food researcher Dr Catherine Borger demonstrated in six trials that east-west sowing can halve annual ryegrass weed seed set, even though weed biomass may not be reduced. This is a rare opportunity for free weed control that could be worth implementing in suitable paddocks.

Similar experiments conducted in barley crops at Bithramere near Tamworth, NSW achieved a 39 per cent weed biomass reduction when crop rows ran east-west compared to north-south. At Trangie the barley varieties Hindmarsh and Granger had higher yield and were more competitive against weeds when sown east-west. In these trials weed biomass was measured rather than weed seed production, but both are good indicators of the weed response to the treatments.

Row orientation suppresses weeds

NSW DPI research and development agronomist, Greg Brooke says that in many cases there are other, more practical, ways to suppress weeds but that row orientation is well worth considering and implementing if it can be easily done.

"The more non-herbicide tactics a grower can use to support their herbicide program the better," he says. "Crop yield is not compromised under east-west sowing."

Researchers in NSW also noticed a stark difference in the growth of the weed fumitory, with the weed being prolific in the north-south rows and absent in the east-west rows.



Weeds researcher Dr Catherine Borger measured the difference in light penetration between the rows and weed growth when the crop was sown east-west compared to north-south. (PHOTO: DAFWA)

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Growing crops in rows at right-angles to the sun decreases the amount of solar radiation that the weed plants can intercept and use for photosynthesis. This translates into lower biomass production and potentially decreased seed production.

A weed seedling can impact crop yield potential well before the weeds are large enough to take moisture, light and nutrients away from the crop.

Canadian researchers Dr Clarence Swanton and Dr Jessica Gal observed this effect in both corn and soybean. The weeds emerging alongside or soon after the crop seedlings reduced the crop yield potential, with the effect occurring at the seedling stage, long before the weeds could be competing directly for resources such as moisture, nutrients and light.

The differences in light wavelengths bouncing off bare soil compared to growing weeds triggers a reaction in the crop plants to put a disproportionate amount of resources into growing taller, with more leaf area – resulting in a comparatively smaller root system.

This response can pre-condition the crop to a lower yield, particularly in years where the crop may encounter moisture stress and have limited ability to seek deeper stored moisture.

Catherine Borger says that crop plants adopt this 'shade avoidance growth characteristic' to allow them to more effectively shade weeds as the plants mature and begin directly competing for light.

"Since crop plants in an east-west orientation physically shade weeds at an earlier growth stage, weeds have less opportunity to trigger the shade avoidance growth characteristics," she says.

Increasing crop competition

"The row orientation is one part of increasing crop competition," says Greg. "The other factors to consider are row width, seeding rate and crop and variety selection."

"The difference in competitiveness between crop types is well known with general rules of thumb such as triticale, barley and rye being more competitive than wheat; and cereals are generally more competitive than pulses and canola," he says.

"What is less well understood are the differences between varieties. In one trial Skipper barley achieved a 30–40 per cent greater weed biomass reduction compared to Hindmarsh barley,



The interrow area is shaded earlier in the season when the crop is sown east-west, suppressing weed germination and weed growth early.

but the competitive ability of different varieties varies widely between sites and seasons."

Generally, varieties that exhibit rapid early growth and early canopy closure will provide better weed suppression than less vigorous varieties of the same crop type. Seeding rate and row spacing also play a part in increasing the crop's competitiveness.

Choosing a highly competitive cultivar in one year of a three to five year program can have a significant and lasting effect on the weed seed bank. If this is coupled with harvest weed seed control, and possibly east–west sowing, the result could be impressive and achieved at a very low cost.

"Introducing more non-herbicide tactics into the farming program gives crops the advantage over weeds and reduces the pressure on the herbicide," says Greg. "Farmers have started using tactics like double-sowing known weed areas such as along irrigation channels. With GPS, double pass seeding automatically gives narrow rows, doubles the seeding rate and makes those key management areas much more competitive."

For more information about managing herbicide resistance visit the Weedsmart website: www.weedsmart.org.au

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Crop rotations – how do the numbers stack up?

RECENTLY released results from a long-running trial have provided new insights into the profitability of different crop rotations and how they interact with seasonal conditions and crop residue.

As part of the Grains Research and Development Corporation (GRDC)-funded 'Long term no-till farming systems' project, monoculture wheat has been compared with more diverse rotations for nine years at Cunderdin in Western Australia's wheatbelt about 160 km east of Perth.

The three main partners of the project are the Western Australian No-Tillage Farming Association (WANTFA), CSIRO and The University of Western Australia (UWA).

GRDC Western Regional Panel member Bill Ryan said that, overall, the continuous cereal rotation had the highest gross margin in the trial, followed by monoculture wheat and the 'maximum crop diversity' and 'maximum profit' rotations.

The maximum diversity rotation was a disc sown, cereal-legume-brassica rotation and the maximum profit rotation was a tyne seeded, cereal-cereal-fallow/legume rotation, with windrow burning and shallow tillage.

Bill said the GRDC Grains Research Update, Perth, was told earlier this year that the lower gross margin in the maximum diversity treatment was because of the cover crop grown in the first three years, along with poor canola yields in the relatively dry years of 2007, 2010 and 2012.



GRDC Western Regional Panel member Bill Ryan says the 'Long term no-till farming systems' project allows growers to see the effects of crop management practices over time.



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Using a disc seeder to sow wheat into a 'high residue' plot during a previous season at the 'Long term no-till farming systems' trial site at Cunderdin.

"The profitability of the maximum diversity and maximum profit treatments was reduced by the inclusion of less profitable legumes, despite higher wheat yields," Bill said.

"The fallow also reduced the profitability of the maximum profit treatment from 2013 to 2015."

Bill said the long-term nature of the trial was valuable as it allowed growers to see the effects of crop management practices over time.

School of Plant Biology and UWA Institute of Agriculture lecturer Ken Flower, who presented the findings, said it was realised that growers did not follow a fixed rotation, but rather moved in and out of different crop sequences as determined by factors such as seasonal outlook, previous yield response, weeds and grain price.

"In the context of this trial, growers would, at different times, be moving in and out of all of the different treatments

– for example growing a number of wheat crops in a row (monoculture wheat), then switching to another cereal such as barley or oats (continuous cereal) and then a break crop or two, perhaps including a fallow (maximum diversity/maximum profit)," he said.

Ken said the gross margins presented in the research reflected those of a fixed rotation and were useful as they showed the more reliable gross margins of cereals, the negative impact of cover crops and fallow on gross margins, as well as the potential for 'boom or bust' with break crops, as influenced by factors such as rainfall and grain price.

Best GM based on cereals, not monoculture

"The rotation giving the optimum gross margin would not in reality be monoculture wheat or continuous cereals, but would largely be based on cereals and also contain break crops like canola.

"The frequency of the canola break crops would be higher under conditions that maximise their benefits – such as high grain price, low weed pressure and good soil moisture/rainfall.

"It should also be remembered that this trial is being conducted on relatively heavy soil. It might well be expected that similar trends would occur on lighter soil, but changes may be more rapid."

Other results from the trial included:

- There were no significant yield differences between monoculture wheat and wheat in more diverse rotations for the first five years;
- After this period, lower yields in some years with monoculture wheat compared with the more diverse rotations was thought to be due to one or more factors including disease associated with lack of rotation and heavy residues from the previous year affecting crop establishment; and,
- Heavy canola residues had no effect on wheat yield, whereas heavy cereal residues reduced yields in some years.

The GRDC Grains Research Update paper 'Effect of rainfall, rotations and residue on wheat performance' outlines the research results and is available at www.giwa.org.au/2016researchupdates

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Pulse crops surge to new highs

PULSE crops have become the 'superstars' of the Australian cropping scene as grain growers take advantage of record prices and the crops' renowned rotational benefits to drive a wave of increased plantings.

Coinciding with the International Year of the Pulse, Australian farmers are expected to sow between 1.74 and 2.29 million hectares of pulses this year, continuing a decade-long rise in pulse production across the country.

The export value of pulses in 2014–15 was \$1.2 billion, rising dramatically from \$770 million in 2009–10 and \$147 million in 2004–05.

Pulse Australia industry development manager for South Australia and Victoria, Mary Raynes, said pulses were the only grain crop growing in value and volume when compared to wheat, barley and canola.

"With the exponential growth, the Australian pulse industry could potentially achieve an export value of \$2 billion in 2016–17 when you look at current pulse prices and global demand," she said.

"It is a massive year for the Australian pulse industry. The planets couldn't have aligned better for Australian pulse grain growers.

Interest driven by record prices

The surge in interest in pulses is being driven by record prices, particularly for chickpeas, lentils and faba beans.

That is encouraging growers to expand the area they plant to pulses and is attracting new growers looking to tap into the

profit opportunities the crops present.

Pulse Australia industry development manager for Queensland, Paul McIntosh, said there was huge interest in pulses in the northern farming region, particularly for mungbeans and chickpeas.

"The rise and rise of mungbeans and the increased demand for Desi type chickpeas is phenomenal," he said.

"There is an expansion of pulses further north around places like Townsville where they are seeking knowledge on how to grow mungbeans, and to a lesser extent soybeans in the cane rotation.

"And in the Bundaberg area where they grow cane they are trying to work out how they can grow chickpeas in their cane rotation.

"There are even graziers in regional areas who are not planting traditional oats paddocks for cattle feed but are putting in chickpeas."



Pulse Australia industry development manager for Queensland, Paul McIntosh.

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GRDC northern regional grower services manager, Sharon O'Keeffe.

Paul said pulse crops were not only good for farmers' bank balances but they had a multitude of agronomic benefits.

Trials have shown that growing a 2.5 tonne per hectare chickpea crop on low nitrate soils can produce 157 kg per hectare of fixed nitrogen and provide a carryover benefit to the next crop of 48 kg per hectare of nitrate-N.

"They are a good break crop, a good broadleaf legume crop. They have the ability to put some nitrogen back into the soil so there is a lesser cost for your next crop," he said.

Getting better at growing pulses

"As well as being a disease break crop, being good for the soil and making money for the farmer, they are relatively easy to grow for the returns on investment.

"We are getting much better at growing them. Strategically GRDC researchers are doing a great job. That increased level of knowledge is being communicated to growers by agronomists and advisers and it is coming together very nicely."

Grains Research and Development Corporation (GRDC) northern regional grower services manager Sharon O'Keeffe said new growers – and even long-standing growers – should source the latest information on crop production from the GRDC's suite of web-based GrowNote publications.

"The GRDC GrowNotes have been produced to support growers and advisers. They are a comprehensive resource for growers and their advisers to access the critical knowledge they need," she said.

GRDC GrowNotes have become an essential 'go to' resource for growers throughout Australia. They contain a wealth of valuable information from planning and planting advice to the latest information on nutrition, weed, insect and disease management.

The crop-focused publications can be found at www.grdc.com.au/GrowNotes

They are also available on the new GrowNotes app that growers can download to their mobile devices, giving them all the latest information, whether in the ute, out in the paddock or in the farm office.

The iOS app is available on the Apple app store. It can be found by searching for "GrowNotes" or "GRDC", or via this direct link: <https://itunes.apple.com/au/app/grdc-grownotes/id1103789874?mt=8>

The Android app is available at: <https://play.google.com/store/apps/details?id=fr.netinteractive.grownotes.android>

Making clean seed your business

IN 1980 the Bach family of Toowoomba diversified their farming operation to include a commercial grain storage and handling facility. With a background in grain production the family knows what's needed to provide an efficient and safe grain handling service for other farmers.

Not only do they know the importance of cleaning and grading grain to bring it 'up to spec', they also understand the value of removing weed contamination from seed that is being retained for planting, removing extraneous matter that can lead to problems in long-term storage and selecting the largest seed with the highest germination percentage and early vigour.

David Bach manages the family's grain handling facility near Toowoomba, on Queensland's Darling Downs. He says that since retained seed must be stored for longer than most grain is held on farm, it must be stored in optimal conditions.

"Grading grain at harvest will remove trash such as leaf and stem material that can attract insects and mould while the grain is in storage, either awaiting sale or being retained for seed," he says. "Once cleaned the seed then needs to be kept cool and dry to maintain seed quality."

"When planning to retain seed on farm, select the best part of the paddock and harvest it first," says David. "This way you will have collected the seed with the greatest vigour, which will provide the most competition for weeds in the early growth phase."

Grade hard for best results

If there is not an area of the paddock that is clearly better than the rest, David suggests harvesting much more grain than you need for seed, getting it cleaned and keeping the largest grain aside for seed.

"Grading it hard means that you have the best chance to remove a large proportion of the weed seeds present and you will also have a more consistent line of seed with the highest germination percentage," he says.

"It is very important that grain is cleaned at harvest, before it is stored. Clean seed that is stored and managed properly can remain viable for over nine years."



The best seed cleaning result is achieved using a commercial grading table. But a rotary screen machine – like the Bach's – can also achieve excellent results when an experienced operator uses the right combination of sieves to suit the grain being cleaned.

David's brother, Peter Bach manages the family's farming operation – 1620 hectares of barley, wheat, sorghum, corn, mungbean and some faba bean – 50 km west of Toowoomba.

Retaining seed not only represents a cost saving for them, it also provides a back-up if some or all of a paddock needs to be re-seeded for any reason.

Having a good supply of seed on hand means that growers can take advantage of favourable seasonal conditions. "We try to store enough seed here to plant half of the farm's cropping area as soon as the soil moisture conditions allow," says David. "This way we can make last-minute decisions and be confident that the seed we plant is clean and good quality."

"Especially when the price is up it can be difficult to source seed, so we clean five times as much seed as we expect to use and store it," he says. "To get that seed we might clean 120 tonne of grain and just keep the best 10 tonne for seed knowing that it has been thoroughly cleaned and graded."

David cites black oats as the main problem in their area for barley and wheat crops, and sees that the wild turnip is soon going to be a major concern for growers.

"It pays to clean mungbean seed very hard," he says. "Just one tonne of seed is required to sow 40 hectares so it makes sense for that tonne of seed to be the very best that you have available, and free of weed seed contamination."

Johnstone grass is the most difficult weed to remove from sorghum and maize crops in summer and David sees the herbicide tolerant hybrids providing some useful options for grass control in these summer crops.

But he has seen an increasing problem with herbicide resistant crops growing as volunteers in other crops and contaminating that grain.

"For example, imi-tolerant sorghum might grow as a volunteer in another, conventional crop, and will not be controlled by the herbicides applied in that crop," he says. "Further cross contamination can occur if that seed is unintentionally kept for planting. It is easy to become complacent about the herbicide tolerant crop plants growing on roadsides and the potential flow of seed from roadsides into grain paddocks."

Seed cleaning equipment

There are several types of grain cleaning equipment available that vary in their efficiency when it comes to weed seed removal.

The Bachs use a rotary screen machine that has two main sections:

- An aspirator, where a fan sucks air through the grain, removing fine particles such as dust, and light material such as husks and some weed seeds; and,
- The screens, where the grain rolls around inside a drum with different sized screens that allow the grain to be separated according to size.

"Usually the grain is sorted into two sizes plus the gradings or screenings, where the vast majority of weed seed is collected," says David.

"Improving the grade of the sample is usually fairly simple, but cleaning for seed is much more time consuming and therefore costs more."

"Sometimes growers think that their grain is cleaner than it really is," says David. "On farms where the spraying is contracted out the farmer may not be as aware of the weed populations around their property."

David says the value of having a commercial grain handling contractor do the seed cleaning lies in the contractor's knowledge about how to set the machine up to achieve the best result. "The screens are expensive but it pays to use the right combination of screens to suit the grain and the weed spectrum," he says. "It is



David Bach, Toowoomba Grain Storage and Handling, says it is easy to recoup the costs of cleaning planting seed when you take into account the savings in weed control costs and the extra vigour of seed that has been stored correctly.

probably not economic for a grower to invest in the large number of screens required to do the best job in all situations."

"Grading table gear does an excellent job to remove weed seeds too," says David. "These machines are most commonly found at commercial grain packing and processing facilities, and in some situations, could be a viable option for growers to use."

Research conducted in Western Australia confirms David's comments about the value of having seed cleaned by a specialist rather than using equipment – such as sieves or in-field rotary screens – some growers use to clean their seed on farm.

Economics of seed cleaning

Growing seed for future planting needs to be a planned operation – start with clean seed, sow into a clean paddock, grow a competitive crop that suppresses weeds, keep the crop weed-free by taking action if individual plants survive treatment, harvest the best, cleanest part of the paddock, clean the seed hard and store it under optimal conditions.

"Seed is very valuable and is worth investing in," says David. "If you plant clean seed into clean paddocks the cost savings in time and herbicide will soon pay for the cleaning of the seed."

To determine how many weed seeds are present in a potential seed lot, collect a 1 kg sample and separate the crop seed from all other material. About 100 weed seeds per kilo of cereal or pulse seed sampled equals around one weed per square metre when the crop is sown.

A survey in Western Australia by the GRDC-funded Australian Herbicide Resistance Initiative found that un-cleaned seed samples can contain over 1500 weed seeds per 10 kg planting seed, which would add extraordinary pressure on the next crop. The AHRI survey found that the gravity table method of seed cleaning consistently produces the cleanest seed sample, reducing contamination to about 25 weed seeds per 10 kg. Sieves alone can bring the number down to about 150 weed seeds per 10 kg.

More information:

clean weed-free seed – don't plant weeds <http://www.weedsmart.org.au/bulletin-board/dont-risk-replanting-weeds/>

<http://www.weedsmart.org.au/ask-an-expert/when-is-clean-clean-enough-with-mechelle-owen-senior-research-officer-with-australian-herbicide-resistance-initiative/>

For more information about managing herbicide resistance visit the Weedsmart website: www.weedsmart.org.au and the AHRI website: <http://ahri.uwa.edu.au>

Integrated approach is the key to sowthistle control

A GRAINS Research and Development Corporation (GRDC) funded survey into glyphosate resistance in common sowthistle has found that 20 per cent of the sampled paddocks contain common sowthistle which is not susceptible to glyphosate at label rates.

But Annie van der Meulen, a weeds scientist with Queensland's Department of Agriculture and Fisheries has indicated that many populations of common sowthistle across the region can be effectively controlled with glyphosate when treated early and at robust label rates.

Speaking at a GRDC Grains Research Update in Goondiwindi earlier this year, Annie urged northern region growers to adopt an integrated approach to ensure the key herbicide, glyphosate, remains effective for common sowthistle control.

The Toowoomba-based researcher is part of a team, led by Michael Widderick, which has been benchmarking the level of glyphosate resistant sowthistle across the northern region and identifying 'hot spots'.

The work started after Australia's first cases of glyphosate-resistant sowthistle populations were found in north-west New South Wales in February 2014, confirmed by Tony Cook and the team at NSW Department of Primary Industries, Tamworth Agricultural Institute.

To date, 170 sowthistle seed samples have been received as part of the survey with approximately 20 per cent of tested samples showing resistance. In one seed sample, from a fallow paddock near Gunnedah, 93 per cent of plants survived a glyphosate application at the recommended rate.

A range of methods

Annie urges growers to incorporate a range of methods for weed control, including use of non-chemical and agronomic approaches, from rotations to crop competition to herbicides with different modes of action and potentially strategic tillage.

"Anyone with sowthistle should use integrated weed management to make sure glyphosate remains a viable choice for them in the future," she said.

Annie also recommends growers test for herbicide resistance.

"Early detection is useful because if there is glyphosate-resistant sowthistle on a property, growers can target and hopefully eliminate the resistant populations, before the problem gets out of control."

Tips for sowthistle management include

- Know what herbicides will work. Glyphosate resistance is present in the northern region and Group B resistance is reportedly widespread.
- Aim for 100 per cent elimination of seed set, including roadsides and fencelines.
- Maximise crop competition. In paddocks where common sowthistle is a particular and persistent issue, competitive crop species such as barley at narrow row spacings (eg 25 cm) can help to suppress the weed. Avoid growing chickpeas in these paddocks, as this crop is poorly competitive with common sowthistle and has high potential for sowthistle 'blow outs'.
- If relying on knockdowns in fallow, treat sowthistle when plants are small and double knock with another mode of action to control survivors.
- Apply residuals early in fallow. When using Flame to control summer grasses, remember to partner it with a herbicide that is effective for control of common sowthistle (ie check the label).
- Test weeds for herbicide resistance, rather than relying on spray failure as an indicator. Commercial resistance testing centres will screen weed samples for herbicide resistance to help pin down which options will (and won't) work. Tests range from \$125–\$175 for a single herbicide and \$75–\$95 for each additional chemical tested.

For details on resistance testing options, contact the following herbicide resistance testing centres - Charles Sturt University, contact: John Broster, 0427 296 641, jbroster@csu.edu.au or Plant Science Consulting, contact: Peter Boutsalis, 0400 664 460, info@plantscienceconsulting.com.au



Many populations of common sowthistle across the northern region can be effectively controlled with glyphosate when treated early and at robust label rates.

(PHOTO: Annie van der Meulen, DAF)

New moves against black oats

COMBATING black oats has been a constant chess game for northern New South Wales and southern Queensland croppers, but some new moves in recent times, including using different chemistry groups of knockdown and residual herbicides, are at least keeping the odds in growers' favour.

Tony Lockrey, consulting agronomist at Moree with AMPS Agribusiness – which strongly invests in independent production research in the region – has been dealing with increasing Group A pop resistant black oats in the district for the past 10 years.

Tony said the use of Group A herbicides had been widespread within the popular wheat-chickpea rotation in the region.

"Products that were the safest on the crop, cheapest and most active have been pushed hard and are now less effective," Tony said. "Group A resistant black oats forced us to look to new modes of action and herbicide groups for knockdown control in crop, as well as revisiting some of the residual treatments that had been neglected due to the adoption of zero tillage.

"Growers have since been using Atlantis and, to a lesser extent, Hussar and Crusader herbicides and growing more Clearfield wheat and barley in their systems. After 10 years, some of the earliest farms that converted to Clearfield crops are now finding IMI-resistant phalaris. This highlights the need to rotate modes of action and herbicide groupings to prolong the life of our existing chemistry. Integrated weed management is a must."

Assess the whole farming system

He said the only way to sustainably tackle the weed resistance problem was to assess the whole farming system, including crop choice and rotation sequence, to maintain profitable cropping whilst not letting any seedset occur.

"Every lever we can pull to attain this outcome is explored. This has and will include knockdown and residual chemistry, agronomic, genetic, cultural and mechanical solutions where needed."

Tony said while wheat was the traditional mainstay in crop rotations, with pulses, oilseeds and summer crops being used to manage key diseases such as crown rot and nematodes, rotation plans must also work to provide the best possible control of problem weeds and prevent their seedset for a minimum of three years. This helps to relieve pressure on systems.

"We take stopping seedset so seriously that we will spray out wheat pre-harvest with glyphosate to stop viable seedset by late germinating black oats, or even slash or plough down problem patches that have escaped control. Unfortunately, weed seed destructors and windrow burning are less effective on black oats than ryegrass, as early germinated plants have often dropped their seed prior to harvest. Baling crop areas for stockfeed is another alternative to stop seedset."

Critical to get timing and conditions right

He said the use of Group B selective herbicides in wheat, particularly Atlantis, was picking up black oats that emerged in crops when used correctly. But Tony cautioned that Atlantis must be used in the right situation at the right time.

"It is critical that both the crop and weeds targeted are at the right growth stage and in good condition. Get that right and the Atlantis control can be very good," he said.

"Be very careful to avoid spraying stressed weeds and crop – particularly frost stress that is recent or imminent – as weed control results may disappoint and transient crop checking may occur."

Tony recommended using water rates of around 100 litres per



Scott Ariell and Tony Lockrey going through some of the company's research plans for the coming season.

hectare with Atlantis and twin tip nozzles for good coverage of the target, as well as using oil, rather than wetter, .

"While oil may cause some slight spotting on the crop, I think it does the optimum job. Always use the full rate in good conditions and the results will follow."

In terms of residual chemistry, he said in some cases farmers had returned to applying Treflan with Avadex Xtra prior to sowing, hoping to reduce in-crop weed pressures, but their re-adoption was not widespread due to poor performance and incompatibility with the zero tillage/minimum tillage system.

Fantastic brew

Tony said use of the newer Group K pre-emergent herbicide, Sakura 850 WG from Bayer, with Avadex Xtra on a ryegrass area in wheat had been a "fantastic brew" and, in combination with a follow-up Atlantis spray in-crop, a fallow and a dryland cotton crop, the paddock had since cleaned up extremely well.

"The field treated had 90–100 ryegrass plants per square metre, with multiple herbicide resistance the previous year in Clearfield canola, as well as black oats and some scattered barley grass in the headlands," he said.

"While it was a risk to take it to wheat, the stubble cover was required to fallow out to the following cotton crop, so it was decided to tackle the weed burden head-on with well incorporated residual herbicides, as well as the strategic in-crop selective."

The field was planted to a short season wheat after the initial ryegrass emergence had been double knocked.

In addition to suppressing black oats and great brome, Sakura controls annual ryegrass, barley grass, silver grass, annual phalaris and toad rush in wheat (not durum wheat), triticale, chickpeas, field peas, lupins and lentils.

Tony said the new label additions for Sakura made it a "standout candidate" among the soil-applied residuals to investigate and use well in systems.

"There is a lot of room for growth with Sakura because we are not using residuals very much and we need to be exploring every possibility to limit the number of grass weeds emerging in crops – as a starting point to eliminating seedset," Tony said.

"Sakura is taking 50 to 80 per cent of black oats out in trials and upwards of 80 per cent of ryegrass. But it must be used wisely in the rotation as it should not be used more than twice every four years."

He said Sakura was more robust in a variety of conditions, particularly more stable than other residuals in dry conditions following planting, which often occurred.

Nitrogen losses spotlighted in research

WITH nitrogen (N) fertiliser representing one of the most significant input costs for the northern grain industry, it stands to reason that growers are continually striving to minimise applied N losses and boost their return on investment.

Their quest is being assisted by comprehensive research aimed at furthering the understanding of how N is lost from cropping soils and investigating management solutions.

The research is being led by Queensland Alliance for Agriculture and Food Innovation (QAAFI) Principal Research Fellow Professor Mike Bell and Dr Graeme Schwenke from the New South Wales Department of Primary Industries (NSW DPI) and supported by the Grains Research and Development Corporation (GRDC).

Northern growers typically apply nitrogen fertilisers such as urea directly into the soil (banding) or broadcast it on the surface then incorporate.

This is done to reduce the potential for ammonium-containing (eg sulfate of ammonia) or ammonium-producing (eg urea) fertilisers volatilising into the atmosphere as the gas, ammonia.

But N can also be lost through leaching with the drainage of water through the profile, or through nitrate denitrification – a biological process that occurs within the soil profile wherever there is sufficient available nitrate, labile carbon substrate, and low oxygen conditions such as in slowly draining soils.



Queensland Alliance for Agriculture and Food Innovation (QAAFI) Principal Research Fellow Professor Mike Bell believes that understanding N loss pathways and how they are influenced by seasonal conditions and management strategies, is a critical first step in optimising the efficiency and profitability of applied N use.

Understanding N loss pathways

Professor Mike Bell said understanding N loss pathways and how they are influenced by seasonal conditions and management strategies was a critical first step in optimising the efficiency and profitability of applied N use.

“Given growers’ substantial investment in N fertilisers, there needs to be considerable attention given to factors that affect the efficiency of use of applied N (NUE), with indices such as crop recovery of applied N (kg fertiliser N accumulated in the crop or in the grain per kg N applied) and the agronomic efficiency of N use (kg additional grain produced per kg N applied) used to benchmark NUE,” Mike said.

“Any loss of applied N will affect NUE by reducing the pool of N that a crop can use to produce biomass and grain yield.”

A recent survey of more than 150 advisors throughout NSW and Queensland showed the overwhelming majority recognise that N losses exist and can be significant, and highlighted a perception of an increased risk of losses in summer compared to winter cropping.

There was also a perception among survey respondents of greater potential N losses – as much as 20 to 40 per cent of applied N – in the northern part of the region, but given the unpredictability of environmental conditions that favour losses, few advisors were found to actually factor those losses into fertiliser recommendations.

Applied N and sorghum

Over the past three years, the research team has conducted six experiments with isotope-labelled (¹⁵N) urea fertiliser in northern NSW and a further 11 in southern Qld, all focussed on measuring the fate of applied N fertiliser in summer sorghum.

According to Mike, the results found between 56 per cent and 100 per cent of the applied N was retained in the soil and plant at harvest, with in-season rainfall, both timing and amount, and soil carbon (C) and N status having a major impact on the seasonal loss potential.

“The research also found that avoiding unnecessarily high N rates, delaying or splitting N fertiliser so that peak N availability coincides with peak crop N demand and relying on residual N from legume rotations all significantly reduced gaseous N losses from dryland sorghum, although the effectiveness of any management strategy varied with seasonal conditions.

“Depending on the season, delaying/splitting N applications gave either no yield benefit (dry season) or a significantly greater yield (good in-crop rainfall),” Mike said.

“Much of the unused N after a dry season remained in the soil and, provided loss events were not experienced during the fallow, significantly benefited the following crop.”

The trial work also investigated the impact of using nitrification inhibitor-coated urea, which significantly reduced nitrous oxide emissions in all studies but did not improve grain yields enough to justify the additional cost on an agronomic basis.

For more details on the trial work and results, download a copy of Mike’s Updates paper from the research and development section of the GRDC website www.grdc.com.au or visit <http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/02/Understanding-and-managing-N-loss-pathways>.

Harvest Weed Seed Control in the north – it's possible



■ By the Australian Herbicide Resistance Initiative (AHRI)

Two English shoe salesmen were sent to Africa in the late 1800s to see if there was a market for their product.

The first salesman reported back, "Situation hopeless, no-one wears shoes, returning home immediately."

The second salesman reported back, "Glorious opportunity, no-one wears shoes."

Salesman two is the real entrepreneur, the person who sees opportunity where others do not.

Very few grain growers in Queensland or northern NSW use harvest weed seed control. Many feel that most weed seeds shed before harvest so there is little point. Funnily enough, this is what the Americans said, and it turns out their main weeds retain all of their seed at harvest!

A survey of 70 paddocks in 2011 by Queensland Department of Agriculture and Fisheries (DAF) researchers Steve Walker, Michael Widderick and Michelle Keenan has identified a similar 'glorious opportunity'. They found excellent seed retention at harvest of several key weed species in winter crops. Seed retention and height of weed seeds in summer crops was not as encouraging, but there are some isolated opportunities here as well.

All that matters is the weed seed bank. And that makes harvest weed seed control even more critical. Is there a 'glorious opportunity' for harvest weed seed control in the north? We think so...

IN 2011–12, a survey of 70 winter and summer cropping paddocks was undertaken by DAF in northern NSW, southern and central Queensland to identify which weed species were present and setting seed in-crop at harvest time. The Table 1 below is a summary of the seed retention of some of the key weed species.

Which weeds are candidates for harvest weed seed control?

Seed retention at harvest is one thing, but is it possible to capture those seeds and destroy them? Which weeds are in for harvest weed seed control and which are out?

- **Definitely in** – Turnip weed and African turnip weed are likely to be very good candidates for harvest weed seed control (HWSC), but these species are not currently causing growers big resistance issues.
- **Definitely in (winter crops)** – Annual ryegrass and wild oats are good candidates for HWSC in winter crops. We know that wild oats shed their seed at about two per cent per day compared to ryegrass at one per cent per day, but there is still a good opportunity for HWSC at the start of harvest.
- **Possibly in (winter crops)** – Summer weeds barnyard grass and Feathertop Rhodes grass are probably the unlikely

TABLE 1: Seed retention (%) at the beginning of harvest of eight weed species in the northern region

Weed	Wheat (winter)	Chickpea (winter)	Sorghum (summer)
Barnyard grass	95	100	47
Turnip weed	–	100	95
Feathertop Rhodes grass	–	70	79
Fleabane	93	86	34
Annual ryegrass	92	89	–
Wild oat	67	93	–
African turnip weed/mustard	–	100	–
Sowthistle	53	54	57

candidates here. They are known to shed their seed in summer crop but perhaps where they germinate in spring in winter crops they may be good candidates for HWSC.

- **Possibly in (summer crops)** – Feathertop Rhodes grass shows some promise for HWSC in summer crop with 79 per cent seed retention at the start of harvest in this survey. This number is likely to fluctuate so it may be an opportunistic target.
- **Out** – Sowthistle seed retention was low and this weed tends to disperse its seed the same day as the seed head opens. Fleabane appears to retain its seed at harvest but may not be a great candidate due to the wind-borne nature of the seed.

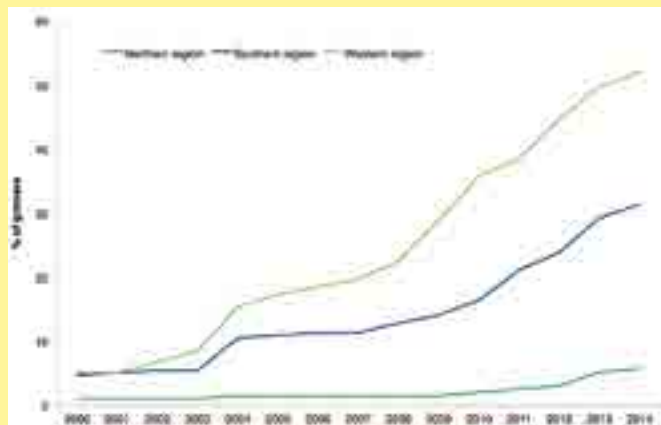
Winter versus summer crop

It's evident from this survey that weeds in winter crops retain more of their seed at harvest than weeds in a summer crop like



Northern region weed researcher Michael Widderick.

FIGURE 1: Adoption of harvest weed seed control (% of growers) for the three GRDC regions in Australia



Survey data from Rick Llewellyn's GRDC funded survey.

sorghum. There are a couple of reasons for this.

Firstly, the growing conditions in summer allow for weeds such as barnyard grass and feathertop Rhodes grass to germinate with the crop so by the time harvest comes around they have matured, set seed and these seeds then have the opportunity to shed.

Also, sorghum is planted on wide rows (eg 1 m) giving the weeds opportunity to grow with low levels of competition. This may reduce the height of the weeds at harvest.

Weeds such as barnyard grass and feathertop Rhodes grass need warm soil to germinate. These weeds can germinate in

spring in winter crops and, as a result, may retain their seed at winter crop harvest.

Adoption of HWSC is very low in the northern region compared to the west and the south (Figure 1). This could be because herbicide resistance levels have been typically lower in the north – until now.

Or it could be because the weeds in the north don't suit harvest weed seed control.

Where to start?

Winter crops are the obvious starting point for HWSC in the north as seed retention is highest here.

The national weeds survey found that 15 per cent of northern region farmers are already diverting the weed bearing chaff fraction onto permanent wheel tracks in controlled traffic farming (CTF) systems. This is a great option for growers already on CTF and can be achieved at low cost.

Narrow windrow burning in chickpea crops is the other easy place to make a start at HWSC. Seed retention was excellent in chickpea crops in this survey and it is simple to burn chickpea windrows without burning the entire paddock.

Burning windrows in cereals is possible but more complex given the higher yields and dry matter production in this region.

To sum up

Weed control is easy when all of the herbicides work. When the herbicides stop working we need to use an integrated approach that includes herbicide and non-herbicide tools.

Is there a 'glorious opportunity' to use harvest weed seed control in the north? This survey would suggest so and we need some farmers, who see an opportunity where others do not, to give it a go.

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Low rainfall cereal crops can take a break and grow profits

GRAIN growers in low rainfall parts of the southern cropping region can potentially lift profitability by including one or two-year break phases in their rotations.

Research funded by the Grains Research and Development Corporation (GRDC) shows that when break phases are incorporated, increased profitability of up to \$100 per hectare per year can be achieved over a four-year period compared with cropping continuous wheat.

Mallee Sustainable Farming (MSF) agronomist Michael Moodie, who has been a co-ordinator of the Low Rainfall Crop Sequencing Project, says two-year break phases are a reliable management tool for increasing the yields of subsequent wheat crops in paddocks where agronomic constraints are affecting yields of continuous cereals.

Benefits accumulate after the break

"Wheat yield benefits of one to two tonnes per hectare commonly accumulate over two or three seasons following the break phase," said Michael.

The Low Rainfall Crop Sequencing Project, a collaboration between the South Australian Research and Development Institute (SARDI*) and five farming systems groups – MSF, Eyre Peninsula Agricultural Research Foundation, Upper North Farming Systems, Birchip Cropping Group and Central West Farming Systems – was established in 2011 at five trial sites across the low rainfall zone (LRZ) of south eastern Australia.

The trial sites were at Minnipa and Appila in SA, Mildura and Chinkapook in Victoria, and Condobolin in New South Wales.

The GRDC funded the research to quantify the yield benefits that break phases provide to subsequent cereal crops and to quantify the impact of break phases on profitability of the long-term rotation.

"The aim of the project was to test if a one or two-year well managed break phase in low rainfall crop sequences could successfully address agronomic constraints, increase the productivity of subsequent cereal crops and most importantly, improve the profitability of the crop sequence when compared to continuous wheat," Michael said.

Michael, who has spoken about the project at recent GRDC Grains Research Updates, said that over the past 15 to 20 years, the intensity of cereal crops in LRZ paddock rotations had increased dramatically and it was not uncommon for farmers within the region to have implemented cropping sequences that included five to 10 consecutive cereal grain crops.

Michael said that when the project started, intensive cereal

cropping sequences in the LRZ were declining in productivity due to constraints such as grass weeds, declining soil nitrogen fertility and crop diseases.

The project involved the establishment of replicated trials in paddocks with a long history of intensive cereal cropping and a prevalence of agronomic constraints. Each trial consisted of up to 19 unique crop sequences which included both one and two-year break phases in 2011 and/or 2012, followed by wheat in 2013 and 2014.

Each trial also maintained a continuous wheat treatment for the four years of the project as a benchmark to assess the impact of the other crop sequences.

Michael said the inclusion of break phases was most

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MSF agronomist Michael Moodie – pictured in foreground speaking at one of the break crop comparison trial sites at Karoonda in SA – says two-year break phases are a reliable management tool for increasing the yields of subsequent wheat crops in paddocks where agronomic constraints are affecting yields of continuous cereals. (PHOTO: MSF)

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profitable at the Mildura and Appila sites where more than half of the rotations with break phases were more profitable than continuous wheat.

At Mildura, the top five rotations increased gross margin by an average of \$230 per hectare over the four years, while at Appila, the five most profitable sequences delivered an average of \$370 per hectare additional profit over four years.

Michael said trials had demonstrated that the type of break phase appeared to have little effect on subsequent wheat production as long as the break phase successfully addressed the agronomic constraints present.

\$400 better than continuous wheat

At Mildura, rotations that included break crops grown for grain such as field pea, canola and chickpea tended to be the most profitable, but at Appila where frost was an issue, improved pasture and hay treatments were best. For example, medic-pasture-wheat-wheat, and a mix of oats, vetch and medic for two consecutive years, followed by two years of wheat, recorded gross margin advantages of more than \$400 per hectare over the four years, compared with continuous wheat.

To address the perceived risk of growing broadleaf break crops in the LRZ, pulse crop comparison trials were implemented at the crop sequencing site near Mildura in 2013 and 2014, involving field pea, chickpea, lupins, faba bean and lentils.

In 2015, a new project funded by the SA Grain Industry Trust (SAGIT) was set up to compare broadleaf break crop performance across four soil types in the northern SA Mallee.

These two trials have highlighted the potential for grain legume crops to be productive and profitable in the northern Victorian and SA Mallee, according to Michael. "Field peas, chickpeas and lentils have produced acceptable yields and gross margins in this region over three consecutive seasons."

<http://grdc.com.au/Research-and-Development/GRDC-Update-Papers>.

***SARDI is a division of Primary Industries and Regions South Australia (PIRSA). ■**

Wheat yields improved by timely powdery mildew control

RESearchers have found that application of a single fungicide spray can reduce the impact of wheat powdery mildew when applied before the disease becomes too severe.

They have also advised growers to be aware of the disease susceptibility of their chosen wheat varieties, and warned that – particularly in Western Australia – significant levels of wheat powdery mildew inoculum has been carried over on infested stubble, which could be multiplied by the presence of a green bridge.

While historically powdery mildew has not caused significant wheat yield losses in WA, in 2015 it was widespread and damaging on crops in the northern and central grainbelt and in the Esperance region.

In 2015, field trials led by the Department of Agriculture and Food (DAFWA) with funding from the Grains Research and Development Corporation (GRDC), investigated foliar fungicide strategies for managing the disease in wheat from stem extension onwards.

DAFWA plant pathologist Ciara Beard told the GRDC Grains Research Update, Perth, that a single foliar fungicide spray applied at a registered rate to a susceptible variety significantly improved yields in four out of six trials across the grainbelt.

“The average yield response across all trials to a single fungicide spray was eight per cent,” she said.

“But yield responses and positive economic benefits from fungicide application are never guaranteed.”

The best timing

Ciara said the best timing was before the disease became severe and before flag leaves and particularly heads were infected.

“Timing of fungicide application – as soon as possible after the disease was observed moving up the canopy – was more important than product choice,” she said.

“In cases where the onset of the disease occurred later in the season, the best timing was once all leaves had emerged, which provided maximum protection for the plant canopy.

“Fungicide sprays applied following head emergence were too late to provide effective head protection and were not economic.

“Researchers believe that a second, follow-up fungicide application could be warranted in some seasons if the weather outlook is conducive to disease persistence – but this was not the case in 2015 due to the hot dry spring.”

Ciara said that selection of wheat varieties with resistance levels better than ‘moderately susceptible’ would significantly reduce the risk of severe wheat powdery mildew infection.

She said there was an increased risk of powdery mildew for early sown or short season varieties where the upper canopy and heads were exposed to disease in favourable environments.

“Early sown, susceptible varieties should be monitored closely this season to avoid significant damage occurring before management is instigated,” Ciara said.

No powdery mildew resistance

Researchers from the Centre for Crop and Disease Management (CCDM), which is co-funded by Curtin University and the GRDC, have so far been able to rule out fungicide



DAFWA plant pathologist Ciara Beard, left, and Madeline Tucker, of the CCDM's Fungicide Resistance Group, at the GRDC Grains Research Update, Perth.

resistance in wheat powdery mildew in WA, at least with respect to currently known resistance mechanisms.

But they have recently observed the first signs of mutations – in wheat powdery mildew samples from New South Wales and Tasmania – which could lead to fungicide resistance issues in the disease in Australia.

To reduce the risk of the development of fungicide resistance growers should:

- Where possible, use registered fungicide mixtures that contain different modes of action; rotate fungicide active ingredients; use recommended fungicide label rates; and, avoid using more than two sprays of any product per season
- Control the disease as early as practicable and before it becomes severe; and, spray fungicides when disease becomes evident in a crop, particularly if weather conditions are conducive to disease development

There are no in-furrow or seed dressing fungicides registered for powdery mildew control in wheat, but a list of registered foliar fungicides is available on the DAFWA website www.agric.wa.gov.au by searching 'cereal foliar fungicides'.

Information about wheat powdery mildew is also available on the CCDM website www.ccdm.com.au. GRDC Grains Research Update papers about wheat powdery mildew are available at www.giwa.org.au/2016researchupdates.

Getting closer to southern growers with regional office opening

THE Grains Research and Development Corporation (GRDC) is boosting its presence and outreach to growers in the southern cropping region through the opening of a dedicated regional office.

The office, located at the National Wine Centre of Australia building in Adelaide, will service the three states that comprise the GRDC's southern region – South Australia, Victoria and Tasmania.

The office houses five staff, with more positions likely to be added over time.

GRDC Chairman Richard Clark says the establishment of the southern regional office enables the organisation to enhance its existing relationships with growers and other grains industry personnel, including grower groups, advisers and researchers.

"The GRDC is complementing operations at its central office in Canberra by setting up regional offices across the country. These offices will foster a stronger connection to our growers and allow us to improve the delivery of outcomes from research and development that are of most benefit to local growers," Richard says.

Increasing diversity prompts move

The transfer of some of the GRDC's functions and roles out of Canberra and into the regions (there will be four regional offices) is in recognition of the increasing diversity in environmental factors, farming systems and grower profiles across the nation.

Richard says this "hub and spoke" model is most appropriate for an organisation like the GRDC which has a mandate to work closely with growers and industry at a regional level but to also maintain and grow strategic relationships with research partners from across Australia and the globe, which can be done most effectively from a national head office.

The GRDC's Adelaide office was officially opened by Assistant Minister for Agriculture and Water Resources, Senator Anne Ruston, who also opened the Fisheries Research and



Australia-wide the GRDC invested nearly \$200 million in grain related research.

Development Corporation (FRDC) office within the National Wine Centre of Australia building, which also houses Wine Australia.

Minister Ruston was delighted to formally open the offices, and said that the move would boost the prosperity of local economies and communities.

"This is a positive move, relocating agencies with a strong rural focus closer to the industries that they serve," Minister Ruston said.

"The move to South Australia to increase regional presence will certainly go a long way in boosting jobs and growth in areas connected to rural and regional Australia."

South Australian Minister for Agriculture Minister Bignell said the new GRDC office reinforced South Australia's position as a major centre for grain research.

"GRDC is a key partner of the South Australian Government and this move will allow us to work even closer on a number of important initiatives, including the \$50 million bilateral agreement with GRDC.

"This agreement through the South Australian Research and Development Institute will help to deliver high quality, locally relevant grains research over the next five years."

The establishment of the GRDC's southern regional office will complement the network of 11 Southern Regional Panel members spread across the region and the 40 members of the Regional Cropping Solutions Networks that support the Panel in identifying GRDC-funded research priorities.

In 2014–15 the GRDC invested more than \$196 million in grains related research – much of which supports researchers, advisers and grower groups based in regional locations in delivering positive outcomes for the benefit of levy-paying growers.



GRDC Chairman Richard Clark at the official opening of the GRDC southern regional office in Adelaide with Assistant Minister for Agriculture and Water Resources, Senator Anne Ruston. (PHOTO: James Knowler)

Testing and planning the key to breaking RLN cycle

GROWERS are encouraged to undertake soil testing from paddocks suspected of having root lesion nematode (RLN) damage in 2015 in order to help plan future rotations and varieties.

This follows unprecedented numbers of the microscopic pest recorded by Department of Agriculture and Food (DAFWA) researchers in parts of the WA grainbelt last year.

Soil testing prior to sowing enables identification of the species of nematode present, which is important as there are differences in the susceptibility of break crops and varieties to different RLN species.

DAFWA nematologist Sarah Collins, who is conducting Grains Research and Development Corporation (GRDC) funded research into RLN, said numbers previously thought impossible in WA were recorded at a Wongan Hills trial site in 2015.

In addition, a targeted DAFWA survey of 31 paddocks across the grainbelt found that 23 had potentially yield-limiting populations.

"What remains uncertain is whether RLN damage spiked last year in WA on the back of crops being moisture stressed at the end of the season, or whether numbers will keep rising in 2016," Sarah said.

"But surveying of RLN through the Focus Paddock project has shown numbers of these microscopic endoparasites have been



DAFWA nematologist Sarah Collins says it is important to correctly identify the species of nematodes present in paddocks due to differences in the susceptibility of break crops and varieties to different RLN.

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increasing right across the WA grainbelt for the past five years at least."

Sarah said the common RLNs found in WA were *P. neglectus*, *P. quasitereoides* (formerly known as *P. teres*) and *P. thornei*. The RLN species *P. penetrans* is rare but can be highly damaging when present.

Breaking the pest cycle

"There are limited in-crop options for preventing damage from nematodes," she said.

"After species identification, management hinges on crop and variety choice for the coming season and beyond. The goal is to break the pest cycle."

Sarah said a run of seasons favourable to RLN and increasing use of canola in crop rotations were likely to be contributing to rising nematode numbers across much of the state.

"The host range for root lesion nematodes is broad and includes cereals, oilseeds, grain legumes, pastures and many broadleaf and grass weeds," she said.

"But well-managed rotations can minimise the damage caused to cereal production."

Sarah said that in DAFWA's nematology group field trials in 2015, all wheat, barley and canola crops were susceptible to *P. neglectus*, *P. quasitereoides* and *P. penetrans*.

Lupins were resistant in all *P. neglectus* and *P. quasitereoides* trials, but proved highly susceptible to *P. penetrans*.

DAFWA is in the process of analysing 2015 trial data to determine RLN impacts on crop yield, and is conducting further trials to help improve understanding of yield impacts for these crops.

Yield losses

"Preliminary results from 2015 trials show there was yield loss for wheat, barley and canola crops, but the degree of loss differed with location," Sarah said.

At a DAFWA trial at Gibson, yields were significantly impacted by *P. quasitereoides* in all five varieties tested, with losses of 10 to 65 per cent. 2015 trials represent the first time that canola has been tested for RLN tolerance in WA and further experiments will be conducted.

As outlined in the GRDC's Wheat GrowNotes for the western region (www.grdc.com.au/GrowNotes), RLN management includes:

- Planning crop rotations with resistant or non-host break crops and resistant pastures;
- Using crop varieties that are resistant or tolerant to the RLN species in the paddock;
- If RLN levels are high to very high, considering growing a moderately resistant variety;
- (MR) or resistant (R) crop or pasture for one or more seasons;
- Avoiding sowing consecutive susceptible crops across seasons;
- Maintaining healthy soils and good crop nutrition, especially at crop establishment;
- Controlling weed and crop volunteers over summer as they may build up RLN populations; and,
- In the lead-up to and around harvest, monitoring cereal crops for potential damage.

The GRDC is funding a nationally-coordinated nematode research program to quantify the yield and economic impacts of RLN in crop production systems.

Soil testing for confirmation of nematodes and species identification can be carried out by AGWEST Plant Laboratories (APL), with further information available at www.agric.wa.gov.au/agwest-plant-laboratories, or by accredited agronomists through SARDI's PreDicta B® service.

Research targets clethodim resistant annual ryegrass

TRIALS have highlighted promising alternative practices – including the use of high vigour, hybrid canola varieties – which could help growers manage clethodim resistant annual ryegrass in canola crops.

They have shown that switching from an open-pollinated canola variety to a hybrid can reduce annual ryegrass seed set by 50 per cent, and that herbicide-tolerant RT canola varieties offer additional options for control.

Chris Preston, of The University of Adelaide, told recent Western Australian Grains Research and Development Corporation (GRDC) Grains Research Update events that



Chris Preston, of The University of Adelaide, has led GRDC-funded short and long-term trials with the aim of developing alternative management practices to help growers manage clethodim resistant annual ryegrass in canola crops.
(PHOTO: Justin Kudnig, Advanta Seeds)

clethodim resistance in annual ryegrass was making this weed difficult to control in canola.

"As a result of extensive resistance to other post-emergent herbicides, clethodim has become the last effective herbicide for later control of annual ryegrass in non-RR canola," he said.

"But annual ryegrass resistance to this important herbicide has been increasing across Australia in recent years.

Seeking alternative practices

To address the problem, Chris has led GRDC-funded short and long-term trials with the aim of developing alternative management practices.

While these trials have been conducted in South Australia and Victoria, he said the results were also relevant to WA growers.

Chris said a 2015 trial at Roseworthy, SA, showed hybrid and high vigour canola varieties offered a simple opportunity to reduce annual ryegrass seed set by providing extra competition against the weed during the growing season.

"The results showed that hybrid canola, used in combination with pre-emergent herbicides and clethodim, can reduce seed set by 50 per cent," he said.

In the trial, hybrid canola varieties Hyola 559TT and Hyola 750TT significantly reduced the number of annual ryegrass spikes at harvest compared with the open pollinated variety ATR Stingray, even in the absence of herbicides. But the effects were much greater where pre-emergent herbicides were used.

A second trial at a high rainfall site at Lake Bolac, Victoria, investigated the use of RT canola – which is resistant to both triazines and glyphosate – as a management tool, given triazine has a residual effect that can be used to reduce the impact of later germinating annual ryegrass.

The site – containing annual ryegrass resistant to all post-emergent herbicides including clethodim – was sown to Hyola 525RT canola in 2014 and subjected to low, medium and high intensity management strategies. In 2015, the site was sown to wheat.

High intensity strategy

"The high intensity management strategy was able to reduce annual ryegrass spike numbers by 70 per cent at the end of 2015 compared with the low intensity management, and by 50 per cent compared with the medium intensity management," Chris said.

"The ability to attack annual ryegrass at least three times during the canola phase is important for restricting the population size when only pre-emergent herbicides are available in cereals."

Chris said it was important to maintain effective control of annual ryegrass during the canola phase due to the lower number of weed management opportunities available in wheat.

"Pre-emergent herbicides, post-emergent herbicides, competition and seed set control are all crucial in achieving this," he said.

The GRDC Grains Research Update paper 'Managing clethodim resistant annual ryegrass' is available at www.giwa.org.au/2016researchupdates.

For information on herbicide sustainability, visit the WeedSmart information hub at www.weedsmart.org.au. It outlines a 10-point plan – including information on testing for resistance – to help you win the battle against weeds.

Useful information is also available in the Integrated Weed Management in Australian cropping systems manual, available at www.grdc.com.au/minilWMM.

Information about sustainable integrated weed management (IWM) practices is available at the AHRI website www.ahri.uwa.edu.au



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Unique pod shatter reduction trait in new canola not a 'windy' claim

THERE'S nothing like a 100-kilometre per hour wind just days before harvest to test a unique pod shatter reduction trait in canola – and that's exactly what occurred during a trial of the technology last season on George and Barbara Burdett's property at Wickliffe, near Lake Bolac, Victoria.

The Burdetts have continuously cropped 900 of their 1000 hectare 'River Bend' farm since 1972, today growing wheat, canola, barley, faba beans and oats for hay. Triazine-tolerant (TT) and, more recently, glyphosate-tolerant canola varieties have been grown to help keep on top of difficult-to-control ryegrass.

Due to consistent strong winds in the region and the threat of canola pod shattering, George said they normally windrowed up to one-third of their canola as a risk management tool. But they consider direct harvesting to be more efficient and so were keen to trial the PodGuard shatter reduction trait in the Roundup Ready hybrid canola variety, IH 51 RR.

"If there's a chance of losing a direct headed crop before we actually get there and PodGuard could alleviate this issue, then it's worth trying," George said.

In conjunction with Bayer and local seed reseller, Gorst Rural, IH 51 RR was grown alongside IH 52 RR as two 4 strips within a 40 hectare paddock sown to GT-50 canola.

Emphatic success

George said after the 100 km per hour winds prior to harvest, the success of PodGuard was emphatic.

"There was a visible contrast. Shattered areas looked white and the IH 51 (RR) just looked like a normal, ripe canola crop."

"There was up to 0.5 tonnes per hour of canola shattered on the ground from all varieties except IH 51 (RR)."

At harvest, the paddock yielded 0.9 tonnes per hectare, while the IH 51 RR strip yielded 1.4–1.5 tonnes per hectare, up to highs of 1.9 tonnes per hectare.

"It was a fantastic yield for the season for the limited amount of rainfall we had and the frost damage prior to the winds," George said.

'River Bend' has rainfall data dating back to 1880 and the 2015 season was the fourth driest on record. The property received 239 mm during the growing period last year, compared with its 400 mm average. The average annual rainfall is 550 mm.

Delaying harvest option

George said, critically, the PodGuard trait would allow delayed harvesting, which could be beneficial for harvesting other crops, including to take advantage of good pricing, and also to assist crop-topping.

"It offers the flexibility of not having to rush in and harvest so early. When stalks are very green, it's very slow harvesting, even though the seed is ripe to harvest and the moisture content of seed is okay."

"With PodGuard, we may be able to harvest other cereal or pulse crops while the canola is still standing there. I would be fairly assured that the IH 51 (RR) wouldn't shatter."

Due to their normal canola harvesting requirement, the Burdetts have previously windrowed barley to access good early malting prices. The ability to delay the canola harvest could allow the opportunity to direct harvest the barley.

A decade of research

The PodGuard technology, developed by life science company, Bayer, over almost a decade, is designed to strengthen canola pods as they ripen.

It strengthens the dehiscence zone – the seam that runs along the top and bottom of pods and which breaks down as plants reach maturity – effectively allowing later windrowing or direct harvesting and opportunity for higher yields through reduced harvest losses. The reduced seed loss at harvest also limits volunteer canola the following year.

For the 2016 season, George said they would plant one-third of their canola production area to IH 51 RR with PodGuard, one-third to the TT variety, Wahoo, and the remaining one-third to another RR variety.

"I have no hesitation recommending IH 51 (RR) to other farmers if they want to direct head, because of the experience we had with the wind damage on everything else, which showed we can harvest an extra 500 kg per hectare," he said. ■



George Burdett, who farms at Wickliffe, near Lake Bolac, says the PodGuard trait in canola can allow delayed harvesting, which may be beneficial for harvesting other crops, including to take advantage of good pricing, and also to assist crop-topping.

India looking to wheat imports to satisfy domestic demand

■ By Nidera Australia analysts

UNFAVOURABLE weather conditions and dwindling stocks will potentially see India import a record quantity of wheat over the next 12 months.

After three years of bumper crops, India's wheat production has fallen short of domestic demand for the second straight year. In February, the Ministry of Agriculture reported plantings down over six per cent to 28 million hectares, and subsequent poor growing conditions across the major production states, has limited the 2015-16 production to as low as 84–85 million tonnes.

This is well below the official government forecast of 93 mt and with wheat demand estimated at 93.5 mt, the production shortfall would explain the rally in domestic Indian wheat prices over recent months.

Back in March, the Food Corporation of India (FCI) set a target to procure 30 mt of wheat for distribution into domestic food channels this season. More recently, the slow pace of purchases led them to reduce this target to 28 mt. This doesn't mean reduced demand. It is just the government saying lack of supply will ration demand and they will scrape through with less.

In mid-May, purchases under the procurement program seemed stalled at 23 mt.

There are two possibilities here. Either the Indian crop is smaller than official forecasts, as suggested, or it could signify Indian growers are holding out for higher prices. They wouldn't be alone in the world right now in wanting a better price for their product.

Indian government wheat imports are likely

The most likely scenario is it is a combination of both, which will see the Indian government stepping into the world wheat market to import 2 to 5 mt.

In mid-2015 wheat prices in India began to rise in response to the domestic supply issues. The falling global wheat price led to a surge in imports and the government reacted in July by imposing



After three years of bumper crops, India's wheat production has fallen short of domestic demand for the second straight year.

an import duty on wheat of 10 per cent. This was increased to 25 per cent in October as global wheat prices continued to fall.

This tax is up for review and there is speculation it will be reduced to 10 per cent as the government realises significant imports are needed to satisfy demand and protect domestic food security.

But this change is unlikely to occur before the end of June meaning any import program will not start until July.

This is certainly supported by heat from India spilling over into the local Australian market with more enquiry and more transactions in old crop wheat.

This is business the Australian market needs to see. And if it does come to fruition the trade will not need to be as aggressive in chasing alternative demand for Australian wheat for the rest of 2016.

That said – and with plentiful world stocks – Australia will not be the only origin looking to do business into India. The strong US dollar will ensure that French and Russian wheat keep the Australian seller competitive assuming the phytosanitary restrictions are solved.

More information contact the Nidera Australia Grower Hotline on 1300 643 372 or go to: www.nidera.com.au/



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Australian poultry industry crowing about growth prospects

AUSTRALIA'S poultry industry is poised to catch the next wave of growth, but needs to focus on alternative strategies to capture new opportunities, rather than relying on increasing per capita consumption, according to a new report by agribusiness specialist Rabobank.

In the report, *Catching the Next Wave of Growth*, Rabobank says strong growth – in both volume and value terms – is possible, but the Australian chicken meat industry should pursue the development of new export markets, higher-value propositions for consumers and productivity gains.

"Through the adoption of these strategies, our analysis indicates that the Australian poultry industry can achieve an average annual growth rate of 3.5 per cent over the next five years," says report author and senior animal proteins analyst Angus Gidley-Baird.

"This represents a moderation from the lofty growth rates of 5.9 per cent achieved in recent years, as the industry matures and domestic consumption stabilises, but it would still see production lift by around 40,000 tonnes per year – equating to an additional 109 million birds by 2021."

The report warns that unless there is an expansion into new export markets, growth in the poultry industry will be linked to population growth, which is expected to be fairly lacklustre at around 1.17 per cent per annum.

Developing new markets

The report says an increase in exports, to around 10 per cent of production, will be key to increasing volume and value in the Australian chicken meat industry.

"Currently, less than five per cent of Australian chicken is exported," he says, "but there are significant growth opportunities in South-East Asia – such as Indonesia, Thailand, Vietnam, the Philippines and Malaysia – as their per capita consumption increases."

Angus says while it would be difficult for Australia to compete from a total cost perspective, there are opportunities to sell different cuts and therefore complement the total return per bird.

"For example, the US exports dark chicken meat and non-breast cuts into the Asian market, which is not only preferred by these markets, but complements the US domestic operations to provide a higher overall value return per bird," he says.

Capturing a larger share of domestic consumer spending

Despite being the cheapest protein, the Rabobank report says "chicken is not necessarily the first preference protein for a price-conscious consumer".

"In Australia, consumers tend to trade down rather than move straight to the cheapest protein," Angus says.

With this consumer mindset, Angus says, the industry should look to expand its product offering by creating higher-value



Angus Gidley-Baird.

HOW MUCH GRAIN IS CONSUMED? – IT'S NOT CHICKEN-FEED

- In this report, calculations were based on 72 per cent of the ration for broilers being grain;
- The current annual production of chicken is 1.12 million tonnes;
- Based on a feed conversion ratio of 1.75, it's estimated that grain usage by the chicken meat industry for 2015 was around 1.9 million tonnes; and,
- Based on (the report author's) projections for the poultry industry to expand production to 1.37 million tonnes – with a probable slight improvement in feed conversion ratio to 1.7 – it's estimated that by 2021 the chicken meat industry will be consuming around 2.3 million tonnes of Australian grain each year.

products, which could potentially add a further five per cent to the overall value of the industry.

"By offering consumers a point of difference or the ability to recognise some of their values in the product (such as animal husbandry or management identifiers) there is the opportunity to extract more margin out of the market," he says. "For example, an organic, branded chicken breast steak with lemongrass and ginger marinade could capture the customer at a higher price point."

The report also highlights the rising social pressures for welfare-friendly and sustainable products such as slower-growing birds or sustainably-sourced feedstocks, which will add additional costs but may not attract additional margins.

Improving margins through productivity gains

The Rabobank report identifies three opportunities to increase value growth in the industry through productivity gains:

- The adoption of new technology;
- Realising economies of scale; and,
- Relocation of industry facilities to centralised operations.

"Industry growth should not be confined to a conversation around production, but instead have a greater focus on profitability," Angus says.

"For example, the implementation of new technologies such as improved monitoring to lift feed efficiency and improve air quality could lift productivity by five per cent. There are also opportunities for greater efficiency at the distribution level, with the use of sensors during transport helping to manage bird stress and welfare."

Angus says realising economies of scale will also lower costs per unit, while relocation in the industry can reduce transport and logistics costs by co-locating grain-growing, milling, chicken-growing and processing operations – with industry hubs established in regional towns such as Tamworth and Griffith.

More information contact Angus at: angus.gidley-baird@rabobank.com

Vietnam seeks Aussie expertise in agribusiness and education

AUSTRALIAN businesses, research and education institutions are encouraged to examine the growing opportunities in Vietnam's agribusiness sector.

In 2010, the Vietnamese Government set a target of 3.5 per cent annual growth in agriculture up until 2020. In order to reach this target, Vietnam is encouraging private-sector investment in the country's education, training, research and development sectors.

Agriculture is a critical component of Vietnam's economic development and food security. It generates about 22 per cent of GDP, comprises nearly 30 per cent of exports and employs over half the country's labour force.

Despite significant achievements in recent years, Vietnam's tertiary education system has been outpaced by the agribusiness sector's rapid growth. As a result, the nation is struggling to meet demand for qualified agriculture graduates, quality education providers and R&D staff and facilities.

The Vietnamese Government is implementing broad reforms to its education system to meet the needs of its agribusiness sector.

Ideal conditions for Australia

Janelle Casey, Austrade's Acting Senior Trade Commissioner for Vietnam, believes conditions are ideal for Australian organisations to showcase their training and research strengths, innovation expertise and new technologies to Vietnam's agriculture industry.

"Agriculture has always been a big part of the relationship between Australia and Vietnam, especially through the Australian Centre for International Agricultural Research's (ACIAR) long engagement in agricultural research, institutional partnerships and scholarships," Janelle says.

"By leveraging our existing relationships through ACIAR and strong education partnerships, Australia can help Vietnam build capacity and research collaborations. The Prime Minister's Global Innovation strategy also encourages future collaboration."

To help access the increasing agribusiness opportunities in Vietnam, Austrade recently hosted the inaugural Australian Agribusiness Research and Innovation Showcase in Hanoi.

The showcase, held in collaboration with the Australian Department of Education and Training, promoted Australian expertise and excellence in agribusiness, education and research.

Daniel Walker, CSIRO Agriculture's Research Director for Agriculture and Global Change, who was also a keynote speaker, said Australia and the Australian innovation system have a long history of engagement with Vietnam and there are many opportunities for new relationships going forward.

"With new horizons in agricultural sciences, new enabling platform technologies, growth in regional trade and new inclusive and sustainable business practice, the meeting provided the chance to build new partnerships," said Daniel.

The event also helped strengthen bilateral relations. Vietnam is currently Australia's 14th largest trading partner. In 2014, total two-way merchandise trade was valued at \$8.04 billion and two-way services trade was worth over \$2 billion.

Visit Austrade's website to read more about international business opportunities and upcoming events or contact Austrade on 13 28 78 or email info@austrade.gov.au

RECENT PROJECTS...

Rodent management systems for rice fields in Vietnam

CSIRO was involved in a project aimed at implementing rodent management systems in intensive irrigated rice production systems in Vietnam. Supported by ACIAR and in collaboration with World Vision of Vietnam and the Vietnamese Plant Protection Department, the project was designed to implement Ecologically-Based Rodent Management (EBRM) which can reduce rat damage, increase yields and reduce the reliance on rodenticides.

Climate change affecting cropping systems in the Mekong Delta

Funded by ACIAR in 2013–14. In collaboration with local partners Dragon Institute (Can Tho University), Southern Institute for Water Resources Planning, and Institute for Agricultural Sciences Adaptation, CSIRO researched the effects of climate change on rice-based cropping systems. The project assessed the socio-economic aspects of climate change, resilient rice production systems and greenhouse gas emissions from crop production systems.

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China ag reforms and food security

■ By Lauren Hooley, Global Food and Water Crises Research Program

CHINA AG REFORMS

- The Chinese Government has announced a wide range of agricultural reforms in its “1 Central Document” – its first policy statement of 2016.
- The document’s focus on the agricultural sector marks the 13th consecutive year that Beijing has listed agriculture as a top policy priority.
- It calls for supply-side reforms to increase quality and efficiency and reduce environmental pressures, while continuing to improve the lives of the rural population.
- The document emphasises the need to reduce the disparity between the oversupply of certain products – particularly grain – and undersupply of other high-quality products, such as meat and dairy.
- Concerns over food security are addressed by increased production capacity and an emphasis on green farming.

THE Chinese Government purchases domestic produce at artificially elevated prices to support the incomes of farmers and guarantee supply. This policy has enabled a country with just seven per cent of the world’s arable land to feed 20 per cent of the world’s population.

While it is a remarkable achievement, the policy has created a vast oversupply of grain – particularly corn – and exerts enormous pressure on the Chinese Government’s storage capabilities. China’s domestic store of corn reached 81.46 million tonnes in 2015, and is estimated to soar to 90 mt in 2016–17.

Government price maintenance undermines demand for Chinese corn by keeping the domestic price much higher than the international market, driving local companies to turn to cheaper imports. Demand is further eroded by a changing modern market.



China will ensure that land dedicated to farming never falls below 120 million hectares and increased attention is given to green development.

Between 2000 and 2010, per capita consumption of staple foods continued to decline, whereas the consumption of higher-value foods – such as poultry and dairy – experienced high growth.

There are inefficiencies between supply and demand in the Chinese market – soybean production, for example, does not match domestic demand. In 2015, the imported volume of soybean reached 81.69 mt, representing 80 per cent of domestic demand.

The ag reform document calls for a reduction in stockpiled products, such as corn, and an increase in the production of in-demand imported goods, such as soybean.

Call for increased efficiency and better quality

The document also calls for increased efficiency in Chinese agriculture through integration and specialisation.

The simplification of the land transfer process combined with higher subsidies for large-scale landholders will stimulate the development of farm co-operatives, which, in turn, will lead to larger and more specialised farms.

The promotion of integration and co-operation between the agricultural, secondary and tertiary sectors is likely to see a greater share of the proceeds made in China’s burgeoning food industry return to farmers.

The document emphasises the improvement in quality of both farming techniques and agricultural produce, which are vital to food security in China.

Arable land in decline

The amount and quality of arable land in China is in decline.

A report conducted between 2005 and 2013 found that one-fifth of Chinese arable soil was contaminated. Cadmium, nickel, and arsenic were the top pollutants.

The Central Document states that China will ensure that land dedicated to farming never falls below 120 million hectares and increased attention is given to green development. The document outlined a plan for 53 million hectares of high-quality farmland by 2020 to be farmed in an environmentally-conscious manner, able to withstand floods and droughts, and capable of producing stable yields.

Initiatives such as this will improve China’s ability to guarantee food security in a more efficient way than simply stockpiling harvests.

But the environmental reforms outlined in the document are limited in application and would require dedicated legislation to fully address the issue.

An improvement in the quality of agricultural products is vital to Chinese food security following repeated food scandals and a loss of consumer confidence. The document emphasised new national standards on food safety that would be prioritised to reduce the incidence of such scandals.

Agriculture Minister Han Changfu has said that there will be a “zero tolerance” approach to dealing with food safety violations and that offenders would face severe penalties.

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Cheers to the world's first gluten free beer

■ By CSIRO

THANKS to an Australian invention, the world's first gluten-free barley beer is now available in German supermarkets. CSIRO's Kebari barley has been used to make the world's first commercially produced, full flavoured, barley-based gluten-free beer.

This is especially good news for people with coeliac disease who could soon enjoy a greater variety of foods and beverages thanks to work by Australian scientists.

German beer brewing company Radeberger has used Kebari barley to develop the barley based gluten-free beer, Pionier, the first such beer under the German Beer Purity law Reinheitsgebot.

Scientists from CSIRO, with co-funding from the Grains Research and Development Corporation (GRDC), have bred the Kebari grain, a new barley variety with ultra-low levels of hordeins, the type of gluten found in barley.

"Using conventional breeding we've reduced the gluten levels to 10,000 times less than regular barley which more than meets the World Health Organization's recommendation for calling a grain gluten-free," CSIRO Principal Research Scientist Dr Crispin Howitt said.



Dr Crispin Howitt and Dr Phil Larkin celebrating the launch of Pionier gluten-free beer, the first product to use CSIRO's Kebari barley.

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CSIRO researchers standing in a field of Kebari barley.

In the future, this will provide more variety for the global population – including one to two per cent of Australians – with coeliac disease and people who avoid gluten in their diet. Diets that restrict grains can be nutritionally poor, high in fat and sugar and low in fibre.

"It's really exciting seeing the first product made with the malted version of our Kebari grain, we hope it's the first of many products," Crispin said.

"We're also working on a hulless version of Kebari which is preferable for use in a range of foods like breakfast cereals, soup, even pasta and flatbreads, which will be the first part of the next generation of gluten-free products helping people with coeliac disease to increase fibre, promote bowel health and enhance nutrition in their diet."

While Pionier beer is only available in Germany, CSIRO is continuing to explore opportunities with Australian brewers to develop a local beer using Kebari barley.

Once development of a hulless version is complete, there is a plan to work with manufacturers to bring a range of foods containing Kebari barley to Australian consumers.

While it is 'ultra-low' in gluten, Kebari grain cannot be called 'gluten-free' in Australia or New Zealand under the current Food Standards Code.

But the gluten level is well below 20 parts per million, the level recommended by the World Health Organization for classification as gluten-free, so in some other countries, like Germany, products made with Kebari barley can be classified as gluten-free.

The Walter and Eliza Hall Institute of Medical Research and The Royal Melbourne Hospital were involved in the early stages of the ultra-low gluten barley project.

Kebari is a trade mark of CSIRO.

THE BREEDING OF KEBARI

The first version of Kebari is a malting barley and was bred using varieties that are about 50 years old. As a consequence, Kebari is not well adapted to Australian conditions and yields are lower than more 'modern' varieties.

The seeds of Kebari are also smaller than those of traditional malting varieties, which also contributes to a lower yield.

The need for absolute segregation from gluten containing grains – and a reduced yield in the first version of Kebari – means that the grain is a premium grain.

"It's been compromised in some ways, but already the breeding coming along behind that is correcting those deficiencies," CSIRO's Dr Phil Larkin said. "So there are improvements coming, both with the malting version, the beer version, and for the food version – we anticipate the grain will be a premium grain."

Tonnages involved

Around 70 tonnes of Kebari were shipped to Germany in 2015 and we are shipping a similar amount in 2016. Production was done under closed loop contracts. We are anticipating production in this season to be two to three times greater than last year.

The CSIRO team is now working on a whole grain version of Kebari which could be used to develop nutritious gluten-free foods such as pasta, cereal and flat breads. Work is now underway to stock up on the wholegrain Kebari barley so food experimentation can be intensified.

"We have to get it into the hands of the food manufacturers," said Phil. "The properties will be different, even to a normal barley in some respects, and that has to be put to the test."

"But we've done a little bit of preliminary testing and we've got a pretty strong sense that there's some products that will be possible and that they will be wanted products."

Collective action can minimise barley disease losses

GRAIN growers are encouraged to take early, collective action to help reduce the risk of yield losses due to barley diseases this season. To underline this point, Department of Agriculture and Food (DAFWA) researcher Kith Jayasena said he had observed high levels of barley leaf rust and barley net-type net blotch (NTNB) in regrowth barley in the Great Southern region of Western Australia.

Kith is conducting DAFWA research under a Grains Research and Development Corporation (GRDC) funded project which aims to reduce costs and losses attributed to crop diseases.

He said barley growers would need to pay particular attention to leaf rust and NTNB this season as some barley varieties were more prone to these diseases following a breakdown in resistance to leaf rust in 2013 and detection of new strains of NTNB.

The Centre for Crop and Disease Management (CCDM) also reported last year that it had discovered a population of NTNB resistant to the triazole (DMI) fungicide tebuconazole and some other types of triazole fungicides.

"Strategies that can help minimise the risk of yield losses include destroying the 'green bridge' including barley volunteers and weeds (to reduce rust carry-over); using appropriate seeding strategies; monitoring emerging crops for signs of disease; and considering using a registered foliar fungicide if the variety is susceptible to the diseases found," Kith said.

"Seeding strategies include avoiding seeding barley on barley; choosing varieties with good disease resistance; using registered seed dressings or in-furrow fungicides; and avoiding a high seeding rate."

Following seeding, growers can consider

- Avoiding high nitrogen rates early in the season which can generate a bigger crop canopy, favourable to disease development.



Net-type net blotch evident in Oxford barley regrowth in the South Stirling area of WA in March, 2016.

- Applying potassium fertiliser to crops deficient in the nutrient six to eight weeks after crop emergence.
- Using registered foliar fungicides.

"I encourage growers to monitor the early development of crops for leaf disease symptoms and to consider using a registered foliar fungicide if the variety is susceptible to the diseases found," Kith said.

"A second spray may be necessary. Whenever possible, rotate fungicides with different actives to reduce the development of fungicide resistant pathogen populations."

Kith is currently conducting studies to determine how new barley varieties with 'adult plant resistance' – a relatively durable form of resistance to disease – respond to fungicides to control leaf rust.

More information about barley leaf rust management is available in a GRDC Hot Topic at www.grdc.com.au/BarleyLeafRust, while more information on NTNB can be found on the DAFWA website by searching 'net blotch'.

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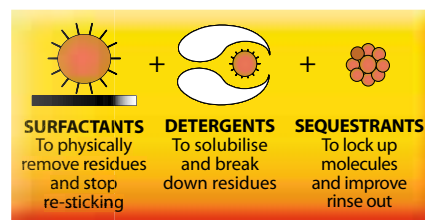
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USDA Nematode Collection is a global resource

■ By J. Kim Kaplan, Agricultural Research Service – USDA

AT A GLANCE

- The USDA Nematode Collection has thousands of stored specimens.
- Harmful nematodes cause \$100 billion in global crop damage annually.

MORE than \$1 billion US dollars worth of US wheat has been sold to Brazil since 2000, thanks to the presence of a seed gall nematode in the USDA Nematode Collection.

Just a few years before then, Brazil had imposed a ban on US wheat imports in fear of also importing wheat seed gall nematodes. But in 2000, Agricultural Research Service scientists proved to Brazilian authorities that a similar pest was already in Brazil. The proof was a slide of a seed gall nematode that had come from Brazil in 1953.

This single slide of an obscure specimen in the USDA Nematode Collection, plus an examination of US wheat by visiting Brazilians, got the ban cancelled, reopening a significant export market for US wheat.

"Had this 47-year-old nematode not been in our collection, export to Brazil could have remained closed for years," says ARS zoologist and Nematology Laboratory research leader David Chitwood. "That shows the value of maintaining a collection like this for the long term."

Nematodes are Earth's most numerous multicellular animals and include species that feed on bacteria, fungi, plants, insects, and animals. Some nematodes are beneficial, but others cause major damage. Root-knot nematodes alone cause 5 per cent of all crop losses around the world each year. In total, nematodes cause \$100 billion in global crop damage annually.

Hard to determine 'friend or foe'

But identification of nematodes as friends or foes, knowledge that is important to many – from farmers to trade inspectors to public health officials – is based on a few physical structures that are very hard to differentiate, or even see, most of the time. And worse, these key structures can vary within a nematode species by life stage, sex, and just in general.

"You can see why nematodes are so hard to identify," David says. "In addition, there are thousands of nematode species that have never been named."

This makes the USDA Nematode Collection, with its thousands of stored specimens, the most important reference guide in the world for identifying nematodes.

For example, in a recent six-month period, USDA's Animal and Plant Health Inspection Service sent the collection 400 plant, soil, and nematode samples – 97 per cent of them urgent – to



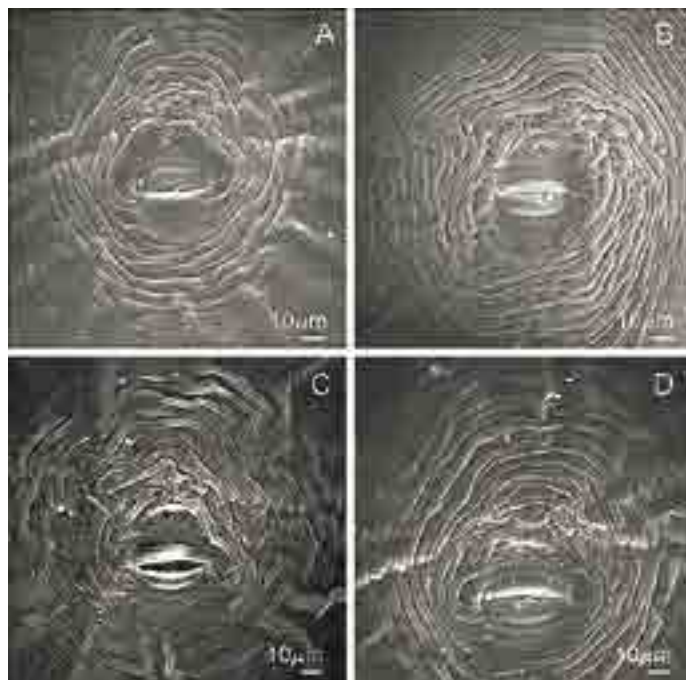
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The fingerprint-like structures on this female root knot nematode help scientists to identify it.
(Image courtesy of ARS Nematology Lab)



ARS nematologist David Chitwood (left) and microbiologist Zafar Handoo examine some of the nearly 50,000 slides and vials in the USDA Nematode Collection. (PHOTO: Stephen Ausmus)

identify nematodes intercepted at ports-of-entry or taken during domestic surveys.

To do so, it helps to have an expert on staff like collection curator Zafar Handoo.

Zafar, an ARS microbiologist at the Nematology Laboratory, made the official identification of the nematodes found in soil samples from Idaho potato-processing plants in 2006. Just six pale cyst nematodes (PCN) were found among thousands of bags of soil. But their identification resulted in suspension of US fresh potato imports by Mexico, Canada, South Korea, and Japan, and kicked off a \$70 million monitoring and control campaign to reopen the markets. Mexico, Canada, and South Korea eventually dropped their bans – except from PCN-regulated areas – and Japan allows very limited imports of US fresh potatoes today.

Available to researchers around the world

In addition to serving as the identification reference, the collection also makes its slides available to researchers around the world. Many of the collection's specimens are unique.

"Our oldest slide was collected in 1890 by Nathan A. Cobb, the father of nematology," says David. "There are other remarkable slides of nematodes collected at USDA's Arlington [Virginia] Farm. Some of these have never been found anywhere else, and that soil was paved over when the Pentagon's parking lots were constructed."

Among the more unusual subcollections is a group of marine nematodes from a German exploration of the South Pole in 1901. These may sound esoteric, but not that long ago they were requested by a Belgian researcher who used them to help revise the taxonomy of this group.

What does the future hold for the collection? The lab would

like to build a library of DNA fingerprints to complement the morphological (structural) identifications.

"You have to be sure you have an identification correct before you make a DNA reference standard. Unfortunately, there are many nematode species for which we lack reference DNA," David says.

The lab also plans to make detailed micrographs and drawings of nematodes and identifying parts accessible on the Internet.

"Global trade is growing, and that means problem nematodes could have greater opportunities to spread if everyone doesn't stay alert," David says. "People have tried to create computer programs to automate identifications. But they have never been able to develop any program that can deal with all of the complexities like a scientist with a good eye and a lot of experience can."

The USDA Nematode Collection was published in the May 2016 issue of AgResearch Magazine.



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Adapting crops to the bittersweet impact of rising CO₂

THE predicted increase in carbon dioxide levels in the atmosphere is bittersweet news for the nation's grain growers.

Research partly funded by the Grains Research and Development Corporation (GRDC) has shown that elevated carbon dioxide (CO₂) increases growth and yield in wheat, peas and other crops by on average 25 per cent, but at the same time decreases protein content in wheat grain by up to 15 per cent.

Other positive and negative crop production responses have been recorded during the studies into the effects of elevated CO₂ levels predicted for the year 2050.

The research, being undertaken by the Victorian Government and the University of Melbourne at the low rainfall environment Australian Grains Free Air CO₂ Enrichment Facility (AGFACE) at Horsham, will assist in the development of crop adaptation strategies to enable future increases in crop production.

Dr Glenn Fitzgerald from the Victorian Department of Economic Development, Jobs, Transport and Resources (DEDJTR) says AGFACE studies into the effects of elevated CO₂ levels on crop production have been carried out over the past nine years.

Speaking at recent GRDC Grains Research Updates, Glenn said with atmospheric CO₂ levels predicted to rise, it was important to understand both the positive and negative impacts that were likely to occur, to prepare farmers and the agricultural industry for the future.

"By conducting studies now into the response of crops

under the levels of CO₂ we anticipate for 2050, we have time to develop adaptation strategies," Glenn said.

"These strategies will need to consider elevated CO₂ impacts on crops to accentuate the positive effects (such as traits to enhance yields) and to overcome the negative aspects (such as reversing reductions in grain protein and bread quality).

"This will allow continued improvement in yields despite changes in climate."

What we know

AGFACE research has so far shown that elevated CO₂:

- Increases growth and yields in wheat, peas and other crops by on average 25 per cent – but with a large range from 0 to over 70 per cent – depending on variety and location;
- Decreases protein content in wheat grain by up to 15 per cent;
- Increases water use efficiency by on average 25 per cent, but water use may only be reduced slightly;
- Decreases bread loaf volume and other quality factors;
- Increases the incidence of barley yellow dwarf virus;
- May reduce the impacts of heat waves near anthesis (flowering).

Simulating higher CO₂ levels

Atmospheric CO₂ levels have risen from 280 parts per million (ppm) in 1870 to 405 ppm in 2015. This concentration is predicted to increase to 550 ppm by 2050.

Work being undertaken at the AGFACE facility has been simulating such atmospheric levels of CO₂ in experimental field trials in which crops are grown in octagonal rings, comprising metal pipes that emit CO₂ into the wind.

Crops in half of the rings are subjected to elevated CO₂ and the other half are grown under current ambient concentrations, so future and current conditions can be compared.

Various treatments have been tested, including times of sowing, different irrigation levels, and different varieties of wheat, field peas, lentils and canola.

Nitrogen use efficiency responsiveness and nitrogen management treatments are currently being tested.

Glenn said there were several AGFACE sub facilities as well as glasshouses and chambers used for more controlled studies for physiology and pest and disease assessment so the mechanisms can be understood to inform pre-breeding adaptation strategies.

Computer simulation is an important tool to synthesise results from AGFACE, particularly where information is not easily obtained from field studies.

Results need to be taken in the context of other possible implications of climate change, including changes in temperature, average annual rainfall and seasonal rainfall distribution.

Integration with economic data will also be valuable in understanding farm-level impacts.

Ongoing research includes synthesising years of AGFACE data to provide a glimpse into future impacts of elevated CO₂ under a range of possible environments.

"This will provide information for development of adaptation strategies for trait selection and management practices (such as sowing time and nitrogen management) to take the most advantage of elevated CO₂," Glenn said.

More information about AGFACE research can be found at <http://www.piccc.org.au/agface>



Dr Glenn Fitzgerald, pictured explaining the work being undertaken at the AGFACE facility at Horsham, says by conducting studies now into the response of crops under the levels of CO₂ anticipated for 2050, industry has time to develop adaptation strategies. (PHOTO: Simone Dalton)

Scouting the Hermit Kingdom

■ By David Dowling

AT *Greenmount Travel*, we often come up with ideas of new places to visit and adventurous farming areas around the world. But all the reading and Googling doesn't answer all of the questions.

The only solution is to do some on-ground, personal investigation. So, in late February, I bravely set out to do some 'ground truthing' for our tours to North Korea and the Silk Road Sojourn this year. Needless to say, it was a fascinating experience.

Scouting in North Korea

For four days in late February, I covered the transport in and out of the country, all of the activities in Pyongyang and a visit to Kaesong and the Demilitarised Zone (DMZ).

The short story

I felt totally safe and secure at all times. As is appropriate in the last Stalinist state on the planet, there were plenty of stern faced officials and soldiers around, but they weren't threatening.

My guides and driver were very capable and lots of fun. We had plenty of laughs and I really enjoyed their company. You can make jokes about most things except the Kims – who are definitely not a laughing matter.

The meals in the local restaurants were superb. On the other hand, I have no idea what the average person ate at home.

The drawbacks were the expected ones. Especially restrictions on freedom of movement – you can't go anywhere without your guide. The border guards checked my phone and laptop on the way in – looking for anything of South Korean origin or subversive American movies such as *The Interview*. They also checked my phone on the way out and deleted many of my photos – often seemingly innocent shots of people working in the frozen fields.

The propaganda which idolizes the Kims never lets up, but it is also one of the things which makes the place so different. As

you would expect, after a lifetime of this propaganda, the people view the world a little differently. Well, a lot differently.

The flight into North Korea

The North Korean national airline is Air Koryo – a 2 or 3 star airline with a fairly modern plane and service as good as most. But the airline does have some quirks – one tip is to eat before you leave.

The in-flight entertainment consists of what appears to be a single (2 hour) song from the Moranbong girl band – a group of attractive ladies dressed in various uniforms and backed by a large army band playing musical numbers which presumably either extol the overwhelming virtues of the three Kims, or



One of David's North Korean guides proudly introduces him to the spy ship USS Pueblo, captured in 1968.



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A 750 hectare co-operative farm south of Pyongyang. Any photos of people working in the fields were deleted from my phone at the border.

denigrate the imperialist enemies (US) or their traitorous, cowardly gangster allies (South Korea).

Our farm study tourists were destined to see a lot of the Moranbong girls during their visit – they seem to be the only musical performers in the country and were hand-picked by the Supreme Leader Kim Jong-Un.

Some no-nos

If you photograph the statues of Kim Il-Sung and Kim Jong-Il at Mansudae, you must include ALL of the statues in the photo. If you cut off one of their hands or head for example, you may lose the camera/phone if it is checked.

If you have a newspaper/magazine with a photo of one of the Kims, do not fold it where the photo is – don't cut them in half.

The roads and city

The main roads in Pyongyang itself don't have much traffic, so it is a good city to travel around. The road down to Kaesong and the DMZ (the re-unification highway) is wide and mostly very good. The car I was in sat on 110 kph most of the way.

Pyongyang city is quite impressive, with plenty of open squares, monuments and public buildings. Noticeable is the almost total lack of advertising.

In the morning, some of the public squares are filled with flag-waving dancers, encouraging the commuters to work hard and produce lots of things.

At each traffic light, there is also a traffic cop (usually a woman) in a distinctive blue uniform and baton to make sure everyone obeys the rules.

The propaganda

Basically, this is a country in a self imposed time warp. Their focus remains on the Korean war, which "ended" over 60 years ago. But it never ended for them – the armistice was just considered a step on the path to eventual re-unification. The propaganda focuses on:

- The glorious victory in the anti-imperialist war (World War II) against the Japanese, led by the Great Leader President Kim Il Sung (he is still called the President).
- The victory, again led by Great Leader President Kim Il Sung against the imperialist war mongers (the US) and the traitorous, cowardly South Korean leaders. No mention (unless asked) that the Chinese helped out with around 1.5 million men and the Russians with planes and weapons to fight a war which ended in a draw.



My two guides at one of the beautiful Pyongyang subway stations. I wasn't allowed to leave the hotel without them.

- The total worship of Great Leader President Kim Il Sung, Great Leader General Kim Jong Il, his son and the current Great Leader Kim Jong Un. Along with the Moranbong Girl's band, they dominate the television. A good tip is to avoid television altogether but it seems to be compulsory to have one blaring in every public place.
- All organisations (including farms) measure their worth by the number of visits they received by one of the Great Leaders, or a commendation or positive mention by one of the Great Leaders. These scraps of praise are preserved for posterity. If Kim Il Sung sat in a chair when he visited, you can be sure the chair has been kept for "posterity," proudly displayed and not sat upon by another soul.

The political situation

Obviously, things are very tense in the area right now, but I didn't pick up any dislike of westerners because of this. Most people in the street just ignored me – probably the safest option.

But the guides and others are very friendly and surprisingly open in their conversations. They have been brainwashed from birth, perhaps more than any other group of people in (recent, at least) history, so, not surprisingly, they have developed a certain view of the world which doesn't always correspond with our view of things, or with any known reality.

The farms

I visited one cooperative farm on the return from the DMZ. After enduring the normal tour of the farm "museum," what I saw was quite impressive given the fact that it was still winter. The farm consisted of 750 hectares of irrigated rice, with a claimed average yield of 10 tonnes per hectare.

On the steeper country, they grow some potatoes and it looked as if there was plenty of corn stubble. Also fields of stonefruit and, apparently, mulberries for silkworms.

About 1000 people live and work on the farm and they have comfortable small houses with compulsory vegetable plots and fruit trees. The labour is organised into work groups of about 100 people, each looking after about 100 hectares of rice or equivalent. There is also a tractor/machinery group and groups for the piggery, cattle feedlot and the fertiliser factory. Presumably this uses manure, stubble etc to produce a compost to spread on the rice fields. There were piles of what seemed like compost in each field we passed.

The train out

On the way out, I caught the train to the Chinese border at Dandong. The train is not fast and not flash, but the carriages are clean and it is an interesting journey.

It only takes about five hours to get to the border, but this is where the fun starts. The train sits at the station on the North Korean side for two hours while passports are collected and bags and cameras, phones, computers etc are searched.

Customs officials deleted a number of photos from my phone – mostly pictures I had taken from the train window of people in the fields. It seemed fairly arbitrary, but I lost many of my pictures of the cooperative farm.

The platform is well guarded and the border guards cultivate an air of menace about them. They also seem to help themselves to any cigarettes and food that takes their fancy.

Eventually the train will move to the Chinese side of the Yalu River border and out into the streets of the bustling Chinese city of Dandong – a stark contrast to the country you have just left.

When I described all this to a Chinese friend a few days later, he said: “It sounds like China 30 years ago,” which is very apt.

Overall, a fascinating experience. The facilities and transport were better than expected. The people I met were really nice, and I'd be happy to go back again. ■

SILK ROAD SOJOURN – FARM STUDY TOUR DEPARTING JULY 3

My scouting trip for this three week tour departing in July focused on western China (Xinjiang) and Kazakhstan – places we hadn't taken tours to before.

Xinjiang

On previous tours, we hadn't ventured west of Urumqi, so this was part of my quest. First of all, the roads are amazing. Four lane divided highways all the way. The car I was in sat on 140–150 kph past some big farms and right at the base of the spectacular Tien Shan mountains. Although the country was frozen, the fields on each side had either dates or cotton and corn stubble, often with sheep or cattle grazing in them.

A highlight was the frozen Lake Sayram, the largest mountain lake in China. By July, the bare and frozen hillsides will be covered in green grass, wildflowers and the yurts (tents) of the nomadic herders. The herders are a mixture of Uyghers (Oy-Gurs) and Kazakhs.

After leaving Sayram Lake, the road goes through a truly spectacular series of high bridges and tunnels as it falls to the scenic Fruit Valley and to the mouth of the Ili Valley. The Ili Valley is a very fertile productive area which stretches as far as the Nalati grasslands, where we will spend a couple of nights in July. This rich grazing and farming country has been a favourite for conquerors for centuries – including Genghis Khan.

Kazakhstan

The largest city, Almaty, has a beautiful mountain backdrop and has a real European feel to it.

Kostanay and the north west

From Almaty, I flew to Kostanay, in the far north west of Kazakhstan, about 150 km from the Russian border. This part of the country is just as Russian as it is Kazakh, with both languages spoken (I couldn't tell the difference).

It was about minus 15°C when we landed in Kostanay and I was met by Madina Brimzhanova, who will be our guide in July.

Madina has the perfect background for this – she trained as an English teacher but now works as an agronomist on a large farm. She is also completing a Masters degree in agriculture and has a great interest in no-till farming techniques. She has also travelled to Australia several times and knows a lot of our farming areas.

The first stop was the Kostanay Mechanisation Institute where I met with several large farmers and some of the researchers. In a surprise move, they grilled me for a couple of hours about Australian farming – I was supposed to be the one asking questions. They must have been reasonably satisfied because they took me to lunch and introduced me to the local drink – vodka of course.



The spectacular infrastructure to promote western China.

Across the Kazakhstan steppes

The following day we drove for about 450 km through a vast snow covered plain to the town of Kokshetau. The road was covered in ice and the temperature didn't get above -3°C all the time I was in Kazakhstan.

The same road in July will be totally different. Instead of snow, there will be fields of wheat and canola stretching into the distance. We have organised a visit to a 'small' farm (7500 hectares) and a 'large' farm (23,000 hectares) with a picnic lunch on the way.

The following day we will take a short drive to DAZ, a joint German-Kazakhstan demonstration farm, part funded by a range of international firms – mostly machinery companies. We will have a specially prepared field day, looking at the demonstration trials followed by lunch and a short question and answer session.

The 'new' capital of Kazakhstan is Astana, a planned city with some stunning architecture and public places.

Overall, Kazakhstan was a revelation. Beautiful scenery, friendly people and some really interesting farming. I can't wait to get back there in July.

STILL TIME TO JUMP ON BOARD

If your passport is current, it is still possible to join the Silk Road Sojourn with *Greenmount Travel*. See www.greenmounttravel.com.au and also call David on 0437 000 234 to get the ball rolling.

Local trials give a head start on best weed control

CONTINUED strong investment in crop trials allows SA-based rural services company YP AG an early insight into new solutions for the region's growers. YP AG has had major technology centres in the northern and central areas of the Yorke Peninsula and last year coordinated multiple sites in these areas, plus additional sites with product suppliers, including Bayer.

Daniel Hillebrand, who has spent five years with YP AG – including four years focused on trials whilst based at Maitland – said the business conducted a major trials program on the peninsula.

"We do trial work up to three to four years prior to the release of products, so this gives us a head start on them," Daniel said.

"We look at the label rates and double rates, pushing the tolerances, and we also do a lot of mixes.

"We generally do four replications, although this year we will wind that back to three to fit in with farmers' boomsprays."

Weed control in lentils

Last season, YP AG coordinated its first joint trial with Bayer at Maitland, investigating the use of the Group K pre-emergent herbicide, Sakura, in lentils, which has since been added to the product label.

Sakura was compared with standard farmer applications as well as Boxer Gold herbicide in the trial.

"On the Maitland soil it looked very safe, whereas Boxer Gold surprisingly touched up the lentils a fair bit," Daniel said.

"Maitland is a higher rainfall area and has heavier soils, so the next step is looking at it on sandy soils, where a higher likelihood of damage would normally be anticipated."

Containing the active ingredient, pyroxasulfone, Sakura controls annual ryegrass, barley grass, silver grass, annual phalaris

and toad rush and also suppresses wild oats (black oats) and brome grass in wheat (not durum wheat), triticale, chickpeas, field peas and lupins, as well as lentils.

Daniel said Sakura had become a popular choice for the wheat phase of growers' cropping rotations, with Boxer Gold used in barley.

"Sakura and Boxer Gold have been massive. About 90 per cent of my grower clients use Sakura on wheat."

Extended length of control

"What we have seen in trials and on-farm with Sakura is its length of control. That is why I prefer to use Sakura over Boxer Gold in wheat. With the past couple of seasons having warmer starts and the cold weather coming in later, ryegrass can sneak out late and some products run out of puff."

He said Sakura was particularly preferred for wheat-on-wheat and was taking over from Treflan and Avadex Xtra in these situations.

"Treflan with Avadex isn't stacking up anymore. It's no good in high stubble situations."

"If a grower still wishes to go with Treflan and Avadex in wheat-on-wheat, I now advise that they burn to get the most out of it."

Daniel said Sakura had helped growers to better control ryegrass, with brome grass and wild oats now becoming more concerning. But he said trial work with Sakura and Avadex Xtra on brome grass had shown good results in some situations, so he has recommended growers use this mix when required.

Daniel said growers have been fantastic at employing other strategies to aid weed management, including crop-topping high population areas of paddocks and growing pulses and Clearfield barley.



Bayer Territory Sales Manager Graham Hatcher and Daniel Hillebrand, YP AG, pictured discussing some of the latest developments in weed control.



ASK AN EXPERT – COULD HERBICIDE RESISTANT CROPS BECOME WEEDS IN THE BUSH OR ALONG ROADSIDES?

■ With Roberto Busi, Research Fellow, Australian Herbicide Resistance Initiative

BACK in 2009, before the commercial release of transgenic canola in Western Australia, some windrowed Round-up Ready (RR) canola plants from a trial site were blown into an adjacent area of bushland during a storm.

For the next four years, Roberto Busi, a weeds researcher at The University of Western Australia monitored the site where the plants had shed their seed.

"Plants established in a on-farm bushland area that wasn't actively managed for weeds," says Roberto. "We monitored the population each year, counting the number of plants, recording plant traits and measuring the amount of seed the plants produced."

"By 2013 the RR canola population was extinct on this site," he says. "Research done in US, Canada, Europe and Japan shows that canola can establish and grow outside agricultural fields but generally doesn't persist. Our data shows that, in Australia, transgenic RR canola doesn't persist for more than three years."

What if RR canola in non-farming areas is actively managed with herbicide?

Short answer: It can persist for longer if other plants around it are removed.

Longer answer: At another site, we monitored RR canola plants growing in a median strip area near a grain depot. This median strip was sprayed repeatedly with glyphosate – which removed all other plants – leaving the RR canola to grow without any competition for resources. These plants grew well and produced large quantities of seed.

Is it possible to control RR canola in these situations?

Short answer: Yes, it just requires a change in management.

Longer answer: RR crops remain susceptible to a wide range



When these canola plants were treated with glyphosate, only the non-transgenic plants died, leaving the RR canola to grow without competition. As soon as a herbicide mix was applied, along with mowing and hand weeding, the site was weed-free again.

of herbicide modes of action. So although they will thrive if the affected area is treated with glyphosate alone, the addition of a different herbicide will effectively remove these plants.

We monitored this median strip for two years and in that time the roadside management team introduced the use of different herbicide mixes, mowing and hand weeding to remove the RR canola plants from this site.

Does RR canola pose any additional weed threat along roadsides or in non-crop areas around farms?

Short answer: No, provided land managers are aware that they must not rely on glyphosate alone in these areas.

Longer answer: All herbicide resistant crop types have the potential to become volunteer weeds in-crop and along roads and fences. Strategies must be put in place to rotate herbicide groups, as well as non-herbicide tactics like mowing, weeding and even haymaking, to control volunteer plants. ■



UWA Research Fellow, Roberto Busi monitored sites where RR canola had established as a weed and has shown that RR canola does not persist in the environment for longer than three years – the same as conventional canola varieties.

HOW TO ASK A WEEDSMART QUESTION

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

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

Farming in Foreign Fields...

Efficiency and technology fit into the concept

ON a guided tour of the farmyard and land of farmer Harald Schmieg, located in a scenically beautiful part of south central Germany near Gerichtstetten, one thing rapidly becomes clear – this farmer has a very entrepreneurial approach to business, he is driven by clear visions and he implements these in an ambitious manner.

At an early stage after taking over the farm, Harald recognised that he was obliged to make a traditional operating concept ‘fit for the future’ – for example with tethered housing for the cattle.

“At this point, we know that the only way forward was towards specialisation, and that we had to penetrate new markets,” reminisced Harald.

Very quickly, the course was plotted and set. Instead of cattle, he switched to pig-rearing. In the newly constructed external climate shed, pigs are now reared for the Schwäbisch-Hall producer group, but only after the market situation turned profitable.

“During foreseeable low-price periods, we shall also dispense with this shed facility,” says Harald.

Energy – the new string to the farming bow

At an early stage, and right at the end of the 1990s, he also recognised the opportunities afforded by sustainable energy sources, and was one of the first farmers to engage in the business of generating electricity from solar power. This started with a solar power system on the roofs of his traditional farm buildings.

“At that point, we identified the growing demand within the farming sector, and we founded a company to service farmers with modules, then later with a turnkey service. Later, this led to our opportunity to enter the photovoltaic components trade,” recounted Harald.

For the last 12 years, Harald has been sole proprietor of EKS Solartechnik GmbH, a company providing solar products and services right across Germany. This not only includes a broad product portfolio of leading PV system manufacturers but also individual project planning, support during all stages of a project right through to turnkey handover of completed systems.

In addition, Harald and his team undertake service and maintenance work.

Optimising arable farming

But arable farming remains an important supporting pillar in his business.

“Over the last few years, we have been able to gradually extend the amount of land we cultivate, and we are now up to about 200 hectares,” Harald explains.

“Mind you, one thing has been clear to us throughout this period – some of the shell limestone land is very stony, and an appraisal of its productive capacity yielded a score of 25 to 50 “soil points” (a German soil rating system where 100 is considered the best soil).

“We also have great fluctuations in the soil characteristics



For the past 12 years, solar power has been another key revenue source for the Schmieg farm.

of the truncated terrain, so we cannot afford any cultivation luxuries."

Enhanced efficiency and low work completion costs are an important prerequisite here to achieve profitable crop yields from wheat, corn, barley and rapeseed (canola) and – traditional within this region – spelt, which is enhanced to provide unripe spelt grain.

"Here of course, cooperation is a vital aspect of any meaningful approach to cost reduction. We closely cooperate with a neighbouring farm. We have, for example, outsourced the entire pesticide application process and we focus on just a few areas that we then tackle with great gusto to get the job done swiftly."

To this end, Harald relies on a fleet of Case IH and Steyr tractors. The latest addition is a new Puma with rated power of 185 hp, and since the 2015 harvest, an Axial-Flow 6130.

"Our experience shows us that the agronomically viable window is getting progressively smaller, due not least of all, to climate change," Harald says. "To this end, we must keep our machinery fire-power ready and available to make optimum use of that window when it arrives – whether for fertiliser spreading or, and most especially, during harvesting work."

"The Case IH machines are an excellent 'fit', and not just because of their price-performance ratio. Maximum efficiency is also delivered through technology such as the fuel-efficient FPT engines."

Compact and not too many driven parts

"When we purchased the new combine harvester, we did of course take a look at a wide range of different concepts. But the Case IH Axial-Flow 6130 scored highest in several respects," Harald explains.

"A compact design, a gentle and loss-free threshing action and, most especially, the drive concept – all of this really appealed to us."

"The same applies to tractors. The entire operating concept is simple, intuitive to operate, very reliable and employs low-maintenance technology, paired to a robust build quality – this is what makes the tractors so special."

A very reliable level of service support was also an important factor. Harald has maintenance done on-farm by local dealers, Bach Landtechnik.

"Naturally, the dealer has a decisive role to play nowadays, not just in terms of sales but also in terms of ongoing support. The machines and vehicles require more maintenance and the investment costs are rising significantly. I need a high level of service support that I can rely upon."

What comes next?

No-one should be surprised that Harald is already implementing the next project in his program of continued development.

"My son is about to go and study Agriculture and he would like to continue to help in running the family farm – which means we can look to tackle new projects together."

"I see a great demand for the further improvement of solar power systems, particularly in respect of in-house energy needs. That would deliver significantly greater energy autonomy. The combination of supplying power to the national grid and servicing domestic needs is one that, in our view, necessarily leads to greater economic viability," Harald says.

"For example, new technologies enable us to store surpluses that we can then make use of during the evening hours. I believe that a concept of this kind fits very well with a great many agricultural businesses. That would make it possible to achieve energy autonomy levels of up to 70 per cent."



On Harald Schmiege's 200 hectare arable farm in south central Germany, efficiency improvements and low work completion costs are important factors.

Harald is also embarking on a new energy farming project. He has taken on the planning of a community-owned wind farm in the region.

"This also fits very well into our business model. Wind power also demonstrates that active environmental conservation and profitable investments can go hand-in-hand."



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A new solar option: Cheap energy for farm businesses

AT A GLANCE

- Businesses seeking Solar as a Service have a relatively consistent and solid base load energy requirement. Any business with adhoc or low energy requirements during daylight hours will see reduced benefits from solar. To drive the best economic return, aim to off-set energy usage rather than producing more energy than the site requires (and exporting it into the grid).
- Savings will vary based on location, roof tilt, roof orientation, amount of available roof space, the percentage of electricity they use during the day and grid electricity rates and structure (now and into the future). Essentially each system is tailored to the specific requirements of the business.
- The ideal unshaded roof would be north facing with a 20–30° tilt (location dependent).

WITHIN the agricultural industry, most businesses believe that energy prices can be a burden. In these businesses where heavy machinery and equipment is required for long hours, energy costs are a constant. So it is not surprising that businesses in this industry have been quicker than those in other sectors of the economy to realise the benefits of solar.

For Terry Burgi, owner of Burgi's Coolstores, based in Victoria's

Yarra Ranges, the decision to go solar was an easy one. With a storage facility that requires 24 hour refrigeration, as well as an irrigation system, he was concerned about his energy costs but also interested in reducing his carbon footprint.

Since installing his system, Terry has already started to see the benefits of energy cost savings and having a positive impact on the community and the environment.

"Carolyn and I basically have a philosophy of leaving things better than we found them," says Terry. "And part of that philosophy is to utilise something like solar energy that cuts down on the demands on the wider electricity grid – and it's cheaper."

No capital expenditure option

While Terry purchased his solar system outright, Origin has recently launched a new service that allows business owners to access solar power at a low rate during the day without capital expenditure in a solar system.

According to Phil Mackey, General Manager, Solar and Emerging Business, Origin, "Solar as a Service provides business with a simple way to save money on their energy bills by providing them with access to low cost solar energy at a lower price than they are presently paying for their grid energy."

"Plus the business does not have to pay for the system or worry about ongoing maintenance as Origin owns the system and looks after all this. This option is ideal for companies with unshaded roof space, who plan to be in their premises for the long term and who operate during the day."



The ideal roof for solar panels faces north and depending on your location has a 20 to 30° slope.

Businesses can ensure that they keep the same rate for up to 15 years, protecting them against any future electricity price hikes, or they can choose a CPI indexed rate.

"We know from customers that being more environmentally friendly is of concern – especially those who use a lot of energy

or operate on 24/7 basis. So offering Solar as a Service is enabling companies to cross two things off their list – saving energy bill costs and doing their bit for the environment," says Phil Mackey.

"The amount that each business can save will depend on their daytime energy needs, roof space, the size of the system installed and the length of their Solar as a Service agreement (see Tables 1 and 2).

"The service is something that adds great benefit to not only a company's cash flow but also to their green credentials too. And, at the end of the day, it gives companies a solution for some of their biggest and ongoing considerations," Phil said.

More information on how solar works can be found on:

<https://www.originenergy.com.au/for-home/solar/about-solar.html>

More information on solar for business can be found on the Clean Energy Council website: <http://www.solaraccreditation.com.au/consumers/purchasing-your-solar-pv-system/solar-pv-guide-for-businesses.html>

TABLE 1: Approximate unshaded roof space requirements

System size (kW)	Required unshaded roof space (m ²)
1	10
10	100
100	1,000
1,000	10,000

TABLE 2: Various agribusiness scenarios and possible savings from Solar as a Service (SaaS)

Sector	Location	System size (kW)	Estimated annual consumption (kW hours)	Estimated % energy powered by solar	Current grid supplied elec rate (cents)	Proposed SaaS rate (with no CPI indexation)	Estimated potential savings over 15 year term
Animal farm	NSW	28	100,000	34%	21.40 cents	13.60 cents	\$71,000
Animal farm	NSW	14	52,000	31%	26.30 cents	13.60 cents	\$38,000
Produce farm	QLD	24	106,177	30%	22.50 cents	12.70 cents	\$74,500
Animal farm	NSW	50	300,000	25%	16.40 cents	10.00 cents	\$139,000
Animal farm	NSW	35	122,240	37%	21.50 cents	11.40 cents	\$116,111
Produce farm	NSW	28.5	151,960	23%	21.99 cents	11.82 cents	\$73,861
Produce farm	NSW	23.92	97,970	32%	22.00 cents	11.80 cents	\$71,763

*Actual savings will depend on customer's particular circumstances, including daily consumption levels and patterns, and any restrictions imposed by local electricity distributor or network currently or in the future. Any potential financial benefit will also depend on applicable grid electricity rates during this Agreement. These rates are likely to change in amount and potentially structure over the duration of this Agreement.

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the gate

Pharmaceutical science opens new frontiers for adjuvants

THE research might of the global pharmaceutical industry is helping the humble plant chemist better understand how spray adjuvants improve pesticide efficacy and why.

Research and development of adjuvant technology has traditionally relied on basic observations of adjuvant properties and trying to work out how they influence the behaviour of active ingredients such as pesticides.

Generating hard data to make this process more exact is a key aim of a research collaboration between Monash Institute of Pharmaceutical Sciences, Deakin University and Australian adjuvant-maker, Vicchem.

The innovative project relies on a range of contemporary techniques including differential scanning calorimetry, laser diffraction and small angle X-ray scattering to generate the necessary data.

According to Dr Graham Webster, based at Monash's Parkville campus in Melbourne, there is significant cross-over between human drug delivery and crop adjuvant technology aimed at delivering a 'drug' into a plant or pest.

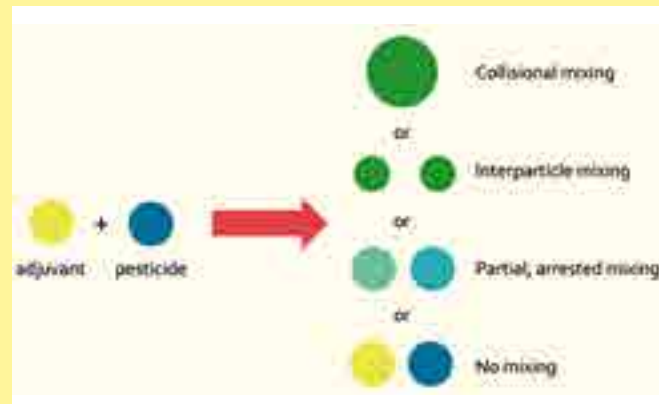
"The challenge of getting medicines to penetrate human skin is not dissimilar to that of getting chemical actives to penetrate plant surfaces," said Graham, who will deliver a paper at the International Symposium for Agricultural Adjuvants in California, USA, in June.

New technologies for adjuvant research

"Pharmaceutical science has a sophisticated suite of exploratory and problem solving technologies that we are now bringing to bear on crop adjuvant research for the first time.

"Our strength at Monash lies in our understanding of the

FIGURE 1: Schematic representation of the range of possible modes of interaction between a pesticide and an emulsion adjuvant



structure of a huge range of materials and exactly how they interact with chemical actives," he said.

The three-year project is sponsored by the Australian Research Council under its Linking Projects Scheme which aims to fast-track the commercial adoption of research, thus improving returns on investment.

According to Peter Jones, development and technical services manager with Vicchem, the interaction of adjuvants and pesticides when combined in a spray tank needs further study.

"There are hundreds of combinations of active ingredients and adjuvant types used by farmers worldwide for crop protection yet only some of these have been studied in detail.

"For this project, we've decided to study the interaction of emulsion adjuvants, Hasten and Empower, with two quite different pesticides – the emulsion-based clethodim herbicide Status and the solid suspension tebuconazole fungicide, Folicur.

"If we can better understand the uptake processes of these different combinations, we hope to develop adjuvants that are more nuanced and targeted in their performance, potentially improving rain-fastness, crop safety and other challenges."

Peter said the role of Deakin University, as a leader in plant biological research, was to validate the results from *in vitro* models used by the Monash team in real plant targets, right down to the cellular level.

"It makes economic sense to use a laboratory initially to screen many possible factors before moving to the next stage of verifying the preliminary findings in a glass house environment – then eventually road-testing these in a paddock situation.

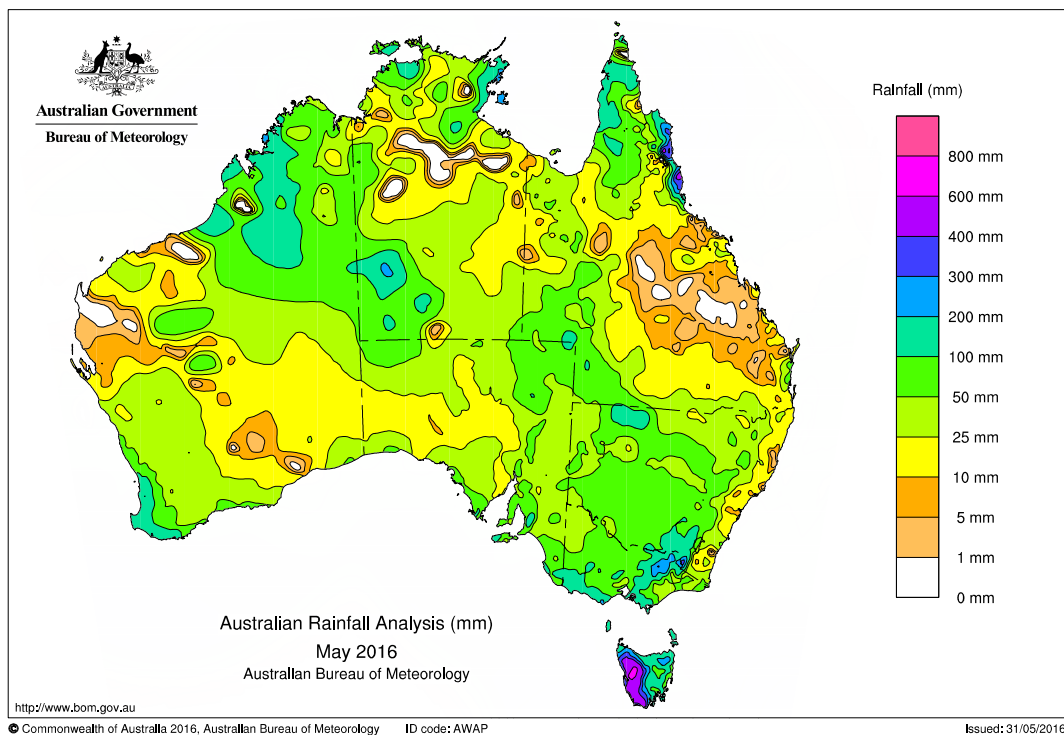
"When this research concludes in another 18 months, we hope our final results lead to more robust recommendations on adjuvant use.

"It's really about creating the right chemistry between every active and adjuvant combination commonly used by farmers today," Peter said.

Other research collaborators include Prof Ben Boyd of Monash University and Prof David Cahill of Deakin University.



Peter Jones of Vicchem with Prof Ben Boyd and Dr Graham Webster at the Monash University laboratory in Parkville, Melbourne.



RAINFALL REPORT...

Rainfall totals for the month of May indicate very favourable planting conditions for the Western Australian and south-eastern Australian grain belts.

Many growers in northern NSW and Qld are looking forward to planting rain in June.

Western region



District Reports...

May-June 2016

Early sown crops, canola, lupins and pastures have produced strong early growth. Additionally, repeated and effective pre-seeding weed control has been possible across most of the grainbelt, meaning cereal crops are facing less risk of weed competition during early growth.

All this points to an expectation that the 2016 crop will be, at worst, average for Western Australia. With timely winter rainfall and average spring rainfall, production will be well above average.

The intended mix of the different grains to be sown in WA has changed slightly in the last month as growers push to take advantage of the April rain that occurred in most districts. The general market outlook for cereals (wheat, oats and barley) has softened in the last month and this has also contributed to a small upward swing to canola plantings (see chart below).

The estimated canola planted area has risen further from the

WESTERN REGION SUMMARY

The 2016 cropping season continues to show excellent prospects with significant moisture levels across much of the grainbelt of Western Australia. Having such widespread high soil moisture levels across the majority of the grainbelt at this early stage of the season is almost unprecedented.

Rainfall during April was widespread and was at least average to well above average in all regions. However, the timing of rainfall varied. The lower Geraldton, Kwinana and Albany port zones received rain in the first half of April while the Esperance zone received rainfall in late April. The northern Geraldton zone continues to be dry into early May.

2016 WA crop area GIWA estimates (hectares)

Port zone	Wheat	Barley	Canola	Oats	Lupins	Field pea	State total
Kwinana	2,363,000	475,000	450,000	148,000	114,000	9,000	3,560,000
Albany	714,000	450,000	315,000	97,000	39,000	6,000	1,621,000
Esperance	490,000	288,000	278,000	6,000	9,000	15,000	1,086,000
Geraldton	885,000	39,000	127,000	8,000	179,000	1,000	1,239,000
Totals	4,452,000	1,252,000	1,170,000	260,000	341,000	31,000	7,506,000
Since April 2016	-0.3%	-1.6%	1.5%	-2.7%	0.6%	0%	-0.3%
*Since Aug 2015	-106%	0%	2.4%	10.2%	8.3%	34.8%	0.2%

*Comparison - percentage of figures compared to 2015 Final Estimate (Aug 2015).

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April 2016 GIWA Crop Report while the estimated area to be planted to oats and barley has been reduced slightly to account for the increased canola area.

Apart from the lower Albany zone, canola and lupin sowings have largely been completed. Wheat sowing is now in full swing, particularly in medium to low rainfall districts. While Mace wheat will continue to have the largest share of the wheat area, a range of other long season varieties more suited to early sowing are being planted to minimise the risk of frost in spring. This is particularly so in the Kwinana east zone, and in the north eastern districts of the Albany zone.

Growers are also moving to start post emergent weed control programs in early sown crops. For very early sown canola, the first post emergent program has already been completed.

**Grain Industry Association of Western Australia
May 6, 2016**

NORTH

Recent days have delivered a good rain across the whole region. Southern areas have had double the rain of the northern fringe of our region. The driest is the north eastern fringe with totals for the year as low as 50 mm in some locations. This makes our patch a real place of contrasts with the southern areas having potential for well above average crop yields and the north east looking like well below average. Some canola in the north east did emerge and die.

There is still a long way to go in this season so hopefully the north east can do well from rain events in coming weeks.

Seeding is complete on many farms and by late next week almost all will be finished. Most of the region has very good crops and there is enough moisture to get all of the later sown crops germinated and growing.

Canola crops are from just emerging to mid cabbage stage. GM canola area is up and TT area is down. Overall, the canola area is up. Insect pressure has been light and some growers are opting out of the prophylactic insecticide sprays. Some crops were planted in very hot conditions and there are some lower stand densities due to drying soil and/or associated fertiliser toxicity. Canola crops are generally very good.

Lupin crops are from emerging to 10 leaf. Lupins can emerge from reasonably deep and many crops were sown down onto moisture. Most have emerged very well. Lupin area is down a bit with some growers opting for GM canola.

Wheat crops are from just emerging to tillering. They are generally very clean with growers taking advantage of good pre sowing weed control. The wheat on wheat area is up so fungicides will be required to go on with post em sprays.

Most areas have very good potential with average rainfall from here on. Most growers are happy with the start except the north eastern fringe that has missed out on rain. So far the season is good to very good for most of our region. Hopefully the favourable conditions will continue.

**Peter Norris
Agronomy For Profit and Synergy Consulting, Geraldton
May 26, 2016**

SOUTH COAST

Seasonal conditions on the South Coast during the past two months have varied from perfect to water-logged depending on where you farm within the region. Munglup and Ravensthorpe are currently 172 mm above average rainfall to date – needless to say getting the crop has come with a fair degree of bogged machinery.

To the north and east of Esperance, rainfall is tracking at average to slightly above average.

Most growers have now completed seeding which is generally earlier than normal. Crop establishment has generally been good, with some minor insect issues and re-seeding due to seed burst from heavy rainfall immediately after seeding.

Post emergent weed control is now underway in addition to nitrogen top ups.

In summary the region has had a very good start. The excellent levels of stored soil moisture should set us up for a very good year... all going well.

**Quenten Knight,
Agronomist, Precision Agronomics Australia
May 30, 2016**



A typical scene of bogged machinery west of Esperance through to Jerramungup. (PHOTO: Martin Brooks)

Southern region



SOUTH AUSTRALIA SUMMARY

The weather

- March rainfall was above average to very much above average in most of the agricultural districts of SA. Rainfall in areas of the Lower Eyre Peninsula, Southern Yorke Peninsula, Kangaroo Island, Northern Mallee and Lower South East was average.
- April rainfall was average on Eyre Peninsula, Southern Yorke Peninsula and below average in most other agricultural districts.
- Mean maximum temperatures for March ranged from below average in the Far West Coast to very much above average in the Mid North and Mallee.
- Mean maximum temperatures for April ranged from average on the Far West Coast to very much above average in the Mid North, Lower North and Northern Mallee.

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- Mean minimum temperatures for April were average for Eyre Peninsula, Yorke Peninsula, Mid and Upper North and Northern Mallee and below average for the Fleurieu Peninsula, Adelaide Hills, Southern Mallee and South East.

Crop conditions

- In early May, sub-soil moisture levels were moderate to low but topsoils were dry in most areas of the state.
- Summer weed spraying continued in most districts during March and into April.
- Some farmers sowed early pasture feed following good rains in mid to late March.
- Above average rainfall in March triggered movement and mating of snails and farmers have been successfully baiting and burning to reduce numbers, particularly on Eyre Peninsula, Yorke Peninsula and the South East.
- Some stubble burning has occurred in a number of districts to reduce stubble loads and weed seed and snail numbers. An increasing number of farmers are burning windrows rather

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

<div><div><div>Brought to you in association with</div><div></div><div>JOHN DEERE</div></div></div>			Summer		Autumn		Winter		Spring	
	25 year Annual Average (mm)	2016 rainfall to date (mm)	25 year Annual Average (mm)	2015–16	25 year Annual Average (mm)	2016 to date	25 year Annual Average (mm)	2015	25 year Annual Average (mm)	2015
Emerald Qld	539	334	252	419	100	22	60	43	122	74
Toowoomba Qld	663	257	277	264	127	96	82	63	121	181
Roma Qld	572	222	252	252	117	29	72	100	126	73
Goondiwindi Qld	612	265	254	348	120	52	96	133	135	79
Narrabri NSW	630	213	227	176	118	78	126	98	160	114
Gunnedah NSW	650	124	232	144	112	53	129	107	177	112
Dubbo NSW	603	223	199	186	122	97	128	172	152	120
West Wyalong NSW	443	189	119	95	78	118	118	189	126	95
Wagga Wagga NSW	541	216	130	109	110	145	151	259	143	160
Swan Hill Vic	318	123	73	48	62	82	89	83	95	41
Bendigo Vic	509	166	108	51	102	129	167	113	136	79
Horsham Vic	379	138	77	63	70	87	132	61	107	46
Lake Bolac Vic	519	201	114	100	99	136	160	113	152	67
Murray Bridge SA	369	104	67	40	80	72	128	83	99	54
Kadina SA	339	165	57	38	76	132	120	112	88	60
Cummins SA	391	209	50	83	90	135	175	176	82	59
Esperance WA	614	242	78	112	142	174	249	211	144	104
Wagin WA	395	212	43	88	94	163	171	107	89	52
Northam WA	399	258	38	83	85	184	192	176	86	40
Mingenew WA	354	109	27	22	91	89	176	137	68	33
Moora WA	382	147	41	40	86	111	183	221	72	40
Mullewa WA	326	92	46	34	96	67	131	135	50	13

Last rainfall reading May 30, 2016.

Last rainfall reading May 30, 2016.

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than whole paddocks to retain stubble cover and reduce the risk of erosion.

- High mouse numbers are present in pockets of Yorke Peninsula and some baiting has occurred in these areas.
- A number of farmers across the state began dry-sowing crops in the third week of April. Crops sown included barley, oats and vetch for feed; oaten hay, lupins, beans, canola and some wheat.
- Farmers with large seeding programs (more than around 3000 hectares) started dry-sowing pasture feed and other crops in mid-April and have moved onto sowing barley and some wheat by the end of the month.

Planting trends

- There will be an increase in the area sown to oaten hay in many districts, due to the high returns, weed and disease control benefits and high frost risk potential of other crops. The increased area is mainly with existing growers but also other growers without hay machinery or infrastructure who will need to rely on contractors.
- The area sown to lentils will increase in a number of districts due to the current high prices. Current growers will increase their plantings, some will grow it for the first time and others are returning after not growing them for a number of years.
- The area sown to canola will increase in some districts (Lower Eyre Peninsula and Mid North), while decreasing in others (Upper South East).
- There is also likely to be an increase in the area sown to other pulses, particularly peas and chickpeas.
- There is likely to be a slight reduction in the area sown to wheat (particularly wheat sown back on wheat). The reduction is expected to be minimal given the forecast low wheat prices.
- The area of barley will also decline and be replaced by oaten hay, canola or pulses.

Pastures

- Rains in March germinated self-sown crops and provided reasonable feed for livestock in many districts.
- With a poor level of pasture cover and reduced stubble feed, an increased number of producers have been supplementary feeding livestock in confinement areas.
- Some pasture and legume stubbles have been heavily grazed with wind erosion occurring on bare areas.
- Annual pastures that germinated in March have either died or are severely moisture stressed.
- It is expected that livestock feeding will continue in the coming months until pastures become well established.

**PIRSA Crop and Pasture Report
May 5, 2016**

WIMMERA/MALLEE

It has been an ideal start to the season with excellent soaking rainfall (GSR decile 6) combined with warm temperatures. Most growers started sowing dry in mid-April – had a few days off with a post Mother's Day rain event – and then completed their sowing program prior to rainfall in the last week of May.

Birchip received a total of 64 mm for May. This, combined with a favourable seasonal outlook and solid commodity prices, has led to about 20–40 per cent of break crops being sown. Crop establishment has been exceptional and growth has been rapid. Many cereal crops are now at approximately three leaf, with canola and lentils at two to three leaf/nodes. An ideal position leading into the cold winter months!

There is little time to draw breath with growers prioritising rolling of pulse and hay crops, early grass and broadleaf weed control and topdressing of sulphate of ammonia and/or urea blends on canola and sandy rises and low N paddocks.

Negotiating the growing jobs list around forecast rainfall has been a positive and pleasant experience compared to recent years.

Warm, moist soil has enabled pre-emergent herbicide activity to be effective. But there are dry sown cereal paddocks with volunteers needing control given limited summer rainfall and small grain thrown out the back of headers during last year's harvest. There may be an option for early grazing of some cereals to halt their rapid growth.

Fingers crossed the season continues in the favourable manner in which it has started.

**De-Anne Ferrier
Birchip Cropping Group
May 30, 2016**

NSW OVERVIEW

Rainfall across inland NSW was generally limited until late April. At that time, most of NSW had received rainfall of 20 to 60 per cent of normal.

The rainfall outlook for May to July indicates wetter conditions are likely across NSW. The El Niño event is close to ending. Half the global climate models suggest a La Niña event is likely in winter and spring.

Topsoil moisture levels remained low, but improved in late April in areas of western, central and north eastern NSW. Levels have improved further from the early May rainfall.

By early May, some winter crops were dry sown or sown on marginal moisture. The early May rainfall stimulated further sowings and crop establishment. Weed control will be a priority during winter.

Crop condition

- Sowings of dual purpose and long season winter crops continued, although to the end of April most had been dry sown or sown on marginal moisture.
- Up to late April, less than a third of the total winter crop area had been sown, and establishment had been patchy.
- About 90 per cent of canola crops and the majority of faba beans and lupins had been sown by early May.
- Chickpea commenced in mid-May in the north.
- The late April-early May rainfall stimulated further winter crop sowing, promoted establishment of dry sown crops and reduced moisture stress on establishing crops.
- Weed control will be a priority due to the lack of control opportunities prior to sowing.
- Harvesting of maize is complete, with yields generally above average.
- Cotton harvesting is continuing, with well above average yields for irrigated crops.

**NSW Department of Primary Industries
May 11, 2016**

Northern region



DARLING DOWNS

Weather conditions

The dry weather in this calendar year has continued and is becoming an increasing source of concern. The El Niño has been confirmed as over but as expected, it is taking time for an increase in rainfall to flow through.

Rainfall for 2016 to the end of May is at 58 per cent of the past 25 year average. But for the months of March, April and May it is running at only 36 per cent of the average, and the soil is very dry. Ground fallowed since the last winter crop has good soil moisture, especially in the top 60 cm, but those paddocks planted to an early summer crop and harvested in the past three months are very dry, and many of these paddocks were earmarked to be double cropped into chickpeas.

Summer crop wrap-up

Sorghum has given a reasonable return this season with most of the crop planted early and yielding strongly at six tonnes per



This Darling Downs scene depicts the changing role of cotton in the northern farming system. Grain growers not only view cotton as a valuable cash crop but also as a rotational crop to help clean up grass weed problems.

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hectare or better, which compensated for the reduced price for the grain. Mungbeans varied in yield depending on rainfall, soil moisture and fusarium but the average was only 1.0 tonne per hectare, although strong prices gave a good return.

There were only a few dryland soybeans planted on good moisture and these averaged 2.0 tonnes per hectare.

The standout crop for yield this summer has been cotton, particularly the increased area of dryland cotton. Exceptional dryland yields of 10 bales per hectare are not uncommon, and irrigated crops have produced up to 14.5 bales – both record yields on the Downs.

Corn crops are still waiting to be harvested due to many growers having full silos, which is causing headaches because of the build-up of mice in the late crops.

Winter crop

The dry conditions have stifled the planting plans of all growers, with many itching to plant forage crops and chickpeas during May being thwarted. There has been an increase in the deep sowing of chickpeas in fallow ground and there are irrigated paddocks being pre-watered, but this is only 25 per cent of the expected area.

Most of the planned crop area needs a good rain to plant and for those aiming to double crop into sorghum ground, significant rain will be needed to fulfil this opportunity.

There have been some oats, forage barley and triticale planted, and some growers west of Dalby have dry planted wheat and barley, although most growers will hold off planting their cereals until decent rain arrives.

Hugh Reardon-Smith
Agronomist, Landmark Pittsworth
May 29, 2016

CENTRAL QUEENSLAND

Weather

The long, hot, dry summer of 2016 has finally ended with cooler weather arriving in the last days of May. This summer was characterised by patchy, scattered, isolated storms. CQ can normally look to widespread good soaking rain during January–February – normally our wettest months – but not this summer we missed out. Only paddocks under narrow storms finished up wet enough to plant. Even some longer-fallowed paddocks were too dry to plant to summer crop. About half the normal area of summer crop was planted.

The Central Highlands received patchy scattered storms in January and February. The Dawson generally fared better receiving more rain in early spring and again in January–February. The southern end of the Callide was wet in January and February but the northern end around Wowan remained dry throughout.

The March–May period has been dry everywhere.

Summer crop

Sorghum: My guess is that about 80,000 hectares of sorghum was planted across CQ with only a small area in the Callide, a bigger area in the Dawson and most of the crop

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planted in scattered paddocks across the Central Highlands. Much of the Central Highlands crop was planted very late into February. A wide spread in the planting date and a later than normal planting time will mean a wide spread, late harvest.

Harvest has started but the majority of the crop is close to maturity and still drying down.

I am amazed at how well the sorghum is yielding across CQ especially given the hot, dry summer and only isolated storms. The rain while minimal was timely, and grew grain and not weeds. Also, soil tests reveal that a longer spell without crops has allowed mineralised nitrogen to accumulate with much higher N levels available to crops. CQ farmers have used starter phosphorus fertiliser for many years but now recognise that almost every paddock needs some N to achieve higher yields.

This summer also demonstrated just how tough and forgiving sorghum is IF it rains at flowering. Yields of four to six tonnes per hectare are common in the better paddocks. Charcoal rot continues to be a major issue for growers when there is a dry finish to the season with the biggest and best heads likely to lodge.

Mungbeans: Low sorghum prices and high mungbean prices encouraged new and old growers to plant large areas of mungbeans this summer. Generally, both spring and the summer crops encountered tough growing conditions in almost all districts.

The largest area of spring mungbeans was planted in the Callide and had a wet start but a dry finish. Generally the earlier summer crops across all districts fared better than later planted summer crops. About 15,000 hectares of spring and 50,000 hectares of summer mungbeans were planted. Yields varied enormously from fail to better than two tonnes per hectare.

Cotton: The 2015–16 summer saw about 18,000 hectares of cotton planted on the Emerald Irrigation Area and 3000 hectares on the Dawson. A hot, dry, summer set up high yields for cotton in CQ but for some growers a week's wet weather at defoliation resulted in a down-grade in quality.

IAN'S CLASSIC TRACTOR QUIZ ANSWERS

- 1 – 745D.
- 2 – Lanz.
- 3 – 1.
- 4 – Snow plough.
- 5 – Munktells.
- 6 – John Deere D.
- 7 – Glasgow.
- 8 – Ulsterman.
- 9 – Hunting Pink.
- 10 – Caterpillar.

Winter crop

Chickpea: High chickpea prices and a dry soil surface resulted in a record chickpea area for CQ. About 40,000 hectares south of Emerald (Gindie, Rolleston, Dawson and Callide) and up to 80,000 hectares north of Emerald has been planted to chickpea. Almost all of that was deep planted to 'seek moisture'.

Wheat: A big area of chickpeas combined with a lack of planting rain resulted in a major reduction in the area planted to wheat. My guess is about 70–80,000 hectares of wheat has been planted across CQ, mostly on paddocks that had either grown chickpea last year or were in need of groundcover to reduce the risk of erosion.

Still more chickpea and wheat will be planted if good rain (>50–100 mm) falls in the next couple of weeks – but mid-June is the cut-off date for most farmers.

Weeds: Feather top Rhodes grass (*Chloris virgata*) continues to be a major weed problem in CQ and a common reason for ploughing. More cases of hard to kill (potentially resistant to glyphosate) sweet summer grass (*Brachiaria eruciformis*) are being reported. Common hard to kill broadleaf weeds include milk thistle or sowthistle, tridax daisy and fleabane.

Livestock and pastures: Lower than average rainfall resulted in many paddocks growing good quality but a reduced quantity of grass this summer. The grass on offer is dry. Lack of follow up rain meant that many paddocks especially where stock numbers are high are now grazed short. Generally cattle across CQ are in good to excellent condition. Excellent prices are being paid for weaners encouraging some producers to sell earlier or to reduce stock numbers. Selling empty cows is an obvious choice but is not something all managers do

Water: The Fairbairn dam is currently at 39 per cent capacity or 506,925 ML.

Maurice Conway
Department of Agriculture, Fisheries & Forestry
Emerald, Queensland
May 30, 2016

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