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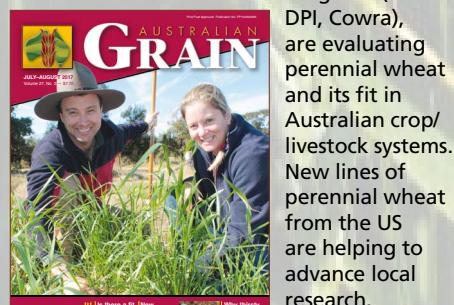
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FRONT COVER

Matthew Newell and Susan Langfield (NSW



DPI, Cowra), are evaluating perennial wheat and its fit in Australian crop/livestock systems. New lines of perennial wheat from the US are helping to advance local research.

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Covering Northern NSW and Queensland

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A LONG with a great bunch of Aussie grain growers, I'm currently tracking my way through a large slab of western Canada's very scenic breadbasket as well as some of the best farmlands of the Pacific Northwest of the United States. And if you have a winter crop showing some potential – or some silos bulging with stored grain – the information and insight we are gathering as we travel, boils down to pretty good news for Australian growers.



A prolonged 'dry spell' in the major farming zones of Canada and the US has made the international grain market very jittery and much better prices are the result. Two or three weeks without significant rain, along with above average temperatures, really takes a toll on heavy North American grain crops.

Adding to this positive price pressure is the fact that we have seen the smallest area planted to wheat in the US for 100 years. Canadian farmers are also doing their bit for world wheat prices by planting – for the first time ever – more hectares to canola than wheat.

With this surging wheat price, it's pretty simple really – all Australian growers have to do to cash in is to grow as much grain as they can in what's turning out to be a very difficult and dry season. Irony is never lost on farmers.

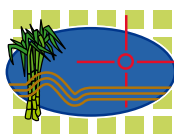
Pulse prices also finding support

Chickpeas are undoubtedly the current glamour crop. Not only does this pulse provide a range of rotational benefits in Australian farming systems, recent prices have also been excellent. And these strong prices may just be around for a while.

Nidera Australia Pulse Trader, Rob Brealey, has just returned from the Global Pulse Conference in Vancouver and reports that the general mood amongst delegates was very upbeat (see article page 25).

The conference delegates heard that global demand for pulses is growing at a rapid pace – nothing new there – but Rob points out that it is not just the traditional sub-continent markets driving this demand. There is broadly-based demand growth from Western and Asian countries. And it is not just these 'new' consumers looking for healthy food alternatives, pulses are finding a home in more stockfeed rations as well as a wider range of industrial uses.

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In this issue...

Disrupting insects' sense of smell to save crops and lives



An international team of scientists – including researchers from the ANU and CSIRO – say disrupting the ability of insects to smell the scent of food and potential mates may offer a way to protect humans from deadly diseases such as malaria and agricultural crops from pests.

See article Page 10

Knowing when frosts strike to avoid total crop loss



In-paddock temperature measurement can help determine if your crops have been subjected to frost, therefore enabling you to quickly activate strategies to salvage a return from affected crops.

See article Page 14

Why thirsty weeds are hard to kill

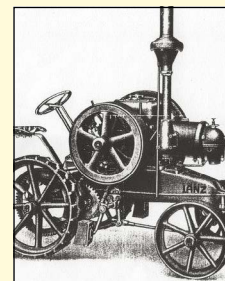


We had to go back more than 20 years to find some relevant research on spraying stressed weeds – but it was worth it. The DAFWA research in the 90s is pure gold! The work set out to determine what factors influence herbicide rate. A number of factors had an effect, but it appears that moisture stress had the biggest impact.

See article Page 16

Mein Bulldog

Astonishment! That is the word which describes the facial countenance of spectators at vintage tractor shows, when the Bulldogs are paraded. Though, to be honest, elderly farmers who know all about Bulldogs, might simply grin, as they remember with nostalgia these remarkable hunks of ironmongery.



See article Page 19

Analysing the season of records

The 2017 La Niña event served Australian growers well, with above average rainfall for the majority of growing regions. Records were set for both wheat and barley production. As the marketing portion of the 2016–17 season progresses, we now see a record grain export pace across Australia

See article Page 28

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The fragrance of a new pesticide

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

AT A GLANCE...

- Methyl benzoate is a natural compound used in foods and cosmetics.
- ARS scientists found that methyl benzoate kills several insect pests.
- Methyl benzoate could be an environmentally friendly pesticide.

YOU probably know methyl benzoate when you smell it. The natural compound's wintergreen-spicy, floral-fruity aromas make it a popular ingredient in perfumes, soaps, and shampoos.

Snapdragons and petunias emit methyl benzoate to attract bees for pollination. Many insects also produce it as an attractant. But not all insects like this compound.

Chemist Aijun Zhang, with the Agricultural Research Service Invasive Insect Biocontrol and Behavior Laboratory in Beltsville, Maryland, has found a new use for methyl benzoate, namely as an environmentally friendly control for agricultural pests like the spotted wing drosophila fly (SWD), an invasive species from Asia.

First found in California in 2008, SWD has quickly spread across the US and can cause significant damage to fruit crops,

especially berries. There are currently few choices for controlling SWD. The possibility of a new bio-based pesticide – especially one based on an inexpensive chemical whose residue lasts a relatively short time in the environment – is exciting.

Originally, Aijun was identifying volatile compounds in apple juice that attracted fruit flies. "Rotted apples and other fruits usually attract flies, including SWD. We had isolated out several compounds which did that," Aijun says. "But we found one compound – No. 19 – that strongly repelled SWD, and we later showed that it killed SWD as well."

Compound No. 19 turned out to be methyl benzoate, a compound approved by the US Food and Drug Administration for use in foods and cosmetics.

Wider agricultural application

Aijun then tested methyl benzoate against other agricultural pests, including the brown marmorated stink bug (BMSB), diamondback moth, and tobacco hornworm. He found that the compound can kill all stages of these insects – egg, nymph, and adult – though it works better against smaller insects than larger ones.

Aijun focused first on SWD and BMSB because they are fast becoming important agricultural and household pests, even though they are relatively new invasive species. New controls for these pests are urgently needed.

According to Aijun's tests, methyl benzoate is 5 to 20 times



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ARS chemist Aijun Zhang collects volatile compounds from apple juice. (PHOTO: Peggy Greb)



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more toxic to eggs of BMSB, diamondback moth, and tobacco hornworm than a conventional pyrethroid insecticide, a sulfur and pyrethrin mixture, and some organic products currently on the market.

Next, he is planning to test methyl benzoate's effectiveness against fire ants, gypsy moths, stored-product insect pests, and mosquitoes. All these insects are developing resistance to standard pesticides.

Aijun is also investigating whether low doses of methyl benzoate could control Varroa mites, the number-one problem of managed honey bees today.

A patent has been applied for methyl benzoate's pesticide uses. One company has already expressed interest in it.

Further information: Aijun Zhang, Invasive Insect Biocontrol & Behaviour Laboratory, USDA Beltsville, MD 20705.

Email: aijun.zhang@ars.usda.gov – Ph: +1 (301) 504 5223



ARS scientists found that a naturally occurring chemical, methyl benzoate, can kill brown marmorated stink bugs. Stink bugs (top) and tobacco hornworms (bottom).
(PHOTO: Peggy Greb)

RNAi technology enters the insecticide resistance battle

PIPs AND RNAi JOIN FORCES

Plant incorporated protectants (or 'PIPs') are plants that have genes inserted causing them to produce a pesticide.

For Australian summer crop growers there is nothing new here as Bt transgenic cotton is a form of PIP and the technology has been around for several decades.

But in this first for US corn growers, RNAi technology has been used to work as a pesticide by 'silencing' or turning-off the activity of a gene critical to corn rootworm survival. This is the first RNAi-based plant protectant product to target a specific insect pest.

This has the potential to help combat insecticide resistance.

THE US Environmental Protection Authority has recently registered four products containing a new and innovative plant-incorporated protectant (PIP) called SMARTSTAX PRO that will help US farmers control corn rootworm (*Diabrotica* spp), a devastating corn pest that has developed resistance to several other pesticides.

Controlling corn rootworm is a major challenge for many corn growers and infestations frequently result in significant yield losses to corn crops. Corn rootworm has been referred to as the "billion-dollar pest" because the US Department of Agriculture estimated that the insect can collectively cost corn growers in the US over a billion dollars in terms of control costs and yield losses.

What are PIPs?

PIPs are plants that have genes inserted causing the plants to produce a pesticide inside their own tissues. In the US, when plants are genetically modified to produce pesticides in this manner they are regulated by the EPA.

The ribonucleic acid interference (RNAi) technology found in the new US insecticide SMARTSTAX PRO, works through a process of gene control that occurs naturally in plants, animals, and humans alike. Scientists harnessed this control process to create the product, which works as a pesticide by silencing or turning-off the activity of a gene critical to corn rootworm survival, resulting in the death of the corn rootworm.

This product is so specific that it only affects the corn rootworm.

This technology also has the potential to help corn farmers combat resistance to Bt corn in corn rootworm.

Bt corn has significantly decreased the amount of conventional soil insecticide used to control corn rootworm, but farmers would lose this important pesticide should resistance to Bt spread throughout the corn rootworm population.

When combined with Bt traits, SMARTSTAX PRO will provide a new tool for US corn growers to combat resistance to Bt in corn rootworm.

More information: www.epa.gov/pesticide-registration

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Disrupting insects' sense of smell may save crops and human lives

AN international team of scientists say disrupting the ability of insects to smell the scent of food and potential mates may offer a way to protect humans from deadly diseases such as malaria and agricultural crops from pests.

Lead researcher Faisal Younus from The Australian National University (ANU) and CSIRO said insects' sense of smell played a critical role in the transmission of disease to hundreds of millions of people and the damage to food crops worth billions of dollars each year.

Designing better insecticides

He said the research improved understanding of how insects process odours to find food and suitable mates.

"The findings could help us to design better insecticides and find more efficient ways to reduce insect populations so they spread less disease and destroy fewer crops," said Faisal, a PhD candidate from the ANU Research School of Chemistry who is funded by a CSIRO scholarship and based at CSIRO.

"The research will allow us to better understand fruit fly species like *Drosophila suzukii*, a major invasive agricultural pest that Australian government officials label as a serious biosecurity threat or 'megashock' if it ever enters Australia. These fruit flies have the potential to cause millions of dollars of damage in the fruit industry."

Fruit flies like *Drosophila suzukii* lay their eggs inside fresh fruit and vegetables. The eggs hatch into maggots, which rapidly feed on the flesh of the fruit and vegetables, rendering them unsuitable for human consumption.

Faisal said insects had evolved a highly sophisticated olfactory system to smell odours.

"An insect's sensory neurons are being cleared constantly at a very fast rate, ensuring their brain is not overloaded with odours," he said.

"For the first time, we have confirmed the involvement of an enzyme that breaks down food odour molecules to help insects



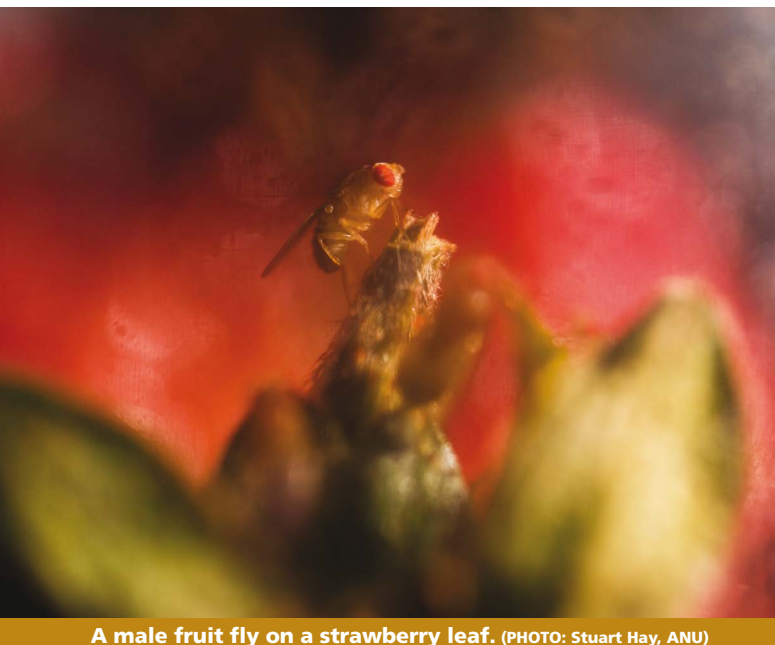
Faisal Younus examining the effect of fly infestations on fruit species. (PHOTO: Stuart Hay, ANU)

smell efficiently, and described the structure of this enzyme. Our study has also shed light on the crucial role the enzyme plays in re-priming the sensory neurons of an insect at a neurological level."

Faisal said the research provided a highly promising molecular target to disrupt insects' ability to sniff out potential mates, consequently reducing their populations so they spread less disease and destroy fewer crops.

ANU and CSIRO conducted this research with scientists at Université Pierre et Marie Curie (UPMC) and Institut National de la Recherche Agronomique (INRA) in France.

The research is published in *Scientific Reports*.



A male fruit fly on a strawberry leaf. (PHOTO: Stuart Hay, ANU)



Drosophila flies being exposed to various odours to measure their neurological activity. (PHOTO: Stuart Hay, ANU)



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International effort to deliver perennial wheat

AUSTRALIAN farmers are a step closer to growing perennial wheat to produce dual purpose grazing and grain crops as a direct result of collaboration between NSW Department of Primary Industries (DPI) and United States researchers.

NSW DPI researcher, Matthew Newell, has returned from The Land Institute (TLI), a non-profit research organisation in Kansas, with 18 new lines of wheat to bolster 20 existing lines currently under investigation at Cowra in central west NSW.

"DPI evaluation trials demonstrated perennial cereal crops could be produced in Australia with the potential to boost sustainability," Matthew said.

"Now with 18 new TLI-bred lines, 10 of which are registered Kernza lines, we aim to expand our research and focus on developing robust perennial wheat suited to grazing and grain production under Australian conditions."

Kernza is an intermediate wheatgrass, a perennial relative of traditional annual wheat, which is commercially available in a staged release to select US restaurants and a brewing company producing Long Root Ale, a beer named after the plant's root system.

Matthew said the aim is to develop perennial cereals as dual purpose crops to better integrate livestock and cropping enterprises.

"Perennial wheat has high energy and digestibility levels for

grazing stock, with the added bonus of producing high protein grain," he said.

"These dual purpose crops could provide valuable winter forage for livestock, at a time when pasture growth is limited, and in the right conditions, be harvested for grain.

"Farmers growing perennial wheat would have the opportunity to spell pastures while the wheat crop is grazed, increasing feed availability and generating pasture growth to increase carrying capacity and farm productivity."

New dual purpose cropping systems based on perennial crops could help farmers adapt and better manage climate variability by putting extra flexibility into local farming systems.

In marginal cropping areas, particularly in drought years, perennial wheat may allow farmers to vary their inputs, reduce costs and deliver environmental benefits.

Perennial crops can take advantage of out-of-season rain, which helps increase water-use efficiency, reduce soil acidification and salinisation and has the potential to reduce erosion. ■



NSW Department of Primary Industries staff, Matthew Newell and Susan Langfield, evaluating perennial wheat grazing trials at the Cowra Agricultural Research and Advisory Station. New lines of perennial wheat from the US are helping to advance local research.



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Aphids and other green profit suckers

A LEADING entomologist is warning grain growers and agronomists they will need to be actively 'searching and detecting' for pests this winter, rather than just monitoring crops.

The call for increased vigilance is due to the potential spread of the high priority pest Russian Wheat Aphid (RWA), as well as growing awareness of the benefits of early detection in protecting yield when it comes to insect pests, like winter cereal aphids and green mirids in faba beans.

Speaking at GRDC updates in Queensland and New South Wales, entomologist Melina Miles said growers and advisors needed to be alert and ready to take action to reduce the profit risk of insect pests, particularly RWA.

Melina, from the Queensland Department of Agriculture and Fisheries (DAF) said while RWA has not yet been detected north of Rankin Springs in the Riverina of NSW, vigilance is required to ensure early detection of further outbreaks.

"RWA is a high priority pest because of its potential to cause significant yield losses in wheat and barley if not well managed. Triticale and rye are also susceptible but oats are considered relatively resistant," Melina said.

Inevitable spread

"It is inevitable that RWA will establish in the northern grains region, but we don't know when we will start to see it in crops, so it is critical that crops are monitored more frequently during the 2017 season in case it does occur this year.

"Growers should sample for the RWA in the same way they do for other cereal aphids. Concentrate on the field margins and in areas of the paddock which are stressed, looking for both the symptoms and presence of aphids."

Key symptoms include striking symptoms in wheat and barley, rolled leaves or rolling of the flag leaf. Plant damage is in response to direct aphid feeding, so only the leaves and/or tillers infested show symptoms.

Should control of RWA be needed, an Emergency Use Permit (APVMA PER82792) is in place for chlorpyrifos and pirimicarb and is valid until June 2018. Pirimicarb will kill aphids but not the beneficial insects in the crop so should be used in the first case, as the beneficials may suppress further outbreaks.

Other pests to watch for

"Meanwhile, other things to watch for are winter cereal aphids, which can be managed successfully, with nominal thresholds and an understanding of their damage potential," she said.

"Field trials attempting to determine the aphid impact on winter cereals over the past ten years have proven extremely difficult, but a combination of some Northern Grower Alliance work and some glasshouse trials – whilst not being able to confirm an economic threshold – has been useful in developing a greater understanding of the aphids and a reasonable approach to management.

"Weather, crop conditions and natural enemies all play a role in influencing aphid numbers. The damage potential of aphids in cereals seems to be based on the relationship between crop stage at infestation, density and duration of infestation."

Seed treatment is an option for districts where aphid pressure is high in most seasons, although the use of neonicotinoid seed dressing poses some risks to the build-up of natural enemies and potential insecticide resistance.

It's also worth noting the potential impact of late infestations on yield, particularly from grain-fill on, is low. The exception is RWA where infestations from stem elongation can prevent heads from emerging normally and impact on grain set and filling.

"The other research we have undertaken is to understand conclusively whether mirid feeding cause spotting on the seed, and hence if mirids warranted further research as a faba bean pest," Melina said

"We have found that green mirids do cause spotting on faba bean seed and impact on seed size and yield. Both adult and late instar nymphs are damaging and warrant control in faba beans crops.

"All of these pests directly relate back to growers yield and profits, so continuous monitoring and detection is certainly one of the keys to a successful season."

For more detail on this research, go to Melina's Research Update paper <https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2017/02/Aphids-and-other-green-profit-suckers>.

Information on RWA preparedness is available on the Beatsheet blog. ■



Colony of Russian wheat aphid adults and nymphs. (PHOTO: Melina Miles, Queensland DAF)

Knowing when frost strikes is key to avoiding total crop losses

IN-PADDOCK temperature measurement could assist grain growers in determining whether their crops have been subjected to frost, therefore enabling them to quickly activate strategies to salvage a return from affected crops.

Temperature monitoring within a paddock in frost-prone areas is seen as an important tool, yet very few growers measure temperature at the susceptible parts of their property, according to Agrilink Agricultural Consultants principal consultant Mick Faulkner.

Mick, who is part of the Grains Research and Development Corporation (GRDC) National Frost Initiative (NFI) project, "Spatial temperature measurement and mapping tools to assist growers, advisors and extension specialists manage frost risk at farm scale", says growers should consider using temperature loggers to more accurately identify when low temperatures occur.

"Until now, frost identification has often been registered by the presence of ice at or after dawn, at ground level near the farm residence," Mick says. "But this may not reflect the actual temperatures at the susceptible parts of a paddock where crops are being grown."

"Often frosts that have occurred earlier in the night but have cleared by dawn are missed, and frosts that caused ice on lawns are assumed to have had a similar effect in paddocks but that may not necessarily be the case."

Temperature monitoring equipment, such as Tiny Tags,

iButtons and weather stations, are currently commercially available and can help determine growers' frost mitigation strategies and enable them to accumulate data over numerous seasons to develop farm frost incidence and severity maps.

Such equipment is recommended as part of an integrated management plan to enable growers to build their knowledge base of their properties to mitigate the impacts of frost – a central focus of the GRDC's NFI – of which the spatial temperature measurement and mapping tools project being led by Steven Crimp from CSIRO is a major contributor.

Mick says temperature loggers should be situated at or just above the canopy height and raised every week or so during the growing season to account for crop development, particularly when the head is emerging (booting to milk development or Growth Stage 40–80).

"As this is the most sensitive stage for the plant, accurately measuring temperature experienced by the head is most critical at this stage."

Where possible, monitoring should be done in a number of locations that take into account differing factors that influence frost impact, such as varying landscape gradients (on the flat, break of slope and a short distance up a slope in areas affected by cold-air drainage) and soil types (particularly from darker loamy soils to lighter sandy soils).

While this is the most accurate method to collect data on the temperature the plant has been exposed to and likelihood for frost damage, data from sites further away, such as fence lines or other weather stations on the property, may still be useful.

Mick, who is also a member of the GRDC's Southern Regional Cropping Solutions Network, says using data from the closest Bureau of Meteorology site to determine farm temperature may be valid for some farms but is usually inadequate for most.

As part of the NFI project, in which Agrilink is involved, temperature loggers have been installed at trial locations in the Mid North of South Australia as well as at a number of on-farm monitoring sites for the past two years. The results indicate minimum temperatures between the BOM sites (1.2 metres above bare ground) and the height of the crop fluctuate significantly and there is greater variability in temperature in spring than winter.

Mick says the time from frost damage occurring to identification is critical.

"Identification of frost damage is important because it enables a grower or adviser to understand the impact of frost on yield and extent of the area of damage. Assessment provides information on financial exposure and immediate mitigation options which include cutting for hay or silage, and grazing a standing crop."

What parts of the crop to inspect?

Mick advises that the parts of crops that should be inspected regularly include:

- Cereals – juvenile damage in high stubble loads; all internodes during stem elongation and the reproductive period; the soft tissue above each node; the stem where the flag leaf attaches; whole heads during and after booting; anthers, stigmas, embryos and grain.

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- Pulses – juvenile damage in high stubble loads; leaf death of lentils, stems of faba beans and lupins; bacterial blight of some pea cultivars; flower abortion; developing pulse pods; and grain inside pods.
- Canola – leaf damage in juvenile plants; stem splitting; flower abortion; developing pods; and grain in pods.

Through the NFI, consultants are researching sensors and other methods to more accurately identify damaged plant tissue or damaged parts of a paddock soon after frost events, which each year inflict an estimated average of \$400 million in crop losses in Australia.

Since 1999, the GRDC has invested in more than 60 frost-related projects. As of 2014, investment in frost research increased to \$4 million a year through the five-year NFI. The initiative aims to deliver to growers a combination of genetic and management solutions, along with tools and information to better predict, plan and manage frost events.

More information on frost management can be found in the GRDC Tips and Tactics publication, www.grdc.com.au/ManagingFrostRisk, and via the GRDC's suite of GrowNotes™ publications at <https://grdc.com.au/Resources/GrowNotes>.

More information: Mick Faulkner, Agrilink, Ph: 0428 857 378.



Agrilink consultant Mick Faulkner demonstrating how to assess stem frost damage during a GRDC frost management workshop.

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Why thirsty weeds are hard to kill

UNFORTUNATELY, during June large parts of Western Australia, South Australia and Queensland were as dry as a London newspaper! This AHRI insight article looks to address the issue of spraying stressed weeds.

We had to go back to 1995 to find some relevant research – but it was worth it. The GRDC funded research conducted by Dave Minkey and John Moore at DAFWA in the 90s is pure gold!

They set out to determine what factors influence herbicide rate. They looked at moisture stress, relative humidity, temperature, and days since 5 mm of rainfall. As you would guess all of these factors had an effect, but it appears that moisture stress had the biggest impact.

The rate of glyphosate to kill moisture-stressed wheat was more than 10 times that of wheat growing with adequate moisture.

In a dry year, we're often faced with the whole kit and caboodle – moisture stressed weeds, high temperatures, low relative humidity and long durations between rainfall events. There's no quick fix, but by understanding the driving factors, it can help us to pick the best time to spray weeds.

This research also reminds us that we're likely to see surviving weeds at harvest, which is why we believe that perhaps this year is the year to adopt chaff lining at harvest.

Dr Dave Minkey is now the Executive Director of the WA No-till Farmers Association (WANTFA). The Dr part of his title was achieved by completing his PhD at AHRI studying ants and their predation of weed seeds. But once a weedie always a weedie and a big thanks to Dave for his help to drag out this old research that's still extremely relevant today.

Over the range of conditions encountered in this research, the glyphosate 450 rate for 90 per cent control ranged from 150 mL per hectare to 3.0 L per hectare.

That's a 20-fold difference in rate to kill the same sized weed, purely as a result of seasonal conditions. In other words, if conditions are cool and wet with high relative humidity at spraying the lethal dose of glyphosate to kill wheat could be as low as 150 mL per hectare. But if ryegrass is being sprayed and conditions are hot and dry, that rate could be 3.0 L per hectare or even higher. This was also observed for a range of leaf uptake herbicides.

Moisture stress

It comes as no surprise that moisture stress has arguably the biggest impact on herbicide efficacy, but what will surprise you is the sheer size of the effect.



Dr Dave Minkey is now the Executive Director of the WNTFA – but once a weedie always a weedie!

For these trials in 1995, Dave and John Moore sowed wheat and then used a rain out shelter to remove 50 per cent of the rainfall from some plots. The rain from the shelter was then used to irrigate other plots and these were compared to normal rainfall, six weeks after seeding.

We must note that glyphosate 360 was used in this research – they didn't have the fancy new glyphosates with fully loaded surfactant packages back then.

TABLE 1: ED90 (herbicide dose to kill 90 per cent of the population) and ED50 for wheat sprayed with glyphosate for low, medium or high soil moisture treatments

Moisture treatment	Relative wheat leaf water content (%)	ED90 (gai/ha)	ED50 (gai/ha)
Low	65%	1292	431
Medium	74%	270	90
High	85%	114	38

gai/ha = grams of active ingredient/hectare

Plant species

This research also investigated the rate of glyphosate required to control different plant species. Keep in mind that this was back in the good ol' days, before glyphosate resistance. In simple terms, ryegrass is about twice as hard to kill with glyphosate as wheat.

Species	ED90 (gai/ha)
Wheat	294
Canola	258
Capeweed	447
Annual ryegrass	618

Relative humidity

Two WA field sites in Newdegate and Katanning were sown to wheat and experienced almost identical growth, climatic conditions and relative water content of the wheat leaves at spraying (95 per cent). The only measurable difference was the relative humidity at spraying.

The rate of glyphosate to kill wheat at Katanning with low RH was about 60 per cent higher than the rate needed at Newdegate with high RH.

Site	Relative humidity	ED90 (gai/ha)
Katanning	30%	198
Newdegate	80%	121

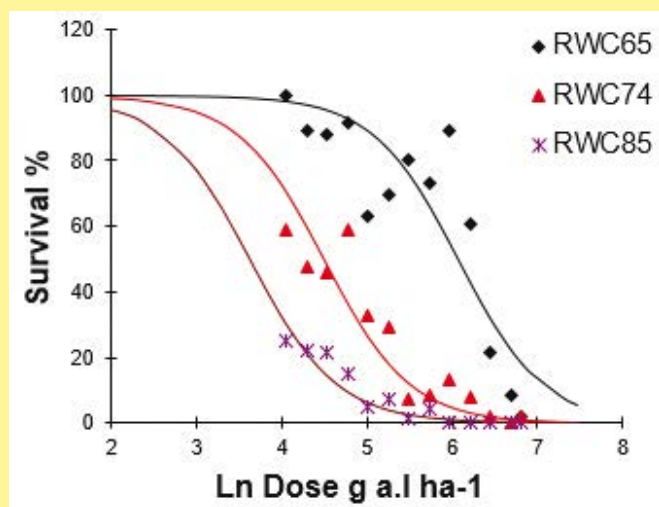
Temperature

The mean degree days (average of max and min temperature) from germination to spraying was 11.9°C in 1995 and 16.2°C in 1996. This roughly doubled the rate of glyphosate required to kill 90 per cent of the ryegrass population (ED90).

Why is it so?

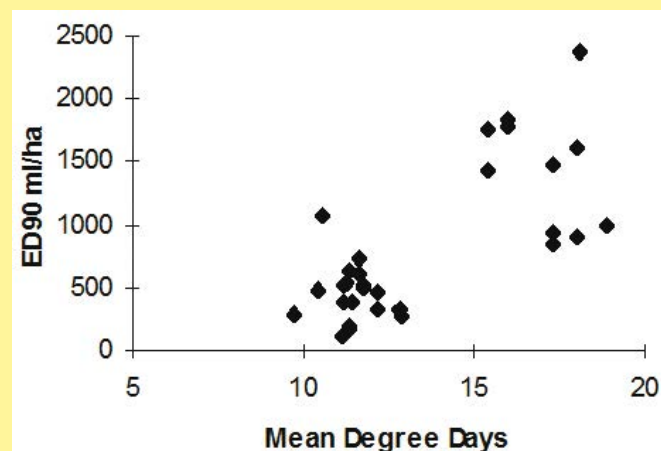
When plants are moisture-stressed they:

FIGURE 1: Log scale dose response curves of glyphosate rates for wheat at three different levels of moisture stress



RWC = Relative Water Content (per cent) of wheat leaves.

FIGURE 2: The effect of mean degree days on Roundup CT control of annual ryegrass



find ourselves in a situation where moisture/heat stress returns.

Spraying during high relative humidity helps, but it only helps a little compared to spraying after rain.

It's important to get your adjuvant and spray quality right.

Some adjuvants/spray quality are better than others under these conditions. Consult your agronomist to determine the best options.

- Thirdly, we can expect surviving weeds in a dry year and we should aim to do something about them. Spraying out failed crops in spring is a good option or even crop topping where possible. Harvest weed seed control is a must and we believe that perhaps the best fit (if you are not already practising HWSC) is to adopt chaff lining. It's low cost, has high residue retention, and it's easy to adopt. One farmer recently commented to AHRI communication Lead, Peter Newman that he let some wild radish set seed in the 2006 drought and he's still battling that population now. The cheque book may be stapled shut but there are low-cost options that could make a big difference in the future.

To sum up

We all hate a dry season and agronomy decisions are challenging during these times. This AHRI insight aims to help make the best decisions at the lowest cost for growers experiencing dry times.

Hats off to Dave Minkey and John Moore on some excellent, timeless research. Let's hope we don't need to drag it out again anytime soon.

- Develop a thick, waxy cuticle on their leaves that is a barrier to herbicide uptake; and then,
- After a rain event, the weeds freshen up as they start to grow again but the waxy cuticle remains – so even though rainfall helps, it doesn't completely undo the harm that has been done and these weeds will remain relatively hard to kill.

If conditions improve and new leaves emerge with a normal, thin cuticle, the weeds can become more susceptible to a herbicide.

Translocation is slow during moisture stress so translocated herbicides struggle to reach their site of action.

Low relative humidity at spraying reduces droplet survival on the leaf and reduces the amount of herbicide that the plant takes up.

What can we do?

- Firstly, we need to be acutely aware of just how big an effect moisture stress and seasonal conditions are on herbicide efficacy.
- Secondly, we can only do our best to choose the best possible conditions to spray weeds in a dry year.

The best-case scenario is to wait for a rain event to remove moisture stress/wash the dust off the leaves and then wait even longer for new leaves to emerge that do not possess a thick waxy cuticle. This isn't always possible, and by waiting we may once again

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Delay spraying stressed weeds after rain

DRY season agronomy is difficult. In affected areas there is a reasonable chance that pre-emergent herbicides applied at or before seeding will not work as well as they usually would, even when it does rain. This fact, combined with the significantly reduced crop competition in most paddocks, will mean weeds will have the opportunity to grow in greater numbers.

Knowing that spraying moisture stressed weeds in dry conditions is less effective, many growers will be looking for any sign of rainfall as an opportunity to quickly apply post-emergent sprays in an attempt to reduce weed seed set.

Australian Herbicide Resistance Initiative communication lead, Peter Newman says waiting for new leaves to grow after a rainfall event is likely to give better results than spraying just a few days after rain.

"When plants are stressed, one of their survival mechanisms is to thicken the cuticle of their leaves," he says. "This reduces moisture loss from the leaf during hot, dry periods and also reduces the uptake of post-emergent herbicides."

"These leaves remain thicker and waxier, even when it rains and the plant freshens up," he says. "Waiting for new leaves to emerge after rain will result in a much better level of control and help minimise weed seed set. The use of the correct adjuvants and spray quality to counteract the increased waxiness of the leaves will also improve herbicide efficacy."



AHRI communication lead, Peter Newman suggests that when rain does fall in the currently dry grain-growing regions, there may be some advantage in delaying spraying herbicide until new leaves start to emerge on weeds in-crop, particularly if more rain is forecast.

But waiting for new growth also has its problems if dry conditions return. "These decisions are not easy, but if rain has fallen and more rain is forecast, perhaps waiting for new growth of the weeds will give the best results," he says.

Department of Agriculture and Food WA research conducted by Dr David Minkey and John Moore in the 1990s demonstrated the impact of moisture stress and low humidity on herbicide efficacy. Their research showed a 20-fold difference in efficacy of glyphosate sprayed on weeds of the same age under favourable and stressful environmental conditions (see previous article).

"Unfortunately, spray events are going to be difficult to time and the results are probably going to be less than optimal. This is out of the grower's control in most instances," says Peter. "Given that there is a good chance of more weeds surviving in-crop weed control efforts, implementing some form of harvest weed seed control will be an even higher priority this year."

"High numbers of annual ryegrass is a concern but we know that we can get back on top of a ryegrass seed bank in just a few years," he says. "But wild radish produces seed that remains viable in the soil for five to 10 years so it takes much longer to drive weed seed numbers down if this weed blows out."

If faced with a crop failure, spraying out early could be a good option and for crops that are harvested, consider a low cost harvest weed seed control option, such as chaff lining, to minimise the potential impact of a weed blow-out.

Chaff lining involves placing a chute on the rear of the harvester that concentrates the chaff-only fraction into a narrow band between the wheeltracks of the header. The straw is chopped and spread as usual. The chute can generally be built on farm at a very low or even nil cost.

For more information about manage herbicide resistant weeds in dry seasons, visit the Weedsmart website: www.weedsmart.org.au

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Mein Bulldog

■ By Ian M. Johnston

ASTONISHMENT. That is the word which describes the facial countenance of spectators at vintage tractor shows, when the Bulldogs are paraded. (Tractors I mean, not the four legged variety). Though, to be honest, elderly farmers who know all about Bulldogs, might simply grin, as they remember with nostalgia these remarkable hunks of ironmongery.

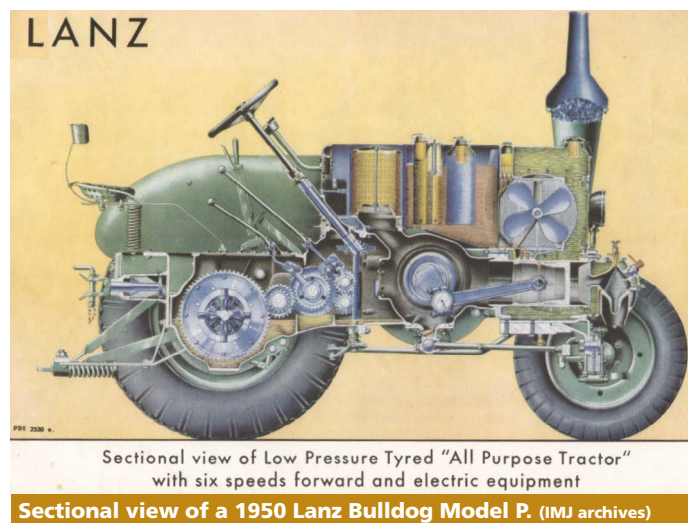
But there are so many new people around these days (by new I mean anyone not around in the days of Bing Crosby and Robert Menzies) that it follows, many of these youngsters are probably seeing a Bulldog for the first time. So why is it these idiosyncratic tractors astonish, amaze and obviously highly amuse, those who first set eyes upon these absurd relics of technology?

So let's deal with the history stuff first

In 1922 the German firm of Heinrich Lanz A.G. had been in existence for over six decades, churning out a vast array of innovative and top quality farm and industrial machinery, including 30,000 mobile steam engines of up to a whopping 1000 horse power. Yes, and the range even included giant airships that design-wise left the Zeppelins for dead!

But the firm's venture into tractors had proved disappointing

from a marketing point of view. Certainly, the five tonne 80 hp tractor introduced in 1912, was undoubtedly a better unit than the majority of tractors of that period. But its price to farmers rendered it beyond the financial thought process of their bank managers. The horse remained supreme!



Sectional view of Low Pressure Tyred "All Purpose Tractor" with six speeds forward and electric equipment
Sectional view of a 1950 Lanz Bulldog Model P. (IMJ archives)

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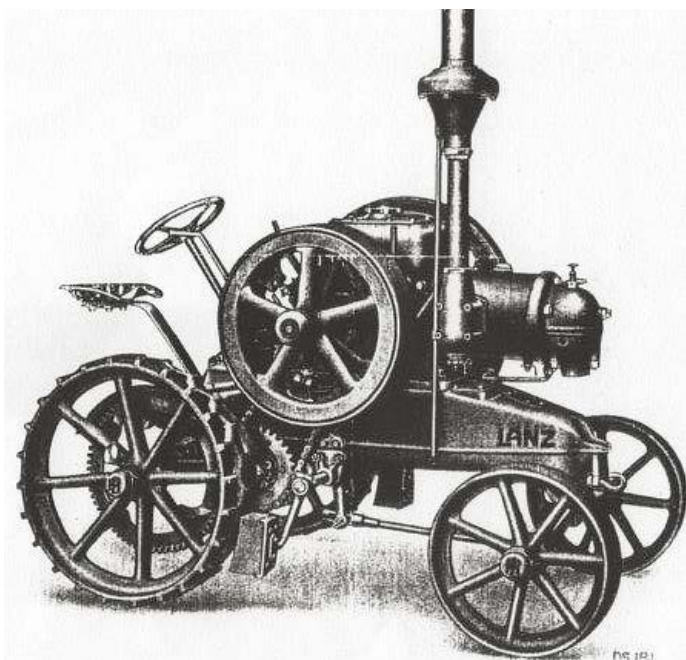
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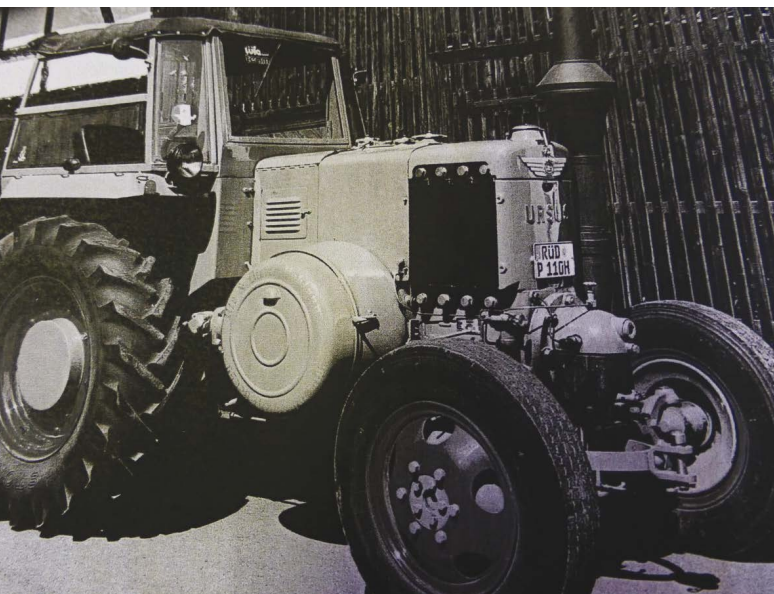
The remarkable HC12. (IMJ archives)

A fresh approach to the tractor situation was required. Enter Doctor Fritz Huber, the Lanz chief design engineer.

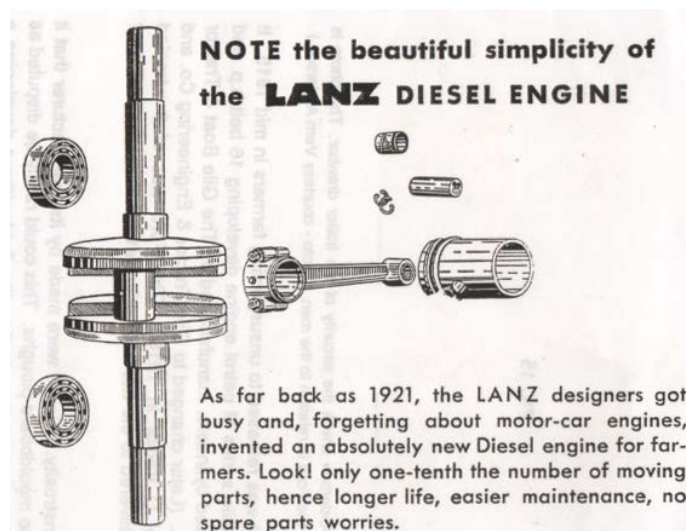
In 1921, with the release of Huber's HC12 tractor with its remarkable hot bulb engine, a significant milestone in the history of Lanz was achieved. The simplicity of design, yet the efficiency of the engine, was breathtaking in the extreme!

Now the technical stuff (not too technical!)

Put simply, it was a single cylinder two-stroke design, incorporating a horizontal cylinder with a displacement of 10.4 litres and containing only three moving parts – piston, connecting rod and crankshaft. There were no valves, valve rods or camshafts. The compression ratio was a mere 5.5 to 1. The fuel used was inexpensive crude oil or even sump oil drained from a more sophisticated engine. The fuel pump and atomiser (ie. injector) was more akin to a leaky garden hose nozzle.



A Polish manufactured Ursus Bulldog, made under licence. (IMJ archives)



The engine components of a Lanz Bulldog. (IMJ archives)

The scavenging system of drawing the air into the combustion chamber via a flap valve located in the crankcase, proved super efficient. In essence – as the piston returned on its forward stroke, the resulting suction simply drew air into the crankcase, which in turn was compressed in the 'downward' stroke and channelled into the hot combustion chamber, along with an injection of fuel. Simple and nothing to go wrong.

The custom designed diminutive rudimentary HC12 tractor, was constructed around the engine. Doctor Huber referred to this inexpensive, simple to operate, idiosyncratic machine, as "Mein Bulldog."

(To the new farmers, to whom I referred hitherto, 10.4 litres displacement will suggest mega doses of horse power. So let me be quick to point out that Huber's machine could only manage a measly 12 hp. Well, after all, this was back in 1921!)

Prior to starting the engine, the hot bulb portion of the cylinder head required to be pre-heated with a rather fearsome snorting petrol fuelled blow lamp – a sort of larger version of the ones house painters used to use (for some obscure reason or other, which escapes me at the moment). Note: The blow lamp was only required for the initial start. Once running, the engine generated its own heat.

Providing the farmer's fingers had not been barbecued by the daunting blow lamp, and the hot bulb now appeared to be cherry red, he then grasped the side mounted fly wheel – remember this was a horizontal cylinder lying north/south – and rotated it back and forth in a pendulum motion, thus causing the piston to compress the hot gasses in the combustion chamber.

Then all hell broke loose!

BANG!

Suddenly, there was an ear shattering explosion as the gasses detonated and the engine bounced into life. And I do mean bounced! Despite the massive flywheel, the kinetic energy created by the big cast iron piston surging to and fro, caused the tractor to shake-rattle-and-roll to such an extent that had chiropractors been around in these days, they would have had a regular queue of crippled Bulldog tractor drivers at their door! A day spent driving and thus being tossed around, perched on the cast iron seat of a steel wheeled unsprung HC12 Bulldog, was not a joyful experience.

The tractor was equipped with chain drive and horse cart brakes. There was no reverse gear. Should it be required to travel backwards it was necessary for the operator to stop and restart the engine, in the hope its rotational cycle would run in reverse!



A 1957 Lanz Bulldog Model DT operating on a rice farm near Leeton NSW. The DT was an immensely powerful tractor and in 1957 had a greater drawbar pull than any other wheeled tractor. Note; these later Bulldogs were equipped with a passenger seat located on the left mudguard. (Photo IMJ)

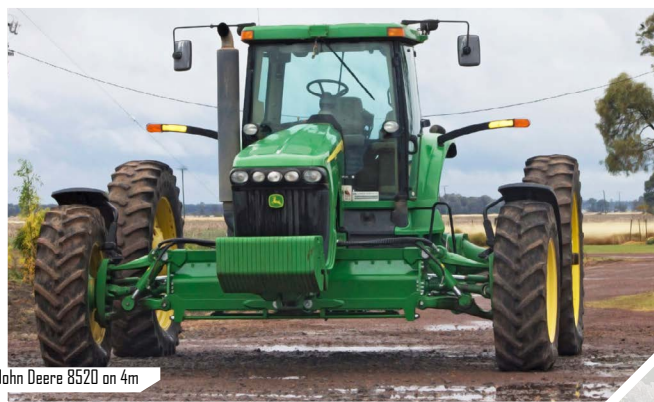


A 1958 Lanz Bulldog Model H, restored by the author. (Photo IMJ)

Incidentally, having only a low 4.5 to 1 compression ratio, the Bulldog was classed as a semi-diesel and therefore unable to produce sufficient heat to perform a cold compression start, as is the case with a full diesel (ie. at least a 15.5 to 1 ratio). Hence the need for the blowlamp.

Developments

Throughout the next four decades, Lanz progressively developed and improved the Bulldogs, but retained the classic principle of the single cylinder, low compression, crude oil-fuelled engine. Indeed, replicas were made by various manufacturers, in numerous countries including Poland, Brazil and Australia.



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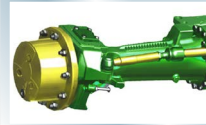
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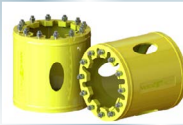
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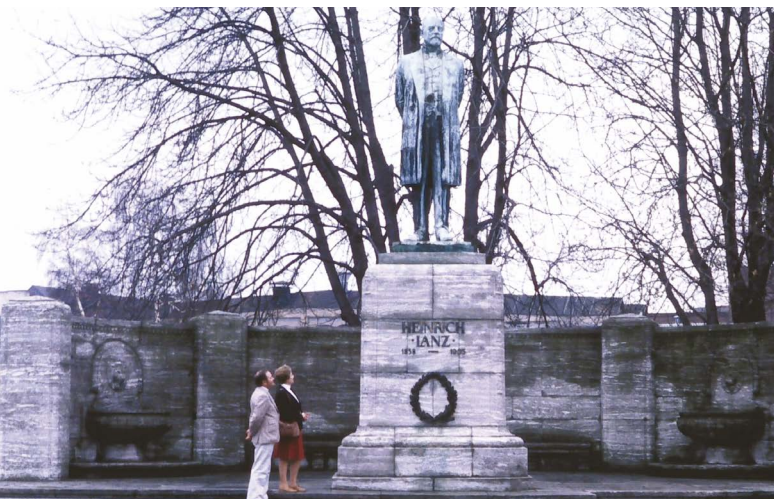
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The author and his wife Margery visit the Heinrich Lanz Memorial Garden, located at the original Lanz factory in Mannheim, Germany

It was not until the mid 1950s that new technology was introduced to the basic design. A flat headed alloy piston was incorporated along with an updated cross flow loop scavenging system. The compression ratio was increased to 10.5 to 1 enabling regular diesel fuel to be used and the incorporation of a cleverly designed Bosche 12 volt pendulum starter motor.

This was now 1953 and farmers were being lured by sophisticated multi-cylinder 'modern' tractors, but a number (albeit dwindling) of farmers around the world were attracted to this new range of push button start Bulldogs, and in particular their unparalleled simplicity of design and fuel economy.

Indeed in 1958, the big Lanz Model DT, with its live power take off shaft and nine forward gears, was considered the most powerful wheeled tractor available in Australia. At the opposite end of the scale was the lightweight Model H, capable of out pulling a Ferguson 35. Its fuel consumption was measured by the cupful!

Conclusion

It really is not surprising to see crowds pressing forward to see a Bulldog in action at vintage tractor shows. Folk are fascinated when they see the fearsome blow lamp being attached to the front of the tractor and large blue flames bellowing forth!

It is comical to watch the expression on the face of an inattentive operator when he selects a forward gear and the tractor heads off in reverse, due to the engine deciding to run backwards!

Nervy types, such as bank managers and over protective Mums, are likely to experience palpitations when a Bulldog engine is first fired up and announces the fact with an ear shattering BANG!

Today, Bulldogs are possibly the most collectable of all classic tractors. Their value has tripled over recent years.

On a personal note – I have farmed with bulldogs, and in the 1950s served as a company marketing rep for Lanz Australia Pty Ltd. In the intervening years I have restored several bulldogs, which were part of my extensive tractor collection.

A significant experience for me, was visiting the Lanz factory at Mannheim in Germany, where I paid my respects to the founder Heinrich Lanz at his memorial garden.

So forgive me if you detect a degree of nostalgia in this epistle about Mein Bulldog.

IAN'S MYSTERY TRACTOR QUIZ

Question: Can you identify this 1937 tractor?

Clue: Made in Canada.

Degree of difficulty: Easy to a grandpa farmer.

Answer: See page 48.



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Lending plants a hand to survive drought

A RESEARCH team led by The Australian National University (ANU) has found a new way to help plants better survive drought by enhancing their natural ability to preserve water.

The findings have helped some plants survive 50 per cent longer in drought conditions, and could eventually benefit major crops such as barley, rice and wheat, which are crucial to world food supplies.

The research team, led by Dr Wannarat Pornsiriwong, Dr Gonzalo Estavillo, Dr Kai Chan and Dr Barry Pogson from the ANU Research School of Biology, mapped a new molecular signalling pathway that controls the ability of plants to close the pores on their leaves to conserve water during drought stress.

"This basic scientific research has the potential to be able to improve farming productivity not just in Australia, but potentially in other countries that suffer from drought stress," Barry said.

"If we can even alleviate drought stress a little it would have a significant impact on our farmers and the economy."

Chloroplasts and hormones

The researchers found that chloroplasts, better known for their role in photosynthesis, are actually key players that work together with plant hormones during drought stress.

Barry said the research found chloroplasts in cells surrounding the pores on leaves, called stomata, can sense drought stress and thereby activate a chemical signal that closes stomata to conserve water.

"This finding was completely unexpected and opens new avenues of inquiry into how chloroplasts can contribute to plant responses to the environment," Barry said.

The team conducted tests on barley and arabidopsis – a small flowering native plant – and enhanced levels of the chloroplast signal which helps plants close stomata.

"Boosting the levels of this chloroplast signal also restores tolerance in drought-sensitive plants and extended their drought survival by about 50 per cent," Kai said.

He said boosting the chloroplast signal, by breeding, genetic or agronomic strategies, could be the key to help plants preserve water and boost drought tolerance.

"Dr Pornsiriwong, who has started her own research lab in Thailand, is currently investigating breeding strategies that naturally enhance levels of this drought tolerance-promoting chloroplast signal in rice," Kai said.

The research was funded by the Australian Research Council Centre of Excellence in Plant Energy Biology and was a collaboration between ANU, the University of Adelaide, Western Sydney University, CSIRO, Kasertsart University (Thailand) and the University of California San Diego (US).

The research has been published in *eLIFE*.

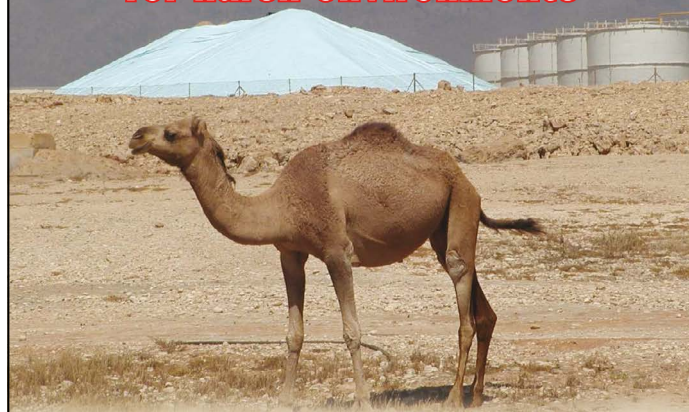


Diep Ganguly and Dr Kai Xun Chan. (PHOTO: Stuart Hay, ANU)



Members of the ANU research team Dr Su Yin Phua, Dr Kai Xun Chan, Diep Ganguly and Estee Tee. (PHOTO: Stuart Hay, ANU)

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How to best bring family members into the fold

TRANSITIONING the next generation into a farming business is a great idea in theory, but what are the practical realities of bringing more family members into the fold and how can families overcome these challenges?

2015 Nuffield Scholar Andrew Baldock used his scholarship to identify the best approaches for building farm enterprises to accommodate growing families in a changing business environment.

"Farm succession planning has traditionally been undertaken by the accountant and family lawyer and has focused on minimising tax through carefully managed asset transfer and retirement planning," Andrew said.

"While these are extremely important considerations, positive succession planning starts with open and honest communication.

"It sounds simple, but most successful family farm businesses allow all existing family members to have input into succession planning, even if they are not a part of the day-to-day operations.

"Clearly defined business roles and responsibilities are also an essential component of management transfer and building the family farm."

Andrew is a fourth generation farmer from Kimba, on South Australia's Eyre Peninsula, who returned home in 2010. Farming with his wife Dale, parents Jeff and Jenny and brother Mark with his wife Libby, the Baldock family runs a mixed cropping and livestock operation comprising of 2000 breeding ewes and 6000 hectares of cropping across 7400 hectares of owned and leased land.



Andrew Baldock on his farm in South Australia.

Andrew says with multiple siblings wanting to be involved in the family farm, they have a need to expand the business to support growing families.

"Having both recently been married and having our own children, Mark and I face the same scenario our family faced 30 years earlier – how do we want to move forward and what can the business handle?"

To help answer this question and help other farmers in a similar position, Andrew visited successful multi-generational family farms in North America, Brazil, Eastern Europe and Africa, thanks to a Nuffield Scholarship supported by Grain Growers.

"My Nuffield Scholarship has been a fantastic experience and there are certainly some common trends associated with succession planning and building farm enterprises with family members," he said.

Other ways of creating wealth

"It is a common mistake for farming families to dismiss business capacity to support returning children on the basis that the current business can't provide a living for everyone involved.

"But where there is little capacity to support family members returning to the farm, new methodologies of wealth creation such as collaborative business models, value-adding and contracting can be adopted."

Andrew said family farm businesses are somewhat unique in that there is usually a diverse framework of family members linked within it.

"An important aspect of unity and business success is understanding ourselves and the differing views and mindsets of others. New family members can improve the viability of the enterprise," he said.

"Farmers are too commonly caught up in the day-to-day running of the farm. Without setting aside time for reflection and future planning, much of the hard work will be in vain." ■



Chris Barron and Andrew Baldock at Carson and Barron Farms, Iowa, in the American Midwest.



Phosphine fumigation, venting and avoiding load rejections

■ By Philip Burrill, Greg Daglish, Manoj Nayak – DAF Qld

AT A GLANCE...

- The time requirement for venting grain after phosphine fumigation to prevent phosphine residues may be longer than the current label minimum recommended times (eg. one day fan venting after the completion of the exposure period).
- Applying the workplace phosphine safety limit of time weighted average (TWA) 0.3 ppm, using the current testing method of 'spearing grain in truck' at delivery point, may need industry assessment.
- During fumigation, grain absorbs small amounts of phosphine. It takes a number of days for the grain to desorb this gas to very low levels.
- Augering grain into a truck immediately after fumigation – with no venting – only briefly removes phosphine gas from the intergrain spaces. Grain rapidly desorbs more phosphine gas.
- Research presented in this paper is from only one recent trial on wheat. There is very little field research data on venting phosphine fumigations. More research is required.

IN 2016 more than 70 truckloads of grain were rejected at the Port of Brisbane. These loads exceeded the current 0.3 ppm phosphine gas concentration limit at delivery when grain was speared in the truck on the weighbridge. Grain load rejections for phosphine detections are also occurring at the Port of Melbourne and other grain receival sites, plus at a range of domestic grain buyers, such as stockfeed manufacturers, throughout Australia.

The majority of the loads rejected had phosphine gas concentrations in the range of 0.5 to 2.5 ppm, well above the 0.3 ppm limit for deliveries. A few loads had very high concentrations of 32, 82 and 440 ppm.

These grain rejections at the point of delivery are not only costly to individual grain growers and grain handlers, but also present additional risks and costs to Australia's grain logistics and export supply chain.

In the interests of employee safety at grain receival sites, businesses are applying the Workplace Health and Safety (WHS) standards for phosphine (PH₃) using the threshold limit value (TLV) – time weighted average (TWA) of 0.3 ppm.

The current method of testing when applying the TWA 0.3 ppm standard is to spear the grain in the truck on arrival and test gas concentrations within the grain before unloading.

The phosphine label and ventilation

Ventilation of fumigated grain storage structures is complete only when the phosphine concentration measured at appropriate locations in the enclosure and work area are below TLV – TWA exposure standard 0.3 ppm.

Listed below are the label minimum ventilation periods (on completion of the exposure period) for phosphine. It should be noted that longer periods may be required to ensure the 0.3 ppm phosphine gas concentration limit is not exceeded in grain deliveries.

Minimum ventilation periods for structures, including bunker storages include:



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- Not less than one day: With throughflow and forced draught (flash-proof fan) operated two hours on and two hours off;
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Applying the TWA workplace safety standard

It is suggested that the grains industry in conjunction with the appropriate national and state, WHS authorities should clarify the interpretation and practical application of the TLV – TWA 0.3 ppm standard. In particular the wording “phosphine concentrations measured at appropriate locations in the enclosure and work area”.

Is the current practice of measuring phosphine gas concentrations “within the grain bulk” in the truck prior to unloading, an “appropriate location and work area” when applying the 0.3 ppm TWA worker safety standard?

A definition of TWA: “The TWA exposure value is the average airborne concentration of a particular substance when calculated over a normal eight hour working day for a five day working week.”

That is; a worker must not have an average phosphine exposure of greater than 0.3 ppm for eight hours per day, for five days per week (40 hour week).

Stamp out poor, illegal practices

For the sake of worker safety and Australia’s grains industry reputation, using phosphine in accordance with the registered label to control grain storage pests is essential. The following practices by a small minority in the industry must be stopped:

- Grower and commercial grain storage facilities – not venting after fumigations, augering straight into trucks for delivery;
- “Short”, last minute fumigations in loaded trucks before grain delivery (not adhering to label fumigation practices or ventilation periods); and,
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For the sake of market safety and the industry’s reputation, fumigated grain must be properly vented before delivery,

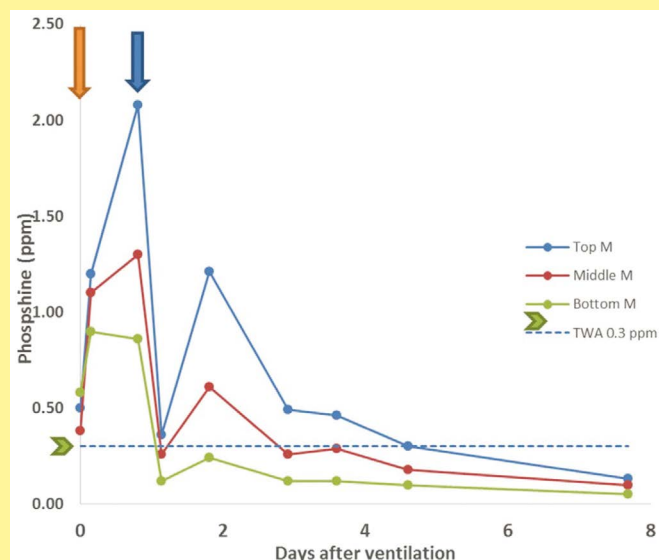
Ventilation research – wheat 2017

In February 2017, phosphine fumigations in stored wheat were conducted in two small research silos (35 tonnes capacity) at the Hermitage research facility (Warwick, QLD) by Department of Primary Industry and Fisheries Qld postharvest researchers.

Following standard phosphine fumigations (1.5 g/m³) for seven days in **Silo A** and 10 days in **Silo B**, lids on the top of the silos were opened and aeration fans turned on for post fumigation ventilation for one day (24 hours).

Silo A – What we found

FIGURE 1: Silo A – Phosphine gas concentration (ppm) in wheat after one day of fan ventilation then followed by two auger transfers



The phosphine gas concentrations in Silo A are shown in Figure 1 after a seven day fumigation and one day (24 hours) ventilation period, with 20 hours of fan run time.

Phosphine gas concentrations in Silo A, prior to ventilation commencing was relatively uniform throughout the grain in the silo (980 ppm).

The orange arrow indicates where the one day ventilation period has finished and gas measurements in grain have started. Gas sample tubes placed in the silo provided measurement points in grain at three locations – top, middle and bottom.

The first gas readings were taken one hour after the ventilation fan was turned off.

The blue arrow indicates the point where the 35 tonnes of wheat was augered out of the silo and loaded into a truck, then within one hour augered back into the silos.

After one hour, gas readings were once again measured in grain.

- Within 1 to 2 hours after a one day fan ventilation, wheat kernels ‘desorbed’ phosphine back into the intergrain spaces bringing gas concentrations from zero back up to 0.4 – 0.6 ppm.
- 24 hours after ventilation was completed, phosphine gas concentrations within the grain bulk had risen to 0.8 – 2.0 ppm.
- One day after venting wheat, it was augered into a truck and then augered back into the silo. Gas reading 20 hours after twice augering went from zero to 0.2 – 1.2 ppm.

- Wheat kernels are still desorbing phosphine over a number of days beyond a one day fan ventilation, bringing concentrations well over 0.3 ppm.

Phosphine gas in the grain bulk Vs the surface

With the aim of having an initial look at the safety risk of working around grain that has been fumigated and vented for one day (24 hours fan run time), grain at the top of Silo B (10 day fumigation) was tested for phosphine gas concentrations in the grain bulk and at the grain surface.

Using a one metre spear, gas readings were taken at a depth of one metre in the grain at the top of the silo and at the same time, gas reading on the grain surface were recorded (Figure 2).

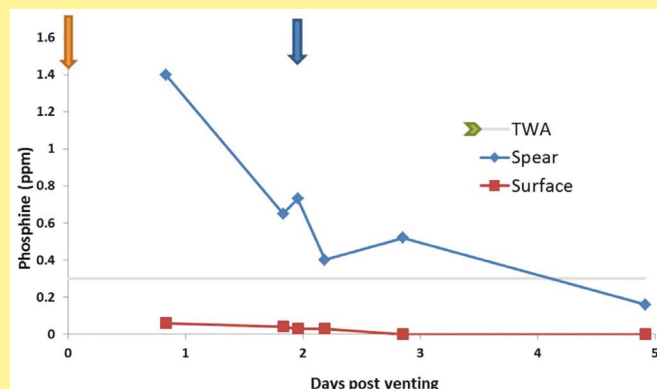
Silo B: What we found

- After 20 hour post ventilation (24 hours fan run) phosphine gas concentration in grain at a depth of 1m in the top of the silo went from zero back up to 1.4 ppm. This was similar to gas levels in Silo A.
- But at the same time, gas readings of 1.4 ppm are measured in the grain bulk, the gas concentrations on the surface of the grain were much lower – 0.06 ppm.
- Phosphine gas concentrations on the grain surface after one day of ventilation are well below TWA 0.3 ppm.

To sum up

- More research is required with phosphine fumigation of wheat and other grains to form reliable conclusions as there is very little field research data available on phosphine gas concentrations after ventilation.
- Wheat grains can 'desorb' phosphine gas for a number of days beyond a one day fan ventilation.
- We require field research into – and clarification of – the

FIGURE 2: Silo B – Phosphine gas concentration in wheat after one day of ventilation, at one metre depth and on the grain surface



appropriate industry 'testing method' that is best suited for compliance with the TWA 0.3 ppm phosphine safety standard.

Further reading: GRDC Factsheet – *Grain Fumigation – a guide*. GRDC booklet – *Fumigating with phosphine, other fumigants and controlled atmospheres*. See <http://storedgrain.com.au>

The research undertaken is made possible by the significant contributions of DAF Qld's Postharvest research team, Hermitage research station staff, agribusiness and growers. The authors would also like to thank the PBCRC, GRDC, and GRDC's national grain storage extension team, for their continued support.

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New silver-cotton fibres battle bacteria

■ By Sandra Avant, Agricultural Research Service – USDA

AT A GLANCE

- A nanoparticle is a particle of matter 1 to 100 nanometres in diameter.
- Silver nanoparticles have powerful antimicrobial properties.
- ARS-developed technology traps silver nanoparticles inside cotton fibre.
- Nanoparticles embedded in cotton kill bacteria after 50 washings.

SILVER has been used as an antimicrobial agent for more than 100 years. Today, silver in the form of nanoparticles is incorporated in such products as plastic food containers, medical materials, and clothing. But in textiles, preventing the nanoparticles' antimicrobial properties from washing away has always been a problem. But not anymore.

Scientists at the Agricultural Research Service's (ARS) Southern Regional Research Center (SRR) in New Orleans, Louisiana, have developed a method to trap silver nanoparticles inside cotton fibres, where they remain wash after wash.

The amount of silver nanoparticles required to kill bacteria is extremely small, which makes them efficient and cost effective to use. Moreover, the new method, developed by ARS materials engineer Sunghyun Nam and her colleagues, is inexpensive and eco-friendly.

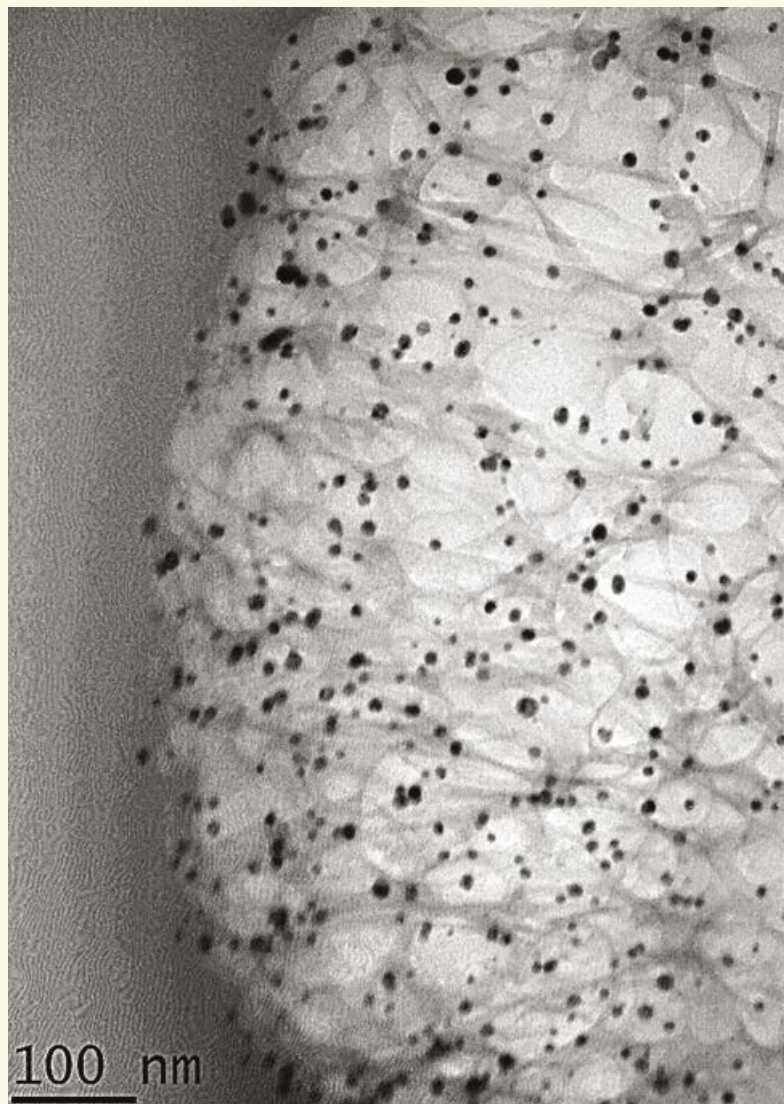
More effective and affordable

Typically, silver nanoparticles – particles that are 1 to 100 nanometres in diameter – are grown in a bulk chemical solution. In the new technology, the silver nanoparticles are produced within the cotton fibres, making their application more effective and affordable.

Silver nanoparticles slowly release silver ions that can kill more than 600 kinds of bacteria, including *E. coli*, says Sunghyun, who works in the SRR Cotton Chemistry and Utilization Research Unit. The problem has been that currently available methods could only apply silver nanoparticles to the surface of fibres, where they would wash away.

"Our new process grows and traps the silver nanoparticles inside cotton fibres," Sunghyun says. "They release their silver ions very slowly, killing bacteria for a long time. Our process also allows us to produce extremely small nanoparticles, about 12 nanometres in diameter." One nanometre is a billionth of a metre. For example, a sheet of paper is about 100,000 nanometres thick. The extremely small size of the silver nanoparticles results in a larger surface area, which increases the number of silver ions coming into contact with bacteria.

In a recent study published in *Scientific Reports-Nature*, Sunghyun and ARS postdoctoral research chemist Krystal Fontenot showed that even after 50 home laundering cycles, their silver-cotton nanocomposite fibre retained about 93 per cent antimicrobial silver nanoparticles and continued to kill harmful bacteria. The new technology also strengthened the cotton fibres.



Cross-section of a cotton fibre with silver nanoparticles (black dots) trapped inside it. (PHOTO: Sunghyun Nam)

This technology has many possible applications. For example, fabrics or bandages made with these new nanoparticle-containing fibres may be effective in wound or burn treatments, says Brian Condon, the unit's research leader. "The nanoparticles may be used in durable or nonwash fabrics – disposable undergarments, shoe liners, upholstery, and bedding – to protect the users from infection," he adds.

For now, the researchers plan to produce a nonwoven fabric cloth for wiping floors to evaluate its antimicrobial activities.

"We want to find out how many bacteria are killed on the floor initially and how many are killed after repeated washing," Sunghyun says.

More information: Sunghyun Nam, Cotton Chemistry and Utilization Research, USDA, New Orleans, LA 70179
Email: sunghyun.nam@ars.usda.gov Ph: +1 (504) 286 4406

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On the cutting edge of cotton production

HOW to make more from less is a question many farmers face, but particularly in regards to water for irrigation. Cotton grower and 2015 Nuffield Scholar, Tom Quigley, says ongoing issues around water availability prompted him to look at new techniques from around the world to help grow more profitable, water efficient and sustainable cotton crops using pressurised overhead sprinkler irrigation.

Tom and his family manage a 1200 hectare irrigation property, alongside dryland cropping and livestock enterprises, in the New South Wales' Macquarie Valley.

Since the implementation of the Murray-Darling Basin Plan in 2012, and as part of the government's incentive to modernise irrigation infrastructure, a large proportion of the district's cotton farms swapped water rights to implement pressurised overhead sprinkler irrigation.

Technology wasn't delivering

Having invested heavily in the new infrastructure, most notably centre pivots and lateral moves (CPLM) systems, Tom says it was clear that the new technology wasn't delivering the promised results of increased yield and reduced water use.

"The initial results were promising, but we weren't seeing the full potential of these machines using existing cotton growing methods. We identified that we had to change our farming technique with the new infrastructure, in order to produce more, with less," he said.

"I began researching new techniques and elements employed by other farmers around the world, which ultimately led to my Nuffield Scholarship, which was supported by Cotton Australia and the Cotton Research and Development Corporation.

"The scholarship enabled me to see first-hand the advances

being made with similar sprinkler irrigation systems in countries like the United States, Canada, Brazil, Mexico, New Zealand and Israel.

"I talked to farmers who had 30 plus years' experience utilising sprinkler irrigation and was able to bring that knowledge back home to help accelerate the change in practices on our own farm, as well as those around us."

His findings uncovered several areas of improvement for growers – ranging from the need to have ground cover to adopting new systems like strip tillage, which has delivered significant gains for US farmers in corn production.

"There was a lot to take away from the whole experience at both a very technical and professional level," he said.

Ground cover and strip tillage

"For instance, it became obvious that ground cover material must have enough lining and cellulose to resist decomposition until after row closure in the cotton crop.

"Introducing ground cover into the system came with its own set of challenges, and while planting cotton into fields with high ground cover residue is possible, it requires specialised equipment and a modified planter set up to achieve the desired results.

"Strip tillage overcomes a significant proportion of the challenges associated with groundcover, and can deliver significant yield increases as seen in the US. It's a precision agriculture tool and highly beneficial in a cotton system under CPLM due to its ability to consolidate various processes in one pass."

Tom's research also found that sprinkler selection determines how water is delivered to the soil efficiently and will have the greatest influence in machine performance for minimal cost.

"There is a 10 per cent reduction in water use up for grabs just from sprinkler choice, which could be a \$400 per hectare decrease in cost," he said.

"Irrigation scheduling is completely different to traditional cotton farming systems. But the same decision making tools are relevant for furrow and sprinkler irrigated crops.

"Machine maintenance is of the highest importance because if a machine breaks down, there is zero capacity to irrigate the crop, which directly impacts the bottom line.

"To help counter this, preventative pre-season maintenance can minimise down time during the season and help prevent severe water stress."

Help technology adoption

Ultimately, Tom hopes his Nuffield Scholarship report and, more broadly, his global experience will encourage other Australian growers to adopt new farming techniques and share these learnings with their peers.

"The cotton industry has a great history in sharing knowledge and helping each other to improve farming practices, so as to obtain greater water efficiency, yields and profitability," he said.

"I hope what I've seen and learnt overseas helps other growers who are already utilising – or are thinking about utilising – sprinkler irrigation to grow cotton.

"Australian cotton has a very positive story to tell. We're not only reducing water, chemical and energy use, we're continuing to increase the quality of a product, that we know our customers love and enjoy."



Tom Quigley says there are significant sprinkler irrigation cost and water savings up for grabs with judicious use of ground cover and tillage practice right through to nozzle/sprinkler selection.



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Herbicide resistance surveys help growers map a path forward

MANAGING the escalating risk of herbicide resistance across New South Wales and Queensland starts with one simple step – knowing what's in your paddocks.

A weed survey investment by the GRDC is making rapid gains into understanding the prevalence of the region's key weed species, their resistance status and the effectiveness of commonly used herbicide modes of action.

Growers are being encouraged to become involved in the survey to help establish a baseline knowledge about their property's weed populations and enable industry to generate a more thorough understanding of the herbicide resistance situation across the northern region.

Queensland Department of Agriculture and Fisheries (DAF) principal research scientist (weed science) Michael Widderick said understanding the incidence and risk of herbicide resistance development would help growers determine the likely effectiveness of various weed management tactics.

"If growers are unsure whether herbicide resistance exists on their property, they could end up wasting a great deal of time and money on herbicide applications that are basically ineffective," Michael said.

"The only way to find out whether herbicide resistance is present is to test."

The surveillance work is being conducted in Queensland by DAF and in New South Wales by Charles Sturt University (CSU).

Weeds targeted

Weeds targeted in the survey include common sowthistle, fleabane, wild turnip, African turnip weed, wild oats, feathertop Rhodes grass, awnless barnyard grass, sweet summer grass, liverseed grass, windmill grass, annual ryegrass, wild oats and Brassica species.

All commonly used herbicide modes-of-action will be screened and once findings are collated, confidential reports will be available to participating growers.

General survey data will be used anonymously to prepare large scale maps showing the distribution of resistant weed populations across Queensland and NSW to help highlight priority issues and ensure they are addressed.



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DAF is seeking permission from growers and land managers to enter properties to collect weed seeds and is conducting surveys in Queensland to coincide with winter and summer grain and legume harvests. Growers will be contacted prior to paddock visits with a date and an estimated time of visit.

Both DAF and CSU personnel will take the utmost care to ensure boots and clothing are free from weed seeds before entering property.

Survey work began last year on a range of winter weeds and herbicides, and is continuing throughout 2017.

The winter weed survey was conducted during October to November 2016 and resulted in almost 600 paddocks being surveyed across Queensland and NSW. Sowthistle and wild oats were the most common weeds collected for testing.

Surveys started in 2014

The survey work builds on an earlier project led by DAF researchers into the level and status of herbicide resistance in common sowthistle across the northern region in 2014–16.

The work started after Australia's first cases of glyphosate-resistant sowthistle populations were found in north-west NSW in February 2014.

More than 170 sowthistle seed samples were received as part of the survey with approximately 19 per cent of viable samples showing resistance to label rates of glyphosate. In one seed sample, from a fallow paddock near Gunnedah, 93 per cent of plants survived a glyphosate application at the recommended rate.

On the flip-side, 81 per cent of the samples tested were susceptible to the label rate of glyphosate under test conditions.

This indicates that, for the majority of properties in the north, glyphosate remains an effective control option for common sowthistle as long as plants are treated at an early growth stage using robust label rates of herbicide.

But in the longer term the sustained effectiveness of glyphosate will hinge on the widespread adoption of diversity in weed control as part of an integrated approach.

"Both the sowthistle resistance survey and the broader herbicide resistance surveillance which is currently underway will provide critical benchmarking information for the grains industry at farm, industry and state levels," Michael said.

"This information is critical if we are to be proactive in dealing with herbicide resistance in the north – we need to know the situation in paddocks so we can take action and protect the longevity of our most important herbicides."

SURVEY CONTACTS...

Queensland landholders interested in taking part should contact Dr Adam Jalaludin on 07 4529 1346 or adam.jalaludin@daf.qld.gov.au.

In NSW, CSU will be conducting random surveys, sampling at 20 km intervals around the state. For more information or to become involved with the NSW testing, contact Dr John Broster on 02 6933 4001 or email jbroster@csu.edu.au

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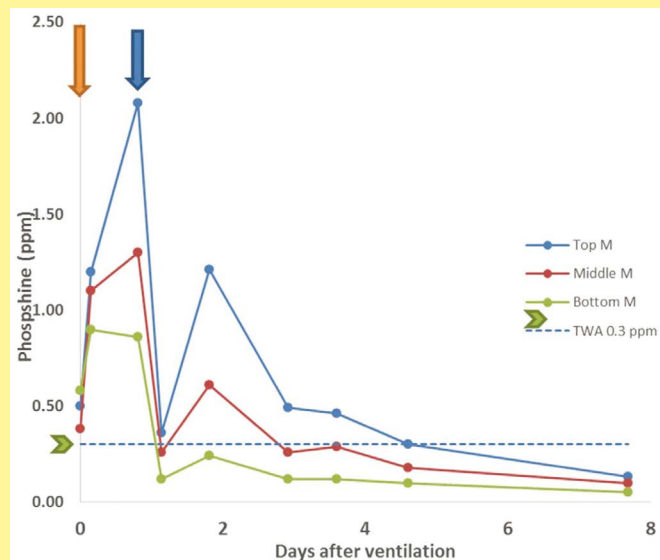
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With the aim of having an initial look at the safety risk of working around grain that has been fumigated and vented for one day (24 hours fan run time), grain at the top of Silo B (10 day fumigation) was tested for phosphine gas concentrations in the grain bulk and at the grain surface.

Using a one metre spear, gas readings were taken at a depth of one metre in the grain at the top of the silo and at the same time, gas reading on the grain surface were recorded (Figure 2).

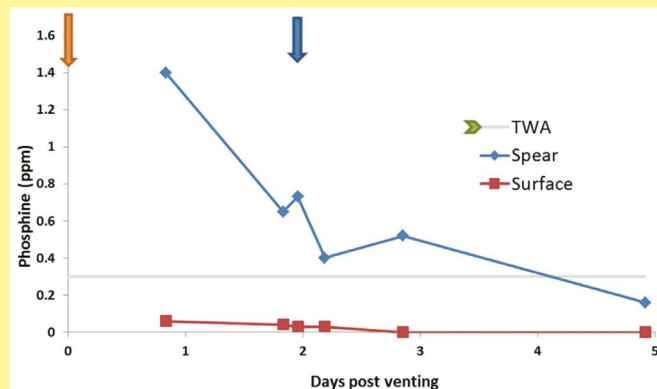
Silo B: What we found

- After 20 hour post ventilation (24 hours fan run) phosphine gas concentration in grain at a depth of 1m in the top of the silo went from zero back up to 1.4 ppm. This was similar to gas levels in Silo A.
- But at the same time, gas readings of 1.4 ppm are measured in the grain bulk, the gas concentrations on the surface of the grain were much lower – 0.06 ppm.
- Phosphine gas concentrations on the grain surface after one day of ventilation are well below TWA 0.3 ppm.

To sum up

- More research is required with phosphine fumigation of wheat and other grains to form reliable conclusions as there is very little field research data available on phosphine gas concentrations after ventilation.
- Wheat grains can 'desorb' phosphine gas for a number of days beyond a one day fan ventilation.

FIGURE 2: Silo B – Phosphine gas concentration in wheat after one day of ventilation, at one metre depth and on the grain surface



- We require field research into – and clarification of – the appropriate industry 'testing method' that is best suited for compliance with the TWA 0.3 ppm phosphine safety standard.

Further reading: GRDC Factsheet – *Grain Fumigation – a guide*. GRDC booklet – *Fumigating with phosphine, other fumigants and controlled atmospheres*. See <http://storedgrain.com.au>

The research undertaken is made possible by the significant contributions of DAF Qld's Postharvest research team, Hermitage research station staff, agribusiness and growers. The authors would also like to thank the PBCRC, GRDC, and GRDC's national grain storage extension team, for their continued support.

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2017 producing a mixed bag of canola diseases in the south

SEASON 2017 is producing mixed fortunes in terms of canola diseases for growers in the southern cropping region.

While the risk of blackleg disease has reduced with the lack of consistent rainfall in many parts of the region, there has been an increased incidence of canola white leaf spot.

Growers of canola are therefore being advised to take a considered approach to disease management this year.

Oilseeds disease expert Dr Steve Marcroft, who undertakes research through a Grains Research and Development Corporation (GRDC) investment, says seasonal conditions have so far not been conducive to the severe development of the blackleg fungus.

"Blackleg likes continual wet conditions for spore release and germination, which is why blackleg severity on seedlings was so high in 2016," says Steve, of Marcroft Grains Pathology.

"In contrast, a large area of southern Australia has received rainfall in only a couple of major rain events, and conditions have remained dry between these events. Consequently, blackleg lesions are only starting to occur now (mid to late June)."

Steve advises that if crops are already past the vulnerable seeding stage (1–4 leaf) and have no or few lesions, these crops

most likely will not develop severe crown canker and therefore may not benefit from a foliar fungicide application.

"But if a crop was sown later, has a moderately susceptible (MS) or lower blackleg rating and is currently still in the vulnerable seedling stage, it may develop severe crown canker and therefore benefit from a foliar fungicide application," Steve says.

Effective up to 8–9 leaf

"Growers should monitor crops for blackleg lesions on the first four leaves, estimate the potential crop yield and decide if it is economical to protect the crop.

"Foliar fungicide has the highest efficacy against blackleg crown canker if applied at the 4–6 leaf stage, but is still very effective up to the 8–9 leaf stage.

"If growers are unsure about the blackleg severity on their crop and the potential yield, they can wait until the 8–9 leaf growth stage and then make a disease management decision."

Increased white leaf spot

Meanwhile, Steve says an increased incidence of canola white leaf spot has occurred in many parts of southern Australia this season.

"The disease is distributed worldwide, but in Australia it is not usually severe enough to cause yield loss. But if environmental conditions are favourable, it can result in significant defoliation, causing reduced plant vigour and subsequent yield loss.

"White leaf spot is not usually severe enough to warrant fungicide control."

White leaf spot normally only occurs on oldest leaves near the soil surface. Occasionally it is observed moving up the canopy, infecting younger leaves and reducing the leaf area significantly – this is when yield loss may occur. It is not currently well understood why it can occasionally become more severe in individual regions and seasons.

Nutrient-deficient canola crops can be more severely affected by the disease.

The symptoms of white leaf spot are leaf and stem lesions that are greyish white to light brown. Leaf lesions can be up to one centimetre in diameter and coalesce to form large irregular-shaped lesions.

Mature lesions often have a brown margin. White leaf spot lesions do not contain pycnidia (black dots) which are characteristic of blackleg.

Beyond this growing season, Steve encourages an integrated approach to managing white leaf spot. This involves controlling cruciferous weeds and volunteer canola, employing strategic crop rotations and reducing infection from wind-borne spores by not sowing near the previous year's canola stubble (both the white leaf spot and blackleg fungus survive on canola stubble).

The disease is not usually seed-borne, but it can spread by infected seeds or infected debris with the seed.

Comprehensive information on management of white leaf spot, blackleg and other canola diseases can be found in the GRDC's *Diseases of Canola and Their Management: The Back Pocket Guide*, which can be viewed and downloaded via <https://grdc.com.au/GRDC-BPG-CanolaDiseases>.

Further information specific to blackleg disease can be found in the GRDC's *Blackleg Management Guide*, <https://grdc.com.au/GRDC-F5-BlacklegManagementGuide>



An increased incidence of canola white leaf spot has occurred in many parts of southern Australia this season. The symptoms of white leaf spot are leaf and stem lesions that are greyish white to light brown. (PHOTO: Steve Marcroft)

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Sclerotinia stem rot in canola

■ By Kurt Lindbeck, Audrey Leo and Joop van Leur, NSW Department of Primary Industries

AT A GLANCE...

- Sclerotinia stem rot is a production issue where spring rainfall is adequate to provide long periods of leaf wetness in the presence of flowering canola crops.
- If there is a history of sclerotinia stem rot in your district causing yield loss, be prepared to use a foliar fungicide to reduce yield loss.
- Sclerotinia stem rot occurred in those districts with a frequent history of the disease in 2016. Wet conditions in spring were ideal for disease development.
- Extended periods of leaf wetness (approximately 48 hours) are ideal for triggering epidemics of stem rot.
- Foliar fungicides for management of the disease are best applied at 20 to 30 per cent bloom for main stem protection.

GROWING season conditions in winter and early spring were highly conducive for the development of sclerotinia stem rot in 2016 in southern and central NSW. Prolonged wet weather in winter was ideal for the germination and development of apothecia, the fruiting structures of the sclerotinia fungus. The first warning signs appeared in early July when apothecia was found within canola crops in southern NSW, with flowering commencing shortly afterwards in some early sown crops.

Continued wet weather throughout August and September provided periods of extended leaf wetness and opportunities for disease epidemics to develop in many districts.

In general, disease levels were low across southern NSW despite the wet conditions. Widespread use of foliar fungicides in high disease risk districts was effective in managing the disease.

How does the disease develop?

The complexity of the disease cycle of sclerotinia stem rot results in disease outbreaks being sporadic compared to other diseases. There are several key stages that must be synchronised and completed in order for plant infection to occur. Weather conditions must be suitable for the pathogen at each stage. These stages of development include:

- Softening and germination of soil borne sclerotia;
- Apothecia development and release of ascospores;
- Infection of petals by air-borne ascospores; and,
- Senescence of infected petals in the presence of moisture and subsequent stem infection.

Weather conditions during flowering play a major role in determining the development of the disease. The presence of moisture during flowering and petal fall will determine if sclerotinia stem rot develops. Dry conditions during this time can quickly prevent development of the disease, hence even if flower petals are infected, dry conditions during petal fall will prevent stem infection development.

Research findings in 2016

Commercial canola crops and trial sites were monitored for the development of sclerotinia stem rot in high sclerotinia risk districts in 2016. These crops were located in southern NSW and northern Victoria where the disease is an annual problem. Consistent with the previous year's results, observations within these crops found a very strong relationship between prolonged periods of leaf wetness and stem rot development.

In addition, a small scale petal survey was conducted across southern NSW and northern Victoria in 2016. The aim of this survey was to investigate the relationship between petal infestation with the sclerotinia fungus and stem rot development.

Stem infection

Infection levels at disease monitoring sites were generally low (under 10 per cent). Despite above average rainfall, foliar fungicides applied by growers were effective at keeping potential disease levels low.

But some reports were received of higher levels of stem infection in some commercial crops, depending on where rainfall events occurred and crop growth stage. Consistent with previous seasons, results showed that extended periods of leaf wetness of at least 48 hours were most effective for the development of stem infection within crops.

Petal testing

For the second year a petal survey was conducted across NSW and northern Victoria. The highest levels of petal infestation (>90 per cent) were detected in crops grown in higher rainfall districts with a high frequency of canola crops. Crops further west had reduced levels of infestation in general (below 60 per cent), with levels of infestation fluctuating with environmental conditions. These results are consistent with the previous year's findings.

Once again the results confirm findings that were observed 10 years ago which found no direct correlation between the numbers of canola petals infested with the sclerotinia pathogen and stem rot development within the crop. This confirms the importance of leaf wetness within the crop canopy as the driving factor behind development of stem rot.



Canola stems infected by sclerotinia showing formation of bleached stem lesions. (PHOTO: Steve Marcroft)



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Where did the disease occur in 2016 in NSW?

Traditionally sclerotinia outbreaks are more frequent in southern NSW and northern Victoria and usually restricted to those districts with a history of sclerotinia, high intensity of canola and reliable spring rainfall. Due to above average spring rainfall in 2016 outbreaks of the disease were widespread and in districts that rarely see the disease develop. Damaging levels of sclerotinia were largely restricted to the 'traditional' districts that frequently see the disease, while in lower rainfall districts the disease was observed but didn't significantly affect canola yields.

What are the indicators that sclerotinia stem rot could be a problem in 2017?

- **Spring rainfall.** Epidemics of sclerotinia stem rot generally occur in districts with reliable spring rainfall and long flowering periods for canola.
- **Frequency of sclerotinia outbreaks.** Use the past frequency of sclerotinia stem rot outbreaks in the district as a guide to the likelihood of a sclerotinia outbreak. Paddocks with a recent history of sclerotinia are a good indicator of potential risk, as well as those paddocks that are adjacent. Also consider the frequency of canola in the paddock. Canola is a very good host for the disease and can quickly build up levels of soil-borne sclerotia.
- **Commencement of flowering.** The commencement of flowering can determine the severity of a sclerotinia outbreak. Spore release, petal infection and stem infection have a better chance of occurring when conditions are wet for extended periods, especially for more than 48 hours. Canola crops which flower earlier in winter, when conditions are cooler and wetter, are more prone to disease development.

Sclerotinia in lower rainfall areas

In lower rainfall regions sclerotinia stem rot is generally not a canola production issue. The disease may appear sporadically in some years, but often at levels that cause negligible yield loss. In these regions disease control would focus on blackleg, rather than sclerotinia stem rot.

To manage sclerotinia stem rot in lower rainfall regions use prevention measures such as:

- **Paddock selection.** Sow this year's crop away from last year's canola stubble to prevent airborne spore movement.
- **Crop rotation.** Canola is an excellent host for the Sclerotinia stem rot fungus. The more frequently that canola is grown in a paddock, the more opportunities for sclerotia to develop and build up. In addition, avoid sowing two consecutive broadleaf crops, such as lupin/canola.
- **Follow recommended sowing dates and rates.** Early flowering crops are more prone to developing sclerotinia stem rot by increasing opportunities for infected petals to lodge in a wet crop canopy. In addition, early sown crops will most likely develop bulky crop canopies which retain moisture and increase the likelihood of infection. Wider row spacings can also help by increasing air flow through the crop canopy to some degree and delaying the onset of canopy closure.
- **Sowing canola seed that is free of sclerotia.** This applies to growers retaining seed on-farm for sowing. Consider grading seed to remove sclerotia that would otherwise be sown with the seed and infect this season's crop.
- **Consider the use of a foliar fungicide.** Weigh up yield potential, disease risk and costs of fungicide application when deciding to apply a foliar fungicide.
- **Monitor crops for disease development and identify the type of stem infection.** Main stem infections cause the most

yield loss and indicate infection events early in the growing season. Lateral branch infections cause lower levels of yield loss and indicate infection events later in the growing season.

Consult the *Sclerotinia Stem Rot in Canola* factsheet for further information. This publication is available from the GRDC website.

The authors wish to thank NSW DPI and GRDC for investment into this research.

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USE OF FOLIAR FUNGICIDES

At this time there are no commercial canola cultivars available on the Australian market with resistance to sclerotinia stem rot. Management of the disease relies on the use of cultural and chemical methods of control.

Foliar fungicides should be considered in those districts which are at a high risk of disease development (eg. districts where the disease frequently occurs, long flowering period and reliable spring rainfall).

There are several foliar fungicides currently registered for use in Australia to manage sclerotinia stem rot including Prosaro and products containing the active ingredients procymidone or iprodione.

Points to consider when using a foliar fungicide

- The most yield loss from sclerotinia occurs from early infection events. Early infection is likely to result in premature ripening of plants that produce little or no yield.
- Plants become highly susceptible to infection once flowering commences. Research in Australia and Canada has shown that an application of foliar fungicide around the 20 to 30 per cent bloom stage (20 per cent bloom is 14–16 flowers on the main stem, 30 per cent bloom is approximately 20 flowers on the main stem) can be effective in significantly reducing the level of sclerotinia stem infection. Most registered products can be applied up to the 50 per cent bloom (full bloom) stage.
- The objective of the fungicide application is to prevent early infection of petals while ensuring that fungicide also penetrates into the lower crop canopy to protect potential infection sites (such as lower leaves, leaf axils and stems). Timing of fungicide application is critical.
- A foliar fungicide application is most effective when applied before an infection event (eg. before a rain event during flowering). These fungicides are best applied as protectants and have no curative activity.
- In general, foliar fungicides offer a period of protection of up to three weeks. After this time the protectant activity of the fungicide is compromised. In some crops development of lateral branch infections later in the season is not uncommon if conditions favourable for the disease continue. The greatest yield loss occurs when the main stem becomes infected, especially early. Lateral branch infection does cause yield loss, but at a much reduced level.
- Use high water rates and ensure droplet size is optimum for good canopy penetration and coverage.
- Fungicide choice is often secondary to timing of application.
- Be aware the maximum number of applications of Prosaro in a season is two.

Healthy pulse demand from more than the sub-continent

■ By Rob Brealey, Nidera Australia Pulse Trader

I've just spent a week in Vancouver at the Global Pulse Conference in mid July. Vancouver is a beautiful and friendly city to visit and the conference had more than 1100 participants from over 70 countries representing growers, exporters, importers and processors.

I will get to the "where does everyone think the price is going" question shortly, but before I do I think it's worth sharing some interesting longer-term issues from the conference.

Demand for pulses is growing globally at an incredible pace. I will save you from the reams of data, but it's not just demand from the traditional markets in the sub-continent, although they are still by far the most significant.

We are also seeing growth throughout the Western world and deep into Asia and not just for a variety of new and wonderful foods, but also for animal feed and industrial uses. Pulses are being marketed as clean, green and healthy food with many new delicious recipes, thus ticking all the boxes for today's tables.

But you get the sense this is not a short-term trend, but a long-term change in consumer habits. No – we aren't all becoming vegans – but even the true red meat lover is seeing the benefits of including some pulses in their diet two or three days a week.

But I should caution that we will see spikes and valleys in this demand and thus price volatility. Desi chickpeas is a good case in point.

While global demand has been steadily increasing, the major part of the spike we have seen in the past two years has come from crop failures in the world's number one and number two producers and consumers – India and Pakistan.

On the supply side of the equation, we have generally seen growth keeping pace with demand as growers respond to price signals. But it's not just long-term traditional producers like Australia, Canada and the USA.

We are seeing many new exporters of pulses, as well as significant increases from some of the previously small players.

Countries like Russia and Ukraine have substantially increased production and other EU countries are exporting for the first time. North Africa is seen as the new frontier, with significant investment in both infrastructure and farming technology.

Prices direction – the Conference consensus

Field peas – steady in the near term as selling pressure from the Black Sea harvest fills the market. In 2018 we expect supplies to tighten and higher global grain and vegetable protein prices to see some switching of feed demand to field peas. It's worth noting on a straight cost per percentage of protein basis



Rob Brealey.

Canadian yellow peas are half the cost of soymeal.

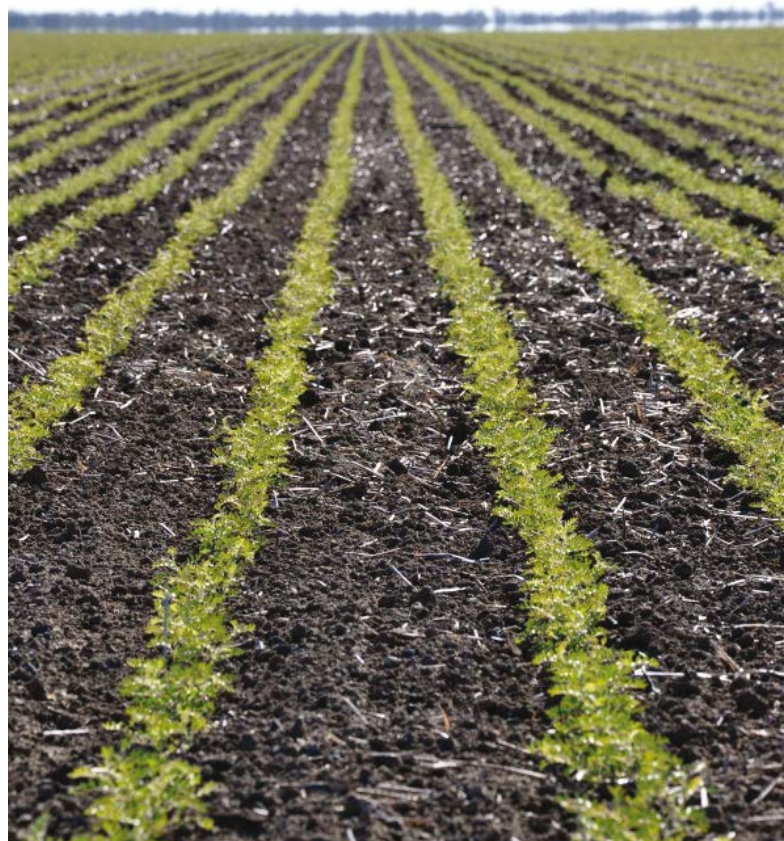
Lentils – general consensus was that the importing countries were holding far too much stock and despite smaller production in the major exporting countries, it would take quite a while to 'chew' through these stocks. Price trend is therefore expected to be steady to slightly lower.

Faba beans – like field peas they are an excellent ingredient for feed millers and this is expected to be supportive of values.

Desi chickpeas – the audience seemed mixed on price direction for this product, with so much still dependant on the Indian monsoons and eventual planting of their new crop in October/November. The general view was both India and Pakistan would import less than last year, but are still expected to be significant buyers.

It is probably fair to say without another failure in India's own crop, or for that matter our own, we are likely to see values ease as we get closer to harvest.

In finishing, let me reiterate that while it is the nature of the products we are dealing with to be price volatile, the long-term outlook is still very healthy. ■



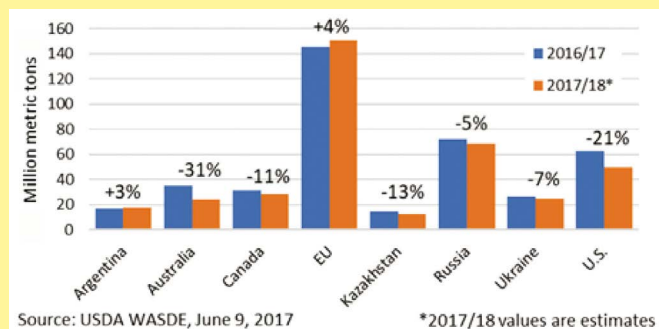
The conference delegates had mixed opinions on the price direction of pulses – particularly desi chickpeas – but the longer term outlook for all pulses is very positive.

World wheat production to decline in 2017–18

■ By Stephanie Bryant-Erdmann, US Wheat Associates Market Analyst

WITH wheat harvest underway in the Northern Hemisphere during June and wheat planting underway or complete in the Southern Hemisphere, wheat buyers began to see a downward trend in production numbers. High quality, high protein wheat supply is shrinking and supporting prices. USDA expects global wheat output to decrease for the first time in five years to 739 million tonnes (mt), down 14.6 mt from the 2016–17 record of 754 mt. In this article, we summarise current expectations and conditions in the world's major wheat exporting countries, which account for 90 per cent of all world wheat exports.

FIGURE 1: Changes in world exporter production 2016–17 versus 2017–18



Argentina

In June, Bolsa de Cereales, the Buenos Aires Grain Exchange, reported Argentine farmers will plant 17 per cent more wheat acres in 2017–18 as wheat production continues to expand under President Macri's favourable policies. Bolsa estimated wheat planted area at 13.6 million acres (5.5 million hectares).

On June 22, 53 per cent was planted, up from 37 per cent the prior week. USDA's July estimate for 2017–18 Argentinian wheat production was 17.5 mt, up 3 per cent from 2016–17 and 41 per cent greater than the five-year average.

Australia

In its June report, the Australian Bureau of Agricultural and Resource Economics and Science (ABARES) forecasted 2017–18 production at 24.2 mt. That is 31 per cent below 2016–17, due to an expected 25 per cent reduction in average yield and a slight decline in planted area from 2016 to 31.4 million acres (12.7 million hectares). Autumn rainfall was below normal in Western Australia and variable across South Australia – states that account for roughly half of Australia's winter crop planted acres and production. The Australian Bureau of Meteorology expects drier than average conditions across wheat producing regions during the next three months.

Black Sea

Winter wheat harvest is underway and USDA projects combined 2017–18 output from Russia, Ukraine and Kazakhstan will decrease six per cent to 107 mt based on an expected return to trendline yields. If realised, the combined harvest would still be greater than the five-year average.

Russian consultancy SovEcon pegged Russian planted wheat area at 68.9 million acres (27.9 million hectares), down slightly from 2016–17 due to a four per cent decrease in spring wheat area.

Russian wheat production is expected to decline to 70.4 mt, down three per cent from 2016–17 due to the smaller planted area and anticipated lower yields. SovEcon forecast Russian winter wheat yields at 3.50 tonnes per hectare, down from 3.73 tonnes in 2016–17.



World wheat production in the 2017-18 season is forecast to drop for the first time in five years.

Spring wheat yields are expected to fall seven per cent year over year to 1.42 tonnes per hectare.

UkrAgroConsult reported Ukrainian wheat planted area decreased slightly year over year to 15.6 million acres (6.30 million hectares), and expects yields to fall seven per cent year over year to 3.91 tonnes per hectare. 2017–18 Ukrainian wheat production is forecast at 24.5 mt, compared to 26.1 mt in 2016–17.

UkrAgroConsult noted yield declines and a three per cent smaller planted area will lower Kazakhstan wheat production to 13.7 mt, down 9 per cent from 2016–17, if realised.

Canada

Agriculture and Agri-Food Canada (AAFC) expects wheat production of 29.5 mt in 2017–18. That is down seven per cent year over year because average yield is expected to decline to 3.20 tonnes per hectare in 2017–18. Slightly higher planted area will partially offset expected yield declines.

StatsCan put planted area at 22.4 million acres (9.07 million hectares) of wheat in 2017–18. Spring wheat planted area rose two per cent to 15.8 million acres (6.39 million hectares) due to low carry-in stocks and increased price competitiveness with alternative crops. Durum planted area decreased 16 per cent year over year to 5.2 million acres (2.11 million hectares) due to high carry-in stocks and lower prices.

Canada's winter wheat seeding decreased 16 per cent year over year from a shift to spring wheat. Crop conditions this year are variable with excessive moisture in northern areas while southern areas remain dry.

European Union

After a challenging 2016–17, Strategie Grains expects EU common wheat production will rebound 4 per cent to 142 mt in 2017–18 with a 5 per cent increase in yield expected to offset a one per cent decrease in planted area.

French production is expected to increase 7.66 mt year over year to 35.6 mt – a 33 per cent improvement in yields. But precipitation across France is 25 per cent below normal since March.

The French crop bureau, FranceAgriMer, rated 68 per cent of French soft wheat in good or excellent condition, down from 74 good to excellent per cent the prior week.

Dry conditions are also threatening yield potential in Austria, Germany, Italy and Poland. In Spain, drought conditions are expected to cut wheat production by 32 per cent year over year to 4.72 mt.

Additionally, the EU's crop monitoring service MARS reduced its forecasts for wheat yields to 5.86 tonnes per hectare. Weather forecasts for early July provide little relief for EU farmers, which could further threaten yield potential.

United States

USDA forecast US 2017–18 wheat production at 49.6 mt, down 21 per cent year over year and 15 per cent below the five-year average due to an anticipated 10 per cent decline in average yield and the lowest planted area since USDA records began in 1919.

USDA expects the average yield to be 3.18 tonnes per hectare compared to the five-year average of 3.14 tonnes.

Source: US Wheat Letter Associates *Wheat Letter* released June 29, 2017. ■

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Analysing the season of records

■ By Chris Nikolaou, Agfarm General Manager Operations

THE 2016–17 season started on the back of a record strong El Niño sea surface temperature event in the Pacific Ocean.

This weather pattern eventually broke down and led to a La Niña, which served Australian growers well, with above average rainfall for the majority of growing regions. As a consequence, records were set for both wheat and barley production. As the marketing portion of the 2016–17 season progresses, we now see a record export pace across Australia.

Fears of the 2015 El Niño impact evaporated almost as quickly as the weather pattern itself. A mild La Niña formed in 2016 which proved to be highly supportive for Australian winter crop production. For example, South Australia recorded its fourth wettest year on record. All growing regions notched double digit percentage gains on the average rainfall. The final culmination was the wettest May–September on record (Figure 1).

Rain makes grain

The February 2017 ABARES update stated “total Australian winter crop production is estimated to have increased by 49 per cent in 2016–17 to 58.9 million tonnes (mt).” The report goes on to state yields “reached unprecedented levels in most growing regions.” Wheat achieved a record high production of 35.1 mt, barley set a record of 13.4 mt, chickpea production set a record of 1.4 mt and canola matched the previous record of 4.1 mt.

The big yielding season saw a significant increase in canola oil content with reports of up to 50 per cent oil. Unfortunately, cereal quality didn’t fare as well, with the normal APW1 quality being reduced to ASW1 in many cases. In South Australia, ASW1 deliveries made up over 40 per cent of Viterro receivals.

Pricing reacts to large southern hemisphere wheat production

Australia and Argentina both experienced 40 per cent (plus) increases in production. As a consequence, pricing continued to fall over the harvest months of October through January. Off shore markets also reacted to the pricing of these large crops, with the benchmark CME futures markets seeing season lows through the month of December.

Australian exports for wheat and barley surge

The high yielding and lower priced 2016–17 season created the perfect scenario for a strong year on year increase in exports for most winter crops. After a late harvest for most regions, exports really fired in January. Wheat exports totalled a record 2.53 mt for

the month. Barley also set a record at 1.04 mt. In February, barley exports increased yet again to 1.12 mt. Wheat decreased to a still very strong 2.37 mt. At the time of writing, wheat exports have average a very impressive 2 mt per month for January through June of 2017.

The dramatic pace of Australian cereal exports is largely a function of price. In particular, price against our competitors in regions such as the Black Sea, North America and to a lesser extent Europe. For the past three years, Black Sea wheat has been the lowest cost wheat origin, a result of three banner seasons in a row. Since 2012–13 to now, Russia has increased wheat production from 38 to 70 mt. The increase of 32 mt over this period led to Russia being the world’s largest exporter for 2016–17 and likely again for 2017–18.

Can the Black Sea production streak continue?

The marketplace expects a slight increase in the acreage planted in Russia this season. But the critical factor as wheat

FIGURE 1: 2016 Australian rainfall decile map

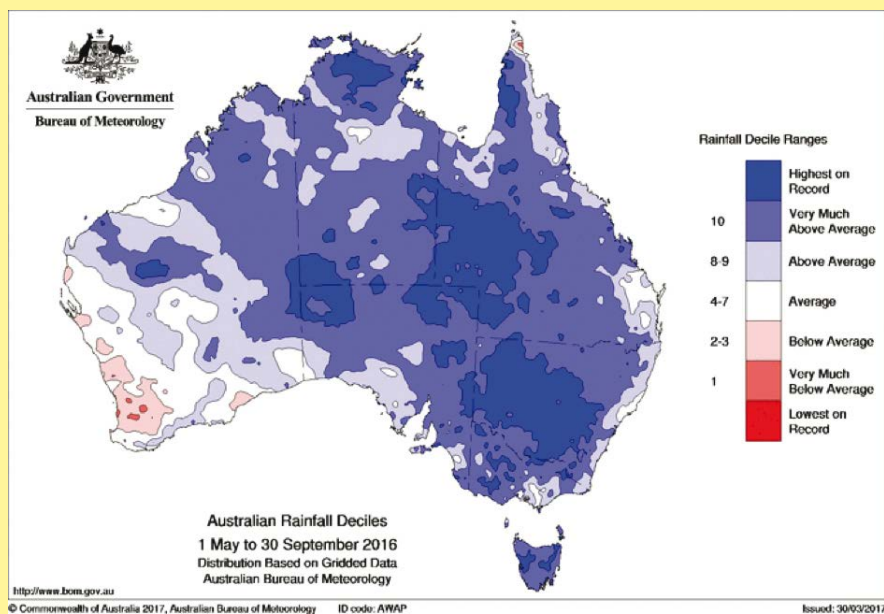


FIGURE 2: CME Wheat Futures for May 2017 delivery



matures, is the weather. At the time of writing, Russian rainfall has been relatively normal. The outlier is March, where they saw a decline in rainfall deciles and a sharp increase in temperatures. But Black Sea weather has been relatively benign as the crop finishes and farmers prepare for harvest.

It is worth noting other Black Sea and European producers have experienced a dryer and warmer than usual season. France is currently at approximately 75 per cent of their annual rainfall for the season, Italy at approximately 77 per cent and Spain at 66 per cent. These weather trends have led to yield penalties in production but the outlook is still for a relatively healthy 140 mt European crop.

Impact on Australian exports and pricing

Figure 3 shows the relative pricing of major wheat exporters into Indonesia, a major wheat importer. The chart follows pricing

between May of 2016 and June of 2017. HRW is representative of the US. We will use the APW ex Adelaide to represent Australia. The noteworthy item is the impact of last season's big Russian harvest on pricing. Over July–August, a large Russian crop acted as an anchor on world values into key destination markets. As a consequence, Australian and Argentinian values dropped to remain price competitive.

Through the 2016–17 season we have seen Australian and US values remain very competitive which has driven large exports for the season. But this changed over May and June of 2017. Ongoing dry conditions in Australia and what has been referred to as a 'flash' drought in the Dakotas region of the US (Figure 4) has decreased the outlook for new crop production. As a consequence, grain values in both origins have rallied substantially.

In the meantime, the outlook for European and Black Sea production has remained positive, and values have responded accordingly with a lower degree of volatility.

FIGURE 3: Matrix of multiple origin wheat values

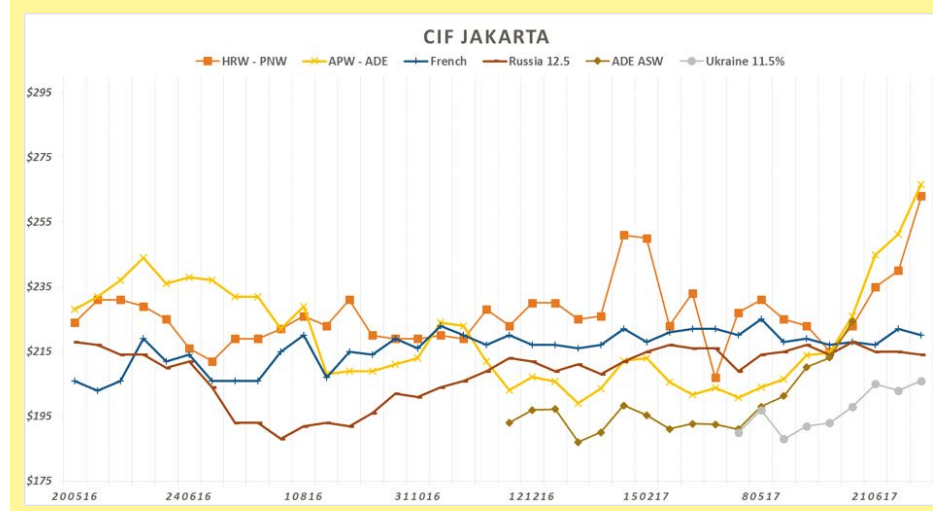
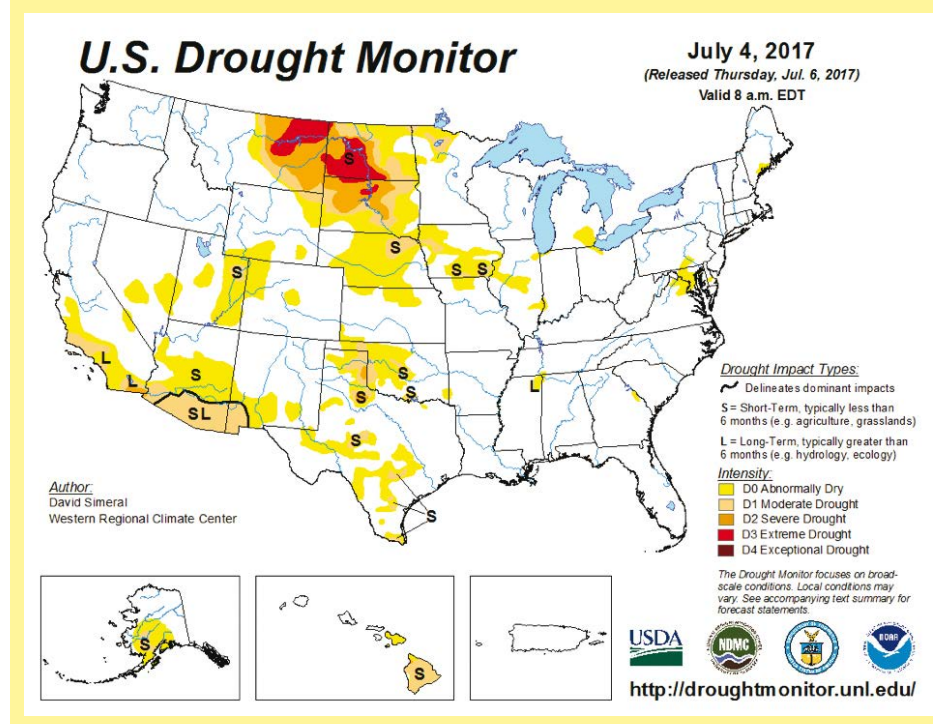


FIGURE 4: US Drought Monitor



Subtropical ridge leaves us high and dry this June

On July 6, 2017 the Australian Bureau of Meteorology released a blog article discussing the recent dry weather. The article sought to answer the question of what had been driving the "sunny, chilly and dry weather" over the month of June. In short, it is due to the subtropical ridge. "The subtropical ridge is a belt of high pressure systems that circle the southern midlatitudes...and...is a dominant influence on the climate of Australia".

During the summer this system tends to sit over southern Australia bringing generally dry weather. In winter, it tends to migrate north bringing cold fronts and low pressure systems that provide rainfall. But this season that weather system migration has not occurred and southern regions have experienced dry and sunny weather as a consequence.

How does the season of records end?

As we have seen, 2016–17 showed us weather can take a positive turn and reward with yield in a low priced environment. But just as easily it can turn against.

Over the next three months, we will see headers finish up their good work on wheat paddocks in the northern hemisphere. Fair yields are expected for most regions except for southern Europe and northern US.

Australian new crop production will be monitored very closely for any signs of further stress after the dry June experienced by many growing regions.

From there, the function of the marketplace will be to price grain correctly in each region, either for consumption or conservation.

Mapping out Australia's food future

■ By CSIRO

NEW technologies could see us eating algae-based sources of protein, developing allergenic-free nuts and tolerable varieties of lactose and gluten, and reducing environmental impact through edible packaging.

Speaking at the Australian Institute of Food Science and Technology's (AIFST) 50th Anniversary Convention in Sydney, Assistant Minister for Industry, Innovation and Science, Craig Laundy, highlighted the importance of innovation and entrepreneurship in driving new economic growth in the industry.

Keeping a greater share of food processing onshore and better differentiating Australian food products are major themes across a *Food and Agribusiness Roadmap*, which calls on businesses to act quickly or risk losing future revenue streams to the competitive global market.

Developed with widespread industry consultation and analysis, the *Roadmap* seeks to assist Australian food and agribusinesses with the desire to pursue growth and new markets.

Deputy Director of CSIRO Agriculture and Food, Dr Martin Cole said Australia was well positioned to act as a 'delicatessen' of high-quality products that meet the needs of millions of informed and discerning customers both here and abroad.

"Australian businesses are among the most innovative in the world, and together with our world-class scientists, can deliver growth in the food and agribusiness sector amid unprecedented global change," Martin said.

"Less predictable growing conditions, increasingly global value chains and customers who demand healthier, more convenient and traceable foods are driving businesses to new ways of operating.

"Advances are already being made through the use of

blockchain technology and the development of labels that change colour with temperature or time, or are programmed to release preservatives.

"This *Roadmap* will set us on the path to sustainable growth in the sector."

The *Roadmap* was developed in collaboration with the government-funded food and agribusiness growth centre: Food Innovation Australia Limited (FIAL).

Recently, FIAL launched their Sector Competitiveness Plan, which outlines the over-arching industry vision to grow the share of Australian food in the global marketplace and the necessary strategy to achieve the vision.

Australia in the box seat

"With the growing Asian middle class, Australia is in the box seat to take advantage of the many emerging export opportunities," FIAL Chairman Peter Schutz said.

"Consumers are looking for differentiated products that cater to their needs.

"This is especially exciting for Australian food and agribusinesses which have the capability to respond with customised and niche products."

Australia exports over \$40 billion worth of food and beverages each year with 63 per cent headed for Asia.

Martin explained that Australia is a trusted supplier of sustainable, authentic, healthy, high quality and consistent products.

"We must focus on these strengths and enhance the level of value-adding to our products," Martin said.

"Recent Austrade analysis shows early signs of such a shift. For the first time in Australia's history value-added foods have

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accounted for the majority (60 per cent) of food export growth.”

The *Roadmap* outlines value-adding opportunities for Australian products in key growth areas, including health and wellbeing, premium convenience foods and sustainability-driven products that reduce waste or use less resources.

Five key enablers for these opportunities are explored in the *Roadmap*:

- Traceability and provenance;
- Food safety and biosecurity;
- Market intelligence and access;
- Collaboration and knowledge sharing; and,
- Skills.

These enablers align with FIAL’s knowledge priority areas that are central in helping the food and agribusiness industry achieve its vision and deliver increased productivity, sustainable economic growth, job creation, and investment attraction for the sector.

The *Roadmap* calls for improved collaboration and knowledge sharing to generate scale, efficiency and agility across rapidly changing value chains and markets.

“To survive and grow, the challenge facing Australia’s 177,000 businesses in the food and agribusiness sector is to identify new products, services and business models that arise from the emerging needs of tomorrow’s global customers,” Martin said.

See CSIRO for the full report: *Food and Agribusiness Roadmap: unlocking value-adding growth opportunities for Australia*.



Asian consumers are looking for high quality, safe and differentiated food products.

CURRENT FOOD SITUATION

- Australia exports over \$40 billion worth of food and beverages each year, and 88 per cent of these exports are bulk commodities.
- Australia is a trusted supplier of sustainable, authentic, healthy, high-quality, safe and consistent products.
- While Australian SMEs rank among the most innovative in the world, FIAL has found that only 5 per cent of our employing food and agribusinesses are ‘businesses of tomorrow’ that actively pursue new markets, take risks, connect well to end markets and continually invest in capability and knowledge.

Projections and trends

- Less predictable growing conditions, more connected global value chains and customers who demand healthier, more convenient and traceable foods are the major trends influencing food and agribusiness in Australia.
- By 2021, markets for naturally healthy (US\$291 billion), food intolerance (US\$42 billion) and organic products (US\$45 billion) are expected to have grown at up to 4.5 per cent compound annual growth rate.
- The global edible insect market is expected to grow from US\$34 million in 2014 to over \$520 m by 2023.
- Australian businesses are increasingly value-adding. For the first time in Australia’s history, value-added/premium foods accounted for the majority (60 per cent) of food export growth in the three years to 2016.

Value-adding opportunities for growth

- Products for health and wellbeing, including free-from and natural foods, supplements, fortified and functional foods, and personalised nutrition.
- Sustainability-driven products and processes, including those that convert waste, provide alternative protein sources, sustainable packaging and green and ethical value chains.
- Premium foods, including high-quality, convenient, fresh and

packaged products; luxury products and gifts; tourism; and novel tastes, smells and textures.

Equipping food and agribusiness for the long-term

- Traceability and provenance: Food fraud costs the global food industry an estimated US\$40 billion each year. Key technologies in the F&A sector include digital tracking (RFID chips, bar codes, QR codes, blockchain) and biological readings (isotopic analysis, DNA fingerprinting, biomarker compounds).
- Food safety and biosecurity: An estimated 600 million (almost one in 10 people in the world) fall ill after eating contaminated food and 420,000 die every year, with the impacts greatest in Africa and South East Asia. Technologies that can increase food safety include microwave assisted thermal sterilisation and advanced packaging, such as labels that change colour with temperature or time, release preservatives or absorb moisture or odours.
- Market intelligence and access: There is a significant lack of market intelligence within Australian F&A SMEs. Sensors and data analytics can track the end consumer and how the product is being used. Additional research can better understand regional preferences of different markets, especially in Asia.
- Collaboration and knowledge sharing: Regional clusters, business consortia and more holistic R&D solutions will enhance the collaboration needed to generate scale, efficiency and agility across value chains and markets.
- Skills: In coming decades, companies will need employees with broad-ranging skills, combining technical knowledge with an understanding of supply chains, experience with digital platforms and strong interpersonal skills. Both tertiary education and more structured on-the-job training have a role to play in developing these skills.

Stubble management for weeds and yield

DANIEL FOX CASE STUDY

MARRAR (southern NSW) farmer Daniel Fox is chasing higher yields across his 2100 hectare cropping program while also driving down weed seed numbers. For a few years Daniel has been adding components to his system to conserve moisture and keep herbicide resistant weeds at bay.

"A series of drought years got us started down this track of better soil moisture conservation," he says. "We have been able to store more water than we expected really and this has been converted into better yields."

The long-term average rainfall at Marrar, north of Wagga Wagga, NSW is 500 mm and although last year was extraordinarily wet, the 15 years prior to this were relatively dry. This long dry stretch made growers like Daniel and his father David think more about conserving soil moisture over summer and using stubble to protect the soil moisture from evaporation.

Seeing a 60 per cent increase in yield

As they add more strategies to their management system they are seeing yields rise from an average 2.5 tonnes per hectare for wheat to 4.0 tonnes per hectare in years that would have seen the crop suffer due to a lack of spring rainfall.

To tackle increased pressure from annual ryegrass Daniel and David started narrow windrow burning but found that a combination of cutting the crop low at harvest and burning much of the crop residue was impacting on yields. To investigate, they participated in a trial run by Grassroots Agronomy to see if cutting the crop higher – at 30 cm rather than the recommended 15 cm for narrow windrow burning – would still be an effective harvest weed seed control measure.

"The results showed a half-tonne difference between cutting barley low and cutting higher," he says. "It seems that the taller stubble provides better protection for the soil surface and the trial with the taller stubble had better conserved moisture, which was needed to finish the crop that year, where we had no rain from early September to mid October."

To maintain the effectiveness of harvest weed seed control Daniel has recently purchased a Shelbourne stripper for the header to collect the grain, and weed seeds, while leaving most of the stubble standing. "Using the stripper we are putting less material through the harvester but still collect grain and weed seed in the crop canopy," he says. "This means we are picking up yield and reducing the weed seed bank without compromising harvesting efficiency."

Having used narrow windrow burning for a few years and seeing the benefit of capturing seed from late germinated weeds at harvest, the Foxes have now built a chaff lining chute for the header and are delivering the chaff component, including weed seeds, into a 250 mm chaff line in the middle of the 12 metre CTF lap. This maintains most of the crop residue evenly across the paddock and avoids the need for burning.

"Having the weed seed concentrated in a narrow band reduces the amount of seed that germinates and also reduces the chance of weed seed being buried and 'stored' underground at planting now that we are using a disc seeder," says Daniel.

Daniel has had no problem sowing through the chaff and is also able to apply more herbicide to the tramlines if the weed numbers appear to be increasing. He is also keeping an eye on the developments of microwave weed control technology



Highly competitive crops, like this barley, tend to hold annual ryegrass seed heads up high in the canopy where they can be easily collected by the stripper front on the Fox's harvester.



Daniel (left) and David Fox are pleased with the chaff lining chute they have introduced as a harvest weed seed control method on their Marrar farm near Wagga Wagga.



Daniel Fox has implemented a double break crop system where the cereal stubble is maintained on the soil surface across the four-year rotation, conserving soil moisture and improving crop yields.

as a potential non-herbicide method to treat the tramlines in the future. "We realise that there might be an impact on soil microbes and earthworms but if the microwave is only treating the chaff lines then it could still be a good option," he says.

Croptopping in non-malting barley, canola and pulses provides an additional opportunity to stop seed set with the chaff lining providing an effective, non-herbicide second knock to support the herbicide.

The cereal stubble persists across the four-year rotation of two cereal crops followed by two break crops, providing more shade and wind protection, and keeping the soil surface cooler.

Double break crop – better weed control

The double break cropping rotation enables Daniel to have a two-year shot at both grass and broadleaf weeds using a combination of herbicide and non-herbicide tactics. "With herbicides we are using robust pre-emergent and in-crop applications and double knocking our knockdown herbicides," he says. "The non-herbicide tools are collecting weed seed at harvest with the chaff lining chute, strong crop competition from narrow row spacing and haymaking if required. In just three years we have seen a huge reduction in the ryegrass population on the farm."

Resisting the temptation

During the 2000s David stayed with the canola / wheat rotation they had in place even though it meant that they had a few failed crops, which they converted into silage. "By resisting the temptation to go with a long cereal rotation we avoided the weed blow-out that occurred on some farms," he says.

The Foxes grow wheat and barley in the cereal phase with an option for oats on their frost-prone paddocks. "Wheat is our mainstay on the higher paddocks where we sow early and the crop flowers in cooler weather, which can make a 2 tonnes per hectare difference in yield compared to sowing later," says Daniel.

"We are wanting to raise our average wheat yield from 2.5 to 3 tonnes per hectare, even in lower rainfall and lower radiation years. Likewise, for barley we are confident that significant yield gains are possible in the system we have developed."

In the broadleaf phase they grow canola and a pulse, usually lupins, and are considering faba bean and lentils as alternative pulse options. They are also investigating whether winter cover

crops followed by a summer crop might have a fit in their system to give them the opportunity to use different chemistry at different times of the year to combat weeds.

"No-till and glyphosate generated a big jump in productivity on this farm and now we are seeing another big improvement with new gear such as the chaff lining chute, stripper front and high clearance sprayer," says Daniel. "We could not have got through last season without the sprayer. It has allowed us to get onto weeds when they are small and cover a big area in the best conditions."

Doing their own spraying and planting gives Daniel and David the opportunity to monitor their paddocks during the season to keep an eye on weed numbers, which also helps when they go around the farm with their agronomist to plan the weed control program.

A new disc seeder has also made stubble management easier and allowed Daniel to move to 6.5 inch (165 mm) row spacing for all crops. The single disc seeder has 72 units over the 12 metre span which, like the sprayer, fits within the controlled traffic system.

Daniel is conscious of brome grass and black oats entering the farm from the roadside so he is spraying through the external fences with a mix of glyphosate and residual herbicide to help minimise the risk of weeds moving into the cropping areas. "We sow right up to the fence to maintain competition and if we need to, we bale the outside lap of the crop," he says. "After harvest we plough along the fencelines as a firebreak, which is a council requirement."

The Foxes look for crop traits that provide a competitive edge such as hybrid canola over open-pollinated types and taller wheats such as Spitfire, while still maximising yield and profit from the available moisture.

"The 29 year row spacing trial in WA demonstrated that narrow rows produce more crop and less weeds, and we have seen a 400 to 500 kg per hectare benefit through less tiller deaths and more heads here too," says Daniel.

"To achieve this it is essential that the soil fertility is able to support the increased production. Our granite soils tend to leach nitrogen in wet years and that has a big impact on yield."

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

Making pre-em herbicides work in high stubble

WHETHER stubble is standing or laying flat on the ground it represents a challenge for farmers using pre-emergent herbicides to control weeds early in the cropping season.

Most growers and advisors are aware that products such as trifluralin are quite tightly bound if they contact stubble during application, but the behaviour of newer products has been largely unknown.

For pre-emergent herbicides to be effective the product must be placed in contact with the soil and must provide an even layer of chemical to intercept germinating weeds. Decisions at harvest will have a direct bearing on pre-emergent choices and efficacy for the next season.

Pre-ems, crop residue and rainfall

Yaseen Khalil is a PhD candidate at the UWA School of Agriculture and Environment, studying the availability of pre-emergent herbicides applied to crop residue and then exposed to different rainfall simulations.

The three pre-emergent herbicides investigated were trifluralin, Sakura (pyroxasulfone) and Arcade (prosulfocarb).

As expected, trifluralin was very resistant to leaching from crop residue with minimal amounts of the product washing off stubble in rainfall events simulated just one day after herbicide application.

On the other hand, a sufficient quantity of Arcade was leached by rainfall applied after seven days to provide some control of annual ryegrass.

Sakura was the clear 'stand-out' when it comes to efficacy of leachate. Product applied to four tonnes per hectare crop residue pots provided 100 per cent control of annual ryegrass when just five mm of simulated rainfall was applied 14 days after the herbicide application.



Decisions at harvest will have a direct bearing on pre-emergent choices and efficacy for the next season. Yaseen Khalil, PhD candidate at the UWA School of Agriculture and Environment, is studying the availability of pre-emergent herbicides applied to crop residue and then exposed to different rainfall simulations.

"The implications for growers are that they can rely on significant amounts of Sakura and Arcade being washed off crop residues and into the soil if there is a rainfall event of at least 5 mm within about one week of applying these pre-emergent herbicides," says Yaseen.

"If the crop residue is already wet when the pre-emergent herbicides are applied, the products are more tightly held and less product leaches off the residue in subsequent rainfall events, compared with spraying onto dry stubble."

Yaseen's supervisor University of Western Australia senior lecturer, Dr Ken Flower says an important factor to consider is the unevenness of residue spread at harvest. "While the residue level across the paddock may average out to an acceptable three tonnes per hectare it is common for the residue to be as high as 10 to 15 tonnes per hectare directly behind the header," he says. "This in itself has implications when it comes to growers' decisions about their weed management tactics."

Australian Herbicide Resistance Initiative communication lead Peter Newman says getting the pre-emergent product through the crop residue and onto the soil at application time is still the priority.

"It is good to know that some products remain effective and can be leached off the crop residue with rainfall following the application," he says. "Yaseen's research has added to the growing knowledge bank about the most effective use of pre-emergent herbicides in no-till, stubble retention systems."

While quite extensive in itself, this study only compared three pre-emergent herbicides. The chemical properties of the over 50 active ingredients that possess pre-emergent, or residual, activity vary enormously, and they are found in 10 mode of action groups. The efficacy of these products relies on different environmental, soil and crop residue conditions.

"Understanding how these products can best fit into an integrated weed management program on a farm requires considerable thought, taking many, many factors into consideration," says Peter. "There are great opportunities to use these products to add diversity to weed management but it is essential that they are not over-relied on as 100 per cent weed control is uncommon, even when the conditions at application are as good as possible."

More focus on herbicide mixes

"We used to talk a lot about rotating herbicides from one year to the next, now we are more focused on herbicide mixes as the best way to go – mixing two pre-emergent herbicides together where possible, and then perhaps rotate to another mix next year," he says. "They say that rotating herbicides buys you time, but mixing herbicides buys you shots. Mixing and rotating buys you time and shots, which is the best that we can hope for."

Peter recommends growers take the time to discuss a variety of options with agronomists and take on board research like Yaseen's, along with their own observations, to build a robust and ever-changing weed management program. "The aim is to keep overall weed numbers low as this is the best way to minimise the risk of herbicide resistance," he says.

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

Satellite imagery detects and monitors weeds

HAVING 'eyes in the sky' checking crops every 10 days is a useful tool for growers and agronomists monitoring crops and managing weeds. Satellite images provide a very objective means of identifying weedy areas and measuring the response to management tactics.

From his family farm in northern NSW, remote sensing tech enthusiast Ben Boughton runs a satellite imagery business, Satamap, utilised by growers and agronomists from across Australia.

"Using the satellite images agronomists can look for anomalies in biomass production on their clients' farms and can then go directly to the area on the farm to identify the problem," says Ben. "In the case of weeds, it is easy to calculate the size of weedy patches and to monitor the impact of herbicide or cultural practices."

"An example on our own farm was to clearly see the impact when we sprayed a paddock where awnless barnyard grass was a problem and we were not able to get back with the second knock due to rain," he says. "The recovery and spread of what we now know for sure was glyphosate resistant barnyard grass showed very clearly in the satellite images taken before and after the event."

Agronomists use the Satamap service to observe trends across their district and to make their farm visits more time efficient. In fallow paddocks the satellite images show the extent of vegetation (weed) growth that can be hard to see amongst tall stubble. The images show an average reflectance over a 10 m by 10 m area so a similar sized patch on the map may represent a number of large individual plants spread out across the area, or a carpet of grass. That is the reason why 'boots on the ground' are still required to investigate exactly what species are present and to plan appropriate management.

"The satellite images are not a diagnostic tool on their own but they do provide valuable information for the grower and their advisor," he says. "Some agronomists are even using imagery from the previous year to plan variable rate application of pre-emergent herbicide to treat areas where the weed seed bank could be expected to be high in paddocks with known problems."

The use of satellite imagery links well with UAV (unmanned aerial vehicles, aka drones) to assist with the ground-truthing process across a farm.

The Boughtons property, north-east of Moree, NSW is predominantly winter cropping with up to 25 per cent summer cropping if the season permits. Ben says summer cropping is a great way to help clean up black oats coming out of winter cereals.

The farm is 100 per cent dryland cropping with no internal fencing and all paddocks set up in a three metre controlled traffic configuration. Ben has found the tramlines can present a weed control challenge with black oats and phalaris taking advantage of the lack of crop competition.



Satamap founder and grain grower Ben Boughton uses satellite imagery to assist with the management of herbicide resistant weeds.

The crop rotation is generally wheat, barley, chickpea to give a two year break for the chickpeas and avoid planting wheat on wheat.

Even establishment, high competition

"We aim for good, even crop establishment to generate strong crop competition early in the season," he says. "This is even more important in paddocks where we dry sow and can't do a pre-sowing knockdown on black oats."

With Group A-resistant black oats on the increase Ben uses crop competition in barley to support a one-off use of Group A (Axial) and switches to Group B (Atlantis) in wheat. Ben is conscious of the risk of losing Group A efficacy altogether and is looking for alternatives to use in the barley.

"Sorghum is a good crop to combat Group A-resistant black oats using a glyphosate spray at the end of the winter fallow and planting in September," he says. "Chickpea is also providing a useful crop for black oats control using Verdict and Select, both Group A, with high rates of oil and ammonium sulphate."

Ben is using pre-emergent products such as Flame in the summer fallow but is very conscious of the impact these applications can have on crop rotation choices, particularly in years where the summer rainfall is limited.

"It is important to have a rotation plan worked out so you can take advantage of summer cropping opportunities and Flame can even cause crop damage in barley the following winter if there has not been enough summer rain," he says.

Fleabane is another challenging weed to manage due to its natural tolerance of glyphosate and the need to be very careful with applications of Group I products, such as picloram in fallows, adjacent to neighboring cotton crops. Ben says Tordon 242 applied early in wheat crops to treat late germinating fleabane is providing very effective control with some residual activity.

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



Glyphosate-resistant awnless barnyard grass is one of the Boughton's main challenges, with a patch visible on satellite imagery following a fallow double knock where the second knock application was prevented.

Microgreens' study shows health benefits

■ By Jan Suszkiw, Agricultural Research Service – USDA

AT A GLANCE

- Tiny plant seedlings called 'microgreens' are nutritious.
- ARS scientists studied health benefits of red cabbage microgreens.
- Mice fed red cabbage microgreens had lower "bad" cholesterol levels.

MICROGREENS are tender young plants grown from the seed of certain herb, vegetable, and grain crops that can be clipped at the stem and eaten fresh within two weeks of germinating.

Some chefs have touted the taste, texture, colour, and delicate appearance of microgreens, adding them to soups, salads, sandwiches, and main dishes. Microgreens can also contain more nutrients than full-grown plants. Red cabbage microgreens, in particular, have garnered attention for their potential to help protect against chronic diseases like cardiovascular disease.

"Although microgreens, such as those from red cabbage, have been reported to possess more nutrients [than mature plants] and are perceived to be 'healthier,' no known study has been conducted to evaluate whether consumption reduces cardiovascular disease risk factors," according to Agricultural Research Service (ARS) chemist Thomas Wang and his co-authors



Red cabbage microgreens (front) and mature red cabbage.
(PHOTO: Stephen Ausmus)

in the December 2016 issue of the *Journal of Agricultural and Food Chemistry*.

To learn more, Thomas and colleagues with ARS in Beltsville, Maryland, and the University of Maryland-College Park conducted a study in 60 young mice.

They fed each mouse one of six diets: low-fat, high-fat, and with or without mature or microgreen red cabbage. Both types of cabbage were freeze-dried and fed in amounts equivalent to 200 grams (about 1 cup) of vegetables per person per day.

Among the results:

- Mice on high-fat diets containing either type of red cabbage had lower levels of blood-cholesterol and triglycerides associated with liver inflammation than mice on high-fat diets without the vegetable.
- Both forms of red cabbage (mature and microgreen) helped the mice gain less weight from their high-fat diets than their vegetable-free peers.
- Mice on diets with red cabbage microgreens had lower levels of 'bad' (low density lipoprotein) cholesterol than mice on diets with mature red cabbage. Perhaps not surprisingly, mice on low-fat diets were healthiest of all groups.
- Red cabbage microgreens had more polyphenols and glucosinolates than mature red cabbage. Both are 'phytonutrients' thought to confer antioxidant, cholesterol-lowering, and anti-inflammatory properties when consumed.

"Although microgreens have more polyphenols and glucosinolates, we did not demonstrate that these phytonutrients are the active compounds that led to the health benefits observed in mice," says Thomas. How these microgreen components actually benefit the health of humans remains to be determined, he adds.

Further information: Tom Wang, Diet, Genomics and Immunology Laboratory, USDA Beltsville, MD 207052350

Email: Tom.Wang@ars.usda.gov Ph: +1 (301) 504 8459 ext. 239

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Farming in Foreign Fields...

Profiling US wheat sustainability: John Hoffman, soft red winter wheat farmer

By Elizabeth Westendorf, US Wheat Associates Policy Specialist

JOHN Hoffman farms some of the same land that four generations of his family have managed since the late 1800s. Today, the farm covers roughly 3200 acres (1295 hectares) where he grows corn, soybeans and soft red winter (SRW) wheat. For John, sustainability is key to preserving his family's farming tradition for the next generation.

"I think we're sustainable when every year we are able to plant a crop, harvest a crop, and do it again the next year," said John. "If we are not sustainable, that would not happen – we would not stay in business every year."

John believes being sustainable means being an early adapter of emerging practices on his farm. He tries to embrace the latest

Family farming is a way of life, but it is also a large business. Anything we can do to improve on what we do as business people, farmers and human beings to make things better, we are going to attempt to do it..

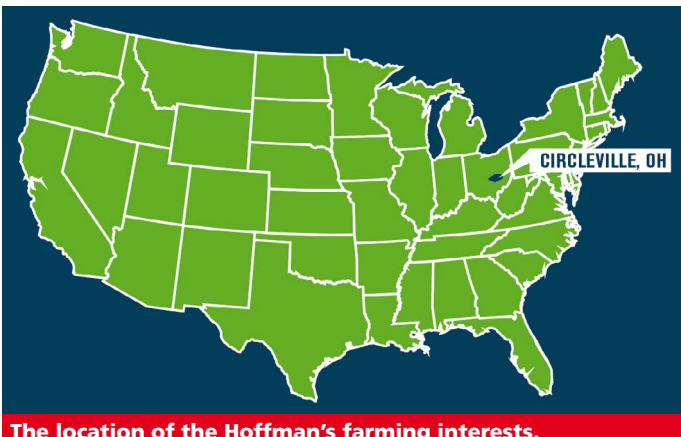
farming technologies to help improve his business, such as no-till and minimum till practices to improve soil health, GPS technology to increase accuracy and use inputs efficiently, and government conservation programs to give back to the environment.

John is the fourth of six US wheat farmers featured in a USW series on wheat sustainability. These profiles show the differences in wheat production practices across the country and how those farming practices enhance the sustainability of US agriculture.

"Family farming is a way of life, but it is also a large business," said John. "Anything we can do to improve on what we do as business people, farmers and human beings to make things better, we are going to attempt to do it."

A good example is how John uses a combination of no-till and minimum-till practices depending on crop need. No-till farming does not disturb the soil, which increases the amount of water that penetrates the soil surface and improves organic matter. Minimum-till helps warm the soil or reduce excess moisture. Both techniques reduce erosion compared to traditional tillage. He produces all his wheat and 80 per cent of his soybeans with no-till technology, and he uses minimum tillage in corn production.

Access to better seed over the years has allowed John to improve his farming practices and use innovative techniques so that his farm is constantly improving. This story is true for many farmers, as plant breeding comes up with new varieties that



The location of the Hoffman's farming interests.

respond to specific agronomic and economic challenges. That innovation is just another facet of the sustainability story.

"With the new genetics available in seed today, we can be more cost-effective and utilise less chemicals. That also made the no-till option a lot more practical," said John. "Plus, the soil savings – the conservation aspect of it – we thought it was better for our land. It really helped reduce soil erosion."

Another issue in John's area is how farming affects water quality. By reducing soil erosion, he and other farmers reduce the amount of water that runs off their fields. John has also tried to reduce his inputs over the years to help with water quality and makes sure to use them intelligently – by not applying fertiliser on frozen ground or before a large rain, he makes sure that those inputs stay in the field instead of being washed away. On some of his land, he has been able to use government conservation programs and plant grass around the natural water runoff areas.

Hoffman's farm has thrived because John has been able to innovate and adopt new technologies and practices over the years. At its core, that is what sustainability is about – constant improvement. Each of the farmers featured in USW's Sustainability Profiles embody this idea. They do it in different ways, but with that one idea in common.

Learn more about John and his farm at www.uswheat.org/factsheets. US farmers, ranchers, fishermen and foresters also share their values, sustainability experiences and conservation practices at the US Sustainability Alliance.



Hoffman's farm has thrived because John has been able to innovate and adopt new technologies and practices over the years.

Developments in autonomous tractors

■ By Craig Baillie¹, Craig Lobsey¹, Cheryl McCarthy¹, Dio Antille¹, Alex Thomasson^{1,2}, Zhe Xu³ & Salah Sukkarieh³

AT A GLANCE

- Technology underpinning autonomous tractors is relatively advanced and has been developed by the major tractor manufacturers. Farmers currently realise many of these technologies and their benefits now.
- There is an opportunity for the early release of autonomous tractors in Australia by engaging with OEMs (ie. John Deere and CNH) to incubate technology before worldwide release.
- Technology companies are emerging that provide aftermarket solutions to make current model tractors autonomous (here and now).
- Disruptive technology concepts in automation / robotics are pre commercial or in the early stages of commercialisation.

THE development of autonomous and intelligent technologies provides a mechanism to increase the precision of crop management and realise additional potential from precision agriculture. This means that the right management strategy can be implemented in the right place, at the right time.

The introduction of these technologies will also lever and enhance past developments and improvements in cropping systems and agronomy.

While there is much interest in the development of new automation and robotic technologies, multinational machinery manufacturers have already developed a number of incubated autonomous, agricultural technologies with near commercial potential. Australia provides a significant opportunity in the refinement and commercial release of these technologies and is relatively advanced in comparison to North America and Europe in the practical application of precision agriculture technologies.

Working with the manufacturers

A review of autonomous tractor developments and enabling technologies was undertaken to inform future engagement with equipment manufacturers and with the view of accelerating the release and adoption of autonomous tractors for the Australian grains industry.

The review involved commercial developments undertaken by the six largest tractor manufacturers (ie. OEMs) and included John Deere, Case New Holland, AGCO, CLAAS, Same Deutz-Fahr and Kubota. This work also examined the status of research on autonomous tractor technologies, the current status of intellectual property in this space, aftermarket technology developments, fully autonomous tractor concepts and emerging technologies.

Manufacturing developments

Autonomous vehicle enabling technologies are relatively advanced in agriculture and informed by both the potential for efficiency gains from more precise operation of tractors and the

laborious, systematic nature of machine operation in agriculture. The agricultural operating environment is also conveniently suited to automation with vehicles operating in large, well defined open areas that are relatively free of obstruction and personnel.

A number of technologies have been developed over the last two decades to improve the operational efficiency and productivity of tractors (e.g. guidance, drive-by-wire, continuously variable transmissions).

Technologies have also been developed to improve management of crops using precision agriculture (PA) techniques (eg precision seeding, variable rate application, yield monitoring).

Machine to machine communications are improving logistics and coordination between multiple vehicles and new telematics solutions are now available that provide in-field management of tractor operations and monitoring of vehicle performance.

These technologies are routinely used today and there is a range of products commercially available or in active development. While these technologies are being developed as products to augment human operation of the tractor, they form key technological elements of full tractor autonomy (ie. a pathway to autonomy).

Each of the six major tractor manufacturers has made significant developments that inform key components of an autonomous tractor and essentially a technology pathway to autonomy. Currently this technology has been developed to augment human operations which are currently accessible via features or product offerings on tractors commercially sold and available to Australian farmers including the following:

- Hands free tractor/implement guidance including GNSS and vision based solutions;
- Variable rate control including functionality where the tractor and implement (ie. seeding, spraying, fertilising etc.) operate in concert;
- Machine optimisation via constantly varying transmissions and adaptive control to environmental conditions and work requirements;
- Path planning/automated machine operations which includes auto turn and auto control of implement functionality for example, raising and lowering, starting and stopping operations (ie seeding, spraying, fertilising etc);



Case IH autonomous tractor.

- Sensing and perception which includes interaction/awareness of the machine and i) the surrounding environment, ii) the crop and iii) the task being undertaken; and,
- Telematics and infield communications for remote control of tractor operations and uploading of task related data.

The six major tractor manufacturers have made significant developments that inform key components of an autonomous tractor and essentially a technology pathway to autonomy. Currently this technology has been developed to augment human operations which are currently accessible via features or product offerings on tractors commercially sold and available to Australian farmers.

In addition, John Deere and CNH have released operational concept vehicles to gauge consumer interest and the application of this technology in commercial farming operations and environments.

AGCO has developed a semi-autonomous concept which

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John Deere concept autonomous vehicle.

includes leader (ie. manned)/follower (unmanned) technology, while Kubota has announced plans to develop autonomous driver technology.

AGCO, CLAAS and Deutz have developed sensors for both perception and process monitoring as key enablers of autonomous tractor developments which are presented as independent technologies.

It would appear that John Deere and CNH are the most advanced in terms of having potential to accelerate a product to market.

Aftermarket solutions

In addition to the major tractor manufacturers there is the emergence of autonomous technology providers such as ASI and Precision Makers that provide 3rd party 'bolt on' solutions.

Notably ASI has worked in partnership with John Deere (early autonomous tractor developments) and more recently CNH.

Precision Makers has equipped a Fendt tractor in Australia (Beefwood, Moree NSW) for autonomous commercial operations.

The emergence of these 3rd party technology providers is akin to the initial release of GPS autosteer technology in Australia by Beeline Technologies before the major tractor manufacturers.

This provides an additional avenue for Australian producers to access autonomous tractor technology as an aftermarket solution.

Early adopters of aftermarket solutions are potentially exposed to compatibility issues with OEM technology and development cycles in offering a robust retrofit product (presuming this is in isolation to OEMs).

But the experience with GPS autosteer indicates that third party suppliers of autonomous technology are more likely to release product before the major tractor manufacturers (in the absence of coordinated industry engagement). This provides an additional option for Australian agricultural industries to access autonomous tractor technology notwithstanding the potential for exposure to developmental risks which would need to be determined.

Disruptive technologies

Early start-ups and disruptive technologies is another potential area in which autonomous tractors/platforms may have some bearing on autonomy in agriculture outside of the work by the large OEMs.

Swarm Farm based in Central Queensland is a notable example and the most relevant to Australian agricultural industries at present. Swarm Farm is an emerging service based business that provides autonomous platforms on a contract operator basis that is currently centred on spray applications. The service based business model means clients are less exposed to technology risk.

As the technology matures departure from the service based model is envisaged to on-sell technology to early adopters who have demonstrated technical ability to use the technology and incorporate into their farming operations.

In the interim the adoption/uptake of the technology is based on the initial growth of the current service based business model.

Further research & development

Apart from the commercial application of existing technologies, key areas of research include interaction of autonomous vehicle with unstructured environments (ie. terrain); sensing for navigational control and environmental awareness and path planning to optimise machinery operations.

Other key areas include machine intelligence for oversight of operations and perception relating to machine/environmental/human interaction. A revision of registered intellectual property relating to autonomous tractor developments identifies machine to machine communications and sensing and perception as a primary focus.

This is suggestive of future developments in the commercialisation pipeline.

To sum up

Tractor companies are relatively advanced in terms of the development of technologies which inform autonomous tractor concepts. Of the six major tractor manufacturing companies John Deere and CNH appear to be the most advanced.

Other tractor manufacturers including AGCO, CLAAS, Same Deutz-Fahr and Kubota have developed technologies which also inform various components of autonomous tractor functionality such as guidance, perception, machine optimisation and sensors for process monitoring.

In addition to the large tractor manufacturers is the emergence of technology companies providing aftermarket solutions. Similar to the advent of GPS auto steer, these companies provide an independent opportunity for farming enterprises to engage in autonomous tractor technology.

The compatibility and field readiness of these technologies requires further investigation although it is noted that there are some examples of deployment under commercial operating conditions.

Emerging/disruptive technologies also feature as a potential opportunity for autonomous technologies on farm and a number of companies have developed platforms that are pre commercial or in the early stages of commercial release.

In comparison to the large tractor manufacturers the accelerated roll out of these technologies will be tempered by early adopter interest in new technology and farming systems concepts as well as the establishment of dealer network and support services.

The research undertaken as part of this project is made possible by the significant contribution of growers through the support of GRDC. The authors would like to thank them for their continued support.

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Reducing risk through smart variety choices

SEASONAL risk management is at the top of the priority list for Jamie and Anna Tait on their property 'Heath', in the Border Rivers region of southern Queensland.

The Yelarbon growers, who operate as the 'Lyal Farming Partnership', run a five-year dryland cropping rotation, consisting mainly of wheat/chickpea/barley and sorghum, with variety selection and time of planting key to spreading seasonal risk.

The Tait's have grown Pioneer brand G33 hybrid sorghum for the past five seasons, after being impressed with its characteristics when looking for new varieties to introduce to his cropping program.

"G33 looked good on paper, showed a good test weight in dryland conditions and when the heat comes on it, seemed to have good head emergence compared to some of the other varieties, easier harvesting and a good top-end yield," Jamie explains.

Spreading his 2016–17 summer crop plant across five sowing dates, Jamie selected G33 to be the last plant, in early January, with 140 kg per hectare of urea applied pre-plant.

"G33 established very well, we had good planting rain and it was quite wet and very hot," he explains. "We went with the G33 in the last plant because of its faster maturity, so it would be ready to harvest before colder weather affected operations."

"We had good late season rain from ex-Tropical Cyclone Debbie and the G33 just kept tillering and putting on more and more yield – it went really well."

Harvest took place in June 2017, and Jamie reports the good head emergence in G33 made it easy to harvest compared to some of his other varieties.

"Moisture levels were all fine, and G33 returned great test weights of 80 kg per hectolitre and low screenings of 1.5 per cent," he says.



Jamie Tait says seasonal risk management is their top priority.

"It had a big grain size and was a nice red grain, and not only did it make the top grade, we were also able to use G33 to blend up some poorer quality varieties to get them into the top grade too."

G33 yielded 4 to 4.5 tonnes per hectare over 150 hectares, with the variety's continued performance meaning it will be around 30 per cent of the 1000 hectare sorghum program on 'Heath' moving forward.

"I'll aim to plant G33 on our heavier soils, and it will be the last sorghum we plant each season as part of our aim to reduce seasonal risk through smart variety selection and planting dates," Jamie explains. ■



Pioneer brand G33 hybrid sorghum was chosen for its late planting, fast maturing characteristics.

Croplands unveil new Weedit PhantomDrive

AUSTRALIAN owned, agricultural spray equipment manufacturer, Croplands has partnered with autoTRAC to marry the hugely successful Weedit optical spot spray technology with PhantomDrive – a smart autonomous, driverless platform kit that can be ‘added-on’ to current model tractors with CVT transmission.

Croplands adopted the Weedit technology from Europe over five years ago and it is now in use by some of Australia’s leading broadacre farmers to improve the efficiency of their herbicide spraying. The results have proven to be excellent in chemical savings, combating hard to kill weeds, lowering weed seed banks and retaining soil moisture.

The Weedit sensors detect weeds by recognising the active chlorophyll present in all living plants. A signal is then sent to a solenoid to activate the correct nozzle as it passes over the target weed – minimising the amount of herbicide that is applied to bare ground. Croplands have engineered spray systems that not only maximise the efficiency of the Weedit sensors, but withstand the rigours of Australian broadacre conditions.

Croplands Northern Regional Manager, Jeremy Rennick is based at Croplands Toowoomba headquarters and was heavily involved in the project.

Autonomy the logical next step

“Making the Weedit autonomous was the next logical step for us with this product and we see it suiting medium to large scale

farmers trying to get more efficiency into their operation either by giving themselves more time for other tasks around the farm or through better utilisation of their existing workforce.”

This versatile toolbar kit allows your machine to not only perform autonomous tasks on demand, but also allows for normal use of the tractor when other jobs around the farm require it. Croplands 12 metre Weedit toolbar kit has been a great success in irrigation and smaller broadacre applications since its release in 2015. Croplands are expecting existing toolbar owners will be the first in line to upgrade to the autonomous platform technology, enhancing the use of their current machine.

Croplands’ intention for the Weedit PhantomDrive is to allow farmers to do more, at a higher level of accuracy, within a limited time frame – a factor that will contribute to improved fatigue management and monetary savings associated with labour costs.

The platform can be accessed remotely on any smart phone, tablet or computer with internet access. It monitors both the tractor and sprayer and any issues with either is immediately known through the warning system.

It has weather station capabilities for monitoring environmental conditions at the site of application and the system will stop operation if pre-set weather parameters are triggered.

The Croplands Weedit PhantomDrive also incorporates a collision avoidance system, to eliminate any accidents on farm with people, animals or foreign objects.

Truly integrated system

Creator of the platform, Luke Schelosky brands the PhantomDrive as a truly autonomous drive system.

“We understood that an autonomous tractor by itself is simply a novelty so we had to provide a truly integrated system that not only gives excellent autonomous performance but also monitors and works in conjunction with the implement. Things like an on board weather station, SMS warning system for both the tractor and implement, tyre pressure monitoring and the ability to successfully steer around obstacles in the paddock were all critical in making the system a success.”

Weather conditions permitting, Croplands Weedit PhantomDrive can work 24 hours a day.

Luke is excited about the prospects for farmers with the new technology.

“PhantomDrive relieves farmers from spending long hours on farm machinery – it will take farming to new levels of efficiency and productivity.”

Croplands recently released the Weedit PhantomDrive to its local dealer network and it is safe to say many were impressed by the new platform. Michael O’Hara of Black Truck and Ag in Dalby was one of the dealers that attended the launch.

“Although slightly sceptical at first we’ve been impressed with what was shown to us and believe that we now have a system we can take to the market. I particularly like the idea of it being mounted to an existing tractor platform, making the unit a lot more versatile for the owner as it can be used for other jobs on the farm when not being used as a spot sprayer.”

Contacts: Jeremy Rennick, Northern Regional Manager, Mob: 0409 065 994 or Steve Norton, Portfolio Manager, Mob: 0437 878 695. ■



The new autonomous spot spray system is fully integrated with both the tractor and implement.

Parkes growers turn to 'old reliable' for grain fumigation

EFFICACY and reliability are paramount when it comes to grain fumigants and for Parkes grower Spike Orr, it's why he and his family have trusted the same product for more than two decades.

Spike farms with his brother Tim and their parents, Bob and Colleen, at Parkes in central west New South Wales.

The family's property spans 3240 hectares, of which one third is used for cropping and the remainder for running sheep and cattle.

A typical cropping program for the Orrs comprises wheat and canola or wheat and barley, with about 1000 tonnes of on-farm storage in the form of sealed cone silos.

The on-farm storage allows them flexibility for their grain marketing, as well as retaining grain for seed and feed purposes.

"Most of the grain we keep is used for seed, or barley for stockfeed," Spike said.

"We've had problems in the past with weevils, which is why we started using QuickPhos all those years ago. We've been using it for as long as it's been available and it has never let us down."

UPL QuickPhos is a phosphine fumigation method used for eradicating stored grain pests.

It can be used on practically all food-grains, milled products, processed food and other agricultural products.

Available in tablet, pellet and bag form, QuickPhos offers a simple delivery system that ensures even distribution of phosphine with no toxic residue.

It's effective on a wide range of pests, including granary weevil, lesser grain borer and flat grain beetle.

For Spike, QuickPhos is the main weapon they use to eliminate grain pests in their stored grain and they source the product through their agronomist, Luke Wood, from CRT AgriWest Parkes.

"We generally don't treat our grain as it goes in the silo, apart from the occasional lime application, which is supposed to help keep the bugs away," he said.

"At the first sign of weevils, we'll go straight in with QuickPhos as for us, it's the most cost-effective option."



Luke Wood, agronomist with CRT AgriWest Parkes, and local grower Spike Orr, who relies on QuickPhos phosphine fumigation to eradicate stored grain pests.

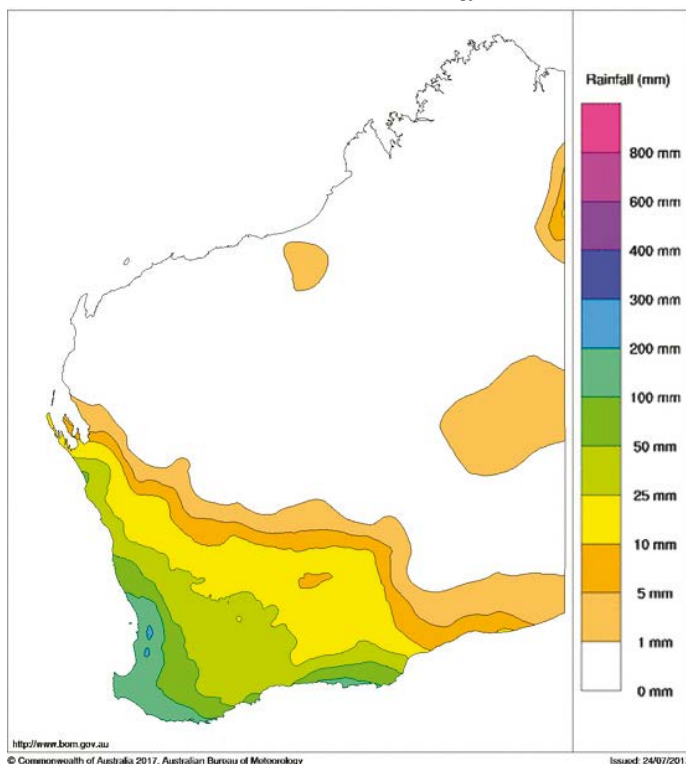
District Reports...

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Western region



Western Australia rainfall totals (mm) – July 1–24, 2017
Australian Bureau of Meteorology



Most grain producing areas of Western Australia have had an extremely dry start to the 2017 winter crop season.

WESTERN AUSTRALIA SUMMARY

The June winter rainfall in Western Australia has been much lower than average and there has been inconsistency in growing season rainfall across the grainbelt. In particular, rain has been significantly lower in the north and eastern grain growing regions of the state. With the season looking so patchy and areas still waiting on good rains, the total grain production for WA is going to be down significantly on the record harvest achieved in 2016.

At this stage, we estimate the total 2017 harvest to within a range of 10 to 12 million tonnes.

Recent rainfall over the last weeks of June turned the season around in the western Kwinana and Albany port zones – these zones now have the potential of at least average grain yields

for this harvest. The Esperance port zone is on track for above average cereal grain yields and at least average canola grain yields.

The recent rainfall events did not reach the north and eastern Geraldton port zone or the north and eastern Kwinana port zone. In early July, these regions still had large areas of land where crop has not emerged. At this stage, around 30 per cent of intended crop area in the Geraldton port zone and about 10 per cent of the north and eastern Kwinana port zone will not be harvested.

Pasture production has been very poor across all port zones of WA and growers are faced with the prospect of hand feeding livestock for several more months. Consequently, the large volume of feed grain stored on-farm from the 2016 harvest is expected to be run down to low levels by the start of the 2017 harvest.

Geraldton

The areas to the north and east of Geraldton missed out on rain once again in June with some farmers facing the prospect of not even recovering seed for next year. At least 30 per cent of the zone will not harvest a crop, and whilst the remaining areas will probably put a header over the remaining crop, grain yields will be very low.

The biggest impact will be on lupin tonnages, as this region usually produces more lupins than the rest of the other zones combined. And even with the increase in canola plantings, there will be very little canola tonnage coming from this zone.

Thanks to some late June rain, there has been some improvement in crops in the western areas close to the coast north and south of Geraldton.

Early sown crops on the eastern fringe that were sown into stored moisture are still growing, although as most of this region has had less than 15 mm of growing season rainfall, it is uncertain how long the crops can hold on for without further substantive rain events.

The Midlands

The region has been hit hard by the lack of winter rain. Agronomists in the region are commenting that they have never seen it as bad at this time of the year, particularly in the more reliable areas close to the coast. At this stage 90 per cent of the crops in the zone will be harvested but for many, yields will be just to recover seed. Agronomists still haven't written off the season completely as there are still good reserves of sub-soil moisture in many areas to enable crops to return more than seed if it rains over the next few weeks.

The rain in the last weeks of June saw an improvement in patches, but in large areas of the region, crops have still not emerged.

Kwinana West

The crops in the western Kwinana port zone have picked up following rainfall events at the end of June. Crops that were up before the rains have their roots down into the subsoil moisture and plants in sections of paddocks that were yet to germinate have now come through and are filling in the gaps.

Crops have noticeably greened up and are looking much healthier than two to three weeks ago. Where there was no activity a few weeks ago there is now post emergent weed spraying and some post emergent fertiliser application.

Overall, the outlook for the region is for a below average season for most growers due to crops being behind in growth stage and the late start to the growing season. In comparison to other very dry years and late starts, the crops this year have good stores of sub-soil moisture and this is starting to show up, particularly where weeds in the summer were sprayed out early.

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Kwinana East

The situation in the Kwinana East zone has improved over the last few weeks, particularly south of the Great Eastern Highway. Several rainfall events of more than 10 mm have revived prospects of at least an average harvest for those receiving rain.

Cereal crops are generally looking okay in the western and southern regions of the zone, but are patchier and have less potential to the east and north.

Canola and lupin crops are poor over most of the zone and have low grain yield potential.

Western Albany

Rain over the past few weeks turned around the grain yield prospects. Generally, crops have emerged well and are some of the more evenly germinated in the state. Most of the region west of Albany Highway has now had at least 15–20 mm of rain over the past two weeks and crops are down into the subsoil moisture. Canola is cabbaging up and cereals are growing nicely.

Agronomists are still only expecting below average grain yields at this stage as total growing season rainfall is well below average. But the crops do look good for the rainfall that has fallen.

Southern Albany

Recent rainfall has improved the outlook for the region and most growers are now looking at around average grain yields for all crops. The stored moisture is low for this time of year so the region will need good rainfall through until spring to push yields higher. One positive with the lower stored moisture is that

crops in areas prone to waterlogging are at less risk. The timing of spraying out summer weeds is showing up in crops. Paddocks that were sprayed out early are more even and more advanced than those kept green for longer.

Threats to the current crop are widespread and include green peach aphid and turnip aphid in canola and the potential for barley leaf rust infection in wetter areas close to the coast.

Eastern Albany (Lakes Region)


The region has benefited from the rains over the past few weeks and most of the later sown crops that were waiting for rain have now emerged.

Crops are growing well around Lake Grace and Kulin where some of the higher falls of rain have been recorded and areas that have had up to 20 mm in the last few weeks can expect at least average grain yields.

Esperance

The Esperance port zone continues to be the one bright spot in the state with more good rain falling for most of the region

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

<div><div>Brought to you in association with</div><div></div><div>JOHN DEERE</div></div>			Summer		Autumn		Winter		Spring	
	25yr Annual Average (mm)	2017 rainfall to date (mm)	25yr Annual Average (mm)	2016–17	25yr Annual Average (mm)	2017	25yr Annual Average (mm)	2017 to date	25yr Annual Average (mm)	2016
Emerald Qld	553	335	255	165	99	224	70	8	122	68
Toowoomba Qld	667	523	277	148	129	348	88	60	177	158
Roma Qld	574	346	254	179	113	183	78	34	131	155
Goondiwindi Qld	615	310	256	185	119	148	103	41	140	163
Narrabri NSW	628	402	226	145	112	231	130	53	165	201
Gunnedah NSW	638	288	224	186	106	138	129	59	181	189
Dubbo NSW	615	265	198	155	122	237	135	11	160	248
West Wyalong NSW	461	159	120	85	80	109	125	7	135	254
Wagga Wagga NSW	554	168	132	116	115	87	153	35	152	260
Swan Hill Vic	321	174	71	37	64	132	87	10	99	140
Bendigo Vic	514	299	108	102	106	187	160	39	143	249
Horsham Vic	379	210	77	86	71	120	122	36	108	154
Lake Bolac Vic	524	251	113	101	102	143	156	34	152	259
Murray Bridge SA	374	161	67	102	81	83	122	31	103	155
Kadina SA	347	142	56	165	82	43	114	22	91	116
Cummins SA	400	172	50	124	94	25	172	51	83	93
Esperance WA	622	444	80	201	146	107	250	159	143	153
Wagin WA	396	317	43	230	98	77	166	53	88	63
Northam WA	399	345	40	262	89	41	188	56	83	55
Mingenew WA	354	145	27	87	93	29	175	6	60	41
Moora WA	383	259	41	165	88	32	185	73	69	52
Mullewa WA	325	213	47	181	97	11	133	24	48	18

Last rainfall reading July 18, 2017.

District Reports...

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on June 30 and July 1. It is slightly drier in the Salmon Gums and Beaumont areas, but the rest of the zone from Ravensthorpe to Condingup has adequate soil moisture.

Wheat and barley crops have above average yield potential at this stage of the season while canola yields should be at least around the average mark.

Crops are growing away from any previous bug or grub damage and leaf diseases are at low levels in cereals and canola.

Snails continue to be an emerging issue in the region, and there are also low levels of turnip aphid and diamond back moth in canola crops.

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

**Grain Industry of Western Australia Crop Report
July 7, 2017**

NORTH

The 2017 season is turning out to be one of the driest on record. Most of the region is under 30 mm of rain for April, May and June which is a bloody disaster. It is tough times for all in the broadacre agricultural industry in our part of the world.

With year to date rainfall in the region ranging from as low as 75 mm, crop growth is very poor.

Some areas that were lucky enough to have a thunderstorm go over them have good crops on them. These few green areas are mostly coastal with the odd strip inland.

Geraldton had 125 mm for the year to the end of June – this is the 29th driest for this period on record. The good news here is that all of these 29 dry start years had more rain in the second half of the year. Geraldton records go back to 1877 so there are 140 years of records.

Also, rainfall even close to the Geraldton BOM site, varies greatly over a handful of kilometres.

A wind event on June 12 caused erosion damage in some parts of the landscape. High levels of crop residue out of last year meant many growers had to burn stubble to get seeders through. This has removed much of the cover and some sand soils farms have suffered wind erosion.

Growers need to work hard to avoid wind erosion as it has the greatest cost in lost soil fertility and water holding capacity. Some will need to sow a cereal crop for cover after the soil wets up (at some point we would hope...) and stop wind erosion as much as possible.

Some northern and eastern growers have already shut the farm down and “moth-balled” their operation until next season. The crops in these areas have little prospect of being harvestable.

Western areas have had more rain and are still in the race to get a crop even though most areas will only be well below average.

It has been a taxing year in our area with grain and livestock producers the worst hit with very little pasture growth.

Rallying grain prices mean those with a crop might have an OK year but many are looking at their worst crops on record.

Roll on 2018...

**Peter Norris
Agronomy For Profit and Synergy Consulting, Geraldton
July 11, 2017**

SOUTH COAST

Seasonal conditions on the South Coast for the past two months have been mixed.

The later part of May and June were very dry and warm with temperatures 2.5 degrees warmer than average. With the warm temperatures, crop development was very fast with a high demand on stored soil moisture. By the end of June, some crops were wilting in the heat of the day and growers were getting anxious for rain.

Timely rainfall from around June 22 through to July 8 has the district back on track. Stored soil moisture levels have been topped up as has grower confidence as they chase average to above average yields with in-crop nitrogen applications.

Along with rising grain prices and relatively inexpensive nitrogen, many growers are optimistic for robust financial returns for the 2017 harvest.

In this difficult season, the South Coast is a very fortunate place in the WA grainbelt.

Growers are very appreciative for what the season has delivered to date compared to the vast majority of the state.

**Quenten Knight, Agronomist
Precision Agronomics Australia, Esperance
July 11, 2017**

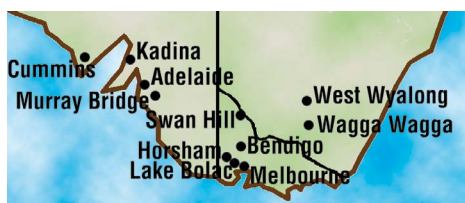


Emu Rock wheat at Schutz Grains, Grass Patch about 80 km northeast of Esperance.

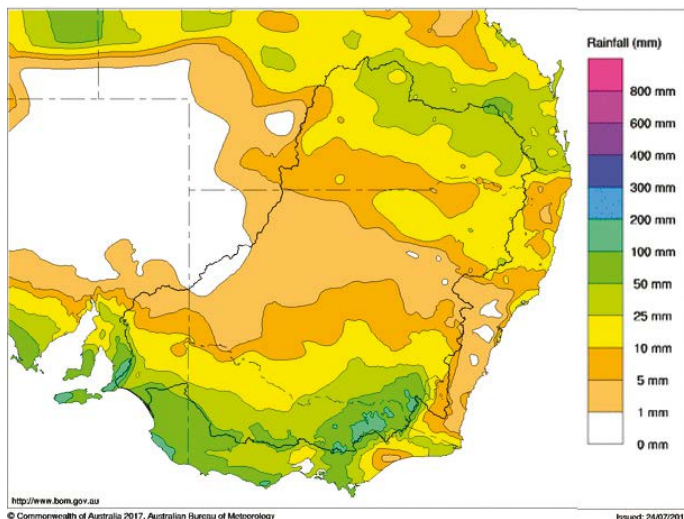


Warakirri Farm manager at Condingup (70 km east of Esperance), Con Murphy, discussing nitrogen and sclerotinia management with analyst Brendan Lynch (Melbourne) and Laura Bennett (Warakirri Cropping Graduate Program).

Southern region



Murray–Darling Basin rainfall totals (mm) – July 1–24, 2017
Australian Bureau of Meteorology



Patchy rainfall events have created a mixed bag of winter crop prospects for most regions. In particular, crops in the central and northern regions of NSW – and stretching into southern Qld – are on a knife's edge.

Northern region



LIVERPOOL PLAINS

Winter has definitely arrived on the Liverpool Plains with temperatures barely reaching a maximum of 20 degrees during the day with lows of minus 5 overnight – this is not helping emerging crops to establish.

But winter crops are generally in good shape. Chickpeas are an exception with a number of growers reporting that their (mostly increased) area of chickpeas is slow to get going.

On our farm we finished sowing chickpeas by mid July and we're now waiting for them to emerge.

The chickpeas were planted into recently harvested sorghum with about half full profile of soil moisture.

A very real challenge we face – as does every farmer on the

District Reports...

July–August 2017



These Liverpool Plains chickpeas were planted into recently harvested sorghum stubble.

Liverpool Plains – is the ever increasing numbers of wild pigs. Pigs can cause a lot of damage in chickpeas uprooting rows at a time.

Lauren McGavin
Precision Seeding Solutions, Premer
July 16, 2017

DARLING DOWNS

May and June passed the Darling Downs by without any general planting rain – but in the first week of July, falls of between 15 and 40 mm have allowed planting in some dry areas – at last filling some gaps.

Subsoil moisture is good after the March rain, but it has been difficult to wet the dry layer at 7–10 cm to allow planting. The result is that we have a much later planting than usual across the Downs.

Winter crop

There is about 80 per cent of the planned winter crop planted, with up to 20 per cent of that being a July plant.

Chickpeas have again been the major crop and the area will

District Reports...

July–August 2017



Ascochyta has already been found in some chickpea crops this season. This particular infection was from neighbouring volunteer plants.

be similar to last season. A high proportion of the crop has been deep planted.

The crops range from starting to flower to being planted in mid-July, with most between 3 to 6 nodes.

There has been ascochyta found in some crops, but only where volunteer chickpeas were in neighbouring paddocks through the summer.

There is also some phytoplasma showing up which is being spread by grey jassids, especially in the western areas. Most crops emerged have received their first fungicide protection, which appears to be successful.

The wheat and barley area has received a late boost from the July rain – plus some more attractive prices – but the area is well down due to the chickpea area, and is under half of the traditional area.

The early crops are up to in-crop weed control, but most paddocks are just emerging.

Summer crop outlook

The outlook for summer is mixed. Irrigators appear to have fair supplies of water and the irrigated cotton area is expected to be similar to last season. But there could be an increase in irrigated corn with stronger prices for both silage and gritting varieties.

On the dryland front, sorghum is expected to be the main crop

ANSWER TO IAN'S MYSTERY TRACTOR QUIZ

The Mystery tractor is a Canadian manufactured Massey Harris 25, powered by a four cylinder petrol/kero fuelled engine of 41 belt hp.

once again, with improved prices swaying many growers away from cotton after last season's disappointing results.

Summer plants of mungbeans and sunflowers could again be strong, and there is some interest in soybeans. Stored soil moisture levels are fair.

Hugh Reardon-Smith
Agronomist, Landmark Pittsworth
July 12, 2017

CENTRAL QUEENSLAND

Central Queensland has entered its traditional dry winter. On the Central Highlands there has been no widespread or significant rain since the end of April. It has been wetter in the east with 50 to 75 mm falling across much of the Callide Valley in May/June and 25 to 50 mm falling across the major cropping areas in the Dawson Valley over the same period.

Temperatures have been unseasonably warm – early sown wheat and chickpea were flowering by late June. Crops planted in May are developing rapidly, with some uncomfortably close to flowering.

Some crops will face the risk of frost injury if late July and August turn cold.

Dry conditions in May and June have seen many Central Highland wheat crops start to suffer from moisture stress and this has been compounded by limited secondary root development. These crops require rain soon.

Some early April planted wheat crops (especially north of Clermont) with over 10 mm of in-crop rain, have developed secondary roots and are travelling well.

Dawson and Callide wheat crops fared better with substantial rain in May and June and they are progressing well.

There have been no reports of major wheat diseases or other issues in CQ so far this season – but rain would help.

Chickpeas are generally doing well. Helicoverpa may become a concern from July onwards as flowering starts. Warm weather is facilitating their lifecycle and moths remain active.

Ascochyta blight risk will be dependent on rainfall but there haven't been any reports of major outbreaks yet, thanks to dry conditions.

Cotton picking has extended into July with the last crops now off. The Bollgard III planting window starts August 1.

The Fairbairn Dam was at 42 per cent on July 10.

Max Quinlivan
Department of Agriculture & Fisheries, Emerald Qld
July 20, 2017.

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