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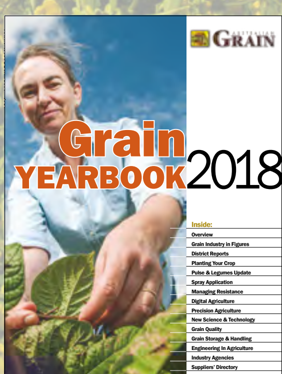

FRONT COVER – Choosing nematode tolerant crops
USQ researcher Kirsty Owen says when nematodes are present in paddocks at damaging populations, it could be managed by growing tolerant crop varieties – see article page 79. (Image courtesy USQ)

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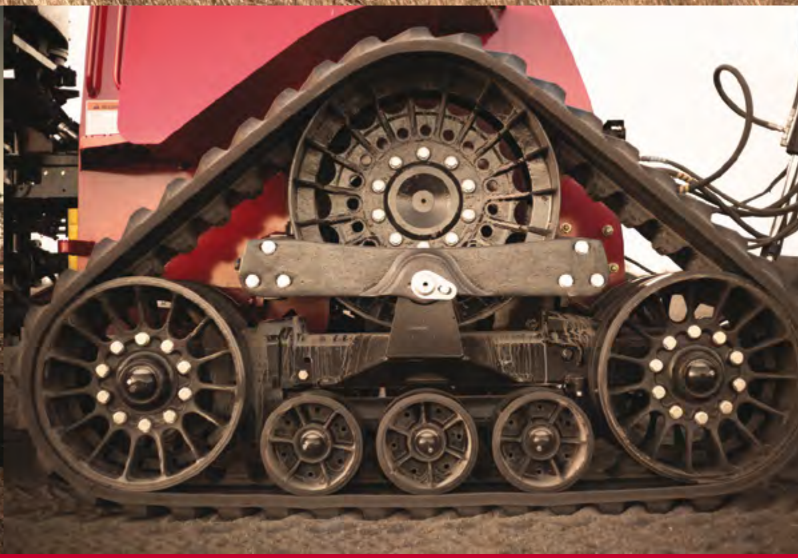

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CASE IH AGRICULTURE

Section 1

Overview

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Australia area ('000 ha) and production ('000 tonnes) of major winter and summer crops planted for grain during 2017

	NSW		VIC		QLD		WA		SA		TAS		AUSTRALIA TOTAL	
2017–18	**Area**	**Prodn**	**Area**	**Prodn**	**Area**	**Prodn**	**Area**	**Prodn**	**Area**	**Prodn**	**Area**	**Prodn**	**AREA**	**PROD'N**
Wheat	3100	4495	1550	4000	610	683	5000	7945	1970	4090	6.8	30.4	**12,237**	**21,244**
Barley	790	1185	800	2100	87.9	120	1400	3705	795	1800	5.0	17.3	**3878**	**8928**
Oats (for grain)	280	252	120	270	24.1	8.4	270	478	45.0	105	3.0	5.6	**742**	**1119**
Triticale	43.0	64.5	5.0	11.7	3.9	4.9	10.0	11.5	15.0	20.0	0.6	1	**78**	**114**
Sorghum#	150	465			350	998	1.0	2.0					**501**	**1465**
Maize#	20.0	178	1.0	6.7	35	195	0.4	3.6					**56**	**383**
Rice#	77.9	790	0.2	0.8	1.7	8.7							**80**	**799**
Canola	650	618	450	750	2.0	1.2	1376	1978	250	320	1.0	1.4	**2729**	**3669**
Sunflowerseed#	16.0	20.8			9.2	9.9							**25**	**31**
Soybean#	20.0	40.0	0.6	0.9	12.8	21.8							**33**	**63**
Peanuts#					8.0	22.0							**8**	**22**
Cottonseed#	310	943			190	464							**500**	**1407**
Lupins	75.0	75.0	35.0	40.0			350	441	58.0	75.0			**518**	**631**
Field peas	52.0	52.0	60.0	70.0			20.0	42.3	90.0	125			**222**	**289**
Chickpeas	450	360	55.0	60.0	575	565	6.0	7.5	30.0	35.0			**1116**	**1028**
Faba beans	33.0	49.5	105.0	150.0	5.9	6.6	3.2	4.1	73.0	120.0	0.1		**220**	**330**
Mung beans#	40.0	35.6			78.6	70.5							**119**	**106**
Navy bean#					5.0	6.0							**5**	**6**
Lentils	22.0	28.6	150	180			6.0	6.0	175	250			**353**	**465**
TOTAL	**6129**	**9652**	**3332**	**7640**	**1999**	**3185**	**8443**	**14,625**	**3501**	**6940**	**17**	**56**	**23,420**	**42,098**

Estimate for summer crop harvested in 2018. Principal source: ABARES.

Farmers' terms of trade from Australian grain production (base year is 1997–98 = 100)

	2012–13	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19 (forecast)
PRICES RECEIVED (excl GST)							
Wheat	158.3	159.8	151.7	140.1	125.0	143.3	150.5
Barley	173.4	167.9	175.6	159.0	114.6	154.9	157.3
Canola	142.1	144.1	130.6	137.9	134.9	130.5	129.2
Lupins	173.5	176.4	149.3	185.0	141.4	133.8	228.3
Oats	172.9	156.0	183.1	224.0	174.0	184.0	175.3
Sorghum	148.9	177.2	178.1	162.3	141.0	176.4	181.1
TOTAL GRAINS[a]	**147.9**	**149.9**	**147.0**	**141.9**	**124.0**	**141.4**	**143.0**
PRICES PAID (excl GST)							
Fuel & lubricants	216.8	221.1	207.9	167.9	175.7	187.2	200.3
Fertiliser	157.9	153.2	154.7	157.8	134.1	136.8	143.4
Chemicals	110.3	113.6	115.0	116.2	117.7	119.4	121.4
Seed	128.0	130.6	130.4	129.9	122.0	131.8	134.0
Electricity	157.9	185.7	176.4	178.9	181.9	200.1	204.6
Labour	159.2	163.5	166.3	168.6	171.5	174.8	178.8
Marketing	153.5	159.3	152.9	144.1	149.6	157.0	165.8
Interest paid	96.4	85.3	79.5	74.8	68.4	68.6	77.5
Insurance	190.0	195.2	198.5	201.3	204.7	208.7	213.4
Capital items	157.0	161.5	164.4	166.9	169.8	173.1	177.0
TOTAL PRICES PAID[b]	**145.1**	**145.5**	**146.7**	**147.4**	**147.1**	**150.9**	**156.0**
TERMS OF TRADE	**101.9**	**103.0**	**100.2**	**96.3**	**84.3**	**93.7**	**91.7**

Notes: Terms of trade is the ratio of the index of prices received and the index of prices paid by farmers.
a: Includes grains not separately listed; and, b Includes other overheads such as rates and taxes etc but excludes livestock costs. Sources: ABARES, ABS

Domestic and global wheat outlook

By Tim Whitnall, ABARES

AT A GLANCE…

- In 2018–19 world wheat prices are projected to rise modestly from low levels and then fall from 2020–2021 for the rest of the projection period (in real terms).
- World wheat production is forecast to grow over the medium term, driven by productivity gains, particularly in the Black Sea region.
- Australian wheat production and exports are projected to grow over the medium term.

Outlook for Australian wheat to 2022–23

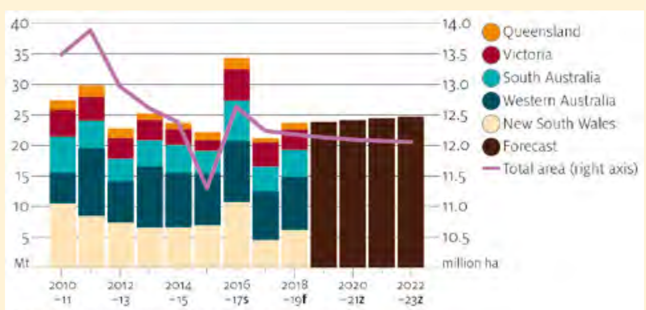
Wheat production to rise but area to fall

In 2018–19 area planted to wheat is forecast to remain relatively unchanged at 12 million hectares in response to low world prices. This will depend on climatic conditions leading into planting (March to June).

Assuming average seasonal conditions, wheat production is forecast to rise to 24 million tonnes (mt) in 2018–19. This reflects yields returning to trend after frosts, above average temperatures and dry conditions during the winter of 2017. These factors resulted in below average yields in Western Australia, New South Wales and Queensland in 2017–18.

Over the medium term, area planted to wheat is projected to fall because world prices are projected to remain near historic lows in real terms. But wheat production is projected to continue to rise modestly, reaching 25 mt in 2022–23 due to productivity improvements increasing yields.

Wheat production and area, Australia, 2010–11 to 2022–23



f ABARES forecast. s ABARES estimate. z ABARES projection.

Wheat export shipments to fall in 2018–19 but rise over the medium term

Wheat exports are forecast to fall by 3 per cent to 16 mt in 2018–19 despite higher production. In the first three months of 2017–18 exports were high, boosted by ample supplies from a record harvest the previous year. But the lower volume of exports in 2018–19 is expected to be more than offset by higher average world prices and result in the value of exports rising to $5.5 billion.

Over the medium term, the volume of wheat exports is projected to rise in response to higher domestic production and increased import

Wheat exports, Australia, 2010–11 to 2022–23

f ABARES forecast. z ABARES projection.

Table 1: Australia and world outlook for wheat

	unit	2015–16	2016–17s	2017–18f	2018–19f
World					
Area	million ha	225	222	221	220
Yield	t/ha	3.3	3.4	3.4	3.4
Production	Mt	736	754	750	742
Consumption	Mt	719	736	742	744
Closing stocks	Mt	224	242	250	248
Trade	Mt	166	176	178	180
Stocks-to-use ratio	%	31.2	32.9	33.8	33.4
Price[a]					
– nominal	US$/t	211	197	221	234
Australia					
Area	'000 ha	11,282	12,634	12,237	12,176
Yield	t/ha	2.0	2.7	1.7	2.0
Production	kt	22,275	34.369	21,244	23,742
Export volume[c]	kt	15,777	22,057	16,828	16,287
Export value[c]					
– nominal	A$m	5,120	6,094	5,174	5,462
APW 10 net pool return					
– nominal	A$/t	303	268	309	317

a US no. 2 hard red winter wheat, fob Gulf, July–June. **c** July–June years.
f ABARES forecast. **s** ABARES estimate.
Sources: ABARES; Australian Bureau of Statistics; International Grains Council; and, US Departmennt of Agriculture.

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World wheat prices in 2018–19 are forecast to rise around 6 per cent.

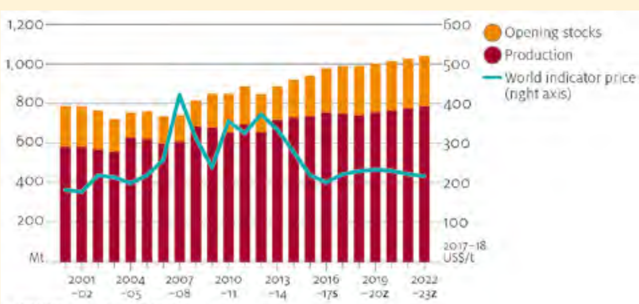
demand from Asia. The value of exports in nominal terms is projected to rise each year to 2022–23 but remain largely unchanged in real terms. This reflects higher export shipments and an assumed depreciation of the Australian dollar against the US dollar. But other major exporters (particularly Canada, the Black Sea region and the US) are expected to provide increased competition for Australian exports to key markets in South-East Asia.

World prices to rise from historic lows

The world wheat indicator price (US no. 2 hard red winter, fob Gulf) is forecast to average US$234 per tonne in 2018–19 – a 6 per cent rise from the forecast average of US$221 per tonne in 2017–18. Overall, production in the major wheat-exporting countries is forecast to fall (from very high levels) for the second consecutive year. This would reduce tradeable supplies and lead to some recovery in prices.

Prices are projected to rise in 2019–20 (in real terms). Exportable supplies in major exporting countries are expected to continue contracting as producers respond to low prices by planting less area to wheat. World wheat import demand is also expected to continue increasing due to population growth, changing diets and rising incomes. Prices are projected to then ease (in real terms) in each subsequent year to 2022–23, when productivity improvements in the Black Sea region cause supply to grow faster than demand and competition for export markets increases.

World wheat supply and price, 2000–01 to 2022–23



s ABARES estimate. z ABARES projection.

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Wheat demand projected to rise

World wheat consumption is forecast to remain largely unchanged in 2018–19. An increase in human consumption of wheat is forecast to offset a 2 per cent fall in wheat for feed use because of strong competition from substitute feed grains.

Over the medium term, world wheat demand is expected to continue to grow. Demand for milling wheat is projected to increase as a result of population growth, changing diets and rising incomes in Asia. These factors are expected to more than offset falling per person consumption of wheat in western countries, including the US and the European Union.

Milling wheat has few substitutes and the quantity demanded is relatively unresponsive to price changes. In contrast, demand for feed wheat is much more price sensitive, making consumption of feed wheat more volatile than milling wheat. Demand for all feed grains is projected to rise in the medium term because of projected higher meat and dairy production. But consumption of feed wheat is expected to rise only marginally due to strong competition from low-cost substitute coarse grains, especially corn.

Year-on-year change in wheat consumption and wheat-corn price ratio, 2000–01 to 2022–23

f ABARES forecast. s ABARES estimate. z ABARES projection.

World production to fall in the short term but increase over the outlook period

In 2018–19 world wheat production is forecast to fall to 742 mt, reflecting a slight fall in area planted and relatively unchanged average yields. Lower production is forecast in the Black Sea region and the European Union. This is expected to be driven by a decline from the above-average yields achieved in 2017–18 that resulted from exceptional seasonal conditions, particularly in the Russian Federation. This fall is expected to more than offset a slight recovery in production in Australia and the US, following poor conditions in 2017–18.

Area planted globally to wheat is expected to fall by 1 per cent in 2018–19. Declines are expected in high-cost countries such as Australia, the US and the European Union in response to ongoing low world prices. But area is expected to continue to expand in Argentina and China, where producers are still adjusting to relatively recent government initiatives that have made wheat production more appealing. For example, in 2015 the Argentinian Government eliminated wheat export taxes and allowed the peso to devalue, and in 2016 the Chinese Government abolished the corn minimum support price.

Over the outlook period, production is expected to increase to 786 mt in 2022–23. This rise is expected to stem from productivity improvements, including the adoption of higher-yielding varieties of wheat and improved farm practices that will increase average yields. Only a marginal rise in planted area is projected because relatively low world wheat prices provide little incentive for producers to expand.

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World wheat trade to increase over the medium term

The volume of wheat exports is forecast to rise by 1 per cent in 2018–19 to a record 180 mt. This mainly reflects increased milling wheat imports by the Middle East and North Africa, following a drawdown of stocks in 2017–18.

Over the medium term, projected higher production of wheat is expected to increase exports from most major exporting countries, especially in the Black Sea region. Black Sea wheat is generally more affordable than wheat from western countries because of relative costs of production. A depreciation of the Russian rouble in 2014 has also kept exchange rates favourable for exporters. The Russian Government has committed to investing in port capacity and export infrastructure, anticipating an expansion of wheat exports to North Africa and Asia.

For production of noodles and high-end bakery products, Asian processors generally see Black Sea wheat as inferior to hard, high-protein milling wheat from countries such as Australia, Canada and the US. The Russian Federation also has a history of putting sudden export restrictions in place in times of drought, decreasing the reliability of supply. Recent export trends and local reports indicate that Black Sea wheat is gaining acceptance in more price-conscious Asian markets such as Indonesia, but it is unlikely to be considered fully substitutable in markets that value quality milling wheats. Future improvements in the quality and stability of Black Sea wheat exports could displace exports from higher-cost producers, including Australia.

Chinese stocks to grow, but major exporter stocks to fall

World wheat stocks are projected to rise over the outlook period. But almost all of this accumulation is expected in China. The Chinese Government operates a minimum price support scheme that buys domestically produced wheat at a higher price than current world prices to encourage domestic production. This support price is based on weight, providing producers with an incentive to prioritise quantity over quality when making growing decisions. This means much of the wheat entering stocks is likely to be of feed grade rather than high-quality milling wheat.

Demand in China for feed wheat is currently low because domestic corn is much more affordable as a result of high stocks accumulating under a similar support price that was removed in 2016. The Chinese Government is considered likely to continue stockpiling wheat to maintain domestic prices over the outlook period.

By 2022–23 China is projected to hold almost half of the world's wheat stocks. This assumes that the Chinese Government will continue its domestic price support scheme in its current form, in line with its 2016–2020 five-year plan. Increasing wheat stocks could result in a government review of the scheme or its settings.

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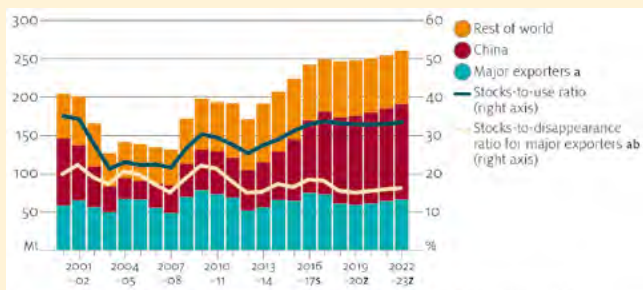
For example, in October 2017 the government lowered the minimum support price by 2.5 per cent, from 2,360 to 2,300 yuan. This may indicate that the government is testing the effects of a lower price in preparation for further alterations to the scheme. If the government abolished or reduced the minimum wheat price, domestic prices and production would fall and marketing of China's large wheat stocks would be likely to increase. This would put downward pressure on world prices, particularly for feed wheat. For more information on China's grains support policies, see box China's grain policies – an update (page 18).

Stocks in major exporting countries are projected to fall over the first half of the outlook period when domestic consumption and exports outpace domestic production. The stocks-to-disappearance ratio for major exporters is projected to fall to 15 per cent in 2019–20 – the lowest level since 2012–13. A falling stocks-to-disappearance ratio indicates a fall in availability of exportable supplies for the global market (typically occurring with rising prices or significant supply shocks). This means that world prices are expected to react more sharply in the event that poor seasonal conditions adversely affect crop development – representing an upside risk to the world indicator price projection.

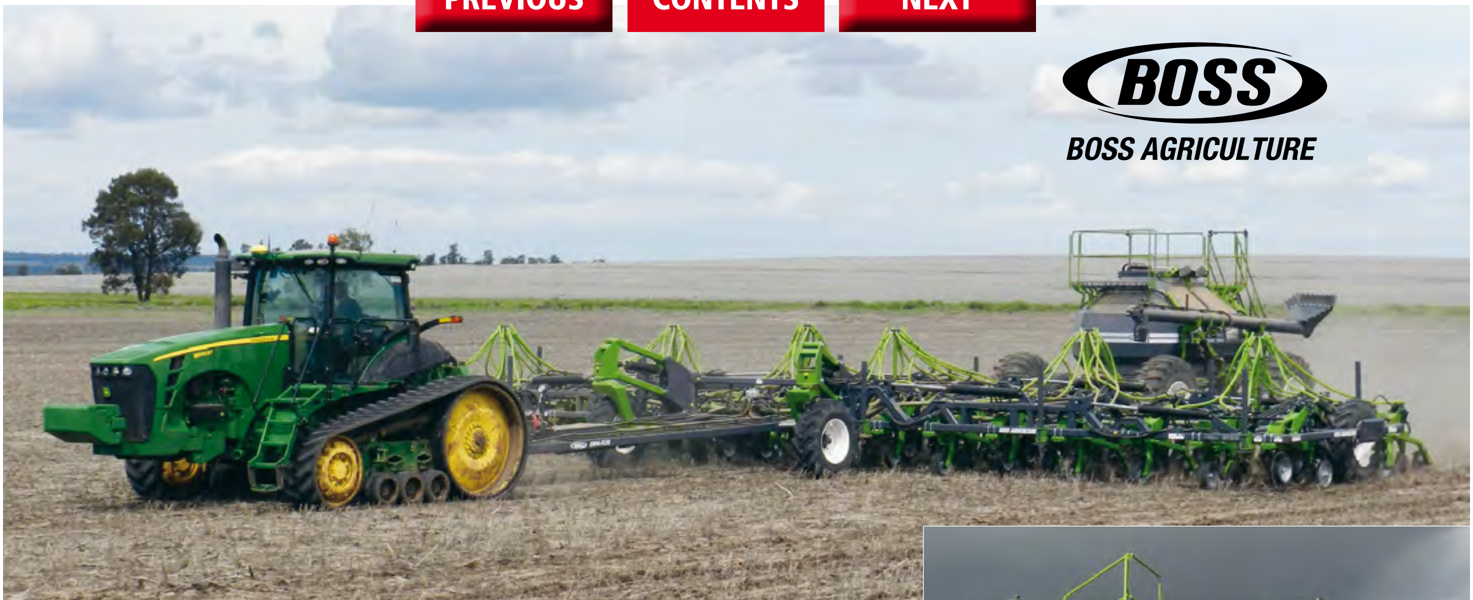
ABARES 2018, Agricultural commodities: March quarter 2018. CC BY 4.0. (For details of the licensing under a Creative Commons Attribution, please see the inside cover of an issue of Agricultural commodities.)

World wheat closing stocks, 2000–01 to 2022–23



a Argentina, Australia, Canada, the European Union, Kazakhstan, the Russian Federation, Ukraine and the United States. b Disappearance defined as domestic consumption plus exports. s ABARES estimate. z ABARES projection.

Within five years, China is expected to hold half the world's wheat stocks.



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Domestic and global coarse grains outlook

By Amelia Brown, ABARES

AT A GLANCE…

- World coarse grain indicator prices are forecast to increase in 2018–19. This trend will continue to 2020–21, reflecting a tightening of world grain stocks.
- Industrial use of corn to increase as China strives to meet policy goals for greater use of biofuels.
- Australian coarse grain production and exports forecast to increase in 2018–19 and continue to do so over the medium term to meet growing global demand.

Outlook for Australian coarse grains to 2022–23

Area planted to coarse grains in 2018–19 is forecast to increase by 6 per cent to 5.6 million hectares. Area planted to barley and oats is expected to increase as the price of these crops rises from low levels, increasing their profitability relative to pulse crops. Rotational constraints are also likely to encourage planting of cereal crops after consecutive years of high pulse plantings. Increased demand for livestock feed and historically low global stocks are expected to continue to support barley prices.

Assuming average seasonal conditions, area planted to grain sorghum is forecast to increase by 23 per cent to around 618,000 hectares in 2018–19. This follows two consecutive years of below average plantings due to the greater profitability of cotton and low soil moisture at planting. Continued demand for ethanol production and livestock feed combined with low supply are expected to make grain sorghum production a profitable summer cropping option.

Area planted to coarse grains is projected to increase slowly, reaching around 5.7 million hectares by 2022–23. From 2019–20, area planted to barley is expected to remain relatively flat as the profitability of pulse, oilseed and livestock production limits planting. Assuming yields continue to increase modestly through productivity gains, total barley production is projected to reach 9.5 million tonnes (mt) by 2022–23.

Over the medium term grain sorghum area planted and yields are projected to increase, resulting in production reaching just over 2.0 mt in 2022–23. Demand for feed grain from the domestic livestock sector is forecast to increase as is the number of grain-fed cattle in feedlots close to grain-producing regions in northern New South Wales and southern Queensland. The Dalby Bio-Refinery in southern Queensland will provide steady demand for grain sorghum.

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Exports to increase

Australian coarse grain exports are forecast to be around 14 per cent higher in 2018–19, mainly reflecting a forecast increase in barley supply – which makes up the vast majority of coarse grain exports. Assuming continued growth in global demand, Australia is forecast to continue to be one of the biggest global exporters of barley. Grain sorghum exports are forecast to rise in 2018–19, assuming increased production. This follows two consecutive years of below average production due to adverse seasonal conditions.

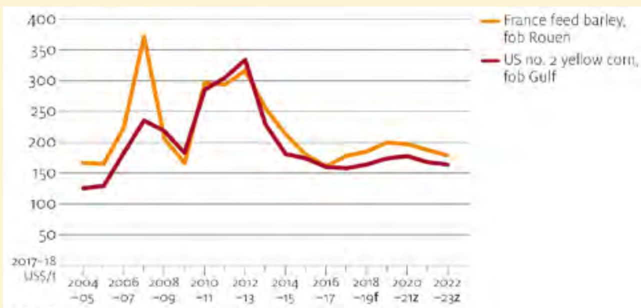
By 2022–23 Australian coarse grain exports are projected to increase to around 9.1 mt to meet growing world demand for feed grain. Demand for malting barley is projected to continue growing over the medium term to meet increasing demand for beer, particularly in Asia. Demand for grain sorghum for distilling baijiu (a Chinese alcoholic beverage made from grain sorghum) is expected to remain strong.

Feed and industrial demand to increase prices

The 2018–19 world coarse grain indicator price (US no. 2 yellow corn, fob Gulf) is forecast to be US$167 per tonne. This is historically low but 6 per cent higher than the forecast for 2017–18. In 2018–19 the world indicator price for barley (France feed barley, fob Rouen) is also forecast to average 6 per cent higher at US$190 per tonne.

This increase in prices reflects a fall from the very high world coarse grain supplies of 2016–17 and strong demand for coarse grains for feed and industrial use.

World coarse grains indicator prices, 2004–05 to 2022–23



f ABARES forecast. z ABARES projection.

Consecutive years of increasing global production were the result of favourable growing conditions in most major producing countries. Record corn yields in 2016–17 and 2017–18 in Brazil, China, Ukraine and the US resulted in record world stocks and low prices.

In September 2017 China announced plans to set a nationwide ethanol blending mandate for the inclusion of E10 (10 per cent fuel ethanol and 90 per cent gasoline) in motor fuels by 2020 (see box China's grain policies – an update). If this ambitious target is reached, an estimated additional 40 mt of corn per year (around 19 per cent of current global corn stocks) would be required to produce an additional 12 mt of ethanol. This would have a significant impact on world coarse grain supplies.

China is currently the third-largest producer of ethanol after the US

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Table 1: Outlook for coarse grains

	unit	2015–16	2016–17s	2017–18f	2018–19f
World					
Area	million ha	324	326	324	328
Yield	t/ha	3.9	4.2	4.1	4.0
Production	Mt	1,260	1,366	1,324	1,317
corn	Mt	973	1,076	1,045	1,026
barley	Mt	150	146	142	148
Consumption	Mt	1,273	1,328	1,347	1,364
corn	Mt	988	1,035	1,061	1,074
barley	Mt	146	149	146	148
Closing stocks	Mt	252	262	234	187
Trade	Mt	163	202	189	188
Stocks-to-use ratio	%	19.8	19.7	17.4	13.7
Corn price[a] – nominal	US$/t	168	157	158	167
Barley price[c] – nominal	US$/t	173	158	180	190
Australia					
Area total	'000 ha	5,581	5,507	5,254	5,583
Production total	kt	12,610	17,073	12,008	12,863
Export volume	kt	6,845	10,708	6,960	7,900
Export value – nominal	A$m	2,280	2,797	1,963	2,287
Price – nominal					
feed barley[e]	A$/t	237	174	236	238
malting barley[g]	A$/t	274	188	250	257
grain sorghum[h]	A$/t	275	239	298	306

a US no. 2 yellow corn, fob Gulf, July–June. **c** France feed barley, fob Rouen, July–June. **e** Feed 1, delivered Geelong. **f** ABARES forecast. **g** Gairdner Malt 1, delivered Geelong. **h** Gross unit value of production. **s** ABARES. forecast. **z** ABARES projection.
Sources: ABARES; Australian Bureau of Statistics; FranceAghriMer United Nations Commodity Trade Statistics Database (UN Comtrade); US Department of Agriculture.

and Brazil. If China's increased demand for ethanol cannot be met by domestic production, import demand will increase. In addition, it is unclear where these additional imports will be sourced because the US ethanol industry is close to capacity and Brazil, despite being a major producer, is currently a net importer of ethanol. The capacity for the US ethanol industry to expand to meet increased demand from China is expected to be limited over the projection period as a result of US biofuel policies and consumption mandates. But if China relaxes import restrictions, the US industry may respond by increasing production capacity and exports, which would increase demand for corn.

Increasing demand for livestock products is expected to drive demand for coarse grains for livestock feed in developing countries. Demand for grain for human consumption is also expected to increase over the medium term in line with population growth and rising incomes in developing countries, particularly in Africa, Latin America and Asia.

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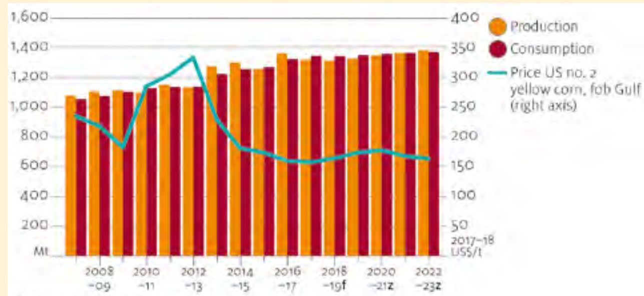
World coarse grain prices are forecast to increase in 2018–19 and continue to increase until 2020–21 (while remaining at historically low levels) as growth in supply is not expected to meet growing demand. Prices are expected to stabilise and then fall towards the end of the medium term as supply responds to higher prices.

World coarse grain stocks are projected to fall from very high levels in the short term – providing some support for prices – but to start to recover towards the end of the outlook period to 2022–23.

Production

In 2018–19 world production of coarse grains is forecast to fall marginally to 1.3 billion tonnes from the record highs reached in 2016–17 and 2017–18. Despite a 1 per cent increase in the area planted, yields are expected to return to trend after consecutive years of being above average. Over the remainder of the outlook period, growth is projected to resume and production to reach around 1.4 billion tonnes.

World coarse grain use, 2007–08 to 2022–23



f ABARES forecast. z ABARES projection.

Corn

World corn production is forecast to fall by 2 per cent in 2018–19 to just over 1 billion tonnes. Area planted to corn is expected to remain largely unchanged, but average yields are expected to be lower than the historically high yields achieved in the previous two seasons, particularly in Brazil, the US and Ukraine. In 2018–19 US corn production is forecast to fall by 4 per cent to 357 mt. This fall reflects an assumption that yields will be closer to the long-term average after successive records in 2016–17 and 2017–18.

In Argentina, area planted to corn in 2018–19 is forecast to increase by 2 per cent to 5.3 million hectares. This reflects a continuation of the Argentine Government's policies to support corn production, including the removal of export restrictions and taxes on corn. Yields in Argentina are assumed to be around the five-year average, resulting in a 9 per cent increase in production to around 43 mt.

Corn production in Brazil is forecast to fall by 4 per cent in 2018–19 to around 91 mt. Yields lower than the previous season are expected to be partly offset by a 2 per cent increase in area planted. Brazilian corn production continues to trend upwards due to a significant production increase from its safrinha (second-season) crop. Second-season crop yields have been trending upwards but are more susceptible to production risks because the crops are planted after soybeans are harvested. If planting is delayed, the risk of reduced growing-season rainfall increases.

Safrinha planted area is expected to continue to increase over the projection period.

In 2018–19 production of corn in China is forecast to fall for the third consecutive year to around 212 mt, assuming yields will fall to around the five-year average. The area planted to corn is expected to be similar to the previous year, when it fell in response to the Chinese Government's March 2016 removal of the corn price support scheme.

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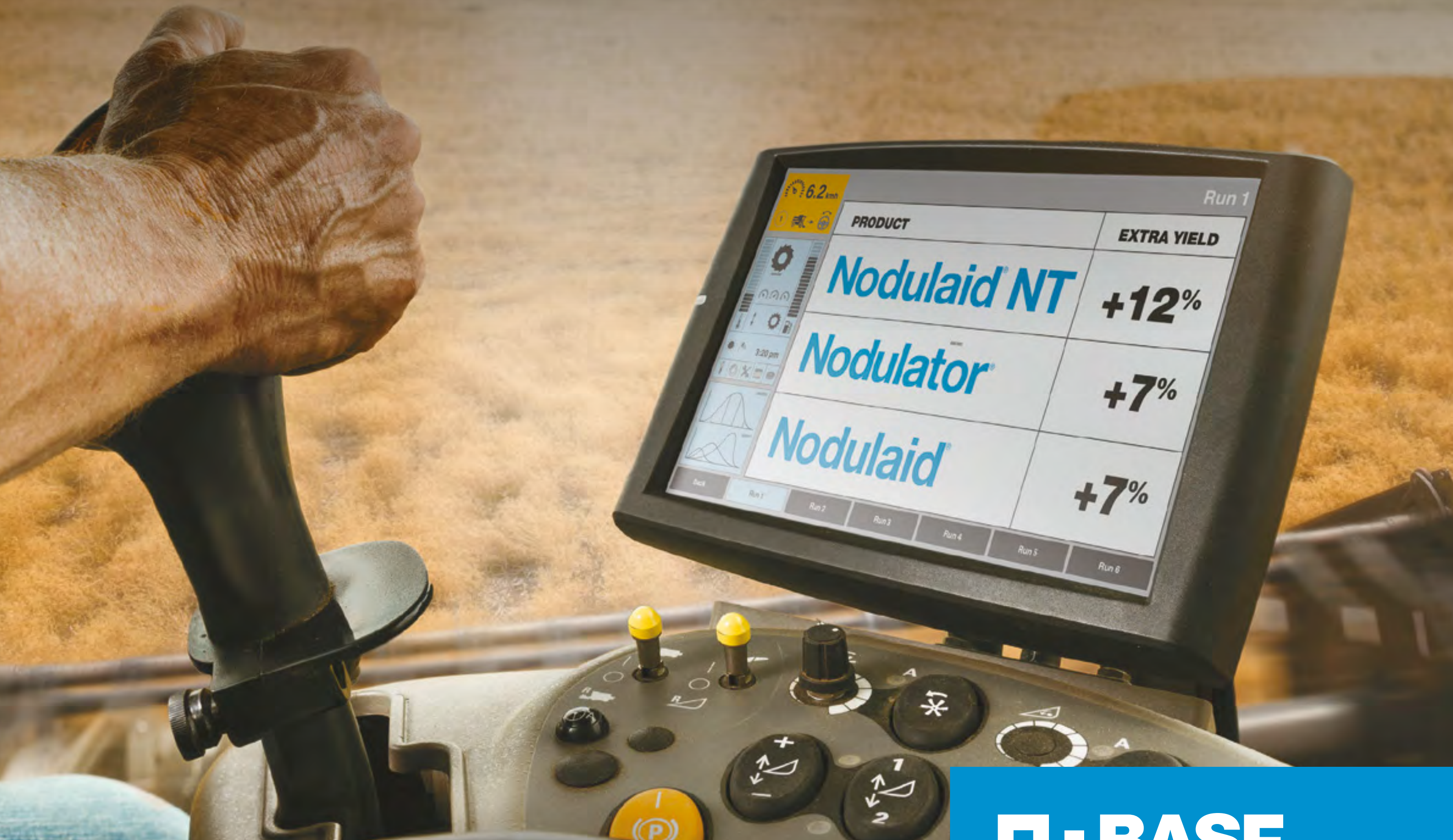

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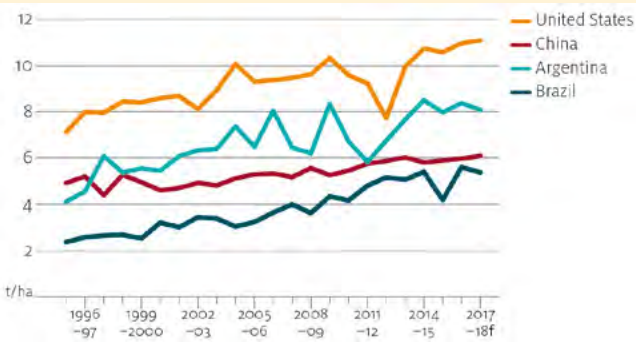
From 2019–20 onwards, world corn production is projected to increase – reaching around 1.1 billion tonnes in 2022–23. Production increases are expected to come mainly from yield improvements. This is because limited land is available to expand crop production in developed countries. In developing and emerging countries where area expansion is possible, competition with soybeans is likely to limit the expansion of corn.

Average corn yields, 1995–96 to 2017–18



f ABARES forecast.

Barley

In 2018–19 world barley production is forecast to increase by 4 per cent to around 148 mt. This will be driven by producers responding to higher prices by increasing the area planted by an estimated 3 per cent. This would be the highest production since 2015–16 and around 4 per cent above the five-year average. The area planted to barley is forecast to increase in all major producing countries.

EU production is forecast to increase by 5 per cent in 2018–19 to just over 61 mt, following two consecutive years of falling production. Area planted to barley is forecast to increase marginally from 2017–18 in response to higher prices. Yields are assumed to return to average (with assumed average seasonal conditions) after a below average season the previous year.

Despite a 4 per cent assumed increase in the area planted to barley in the Russian Federation in 2018–19, production is forecast to fall by 9 per cent to around 18 mt, reflecting lower average yields than the record achieved in 2017–18.

World barley production over the medium term is projected to rise as the area planted to barley increases moderately and average yields continue to trend upwards. After increasing in 2018–19, the area planted to barley in Australia, Canada and the European Union is expected to remain fairly flat, reflecting limited arable land. Area planted in Argentina and the Black Sea region is expected to increase moderately over the medium term, reflecting supportive government policies and an improved outlook for prices.

Consumption

In 2018–19 world coarse grain consumption is forecast to increase to just under 1.4 billion tonnes and continue to grow over the medium term. This mainly reflects increasing demand for feed grains from livestock production industries and continued increases in industrial

World corn consumption will continue to rise on the back of increased livestock production.

demand, particularly for corn-based ethanol. Industrial use of barley is also expected to grow but at a slower rate than industrial-use corn, as demand for malting barley for beer production continues to grow.

Corn

Despite lower world production, consumption of corn in 2018–19 is forecast to increase by 1 per cent to just under 1.1 billion tonnes, reflecting ongoing increases in both feed and industrial demand.

In 2018–19 US corn consumption is forecast to reach a record high of around 320 mt. This is due to low prices and strong demand for both feed use and industrial use. Growth in US corn consumption over the medium term is expected to be driven primarily by feed demand to increase the production of beef, pork and broiler meat. After growing rapidly over the past 10 years, demand for corn for ethanol production is expected to decrease from 2018–19. According to the USDA, falling domestic demand reflects a declining trend in US gasoline consumption due to factors including the adoption of more fuel-efficient vehicles. As ethanol production drops, production of distillers dried grains with solubles (DDGS), a co-product used as animal feed, will also drop, possibly resulting in increased demand for feed corn.

Corn consumption in China is forecast to increase to a record 229 mt in 2018–19 due to increased feed and industrial use. The proposed ethanol blending mandate is expected to boost industrial use. Consumption of an additional 40 mt of corn per year for ethanol production would rapidly deplete China's stocks. A domestic supply response to increasing prices can be reasonably expected, but China may supplement domestic production through imports of corn or ethanol. The result is likely to be lower world corn stocks and higher prices in the second half of the projection period.

Increased ethanol production in China would result in a rise in the co-production of DDGS, used as livestock feed.

World consumption of corn is projected to increase to over 1.1 billion tonnes by 2022–23. This will be driven by growth in world livestock production as a result of growing world population, evolving diets, higher incomes – especially in developing countries – and demand for corn-based ethanol.

Barley

In 2018–19 world barley consumption is forecast to increase slightly as production increases to meet strong demand for feed barley in China. Demand for malting barley is forecast to remain strong as beer consumption continues to increase, particularly in Asia.

Consumption of barley is projected to reach 157 mt in 2022–23. Feed demand is expected to continue to increase, as a result of population growth and rising incomes in developing countries increasing demand for meat and providing price incentives to intensify livestock production. Increasing incomes will also lead to strong growth in world beer demand over the medium term, particularly in Asia, resulting in increased demand for malting barley.

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Trade

In 2018–19 world trade in coarse grains is forecast to increase to 188 mt. In countries such as Mexico and South-East Asia, livestock production continues to expand and increased import demand for feed corn and barley is expected. Exports of malting barley to Asia are also expected to increase from major producing countries like Australia, Canada and the European Union.

World trade in corn is projected to increase to 155 mt by 2022–23. This primarily reflects increased demand for livestock feed. China is likely to import corn or ethanol, depending on the strategy used to meet its fuel ethanol mandate. An increase in China's ethanol imports will likely result in the US diverting corn from feed export markets.

World trade in barley is projected to grow to 32 mt in 2022–23. This reflects expected growth in world demand for feed and malting barley.

Stocks

In 2018–19 world coarse grain closing stocks are forecast to fall by 20 per cent to 187 mt with reductions in corn stocks outweighing increases in barley stocks as continued growth in world coarse grain consumption outpaces production.

World closing stocks of corn are forecast to fall in 2018–19 by 23 per cent to 155 mt. This fall mainly reflects a drawdown of stocks in China, the European Union and the US as consumption continues to increase and production falls. In 2018–19 world closing stocks of barley are forecast to increase by 3 per cent to 19 mt, the second-lowest level of stocks since 1983–84.

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CHINA'S GRAIN POLICIES – AN UPDATE

By James Fell

ABARES published an overview of China's grain policies in *Agricultural commodities: June quarter 2017*. This box provides an update on significant changes since June 2017.

Between mid 2017 and January 2018 the Chinese Government announced several changes to its grain policies. China is a major producer, consumer and importer of coarse grains. Changes to its grain policies can therefore influence demand and supply on international grain markets and affect international prices.

Revision of wheat minimum purchase price

In late October 2017 China cut the commonly-quoted minimum purchase price for third-class wheat from 2,360 yuan per tonne to 2,300 yuan per tonne. The announcement came near the close of the winter wheat planting window, and is unlikely to result in reduced March to April spring wheat crop plantings.

The relatively higher producer price of wheat continues to make it a significantly more attractive production option than alternatives such as barley, corn and soybeans. The relatively small reduction in the wheat minimum purchase price is not expected to affect China's domestic wheat production or import demand for Australian wheat.

Ethanol blend mandate

In September 2017 the Chinese Government announced a program to increase production and consumption of ethanol as a biofuel. The government indicated that the program is aimed at resolving the problem of high government stocks of corn, consistent with the 2017 No. 1 Central Document policy goal of reducing corn stocks.

The announcement followed the abandonment of the corn minimum purchase price and the introduction of a market system for corn producers in 2016 after significant growth in corn stocks over several years. These stocks had imposed a growing financial burden on the government because of the estimated high proportion of publicly-held stocks in the total. The US Department of Agriculture estimates that total corn stocks nearly doubled between 2011–12 and 2015–16 to 111 mt.

State media reported that the ethanol program would introduce a 10 per cent ethanol and 90 per cent petrol blend in motor fuel across the country. Once in place, it is estimated the program will result in consumption of around 12 mt of ethanol, a calculation based on 2016 Chinese petrol consumption levels. This volume of ethanol would require around 40 mt of corn per year, depending on ethanol yields. As a result, China's stocks of corn are projected to fall significantly over the medium term.

In the September announcement, the Chinese Government also announced that it would promote ethanol production to ensure that increased demand for ethanol is filled solely by domestic production. To achieve this, China increased its most favoured nation (MFN) tariff for denatured ethanol from 5 per cent to 30 per cent on January 1 2017 – effectively raising the cost of imported ethanol for fuel vendors. The MFN tariff for undenatured ethanol remains unchanged at 40 per cent.

The by-product of producing ethanol from corn is dried distillers grains with solubles (DDGS), which is used as livestock feed. The production of 12 mt of ethanol would result in additional supplies of around 12 mt of DDGS, which is likely to compete with the 191 mt of grain used as feed in China.

The increased supplies of DDGS are expected to compete with Australia's exports of feed grains (mostly barley and grain sorghum). As a result, the ethanol blend mandate is likely to put downward pressure on demand for imported feed grains from Australia.

Value-added tax exemption for dried distillers grains with solubles

In mid November 2017, China announced that imports of corn DDGS would be exempt from the 11 per cent value-added tax (VAT), effective from 20 December 2017. The VAT exemption improves the price-competitiveness of DDGS relative to feed grains such as corn, barley and grain sorghum, and may put downward pressure on demand for imported Australian feed grains.

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Oilseeds outlook to 2022–23

By Nathan Pitts, ABARES

AT A GLANCE…

- Canola prices are forecast to fall in 2018–19 due to an increase in global oilseed supplies partly driven by increased Australian production.
- Oilseed prices are projected to continue falling in real terms over the medium term as a result of growth in supply from South America.
- Australian canola production to grow over the medium term.

Outlook for Australian oilseeds to 2022–23

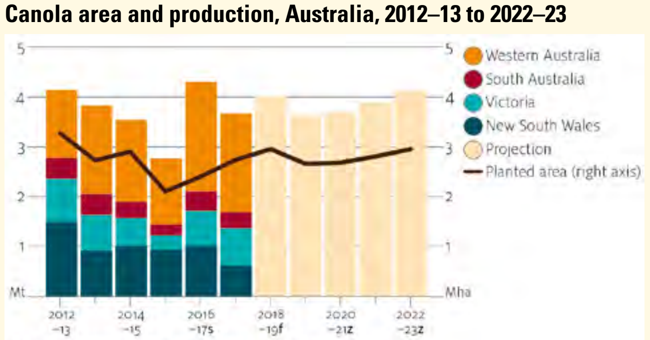
In 2018–19 area planted to canola is forecast to increase by 8 per cent to 3.0 million hectares. This will be driven by low grain and falling pulse prices providing economic incentives to increase canola production. But area planted to canola will depend on climatic conditions in autumn, and timely and sufficient rainfall will be needed to support plantings. Assuming an average yield of 1.4 tonnes per hectare, production is forecast to increase by 9 per cent to 4.0 million tonnes (mt).

Area planted to canola is projected to fall in 2019–20 due to grain prices recovering and farmers shifting back to grain production to balance rotational constraints. But between 2020–21 and 2022–23 area planted is expected to increase again if strong EU demand for GM-free canola provides incentives for increased Australian plantings. Assuming modest yield improvements are consistent with historical trends, production is projected to reach 4.1 mt in 2022–23.

In 2017–18, 23 per cent of Australia's canola production is forecast to be consumed domestically and imports are expected to be insignificant. Australian consumption of canola is expected to increase marginally over the medium term. Domestic crush is expected to remain constrained by the high cost of crushing canola compared with importing low-cost soybean meal. This is despite strong feed demand for oilseed meal from livestock industries.

In 2018–19 the value of canola exports is forecast to increase by 22 per cent to $1.7 billion and higher export volumes will more than offset lower prices. The value of Australian canola exports is projected to reach $1.8 billion in 2022–23 (in 2017–18 dollars). Low prices throughout the projection period mean that the value of exports will grow at a slower rate than the quantity of exports.

Canola area and production, Australia, 2012–13 to 2022–23



f ABARES forecast. s ABARES estimate. z ABARES projection.

Table 1: Outlook for oilseeds

	unit	2015–16	2016–17s	2016–17f	2018–19f
World					
Oilseeds					
Production	Mt	520	564	574	585
Consumption	Mt	526	551	573	580
Exports	Mt	153	167	176	181
Closing stocks	Mt	88.6	102	102	107
Indicator price[ba]	US$/t	373	384	370	360
Canola indicator price[bc]	US$/t	415	425	425	410
Protein meals					
Production	Mt	306	319	333	337
Consumption	Mt	305	321	330	338
Exports	Mt	87.3	89.5	96.5	98.5
Closing stocks	Mt	16.7	15.1	18.5	17.5
Indicator price[bd]	US$/t	345	348	325	316
Vegetable oils					
Production	Mt	176	184	194	197
Consumption	Mt	178	184	191	199
Exports	Mt	74.8	75.6	79.5	83.8
Closing stocks	Mt	18.7	18.0	21.2	19.5
Indicator price **be**	US$/t	742	837	850	836
Australia					
Oilseed production	kt	3,750	5,684	5,200	5,297
Oilseed exports	kt	2,102	3,925	2,795	3,624
Canola					
Area	'000 ha	2,091	2,388	2,729	2,950
Production	kt	2,775	4,309	3,669	4,012
Export volume[g]	kt	1,946	3,599	2,530	3,123
– nominal	A$m	1,097	2,128	1,388	1,697
Price[bi]	A$/t	542	530	513	508

a US no.2 soybeans, fob Gulf. **b** In 2017–18 US dollars. **c** Rapeseed, Europe, fob Hamburg, July–June. **d** Soybean meal, cost insurance and freight, Rotterdam, 45 per cent protein. **e** Soybean oil, Dutch, free on board ex-mill. **f** ABARES forecast. **g** July–June. **h** In 2017–18 Australian dollars. **i** Delivered Melbourne, July–June. **s** ABARES estimate. **z** ABARES projection.
Sources: ABARES; Australian Bureau of Statistics; US Department of Agriculture

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Prices to fall over the medium term

In 2018–19 the world canola indicator price (Europe rapeseed, fob Hamburg) is forecast to fall by 4 per cent to average US$410 per tonne. This is due to increased global supply, including from Australia (assuming average seasonal conditions). The world oilseed indicator price (US no. 2 soybeans, fob Gulf) is forecast to decrease by 3 per cent in 2018–19 to average US$360 per tonne. High opening stocks and forecast high production in 2018–19 are expected to lead to ample exportable supplies of soybeans and reduced prices.

In real terms, from 2018–19 to 2020–21 both indicator prices are forecast to fall before increasing slightly between 2021–22 and 2022–23. South American soybean production is projected to keep supplies near historical highs, exerting downward pressure on prices until 2020–21. Prices are projected to rise slightly in 2021–22 and 2022–23 in response to growth in demand exceeding growth in supply.

The canola indicator price is projected to increase by more than the soybean indicator price because low rapeseed and canola stocks are expected to dissipate more rapidly. Agronomic constraints and low stocks expose world canola supplies to significant fluctuations in the event of a disease or negative climatic conditions. This represents an upside risk to prices over the outlook period.

Oilseed indicator prices, 2007–08 to 2022–23

f ABARES forecast. z ABARES projection.

Production to grow

World oilseed production is forecast to rise by 2 per cent to 585 mt in 2018–19 as a result of favourable expected returns leading to an increase in area planted to oilseeds. Global production of rapeseed and canola is forecast to increase by 4 per cent to 77 mt. Canadian canola production is forecast to increase slightly in 2018–19 to 22 mt as a result of harvested area for canola increasing to around 9.7 million hectares.

Over the five years to 2022–23 world oilseed production is forecast to grow by 6 per cent to 621 mt, mostly due to an expansion in area harvested in Argentina and Brazil. Soybean area harvested in Brazil is projected to increase by 9 per cent and in Argentina by 7 per cent. A continuing reduction in soybean export taxes in Argentina will increase the profitability of producing soybeans relative to corn or wheat and is expected to result in increased soybean plantings early in the projection period. World harvested area is expected to stabilise late in the period

Improving world oilseed prices will see an increase in the area planted.

when farmers begin shifting back to corn and wheat in response to falling soybean prices.

Soybean harvested area, Argentina, Brazil and rest of world. 2008–09 to 2022–23

f ABARES forecast. z ABARES projection.

World rapeseed and canola production is projected to increase slowly to 78 mt over the medium term. Production in Canada is projected to fall by 4 per cent when higher milling wheat prices increase grain production at the expense of canola.

From 2021 demand for canola in the European Union is expected to increase, assuming EU ratification of RED II – an updated legislative framework for renewable energy. European lawmakers (European Parliament and European Council) have announced their respective negotiating positions for this framework.

The parliament proposes restricting biodiesel produced using palm oil from being counted towards renewable transport fuel targets. It also proposes limiting the contribution of first-generation biofuels, such as those made from rapeseed (including canola) oil and palm oil, to 2017 levels or 7 per cent of transport fuel, whichever is lower. The council has not proposed any restrictions on the use of palm oil, but it has proposed maintaining the current 7 per cent cap on first-generation biofuels.

Negotiations between parliament and the council will determine the EU's final position. EU first-generation biodiesel production is assumed to increase slightly over the projection period while negotiations are underway. This outlook assumes that from 2021 proposed restrictions on the use of palm oil will be enacted.

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Consumption to grow

In 2018–19 global oilseed consumption is forecast to increase to 580 mt, driven by low prices that encourage consumers to switch from higher-priced alternative sources of feed and oil. Rapeseed and canola consumption is forecast to increase by 4 per cent to 74 mt in response to higher supplies and relatively low prices.

World oilseed consumption (mainly crush) is projected to grow over the medium term by 8 per cent to 627 mt in 2022–23. Oilseed crush is expected to grow to meet strong demand for oilseed meal for use as livestock feed and vegetable oil for human consumption.

Over the medium term, global oilseed meal consumption is projected to grow by 8 per cent to 364 mt, driven by expected growth in livestock production increasing demand for feed. Chinese soymeal consumption will remain the primary driver of world demand for oilseed meal despite slower economic growth. Chinese soymeal consumption growth is projected to ease to an annual average of 3 per cent over the projection period to reach 85 mt. This projected growth is lower than the annual average of 6 per cent growth over the four years to 2017–18.

Vegetable oil consumption is forecast to grow over the medium term by 9 per cent to reach 217 mt in 2022–23. Increasing food demand is expected to be driven by rising incomes in developing nations and moderate global population growth. Over these four years the use of vegetable oil in food production is projected to grow by 12 per cent to 168 mt and industrial use of vegetable oils is projected to increase by 3 per cent to 48 mt. This reflects a shift towards advanced biofuels in the European Union and the United States and constrained growth in the industrial use of vegetable oils.

Exports to rise over the medium term

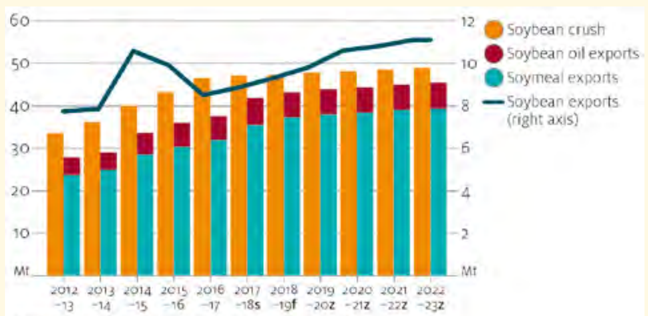
In 2018–19 world oilseed exports are forecast to increase by 3 per cent to around 181 mt. This is a result of abundant supplies being traded at low prices to meet high levels of consumption. World exports of rapeseed and canola are expected to increase by 4 per cent to 18 mt, mainly reflecting increased export of Australian production to Europe.

Global oilseed exports are projected to grow by 8 per cent over the medium term, mainly as a result of increased South American soybean production. By 2022–2023 Brazilian exports are projected to increase by 13 per cent to 74 mt.

Reductions in taxes on exports of soybeans and soybean products from Argentina are expected to increase exports. In January 2018 the Argentine Government began reducing soybean export taxes by 0.5 percentage points each month for a planned 24 months, starting at 30 per cent for soybeans and 27 per cent for soymeal and soybean oil. An upside risk to production and exports of Argentine soybeans is the possibility that export taxes will be removed entirely rather than reduced gradually.

World rapeseed and canola exports are projected to fall by 8 per cent over the outlook period due to decreased exports from Canada. Assuming that biodiesel produced from palm oil is excluded from counting towards EU renewable energy targets as voted on by the European Parliament, the European Union may significantly increase its industrial use of rapeseed and canola oil over the medium term. Demand is expected to be partially met through increased imports from Australia and Ukraine.

Argentine soybean crush and exports, 2012–13 to 2022–23



f ABARES forecast. s ABARES estimate. z ABARES projection.

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Stocks to fall from record highs

In 2018–19 world oilseed closing stocks are forecast to increase by 4 per cent to 107 mt from the estimated record high of 102 mt in 2017–18. This is the third consecutive year where oilseed stocks are expected to set a new record.

Record high global oilseed stocks are projected to continue in the period to 2020–21 due largely to growth in South American production. But stocks are forecast to fall from 2021–22 until the end of the projection period when production stabilises and consumption increases.

ABARES 2018, Agricultural commodities: March quarter 2018. CC BY 4.0. (For details of the licensing under a Creative Commons Attribution, please see the inside cover of an issue of Agricultural commodities.) ■

The changing landscape of global farm trade

By Jayson Beckman, John Dyck and Kari Heerman, Economic Research Service – USDA

AT A GLANCE…

- Annual global agricultural trade is now around US$1 trillion and has been rising about 3.6 per cent per year for the past two decades.
- The largest importers and exporters of agricultural products are largely unchanged over the last 20 years but Brazil, Russia, India, Indonesia and China account for much of the increase in trade.
- The landscape of policies affecting trade is increasingly complex, and agricultural trade is facing obstacles that may restrict future growth.
- Despite trade rules (eg. WTO), countries impose trade barriers.
- Rising domestic support in some countries could undermine a level playing field for agricultural trade.
- Sanitary and phytosanitary barriers and other technical barriers to trade are growing.

For the past 20 years, annual global farm trade has increased by an average of 3.6 per cent.

The Uruguay Round Agreement on Agriculture (URAA) of 1994 imposed new disciplines on market access barriers, domestic support, and export subsidies, and set up rules for nontariff measures as well. In the two decades since the URAA, government interventions in agricultural trade have evolved, agricultural trade has expanded, and BRIIC countries (Brazil, Russia, India, Indonesia, and China) and other emerging economies have become significant agricultural traders.

Although clear progress has been made in many areas – such as tariff reductions and elimination of export subsidies – there is room for further disciplines on tariffs, nontariff measures and domestic policy.

How has global farm trade changed?

Since 1995 global agricultural trade volume increased steadily and quickly, averaging over 3.5 per cent per year. Growth occurred across all major categories, with trade in oilseeds/oilseed products growing fastest. But this growth in trade across countries and regions was uneven.

Agricultural exports by the five BRIIC countries grew much faster than the global average.

Agricultural imports of emerging economies grew quickly, dominated by growth in China's imports – while Europe's agricultural imports grew much more slowly.

Across the largest economies and trading countries, applied agricultural import tariffs averaged 15–22 per cent and bound tariffs (that is, the maximum tariff rates established in the World Trade Organization) was 46 per cent.

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A country's tariffs tend to be higher for imports that compete with domestic products, and additional duties can be applied for limited periods and in certain circumstances. Tariffs at these levels can significantly restrict agricultural trade.

Regional and bilateral trade agreements give preferential tariff treatment to certain agricultural products traded among the members of these agreements. Trade volumes can be limited by government administration of tariff-rate quotas (TRQs), government licensing of the right to import, and special privileges given to state-trading enterprises active in agricultural markets.

While export subsidies are scheduled to be eliminated in a series of steps beginning in 2017, export restrictions – such as taxes and licensing – have proliferated.

Domestic farm support has evolved since the URAA due to income growth, commodity price changes, political factors and WTO commitments. Some developed economies initially moved to a system of direct, decoupled payments, more recently emphasising countercyclical support for producers, which is more substantive when yields or returns are low.

The amount of agricultural support has remained about the same (or fallen) since the URAA for developed countries. But major emerging economies have increased the support they provide to farmers, sometimes using methods like price support or input subsidies that are more likely to distort trade.

In some of these countries, the recent emphasis on support for agriculture is a sharp departure from earlier policies that implicitly taxed agriculture.

Changing trade patterns have exposed other domestic policies that act as barriers to agricultural trade.

Although often essential to protecting the health and safety of consumers and the value of the agricultural sector, nontariff measures like sanitary/phytosanitary standards have been used to protect favoured producers from competition.

The number and stringency of regulations and standards affecting agricultural trade have increased dramatically since the Uruguay Round.

Whether they are mandatory government policies or requirements of private firms, these sanitary measures often dictate market access more than tariffs and other traditional trade policies.

For more information see the full report: *The Global Landscape of Agricultural Trade, 1995-2014*, EIB-181, US Department of Agriculture, Economic Research Service, November 2017 – Jayson Beckman, John Dyck and Kari E.R. Heerman. ■

Competing for hectares: 2018–19 global wheat production tipped to fall

By Stephanie Bryant-Erdmann, US Wheat Associates

At first glance, the USDA's 2018 April edition of the *World Agricultural Supply and Demand Estimates* (WASDE) held very few surprises for wheat. Most reviewers would have considered it a bearish report with another increase in predicted global and US wheat ending stocks. But a somewhat unnoticed factor was increased global wheat feed use, now forecast at 146 million tonnes (mt) – 7 per cent above the five-year average.

This was due largely to shrinking supplies of traditional feed grains. With an average 19 per cent of global wheat production being used as feed each year, the current feed grain supply and demand situation has implications for wheat.

Pressure on corn

A deeper look at the feed grain situation shows the most striking decrease was in global corn production, which fell 4 per cent year over year to 1.04 billion mt due to sharply lower production in drought-stricken Argentina and lower second-crop corn production in Brazil.

At the same time, 2017–18 corn feed demand grew 18 mt. These facts set up a total stocks-to-use ratio of 19 per cent.

But it is important to note that China holds 40 per cent of the world's corn stocks, which will not leave the country. Removing China from the equation brings the stocks-to-use ratio down to 14 per cent.

The constrained corn supply caused the USDA to reduce global corn feed demand by 4 mt from the March 2018 estimate of 654 mt. In addition to reduced corn feed use in Argentina, USDA noted decreased corn feed demand in the European Union with a corresponding increase in wheat feed demand. EU 2017–18 wheat feed use is expected to reach 58.5 mt. If realised, this is 9 per cent above the five-year average.

Global feed grain supplies are tightening.

While corn had the most precipitous drop in supply and increase in demand, global production of barley, millet, oats and sorghum also fell in 2017–18, while rye remained stable year over year.

Including corn, global feed grain production fell 4 per cent – or 49.9 mt – in 2017–18. At the same time, global feed grain consumption increased 15.1 mt.

Lower feed grain stocks to also help wheat prices

The increased consumption and decreased supply of traditional feed grains will cut 2017–18 ending stocks for those grains by 38.8 mt.

With the global feed grain supply tightening, prices for those commodities continue to rise. Since the beginning of 2018, world feed barley prices have increased an average US$19 per tonne, global sorghum prices are up US$15 per tonne and the average world corn price has increased US$26 per tonne.

Supported by increased feed wheat demand, global wheat prices also increased an average of US$9 per tonne.

With feed grain prices increasing, farmers around the world have taken notice and are expected to plant more corn, barley and sorghum in 2018–19 – at the expense of wheat.

The International Grains Council expects 2018–19 global wheat harvested area to fall to a six-year low to 218 million hectares, down 1 per cent from 2017–18 levels.

The IGC also expects generally favourable northern hemisphere weather to increase global yields and partially offset the reduced planted area. Still, IGC currently forecasts 2018–19 global wheat production to fall 17 mt to 741 mt.

Weather news dominates the grain futures markets during April-May each year, but growers should be mindful of the current global feed grain situation which is slowly but surely siphoning some of the world's excess wheat stocks. ■

BIG TYRE

Tyres, Wheels & Rubber Tracks

AUSTRALIAN MANUFACTURER LEADS THE WAY

At a time when the Australian manufacturing industry appears to be falling apart with the closure of Australia's iconic Ford and Holden production facilities, family owned and operated company, Big Tyre, is stepping up its game. In operation for over 60 years, Big Tyre has weathered many storms and learned many lessons to become Australia's leading specialist in tyres, wheels and rubber tracks.

Since its beginning in 1954, when it was known as Vacu-lug, Big Tyre has maintained a strong focus on the agricultural sector. For its first 40 years, Big Tyre's work was mainly focused on relugging and repairing tractor tyres. Over the last 20 years, Big Tyre has reconditioned over 1,000 rubber tracks for agricultural tractors, rebuilt thousands of undercarriage wheels, become a world leader in the manufacture of solid underground mining wheels, and, yes, they still relug and repair tyres.

In recent years, Big Tyre has led the way in switching from the use of rubber to polyurethane on rebuilding mid-rollers (to handle the high loading) whilst still maintaining the use of rubber on the drive and idler wheels to maximise grip. In the last couple of months, Big Tyre has also released its own new and

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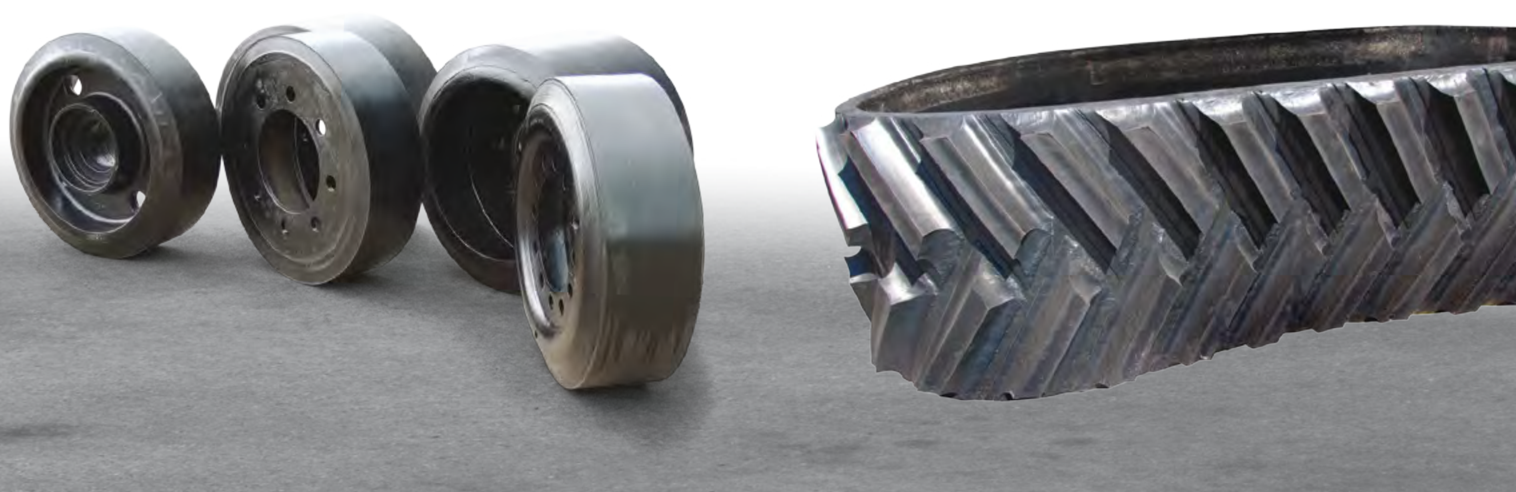
Big Tyre services industry locally and overseas from its factory at 226 North Street in Toowoomba

improved version of the 8RT mid-roller, which stands to significantly reduce the chances of premature failure with a 60% improvement in the load carrying capacity per wheel (compared to the original design built in polyurethane).

Big Tyre's expertise in the industry hasn't gone unnoticed by the leading manufacturers either. Both Continental and Firestone have awarded Big Tyre with the Australian distribution rights for their high quality agricultural tracks, which Big Tyre now imports directly from the USA and Japan to supply farmers and dealerships around the country. These distributorships give Big Tyre two of the leading three brands and enable the company to be an effective one-stop shop for tracks and undercarriage wheels to farmers.

In keeping with its name, a Big Tyre Store has been created on-line providing the most comprehensive catalogue of tyres in Australia complete with prices, photos and tyre specifications. Even without car and 4WD tyres, which will be added once fitting and wheel balancing services have been arranged throughout the country, Big Tyre lists over 4,500 different tyres (www.bigtyre.com.au) that they can supply throughout the country.

In an age of global economic uncertainty, it is refreshing to see this Australian manufacturer not only surviving major changes and challenges, but actually extending their services to the agricultural industry by focusing on continual development, applying new innovative technologies, and actively pursuing new opportunities as they arise.



Optimistic grain growers seeking more land

A recent survey shows Australian grain growers are continuing to invest in their businesses even as wheat prices remain low, as they look to a future of opportunities underpinned by a growing global middle class and a revived Trans Pacific Partnership.

Results of the March 2018 Commonwealth Bank *Agri Insights* report show grain growers are the most likely to be looking for more land, with 19 per cent saying they intend to increase their landholding in the year ahead, against an average of 9 per cent across all farm types. Grain growers are also most likely to be planning to invest in infrastructure, plant and equipment, and have solid investment intentions around technology and employment.

Commonwealth Bank's General Manager Specialised Agribusiness Solutions, Adrian Parker, says a relatively tough period has not dampened the optimism of future-focused croppers.

"These results show that Australian growers have their eye on the future. Even though the last harvest was considerably down on recent records, Australian growers are still intent on investing in their operations, because they recognise that agribusiness is a long term prospect. They're evolving their operations to be ready for upcoming opportunities. Already we're seeing this demonstrated with a much better outlook for the summer season.

The TPP and dining boom

"In addition, the new Trans Pacific Partnership has just been signed. With nearly a fifth of Australian grain exported to TPP countries, growers will certainly be looking for opportunities out of that. The ongoing 'dining boom' is another example of future opportunity for the sector, as the continued growth in global incomes continues to drive demand for quality food," Adrian says.

While the focus of the dining boom has been largely around demand for meat, Adrian notes that growing economies support other parts of the food production sector, too.

"Rising global incomes are not just impacting those who eat meat. They're changing vegetarian diets, too. Two decades ago wheat represented about two-thirds of the Australian winter crop planting. That share is now about half, with the difference made up mostly by canola and pulses."

Adrian says the continuing positive investment intentions from grain growers show a commitment to productivity, efficiency and sustainability.

"For some growers, this is about increasing their landholding to enable increased production, although scaling up does not always mean more distance between the front and back fence. We're also seeing strong interest in upgrading equipment, investing in technology and taking on new staff to help growers achieve more from their operations.

"Against a backdrop of generally lower prices, Australian grain growers are looking ahead and investing strategically."

Key findings from the *Agri Insights* survey:

- 19 per cent of grain growers said they would look to increase their area of land, compared with 9 per cent of farmers overall.
- 40 per cent of grain growers said infrastructure, plant and equipment was their biggest area of investment increase last year. 45 per cent said they would increase investment in this area again this year, compared with 35 per cent of farmers overall.
- 45 per cent of grain growers said they would increase investment in technology and innovation, compared with 37 per cent of farmers overall.
- 20 per cent of grain growers said they would increase the number of employees in their business, compared with 15 per cent of farmers overall.
- 33 per cent of the grain growers who said they would increase technology investment said they were motivated by productivity and efficiency.

NOTE: The research was conducted among 1400 Australian farmers, including 243 grain growers, during September 2017. It focused on farmers' intentions for their farm enterprises over the coming 12 months, as well as their investment over the past 12 months. Additional analysis on this data set was conducted in January 2018. Research was conducted by Kynetec.

For more details see *Agri Insights* www.commbank.com.au/agriinsights ■

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The survey found almost one fifth of Australian grain growers are looking to buy more farm land.

Section 2

The Grain Industry In Figures

- All figures and tables presented in this Yearbook have been derived from a combination of ABARES, ABS, Pulse Australia, International Grains Council and USDA sources.
- For Australian and other southern hemisphere winter crops the year listed is generally the calendar year the crop is planted and harvested.
- Australian summer crop figures are for the harvest in the following calendar year.
- For northern hemisphere crops, a figure for 2017 for example, is an estimate for the crop harvested in the 2017–18 financial year.
- (Mt = 1,000,000 tonnes) (Kt = 1000 tonnes)

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Winter crop production better than expected and above the 10 year average

Given very mixed seasonal conditions, there were better than expected 2017–18 harvest results in some key winter crop growing regions of the Australian grain-belt. Favourable growing conditions during spring in some regions of Western Australia and South Australia – and during most of the winter crop season in Victoria – lifted production well above earlier forecasts.

But winter crop yields in Queensland and New South Wales were well below average because of mixed and largely poor growing conditions during much of the season.

As a result, total national winter crop production is estimated to have decreased around 36 per cent on the previous (and all-time record) 2016–17 season to 37.8 million tonnes (mt).

If we leave out the 'distortion' caused by the record 2016 season, this production level is 6 per cent above the 10-year average to 2015–16.

For the major crops, wheat production is estimated to have decreased by 38 per cent on the previous year to 21.2 mt, barley by 33 per cent to 8.9 mt and canola by 15 per cent to 3.7 mt.

Amongst other crops, chickpea production in 2017–18 is estimated to have decreased by 49 per cent on the previous year to 1.0 mt and oats production by 40 per cent to 1.1 mt.

The 2017–18 summer crop

The 2017–18 summer crop will return mixed results. Below average rainfall and above average temperatures in late spring and early summer curtailed summer crop planting in the latter part of the planting window which lowered yield prospects for dryland crops.

The summer crop planted area is estimated to have increased by 2 per cent on 2016–17 to 1.3 million hectares. Total summer crop production is forecast to increase by 12 per cent to around 4.3 mt.

On the back of improved price prospects, the area planted to grain sorghum is estimated to have increased by 26 per cent to just over 500,000 hectares with a production forecast of around 1.5 mt.

The area planted to cotton in 2017–18 is estimated to have fallen by 10 per cent on the previous season to 500,000 hectares – dryland cotton makes up about 20 per cent of this area. Dryland cotton planting fell by around 17 per cent on last season to 106,000 hectares due to low levels of soil moisture during the planting window – August to December.

Cotton production for the 2017–18 season is forecast at 995,000 tonnes of cotton lint and 1.4 million tonnes of cotton seed.

The 2017 winter crop delivered a mixed bag of on-farm yields across the national wheat belt. In some regions, particularly in WA, late season rain saved the day.

The area planted to rice is estimated to have been 80,000 hectares. Supplies of irrigation water were sufficient to realise rice planting intentions. Rice production for the 2017–18 season is forecast at around 800,000 tonnes – a similar tonnage as the previous season.

Source: ABARES *Australian Crop Report*, February 2018. ■

Table 1: Winter crop production in Australia over the past 10 years (Kt)

Year	Unit	NSW	Vic	Qld	SA	WA	Australia
2008–09	kt	9,438	3,887	2,326	4,863	13,785	34,378
2009–10	kt	7,787	5,889	1,617	7,035	12,943	35,344
2010–11	kt	14,784	7,625	1,821	9,316	8,044	41,672
2011–12	kt	11,952	7,352	2,329	7,371	16,600	45,670
2012–13	kt	11,123	6,886	2,156	6,470	11,243	37,934
2013–14	kt	9,773	6,773	1,516	7,221	16,510	41,878
2014–15	kt	10,445	5,117	1,464	7,439	14,662	39,197
2015–16	kt	11,624	3,568	2,104	6,105	14,206	37,687
2016–17s	kt	16,093	10,180	3,304	11,157	18,041	58,846
2017–18s	kt	7,181	7,634	1,390	6,945	14,619	37,824

s ABARES estimate.
Note: Includes barley, canola, chickpeas, faba beans, field peas, lentils, linseed, lupins, oats, safflower, triticale and wheat.

Table 2: Summer crop area and production in Australia over the past 10 years

Year	NSW		Qld		Australia	
	'000 ha	kt	'000 ha	kt	'000 ha	kt
2008–09	402	1,430	746	2,350	1,156	3,794
2009–10	381	1,405	514	1,342	903	2,764
2010–11	713	2,514	790	1,901	1,514	4,446
2011–12	757	3,064	783	2,379	1,558	5,494
2012–13	711	3,205	686	2,250	1,412	5,506
2013–14	568	2,317	559	1,469	1,139	3,847
2014–15	435	2,044	696	2,134	1,149	4,262
2015–16	412	1,656	624	1,821	1,054	3,563
2016–17s	687	2,259	594	1,478	1,296	3,809
2017–18f	634	2,473	685	1,789	1,327	4,282

f ABARES forecast. **s** ABARES estimate.
Note: State production includes cottonseed, grain sorghum, corn (maize), mung beans, rice, peanuts, soybeans and sunflower. Total for Australia also includes navy beans, and small areas and volumes of summer crops in other states.

SECTION 2 THE GRAIN INDUSTRY IN FIGURES
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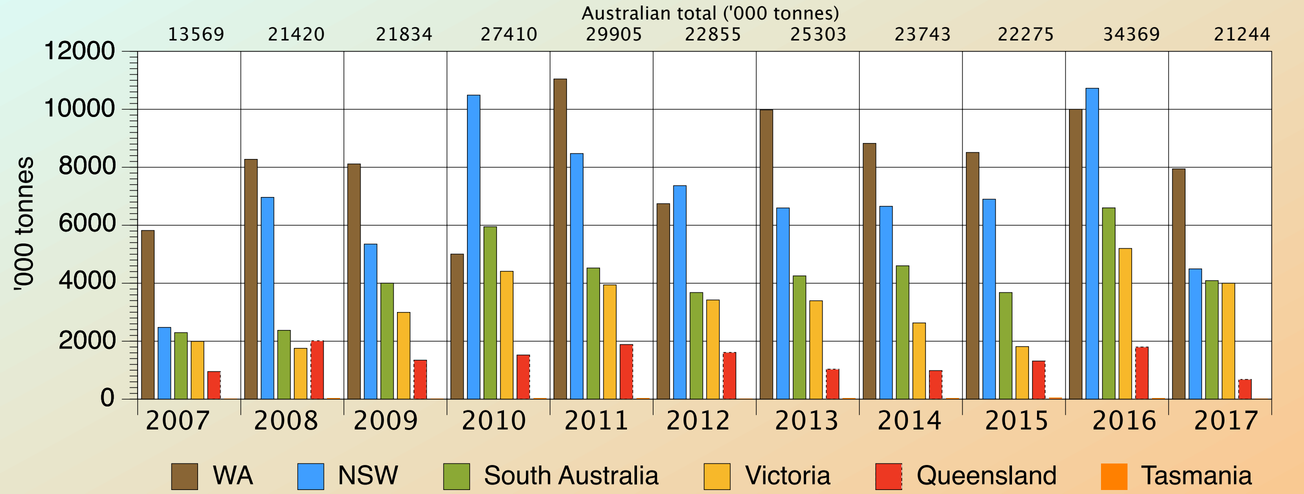
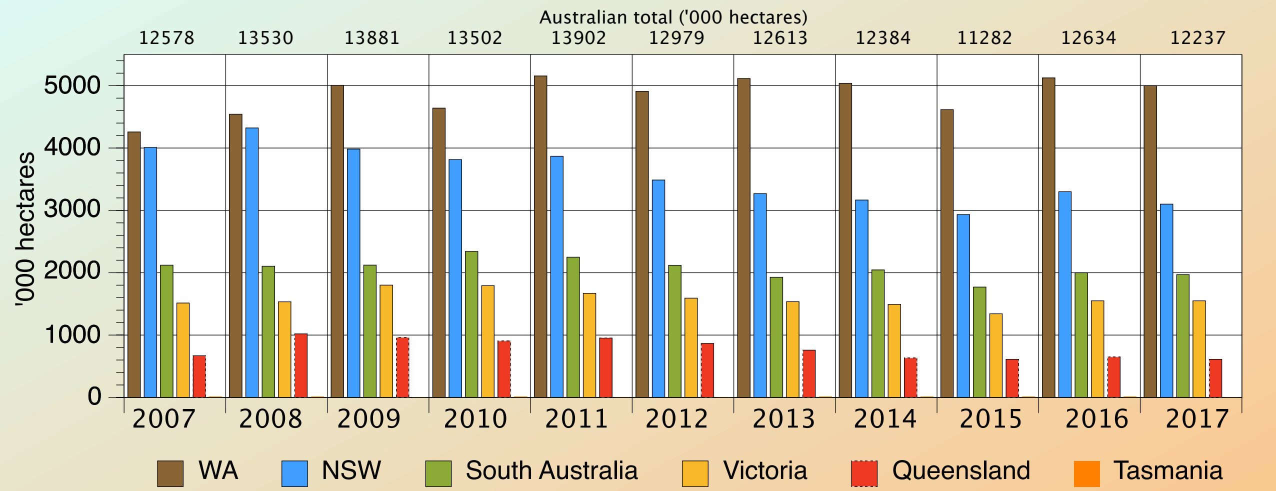
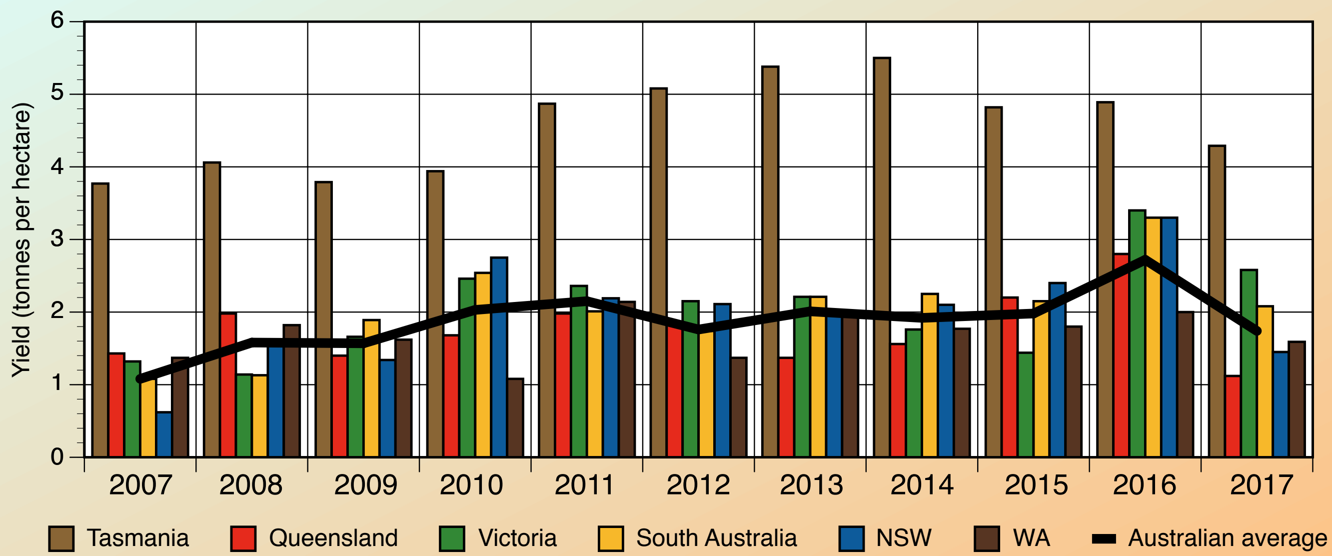
Total Australian wheat production



Total Australian wheat area



Average Australian wheat yields by state



Australian wheat production, domestic disposal and exports (Kt)

	2013	2014	2015	2016	2017
Opening stocks	5678	5584	5586	4482	8633
Production	25303	23743	22275	34369	21244
Availability	30981	29327	27861	38851	29877
Total domestic use	6785	7154	7263	7582	7600
Stockfeed, Human, Indus	6165	6590	6621	6960	*6950*
Seed	619	564	642	622	*650*
EXPORTS					
Wheat (incl. grain & flour)	18612	16587	16116	22636	16828
Price APW10 net pool (A$/t)	$334	$326	$303	$268	$309
MAJOR DESTINATIONS					
China	1491	930	1366	1859	na
Japan	882	904	899	970	na
Korea, Rep. of	910	1048	1203	1050	na
Malaysia	957	906	835	1065	na
Thailand	387	466	409	432	na
Indonesia	3720	4377	3648	4833	na
Egypt	275	427	288	135	na
Iran	849	269	102	0	na
Iraq	959	155	53	0	na
United Arab Emirates	40	99	166	331	na
Yemen	1070	928	915	977	na
Kuwait	436	381	403	466	na
Saudi Arabia	377	13	16	7	na
Oceania (NZ, Fiji, PNG)	845	902	899	869	na
CLOSING STOCKS (Kt)	**5584**	**5586**	**4482**	**8633**	**5449**

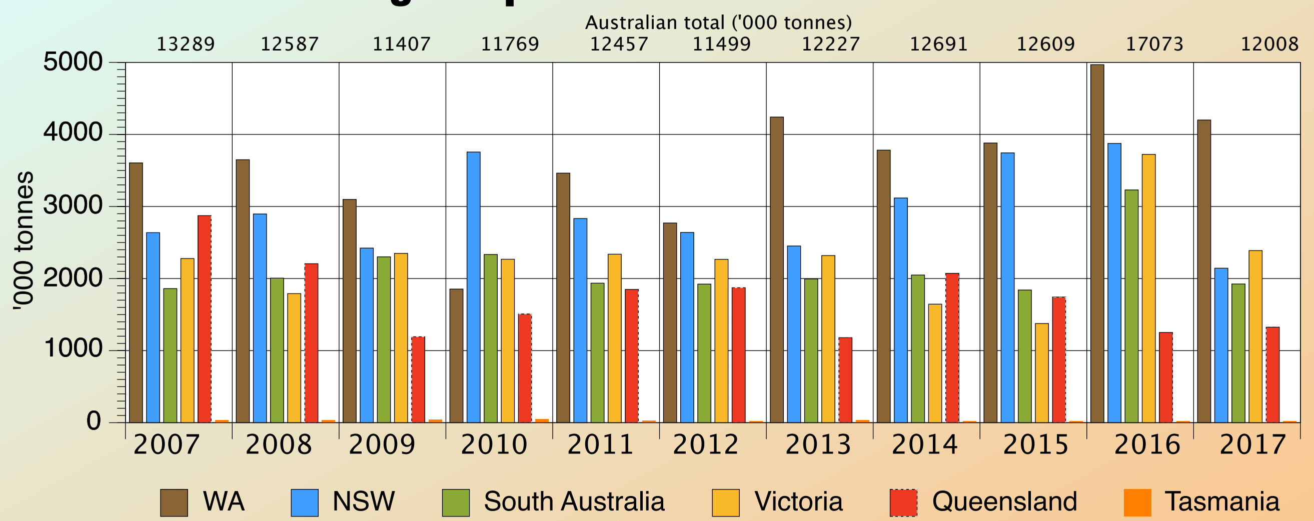
Wheat production & area by state

		2013	2014	2015	2016	2017
NSW:	Prod. (Kt)	6596	6654	6898	10725	4495
	Area ('000 ha)	3269	3166	2933	3300	3100
Vic:	Prod. (Kt)	3396	2631	1815	5200	4000
	Area ('000 ha)	1536	1493	1342	1550	1550
Qld:	Prod. (Kt)	1036	987	1316	1800	683
	Area ('000 ha)	758	634	611	650	610
WA:	Prod. (Kt)	9977	8824	8511	10000	7945
	Area ('000 ha)	5115	5038	4616	5125	5000
SA:	Prod. (Kt)	4254	4602	3679	6600	4090
	Area ('000 ha)	1927	2045	1770	2000	1970
Tas:	Prod. (Kt)	43	44	53	44	30
	Area ('000 ha)	8	8	11	9	7

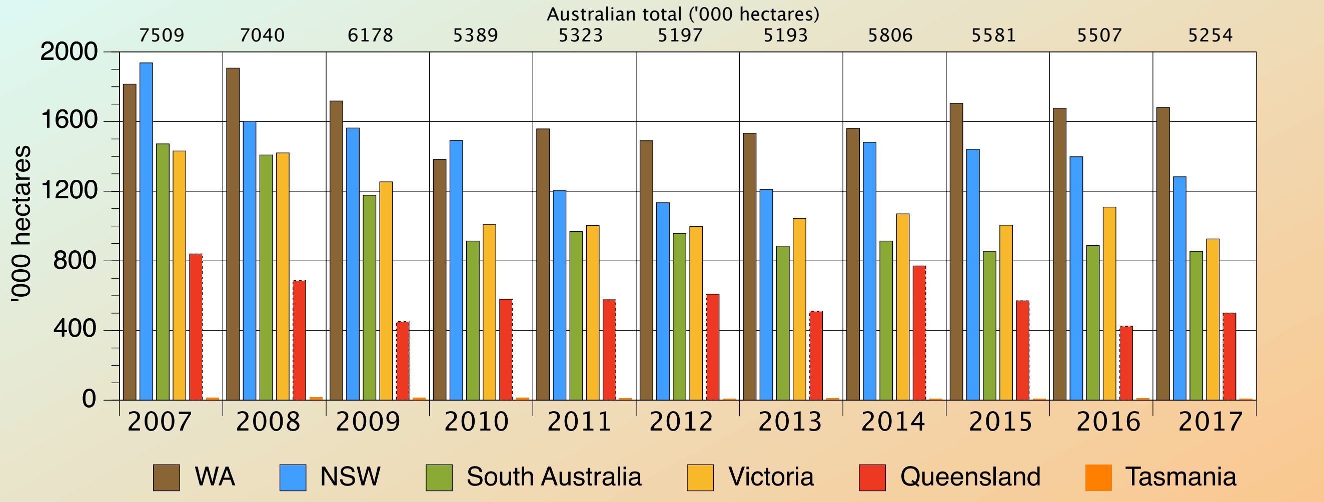
Barley production & area by state

		2013	2014	2015	2016	2017
NSW:	Prod. (Kt)	1486	1869	2528	2697	1185
	Area ('000 ha)	715	882	966	870	790
Vic:	Prod. (Kt)	715	882	966	870	790
	Area ('000 ha)	919	916	844	940	800
Qld:	Prod. (Kt)	180	253	372	300	120
	Area ('000 ha)	106	125	138	95	88
WA:	Prod. (Kt)	3556	3192	3248	4200	3705
	Area ('000 ha)	1258	1308	1384	1325	1400
SA:	Prod. (Kt)	1892	1941	1719	3000	1800
	Area ('000 ha)	810	840	769	800	795
Tas:	Prod. (Kt)	25	17	16	17	17
	Area ('000 ha)	6	5	6	5	5

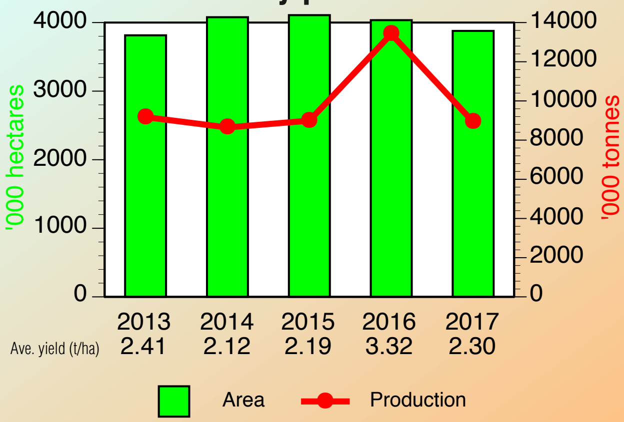
Australian coarse grain production (includes barley, oats, triticale, sorghum and maize production for grain)



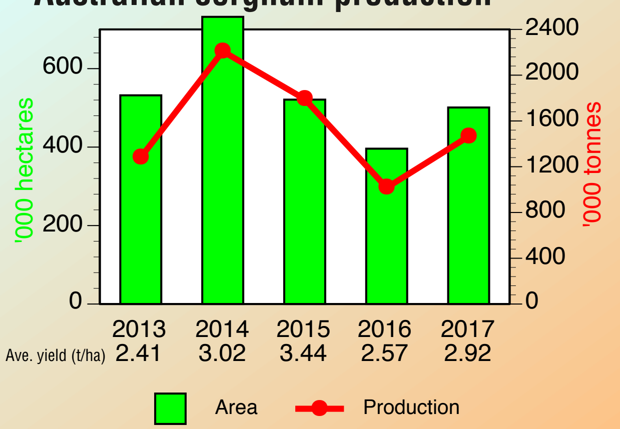
Total Australian coarse grains area (includes barley, oats, triticale, sorghum and maize production for grain)



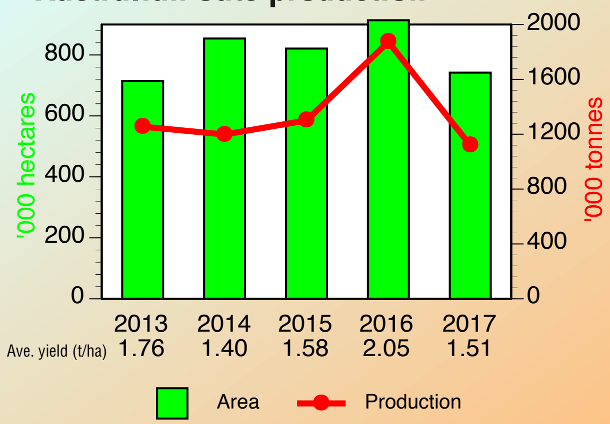
Australian barley production



Australian sorghum production



Australian oats production



SECTION 2 THE GRAIN INDUSTRY IN FIGURES

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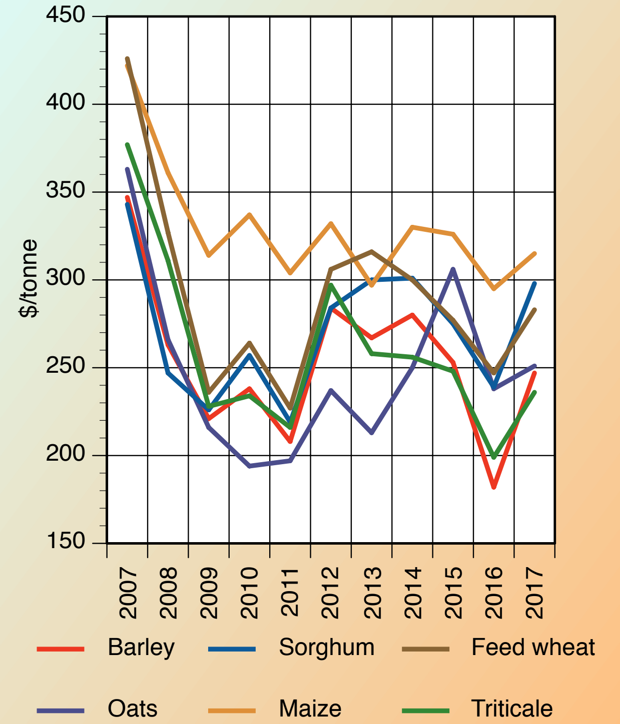
Supply and disposal of Australian coarse grains (Kt)

	2013	2014	2015	2016	2017
BARLEY					
Production	9174	8646	8593	13414	8928
Domestic use, +/- stocks	2050	2438	3095	3877	2729
Exports	7124	6208	5498	9537	6199
OATS					
Production	1255	1198	1300	1873	1119
Domestic use, +/- stocks	1042	914	1070	1504	909
Exports	213	284	230	369	210
SORGHUM					
Production	1282	2209	1791	1017	1465
Domestic use, +/- stocks	581	1004	716	288	981
Exports	701	1205	1075	729	484
MAIZE					
Production	390	495	400	514	383
Domestic use, +/- stocks	307	437	359	441	316
Exports	83	58	41	73	67
TRITICALE					
Prod'n, use & stocks	126	143	127	255	114
TOTAL PRODUCTION	**12227**	**12691**	**12609**	**17073**	**12008**
TOTAL EXPORTS	**7387**	**7756**	**6845**	**10708**	**6960**

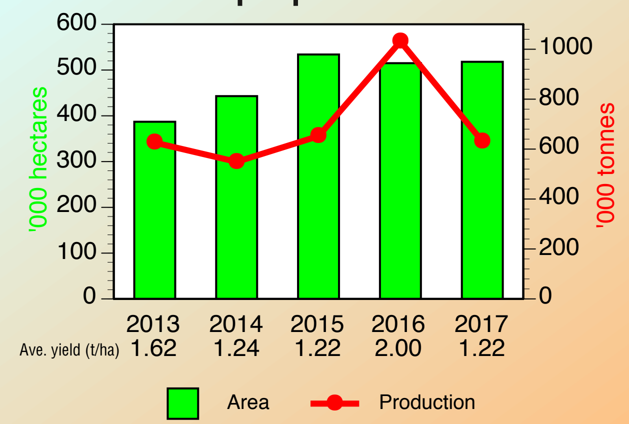
Australian coarse grains domestic feed prices ($/tonne delivered capital city)



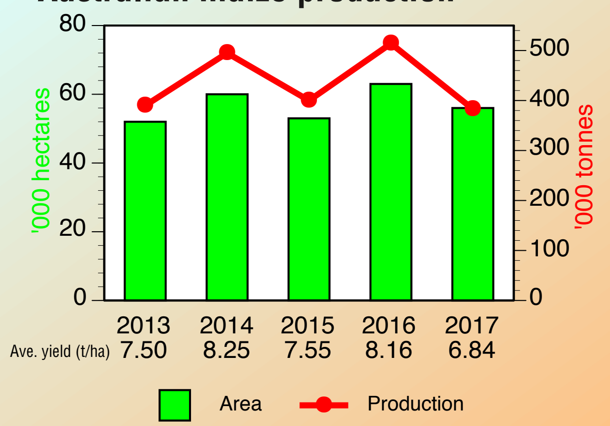
Supply and disposal of Australian pulses (Kt)

	2013	2014	2015	2016	2017
LUPINS					
Production	626	549	652	1031	631
Domestic use, +/- stocks	328	279	432	651	315
Exports	298	270	220	380	316
FIELD PEAS					
Production	342	290	205	415	289
Domestic use, +/- stocks	187	111	62	190	80
Exports	155	179	143	225	209
CHICKPEAS					
Production	629	555	875	2004	1028
Domestic use, +/- stocks	67	-119	-265	34	-268
Exports	562	674	1140	1970	1290

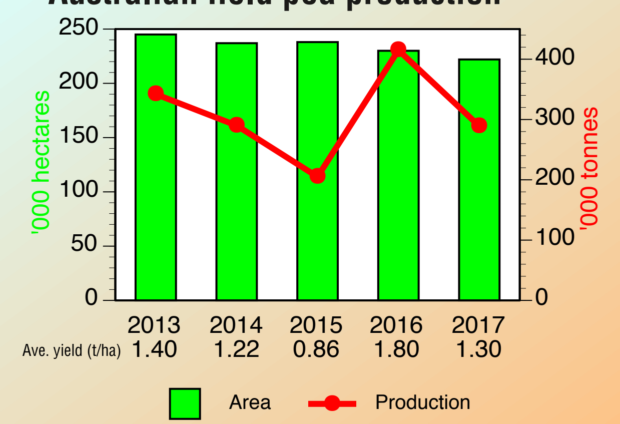
Australian lupin production



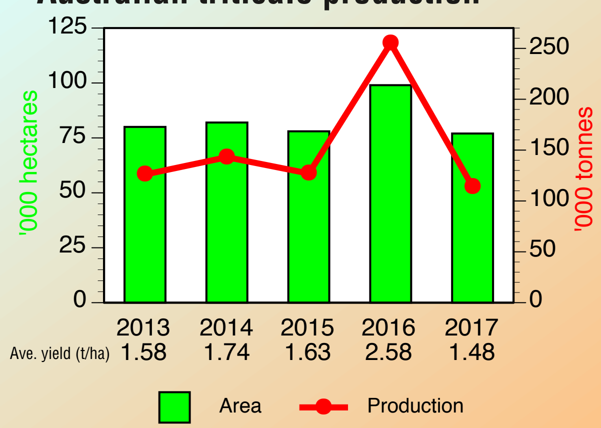
Australian maize production



Australian field pea production



Australian triticale production



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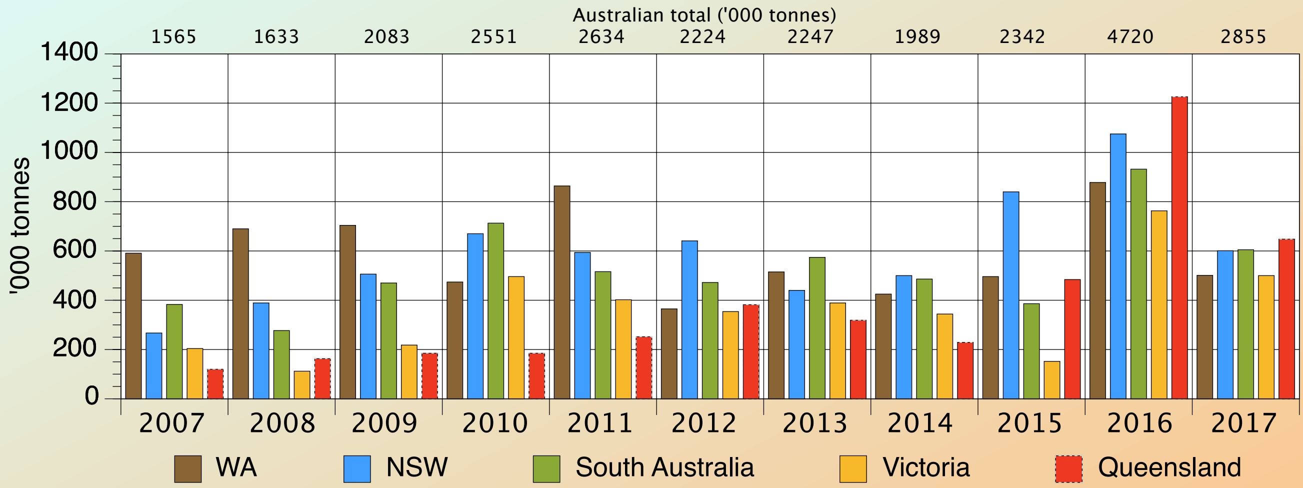
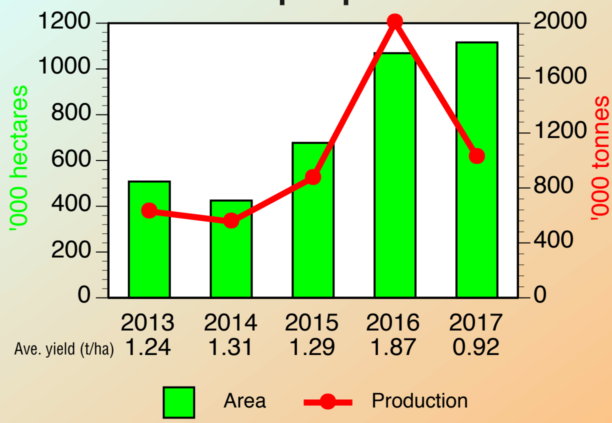
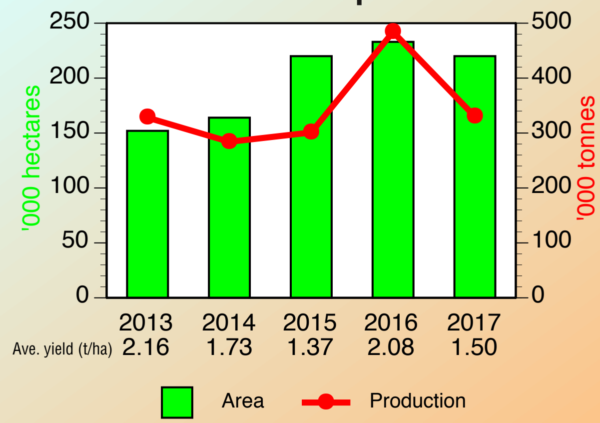
Total Australian pulse production



Australian chickpea production



Australian faba bean production



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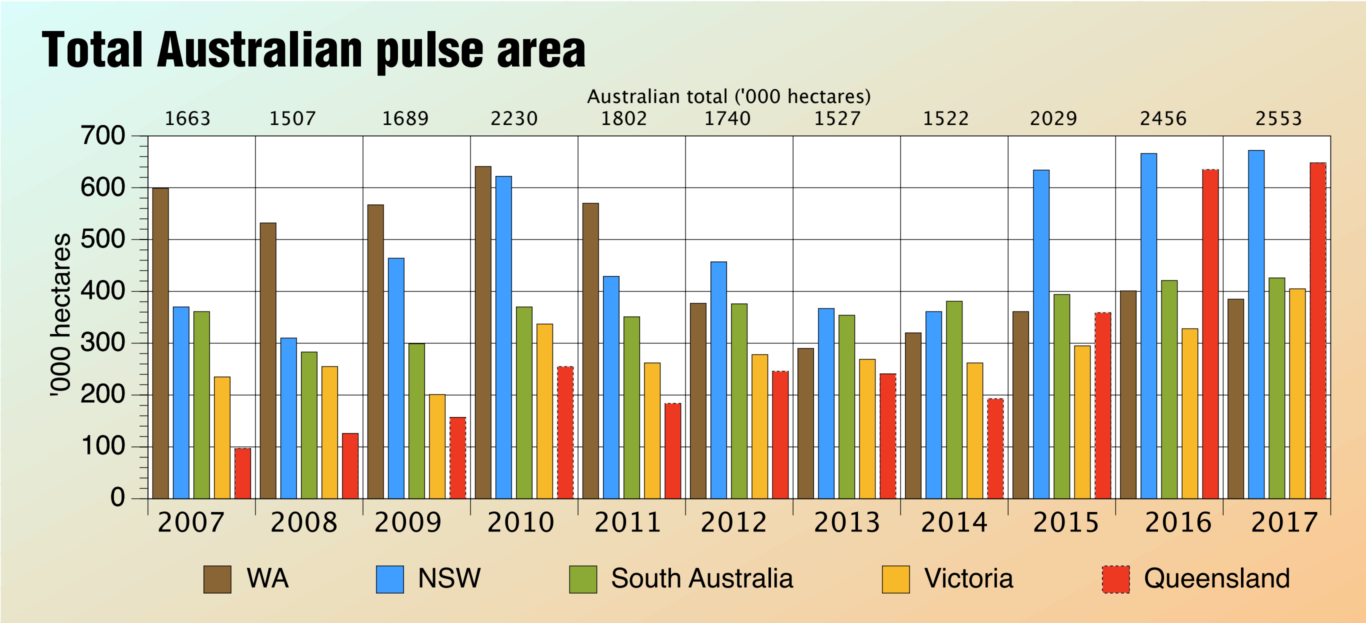
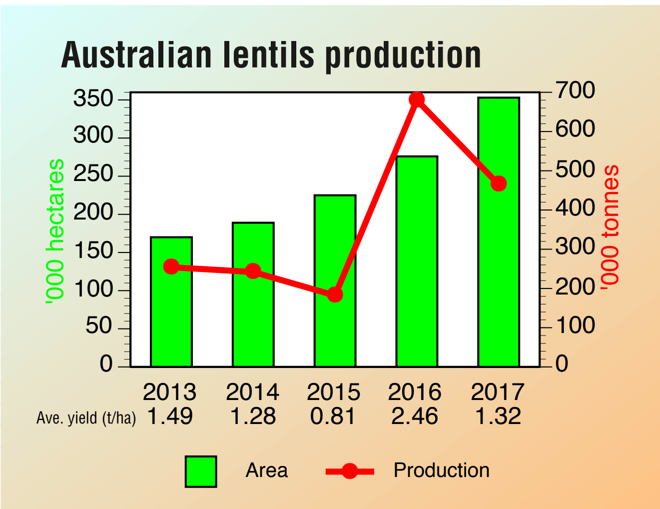
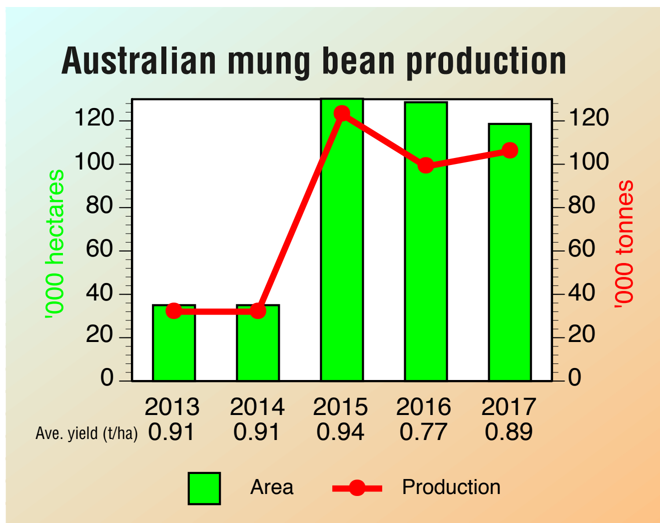
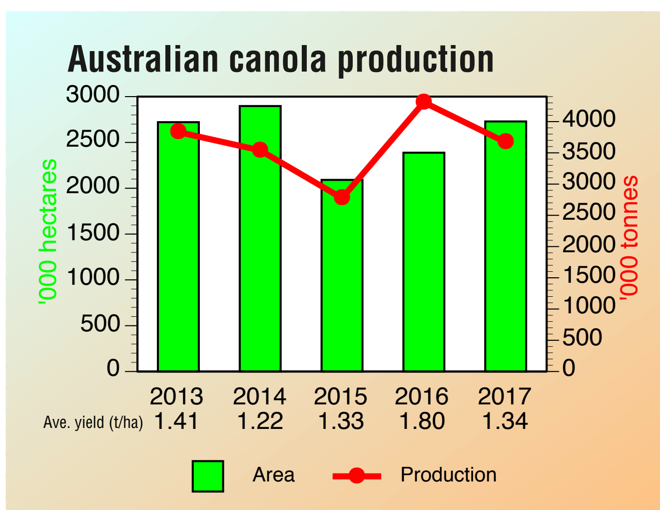







(PHOTO: Pulse Australia)



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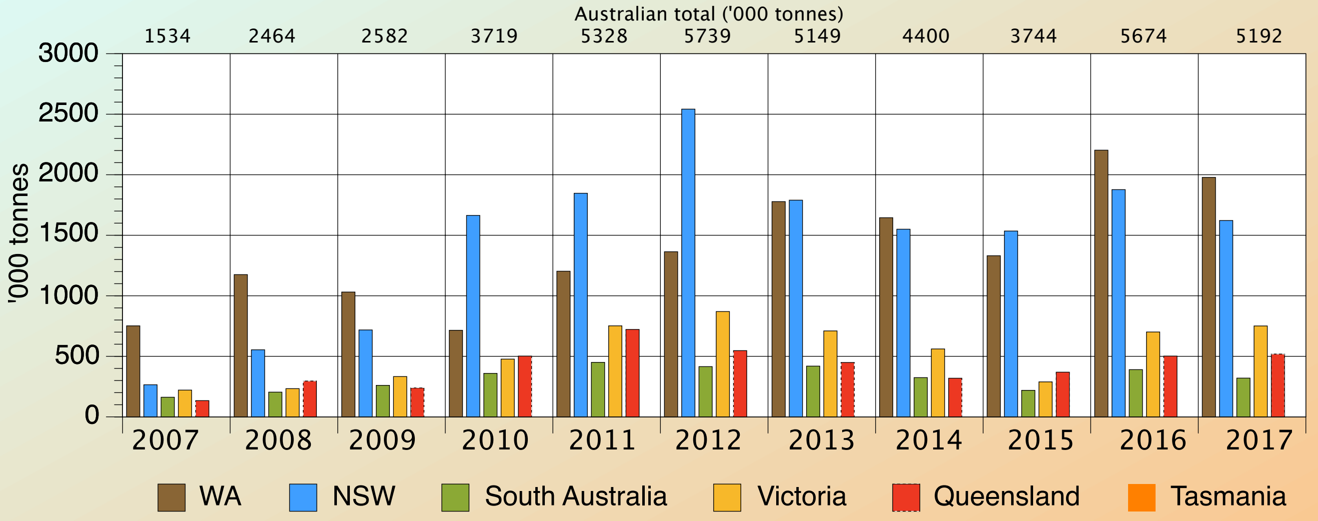
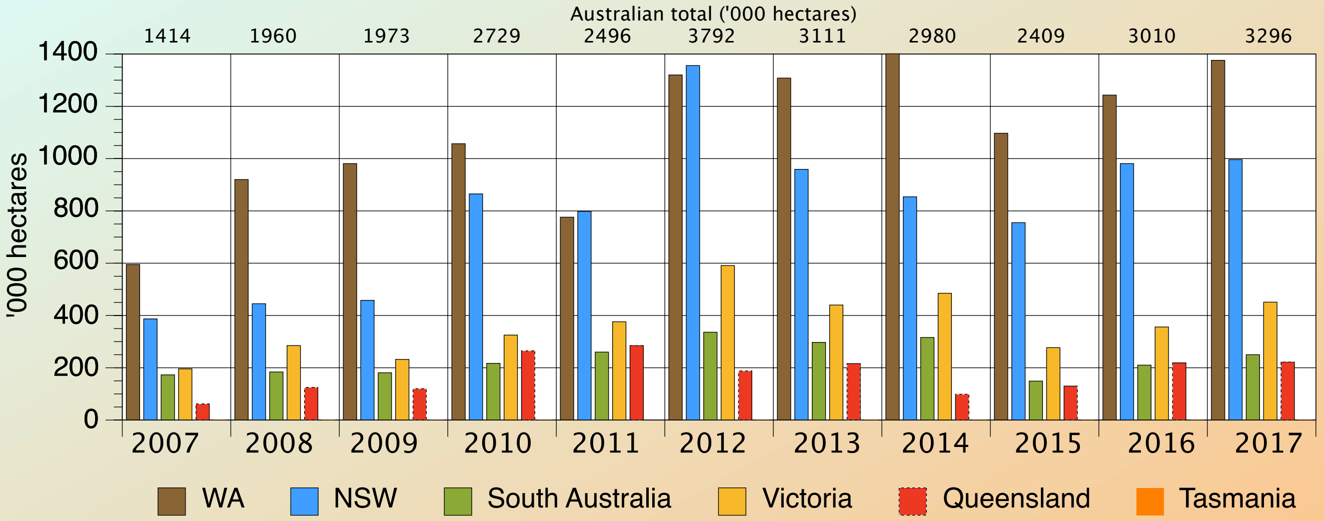
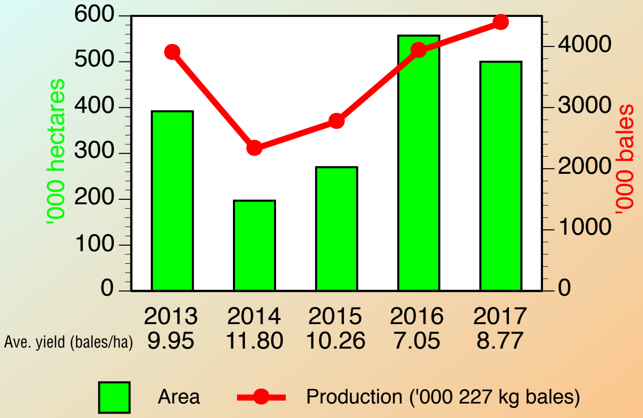
Total Australian oilseed production



Total Australian oilseed area

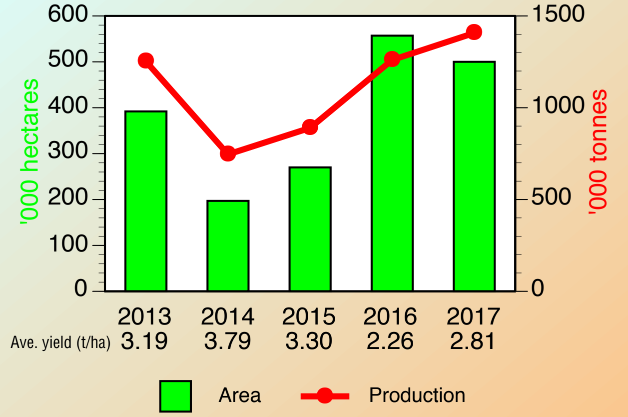


Australian cotton lint production



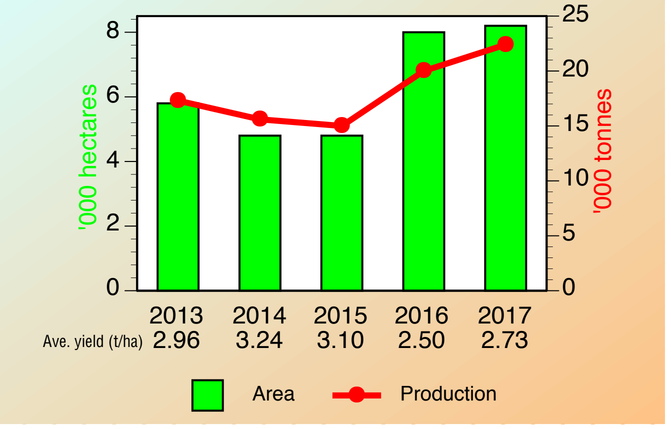
(Includes irrigated and dryland production)

Australian cottonseed production

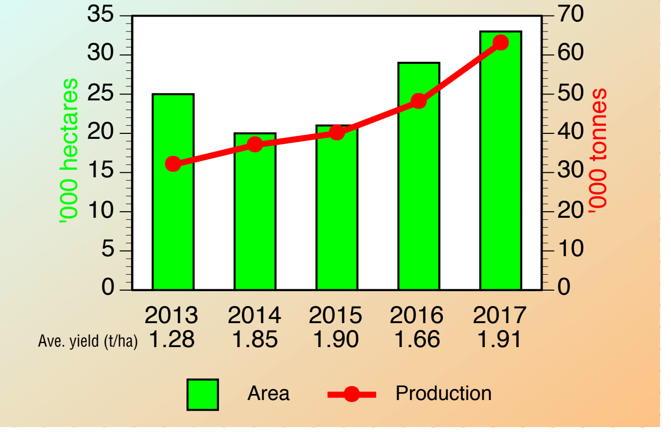


(Includes irrigated and dryland production)

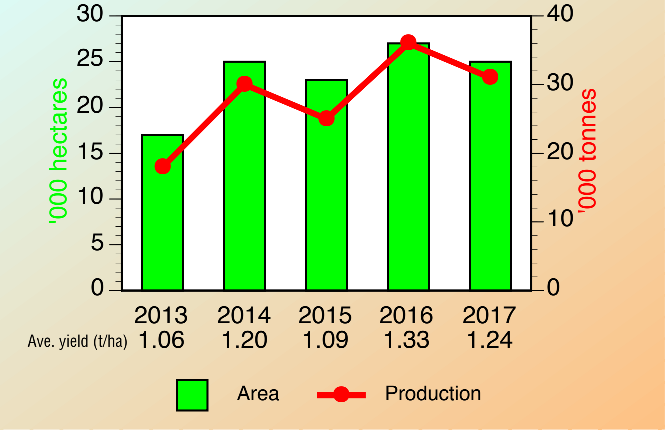
Australian peanuts production



Australian soybean production



Australian sunflower seed production



Australian canola production, domestic use, price, seed and oil exports (Kt)

	2013	2014	2015	2016	2017
Seed production	3832	3540	2775	4309	3669
Domestic use	969	915	1088	972	na
Price (A$/t)	$529	$484	$542	$530	$513
EXPORTS					
Seed	3194	2445	1946	3598	2530
Oil	152	159	154	148	na
Meal	42	37	23	6	na

Australian exports of oilseeds, vegetable oils and meals, by type (Kt)

		2012	2013	2014	2015	2016	2017
OILSEEDS	**Canola**	3488	3194	2445	1946	3598	2530
	Cottonseed	753.6	463.7	166.6	146.7	315.9	250.2
	Linseed	0.05	0.02	0.01	0.02	0.0	0.0
	Peanuts	2.8	3.2	3.0	3.4	4.6	na
	Safflower seed	3.0	0.9	0.4	1.6	1.6	na
	Soybeans	3.1	9.0	2.2	4.8	3.4	na
	Sunflower seed	0.95	0.51	0.17	0.27	0.30	na
	TOTAL (Kt)	**4251**	**3672**	**2617**	**2102**	**3925**	**2795**
OILS	**Canola**	116.2	151.7	159.5	154.1	148.2	na
	Cottonseed	3.7	3.0	4.3	5.2	12.5	na
	Peanut	0.38	0.70	1.19	0.99	0.20	na
	Safflower & Sunflower seed	1.5	0.22	0.04	0.38	1.20	na
	Soybeans	1.4	2.1	5.0	4.2	3.7	na
	Olive	3.0	4.9	4.4	4.8	3.8	na
	TOTAL (Kt)	**146**	**181**	**193**	**188**	**196**	**na**
OILSEED MEALS	**Cottonseed**	42.6	35.8	22.5	0.19	11.8	na
	Soybeans	2.9	2.0	1.4	1.5	5.2	na
	Canola	41.2	42.2	36.9	22.9	6.1	na
	Sunflower seed	1.7	0.0	0.0	0.0	0.0	na
	Other	43.1	43.8	37.8	23.7	7.8	na
	TOTAL (Kt)	**131**	**124**	**99**	**48**	**31**	**na**

Australian gross grain prices ($A/tonne delivered to principal market/port, averaged across all grades)

	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18f
Wheat	257	252	313	316	300	277	247	283
Barley	216	196	276	267	280	253	182	247
Oats	196	201	236	213	250	306	238	251
Triticale	184	175	249	258	256	248	199	236
Maize	259	223	238	297	330	326	295	315
Sorghum	213	201	252	300	301	275	239	298
Rice (average return to growers)	240	270	260	340	395	419	350	365
Lupins	268	232	340	345	292	362	277	262
Field peas	266	231	406	419	413	449	328	297
Chickpeas	404	457	394	352	567	784	833	955
Sunflower seed (at crusher)	567	551	570	660	756	652	590	654
Soybeans	501	472	468	538	588	560	558	519
Canola	544	500	548	555	503	532	520	503

Gross value of Australian grain production ($A million)

	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18f
Wheat	7052	6775	7154	7998	7124	6170	8494	6020
Barley	1729	1723	2063	2453	2417	2277	2447	2201
Oats	221	255	265	268	300	398	445	281
Triticale	65	50	43	32	37	32	51	27
Maize	92	113	120	116	163	130	151	121
Sorghum	412	423	562	384	666	492	243	437
Rice	174	248	302	279	273	115	283	292
Lupins	216	228	156	216	160	236	285	165
Field peas	105	101	130	143	120	92	136	86
Chickpeas	207	308	320	222	315	685	1669	982
Canola	1283	1759	2270	2129	1782	1476	2241	1846
Sunflower seed	24	16	22	12	23	16	21	20
Soybeans	15	27	33	17	22	23	27	33
Peanuts, linseed, safflower seed	30	44	33	26	26	19	27	18
TOTAL	**11625**	**12070**	**13473**	**14800**	**13943**	**12697**	**17781**	**13466**

Value of major Australian grain exports ($A million, fob)

	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18f
Wheat (incl. flour)	5516	6378	6776	6103	5547	5120	6094	5174
Barley (incl. malt)	1295	1875	1626	2199	2137	1790	2427	1724
Oats	37	47	83	80	106	104	126	66
Sorghum	146	299	364	253	424	364	212	137
Rice	165	427	459	490	506	408	245	527
Lupins	89	86	143	125	119	97	136	99
Field peas + Cow peas	85	93	89	67	91	86	109	87
Chickpeas	213	384	533	297	414	1013	1921	1170
Cottonseed	85	195	219	168	75	69	137	101
Canola	866	1344	2094	1929	1349	1097	2128	1388
Other oilseeds	14	10	13	18	14	19	30	22
TOTAL	**8511**	**11138**	**12399**	**12296**	**11352**	**10772**	**14559**	**11310**

Australia 'piggy in the middle' of trade war between US and China

Grain and other farm sectors expected to benefit from retaliatory tariffs

According to business information analysts IBISWorld, Australia stands to be caught in the middle of a trade war between the US and China, as the world's two largest economies launch increasingly retaliatory tariffs at each other. While some local industries may become more exposed to risk as a result, IBISWorld believes Australia will also have the rare opportunity to seize export market share in both markets.

"Australia is one of the best-placed countries in the world to reap the gains of a trade war, due to our natural advantage of having ease of access to maritime trading with both major economies," said Jason Aravanis, Senior Analyst at IBISWorld. "In addition, Australia has beneficial bilateral free trade agreements with both China and the US, which provide more stability to international trade.

"While the trade war presents opportunities for some sectors, others will likely be at greater risk, as Australia is being caught between its largest trade partner and its largest investor; between the economy we rely on and the nation we look to for our security."

Why US and China matter to Australia

According to IBISWorld, the US and China are both vital trading partners for Australia, but for different reasons.

China is Australia's largest two-way trading partner, accounting for 17.7 per cent of all imports into Australia and 29.6 per cent of Australian exports in 2016–17. As such, the Australian economy is intrinsically tied to the performance of the Chinese economy. Many industries rely on Chinese demand for exports, or Chinese supply of imported production inputs.

The US is Australia's third largest trading partner, after Japan. But the US is the largest foreign investor in Australia, with over $860 billion invested in 2016. In contrast, China is only the seventh largest investor in Australia.

Australian winners

As China and the US increasingly lock each other out of their domestic markets, certain Australian industries have the ability to seize market share.

"The Australian agricultural sector is likely to be one of the largest winners, as China has enacted tariffs on popular US food products," said Jason.

In 2017–18, China is expected to account for 25.1 per cent of export demand in the Australian wine production industry, and this is forecast to grow in response to a 15 per cent tariff imposed on US wines this month. Similarly, a 25 per cent Chinese tariff on US soybeans will create massive opportunities for the Australian grain growing industry, particularly as China consumes about two-thirds of global soybean production each year. Rising demand for premium meats in Chinese households has led to strong growth in Australia's meat processing industry, and this industry's performance is expected to further improve as a 25 per cent tariff is imposed on US meats.

Other Australian agricultural industries are also likely to benefit, including fruit and seed industries.

According to IBISWorld, some Australian industries also have the opportunity to gain market share in the US, but Australian exports are likely to encounter greater competition from other countries in this market, such as Canada, Brazil, and the European Union.

"As the US has imposed a 25 per cent tariff on steel and 10 per cent tariff on aluminium from China, the Australian black coal mining and aluminium smelting industries may experience greater demand from US clients. In addition, US tariffs on Chinese chemicals, medicinal products, and electronic components are likely to create opportunities for Australian firms," said Jason.

Australian losers

Despite the positive gains for some Australian industries, others are likely to be negatively affected by a trade war.

"On a macro-economic scale, a downturn in either Chinese or US GDP growth is highly likely to undermine the growth of Australia's GDP. This could lead to an increase in unemployment, as well as a sustained hit to business confidence as the stability of trade liberalisation in undermined," said Jason.

"Some industries are highly exposed to the risk of a trade war. Major mining industries such as the iron ore mining industry could be affected by a slowdown in Chinese economic growth, which would lead to far lower export prices and total demand. Tourism in Australia would also likely be negatively affected, as a hit to consumer confidence in both China and the US would encourage consumers to postpone luxury expenses such as international holidays."

Despite these challenges, IBISWorld believes the overall Australian economy is well placed should a trade war eventuate, at least relative to the conditions of other global economies. But a trade war would likely lead to an overall decline in economic prosperity for Australia. ■

Chinese tariffs on US goods

Item	Tariff
Pork	25%
Soybeans and grains	25%
Wine	15%
Fruit	15%

US tariffs on Chinese goods

Item	Tariff
Steel	25%
Medical supplies	25%
Aerospace equipment	25%
Whitegoods	25%
Aluminium	10%

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New season grain price outlook: Hook, line and sinker…

By Thomas Kim, COFCO

In fishing, the drug, or 'lure' if you will, lies in reeling in the big one. And, for those of you lucky enough to have hooked that prized fighter on your post-harvest fishing trip to the coast, you would rightfully still be reminiscing about that euphoric sensation.

But it's autumn in the southern hemisphere and time to check the planter is in good order and that you're ready to kick off the new winter crop season.

As always, there are still more questions than answers when facing the full stretch of a new crop campaign. Here's a few key points pertinent to the new crop price outlook.

Wheat

Much of the poor US crop condition as at April 2018, has been priced into the market. This means the wheat market will need to look for crop problems in the Black Sea or Europe for further upside. Australian wheat prices will benefit most from a Black Sea production issue. The new crop Black Sea production consensus is at around 75 million tonnes versus 85 mt for last season. Given that wheat has progressed through the northern hemisphere winter unscathed – and with good snow cover – the level of concern is low for the moment.

Price relativity for new crop against the Black Sea, is not necessarily a driving factor this far out. This is underlined by the fact that the critical weather period for both Black Sea and Australian production is still to come. It is too early for Asian consumers to engage for 2019 demand, but as a guide, APW in Western and South Australia is at a US$10–$12 premium to Russian origin on CFR basis to Asia.

Taking into account, the superior Aussie quality and moisture level, the premium would be narrower, which shows Australia is reasonably priced.

Barley

The talk around town is how many hectares will swing into barley, especially given that prices have been relatively high this season, thanks to consistent Chinese demand. It's a question that is not only for Australia but all around the globe. We expect to see Chinese demand continue to flow at new crop price levels, of which, are heavily inverted across many origins. Subsequently, we anticipate good underlying support in new crop prices.

Political risk is also extreme for barley. It is relatively immune on the surface, but amongst Chinese tariff issues, policy on domestic corn will need to be monitored with care. Further implementation of the protectionist policy increases the likelihood of China being able to fortify their local grain and oilseed supply through higher subsidies to growers.

With increased production, this may mean lower domestic corn prices, and eventually, this may translate to lower barley prices for Australia.

Canola

Despite the announcement of a planned 25 per cent tariff on US soybeans, the Australian and European canola markets have remained largely unmoved. This statement caught a few oilseed traders by surprise, given the news was anticipated, and markets moved quickly to reprice specific origins to alleviate the expected change in trade flows.

As a result, soybean basis in Brazil firmed instantly given it will be the major substitute.

Chickpeas

Having seen past chickpea prices almost double that of new crop chickpea prices on offer, the rational thing to do is for growers to switch excess chickpea area to cereals. Even with the switch, an average yield will get Australian production close to 1.0 million tonnes.

With Indian exports coming to an abrupt halt, it will mean that even 1.0 mt will generate a loose supply and demand situation. Also, the first of the monsoon forecast shows a minor skew towards above average rainfall, which translates into better new crop prospects for India.

Australian growers can expect extended tariffs on chickpeas. And, while chickpeas have had a couple of years in the spotlight, things are pointing to a subdued season.

In the end, take your pick on which commodity to be a bull or a bear – but don't be a pig…

US–China trade stoush

On the issue of escalating US–China tariffs, we won't delve into the guessing game of what may transpire, especially given the magnitude and intricacies of the global flows involving two of the most influential economies in the world. We will finish by saying that the exceptional global economic growth experienced through the last half-century, is attributable to increased global trade and reduction of protectionism.

A reversal of this progress will generate casualties on both sides of the Pacific, hindering economic growth prospects for all those involved, both directly and indirectly.

The recent politics though may end up being merely a bad haircut. For Australian farmers, this issue is more likely a boon in the short term, (without a significant shift in global supply and demand), on the back of reduced competing origin. But in the long run it won't do any good for most of the market participants.

COFCO report submitted April 10, 2018. ■

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World supply and demand for wheat and total coarse grains, million tonnes (Mt)

Supply and demand for wheat (by major producer)

	Opening stocks	Production	Imports	Total supply	Total use	Exports	Closing stocks
Argentina							
2015	4.5	11.3	0.0	15.8	5.7	9.5	1.3
2016	1.3	18.4	0.0	19.7	5.4	13.9	0.4
2017	0.4	18.5	0.0	18.9	5.4	12.8	0.6
Australia							
2015	5.6	22.3	0.0	27.9	7.3	16.1	4.5
2016	4.5	34.4	0.0	38.9	7.6	22.7	8.6
2017	8.6	21.2	0.0	29.8	7.6	16.8	5.4
Canada							
2015	7.1	27.6	0.1	34.7	7.9	21.7	5.2
2016	5.2	31.7	0.1	37.0	10.0	20.2	6.8
2017	6.8	30.0	0.1	36.9	8.8	21.9	6.2
China							
2015	63.4	130.2	3.6	197.2	115.9	0.7	80.5
2016	80.5	128.9	4.7	214.1	117.3	0.9	95.9
2017	95.9	129.8	3.6	229.3	119.3	1.0	108.9
EU-28							
2015	14.2	159.6	7.6	181.4	129.3	35.1	17.1
2016	17.1	144.2	6.0	167.3	126.5	27.6	13.1
2017	13.1	151.2	6.0	170.3	128.8	24.2	17.3
India							
2015	18.0	86.5	0.4	104.9	88.7	0.9	15.3
2016	15.3	86.0	6.2	107.5	97.3	0.4	9.8
2017	9.8	98.5	2.0	110.3	97.9	0.4	12.0
Russia							
2015	6.6	61.0	0.7	68.3	37.1	25.5	5.7
2016	5.7	72.5	0.3	78.5	40.2	27.8	10.5
2017	10.5	84.9	0.3	95.8	43.7	36.3	15.7
Ukraine							
2015	5.5	27.3	0.0	32.8	11.8	17.4	3.5
2016	3.5	26.8	0.0	30.4	10.4	18.1	1.9
2017	1.9	27.0	0.0	29.0	10.1	17.0	1.9
United States							
2015	20.5	56.1	3.1	79.7	31.9	21.2	27.6
2016	26.6	62.8	3.2	92.6	31.8	28.7	32.1
2017	32.1	47.4	4.2	83.7	29.6	25.2	28.9
Total world supply and demand for wheat (Mt)							
2015	206.1	737.7	166.2	943.8	718.3	166.2	224.2
2016	224.2	754.1	175.7	978.3	737.8	175.7	240.4
2017	240.4	757.7	173.8	998.1	741.7	173.8	256.4
Total world supply and demand for coarse grains (ie. total of corn, barley, sorghum, oats & rye) (Mt)							
2015	247.2	1259.2	181.1	1687.4	1254.9	163.5	269.0
2016	269.0	1364.9	172.6	1806.5	1352.8	198.3	255.4
2017	255.4	1315.0	184.9	1755.3	1353.8	190.5	211.0
Total world supply and demand for wheat and coarse grains (Mt)							
2015	453.3	1996.9	347.3	2631.2	1973.2	329.7	493.2
2016	493.2	2119.0	348.3	2748.8	2090.6	374.0	495.8
2017	495.8	2072.7	358.7	2753.4	2095.5	364.3	467.4

Summary of world statistics for wheat

	Area (million ha)	Production (Mt)	Use (Mt)	CLOSING STOCKS World (Mt)	CLOSING STOCKS Major exporters (Mt)	Stocks to use ratio (%)	Trade (imports) (Mt)	Price US$ (Hard Red Winter, Gulf)
2009	226	678	652	199	77	31	128	209
2010	217	652	659	194	74	29	126	317
2011	221	697	698	192	68	28	145	299
2012	216	655	677	169	50	25	141	348
2013	220	717	699	188	54	27	157	317
2014	222	728	705	218	50	31	159	266
2015	224	735	711	243	52	34	170	211
2016	222	751	739	255	54	34	177	197
2017	220	760	743	271	66	36	182	221

World wheat production by region (Mt)

	Argen.	Aust.	Canada	China	EU 28	India	Iran	Kazak.	North Africa	Other FSU 12	Pakis.	Russia	Turk.	Ukraine	US	TOTAL WORLD
2010	15.9	27.4	23.3	115.2	136.8	80.8	13.5	9.6	16.5	13.1	23.9	41.5	17.0	16.8	60.1	652
2011	14.5	29.9	25.3	117.4	137.4	86.9	12.4	22.7	18.4	13.8	25.0	56.2	18.8	22.3	54.4	697
2012	8.0	22.9	27.2	120.8	131.6	94.9	13.8	9.8	17.2	14.5	23.3	37.7	16.0	15.8	61.8	655
2013	9.2	25.3	37.5	121.9	143.2	93.5	14.5	13.9	19.7	15.6	24.2	52.1	18.8	22.3	58.1	717
2014	13.9	23.7	29.4	126.2	156.9	95.9	13.0	13.0	17.0	15.8	26.0	59.1	19.0	24.7	55.1	728
2015	11.3	22.3	27.6	130.2	160.5	86.5	13.8	13.7	20.0	15.7	25.1	61.0	22.6	27.3	56.1	735
2016	18.4	34.4	31.7	128.9	145.2	87.0	14.5	15.0	14.1	16.2	25.6	72.5	20.6	26.8	62.8	751
2017	18.0	21.2	30.0	129.8	151.6	98.5	14.5	14.8	19.0	15.8	26.6	85.0	21.8	27.0	47.4	760

TABLE NOTES...

European Union 28 (EU 28) consists of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany (originally West Germany), Great Britain, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden.

Former Soviet Union 12 (FSU 12) consists of Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine and Uzbekistan.

Near East Asia refers to Iran, Saudi Arabia, Syria and Turkey.

Far East Asia refers to China, Afghanistan, India and Pakistan.

Southeast Asia refers to Indonesia, Malaysia, Philippines, Thailand and Vietnam.

SECTION 2 THE GRAIN INDUSTRY IN FIGURES
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Major world wheat trading regions/countries (Mt)

	2013	2014	2015	2016	2017
IMPORTS					
Brazil	7.1	5.4	6.7	7.3	7.7
EU 28	4.1	6.0	6.9	5.3	5.5
FSU 12	7.4	7.7	7.4	7.4	7.9
Japan	6.1	5.6	5.6	5.8	5.8
Mexico	4.6	4.6	4.7	5.5	5.3
Middle East	20.7	21.3	19.9	18.1	18.2
Northern Africa	25.2	25.4	27.8	28.4	27.3
Southeast Asia	16.4	19.9	24.6	26.9	27.4
EXPORTS					
Argentina	2.3	5.3	9.6	13.8	12.8
Australia	18.6	16.6	16.1	22.6	16.8
Canada	23.3	24.2	22.1	20.0	22.5
EU 27	32.0	35.4	34.7	27.3	24.0
US	32.0	23.5	21.2	28.7	25.2
Russia	18.6	22.8	25.4	27.8	38.5
Ukraine	9.8	11.3	17.4	18.1	17.2
Others	20.2	19.9	23.5	18.9	25.1
TOTAL WHEAT TRADE (Mt)	**156.8**	**159.1**	**170.0**	**177.2**	**182.1**

World durum wheat production and trade

	2013	2014	2015	2016	2017
PRODUCTION (Mt)					
Algeria	2.5	1.3	2.2	1.7	2.0
Australia	0.5	0.5	0.5	0.6	0.5
Canada	6.5	5.2	5.4	7.8	4.2
EU 28	8.1	7.6	8.5	9.4	9.1
India	1.2	1.3	1.2	0.9	1.1
Kazakhstan	2.0	2.0	2.1	2.1	2.0
Mexico	2.3	2.0	2.0	2.3	2.1
Syria	1.5	0.8	1.4	1.0	0.9
Turkey	4.1	3.3	4.1	3.6	4.0
United States	1.6	1.5	2.3	2.8	1.5
Other	8.6	8.8	9.1	7.7	9.2
WORLD TOTAL PROD'N (Mt)	**38.9**	**34.3**	**38.8**	**39.9**	**36.6**
MAJOR IMPORTERS (Kt)					
Algeria	1529	1748	1701	1900	1800
EU 28	1902	2828	2482	1983	1900
Japan	212	205	198	250	200
Morocco	734	633	805	850	750
United States	819	908	392	400	750
Venezuela	440	407	339	275	300
MAJOR EXPORTERS (Kt)					
Australia	245	102	176	282	200
Canada	4740	5680	4354	4601	4650
EU 28	1089	1207	1365	1383	1250
Kazakhstan	83	133	160	288	300
Mexico	1275	1039	1484	1033	1150
Turkey	4	101	98	72	100
United States	689	773	616	589	450
WORLD TOTAL TRADE (Kt)	**8150**	**9291**	**8721**	**8810**	**8584**
Semolina component (Kt)	*369*	*390*	*400*	*400*	*420*

Summary of world statistics for coarse grains

	2013	2014	2015	2016	2017
Area (million ha)	326	326	323	325	319
Production (Mt)	1281	1308	1259	1365	1315
Total use (Mt)	1236	1277	1255	1353	1354
Closing stocks: World (Mt)	212	247	251	264	225
Closing stocks: US (Mt)	34.3	47.0	51.3	63.0	57.9
Stock to use ratio (%)	17.1	19.3	20.0	19.5	16.6
Trade (Mt)	165	174	185	181	189

World coarse grains production by region and country (Mt)

	2013	2014	2015	2016	2017
Argentina	35.7	36.8	38.4	48.6	39.8
Australia	12.2	12.7	12.6	17.1	12.0
Brazil	82.6	87.7	69.1	101.6	94.8
Canada	28.7	22.0	68.6	25.8	26.2
China	225.4	222.7	231.5	226.9	223.4
EU 28	158.9	170.7	152.7	152.6	151.6
India	43.2	43.1	38.7	44.4	45.2
Mexico	32.0	32.7	32.4	33.7	32.4
Nth Africa & Mid. East	31.1	26.7	32.8	26.2	30.0
Russia	35.7	40.4	37.4	40.8	41.7
Southeast Asia	26.8	26.8	27.5	29.4	29.4
Sub-Saharan Africa	101.9	110.2	98.3	113.4	109.2
Turkey	13.1	9.4	14.2	10.9	13.0
Ukraine	40.0	39.4	33.4	39.2	34.1
United States	367.1	377.2	367.0	402.6	384.3
Other	46.6	49.5	4.4	51.8	47.9
WORLD TOTAL (Mt)	**1281**	**1308**	**1259**	**1365**	**1315**
Corn Total	991.4	1016.0	972.2	1075.5	1036.1
Barley Total	145.0	144.4	150.0	150.6	143.9
Sorghum Total	58.8	64.4	62.2	60.9	59.2
Oats Total	23.8	22.9	22.4	24.2	24.1

Major world barley and sorghum producers (Mt)

	2013	2014	2015	2016	2017
BARLEY					
Argentina	4.7	2.9	4.9	3.3	3.2
Australia	9.2	8.7	8.6	13.4	8.9
Canada	10.2	7.1	8.2	8.8	7.9
China	1.7	1.8	1.9	1.7	1.8
EU 28	59.7	60.6	62.1	59.9	58.7
Russia	15.4	20.0	17.1	17.6	20.2
Turkey	7.3	4.0	7.4	4.7	6.4
Ukraine	7.6	9.4	8.7	9.9	8.7
United States	4.7	4.0	4.8	4.3	3.1
TOTAL WORLD PROD'N (Mt)	**145.0**	**144.4**	**150.0**	**150.6**	**143.9**
SORGHUM					
Argentina	4.4	3.5	3.4	3.4	3.0
Australia	1.3	2.2	1.8	1.0	1.5
India	5.5	5.4	4.2	4.6	4.7
Mexico	8.5	6.3	5.6	4.7	4.8
Sub-Saharan Africa	23.8	28.1	23.2	27.8	25.9
United States	10.0	11.0	15.2	12.2	9.2
TOTAL WORLD PROD'N (Mt)	**58.8**	**64.4**	**62.2**	**60.9**	**59.2**

World coarse grains trade by region and country (Mt)

	2013	2014	2015	2016	2017
MAJOR IMPORTERS					
Algeria, Egypt & Morocco	16.6	15.0	17.3	15.8	18.5
China	12.4	25.7	17.5	16.1	17.3
EU 28	16.3	9.4	14.3	15.9	16.9
Iran	6.6	8.0	8.3	10.0	11.4
Japan	17.5	16.7	17.1	17.0	16.7
Malaysia	3.5	3.2	4.1	3.5	3.5
Mexico	11.3	11.6	14.9	15.2	16.5
Saudi Arabia	11.3	11.2	14.0	11.8	12.5
South Korea	10.5	10.2	10.2	9.3	9.8
United States	3.3	3.3	4.0	3.4	3.3
Vietnam	4.3	6.7	8.6	8.5	9.5
MAJOR EXPORTERS					
Argentina	16.6	21.0	25.3	26.1	27.1
Australia	7.4	7.8	6.8	10.7	7.0
Brazil	22.1	21.9	35.4	19.8	31.1
Canada	5.5	3.6	4.7	5.0	4.6
EU 28	7.8	15.1	11.0	8.2	8.5
Russia	7.1	9.2	8.5	9.3	10.3
Ukraine	24.1	24.2	21.5	26.9	25.1
United States	56.8	56.4	59.2	61.8	62.5
TOTAL WORLD TRADE (Mt)	**165**	**174**	**185**	**181**	**189**

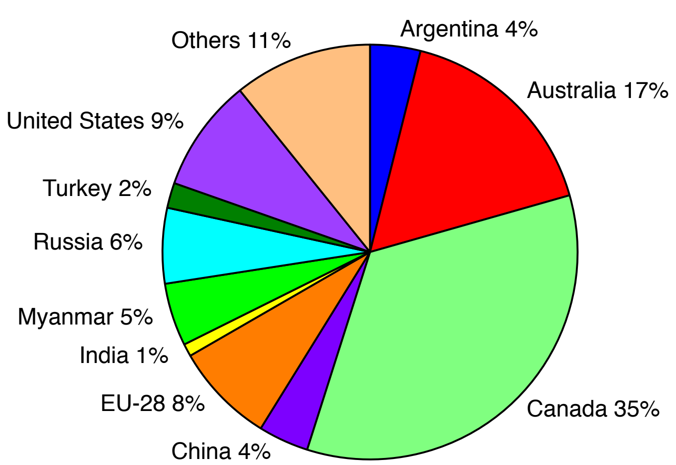
World sorghum trade by country (Kt)

	2013	2014	2015	2016	2017
IMPORTS					
Chile	109	98	134	72	100
China	4161	10162	7900	5209	5600
Colombia	104	0	64	0	50
EU28	184	131	119	194	150
Japan	1003	903	649	561	550
Mexico	162	29	661	548	200
South Sudan	108	87	19	50	150
Sudan	75	120	200	100	200
Others	1841	1055	22	939	610
MAJOR EXPORTERS					
Argentina	953	954	772	457	550
Australia	701	1205	1075	729	484
China	11	9	23	34	30
India	88	122	74	24	50
United States	5714	9269	7871	6090	6300
TOTAL EXPORTS (Kt)	**7747**	**12585**	**9768**	**7673**	**7610**

World barley trade by region (Kt)

	2013	2014	2015	2016	2017
MAJOR IMPORTERS					
Algeria	778	723	864	533	700
Brazil	337	489	551	737	550
China	4891	9859	5869	8104	7200
EU 28	58	269	315	447	500
Iran	1100	1900	1700	2200	2900
Japan	1294	1097	1154	1197	1100
Jordan	997	759	902	759	700
Libya	681	1001	1324	1085	1300
Saudi Arabia	8500	8200	10400	8400	8000
Tunisia	456	483	696	501	600
Turkey	596	332	146	291	600
United Arab Emirates	468	393	668	400	400
Others	3766	5190	3459	5657	4385
MAJOR EXPORTERS (feed and malting)					
Argentina	2829	1599	2836	2696	2500
Australia	7124	6208	5498	9537	6199
Canada	1714	1386	1147	1770	1500
EU 28	4926	10642	8644	5683	6200
Kazakhstan	596	479	807	823	1100
Russia	2791	5807	3735	3629	5400
Ukraine	3827	4332	4673	5337	4900
United States	336	291	161	125	130
TOTAL EXPORTS (Kt)	**23922**	**30094**	**27587**	**29573**	**27835**

Major pulse exporters as a percentage of total world trade in 2017 (16.9 million tonnes)



Total world pulse trade in 2017: 16,941 Kt

World pulse trade and type (Kt)

	2014	2015	2016	2017
MAIN IMPORTERS				
EU-28	1268	1143	1112	1126
CIS	89	78	86	96
North & Central America	1180	1029	1093	1148
South America	661	567	726	753
Near East Asia	2071	2159	2073	2199
Far East Asia	7521	8837	9257	9701
Africa	1614	1789	1537	1677
Oceania	45	39	39	42
Others	141	161	174	199
MAIN EXPORTERS				
Argentina	356	515	664	663
Australia	1417	2071	2070	2797
Canada	5745	5906	5679	5864
China	547	499	636	635
EU-28	529	815	1337	1338
India	237	218	176	176
Myanmar	1338	1107	842	844
Russia	633	926	962	956
Turkey	239	311	318	320
United States	1372	1167	1460	1461
Others	2178	2268	1953	1888
TOTAL WORLD TRADE (Kt)	**14590**	**15802**	**16097**	**16941**
TYPE OF PULSE TRADED				
Field (Dried) peas	4824	4910	5517	5705
Lentils	3027	3529	3049	3466
Chickpeas	1665	2358	2288	2387
Kidney beans	1740	1729	1699	1709
Urd/Mungbeans	1133	1092	1377	1380
Broad beans	747	805	829	937
Others	1454	1381	1339	1357
TOTAL WORLD TRADE (Kt)	**14590**	**15802**	**16097**	**16941**
TOTAL WORLD PULSE PRODUCTION (Kt)	**78074**	**77573**	**81799**	**82000[f]**

SECTION 2 THE GRAIN INDUSTRY IN FIGURES

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World chickpea trade and production (Kt)

	2014	2015	2016	2017
MAIN IMPORTERS				
Algeria	62	45	51	52
Bangladesh	229	212	166	167
Egypt	34	34	25	23
EU-28	146	141	138	141
India	297	970	877	876
Pakistan	198	311	406	426
United Arab Emirates	112	101	117	119
United States	35	49	60	61
Others	270	271	251	324
MAIN EXPORTERS				
Australia	674	1140	1970	1290
Canada	56	112	135	133
India	209	188	121	120
Russia	312	326	239	230
United States	52	46	124	125
Others	362	546	-301	489
TOTAL WORLD TRADE (Kt)	**1665**	**2358**	**2288**	**2387**
WORLD CHICKPEA PRODUCTION (Kt)	**13399**	**11036**	**12092**	**13334[f]**

World field (dried) pea trade and production (Kt)

	2014	2015	2016	2017
MAIN IMPORTERS				
Bangladesh	538	385	350	351
China	865	784	1091	1100
Cuba	96	66	81	80
EU-28	328	203	201	205
India	1687	1997	2292	2300
Pakistan	104	123	132	133
Turkey	147	361	398	399
United Arab Emirates	96	40	35	37
United States	237	143	117	119
Others	659	741	754	916
MAIN EXPORTERS				
Argentina	58	70	94	94
Australia	179	143	225	209
Canada	3269	2831	3132	3266
EU-28	96	368	723	722
Russia	312	589	702	705
United States	530	439	563	562
Others	380	470	78	147
TOTAL WORLD TRADE (Kt)	4824	4910	5517	5705
WORLD FIELD PEA PRODUCTION (Kt)	**11661**	**12043**	**14363**	**12830[f]**

World oilseed production, trade and type (Mt)

	2014	2015	2016	2017
PRODUCTION				
Africa	16.10	16.36	16.83	17.52
Argentina	61.4	60.80	62.82	44.62
Australia	4.38	3.74	5.67	5.19
Brazil	100.16	98.91	116.94	118.45
Canada	22.51	24.91	26.20	29.56
China	57.66	54.45	56.53	60.32
EU-28	35.91	32.44	31.91	34.69
FSU-12	36.20	34.39	39.91	39.42
India	32.28	28.64	36.53	33.58
Southeast Asia	4.80	4.65	4.59	4.52
Turkey	2.59	2.28	2.68	3.29
United States	116.03	115.88	126.94	131.3
Other countries	47.53	44.08	47.39	46.35
TOTAL WORLD PRODUCTION	**537.55**	**521.53**	**574.94**	**568.81**
PRODUCTION BY TYPE				
Canola	71.45	69.96	71.28	74.28
Cottonseed	44.40	35.81	39.11	44.99
Peanut	40.45	40.42	43.07	44.12
Soybean	320.02	313.77	350.76	334.81
Sunflower	39.25	40.30	47.85	46.24
Other oilseeds	21.98	21.27	22.87	24.37
TOTAL WORLD PRODUCTION	**537.55**	**521.53**	**574.94**	**568.81**
WORLD OILSEED TRADE				
Canola	15.11	14.35	15.90	16.63
Cottonseed	0.72	0.71	0.93	1.06
Peanut	3.33	3.54	3.74	3.69
Soybean	126.22	132.56	147.46	150.40
Sunflower	1.66	2.01	2.44	2.13
Other oilseeds	0.14	0.17	0.22	0.18
TOTAL WORLD TRADE	**147.18**	**153.34**	**170.69**	**174.09**

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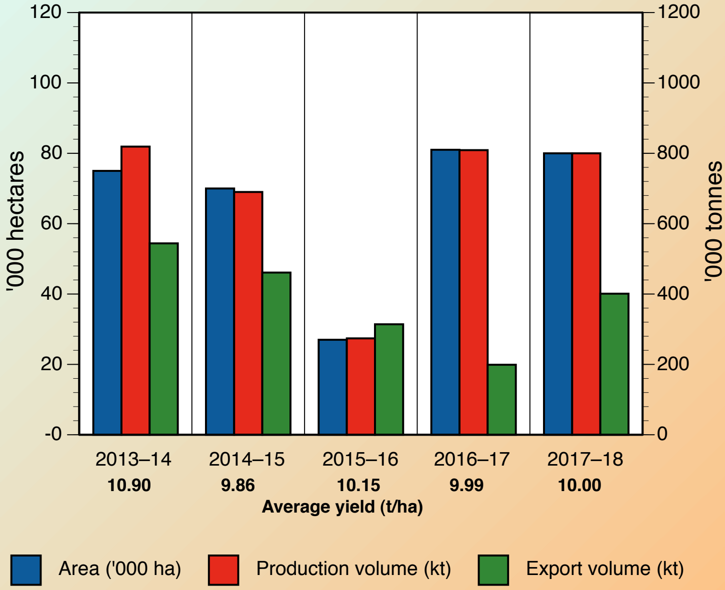
World canola production and trade (Mt)

	2014	2015	2016	2017
MAIN PRODUCERS				
Australia	3.54	2.77	4.31	3.67
Canada	16.41	18.38	19.60	21.50
China	14.78	14.93	14.55	14.40
EU-28	24.00	22.00	20.54	22.10
FSU-12	5.00	3.26	2.67	4.60
India	6.50	5.92	7.09	5.70
United States	1.14	1.31	1.41	1.42
Others	0.08	1.39	1.11	0.89
TOTAL PRODUCTION	**71.45**	**69.96**	**71.28**	**74.28**
MAIN EXPORTERS				
Australia	2.45	1.95	3.60	2.53
Canada	8.00	10.31	11.10	10.52
Ukraine	1.92	1.42	1.01	1.81
Others	1.73	0.32	1.31	0.85
MAIN IMPORTERS				
China	4.60	3.74	4.42	4.50
EU-28	2.62	3.32	5.31	3.92
Japan	2.43	2.21	2.52	2.20
Mexico	1.50	1.41	1.62	1.60
Pakistan	0.92	1.20	1.01	1.10
Others	2.03	2.12	2.14	2.39
TOTAL CANOLA TRADE	**14.10**	**14.00**	**17.02**	**15.71**

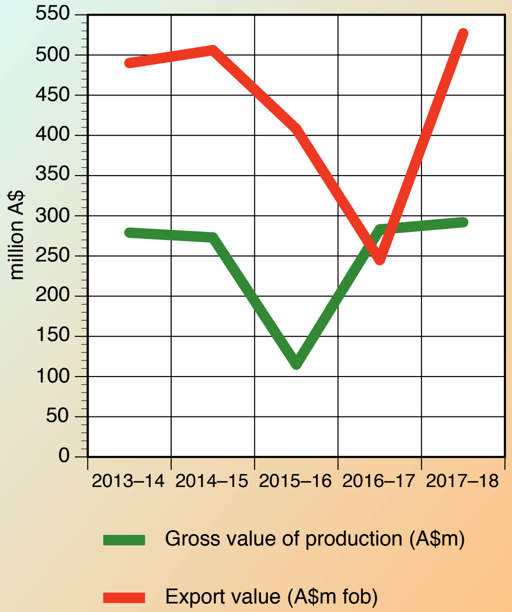
World cottonseed production (Mt)

	2014	2015	2016	2017
MAIN PRODUCERS				
Australia	0.75	0.89	1.26	1.41
Brazil	2.67	1.94	2.27	2.89
China	12.32	8.60	8.80	10.80
FSU-12	2.48	2.34	2.20	2.25
India	12.32	11.00	11.46	12.10
Pakistan	4.44	3.05	3.35	3.60
United States	4.65	3.67	4.87	6.10
Others	4.77	4.32	4.90	5.84
TOTAL PRODUCTION	**44.40**	**35.81**	**39.11**	**44.99**

Summary of Australian rice statistics (paddy) by area and volume



Australian rice export value and gross value of production



Summary of world statistics for rice

	Area (million ha)	Production (Mt, milled)	Use (Mt)	Closing stocks (Mt)	Stocks to use ratio (%)	Trade (Mt)	Av. price US$/t (Thai 100%)
2012–13	159	474	467	117	25.0	42.5	565
2013–14	161	479	479	116	24.3	41	429
2014–15	161	480	475	121	25.4	39	420
2015–16	159	473	473	121	25.5	44	386
2016–17	160	486	483	123	25.4	43	394
2017–18	160	487	480	144	30.0	49	433

World rice production, by country (Mt, milled equivalent)

	Aust.	B-desh	Brazil	China	EU-28	India	Indon.	Japan	Myan.	Pakis.	Philip.	Thail.	US	Viet.	TOTAL
2012–13	0.84	33.8	8.0	143.0	1.9	105.2	36.8	7.9	11.7	6.0	11.4	20.3	6.3	27.5	**474**
2013–14	0.59	34.4	8.3	142.5	1.8	106.7	36.3	7.9	11.9	6.8	11.9	20.5	6.1	28.2	**479**
2014–15	0.50	34.5	8.5	144.6	1.6	105.5	35.6	7.8	12.6	7.0	11.9	18.8	7.1	28.2	**480**
2015–16	0.20	34.5	7.2	145.8	2.0	104.4	36.2	7.7	12.2	6.8	11.0	15.8	6.1	27.6	**473**
2016–17	0.59	34.6	8.4	144.9	2.1	109.7	36.9	7.8	12.6	6.8	11.7	19.2	7.1	27.4	**486**
2017–18	0.58	32.7	8.1	146.0	2.1	110.0	37.0	7.6	13.2	7.5	12.3	20.4	5.7	28.4	**487**

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In this section the rice crop is the year of planting. (The 2017–18 figure is therefore a forecast of the Australian rice harvest in March–April 2018.)

Section 3

District Reports

Reviews of the 2017–18 season and plans for 2018–19

CONTENTS

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National overview

The 2017–18 winter crop returned better than expected harvest results in some key growing regions which boosted production following a mixed season. Favourable seasonal conditions during spring in some regions of Western Australia and South Australia and during most of the winter crop season in Victoria lifted production above mid-season estimates.

But crop yields in Queensland and New South Wales were well below average because of unfavourable seasonal conditions during much of the winter crop season.

Total Australian winter crop production was estimated at 37.8 million tonnes (mt) in 2017–18. This tonnage is 6 per cent above the 10-year average to 2015–16.

For the major crops, wheat production is estimated to have decreased by 38 per cent on the record 2016 year to 21.2 mt, barley by 33 per cent to 8.9 mt and canola by 15 per cent to 3.7 mt.

Amongst other crops, chickpea production is estimated to have decreased by 49 per cent on the previous year to 1.0 mt and oats production by 40 per cent to 1.1 mt.

2017–18 summer crop

The 2017–18 summer crop will return mixed results. Below average rainfall and above average temperatures in late spring and early summer curtailed summer crop planting in the latter part of the planting window which lowered yield prospects for dryland crops.

The summer crop planted area is estimated to have increased by 2 per cent on 2016–17 to 1.3 million hectares. Total summer crop production is forecast to increase by 12 per cent to around 4.3 mt.

On the back of improved price prospects, the area planted to grain sorghum is estimated to have increased by 26 per cent to just over 500,000 hectares with a production forecast of around 1.5 mt.

The area planted to cotton in 2017–18 is estimated to have fallen by 10 per cent on the previous season to 500,000 hectares – dryland cotton makes up about 20 per cent of this area. Dryland cotton planting fell by around 17 per cent on last season to 106,000 hectares due to low levels of soil moisture during the planting window – August to December.

Cotton production for the 2017–18 season is forecast at 995,000 tonnes of cotton lint and 1.4 mt of cotton seed.

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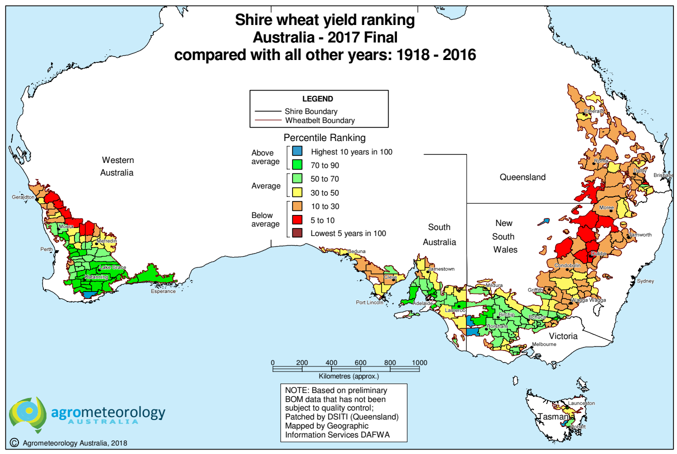
The area planted to rice is estimated to have been 80,000 hectares. Supplies of irrigation water were sufficient to realise rice planting intentions. Rice production for the 2017–18 season is forecast at around 800,000 tonnes – a similar tonnage as the previous season.

Source: ABARES February 2018, *Australian Crop Report*



Western Australia

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

AUSTRALIAN WINTER CROP AREA & PRODUCTION OVER THE PAST 10 YEARS

Year	NSW		Vic		Qld		SA		WA		Tas		Australia	
	'000 ha	Kt	'000 ha	Kt	'000 ha	Kt	'000 ha	Kt	'000 ha	Kt	'000 ha	kt	'000 ha	Kt
2008–09	6295	9438	3492	3887	1208	2326	3979	4863	7899	13,785	27	78	22,901	34,378
2009–10	6106	7787	3488	5889	1173	1617	3783	7035	8271	12,943	23	72	22,844	35,344
2010–11	6158	14,784	3457	7625	1217	1821	3821	9316	7715	8044	24	82	22,392	41,672
2011–12	5969	11,952	3411	7352	1205	2329	3838	7371	8252	16,600	18	65	22,693	45,670
2012–13	5852	11,123	3457	6886	1222	2156	3776	6470	8097	11,243	16	56	22,421	37,934
2013–14	5314	9773	3283	6773	1105	1516	3448	7221	8249	16,510	20	85	21,420	41,878
2014–15	5491	10,445	3304	5117	995	1464	3639	7439	8313	14,662	19	71	21,760	39,197
2015–16	5375	11,624	2915	3568	1049	2104	3152	6105	7771	14,206	20	75	20,283	37,687
2016–17	5739	16,093	3340	10,180	1337	3304	3523	11,157	8442	18,041	14	69	22,400	58,846
2017–18 est.	5496	7181	3333	7634	1309	1390	3505	6945	8441	14,619	16	54	22,101	37,824
10 year average	**5780**	**11,020**	**3348**	**6491**	**1182**	**2003**	**3646**	**7392**	**8145**	**14,065**	**20**	**71**	**22,122**	**41,043**

NOTE: Includes barley, canola, chickpeas, faba beans, field peas, lentils, linseed, lupins, oats, safflower, triticale and wheat.
SOURCE: ABARES February 2018 *Australian Crop Report*.

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TABLE 1: 2017 WA crop production estimates (tonnes) – GIWA

Port zone	Wheat	Barley	Canola	Oats	Lupins	Field pea	State total
Kwinana	3,550,000	1,510,000	610,000	305,000	210,000	20,000	**6,205,000**
Albany	1,400,000	1,300,000	580,000	165,000	65,000	4000	**3,514,000**
Esperance	1,450,000	920,000	565,000	5000	25,000	20,000	**2,985,000**
Geraldton	1,200,000	70,000	145,000	5000	150,000	1000	**1,571,000**
Totals	7,600,000	3,800,000	1,900,000	480,000	450,000	45,000	**14,275,000**
Compared to 2016 harvest	–25%	–9%	–12%	–48%	–37%	–25%	**–21%**

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

TABLE 2: 2017 WA crop yield estimates (t/ha) – GIWA

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

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

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

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

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

A healthy 2017 crop of Emu Rock wheat at Schutz Grains, Grass Patch, about 80 km northeast of Esperance, WA. The Esperance Port Zone went on to receive a record delivery of all grains of nearly 3.0 million tonnes. (PHOTO: Quenten Knight)

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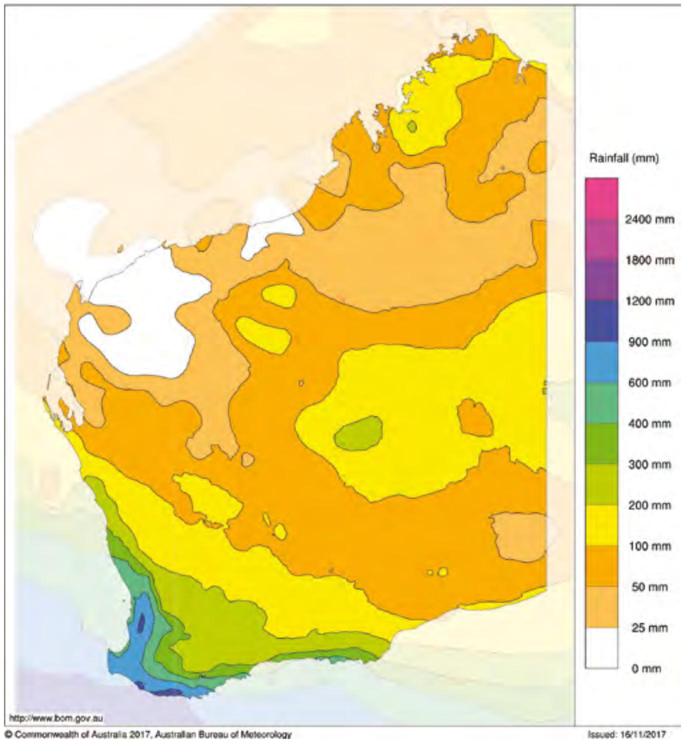
And there was more good news for the Esperance port zone with a record year of just under 3.0 mt production for all grains.

Grain quality in 2017

- Grain weight was high in all regions and screenings low – this was a function of the soft slow finish with minimal frost.
- Very little grain was rain-affected at harvest and/or downgraded from adverse climatic events.
- Protein in wheat and barley was generally low due to dilution from

Western Australia rainfall totals (mm) April 1 – November 16, 2017
Australian Bureau of Meteorology



After an extremely dry start to the 2017 winter crop, late rains gave a number of grain producing areas of Western Australia close to average growing season rainfall totals.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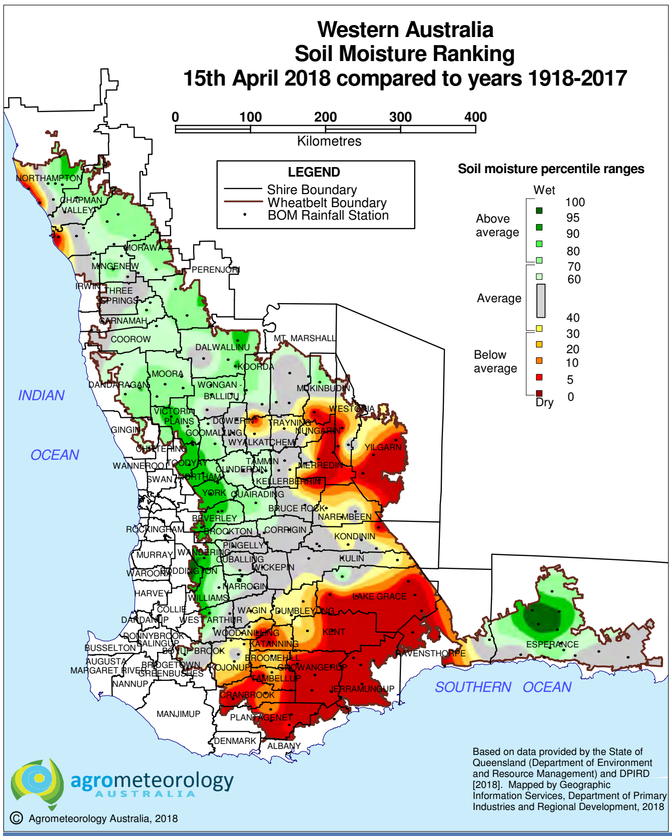
higher than expected yields. It was a difficult year for growers to manage their inputs as most had not experienced such a late start combined with such a good finish.

The comment from several of the consultants contributing to this report last year was: "You could only get protein off a legume, not out of the bag."

- There was more noodle wheat produced than predicted with increased production from the north and south of the state.
- Canola oil quality was high due to the slow cool finish and contributed significantly to the profit margins of canola crops.
- Lupin tonnage was hit hard by the poor season in the north of WA where traditionally most of the lupins are grown. Some of the newer varieties performed well in the central and south of the state and may in future contribute more to production.
- Milling oats have been steadily increasing in area and depending on price stability, may continue to do so as demand continues to increase.
- Field peas finally had a good year and whilst growers may move into more plantings based on success in 2017, there was a noticeable increase in chickpea, lentil and faba bean test plantings around the state.



***Agrometeorology Australia* runs a two-stage fallow evaporation model at over 1000 real-time rainfall stations across Australia. This chart depicts the total plant available soil moisture estimates on April 15, 2018 for shires across Western Australian grain-belt.**
This mid-April 2018 plant available soil moisture estimate is compared to the soil moisture estimates for April 15 for the past 100 years to produce a ranking.
Average to above average early summer rainfall across much of the northern Western Australian grain-belt has set up good soil moisture reserves at depth.
But much of the southern WA grain-belt, excluding the Esperance region, has below average rankings due to below average summer rainfall and mainly light rainfall events where the moisture quickly evaporated.

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Outlook for the 2018 Season

By mid-April, growers in some areas had commenced an earlier start to seeding for 2018 with an estimated area of 8.4 million hectares of winter crop to be planted across Western Australia.

Small areas of canola had gone in on moisture from isolated thunderstorms in the eastern and southern regions but most canola sown by mid-April had been dry sown.

Most growers will start sowing the bulk of the winter crop – dry if need be – by ANZAC Day.

The outlook for increased barley plantings looks likely to occur although this will be less in the regions of the state that had a reasonable season in 2017. The wheat area is continuing to decrease, being substituted for barley and to a lesser extent pasture.

Resowing of pastures to legumes is an increasing trend across the whole state as is the sowing of cereals intended for grazing by stock.

Intended canola and lupin areas will remain about the same as last year, although how April pans out rain-wise will determine the final areas sown.

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

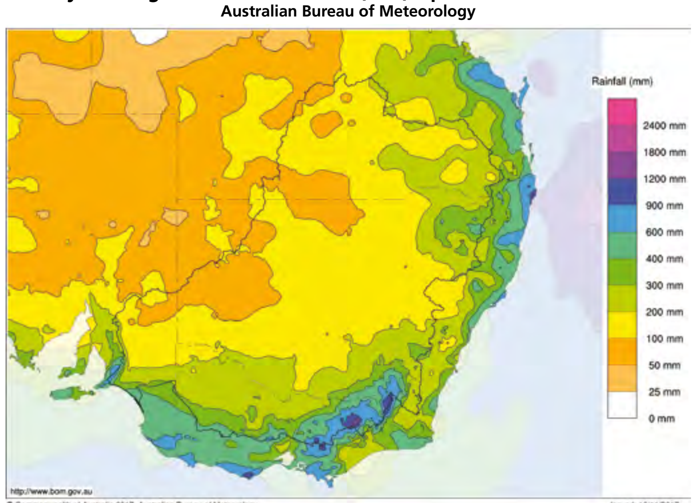
Compiled from Grain Industry Association of WA crop reports

South Australia

Despite below average growing-season rainfall in many districts, total state crop production has been only slightly below the long-term average at 6.8 million tonnes from a smaller than average crop area at 3.6 million hectares.

A dry finish to the season reduced yield potential in most districts,

Murray–Darling Basin rainfall totals (mm) April 1 – November 16, 2017
Australian Bureau of Meteorology



Patchy growing season rainfall in 2017 created a mixed bag of winter crop yields throughout the Murray-Darling Basin.

with crops on deep sands or shallow soils drying off early. Crops on soils with good moisture-holding capacity were able to ripen slowly.

Where good summer weed control allowed soil moisture to be conserved and where crops were sown and emerged early, crops yielded above average. Paddocks with poor summer weed control, or where crops were sown or emerged late, yielded below average.

Frosts in late October and early November severely affected crops yields in the Northern Mallee with average losses of 20 per cent, There was also severe frost damage in areas of the South East and isolated frost damage in a number of other districts.

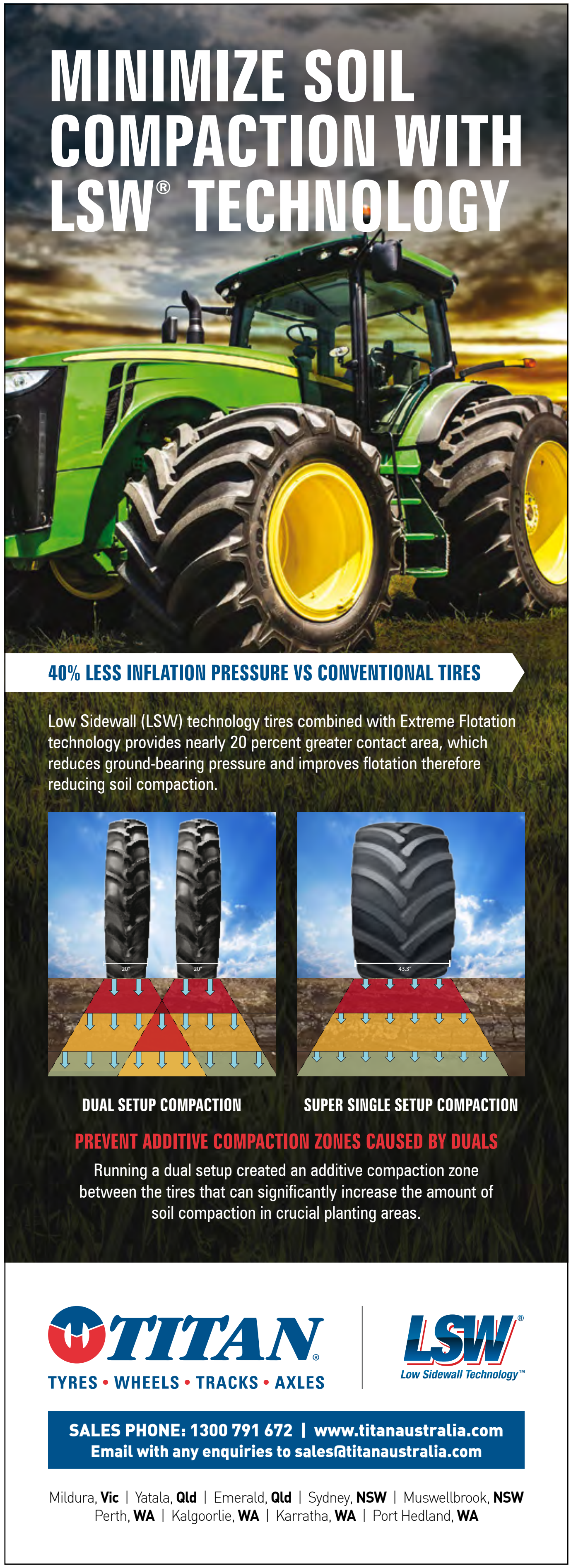
Despite well above average rainfall in the South East, crop yields were only average to slightly above average due to frost and waterlogging.

Harvest was completed in most districts by the end of December. Farmers on Kangaroo Island, Adelaide Hills, Fleurieu Peninsula and Lower South East completed harvest by mid to late January.

Cool and damp weather slowed harvest in early November and heavy rain in late November and early December halted harvest in many districts.

SOUTH AUSTRALIA 2017–18 WINTER CROP PRODUCTION (tonnes) AND AREA (hectares) AGAINST THE 5 YEAR AVERAGE

Crop		5-year average	State total 2017–18
Wheat	ha	2,229,200	2,016,100
	tonnes	4,796,100	4,034,000
Durum	ha	60,300	55,700
	tonnes	158,200	135,900
Barley	ha	840,900	712,100
	tonnes	2,136,200	1,599,200
Oats	ha	81,800	77,000
	tonnes	154,200	146,300
Rye	ha	8700	6500
	tonnes	9000	5100
Triticale	ha	37,800	19,900
	tonnes	63,500	34,950
Peas	ha	101,500	90,200
	tonnes	130,700	112,850
Lupins	ha	70,100	62,800
	tonnes	90,300	53,400
Beans	ha	69,600	67,400
	tonnes	116,500	101,660
Chickpeas	ha	20,200	29,300
	tonnes	25,000	33,080
Lentils	ha	116,600	184,700
	tonnes	196,200	260,200
Vetch	ha	23,000	32,400
	tonnes	16,200	15,100
Canola	ha	267,700	199,700
	tonnes	362,600	248,900
Hay (not in total)	ha	237,700	202,900
	tonnes	1,019,800	948,600
STATE TOTALS	**ha**	**3,927,500**	**3,553,800**
	tonnes	**8,254,800**	**6,780,600**



Heavy rain resulted in weather damage and down-grading of unharvested wheat and barley crops in some districts.

Given the seasonal conditions, cereal crops generally yielded exceptionally well, with most districts achieving close to average yields and some districts above average yields.

Grain harvested before the rain was generally of good quality with low levels of screenings. Higher than expected yields in some districts and fewer opportunities for nitrogen application during the dry growing season resulted in low grain protein in some areas.

Oil content was highly variable both within and across districts, ranging from 35 to 48 per cent. Frost damage resulted in green seed levels above receival standards in some crops in the South East, which diminishes oil quality.

Following the November and December rainfalls there was germination and growth of summer weeds and volunteer crops. Most farmers have begun applying herbicides to control this growth.

Elevated mice numbers damaged the 2017 crop causing yield losses in the Lower and Southern Murray Mallee areas where hail storms destroyed crops in 2016 (the fallen grain providing a food source).

More 'pasture topping' and less elimination of grasses from pastures during spring on Eyre Peninsula increases the risk of certain cereal root diseases in the new season cereal crops.

High numbers of Russian wheat aphids caused some crop damage on Eyre Peninsula before crops were sprayed for the pest.

PIRSA Crop and Pasture Report, January 2018

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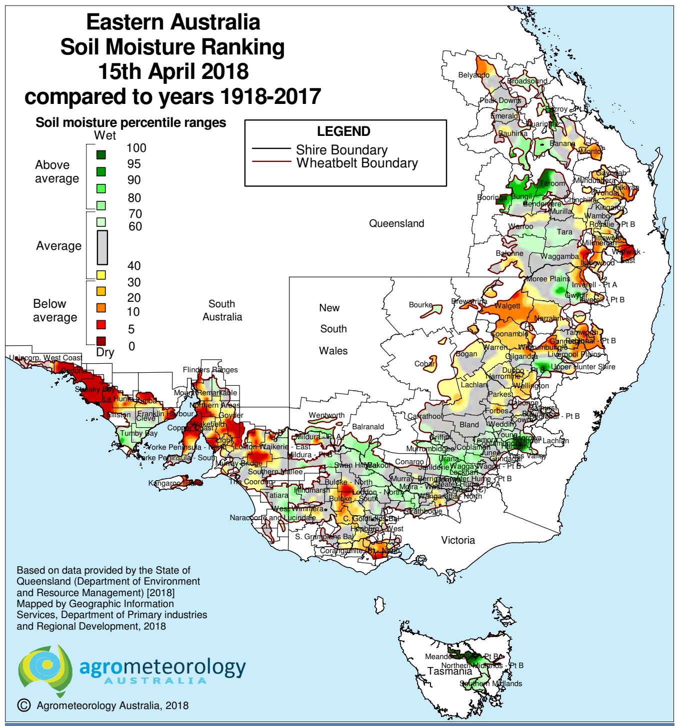
Victoria

Seasonal conditions in Victoria over most of the 2017 winter crop season were generally favourable for production but crops in some regions were adversely affected by frost events and rainfall during harvest. Frost impacts were particularly hard on pulses. But the generally favourable seasonal conditions were the dominant influence on crop production and eventual harvest yields were better than anticipated early in the season.

Total winter crop production in Victoria is estimated to have fallen by 25 per cent on the record previous season to 7.6 mt. Average yields were



***Agrometeorology Australia* runs a two-stage fallow evaporation model at over 1000 real-time rainfall stations across Australia. This chart depicts the total plant available soil moisture estimates on April 15, 2018 for shires across the eastern Australian grain-belt.**
This mid-April 2018 plant available soil moisture estimate is compared to the soil moisture estimates for April 15 for the past 100 years to produce a ranking.
Average to above average early summer rainfall across much of southern New South Wales, southern Eyre Peninsula and central southeast Queensland has set up good soil moisture reserves at depth.
But the northern Eyre Peninsula and parts of southern Victoria and northern New South Wales have below average rankings due to below average summer rainfall and mainly light rainfall events where the moisture quickly evaporated.

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generally above average. Planted winter crop area is estimated to have remained steady at 3.3 million hectares.

Wheat production is estimated at 4.0 million tonnes from 1.6 million hectares planted.

Barley production was around 2.1 million tonnes from 800,000 hectares.

Canola production increased by around 7 per cent on 2016 to 750,000 tonnes, driven by an estimated 27 per cent increase in planted area. The average canola yield is estimated to have decreased by 15 per cent to 1.67 tonnes per hectare.

Source: ABARES February 2018, *Australian Crop Report*

Victorian Mallee

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

An early summer rainfall event warranted spraying and in some instances it was straight off the header and onto the sprayer. Since then, summer rainfall has been minimal meaning little summer spraying has needed to be carried out.

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

Leading up to 2018 winter crop sowing, farmers have been busy soil sampling paddocks to get an understanding of nutrient and soil moisture status. A lot of seed cleaning and grading has been carried out and there's

Grain growers in the Victorian Mallee enjoyed generally good growing season rainfall totals in 2017 which were reflected in above average winter crop yields. (PHOTO: BCG)

A crop of 2017 field peas in the Victorian Mallee in full flower. (PHOTO: BCG)

a push to do germination tests and calibrate seeding rates based on seed size (when retaining seed).

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

Ciara Cullen
BCG extension and communications manager

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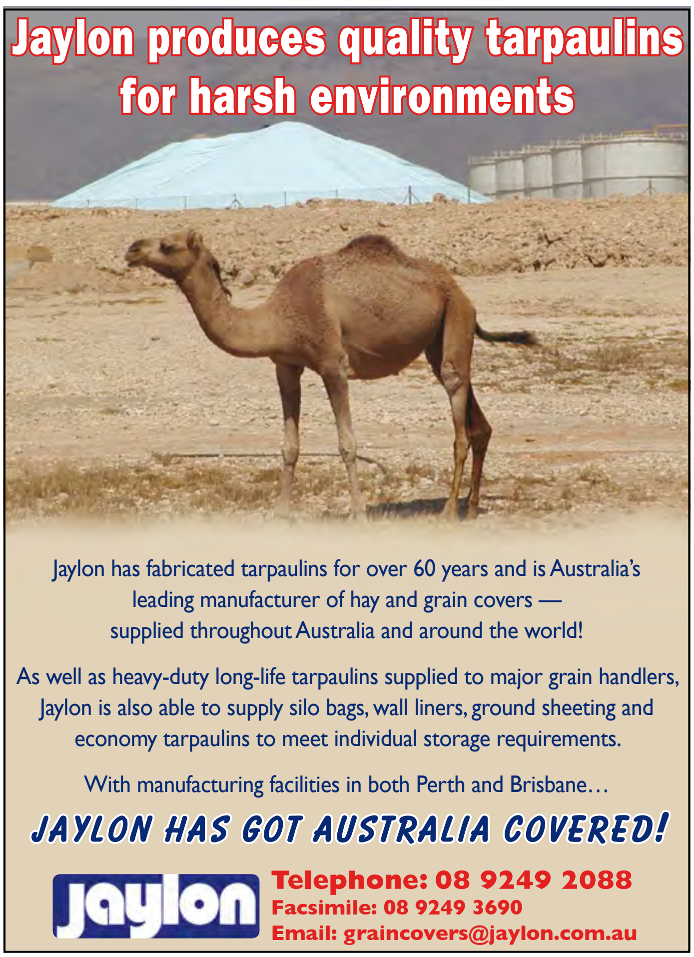
New South Wales

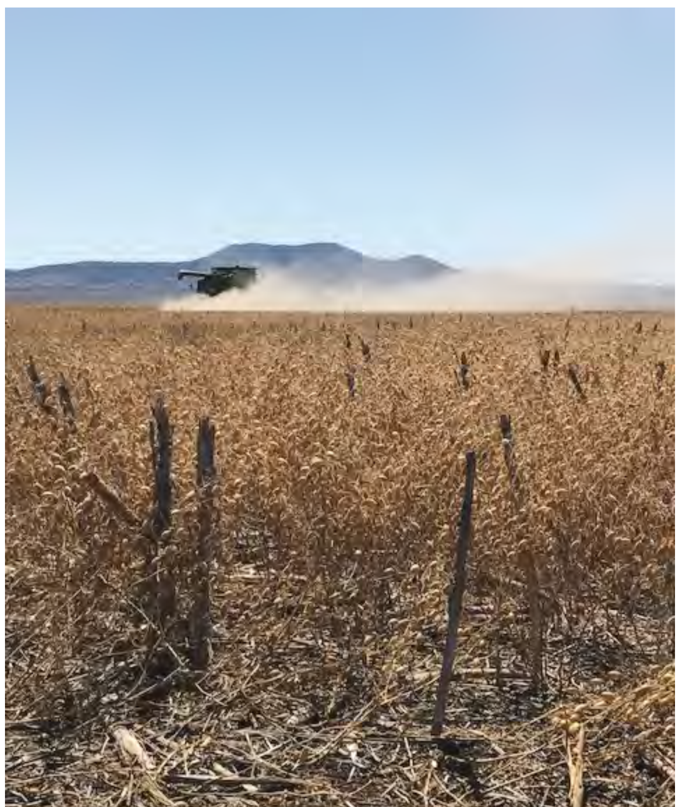
Total winter crop production in New South Wales in 2017–18 was estimated to have decreased by 55 per cent on the record 2016 season to around 7.2 mt. This was driven by significant falls in yields due to unfavourable seasonal conditions and a reduction in area planted to wheat and barley.

Wheat production in 2017–18 was estimated at around 4.5 mt, reflecting average yield of 1.45 tonnes a hectare. Area planted to wheat fell by 6 per cent on the previous season to 3.1 million hectares.

Barley production was around 1.2 mt with an average yield of 1.5 tonnes a hectare – around half of the record high achieved in 2016. The area planted to barley fell by 9 per cent to 790,000 hectares.

Canola production in 2017–18 was estimated to have fallen by around 39 per cent on the previous season to around 618,000 tonnes. This was despite a 12 per cent increase in planted area to 650,000 hectares. The average canola yield almost halved on the 2016 result to 0.95 tonnes a hectare, reflecting unfavourable seasonal conditions.





The 2017 chickpea harvest underway at 'Tipa-Hootti' near Premer on the Liverpool Plains of northern NSW. Below average growing season rainfall in 2017 meant that winter crops planted into long fallow paddocks performed much better than short fallow. (PHOTO: Lauren McGavin)

AUSTRALIAN SUMMER CROP AREA AND PRODUCTION OVER THE PAST 10 YEARS

Year	New South Wales		Queensland		Australian total	
	'000 ha	Kt	'000 ha	Kt	'000 ha	Kt
2008–09	402	1430	746	2350	1156	3794
2009–10	381	1405	514	1342	903	2764
2010–11	713	2514	790	1901	1514	4446
2011–12	757	3064	783	2379	1558	5494
2012–13	711	3205	686	2250	1412	5506
2013–14	568	2317	559	1469	1139	3847
2014–15	435	2044	696	2134	1149	4262
2015–16	412	1656	624	1821	1054	3563
2016–17 s	687	2259	594	1478	1296	3809
2017–18 f	634	2473	685	1789	1327	4282
10 year average	**570**	**2237**	**668**	**1891**	**1251**	**4177**

Note: State production includes cottonseed, grain sorghum, maize, mung beans, rice, peanuts, soybeans and sunflower. Total for Australia also includes navy beans and small areas and volumes of summer crops in other states. Summer crop production figures include northern wet season rice and northern dry season cotton and rice.
SOURCE: ABARES February 2018, *Australian Crop Report*.

The 2017-18 summer crop

Seasonal conditions during December 2017 and early January 2018 were generally not favourable for summer crop planting. Below average January rainfall and very much above average temperatures depleted soil moisture levels and reduced yield prospects for dryland summer crops.

Area planted to summer crops in NSW is estimated to have decreased by 8 per cent on the previous year to 634,000 hectares. This is a reflection of lower supplies of irrigation water and insufficient soil moisture in some regions for planting dryland crops.

The area planted to grain sorghum in 2017–18 in NSW is estimated to have increased by around 11 per cent on the previous summer to 150,000 hectares but still below initial planting intentions. Soil moisture levels were well below average at the start of summer and significant widespread rainfall was needed for planting intentions to be realised.

But December and January rainfall was below average. Very much

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above average maximum temperatures further depleted soil moisture particularly around Moree and Narrabri.

Grain sorghum yields were generally below average with production at around 465,000 tonnes.

Area planted to cotton in 2017–18 is estimated to have fallen by 16 per cent to 310,000 hectares. Around 262,000 hectares was irrigated with about 48,000 hectares sown to dryland cotton.

Production is forecast to increase by around 16 per cent on the previous crop to around 667,000 tonnes of cotton lint and 943,000 tonnes of cotton seed.

Rice production is forecast to be about 790,000 tonnes in 2017–18 off 78,000 hectares. Seasonal conditions have been generally favourable for crop development.

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Total 2017–18 summer crop production in New South Wales is forecast at around 2.5 million tonnes.

Source: ABARES February 2018, *Australian Crop Report*

Queensland

Total winter crop production in Queensland in 2017–18 is estimated to have fallen by almost 60 per cent on the previous season to 1.4 million tonnes. There were well below average yields in all winter crops.

Wheat production fell to around 683,000 tonnes – the lowest Queensland wheat crop since 2002–03. But crop quality was generally better than expected and a higher proportion of the crop met high-quality milling wheat standards.

Chickpea production is estimated to have halved on the previous year to around 565,000 tonnes in 2017–18. A 5 per cent rise in the area planted to chickpeas was more than offset by an estimated 53 per cent fall in the average yield.

Barley production was around 120,000 tonnes. This was driven by a fall in area planted and a 57 per cent drop in average yield.

The 2017-18 summer crop

Rainfall in most summer cropping districts of Queensland was below average from November 2017 to January 2018 and maximum temperatures were above average. These conditions impacted heavily on soil moisture levels. Upper layer soil moisture in parts of the south-west cropping region was in the lowest 1 per cent on record for January.

These unfavourable seasonal conditions reduced the planting of dryland summer crops late in the planting window.

But the area planted to summer crops in Queensland is forecast to have risen by 15 per cent to around 685,000 hectares driven by an increase in area planted to grain sorghum. Total summer crop production is forecast at around 1.8 mt.

The area planted to grain sorghum was around 350,000 hectares – well below the

10-year average of 435,000 hectares. Production is forecast at just under 1.0 mt.

Cotton area is up slightly on the previous summer at around 190,000 hectares. Of that total, dryland cotton is estimated to be 58,000 hectares. Total cotton production is forecast at around 328,000 tonnes of lint and around 464,000 tonnes of cotton seed.

Source: ABARES February 2018, *Australian Crop Report*

Darling Downs

Overview

The weather has been the major influence on crop performance this past 12 months. A dry and frosty winter was difficult after good rain in March from Cyclone Debbie, and then there was no proper follow up until October. This allowed a spring plant and some December rain allowed a summer plant, but very dry and very hot conditions in January and February hammered dryland and irrigated crops alike.

Winter 2017

Another record chickpea planting occurred on the high prices offered again, with most crops planted early, and although the second break in July allowed cereals to be planted, the area was only 50 per cent of the traditional area. The total lack of rain in August and September affected crops, along with heavy frost damage especially to chickpeas, and both yields and quality were disappointing. Crops basically grew on stored subsoil moisture from March. Late infestations of insect pests and disease did not help what turned out to be a disappointing season.

Summer 2017–18

For once there was a proper spring plant with sorghum the crop of choice planted in October, along with irrigated corn and both irrigated and dryland cotton, plus a good area of sunflowers on the eastern Downs. December rain allowed a summer plant of corn, mungbeans and some soybeans, but there were damaging storms just before Christmas north from Norwin, with hail and cyclonic winds.

The biggest pests of this 2017-18 sunflower crop at Felton on the eastern Darling Downs of Qld were photographers!
(PHOTO: Hugh Reardon-Smith)

January and February then turned off the water supply and instead added a lot of heat. This created very difficult conditions for crops, and saw the early sown sorghum die rather than ripen, leading to lodging and screening issues. Irrigated crops were also affected dropping fruit, and it appears the hot soil has damaged the pulse crops inoculum, leading to N deficiencies.

It was a great season for the sunflower photographers, but with hordes descending on roadside crops, the downside was farmers suffering some crop damage, both from trampling and cutting off the heads.

Sorghum yields were significantly reduced by what has been described as a brutal summer, and it was not easy to achieve sorghum 1 quality. Fair to heavy rain in early March has helped the later sown crops, but has been scattered. There was flooding around Chinchilla and parts of Dalby, but the eastern Downs could have absorbed up to 100 mm more. Insect pressure has been low, but in the wet areas there has been some sprouting.

Outlook for winter 2018

We seem to be stuck on only two significant rainfall periods a year, in October and March. Soil moisture levels are varied with some farms under better rain with good profiles, whilst others need 75–100 mm to build up soil moisture reserves.

Cropping trends

There is a definite move back to cereals, mainly based on price, but also for rotational reasons, and this will take the pressure off some of the diseases in the pulse crops.

Hugh Reardon-Smith,
Agronomist Landmark Pittsworth

SECTION 3 DISTRICT REPORTS

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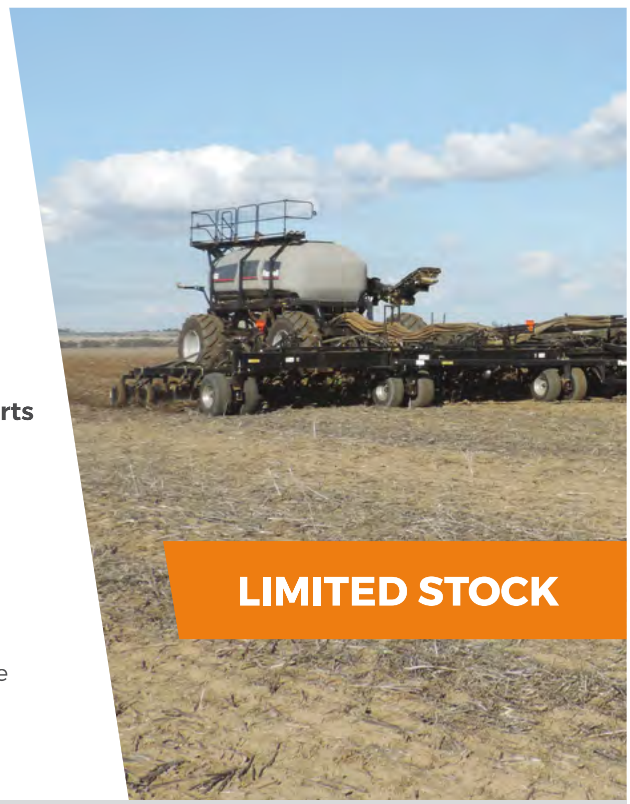

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Section 4

Planting Your Crop

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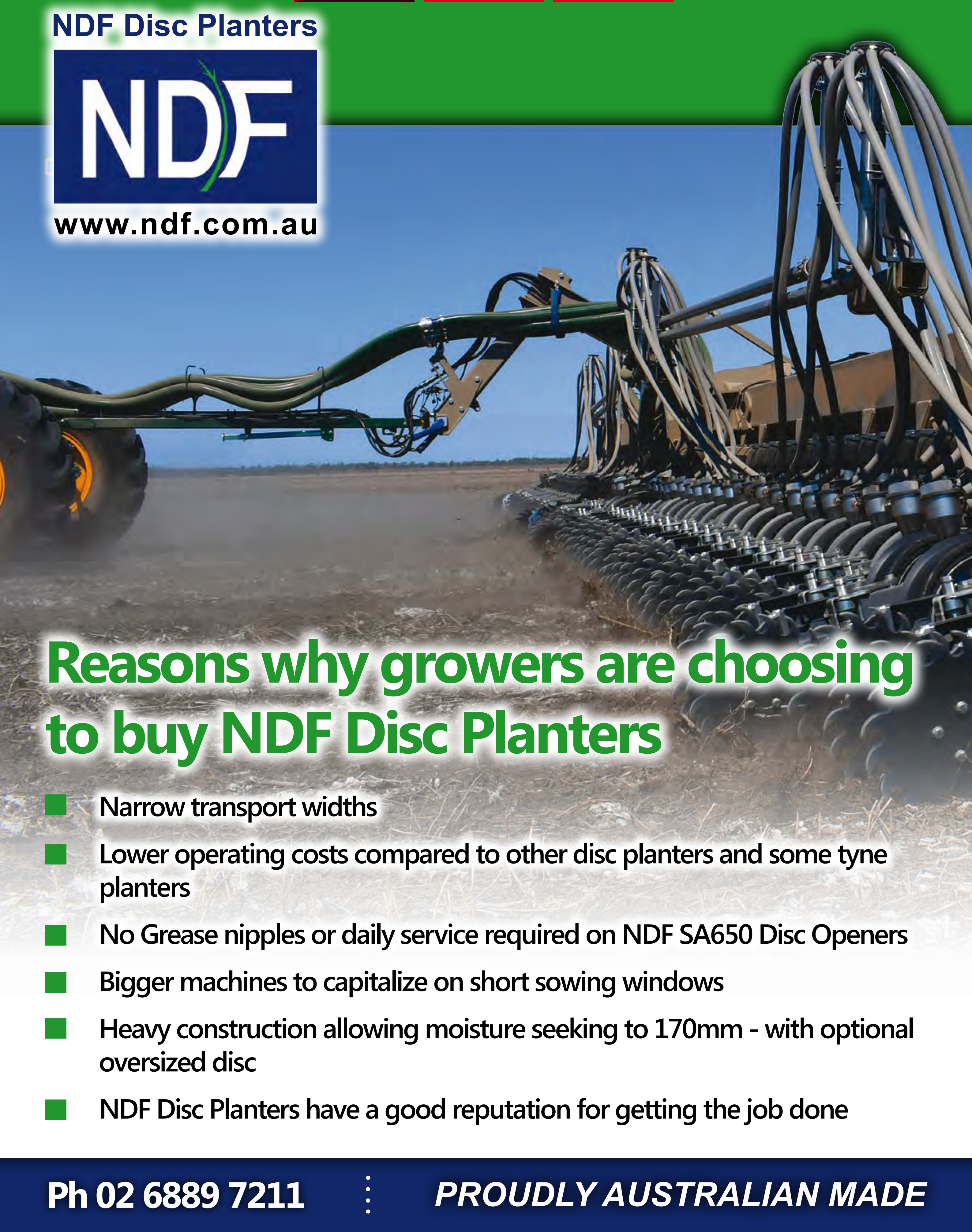
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'R.H. at Bullarah was unhappy with his current planter, after looking on YouTube and liking what he saw, he asked his agronomist what he thought of the NDF who confirmed the NDF would be a good choice based on both his experiences and his peer's recommendations.

Looking over the fence at the NDF operate in wetter conditions than he was able to operate with his tyne machine, R.H soon realized his current tyne planter was inadequate and potentially costing him money. The NDF machine was getting so much done. The decision to go to a 24m NDF when buying his new planter, was "all about the efficiencies'.

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Sowing into stubble: Why seeder calibration and set up is critical

By Toni Somes

AT A GLANCE...

- Growers need to make sure they get seeder set up and calibration correct when sowing into stubble;
- Bar clearance and tyne layout influence a machine's ability to cope with heavy stubble loads;
- Select a seeder based on your farming system, cropping environment and financial position; and,
- Stubble management starts at harvest: height and residue spread will impact sowing.

When it comes to optimising winter crop establishment there are vital steps grain growers can take to improve planting outcomes, particularly when sowing into stubble. Research supported by the Grains Research and Development Corporation (GRDC) as part of the 'Maintaining Profitable Farming Systems with retained stubble' project has investigated machinery and adaptations that will improve sowing efficiency and crop productivity.

Conducted by the Birchip Cropping Group (BCG), Southern Farming Systems (SFS), Irrigated Cropping Council (ICC) and the Victorian No-Till Farmers Association (VNTFA) the research produced guidelines for seeder set-up and selection when working in a stubble retained system.

The guidelines offer growers and their advisors invaluable tactics to select and calibrate seeders when sowing into stubble to maximise crop yield. Those growers who opt to remove stubble commonly do so because they feel it hinders sowing and subsequent crop emergence, due to issues such as seeder blockages, clumping and poor seed to soil contact.

Yet, despite the challenges of sowing into stubble, it is widely adopted because of the benefits of stubble retention through improved soil structure, prevention of wind erosion, reduced evaporation, and improved microbial activity in the soil.

Retained stubble always presents challenges at sowing time. After a big harvest, stubble loads can be 3.0 tonnes per hectare and even up to 7.0 tonnes in irrigated fields. In order to minimise problems – particularly in heavy stubble load situations – your seeding system needs to be spot-on.

And the key to stubble management starts at harvest time, by taking into account next year's planned crop and ensuring all residues are evenly spread across the header width.

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The key to good stubble management at sowing begins with the previous harvest.

Seeder blockages

One of the major challenges when working in a stubble retained system is blockages in sowing implements, particularly in irrigated and high rainfall zones, where yields and stubble loads are generally high.

Blockages become an increasing issue when stubble loads are above three tonne per hectare, or if chaff and straw hasn't been chopped and spread evenly at harvest.

Using seeding equipment designed for retained stubble systems will minimise blockages, but does require a significant capital investment.

This research has also found modification to the profile and tyne layout of the seeder bar can reduce stubble clumping and blockages, and improve the machine's ability to cope with heavy stubble loads.

Utilising inter-row sowing and wider row spacings has also helped growers sow through retained stubbles.

Seeder set-up and modifications

It is possible for simple modifications to be made to the seeder so it handles stubble better. These include:

- A straight rather than curved shank will avoid residue building up;
- Compared to square shanks, rounded cross section shanks have improved residue flow;
- Vertical or slightly backward leaning shanks promote a constant off-balancing effect on residue, thereby reducing build up;

- Sudden changes of shape in shank profile inhibits residue flow and promotes clumping. High 'C' shapes – where the upper part of the 'C' is above the stubble flow – works well;
- Stream-lined designs, such as recessed bolt heads for point mounts, also reduces the amount of residue catching;
- Existing curved shank tynes can be improved by retrofitting stubble tubes to make the face of the shank round and more vertical;
- Long knife-point openers can increase the effective vertical clearance of short tynes, but their break-out rating needs to sustain the greater lever arm effect;
- Tyne shank add-ons (pig tails or other plastic/metal guards) improve trash flow around the tyne;
- Tread wheel residue managers hold down the stubble beside the shank as it moves through;
- Row cleaners move stubble away from the disc to prevent hair pinning and assist in crop establishment; and,
- Residue pinning wheels (Morris Never-Pin wheels) hold the stubble on either side of the disc to assist in cutting ability.

Research has also found both disc and tyne seeders are suited to up and back seeding. While disc planters do not cope that well with contours or on hillsides, they are perfectly suited to controlled traffic farming where inter-row sowing is a perfect complement to stubble handling ability.

Selecting a seeder

As part of the GRDC stubble initiative, Southern Farming Systems has conducted extensive trial work on seeding system performance in relation to stubble retention. Key findings in terms of what to look for in your seeder have been:

- Real time kinematic (RTK) guidance is a critical component to inter-row sowing;
- Each seeder has varying capacity to handle retained stubble;
- As a rule, discs handle higher stubble loads than tyne and press wheel machines;
- Wider tyne spacing across and along the bar will improve stubble handling;
- Changing the angle of sowing direction slightly can minimise blockages;
- Guidance auto steer on seeder bars will improve inter-row sowing;
- Tynes and discs have varying degrees of soil throw and crop safety for pre-emergent herbicides; and,
- Isolation of fertiliser from seed will limit seed burn.

Disc versus tyne

The increasing grower interest in retained stubble farming practices has driven a rise in the use of disc seeders. And this is predominantly because of their improved residue handling capacity and inter-row sowing capabilities. Disc seeders are also favoured because of their capacity for less soil disturbance, improved seed placement and germination, and versatility across various soil types and conditions.

But disc seeders have operational characteristics which means some unique agronomic management is required to maintain crop yields.

In particular, the lack of soil throw in a disc system means the effectiveness of commonly used pre-emergent herbicides requiring incorporation (IBS) will be impaired.

Another challenge of disc seeders is 'hair-pinning' which results in poor contact between the seed and soil, causing poor germination and emergence. Most disc seeders rely on the weight of the machine for soil penetration. But some newer disc seeders are set on a sharper angle, which allows the disc to slice through soil and cut stubble.

As a general rule, disc planters handle heavier stubble loads than tynes.

There are pros and cons for both disc and tyne seeding systems, but design is a critical consideration when evaluating seeders for specific farming environments.

Making the change from tyne to disc

The following tips will help growers make the transition from tyne to disc seeding systems:

- Sow dry/early to overcome stickiness in clay soils – the more residue the less this stickiness will be a problem.
- Harvest management is critical – residues need to be spread uniformly so discs cut through an even layer of chaff.
- Harvest cereals short, before using the disc for the first time, to help with residue flow.
- In the first year using a disc system, sow deep as the gauge wheel could ride high on the old tyne furrow.
- Row cleaners may be needed to level the ridges and furrows for your disc and gauge wheel. Consider a once-off harrowing or prickle chain to level paddocks to ease the transition from tyne to disc. Level paddocks are critical for good seed placement.
- If wet, wait until conditions dry a little for disc sowing.
- Consult your agronomist regarding pre-emergent herbicides. Also note that you cannot band urea when using discs.
- Standing stubble is better. Once you have mastered using discs, aim to cut stubble as high as possible at harvest (consider a stripper front on the header).

More information: Claire Browne, Research Manager, BCG. E: claire@bcg.org.au

GRDC *Stubble Management Fact Sheet*
GRDC *Sowing into stubble: Stubble seeder set up and selection*

GRDC Project Code BWD00024

Widen sowing window to improve reliability of dual purpose crops – a case study

By Robert Freebairn, Agricultural Consultant and David Freebairn, Soil Scientist

AT A GLANCE…

- Dual purpose crops are a vital part of many mixed farming operations, being especially critical for reliable supply of winter feed and grain potential recovery.
- Reliable and timely sowing is vital for profitability of both grazing and grain recovery crop phases.
- To reliably sow in an appropriate sowing window, several factors are vital including sowing on a minimal rainfall event; stored sub soil moisture; stubble cover to maximise duration of surface moisture; a renewed view of what is a desirable sowing time window; and where possible, choosing lighter soil for dual purpose crops.
- The *CliMate* App is a valuable tool for exploring probabilities of sowing success in a multitude of scenarios.

Dual purpose cereals play an important role on our Central West NSW property. Dual purpose winter crops – or grazing only – can reliably gross $1000 to $1500 per hectare with costs typically around $350 a hectare. Additionally, dual purpose crops take pressure off the property's grazing base (pastures), giving them a chance to get away and be a more valuable supply of quality grazing after dual purpose crops are locked up for grain.

Research also shows that in addition to proving valuable winter grazing, dual purpose crops can produce yields similar to a grain only crop.

Dual purpose crops supply quality feed in good quantities when other pastures are growing slowly, especially in years with dry autumns (for example, six of the past seven years on our Purlewaugh property. Purlewaugh is 30 km east of Coonabarabran and averages 625 mm annual rainfall).

Around 20 per cent of our farm area is sown to dual purpose crops in late summer/early autumn, 36 per cent is tropical grass based (we aim for 50 per cent) and 44 per cent is improved native grass based.

In both native and tropical grass pastures, winter legumes (serradella, biserrula, gland, sub and arrowleaf clover) are an important part of these pastures.

Figure 1 shows typical production patterns for these three pasture types. Lucerne is not included here as it is less suited to acidic surface and sub soils in this case study.

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Early sowing is critical

Often missing an early sowing opportunity is the difference between a good or poor winter feed supply. Early sown crops sown onto good subsoil moisture can survive for months and provide reliable winter feed if no follow-up rain occurs.

This was the case in 2017 at Purlewaugh, with the second driest period from April 1 through September 30 since 1900.

Being able to sow early, and often much earlier than the accepted norm for a district, and reliably (as there is a high probability of successful establishment), is critical for securing a high quality winter feed supply.

For our region, this can mean sowing as early as February 20, as was the case in 2014. In many years it will be too hot for a reliable establishment that early. But good subsoil moisture and stubble cover also support reliable early establishment.

Late summer and autumn rains are unreliable. Probabilities of achieving reliable establishment in a desirable sowing window is closely related to being able to successfully establish a crop or pasture on a minimal rainfall event.

Sowing rainfall probability

Based on long term rainfall data at Purlewaugh, the *CliMate* App tells us that we have a 94 per cent chance of getting 10 mm over three days between February 20 to the end of April (our nominally desirably sowing window – see Figure 2).

CliMate is well suited to exploring options as it is easy to adjust dates and rainfall amounts. If 25 mm of rain is required, for example on a heavier soil type or little sub soil moisture, this probability drops to 74 per cent over the same sowing window. If we delayed the sowing window to March 15 (a common judgement), the probability of being able to sow

Figure 1: Typical seasonal dry matter production patterns for tropical grass, oats and annual clovergrass based pastures on lighter soils of northern NSW

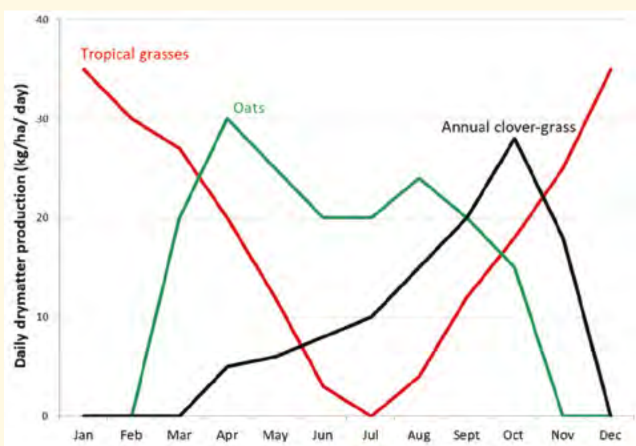
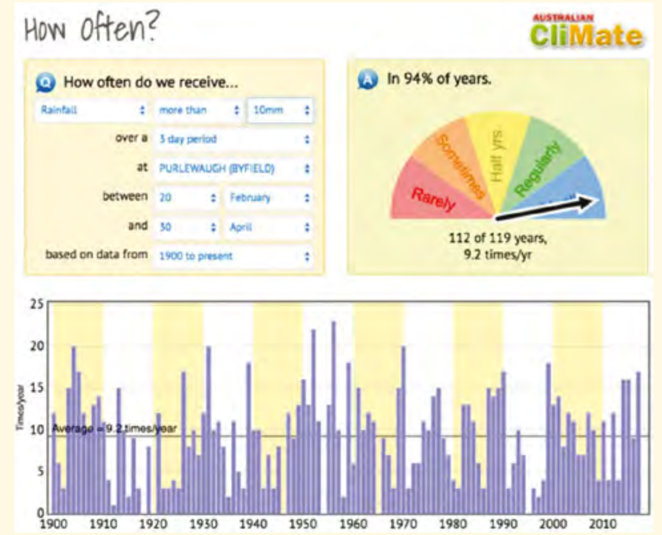


Figure 2: Screen shots from the Australian *CliMate* app showing inputs and outputs for an analysis exploring sowing opportunities. The bottom graph shows the number of times each year the condition is met, emphasising the variable nature of rainfall



Reliable and timely sowing is vital for successful dual purpose crops.

drops to 59 per cent, or missing out on good winter feed from the dual-purpose crop in four of every 10 crops. Hardly a dependable strategy.

CliMate can provide these estimates for any cropping area across Australia, exploring any sowing window and designated rainfall event.

Factors other than soil moisture affecting the success of early sowing

Temperature and temperature forecast

Data is unclear as to what is a "safe" temperature to successfully sow dual purpose winter crops. Based on various sowing date guides (from an internet search), we base our decisions on mean daily temperature (average of maximum and minimum).

If it is 23°C or less and unlikely to rise, it is a pretty good bet to sow if soil moisture is reasonable (but there's little hard data to support this claim). Some farmers have successfully established dual purpose winter crops above this temperature.

Clearly there is scope for future research dealing with temperature, sowing dates and varieties.

Prevailing and forecast temperature is a better guide to sowing time than choosing a fixed date (such as early March for our area), as each season is different and we need to adapt to the conditions we have been given. Sometimes we sow as early as February 20, while in other years with hotter late summers, we delay until around March 10 onwards.

If heatwaves are forecast (rare but can occur at this time of the year) then clearly sowing will be delayed.

Soil type

Generally, it is possible to successfully establish crops on much smaller rain events on light textured soils, compared to heavier textured clays. For example, we have established crops on an 8 mm rain event on a sandy loam with good sub soil moisture, whereas a minimum of 25 mm (and commonly more) would have been required for successful establishment on a clay loam or clay.

Where properties have a mix of soil types, using light soil paddocks for dual purpose crops dramatically increases the probability of being able to sow on time.

Sub soil moisture

Stored soil water is not only important for keeping crops growing during dry periods over autumn, winter and spring, but also maximises the probability of being able to establish them on time.

If there is a good stored soil water at sowing time, the probability of being able to sow on time also increases dramatically.

Evidence from GRDC funded research notes that for every extra mm of stored soil moisture, crop yields can increase by 15 to 30 kg per hectare of grain. Dry matter for grazing will exceed these increases.

It is neither logical nor supported by research to sow crops directly into pastures without storing soil water, especially if reliable grain yields and grazing are the aim. Even in lighter soils that can't conserve as much soil water, an extra 40–100 mm of stored soil water is vital for early sowing and achieving a high probability of good winter growth.

Direct drilling crops into active summer pastures – even poor ones where weeds generally replace pastures for water use – has significant downsides. In addition to not accumulating soil water prior to sowing, such crops commonly face higher levels of nitrogen deficiency.

NSW DPI research has shown differences of 40 kg per hectare or more in available soil nitrogen where fallow weeds were not controlled in a timely manner.

Fallow water capture

Maximising stored soil moisture, as well as having moisture as close to the surface as possible, depends on efficient capture and storage of fallow rainfall. Early control of weeds over the fallow is critical, even if it means additional fallow sprays.

For example, on our farm, it is not uncommon for us to spray our fallows five times over the fallow period. Preparation for a crop or pasture requires early planning for water storage.

Zero till and stubble retention is part of the story

Reasonable levels of stubble cover (old pasture if coming from a

pasture phase or crop residues in a cropping sequence) helps with fallow moisture capture as well as maintaining moisture storage closer to the surface. Zero till with stubble is generally a vital part of a reliable early dual-purpose crop.

Minimal soil disturbance and press wheels

Sowing with minimal soil disturbance (narrow points or disc seeders) plus press wheels, improves the probability of early sowing success on small rainfall events. The ability to moisture seek with narrow points and press wheels also enhances the length of the sowing window after larger rainfall events.

Profitability

On our light acid soil farm in a 625 mm rainfall area, the gross margin for 2017–18 is projected to be similar to the previous two years at around $350 per hectare. This is despite one of the driest 2017 winter seasons on record. Dual purpose winter crop has been especially vital to success this past season and would not have been possible had it not been sown on time and into good sub soil moisture.

Variety choice is critical

“Spring habit” winter cereal varieties (such as oats, wheat, barley, triticale, cereal rye, or other crops like canola sown in February or March) will head in May, June or July, depending on sowing time and maturity type.

These crops commonly recover slowly and poorly after grazing – in large part as they have to form new growing points.

Compare this with “winter habit” types, that stay largely vegetative and continually regrow from existing leaves until their winter habit has been satisfied by a sufficient level of cold weather.

Winter habit is a characteristic where the growing point remains at ground level until a sufficient amount of cold weather triggers plants to change to “spring habit” – which means the head begins rising up the stem.

Spring habit varieties have no such delay, with heads growing up the stem as soon as tillering occurs.

Soil fertility and other agronomy issues

- Nitrogen deficiency remains a more than common yield limiting factor

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in dual purpose crops. A typical dual-purpose cereal crop may provide 4.0 tonnes per hectare of dry matter for grazing as well as yield 4.0 tonnes per hectare of grain. The amount of nitrogen utilised in this example is typically 150 kg per hectare for grazing and a further 84 kg per hectare for grain – a total of 234 kg per hectare.
While not a lot of the nitrogen needed for grazing is removed from the paddock in animal product, it takes time to be re-released to the soil via urine and faeces and trampled plant material. Such nitrogen recycling is not distributed evenly across paddocks.
- A major risk with early sowing of cereal crops is barley yellow dwarf virus (BYDV) – a major disease threat to most varieties of oats, barley and wheat. BYDV occurence can be minimised by treating seed with a registered insecticide to reduce risk of aphid attacks and transmission of BYDV. Note that many insecticides have a grazing withholding period of around nine weeks post sowing.
- When spraying or treating seed with insecticide, always read the product label prior to use to ensure that the product you are using is compatible with your desired grazing schedule.
- Rust can also be a greater risk in early sown crops, especially if autumns are humid. There are few resistant oat and barley varieties and some popular “winter habit” wheats are not resistant to some rusts. Again seed treatment with an appropriate fungicide, or fungicide treated fertiliser applied with seed, can help reduce risk of early rust outbreaks.
- Good in-crop weed control is another important aspect of productive dual-purpose winter crops.

More information: Robert Freebairn, agricultural consultant, Coonabarabran, Email: robert.freebairn@bigpond.com

Australian *CliMate* is available free from the App store and https://climateapp.net.au/ ■

Why invest in a large disc planter?

The investment in new and large farm equipment calls for careful consideration of all the reasons behind your purchase – including the pros and cons. This is particularly important in the selection of the best seeding system when there are large areas to be planted within rapidly closing sowing windows.

Narromine (NSW) based farm equipment designers and manufacturers, NDF disc planters, have asked a number of their clients, from the heavy grey soil plains of northern NSW, the key reasons behind their purchase of an NDF planter. In short, why did they replace 'Old Faithful' (sometimes Un-Faithful) with a large disc planter?

Case study 1: LG from the Moree district

'LG' bought his first NDF Disc Planter in 2017 after he did "plenty of research first". LG talked to local growers who had been operating NDF Disc Planters for a number of years. He also went online to continue his research – including what was being said on blogs by other owners and operators. He saw this as a good way to gauge how the NDF planter was regarded in the wider marketplace.

LG needed weight in his planter for digging in to the heavy clays and to seek moisture. He found there were not a lot of other planter options but the NDF was a good fit for what he wanted.

No greasing of row units also appealed to LG because it meant a significant reduction in downtime during sowing.

NDF Disc Planters' comment: There are no grease nipples or daily service requirements for the NDF SA650 Single Disc opener. This machine, equipped with the optional oversized-discs, is also able to moisture seek to a depth of 170 mm.

Purchased a second NDF planter the following season

Happy with results achieved in the previous season, LG bought his second NDF disc planter in 2018. LG planted around 15,000 hectares in his first season (2017) and his NDF disc planter operating costs were around $0.52 per hectare. Other growers in the area were paying planter operating costs up to $3.50 per hectare.

LG said that maintenance on the NDF was also much simpler than other planters which meant relatively inexperienced operators could be employed.

When LG leased more cropping land for the 2018 season it made good business sense to buy the second NDF disc planter.

Upgrading to a 24 metre NDF disc planter makes for more timely sowing.

Case study 2: GO from the Bellata district, south of Moree

'GO' first purchased a 12 metre NDF machine in 2008 and has traded up to a new 24 metre NDF disc planter for the 2018 season. The main reason behind the purchase was that the 12 metre NDF was going flat-out to get sowing done within very short sowing window.

Double cropping chickpeas into dryland cotton has been a rotation working well for GO. But again the short chickpea sowing window left after cotton harvest was proving difficult to manage with the 12 metre planter.

GO also purchased additional land and the upgrade to the 24 metre NDF had to happen because "there was no way I was going to run two 12 metre machines!"

In mid-April 2018 GO said that he was planting wheat "five inches deep and leaving two inches over the seed and it's doing a far better job than a tyned-machine could."

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Case study 3: RH from the Bullarah district west of Moree

Being unhappy with his existing planter, 'RH' purchased a 24 metre NDF disc planter in early 2018. RH saw the machine working on a YouTube clip and liked what he saw. He asked his agronomist what he thought of the NDF who confirmed that the NDF would be a good choice. RH's agronomist had been impressed with what he had seen of the NDFs in action – his consultant colleagues were similarly impressed.

After looking 'over the fence' at the NDFs disc planters operate in wetter conditions than he was able to with his tyned-machine, RH realised his tyned-planter was inadequate and potentially costing him money.

For RH the decision to purchase a 24 metre disced-machine was "all about the efficiencies". ■

The main reasons given by NDF disc planters' clients when they upgrade to bigger machines are more timely and efficient sowing and the capability to chase moisture. Pictured is a 36 metre NDF in action on the heavy clays of northern NSW.

Section 5

Pulse & Legumes Update

CONTENTS

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We create chemistry

(PHOTO: Kathi Hertel, NSW DPI)

The wild past points to a bright future for chickpea growers

A pioneering, multi-nation research collaboration is expected to unlock valuable new opportunities for chickpea production in Australia.Researchers supported by the Grains Research and Development Corporation (GRDC) have collected and multiplied wild chickpea species from the Middle East to build a unique genetic resource from which important traits are being screened for potential incorporation into new disease-resistant, stress-tolerant, high-yielding varieties for Australian growers.

GRDC Pulses and Oilseeds Manager, Dr Francis Ogbonnaya, says the "very exciting" research undertaking is likely to lead to a substantial expansion of Australia's chickpea production area, especially in regions where opportunities to grow chickpeas have been limited due to the unavailability of lines tolerant to constraints such as acidic soils, abiotic stresses and disease stresses.

"Not only are chickpeas Australia's most valuable cash crop, they also play an important role in terms of overall optimisation and sustainability of our farming systems," Francis said. "They act as a break crop for cereal rotations, they add nitrogen to the soil, assist with weed control and they add diversity to a grower's marketing options.

"But, until now, the genetic base of the domesticated chickpeas we grow today has been very narrow and this has prevented many of our grain growers from being able to grow chickpeas and enjoy all the benefits these pulse crops bring.

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Jens Berger of CSIRO tagging wild chickpea plants during a collection mission to Turkey. (PHOTO: J Berger, CSIRO)


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Big expansion likely in WA

"This research program will open up fantastic opportunities for development of new, resilient varieties for our growers to choose from. The potential impact is quite substantial."

Francis cited the Western Australian situation as an example of that potential impact, stating that chickpea production in that state alone could possibly expand by 100,000 times current levels.

"In New South Wales and parts of Queensland, chickpeas are thriving, but in WA only 5000 hectares was planted to chickpeas last year. The primary reason for that is we don't have chickpeas adapted to acidic soils.

"If growers had access to varieties with acid tolerance – and evidence is already showing those traits exist in the wild material we now have available – the area planted to chickpeas in the west could potentially be around 500,000 hectares. Growers would have a valuable break-crop alternative to lupins, and they would reap the benefits that growers in other regions experience."

The international collaboration to expand the world's chickpea genetic resources began with a GRDC-supported collection mission to Turkey (where the legume was first domesticated) in 2013 and has since developed into a $12 million five-year research program involving eight countries and numerous institutions and laboratories around the globe.

From Turkey to Victoria

The collection mission, the success of which was contingent on Turkish collaboration, was supervised by CSIRO ecophysiologist Dr Jens Berger who has researched chickpea biodiversity and identified serious gaps in the gene pool.

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The painstaking search for and collection of wild genetic material from south-east Turkey, some of which is now being housed at the Australian Grains Genebank in Horsham, Victoria, has led to the capture of an immense amount of valuable genetic and trait diversity, according to Jens.

"Early indications are good for the presence of traits such as water use efficiency, chilling tolerance and nematode resistance," Jens said. "I am optimistic that we captured the adaptive diversity needed to improve the performance of cultivated varieties."

The newly-expanded genetic resource base has been shared among the collaborating countries – Australia, the United States, Turkey, Ethiopia, India, Pakistan, Canada and Morocco – and is now underpinning a series of GRDC project investments that are seeking to introduce valuable new traits from the wild species into domesticated chickpeas suitable for production in Australia.

The wild genetic material is being screened for important traits such as tolerance to acidic soils, drought, heat and cold, as well as water use efficiency and resistance to diseases such as ascochyta blight (the most important disease of chickpeas in Australia), Phytophthora root rot and root lesion nematode.

International teamwork

Involved in this work are a number of the GRDC's Australian research partners, including the CSIRO, the University of Southern Queensland's Centre for Crop Health,ON the Centre for Crop and Disease Management in Western Australia, Murdoch University, the Centre for Plant Genetics and Breeding at the University of WA, New South Wales Department of Primary Industries, the University of Sydney, Curtin University and the South Australian Research and Development Institute (a division of Primary Industries and Regions SA).

With technology enabling researchers to produce four chickpea generations in one year and large-scale screening to begin next year, Francis is hopeful that new lines of chickpeas with traits from the wild accessions will be made commercially available to Australian growers in the "medium term".

The delivery of such new commercial lines will be the culmination of an extensive and concerted international effort in which Australia has played an important role: "This program has demonstrated that there are some things that cannot be done on your own," Francis said.

"Multi-lateral approaches to tackling major issues are the way forward – no one country can do it alone. To see eight countries coming together to drive innovation for the future is terrific."

Francis said the likely expansion of Australian chickpea production could also promote opportunities in the area of functional nutrition.

"It's certainly exciting times – for the research community, our plant breeders, our growers and the wider community."

More information:
Francis Ogbonnaya, GRDC, Ph: 02 6166 4500; Jens Berger, CSIRO, Ph: 0416 004 056
GRDC Research Code: CSP00185

Choose chickpea and wheat varieties carefully to limit root-lesion nematodes

Grain growers looking to limit the effect of the root-lesion nematode, *Pratylenchus thornei*, are advised to consider the impact of including susceptible chickpeas and wheat varieties in their rotations.

In a study of chickpeas, researchers found that while chickpea varieties may not suffer severe yield loss, the crop's susceptiblity may lead to a build-up of nematodes that affects the following crop.

The root-leison nematode, *P. thornei* is found in two thirds of paddocks in Queensland and New South Wales, reproducing in the roots of plants and reducing their ability to take up water and nutrients. It is able to survive fallow periods and there are no registered chemical controls to reduce it.

The University of Southern Queensland ran two-year experiments at Formartin in 2014–15 and 2015–16, to determine the tolerance and resistance of chickpea varieties to *P. thornei* and separate experiments with wheat varieties ranging from tolerant to intolerant grown across a range of *P. thornei* populations from very low to very damaging.

Main trial results

- Chickpeas generally have a good level of tolerance to *P. thornei* but because most varieties are susceptible, populations of the nematode will increase to attack future crops.
- The tolerance of a wheat variety and the populations of *P. thornei* at the time of planting will determine the degree of yield loss at the end of the season.
- Intolerant wheat varieties should be avoided when *P. thornei* populations are at damaging levels, but even moderately tolerant varieties may suffer yield loss.

USQ researcher Kirsty Owen says it is important for growers to understand the difference between tolerant, resistant and susceptible varieties.

"Tolerance is the ability of a plant to produce good yields in the presence of *P. thornei* and its opposite is intolerance, while resistance is the ability of the plant to prevent nematode reproduction. Its opposite is susceptibility," she said.

"Crop varieties may be tolerant but susceptible, that is, they produce good yields but allow the nematode to increase in population. The ideal combinations for management of *P. thornei* are varieties that are tolerant and resistant."

Kirsty said that when *P. thornei* was present in paddocks at damaging populations (greater than 2 per g soil), it could be managed by growing tolerant crop varieties that do not suffer yield loss, and increasing the number of resistant crops in the cropping sequence to reduce populations.

In experiments with chickpeas, the average yield across all chickpea varieties tested was reduced by 6.5 per cent when grown on the high *P. thornei* populations (14 per g soil) compared to the lower populations (5 per g soil), but no differences in yield loss were detected between varieties.

Average yield for chickpea varieties on the low *P. thornei* populations was 2.77 tonnes per hectare, and on the high *P. thornei* populations it was 2.59 tonnes per hectare.

But looking at changes in nematode populations in the soil after growing the chickpea varieties, *P. thornei* were significantly greater than the moderately resistant wheat control after PBA Seamer, PBA Boundary, and Kyabra, increasing by 1.7 to 4.3 times. PBA HatTrick was the least susceptible chickpea variety with populations increasing 1.2 times compared to the moderately resistant wheat control.

USQ researcher Kirsty Owen says when *P. thornei* was present in paddocks at damaging populations (greater than 2 per g soil), it could be managed by growing tolerant crop varieties. (Image courtesy USQ)

In contrast, for the very susceptible wheat control cv Strzelecki, populations at harvest were 67 per g soil, or a 10-fold increase compared to the moderately resistant wheat control.

P. thornei populations at harvest ranged from 8 per g soil for cv. PBA HatTrick to 28 per g soil for Kyabra, which Kirsty said sends a clear message to growers.

"In the northern grain region growers need to consider the impact of growing susceptible crops such as chickpea and wheat that will increase *P. thornei* populations and limit crop variety choice for future seasons," Kirsty said.

"Consider the impact of growing chickpeas in your crop sequences if you are trying to reduce *P. thornei* populations or keep them at low levels." ■

An update on desi chickpeas and Indian government intervention

By Rob Brealey, Pulse Trader – COFCO International

If you grow pulses, you would know of the Indian government's recent intervention in the market – introducing harsh import duties to try and lift local prices. It seems timely then to look forward to the potential impact on new crop desi chickpea prices to see if we can provide Aussie farmers with some assistance in their planting decisions.

Firstly, do we even need India to buy?

This seems a pretty straightforward question and it deserves a pretty straightforward answer – and the answer is: It depends ...

Size does matter when it comes to Australian chickpeas because we export more than 90 per cent of our total production. We are clearly dependent on export markets for our sales and price determination so the size of our domestic chickpea crop really does matter when we are looking for international buyers.

What's the chickpea demand outside of India?

Export demand outside of India can fluctuate depending on a number of factors but it's in the ballpark of 500,000 tonnes per annum.

When government intervention comes into play, no-one can confidently or accurately predict future prices, particularly in the traditionally volatile desi chickpea market.

The major markets making up this (circa) 500,000 tonne demand are Bangladesh, Pakistan and the UAE.

Add to this another 100,000 tonnes for Australia's domestic requirements and we have a total demand of around 600,000 tonnes per annum outside of India.

In the past three seasons Australian desi chickpea growers have produced crops of around 1.2 million tonnes (mt), 2.3 mt and 1.0 mt.

So it is apparent that we have needed India to take the surplus and provide the market with price support.

So what about future chickpea prices?

Well, of course, traditionally there are many factors that will impact future price setting – but in these times of government intervention, the least impact may well come from the eventual size of our chickpea crop or even the outcome of the monsoon season in the sub-continent.

And it's not even the level of import duties (or other measures) that are in place in India come Australian chickpea harvest time.

In today's environment, no-one can forecast with any certainty.

One of the big and negative side effects government intervention brings in any market, is uncertainty.

Who would want to plan exports to India today without knowing if the duty will be zero or 100 per cent?

Let's assume for a moment too, that everything remains the same. A big assumption I know, but it will at least give us a guide as to what the price influence might be should we need our Indian friends buying.

The current import duty for chickpeas in India stands at 60 per cent but when you add some taxes to the duty – that's government for you – the real duty is in fact 66 per cent.

Local desi chickpea values in India in early April, 2018 were around 37,000 rupee per tonne (US$570 per tonne). But the Indian Government's ambition at the time was to push values to above 44,000 rupees (US$670 per tonne).

Now, let's assume India eventually achieves this price rise. This will become the price we need to beat to capture demand in India.

After deducting the duty, freight and loading costs this comes back to around A$425 to $450 per tonne delivered to the port in Australia.

To reiterate, we are not saying that this is what the price will be at harvest. There are many unknown factors that could still influence the outcome, both positively and negatively.

But we do believe that these mid to low $400 per tonne local values are realistic when considering your desi chickpea planting intentions for the coming winter crop.

More information: www.cofcointernational.com ■

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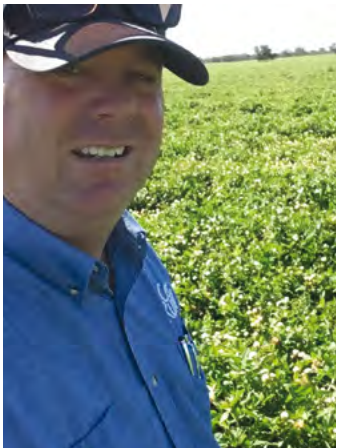
65 not out and still hitting big yields

This year BASF is leading the celebrations of the 65th anniversary of commercial inoculant production in Australia. Since taking ownership of the original inoculant brand – Nodulaid – the company has invested millions in upgrading its local production facility and is keen to make sure the whole farming community is aware of this Australian success story. By improving on the initial development work done in the US, the peat-based inoculants set a standard for the rest of the world to follow.

With that in mind, the company has been on the lookout for long-time Nodulaid users who can remember what a huge impact the initial adoption of inoculants had in many areas.



Scott Hutchings says the use of local rhizobia strains and local manufacturing ensures a high quality inoculant.

Scott Hutchings hasn't been around for the full 65 years, but he can certainly remember the impact of first-time inoculant use around the border districts of South Australia and Victoria. Scott is a senior agronomist at Cox Rural in Keith, SA. He's been recommending Nodulaid for "as long as I've been in agronomy – about 25 years."

He learned all about the benefits of inoculation as a student at Roseworthy Agricultural College and has been putting theory into practice ever since.

Cheap nitrogen

"For me, it's been a given since day one," Scott says. He still marvels at the value peat inoculants can deliver, especially in helping build residual nitrogen. "It's amazing. With good nodulation, you can get 50 to 100 units of nitrogen a hectare – the equivalent of eighty to a hundred dollars' worth of urea for a relatively small spend."

The use of inoculants in his area covers legume-based pasture and seed and fodder crops as well as harvested pulse crops like lentils.

Scott has seen many examples of the yield benefits Nodulaid can provide. "When people started growing lentils in this area on slightly acid soils, there were crops that had been put in without inoculation – and it was very obvious that they didn't perform," Scott said.

High quality and local evolution of the strains

While the Nodulaid name has been around for a long time, the product that is freshly cultured and supplied to growers each season keeps evolving. Each year's new batch contains the latest strains of rhizobia supplied by the Australian Inoculants Research Group. That

The inoculant is freshly – and locally – cultured each season.

relationship continues the unique collaboration between the public and private sectors that has always underpinned the outstanding quality of locally manufactured inoculants.

Scott has noticed the impact of changing strains. “In paddocks which haven’t been inoculated for years, growers are now going back in with new strains and you can really see the response.”

The survival of rhizobia in the soil is one of the few issues still debated in the area. “On four-year rotations, I recommend growers inoculate every time they plant a pulse crop,” says Scott. “I still have the odd grower who questions it a bit, but mainly because they think there are already enough rhizobia in the soil.”

As Scott observes, some signs of nodulation can lead growers into thinking the residual rhizobia in the soil will do the job when they’re actually underperforming. “They still get nodulation, but instead of the pink nodules, they get white and green ones that don’t perform as well.”

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Scott recognises that rhizobia will survive longer in black soils with more organic matter than in the drier, more acidic soils that are more typical of his area. But even that can be deceptive: “You can get nodulation in an organic layer, then the roots hit an acid layer and nothing happens.”

Generally, though, he says the results have shown his clients the value of regular inoculation. “For a lot of my growers, it’s second nature.”

Best form of inoculation

Scott says the local discussion among farmers these days is about the best form of inoculation.

“If it’s a dry sowing, they’re looking more at granules.”

Within the BASF range, that simply means a switch from Nodulaid to Nodulator.

Freeze-dried bacteria have also become an option, but – as Scott points out – they may have more rhizobia per gram, but they can’t match Nodulaid for survivability.

Nodulaid as a brand has now survived for over six decades and is still going strong. In 2018, its reliability continues to give growers all over Australia a big return on a very modest investment. ■

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Section 6

Spray Application

CONTENTS

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The need for planning: A spray operator's perspective

By David Gooden and Bill Gordon for the GRDC

AT A GLANCE…

- Know your current capacity and identify areas for improvement.
- Start with efficiency gains before upgrading the sprayer.
- Plan ahead – for the next job, next crop and changes to the farming system.
- Do your research before upgrading your sprayer.

Pesticide application can be a complex operation that requires knowledge of the weather, mechanics, logistics, chemistry and biology, as well as effective communication skills and good technique. Successful spray operators plan and review all inputs and outcomes to maximise use of the products purchased, while at the same time doing everything possible to reduce the risks and hazards associated with that use.

Planning successful spraying operations often requires research and consultation, but the benefit of good plans is that they can save a lot of time, money and effort in the long run.

All plans require knowledge of your starting point. If you are looking to make improvements to your spraying operations, you need to have a clear idea of what you hope to achieve, the steps you need to take to get there, and most importantly, know when you have reached your goal.

For any plan it is important to identify what success would look like – spraying is no different.

Whether you are performing a single spray operation, upgrading your sprayer or undertaking a major change to your farming system, there are always several steps to take before you get to where you want to be.

Successful spraying is about placing the correct dose of chemical in the right place at the right time.

Know your starting point – what is your current capacity?

Successful spraying is about placing the correct dose of chemical in the right place at the right time. It can involve several parties providing information on any component of the process, which ultimately relies on the spray operator to achieve a successful result.

Timing is one of the most important factors in achieving the best possible spray outcome and planning allows the operator to be efficient throughout the process.

If we want to improve our ability to get the spray out on time we should consider what our current capacity is, how long we have to get the best results from each product and how much time it takes to cover the amount of country we have.

Knowing our starting point helps to identify areas where we may be able to improve.

- What products do I use and how do they need to be applied?
- How can I make the products I use more effective?
- What equipment or set-up(s) do I need to apply to those products?
- How many hectares per hour per day can I spray?
- How long does it take to complete most spraying operations?
- How long to get the products out (before they are less effective)?
- How much time do I spend out of the paddock (filling, mixing, or on maintenance)?
- How do I manage the weather conditions and sensitive areas?
- How much does it cost to operate the sprayer?
- What can I do to reduce the need for spraying (rotations, crop competition, cultivation, green manure crops)?

Increasing capacity and efficiency

Although the time spent spraying is usually only a fraction (often less than 50 per cent) of the total engine hours on the machine, this is not always considered by operators.

There are many things that can be done to change this ratio and to increase your ability to cover the country in a timely manner before buying a bigger, wider or faster sprayer.

The most obvious place to start is to reduce the time spent out of the paddock. Things to consider include faster filling times and better mixing and transfer operations so the boom does not need to be folded while you are in one paddock.

Making use of weather-forecasting tools

Where possible, make use of weather-forecasting tools to help define your spraying windows over the coming week – knowing which days are

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likely to be suitable for spraying and which are not can help you to plan your week.

Several websites make weather forecasts of up to seven days available. Some of these websites are specifically designed for spray operators and indicate factors such as Delta T (a measure of evaporation potential), rainfall, frost and inversion risk.

Improve maintenance to reduce downtime

Service availability is critical to sprayer ownership. Choosing the right dealer is just as important as selecting the type of sprayer you will use. Before purchase make sure you are confident the dealer can provide the services you will require:

- Regular inspection of the sprayer – regular checks can prevent bigger problems later on;
- A plan for maintenance out of and during the season;
- Keeping commonly needed spare parts on hand; and
- Keeping things clean and calibrated – including nozzles, flow meter and components. Even new sprayers should have their nozzles removed and the tank flushed before the first use. Calibrating and checking major components (tank levels, flow meters and controller settings) should also be done before the first use and should continue throughout the sprayer's life. Always flush the sprayer after use and do a full decontamination before changing product type or situation.

If you have done as much as you practically can to reduce the time spent out of the paddock the next step is to look at improving the efficiency of your spraying operations in the paddock.

Maximising productivity in the paddock

It helps to review your farm inputs and outputs to identify areas to maximise your productivity in the paddock.

Knowing what inputs you make (for example, chemicals, fuel, fertilisers and maintenance costs) and their impact on your output (yield) is an important first step in identifying areas for improvement and for knowing what things can produce real gains in productivity.

It is important to have regular discussions with advisers and consultants about what products are available to you, what works well in your area and what recent research suggests. Always try to make evidence-based decisions – do your own homework.

Consider the things you should know or understand about the various products you want to apply.

- Modes of action, translocation and uptake of the products you use.
- What are the volume/coverage requirements and ideal adjuvants.
- Water quality requirements for each product.
- Compatibility and mixing requirements, as well as mixing order.
- Agitation and solubility requirements (for example, for powders, water-dispersible granules, water conditioners).
- Filtration requirements of the various products and their impact on some components.
- Spray quality required for the product or tank mix.
- Label restraints (no-spray zones) and sensitive areas for each product.
- Economics (short-term cost versus longer-term goals, for example, resistance management).
- Operator and farm occupant safety.

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Make use of spray plans and mixing plans

Knowing the application volumes and spray quality requirements for all the products you plan to use is critical to developing spray plans.

Group together products that have similar application requirements (volume and spray quality) and make sure you have the nozzles to do each type of job (group of products).

Groups of products with similar application requirements may include: Knockdown herbicides in fallow, pre-emergent herbicides, liquid fertilisers, contact herbicides (double-knocks), early season broadleaf control, grass-selective sprays in crop, in-crop fungicide and insecticide applications, and pre-harvest desiccation.

Each of these groups of products may require different application volumes and spray qualities, so planning how you need to apply each group makes sense.

Plan to make the most of good weather

Identify acceptable weather conditions for each product you use

Some product labels will indicate requirements for wind speed, rainfall events and no-spray zones (downwind buffers). Also consider wind direction in relation to sensitive areas and the likelihood of dew or frost – these will affect how and when you apply many products.

It is a good idea to identify a couple of spray set-ups (spray quality and application volumes) suitable for each product or tank mix to be ready to manage what is in front of you.

Know when to stop. Regardless of the product used, at some point spraying should not take place.

Make better decisions – monitor and assess conditions as you go

Regularly monitoring and recording the weather provides real data on which to base decisions.

Experienced operators learn to read visual clues, but these observations still need to be supported by actual measurements in the paddock where you are spraying.

Handheld weather meters are good but are only practical when you stop to fill or mix. Many operators should consider having onboard weather stations, particularly if they have large tanks or long periods between filling operations.

Think about how you will spray each paddock

It is worth planning your sprays on a paddock-by-paddock basis. Take into account likely conditions and spray run direction.

Consider what challenges each paddock presents in terms of obstacles and ground conditions (wet or dusty) as these will determine a comfortable speed range for that paddock.

If they are not already fitted to your sprayer, think about the value that systems such as auto-swath/auto-section control, height control, boom recirculation/boom prime or multi-step spray could make to improve your spraying efficiency.

The appropriate speed range

Unless you have a spraying system that can cope with large variations in speed, it may be necessary in some paddocks to increase application volumes to ensure your nozzles are operating effectively when travelling at lower-than-normal speeds.

Headlands

A way to reduce the speed range while spraying is to include sufficiently large headlands. Wide headlands can help to avoid operating at lower speeds (reduced pressure) at the ends of runs and minimise operating with the sprays on during turns. A practical headland matches the seeder width so that crop direction is the same as the spray runs.

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Having auto-section control and an accurate GPS can make this job much easier. Systems that increase your operational speed range, such as multi-step booms or pulse width modulation can reduce the width that headlands may need to be.

Obstacles and turns

While many spray systems can help to manage variations in straight-line speed, very few can fully compensate for the changes in application rate that occur across the boom if operating with the spray on during a sharp turn.

Planning how you are going to spray around obstacles is important for ensuring good control because of the potential consequences of under and over-application. This is a situation where auto-swath/auto-section control is very useful. However, even with auto-section control, gentle turns are critical.

Corners

It is a good idea to square up the ends of the paddock to minimise operating with the sprays on during turns. It is also important to consider how to deal with corners. Generally, the best approach is to back into corners with a rear-mounted boom (or drive into corners with a front-mounted boom), provided your spraying system can operate effectively at the initially low take-off speeds. Auto-section control can also help to prevent overdosing when backing into corners.

Direction of travel

It is a good idea to mix up your direction of travel. Each time you spray a paddock, start at the opposite end to where you started last time. This helps to overcome some of the effects of shadowing behind standing stubble, particularly if you are doing a double knock.

Alternating wheel tracks

In situations where dust is an issue it can be a good idea to alternate the wheel tracks you use for spraying products in fallow situations. Shifting across a planter width each time you spray can help reduce some of the problems associated with poorer weed control adjacent to the wheels and in the centre of the machine.

Leaving unsprayed buffers

Sometimes you may have to operate close to sensitive crops or other areas where you don't want to risk the product moving off-target. If it is not possible to spray these areas first when conditions are favourable, it can be useful to leave unsprayed areas within a paddock.

Unsprayed areas can be left if you are expecting a change in wind direction. This allows those areas to be sprayed later.

Recording the outcome of all spray jobs

- Keeping records serves many purposes including reviewing product performance and for legal reasons. But there are many other reasons to keep records that can help to improve your pest and weed management over time.
- Use record-keeping systems that work for your enterprise and will also be useful in the future.
- Always record things that have worked well (we don't do this enough).
- Assess the level of control you achieved and how long it took.

Plan your sprays on a paddock by paddock basis.

- Record unexpected results – surviving weeds, diseases and pests – and follow-up on these.
- Make notes on how long it takes to complete different types of spray jobs (hectares per hour) to help plan future operations.

Integration of equipment

It is important to consider how well all of your equipment is integrated. This includes: GPS, auto-steer, wheel centres, total widths of seeders, headers and the sprayer. Integrating all of these things can take time and careful planning but the results can be very rewarding.

Make sure vehicle movements around the farm make sense. For spraying operations it can often be logical to increase the number of fill points to reduce travel time refilling sprayers or water carts.

Changes to farm layout are difficult but are sometime necessary to maximise efficiencies and minimise risk to sensitive areas.

Longer spray runs, fewer turns and fewer obstacles can all increase efficiency and reduce running costs.

Fewer wheel tracks in the paddock can often improve yields and reduce running costs, but this generally requires good integration between all of your equipment.

Consider using vegetative barriers to reduce the movement of chemicals from sprayed paddocks towards sensitive areas such as houses, water bodies, pastures and neighbouring crops.

Upgrading your sprayer

Planning for your next sprayer should begin when you start operating your current sprayer.

- Identify the features you found most useful, but also the things that you found limited your ability to spray the way you wanted to spray.
- Consider what features you may require, and why, well in advance of the purchase or upgrade.
- Document your current maintenance requirements and costs.
- Know the real cost of operating your current sprayer.
- Consider depreciation and when to change.
- Know the life you expect out of a replacement sprayer.
- Research and consult as widely as you can.
- Make sure service and after-sales support is available.

Before purchasing a new sprayer, also ask yourself if there are other ways of improving your productivity, and if you do buy a new sprayer, how will it integrate with other equipment.

More information:

The GRDC *Spray application manual for grain growers* is available free online and contains a number of video and print modules which provide up-to-date information about all aspects of spray application technology.
See www.grdc.com.au ■

SECTION 6 Spray spplication
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CROPLANDS

Lighting up fallow paddocks around Australia

Australian owned, agricultural spray equipment manufacturer, Croplands, has recently launched their WEEDit trailed sprayer range in Western Australia. Croplands has sold over 5000 WEEDit sensors in the eastern states since they adopted the technology from Europe in 2013. Croplands have engineered spray systems that not only maximise the efficiency of the WEEDit sensors, but withstand the rigours of Australian broadacre conditions.

Their optical spot sprayers are 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.

Andrew Johnston is an agronomist in the Dalby region of Queensland, where many farmers are using Croplands WEEDit Optical Spot Sprayers as part of their fallow spraying operation.

"It's the tool we use with our customers to target specific weeds at specific times," Andrew says. "It means we don't have to be on the paddock immediately. This sprayer provides flexibility in that we can hold off spraying for a short period and target the weeds at ideal times. And WEEDit allows us to strategically manage paddocks when controlling feathertop Rhodes grass. We don't look at blanket applications, instead, we look at more strategic mixes with different chemistries."

Croplands is equipped to handle demand for their innovative spray systems in WA with the support of a strong dealer network in AFGRI Equipment and Ag Implements. Croplands has also employed a WEEDit specialist from the former distributor (TPS), who will assist in providing service of existing and new WEEDit machines in the west.

Croplands unleashed its dual tank, dual spray line, high capacity optical spot sprayer (the WEEDit 7000) on last year's field day circuit. The machine has a brand new 7000 litre main tank with 800 litre flushing tank and 1500 litre 'hot tank'. The hot tank is aptly named as it used to hold high concentration chemicals specifically for spot spraying – the secret weapon for combating hard to kill weeds and delaying the onset of herbicide resistance.

The innovative sensors have helped revolutionise fallow weed control in the eastern states since 2013.

The new optical spot sprayer has a 7000 litre main tank and a 1500 litre 'hot tank' for high concentration chemicals.

New features

Croplands has also incorporated many features with operator safety and ease of use in mind. The up and over platform allows for safe and easy access from both sides of the sprayer to the tank lids. This space also features a drum rack which can be used to transport extra chemical – or alternatively – can double as a toolbox rack.

The 60 litre Chem-e-flush hopper is fully integrated to the sprayer's control system, with a range of optional extras including a 12 volt chemical transfer pump system, complete with micromatic drum fittings and chemical suction probe. A 30 litre chemical induction hopper is also fitted to transfer chemical directly to the hot tank.

The WEEDit 7000 boasts airbag axle suspension to support the contour following boom – ensuring a smoother ride and longer life. Adding to this is a standard air ride drawbar system that features an integrated Hendrickson airbag – an integral part of the suspension package.

The heavy drawbar also features a heavy duty adjustable hitch and swivelling eye. The manual jack stand comes as standard, while the hydraulic version is optional.

The new sprayer is fitted standard with wide low dust 24.5-32 tyres and wheels.

"Croplands is excited about the opportunity to bring our range of WEEDit sprayers to Western Australia and to provide solutions in the fight to control hard to kill weeds and chemical resistance," said Croplands General Manager, Sean Mulvaney. "The technology has proven to be extremely reliable and the release of our new purpose built 7000 litre platform is the ideal time to extend our reach into the west." ■

SECTION 6 Spray spplication

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CROPLANDS

New self propelled sprayer with a big 48 metre boom option

While the new RoGator C Series doesn't look so different from the exterior, it offers plenty of innovation to enhance application and driveability. Croplands also has an optional 48 metre Pommier-manufactured aluminium boom available for the RG1300C model.

Pommier are world-wide industry leaders in aluminium boom innovation, design and manufacturing. Their booms perform brilliantly in tough, Australian conditions making them the perfect solution for Aussie contractors and broadacre farmers who want a lighter, stronger, wider boom for their new RoGator C Series.

Norac Boom Height Control is a standard feature of the 48 metre boom on the RG1300C self-propelled sprayer and allows the boom to shadow the ground – even in rough or hilly terrain to maintain an optimum boom height, reduce drift and improve stability.

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

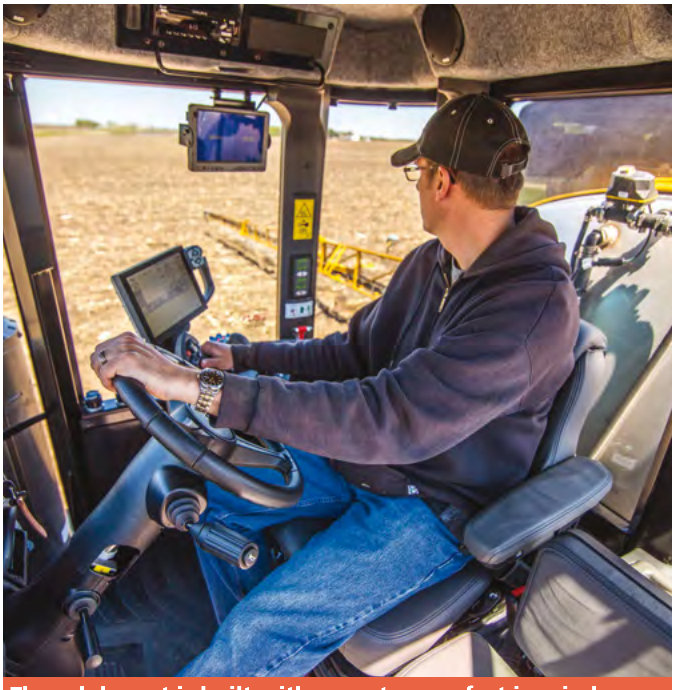
Croplands Victorian Area Sales Manager, Steve Ross attended the launch of the C Series in Jackson, Minnesota.

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

"The flexible chassis provides even ground distribution and with the addition of the traction control – this is the ultimate combination. This machine would perform amazingly in challenging paddock conditions."

The RoGator C series features all-wheel traction control with a hydrostatic, four-wheel drive system. Croplands says this is an industry first that provides power to the wheels with no slip.

If the system senses a wheel slipping, it diverts power to the wheels that still have grip to keep the sprayer moving. The operator has ultimate control with two-wheel or four-wheel drive options that can easily be selected from the cab. Optional four-wheel steering provides a turning radius so tight that the sprayer has the ability to leave only two tracks in the paddock, with the rear wheels following the front with ease.



The cab layout is built with operator comfort in mind.

Croplands RG1300C is available with 48 metre aluminium Pommier boom.

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

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

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

Industry first full recovery system

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

RoGator C Series sprayers features a control interface known as Accuterminal. It has fingertip control to monitor and control virtually all chassis and machine functions, including rate and section control, guidance and optional cameras. The Accuterminal screen navigation allows you to move through screens with intuitive touch-screen technology and view up to four different functions of your choice at the same time. Accuterminal electronic controls can even automatically manage agitation to avoid foaming in the tank as product level falls.

Croplands is releasing the RoGator C-Series 1100C with a 4163 litre tank and the RoGator 1300C with a 5000 or 6000 litre tank to the Australian market. Both models are powered by an 8.4-litre AGCO Power diesel engine.

For more information or sales enquiries for the RoGator C Series contact Croplands Northern Regional Manager, Jeremy Rennick on 0409 065 994.

SECTION 6 Spray spplication

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CROPLANDS

Section 7

Managing Resistance

CONTENTS

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HASTEN† SPRAY ADJUVANT

iHSD – pleasing research despite challenges during 2017 harvest

It would be remiss of us to talk about the latest integrated Harrington Seed Destructor (iHSD) research without acknowledging the challenges with this new machinery during the 2017 harvest.

It was frustrating for everyone, but the researchers, manufacturers and suppliers are playing the long game, and they are dedicated to succeeding in the long run.

Recent research by Michael Walsh commenced at the Australian Herbicide Resistance Initiative (AHRI) and was completed at Sydney University with help from John Broster at Charles Sturt University (CSU), shows that despite the problems that have been experienced with the new machines, iHSD mills are passing the research tests with flying colours.

The research concluded that:

- The iHSD achieved 96–99 per cent destruction of the seeds of 11 weed species when processed in wheat chaff;
- Weed seed destruction varied by about 10 per cent depending on crop chaff type – ryegrass seed kill was greatest in lupin (98 per cent) > wheat (92 per cent) > canola (90 per cent) > barley (88 per cent);
- Weed seed kill dropped by about 4 per cent when chaff moisture increased above 12 per cent; and,
- Weed seed kill increases with mill speed and 3000 rpm is the accepted optimal speed.

For more about this excellent research and the weed species tested read on…

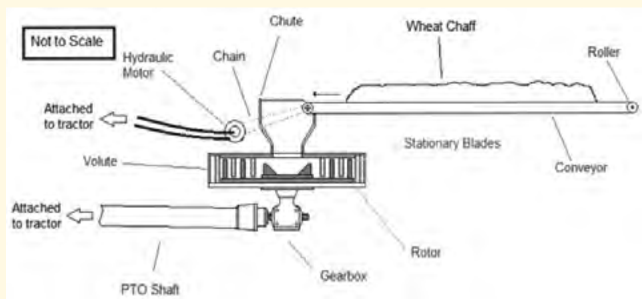
Researching harvest weed seed control isn't easy and it's certainly not glamorous! Michael Walsh from the University of Sydney (formerly AHRI) and John Broster from CSU have spent many hours sifting through huge bags of chaff laced with coloured weed seeds to confirm the iHSD works on a large range of weed species under a range of conditions.

Readers don't generally care too much for scientific methods so we won't go too deep into the detail, but it's important to know this research was done using a stationary test mill as shown in Figure 1. Chaff laced with coloured weed seeds is placed on a conveyor belt that is fed into an iHSD mill with the processed material caught in a mesh bag. A team of eager, well-paid students then spent months sifting through bags of chaff to find any weed seeds for germination testing to see if they had survived their trip through the mill.


Michael Walsh.


John Broster.

Figure 1: Schematic of iHSD test stand showing the mill and conveyor belt chaff delivery system



How much chaff?

The amount of chaff used in the testing has been calculated to simulate harvesting wheat at 35 tonnes per hour. For every tonne of wheat grain harvested about 300 kg of chaff is produced. Therefore, when harvesting 35 tonnes per hour, 10,500 kg of chaff is produced per hour. Each mill in a twin-mill iHSD system must, therefore, process 1.5 kg of chaff per second.

Eleven Australian weed species tested

Previous research has focused on four key Australian weed species. This study dug a little deeper and found that the iHSD mill was effective on 11 different weed species as can be seen in Table 1. Other international studies are currently underway assessing weed kill of a wide range of species, with encouraging results.

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Eject* Defoliant Select* & other Clethodim 240EC products
Platinum* 360 & other Clethodim 360EC products Atlantis*

Tordon*
Regrowthmaster
Valor* & other Flumioxazin products
Logran* B-Power
Sharpen*
Flame* 240g/L
Precept*
Prosaro* Skope
Movento
Shogun*

Terbyne* Xtreme
Arvesta Motsa*
Targa*Bolt
Gesaprim*
Hammer*
Midas* Intervix*
Raptor* WG
Cheetah* Gold
Destiny* OnDuty*
Decision*
Terbyne*
Hussar*

Spinnaker* & other 700g/Kg Imazethapyr products Velocity*
Topik* & other Clodinafop 240EC products Intercept* Blazer*

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Hasten now cross-labelled on 33 crop pesticide brands

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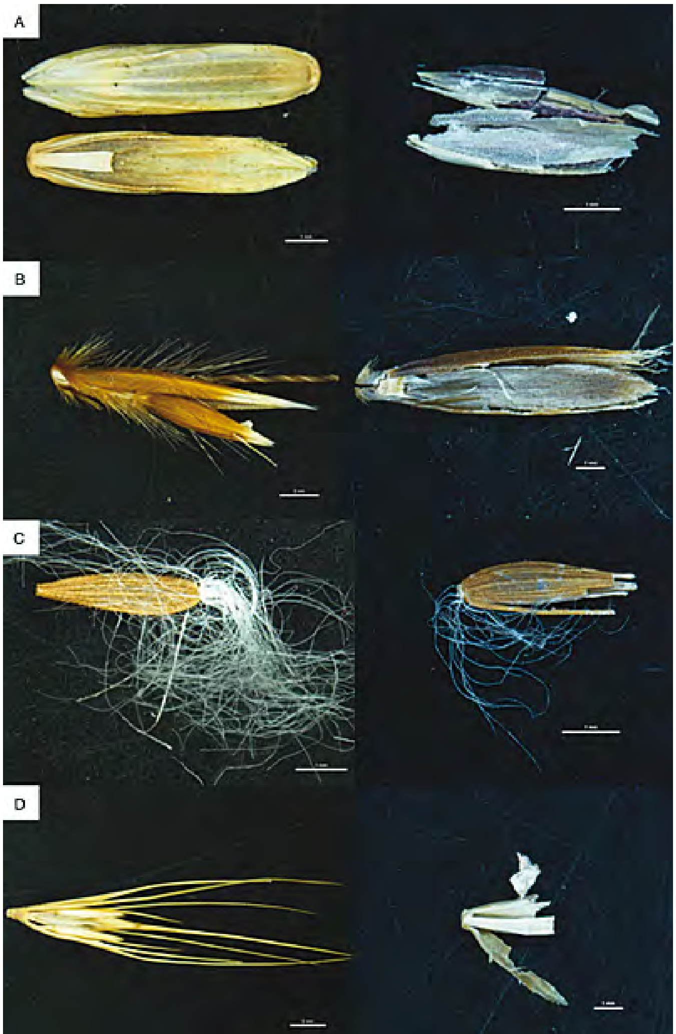

This picture shows the damage inflicted on weed seeds from the iHSD mills.

The effect of crop type

Table 2 shows that there are small differences in ryegrass seed kill between four crop types. But other trials conducted in the field during commercial grain harvest achieved 99 per cent kill of ryegrass, wild radish, brome grass, and wild oat while harvesting canola or barley.

Essentially, it's fair to say that the iHSD mill is effective in all crop types tested so far.

Mill speed

A small increase in mill speed requires a large increase in horsepower to drive the mill, so we need to make sure we are not overdoing it or we will be costing growers time and money with no additional benefit. Figure 2 shows how the researchers and developers of the iHSD, DeBruin engineering, settled on the 3000 rpm mill speed.

SECTION 1 MANAGING RESISTANCE

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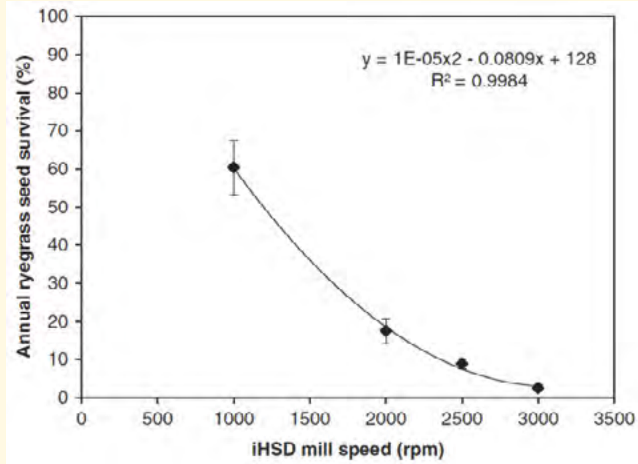
Figure 2: Influence of iHSD mill speed on the survival of annual ryegrass seed processed in wheat chaff



Moist chaff reduces seed kill

The researchers measured ryegrass seed kill at 10, 12, 14 and 16 per cent moisture. Seed kill was 92 per cent at the lower moisture levels (10 and 12 per cent) and dropped to 88 per cent for the higher moisture levels (14 and 16 per cent).

To sum up

The iHSD had some challenges with bearings and excessive wear of the mills, amongst other smaller issues during the 2017 harvest, but we shouldn't lose sight of the big picture. The research is outstanding, the challenge now is to ensure that the machinery develops into a reliable, effective tool, because a large portion of the world's crops need it. ■

Table 1: Percentage destruction of the seed of 11 weed species of Australian cropping used in stationary testing of the iHSD mill

Weed species	Seed kill %
Annual ryegrass (*Lolium rigidum*)	96 (0.1)
Wild oats (*Avena spp.*)	99 (0.1)
Wild radish (*Raphanus raphanistrum*)	99 (0.1)
Barley grass (*Hordeum vulgare*)	99 (0.1)
Brome grass (*Bromus spp.*)	98 (1.0)
Barnyard grass (*Echinochloa spp.*)	99 (0.8)
Indian hedge mustard (*Sysmbrium orientale*)	99 (0.4)
Fleabane (*Conyza bonariensis*)	99 (0.2)
Windmill grass (*Chloris* truncata)	97 (0.4)
Sowthistle (*Sonchus oleraceus*)	99 (0.5)
Feathertop Rhodes grass (*Chloris virgata*)	98 (0.3)

Figures in brackets are the standard errors for the mean of eight replicates.

Table 2: Influence of chaff type on rigid ryegrass seed kill*

Chaff type	Rigid ryegrass seed kill %
Wheat	92 b
Canola	90 bc
Lupin	98 a
Barley	88 c

*Numbers followed by the same letter are not significantly different (P=0.05)

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Aussie-made adjuvant now cross-labelled on 33 pesticides

Years of research and development by Vicchem to create technically-superior crop adjuvants, such as the flagship Hasten brand, is finally paying off for the science-based company. Since its Australian launch in 1994, Hasten has been cross-labelled on 33 leading pesticide brands, the latest being grass herbicide, Platinum360, launched by Adama recently.

The pioneering adjuvant brand has become a genuine home-grown success story for Melbourne-based Vicchem, due to growing popularity among suppliers, resellers, agronomists and growers.

Vicchem's national sales manager, Owen Connelly, said Hasten was one of the few adjuvant brands that could genuinely claim 'Aussie icon' status.

"Hasten is made for local farming conditions – using Australian-grown canola oil – which local producers of grain, cotton and pulses increasingly value these days," Owen said.

"Widely sold in the distinctive 20 L green can, Hasten has a solid research base. It's manufactured to high quality standards and extensively trialled to ensure safety to users, crops and the natural environment.

"Adama's launch of Platinum360 brings to 33 the total number of leading herbicides, insecticides and defoliants now cross-labelled with Hasten."

Adjuvant safety research

From Vicchem's R&D division, technical manager Peter Jones reminded grain growers of encouraging results from the company's recent studies into adjuvant safety. Peter said all adjuvants had the potential to cause crop phytotoxicity which plant chemists believed was due to cellular breakdown.

"Based on our long term studies, canola-derived Hasten produced relatively less cell damage than mineral oil adjuvants, including Uptake and non-ionic surfactant adjuvants such as BS1000," he said.

On environmental safety, Peter said Vicchem had also studied the effect of these same adjuvants on beneficial insects and predatory mites.

"Our results showed that Hasten was generally safer than the other two adjuvants tested, which can be harmful to predatory green lacewing, predatory mite and parasitic wasp when sprayed directly at typical use rates."

Peter said Vicchem was also exploring opportunities to use some of the outstanding properties of Hasten in the development of new products, tailored-made for certain pesticide types.

"A key strength of Hasten is its ability to help systemic selective herbicides penetrate the waxy cuticle of target weeds – without damaging crops.

"We are now trying to incorporate those properties of Hasten into new adjuvant products in a targeted way.

"Ultimately, it's about being more exact with the science and using novel ingredients to get the best result from every pesticide type and application scenario."

For more details, contact Owen Connelly at Vicchem on (03) 9301 7000 or go to www.vicchem.com.au

Hasten cross-labelled pesticide use

Product	Chemical company	Hasten rate/100 L of spray volume
Arvesta Motsa*	Tomen/Arysta	1 L
Atlantis*	Bayer	1 L
Blazer*	UPL	1 L
Cheetah* Gold	Bayer	1 L
Decision*	Sipcam	1 L
Destiny*	Bayer	0.5–1 L/ha
Eject* Defoliant	Sipcam	0.5 L/ha
Flame* 240g/L product only	BASF	1 L
Gesaprim* and other atrazine products	Syngenta	0.5–1 L
Hammer*	FMC	0.5–1 L
Hussar*	Bayer	1 L
Intercept*	BASF	0.5 L
Intervix*	BASF	0.5 L
Logran* B-Power	Syngenta	0.5 L
Midas*	BASF	0.5 L
Movento	Bayer	0.5–1.0 L/ha
OnDuty*	BASF/Cropcare	0.5 L
Platinum*360	Adama	0.5–1 L
Precept*	Bayer	0.5–1 L
Prosaro*	Bayer	1 L/100 L
Raptor* WG	BASF	0.5 or 1 L
Select* and other Clethodim 240EC products	Sumitomo	0.5–1 L
Sharpen*	BASF	1 L
Shogun*	Adama/Farmoz	0.5 L
Spinnaker* and other 700 g/kg Imazethapyr products	BASF	0.5 L
Targa*Bolt	Sipcam	1 L
Terbyne*	Sipcam	0.5 L
Terbyne* Xtreme	Sipcam	0.5 L
Topik* and other Clodinafop 240EC products	Syngenta	0.5 L
Tordon* Regrowthmaster	Dow	0.5 L
Skope	Adama	1.0 L/ha
Valor	Sumitomo	0.5–1.0 L
Velocity*	Bayer	1 L

In Australia, Hasten is now cross-labelled on 33 herbicides, insecticides, fungicides and cotton defoliants, the latest six (in red) in the past 12 months.

SECTION 1 MANAGING RESISTANCE

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SPRAY ADJUVANT

Adjuvants' role in combatting herbicide resistance

Andrew Somervaille, Jubilee Consulting has been evaluating the performance of herbicides for more than three decades and says the role of adjuvants is often either over-rated or under-estimated. This may seem a contradiction, but the fact is that sometimes adding an adjuvant is beneficial and sometimes it is detrimental – and there is an art to knowing how to best deploy these additives.

When weeds are susceptible to the applied herbicides, the effectiveness of adjuvants generally goes unnoticed. But correctly applied adjuvants can reduce the impact of low level herbicide resistance by helping to maximise the amount of herbicide taken up by the plant.

"In the best case scenario, the correct use of an adjuvant can optimise performance of a single herbicide, or a herbicide mix," he says. "This results in the most efficient control of the target weeds, minimises seed set and reduces weed numbers into the future. All research points to low weed numbers as the only sustainable way to manage herbicide resistance.

"In the worst case scenario, the incorrect use of an adjuvant can reduce herbicide performance, may compromise the physical compatibility of mixtures and can alter the function of tank mix components," says Andrew. "This may result in a sub-lethal dose of herbicide being applied, which is known to amplify herbicide resistance if there are low levels of resistance present in the weed population.

"Once populations are highly resistant then the impact of adjuvants is reduced," says Andrew. "This highlights the importance of being very deliberate and calculated when making recommendations or decisions about adjuvants."

Andrew Somervaille, research agronomist with Jubilee Consulting suggests growers and advisors should not overlook or over-rate the use of adjuvants.

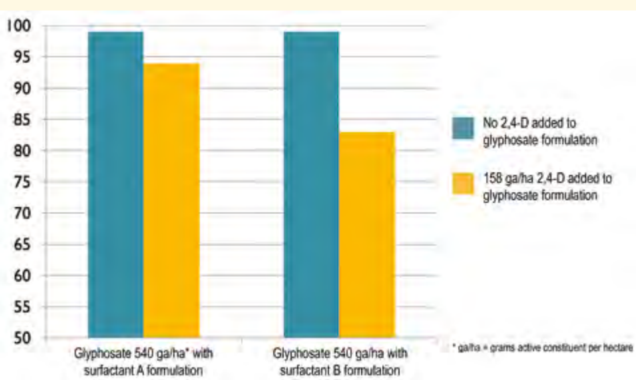
Glyphosate formulations and adjuvants

In one experiment Andrew conducted with two formulations of glyphosate, he measured the effect of the adjuvant used in each formulation, when in the presence of 2,4–D, to control awnless barnyard grass (Experiment 1). "We know there is antagonism between 2,4–D and glyphosate in a tank mix in some situations that results in a reduction in the level of control expected from glyphosate alone," he says. "What we observed in this experiment was that one glyphosate+surfactant formulation mixed with 2,4–D achieved just over 80 per cent control while a second glyphosate+surfactant formulation mixed with 2,4–D achieved 94 per cent control."

Andrew says that although some herbicide products are manufactured with an adjuvant included as part of the formulation, there may still be a benefit gained from adding another type of adjuvant prior to application, depending on the other products in the mix, the water quality or the target weed.

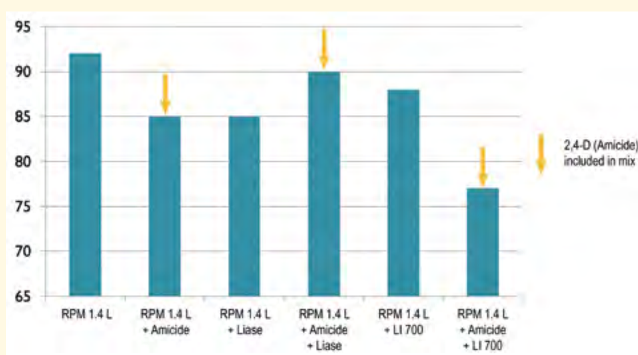
In another experiment (Experiment 2), Andrew investigated the effect of different adjuvants (LI 700 and Liase) on the efficacy of a RoundUp Power Max (glyphosate) and Amicide (2,4–D) mix. The results clearly showed that while Liase improved the performance of the mix, LI 700 reduced performance to less than 80 per cent control of barnyard grass.

Experiment 1: Variability in barnyard grass control to phenoxy (2,4–D) mixed with two glyphosate formulations (same active constituent, different surfactant)



Source: Andrew Somervaille, Jubilee Consulting

Experiment 2: Variability in barnyard grass control in response to glyphosate (RoundUp Power Max [RPM]) and phenoxy (Amicide [2,4–D]) mixed with two adjuvants (LI 700 and Liase)



Source: Andrew Somervaille, Jubilee Consulting

Grower experience, research trials and computer modelling all point toward high levels of herbicide performance, coupled with the removal of survivor plants, to reliably and sustainably extend the useful lifespan of herbicides by removing potential carriers of resistance traits.

"Even small incremental losses in control at the 'top end' can have a large effect on the total seed-bank load," says Andrew. "While 95 per cent control might still be considered a good result from a herbicide application that could have potentially achieved 98 per cent control, this three per cent loss in efficiency could be the start of a substantial increase in weed numbers and allow herbicide resistance to gain a foothold."

Keeping weed numbers low allows the targeted use of more expensive products (for example, through an optical sprayer), makes manual control methods economical, and even allows the use of less efficient products to maintain or slightly reduce numbers while adding diversity to the program (provided there is no cross-resistance).

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For more information about improving herbicide efficacy and minimising herbicide resistance risk, visit the WeedSmart website: www.weedsmart.org.au and download the GRDC publication, 'Adjuvants – Oils, surfactants and other additives for farm chemicals', compiled by Andrew Somervaille.

Adjuvants can play an incremental role in improved herbicide performance and assist with keeping weed numbers low and reducing the risk of sub-lethal resistance traits. But their use does not over-ride the need for correct chemical use and application under the right conditions.

WHAT ADJUVANTS DO

An adjuvant may modify the physical, chemical and biological activity of the herbicide on the target. For example, an adjuvant may be added to improve the physical properties of the spray such as its spray quality, or to allow products to dissolve or mix in water. Adjuvants may also alter the chemical properties of the formulation to counter poor water quality or activate certain components in the herbicide, and from a biological perspective an adjuvant may be used to influence uptake through the plant cuticle and even movement across cell membranes.

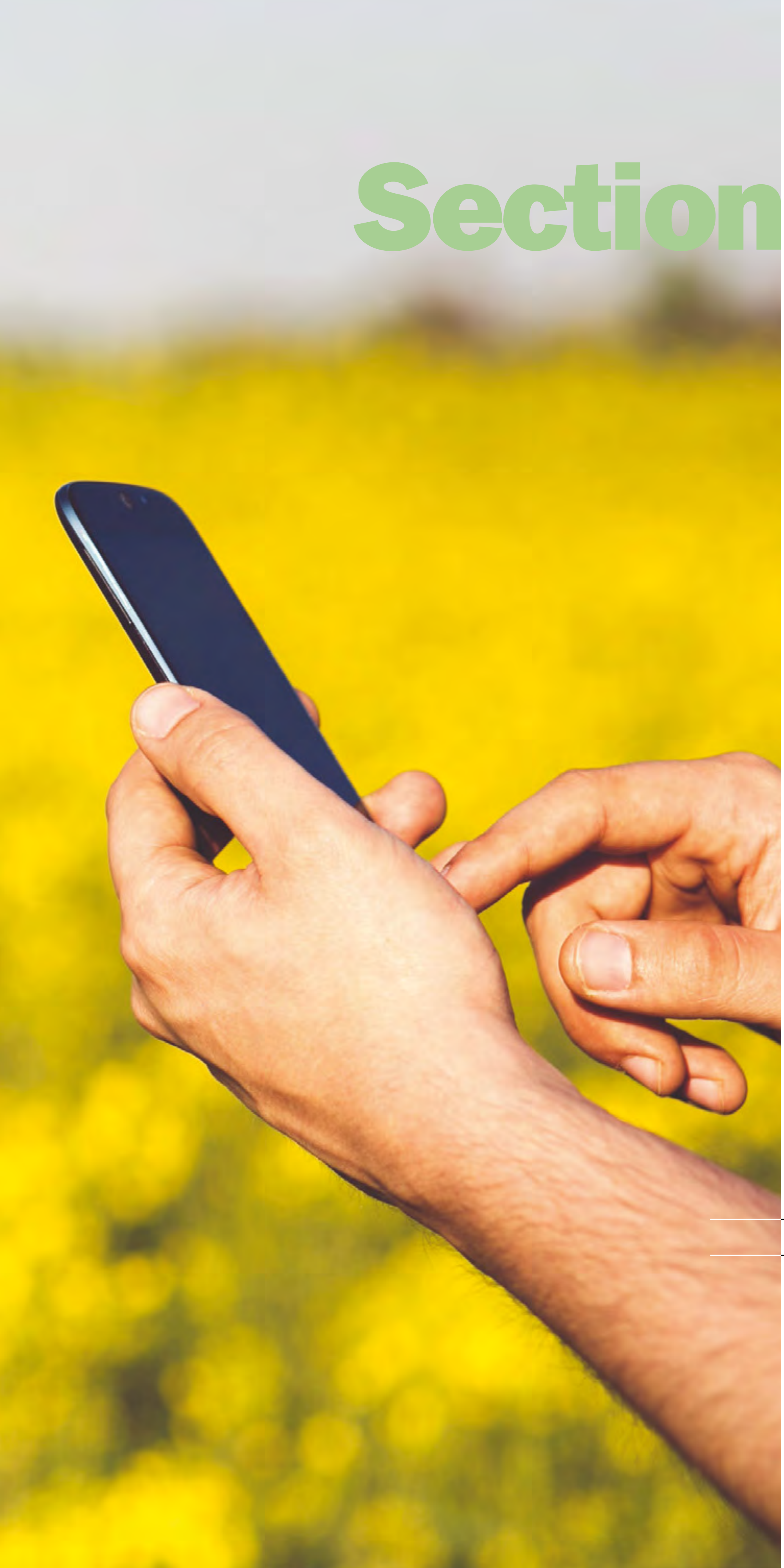
Very small amounts of surfactants are required to achieve adequate 'wetting' of the plant surfaces and adding more surfactant will not necessarily increase the performance of foliar applied herbicides. But some adjuvants (including surfactants) are added specifically to activate the active ingredients and so are an essential component of the formulation or mixture.

The same adjuvant may even perform different functions when included in different mixes or added to different formulations. There are also specific responses in certain weeds to certain surfactants, some giving superior results and other inferior. It is not possible to give rule-of-thumb recommendations – each scenario needs to be examined carefully, taking into account the target weed species, the condition of the weeds, the water quality and the specific herbicide formulations.

They are not always beneficial and can result in sub-lethal doses being applied if they are not used correctly. Combinations of surfactants can modify the functions of the individual components and it cannot be assumed that the effects are additive to herbicide performance.

Also, be aware that the characteristics of the leaf cuticle are not the primary limiting factor associated with the uptake of foliar applied herbicides. Plant stress is usually the main limiting factor and this may only be partly overcome through the use of an adjuvant.

Clearly, it is not a simple matter of making recommendations or decisions to include an adjuvant. Growers and their advisors need to have an appreciation of the chemistry behind the adjuvant's use and the way that it may impact on the uptake of the herbicide into the target weed.



Section 8

Digital Agriculture

CONTENTS

THIS SECTION BROUGHT TO YOU IN ASSOCIATION WITH:

smartagri control
the smarter solution

What's all the fuss about digital agriculture?

By Michael Robertson, Andrew Moore, Dave Henry and Simon Barry – CSIRO

Predictive analytics, remote sensing, knowledge management and blockchain: buzzwords or the agricultural disruptors? Digital agriculture is causing excited chatter, especially about its potential benefits for farmers, industry, agribusiness, researchers and government. But why the fuss?

Farmers need to be aware that, consistent with what has happened in other industries, new types of business will be created, new jobs will be required, existing jobs will change and some jobs may even disappear. For example, the increasing efficiencies from digital agriculture – especially robots – will increase the number of hectares and animals that one farmer can manage. This is the continuation of a century-long trend that has major social consequences in rural Australia.

We are at a vulnerable position on the 'hype curve' and there is fierce competition for market share among many new and established players in digital agriculture. The promises being made by the proponents of some technologies run the risk of sliding towards the trough of disillusionment.

For instance, there's much talk of the 'Internet of Things' in agriculture. If the technology remains isolated from knowledge of agriculture and an understanding of the actual on-farm realities and business problems, then instead of contributing solutions it will remain on the shelf or be of interest only for niche hobbyists.

And what happens when predictive analytics start to match local knowledge? We are conducting social research to explore these trends and drivers. We need to be more mindful of how our research and development will influence the forces of disruption.

A key challenge is to find simplicity on the far side of complexity. Too much information can confuse and not clarify. Technologists need to appreciate that farmers do not need high frequency and precise data for every decision.

Remote sensing systems will be complemented by handheld devices.

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What's in it for producers?

At the heart of digital agriculture lies the opportunity for sensing systems and associated analytics to lower the cost of knowing what's going on and more accurately predict the future. This can come from improved knowledge about an individual enterprise, or via efficient sharing and learning from data from multiple enterprises.

We believe these developments offer three big opportunities:

- Increasing management precision, with producers able to use better information to make more timely decisions with more predictable outcomes;
- Automating tasks using sensing technologies and machine learning could cut costs and increase reliability; and,
- Better categorising, differentiating and tailoring agricultural products and services, which will open up new markets.

All these opportunities are around the point where development translates into practical use on the farm. As yet unexplored new value lies in grasping two or all three simultaneously. For example, crops could be selectively harvested from zones of the farm according to their quality characteristics and then put into different processing and marketing streams to maximise their value.

Crossing key technology frontiers

Just as exciting as creating new data and information, business models and technologies, is creating innovative ways of putting together and using existing ones.

Sensing systems

New remote sensing systems, such as the European Sentinel satellites, will overcome many of the shortcomings of the established Landsat satellites. They will provide data at improved frequency, resolution and cost, with better access and timeliness. For example, satellite imagery can identify what is growing in each paddock and then forecast a yield or feed availability. This information can have a wide range of end uses: Farm management, farm advice, input supplies, risk assessment, planning for logistics and handling and assessment for drought relief.

But digital agriculture in Australia has been constrained by limited access and useability of satellite imagery. We are working alongside Geoscience Australia to create an Earth Observation Data Hub that will provide 'data cubes' of satellite information for applications in digital agriculture. The prototype has given, for the first time, imagery of the whole of Australia's land area at a resolution of 25 square metres. It shows how land use, vegetation, water movements and urban expansion have changed over the past 30 years.

Remote sensing systems will be complemented by proximal systems, such as handheld devices or even cameras on smartphones. In precision irrigation, for example, there are exciting possibilities of linking satellite information, weather forecasts and crop models with ground-based, spot sensing of crop canopy temperature. This involves static infrared thermometers giving precise warnings of the need for irrigation over whole farms and the consequences of delay.

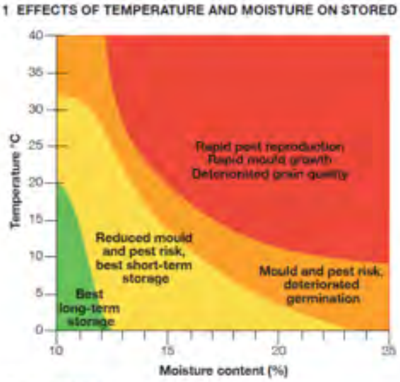
One of these silos is about to be ruined by mould…

Can you tell which one?

Most grain farmers rely on the "smell" of the grain inside to detect if their crop is at risk.

Is your crop at risk of being **ruined by insects or mould** because you trust your nose?

FIGURE 1 EFFECTS OF TEMPERATURE AND MOISTURE ON STORED GRAIN



Source: Csiro Ecosystems Sciences

What causes this?

Grain at typical harvest temperatures of 25-30°C and moisture content greater than 13-14 per cent provides ideal conditions for mould and insect growth. There are a number of ways to deal with high-moisture grain — the key is to act quickly and effectively.

Did you know? There is a new system that works 24/7 to detect the conditions inside your silos and automate heating and cooling to protect your stored grain?

Learn more by contacting Henk de Graaf now at henk.degraaf@ia-group.com.au or call (08) 9300 1844

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ia-group.com.au/agriculture

While sensors abound on the market, there are still some notable gaps. For instance, we still don't have a sensing system that can non-invasively measure soil fertility nor diagnose animal health.

The fewer manual steps needed between data collection and decision-making, the more adoptable the digital technology will be. The experience with yield monitors in the grains industry, where only a minority collect, download and use yield maps, has taught us that simple, easy-to-use systems of data management will facilitate wider uptake by farmers.

Distributed sensing systems can form the basis for knowledge platforms for social learning. For example, our Chameleon soil moisture sensing system, used by smallholder irrigators in Africa, has a learning platform based on colour coding of soil moisture patterns. The data is shared among farmer groups to facilitate them testing and improving their own heuristics for irrigation management. Governments are interested in using the data at the level of the irrigation scheme to assess the performance of their infrastructure investments.

Knowledge discovery and management

The use of artificial intelligence, machine learning and natural language processing will streamline the discovery, access, usability, and confidence farmers place in data. We should grasp the big opportunities in synthesising disparate information that resides in often fragmented and difficult locations, such as government agencies, research and development funding bodies, product manufacturers and distributors, and on-farm data.

Doing this could unlock information for farmers and advisers.

The research community has a long way to go in storing its data in safe, discoverable and interpretable forms so that it is not needlessly duplicated and can be reused for new purposes. The Australia National Data Service is making progress on this front and our Data Access Portal houses a growing number of valuable agricultural data sets.

Predictive analytics

At the moment our ability to collect vast amounts of data easily outstrips our ability to convert it into usable information. Predictive analytics can play a critical role for decision makers who need to interpolate and forecast from a current situation to an alternative state.

For example, we have developed solar-powered eGrazor collars for cattle to monitor and collect real-time data on the behaviour of each animal in order to infer feed intake. This can aid livestock producers in fine-tuning feeding regimes and grazing management. It can also identify individual animals that efficiently convert feed into meat and milk.

Coupled with a forecast of feed availability and the potential to control the movement of livestock with ethical 'virtual fencing', it is easy to see how digital agriculture is well placed to transform traditional livestock farming.

Blockchain

Agriculture and food are ideal domains to exploit the potential of distributed ledgers or blockchain. This emerging technology is most commonly associated with Bitcoin and other cryptocurrencies. But it can be used equally well in agriculture for decentralised and transactional data-sharing across a large network of untested participants. It enables new forms of distributed systems and agreements and captures transactions permanently, without relying on a trusted central authority.

Drones have proven their worth in agriculture and there are more innovations on the way.

Blockchain technology allows information to be carried along a supply chain; to match product to processing demands; to enable traceability, verify provenance and monitor quality and safety.

In future, a Tokyo restaurant could use blockchain technology to verify that a cut of wagyu beef originated from a particular farm in Tasmania.

Through blockchain, producers will be able to escape the trap of commodity production, where products cannot attract premium prices. Blockchain will open up ways for farmers to put their products into differentiated markets by allowing verification of provenance and other attributes. It will meet the demand by consumers for better quality assurance of their food and fibre.

Novel communication systems

A range of new players and enterprising producers are developing solutions to the chronic lack of connectivity and poor mobile coverage across regional Australia. There are examples, such as long range wide-area network (LoRaWAN), successfully operating a low-powered Internet of Things on farms already. They show that not all digital agriculture activities require 4G mobile network coverage in the paddock. The benefits could extend beyond farm decision-making to rural or remote education, health and social wellbeing.

While improved communication will enable farmers to access greater amounts of information faster, it is not a solution in itself. Embedding analytics at the edge will shift the burden of processing large volumes of

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data from the communications network back to the point of collection. This will enable some applications without the need for high-end communications networks.

Value-adding to farm data

There is a huge opportunity in pooling data currently held in thousands of private hands to create products and services that farmers can use to improve their businesses. Working with farmer groups, we are actively exploring the viability of farm data-sharing arrangements.

Once data is shared, individual farmers can benchmark their production against others. For example a farmer could develop more precise soil maps for his or her farm based on aggregated soil test results, or gain a more accurate picture of rainfall patterns in the locality.

Governments and research bodies already pool lots of 'small data' and use it to monitor performance trends in the industry. The innovation challenge in agriculture is finding the right business model for farmers to participate in. Farmers tell us that if they are going to contribute their own data and trust others with it, they want an obvious and transparent explanation of how it will be used to benefit them and others.

New partnerships to even-up information asymmetry

There is currently an imbalance of information between farmers and agribusiness or government. By improving transparency and access to information of common interest, we have the opportunity to increase trust and reduce costs among different players in the industry.

We are part of a new company, Digital Agriculture Services (DAS), which is creating digitised valuations, automated risk assessment, insight and productivity trends for rural land. Such intelligence is of interest to farmers and institutions alike including banks, governments, agribusiness and commodity handlers.

Inventing e-extension

How do we link farmers with the most relevant and knowledgeable agricultural advisor anytime, anywhere? This is particularly important in an era where one-on-one extension advisory services are in decline. Artificial intelligence systems can now be used to mine and interpret knowledge banks. For farmers it opens up fragmented and inaccessible extension and scientific material, and enables them to gain tailored answers to specific queries. Such tools could form an adjunct to advisory services, and support inexperienced staff working in unfamiliar situations.

Enabling digital agriculture to flourish

All of these developments show why there is such excitement about digital agriculture. We are working broadly across this field and actively filling vital information gaps that will enable digital agriculture to flourish.

We have identified a need for data assets, like the digital soil map of Australia, and ongoing improvements. As well as working on remote sensing imagery with Geoscience Australia and on monitoring products for ground cover, soil moisture and feed availability, we're working with the Bureau of Meteorology on climate forecasts at new time and spatial scales.

We are building techniques to allow users to integrate a diverse set of tools with data assets for apps, information services and analytic services. The information technology infrastructure will allow developers to link a climate forecast, a soil data layer, remote sensing imagery and other sensor streams with models and other analytical tools more seamlessly than in the past.

We aim to test the infrastructure by developing a series of innovative digital agriculture products in domains as diverse as grains, aquaculture, sugarcane, irrigated crops, and carbon farming. Our high risk, fast results, frontier research is producing digital tools for farmers and agribusiness that should start being released in the next few months.

We realise it is our role to catalyse commercial activity in digital agriculture and not 'crowd out' private and other public sector players. The start-up community for digital agriculture in Australia is still young and needs vital core technologies that have underpinned the flourishing of agtech in parallel markets in the US. Our role is to develop and deliver those technologies whether it is through licencing, research and development partnerships or free distribution.

We also need to improve some older decision-making tools to accommodate newer, data-driven approaches. The simulation-based approaches used in support tools like *Yield Prophet* and *GrassGro* were created in an era where data was sparse, poor in quality and infrequent.

With the advent of more data streams, informing end users of variables like soil moisture and feed availability, we are helping redesign and upgrade these decision-making tools.

Warning – disruption ahead

Digital transformation is everywhere and, as we have seen, agriculture is no exception. Among the consequences is the trend for the big agri-bioscience companies to transform themselves into knowledge-based businesses, consistent with their earlier transition from manufacturers of agrichemicals and inventors of crop traits.

The relationship between the farmers and service providers will become more about information management, and greater access to information will alter the power balances between the different players in agriculture. Digital technologies reduce the advantage of being the local incumbent. Local knowledge and agility have been the traditional bulwarks of the family farm as an Australian institution.

Given the intersecting food, water, energy and climate change challenges that the world and Australia face, embracing digital technologies for agriculture gives us a significant opportunity. Australia is also a major trading nation and the highly competitive nature of international commodity markets means that we ignore these technologies at our peril.

See our digital agtech on show in August 2018 at our AgCatalyst event in Melbourne.

Dr Michael Robertson is the Deputy and Science Director of CSIRO Agriculture and Food. His research background is in crop agronomy and simulation modelling in broadacre farming systems to inform better management regimes for economic, environmental and social outcomes.

Dr Andrew Moore leads CSIRO's Digiscape Future Science Platform – frontier science to create next-generation decision tools that will transform the agriculture and land management sector. He started his scientific career as an ecologist before moving into agricultural ecosystems.

Dr Dave Henry leads CSIRO's digital agriculture initiative.

Dr Simon Barry is a research director in analytics research at CSIRO's Data 61. ■

AgCatalyst 2018

At the AgCatalyst 2018 event in Melbourne on August 15 and 16, attendees can examine the latest in digital technologies, data science and next generation genomics, delve into biologicals, materials science and new bioproducts, and discuss the latest developments in food science, precision agriculture and robotics.

For more details go to: https://www.csiro.au/en/Research/AF/Areas/AgCatalyst

Digital agriculture, no longer the future but the now!

We have all been aware of the automated positioning features of the latest farm machinery but there is a lot more in the digital world than just GPS.

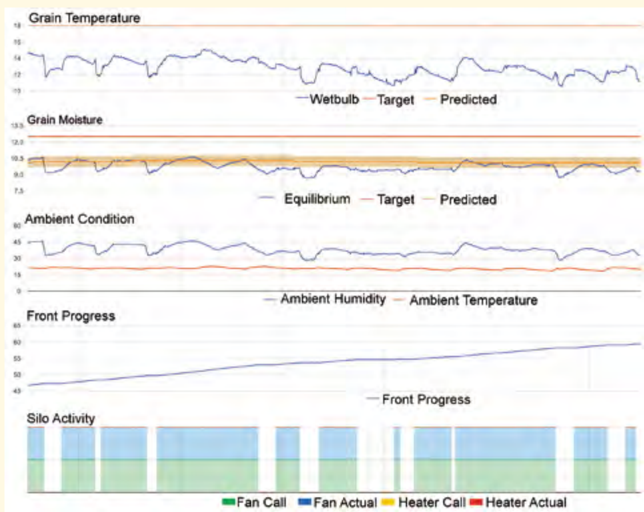
Farming has become more reliant on information – information that allows for the better management of farms, greater access to market information and knowing what the state of your crop is. This information is also no longer just provided on PCs but more and more information is now provided on the mobile platform using tablets and smart phones.

A good example of that is the latest release of the Aeration Manager, Aeration Control Australia's award-winning grain aeration controller. Already available on the Microsoft platform, the latest release of the program provides for device independent (that is, Apple and Android) access to all the features of the controller.

Apart from the unique predictive algorithm that sets this controller apart from anything else in the world, the controller now provides control and data logging of a variety of storage related data through the use of the mobile network and a Melbourne based cloud service.

Take for example the activation of the fans for grain cooling or drying. Since the controller is now linked to a cloud server, the farmer will now be able to see exactly when a fan came on and for how long (see Figure 1).

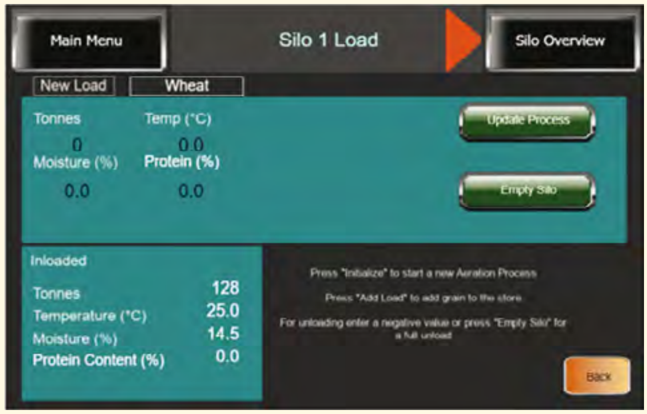
Figure 1: Aeration Manager stored grain data



As can be seen from Figure 1, the front progression through the grain now provides a clear indication as to when the grain will reach its target moisture or temperature level.

Of course, historical data is one thing but there will also be the need for actual data such as the content of a bin when the harvest is in full swing. In that case, the actual fill of each silo can be read from the tablet

Figure 2: Silo content screenshot



located in the delivery truck so that a decision can be made in which silo the next load is to be put. The link directly to the controller allows for the display of the silo details in exactly the same way it is displayed on the local touchscreen operator interface (see Figure 2).

Not only does this provide details of what is in the silo but the new load can be entered in straight away. So when the truck shows up on the

Figure 3: Drag chain control screenshot

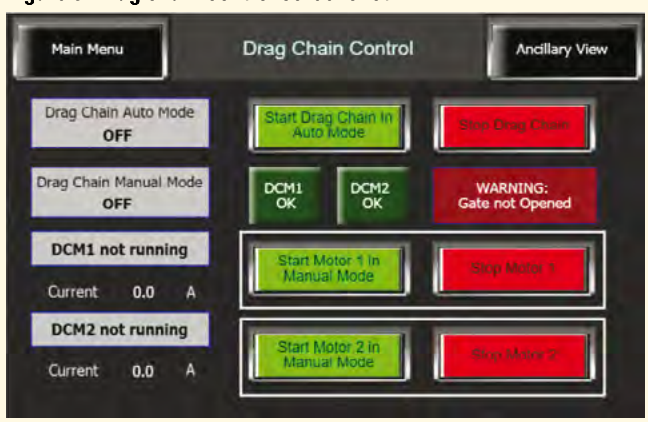
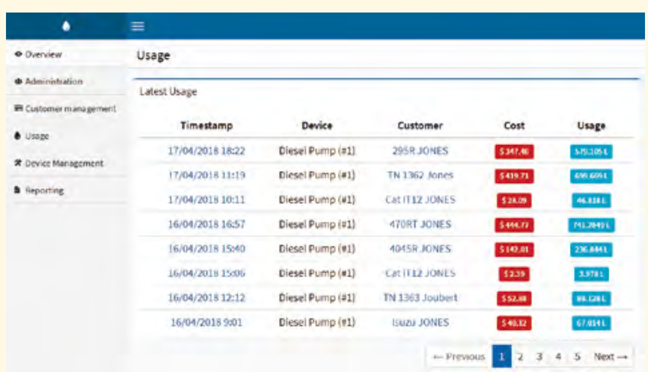


Figure 4: On-farm fuel monitoring



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weighbridge, all the administrative functions can be handled by the truck driver, even the start of the elevator or drag chain can be operated from the same system (see Figure 3).

When all these functions have been made available through the cloud based system, it will automatically enable the recording of data relevant to the efficient operation of the farm. Run hours on each fan or motor can assist greatly in the maintenance of the equipment while power usage will allow cost allocation the relevant area of operation.

Monitoring fuel use

The same applies to the use of fuel in a farm environment. Diesel is used for seeding, spraying, harvesting, trucking and personnel vehicles with in most cases very little information of what is used when and where.

Digital technology can be applied to fuel storage and allocation systems. The controller is the red panel on the left of the tank.

The digital technology has also brought a solution to this issue by providing an automatic fuel allocation system that uses a swipe card in each vehicle to accurately record the use of fuel in all parts of the farm operation.

The controller in the photo is linked to the mobile phone network and a cloud server to record every individual litre of diesel used in the farm. Upon swiping the access card past the card reader in the controller, one can start the diesel pump to fill the vehicle. This then not only records the amount of fuel used and by which vehicle, but also adjusts the remaining tank content and provides a charge associated with the use. This way proper cost allocation can be performed for each activity of the farm operation (see Figure 4).

Remote monitoring via mobiles

And let's not forget about all the monitoring that can now been done using advanced monitoring technology linked to the mobile phone network. Where once extensive radio networks were required to link remote monitoring functions to the farm, low cost wireless routers combined with on-board analog signal (0–100 per cent) processing makes remote monitoring so easy.

Take for instance a water tank level. In years gone by, a high-level switch was all that controlled the bore or other water supply with little or no information of how much water was actually in the tank. Now a level transmitter in the tank linked to a solar powered wireless router will provide you with current level information and the ability to alarm you with a text message on your phone if the level falls below the minimum required.

The same applies to video monitoring where a system can switch between live data and still photos at regular intervals and link all this to your mobile phone. ■

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Section 9

Precision Agriculture

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Utilising spatial data for within-paddock soil and crop management

By Andrew Whitlock, Precision Agriculture P/L

AT A GLANCE…

- A flexible approach is required when developing zonal management plans. Multiple tools are available to help define within-paddock variability, yet no one tool can do it all.
- Explore opportunities to unlock yield potential by addressing any known soil constraint/s. Soil zones are generally stable and easy to define. Common applications include variable rate lime and gypsum, and management of waterlogging with paddock design and strategic drains.
- Focus on site-specific crop management once a healthy soil base has been established. Management zones for variable rate fertiliser, fungicides, weedicides, pesticides and growth regulants will typically vary between seasons. They may or may-not align with your soil zones. Appropriate selection of data, farmer knowledge and careful ground-truthing is the key to a successful variable rate program.
- Continue to challenge your farming system and management decisions with seasonal crop monitoring (normalised difference vegetation index (NDVI) imagery, yield maps, plant testing, etc.) and ideally couple with a coordinated on-farm trial program.
- Precision farming should not be difficult or confusing – it should integrate seamlessly with your established farm management plan. A team approach with the farmer, agronomist and precision agriculture adviser delivers the best results.

All farmers make observations of their soil and topography and assess the implication on yield to help inform how they manage a paddock. In addition, single sample or transect soil testing is commonly used. More advanced approaches may have included sap or petiole testing in-crop for nutrient management. In recent years we have had increasing access to low-cost spatial data which can enable variable rate soil and crop management (that is – yield, imagery, soil conductivity, topography and soil tests).

While not yet perfect, we have seen advancements in the useability, interoperability and connectivity of precision farming hardware. Yet despite these developments the adoption of variable rate management remains incredibly low, especially in south eastern Australia. Lack of technical support to assist farmers with this management approach (hardware, software and agronomics) and perception of low return on investment are just a few known barriers to adoption.

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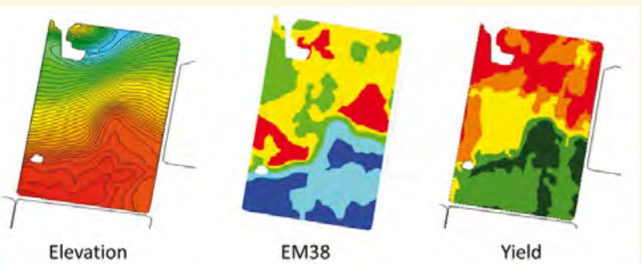
Sub-optimal allocation of inputs (potential lost opportunity for both input savings and yield increase) and missed opportunity to resolve variable soil constraints remains an issue for many paddocks with a paddock scale management unit approach.

There is a range of tools that can inform or define paddock variability. The applicability of the tool(s) used to define and describe within-paddock variability will be determined by the soil constraint or productivity issue that is being tested. Often a single layer of data may not define the issues and the treatment.

Common tools to describe variability

- Yield data – can identify zones of variable productivity which warrant further investigation but will not identify factors that are constraining yield without additional knowledge and/or data. Yield data can also be used to determine nutrient removal maps.
- Electromagnetic induction (EM-38 dual dipole) measures a combination of soil salinity, clay and soil moisture at depth (approximately 1.5m). For many paddocks it can provide an accurate soil map. Soil cores and associated analyses (ideally segmented cores to explore soil profile) are essential to extract paddock management value from such soil maps.

Figure 1: Maps from three data tools highlighting the value of integrating datasets for developing zones



- Gamma radiometrics are another soil mapping tool used predominantly in combination with EM-38 on sand plains and in gravel soils where soil conductivity is less effective in isolation.
- Normalised Difference Vegetation Index (NDVI) provides an assessment of canopy density, biomass and plant vigour. NDVI will not define the underlying factor promoting or limiting plant growth, it simply indicates where to investigate (visual, plant testing, soil testing, etc.) and helps define boundaries around such factors. Multiple layers of data and or integration of existing paddock knowledge will be required to validate NDVI imagery.
  Satellite derived NDVI maps (30 m to 30 cm resolution) offer a low-cost whole-farm monitoring opportunity which can help benchmark paddock performance and assess management.
  Drones or unmanned aerial vehicles (UAVs) can provide similar services as a satellite but also have the flexibility to target timing and the area that is monitored as well as offer a superior resolution.
  From an active crop management point of view, NDVI imagery can

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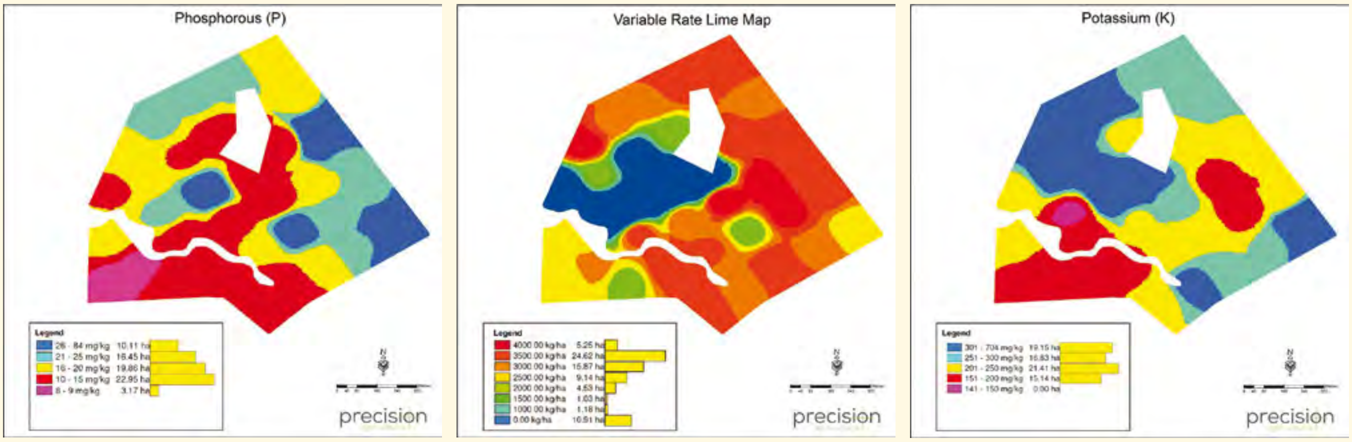
Figure 2: Comparison of results from 2 hectare grid soil mapping of an 80 hectare paddock near Rokewood, Victoria



Colwell P (left), variable rate lime prescription map (middle) and Colwell K (right)

inform the need for a range of activities including variable rate nitrogen (N), variable rate fungicide and crop growth regulants, strategic weed control (spray and/or cut for hay) and definition of seasonal yield constraints such as waterlogging, pests and sub-soil constraints.

- Global Navigation Satellite System (GNSS), in addition to machinery guidance underpins elevation mapping. This data can be converted into digital elevation models, informing water management such as drainage design, water logging zones, erosion control and water harvesting.
- Soil testing can define a broad range of soil physical, chemical, biological and hydraulic properties. Disease pathogen and nematode monitoring can be included in this process.

Our understanding of economic response curves to a range of crop inputs links back to many years of research in soils with known chemical element concentrations. We can extend this thinking to how to develop an accurate variable rate management application in areas of the country where temporal yield variability is less consistent/predictable.

We ideally want to use the same soil measurement from the input response research for developing variable rate management zones. This takes us to the most common method of paddock zoning in the world – grid soil mapping (soil transect sampling per grid unit, typically 1 to 4 hectares).

Soil probes/sensors which assess soil elements *in-situ* are becoming increasing popular as they offer a lower cost per sample enabling greater sampling density. In our experience, these sensors struggle to generate accurate results across all soil types and moisture levels and so it is essential to calibrate every paddock with traditional wet chemistry laboratory analysis.

Addressing the most limiting factor

When addressing within-paddock variability the highest return on investment (ROI) is often achieved by addressing the key soil health factor/s limiting crop performance. Soil acidity (VR lime) and sodicity (VR gypsum) are common strategies to ameliorate soil constraints and in doing so unlock yield potential. As the key soil constraints are ameliorated and broader measures of soil health are improved, site-specific crop management can be implemented. Seasonal management strategies (predominantly VR nutrition, disease and pest control) are developed with the combination of underlying soil levels (grid or zonal soil testing) and crop monitoring information (NDVI, yield maps and boots on the ground).

Macro nutrient supply (predominantly N, P and K) via seeding and spreading are the most common VR strategies employed.

A note of caution must be applied when yield and or NDVI maps are solely used to define zones for VR management strategies. Plant growth and final yield is influenced by a multitude of factors, with the dominant influences being the key plant growth constraints for that particular season. Paddock knowledge is essential when interpreting yield and NDVI maps.

Lumpy capital investments (such as five-yearly lime applications costing $200 per hectare or more) attract an interest in a variable rate approach because of the immediate input savings (this saving is often around 30 per cent).

Other paddock mapping investments may be applied over several seasons such as a grid soil P map coupled with P removal (yield) maps.

To sum up

We are seeing an explosion of interest in ag-tech and we can expect to see a myriad of technologies hit the market in coming years. When evaluating the value of a sensor technology for your farm, start with a clear understanding of exactly what it is measuring and how this data can be converted into an action.

A well-designed ground-truthing process must be employed when relying on surrogate datasets to determine VR application plans.

Where possible link paddock mapping analysis with well-established science-based principles. In essence, precision agriculture is simply the intensification of an agronomic management decision.

Establish partnerships with businesses who can support you with all steps of the variable rate management process – agronomy, data collection/processing and application.

**More information: Andrew Whitlock, 0458 312 589;
E: andrew@precisionagriculture.com.au**

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In-field wheat segregation brings extra protein profits

Jonathan and Alwyn Dyer operate a 2800 hectare family farm in Kaniva, north west Victoria where they grow bread wheat, durum and canola, along with rotation crops such as lentils and chickpeas. In 2016, the Dyers upgraded their CropScan 1000G On Farm NIR grain analyser to the CropScan 1000H On Combine Analyser.

The original CropScan 1000G was returned to Next Instruments for the upgrade which included new electronics, a fibre optic cable, remote sampling head and a touch screen PC.

The CropScan 1000H was installed into one of their two John Deere S670 combines.

Jonathan – a Nuffield Scholar – is a passionate precision agriculture practitioner. He set out to use the new instrumentation to generate paddock maps for protein allowing him to better evaluate the performance of his crops. But once the CropScan 1000H started to generate real-time protein maps on the screen, he could see how much the protein varied across the paddocks.

Large protein variation across the paddocks

Jonathan identified that the high protein wheat was grown in low lying areas where there had been some frost and the soil was heavier clay, (Figure 1). The protein percentage in the blue and green areas varied from 11.5 to 16.0 per cent with an average yield of 4.0 tonnes per hectare.

The yellow and red areas varied in protein content from 9.5 to 11.5 per cent, but with an average yield of 6.0 tonnes per hectare.

The Dyers run two John Deere combines, so they used one combine to strip the areas where the protein was low – those areas where protein was less than 11.5 per cent.

The other combine – which had the CropScan 1000H installed – stripped the high protein areas.

Blending for profit

The chaser bin was used as a means of blending the wheat by alternatively sending the chaser bin to collect the wheat from each combine

"Successful in-paddock grain blending needs good information and good communication between the harvest team," Jonathan says.

Figure 1 shows the protein map for a 174 hectare paddock on the Dyer farm which produced 800 tonnes of wheat for an average yield of 4.6 tonnes per hectare.

Table 1 details how the revenues generated off this paddock compare between in-field blending and aggregating the wheat as harvested.

If there was **no in-field blending**, the Dyers would have delivered:

- 350 tonnes at ASW grade returning $180 per tonne;
- 200 tonnes as APW at $210 per tonne;
- 200 tonnes as H2 at $230 per tonnes; and,
- 50 tonnes as H1 at $240 per tonne.

The total revenue would have been $163,000 for this paddock.

But by **in-field blending** the wheat, the Dyers were able to decrease the amount of ASW and APW graded wheat and dramatically increase the amount of the H2 grade to 600 tonnes.

The net result from this one paddock was an additional $12,500.

Jonathan says that he has never made an equipment purchase that had such an immediate return on investment. Although he could not expect to realise the same return across all his paddocks, the CropScan 1000H made a 7 per cent difference to the bottom line. ■

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Figure 1: Dyer paddock (174 ha) protein map, 2016 harvest

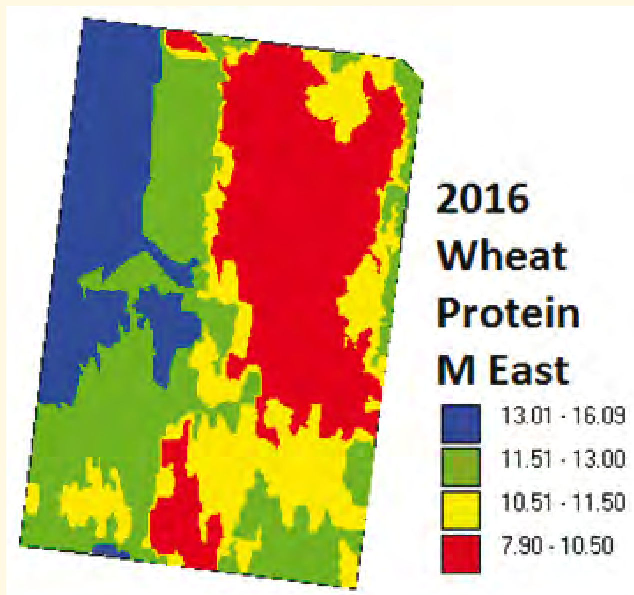

Table 1: With and without in-field protein blending

	If sold as harvested				In-field blended		
Grade	ASW	APW	H2	H1	ASW	APW	H2
Tonnes	350	200	200	50	150	50	600
Price $/t	$180	$210	$230	$240	$180	$210	$230
Paddock return	$63,000	$42,000	$46,000	$12,000	$27,000	$10,500	$138,000
Total return	$163,000				$175,000		

There was a 7 per cent increase in total paddock return by in-field protein blending.

Big advantages with precision farming

From 'The Land' – Australian Community Media

Modern advances in technology continue to give businesses and customers an advantage in industry marketplaces, none more so than the agricultural sector. John Deere's precision farming technology has allowed Australian farmers the opportunity to undertake innovative farm management practices in order to expand and sustain their operation for generations to come.

Broadacre grain and legume farmer Scott Clark, from Jamestown in the mid-north of South Australia, has been implementing a range of precision farming mechanisms since he first encountered the technology in 2006.

Running a traditional family farm in partnership with his brother Luke, with the support of their respective partners and children, Scott said the use of precision tech from John Deere has allowed him to see major financial returns.

"We've got 1300 hectares of cropping land where we plant wheat, canola, barley and fava beans and 400 hectares for our self-replacing Merino flock," Scott said.

"Parts of the paddocks are big, irregular shapes and, with the GPS technology we've cut out the overlap on our turns which is 50 hectares less than what we were previously sowing. That's given us quite a big cost saving."

Initially investing in the technology in order to help his father Dennis during spraying, Scott said the family has adapted quickly to using their three John Deere 2630 displays combined with RTK receivers.

"For my brother and myself, it was pretty simple to get a handle on – but it was more about helping dad.

"Considering he's 65, he does a pretty good job and for him to be sitting on a tractor, checking his emails and having it steer for him just blows him away."

Scott said John Deere has been with the family every step of the way, ensuring the Clark family are using the best product for their operation.

"The progression in farming technology is moving so fast and there are so many different options out there but we have found John Deere to be the simplest and most efficient to deal with so we will continue on that path."

Wide variety of PA technologies

John Deere currently provide a wide variety of precision farming technologies so farmers can get the most out or their investment.

For Scott, maintaining up-to-date mobile data management, cloud storage and implementing automatic steering technology has become a necessity.

"It's getting to the point where we can go even further with what we have and have individual control over spray nozzles and have automatic adjustment on seeding and spraying."

The irony of uploading to an offsite 'cloud' is not lost on the South Australian farmer.

"We usually look to the clouds to check for signs of rain," he says with a laugh, "now we're storing information in them."

"We usually look to the clouds for rain, now we're storing information in them!" – Scott Clark, Jamestown, SA.

The positive financial and agronomic returns the Clark family has enjoyed from PA has encouraged them to share their experiences with other growers.

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Using real time information to track gross margins through the mobile tracking application, Scott said he is able to clearly see where the operation is falling short and deal with any issues to avoid any loss.

"You can see whether you need to cut your losses in a particular part of the paddock or spend more on it to make it viable for production. "What you might think are better performing parts of your paddock might not actually be the case when you look at the figures."

Compatible equipment

With their John Deere 8320RT and 8225R tractors, in conjunction with a S660 combine which incorporates a 635X front, a R4038 boom spray and an 1890 air seeder disc fitted to a 1910 air cart, Scott said the majority of the family's equipment was already precision tech compatible.

"We didn't invest in the technology all at once but we started with full auto switching and we've managed to build it up over the course of five years and now we have auto steering as well."

The auto switching mechanism is connected to Scott's GPS signal and coverage map he has set for the property, turning the seeder or sprayer off during turns to reduce overlap in the course of an application.

The Clark family operation now runs on a full three metre controlled traffic system with the tractor aligning itself to the same GPS coordinates every season.

"We're used to it now but others might see it as a bit obsessive."

Scott said the returns he has made using the John Deere precision farming technology has encouraged him to share their experiences with other broadacre farmers.

"You can use this technology at any age and it makes the days a lot less stressful because there's not the concentration required in trying to see where you're going – it's already done for you down to the millimetre," Scott said.

"It's exciting to think these types of technologies will continue to evolve and give farmers positive returns along the way.

"We're looking at the potential of the market to incorporate things like seed singulation technology, robotic weed identification and specific spraying methods instead of blanket spraying."

Finishing their last harvest back in December, the Clark family is preparing to plant their 2018 winter crops of canola and barley after a dry summer.

"Now, with this technology, it's more about pushing ourselves to be able to use it to its full capabilities and not just what we're comfortable with. There is still a lot of potential." ■

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Section 10

New Science & Technology

CONTENTS

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How to think about emerging technologies

By Paul Higgins, Emergent Futures

AT A GLANCE…

- Drones utilise the technologies of smart phones and tablets, this mean rapid advances are already imminent and will develop quickly over the next five years.
- Artificial intelligence (AI) systems are at the beginning of their evolution – the important aspects are ability to deliver real value and data ownership.
- Blockchain technologies have an application in agriculture (beyond the hype of cryptocurrency), this could lead to increased transparency on the movement of commodities through the value chain. The potential for manufacturers to impose production specifications becomes an increasing probability with the take up of this technology.
- Advisers will continue to play a critical role on-farm; industry knowledge with local understanding as well as networks of expertise to draw from on the latest technology and data services will be important in the future.

Emerging technologies have a long arc from the genesis of the original idea, to custom built models, through to industrialised models and finally to utilities or commodities. Think of the development of computers from the early mechanical concepts of Charles Babbage and Ada Lovelace in the 19th century, through to the custom-built models of the fifties, sixties and seventies, on to the industrialised models of Hewlett Packard and Dell, and now to a world where you can hire computing services by the second from Amazon or Google.

The same cycle applies to electricity, or cars, or a myriad of technologies.

The arc is a way to think about change although the time frames for each stage differ. In the present day there is an acceleration of the time frames, but even things we think about as being relatively recent developments have a long history.

Take artificial intelligence (AI). Research on AI started in the 1940s or 50s depending on who you listen to and how you define the term. Real developments of any significance had to wait until the further developments of computers. There was much excitement in the eighties over the possibilities for AI. But the technology failed to live up to its promise and an 'AI winter' descended for about 20 years before the field accelerated again.

Now we are seeing many AI products and the big technology companies supply machine learning as a service on top of their computing services. Both computers and AI are an example of the 'adjacent possible'. What this means is that while the concepts of a technology may be strong, sometimes a technology has to wait until the underlying components are developed enough to make it a practical reality. The design that Charles Babbage created in the 19th century is still the basic architecture for computers today, but he had to build it from mechanical parts.

We had to wait for the development of silicon, and integrated circuits before the actual applications could take off.

For those that want to think more about this I would recommend Steven Johnson's excellent book; *Where Good Ideas Come From: The natural history of innovation*.

A story of early innovation in agriculture was when farmers in the US used barbed wire fences as telephone lines. Grabbing adjacent technologies and making something new out of them.

So, when we think about emerging technologies in agriculture, we should think about:

- The arc – where is this technology along the arc from idea to utility/commodity?
- At what stage of development are the underlying and adjacent technologies that are needed to make the technology a practical reality?
- And just as importantly in the case or agriculture, how 'hardened' is the technology?

It is fine for the technology to work in a laboratory or in a comfortable city environment but is it too fragile to stand up to practical applications on-farm or along the supply chain. Barbed wire as telephone wires worked because it was an already installed technology that was resilient in the real world.

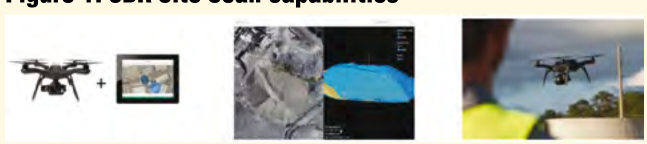
So with these concepts in mind, let's look at a few emerging technologies and where they might be heading.

Drones in agriculture

Drones have been around in agriculture for a while now with some early adopters having drones on their farms for years. Where they sit on the arc of technology development is somewhere between custom built and industrialised models. This applies to the drones themselves, the software components, and the applications for farming operations.

Where they are likely to head is a utility of a commodity model that is akin to Uber today. If we look at what is happening in the mining and

Figure 1: 3DR Site Scan capabilities



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construction industries we can see some clues about what might happen.

Drones are being used in more and more sophisticated applications to map environments. The drones are being used to get three dimensional pictures of mining sites and construction sites which can then be compared to previous data, and 3-D plans. Computer systems can then use this data to track development, mining volumes, consumption of materials, etc. A good example of this is Site Scan from 3DR (Figure 1). This system is being continually improved to make it into an industrialised model that is intuitive to use via simple interfaces.

Where we are heading in the medium term is best represented by Airobotics who provide an automated drone service for the mining industry (Figure 2). This is an automated drone airport that can be towed to a site. The drone inside is automatically fitted with programmed hardware that will carry out the required tasks. The drone then flies on a pre-planned flight, goes back to the automated airport, docks with the airport and downloads the data it has collected.

Within a few years I believe that a system like this will be deployed across agriculture. Farmers will be able to order a specific service and ask for the drone to access a particular paddock from a touch interface. The drone will automatically carry out the required work before going back to the automated airport. The drone can then either be refitted for other work on the same property, or moved on to another farm.

Figure 2: Airobotics automated drone airport

In the longer term the vehicle towing the airport will be a driverless vehicle so that no humans are required to deliver the service. The farmer will be able to control access to the data. They will issue permissions to share the data with agronomists (or even competing agronomists who bid for the work), researchers, suppliers of fertilisers and chemicals (see applications under Big Data and Artificial Intelligence section).

This means development of a utility service that is easy to use and has the capacity to reduce the capital needed for multiple hardware requirements. The business model also centralises the need for technical support and provides redundancy in the system. If you only have one drone and it breaks down, you have a problem. If you are part of a cooperative with 30 drones then this is much less of an issue.

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Drone summary

As drone technologies are built on top of components from the global supply chain for smartphones and tablets many of the underlying technologies are already at the industrialised/commodity stage. This makes the platform stable and well developed and means that we should see rapid advances in services over the next five years.

Farmers should be on the lookout for applications that are easy to use and avoid being drawn into services and arrangements that lock them into a multi-year contract, or do not allow them ownership over their own data.

Big data and artificial intelligence

If we take the wider application of drones and the implementation of broadacre sensor systems – for example, what *The Yield* is to marketing, then the next five to 10 years will see masses of more data being produced in broadacre agriculture.

Big data is both the basis for AI and the reason we need AI to get value. Models are emerging for practical applications of AI.

Some of these are simple; for example, AI is being used to power a phone application to help farmers spot disease in Cassava plants in Africa. One of the interesting facets of this application is that due to improvements in phone capabilities and machine learning applications, all of the processing for the application is done on the phone. No need for cloud storage or internet access for it to work in the field.

In the development of many emerging technologies, applications often emerge from simple systems and the offerings become more and more complex and valuable as the underlying technologies improve. Along with those changes we get better at understanding what works and why, and customers come to be comfortable with what they are using, making the next step of adoption easier.

Applications such as this Cassava plant disease recognition system are likely to develop further into applications that cropping farmers can use to make decisions on-farm in more complex environments and also to capture data that can be analysed by advisers.

At a more complex level the startup company Ceres Imaging has shown promise in using AI for applications that can identify problems with nutrition and disease in crops before they are obvious to human. This means that problems can be addressed before they either become more expensive or impossible to respond to.

The system uses planes rather than drones but the concept is just as applicable to drone technology. The system is able to recognise changes for two reasons.

- First of all it records data on wavelengths that humans cannot see; and,
- Secondly it is able to recognise patterns that humans do not necessarily recognise. This is analogous to the Google AI that beat the world champion at Go (a hugely complex and ancient strategy game). The AI made moves that the humans did not understand. The great thing about that example is that it improved the play of the world champion in subsequent months. He was able to recognise new patterns and new ways of playing.

The same is likely for AI that identifies patterns in agriculture. They will make us better farmers.

These systems are by no means perfect at this stage of their development. They will improve as time goes by as they are able to look at the data they have collected and examine and compare it to real world results. In a biological system this will take years to build up enough data. The systems will also improve as data from in-ground sensing systems can be tied to the aerial data. Networks of farmers using the same system will gain more value.

Big data and AI summary

Artificial intelligence systems are still at the custom built/early industrialised part of technology development. But they are built on top of a long history of research and huge investments are being made in lots of industries which should flow over into developments in agriculture.

The value of applications will grow in time as we get more data over long periods of time. Farmers should look for applications and farmer networks that have value now – or are at least break-even – and will grow in value as more data is available to them.

Farmers need to ensure that they retain ownership of the data and the capacity to export it in a format that can be used by other applications.

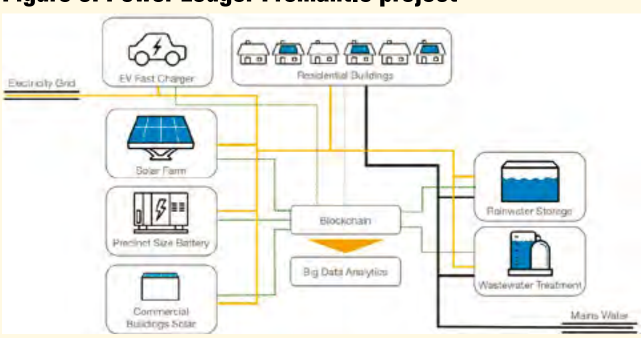
Blockchain enabled systems

While all the attention in recent months has been on the Bitcoin bubble and investment frenzy (which should be avoided at all costs), the underlying technology of Bitcoin and other cryptocurrency is still a completely valid technology development. There are several emerging applications which show some promise.

Outside of agriculture, the Australian company Power Ledger has developed some interesting trading applications for renewable energy. These started by using the blockchain as a system to allow trading of renewable energy between small networks in housing developments and retirement villages. They are also trialling an application with cane growers in Queensland. They are now conducting trials with Origin Energy to use the system over the existing grid in Western Australia, which also includes water applications.

What this means is that anyone could trade with anyone over the network using the blockchain technology to automate and verify the process and transfer funds, as demonstrated in Figure 3.

Figure 3: Power Ledger Fremantle project



If you have an electric car and are 500 km from home, you can use your own energy to charge your car through a technology enhanced charging system.

The price of solar energy in particular has dropped dramatically over the past decade with large scale installations now cheaper than coal fired power stations. At low scale, the costs are still fairly high. The key to reducing these costs is to increase the size of installations. The sort of trading systems enabled by the Power Ledger initiative allow that to happen with a share ownership system, rights to a minimum percentage of the power generated, and an automate trading of any surplus.

Opportunities will arise for agricultural operations to utilise land for larger scale systems that use this process.

Beyond that application there are two possible applications:

- Models are already emerging for using the blockchain technology for the verification of high value products such as wine and fish. These are also being trialled as a food safety system for retailers. Care needs to be taken about hyped up schemes as opposed to real applications, but it is likely that the applications will develop with the move to lower value of agricultural products.
- Scope for the applications that have been developed for energy trading to be applied to grain trading. For example, if you are a producer of feed grain that you store on-farm you could trade a blockchain verified product with an end user such as a feedlot or a piggery. The specifications and price can be built into a smart contract which is traded in the marketplace, this is triggered on acceptance at the feed mill, based on the delivery meeting the volume and quality specifications. Money is transferred via the trading application and the ownership is only transferred once payment is received.

On a wider scale, if the trials that Power Ledger is carrying out with the energy grid are proven to be workable and economic, there is scope for the same sort of system to be applied across the whole grain network thereby placing more control and flexibility in the hands of the grower.

Blockchain summary

Blockchain technologies and applications are still in the idea/custom built stage of the technology arc. They are also attracting a large number of startups and some unscrupulous individuals. This means that there will be high levels of failure in the space over the next few years but what emerges has high potential for agriculture.

Farmers should take a cautious approach unless they are high risk takers/early adopters, and only engage with reputable organisations and even so, be prepared for failure. Farmers will probably have to accept that the food chain will start to apply requirements on them for these sorts of technologies over the next five years.

The changing nature of the adviser

In my time in agriculture the nature of the adviser for cropping operations has changed. From a labour-intensive model of visiting farms at set intervals, the business model has evolved into one that uses technology to record crops on a more regular basis and targets physical visits to a need rather than the stage of crop development.

Precision agriculture applications have further increased the level of data that is available. With the advent of drones and broadacre sensing systems, and the possibilities of blockchain based applications increasing the transparency of information throughout the supply change, we are on the verge of a seismic shift.

The new paradigm will be defined by masses of data, increased transparency, increasing value of networks, and increasing use of AI. This means that the role of the adviser for cropping operations will alter. Some of the characteristics of that change will be:

- Developments of AI agents as, at least, partial advisers to farmers.
- Increased competition in the advisory services area as the pictures formed by data, and our ability to share it anywhere in the world, allow farmers to go further afield to look for services.
- Advisers with AI systems to assist them in their work.
- Increased activities in trading systems that require more specialised advice.
- Increased value of the adviser who can facilitate networks of farmers to get more from their data rather than being a font of knowledge.

Having said all of that, nothing replaces common sense, a strong personal knowledge of farming and business models that have a presence on the ground.

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■

Revolutionising big data to help grain growers answer on-farm questions

AT A GLANCE…

- CSIRO has constructed digital infrastructure to capture agricultural information from soil water sensors, satellites, soil types, crop models, economics and commodity prices. These data are used to create new digital products for the agriculture industry.
- Crop yields can be monitored in near real time across the grain belt using the next generation of crop models.
- Crops can be monitored as the season progresses with a suite of satellites and crop type identified.
- Apps are being created to help farmers access information about the yield potential of their crops and current status of plant available water in their paddocks.
- Digital safeguards are being constructed to enforce high standards of human ethics and privacy.

This article has been reproduced from a presentation to the GRDC Crop Updates held in Perth in February 2018. The presentation was co-authored by CSIRO's Roger Lawes, Gonz Mata, Yang Chen, Joanne Chai, Randall Donohue, Roger Butler, David Factor, Tim Pitman, Chris Sharman and Zvi Hochman.

The explosion of sensors, satellites, and computational models in agriculture has brewed up a whirlwind of data for the modern agricultural business. Making sense of these vast data sets in fast, accurate ways to make important decisions is not trivial. But it would be unwise to ignore these new technological advances, as they will help agricultural businesses remain competitive and make decisions in a timely manner.

Yet this smorgasbord of digital and data products take time to process, often provide information that is difficult to interpret, and require substantial investments in time to derive anything of value.

We know that growers are hesitant to take up complex information technologies if they are difficult to use or the 'payback' time is too long. For example, the complexity of using yield monitors and variable rate controllers has contributed to the lack of uptake of precision agriculture technology by producers. The adoption of digital technology by the agricultural sector has plateaued because, in part, it is too difficult and time consuming to engage with the technology.

Reimagined digital infrastructure

Digital infrastructure needs to be reimagined and new analytical methods developed to deliver fast, intuitive answers.

CSIRO is taking on this challenge, constructing a one stop shop for data storage, access and analysis.

We are building one platform that can:

- House information about soils;
- Capture information from satellites; and,
- Deploy outputs from these information sources through user friendly products such as an App.

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The objective is to allow agricultural businesses to quickly acquire information about production in real time, without the hassle of identifying soil types, calibrating models, or searching for satellite information.

As we bring new data products to the agricultural sector, we also consider how to protect the privacy of individuals, and provide opportunities for individuals to choose whether to engage with these digital products, with full disclosures. These new products include:

- A near real time system for identifying what crops are growing where across the grain belt;
- A yield forecast for those paddocks;
- The current plant available water status in that paddock; and,
- An historical record of the water-limited potential yield in those paddocks.

This new digital capability will have widespread application for growers, advisers, bulk handlers, marketers, commodity forecasters, insurers, and research funders and providers.

How we did the research

CSIRO is using a multidisciplinary approach comprising social, economic, biophysical, analytical, remote sensing, user experience and software engineering components to build digital outputs for Australian agriculture. New crop modelling architectures have been developed with satellite information. Soil grids have been created with a multitude of data-layers and climate surfaces are being generated with the next generation of climate forecasting models.

These frameworks have been constructed to deliver information about crops at the paddock, farm, regional and national scales.

Understanding a grower's digital tech needs

We sent our team across southern Australia to chat to growers about their thoughts on digital information, technology, computers, data, useability and sources of information.

We asked about their interests in a range of digital products that could potentially be built, such as crop yield forecasting, crop rotation management, pest management, planting practices, soil water estimation, nutrient management and crop marketing.

The objective was to simply identify what farmers liked about farming and what they would like from a digital product.

We also talked about privacy, security and ethical issues surrounding the use and creation of data products about agriculture.

We wanted to find out what farmers considered important, and discover how they would like information packaged for them.

The survey was not exhaustive, but was considered instructive as it provided the team with an insight into what useful packages could be produced for farmers with today's technology.

It was no surprise that farmers wanted information packaged in a highly accessible manner. They did not wish to spend time at a computer and had a preference for accessing relevant information while driving around the paddock.

In the first instance, we decided to focus on producing outputs about plant available soil water, historical yield potential and the current yield forecast.

In five short days we harnessed our cross disciplinary advantage to build an App to deliver information about crop yield and plant available water in real time to a farmer on a mobile device.

Our development team followed the Google Ventures methodology (http://www.gv.com/sprint/) and constructed an App which was evaluated by four growers.

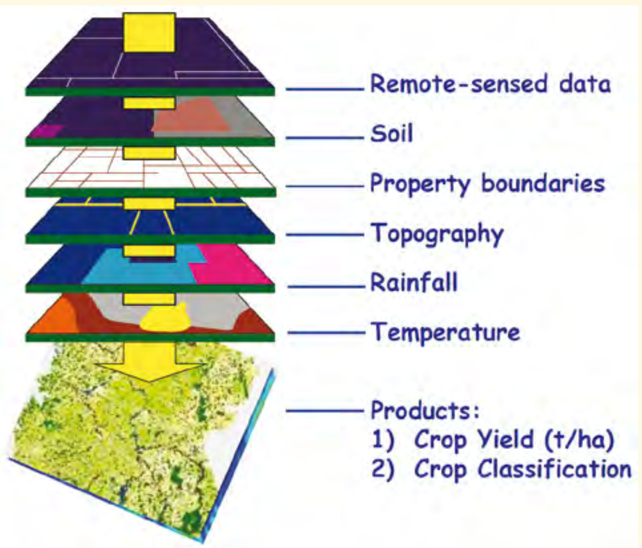
Assembling and creating data layers

We created a number of static and dynamic layers of information relevant from paddock through to national scale that can be used to estimate the identity of what is growing in each paddock, crop yields (back through history and forward into the future), soil water dynamics and with the potential of much more (Figure 1).

First layer

The first layer identifies the crop species growing in each paddock – using a combination of satellite images from Landsat, Sentinel 2 and SAR. The images used vary with location and time, as many paddocks are obscured when it is cloudy. Adaptive learning algorithms identify crop species.

Figure 1: Layers of information used to create digital products



Second layer

A second layer creates an estimate of yield potential and plant available soil water for the current season.

This information can be used for tactical management of crop inputs, risk management and marketing decisions. This layer is calculated with the APSIM crop model.

The most likely soil type, and climate are selected for each paddock in the grainbelt without the need for the user to have local knowledge of these inputs. This is achieved by using the Soil and Landscape Grid of Australia (90 metre resolution) and the SILO datadrill 5 km grid for climate information (https://www.longpaddock.qld.gov.au/silo/).

Because the APSIM simulation of crop growth under current season conditions needs to estimate the daily dynamics of plant available soil water, the system can be used to provide an estimate of plant available water (PAW) in real time, without the need for local knowledge of the actual soil type in each paddock.

These estimates of plant available water often provide better estimates of soil water than a single poorly calibrated stand-alone soil water sensor.

Third layer

A third layer creates an historical series of water-limited potential yield estimates for a particular paddock. This information can assist with benchmarking, diagnosing yield constraints and setting yield targets.

Fourth layer

The fourth layer monitors the growth and expected yield of the crop in real time and can provide a forecast for that season. These new satellite-driven crop models integrate information from multiple MODIS and LANDSAT scenes to build a yield prediction from the observed NDVI signal.

Collectively, we have now housed these layers of information on soil type, climate, climate forecasts, crop yield and crop species in a new digital architecture that allows us to develop fit-for-purpose digital products.

We envisage this capability will have widespread application for growers, advisers, bulk handlers, marketers, commodity forecasters, insurers, and research funders and providers.

Our results

Crop yield forecasts and area estimates

In 2017 crop yield forecasts and crop area estimates were generated for the entire Western Australian wheatbelt. Identification of what crops were growing in each paddock improved as the season progressed, as more cloud free images became available, and the spectral differences (the differences in colour) between crop species increased.

An example of the classification output generated on October 31, 2017 with the actual crop is shown in Figure 2.

This figure is a subset of information generated for the entire state.

The crop yield estimate, generated from remote sensing, and estimated on October 1 is presented in Figure 3 for the same region

Figure 2: Output for crop classification in Western Australia for the 2017 growing season, for a farm, where data was not used to train the classification. Paddock labels were provided by the farmer after the analysis.

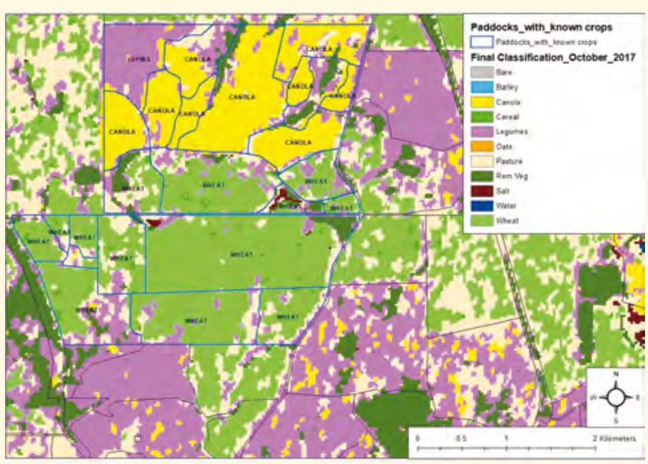
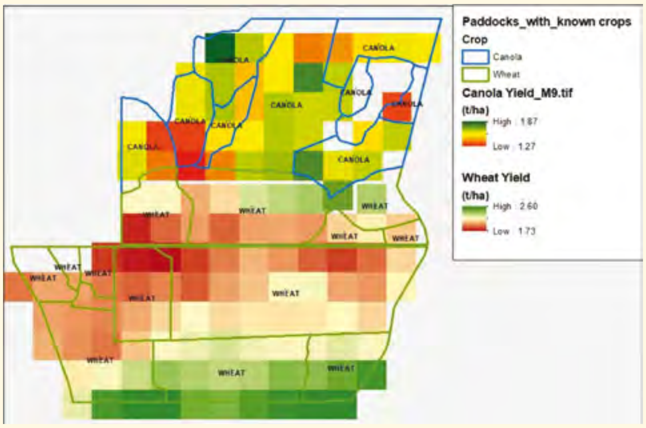


Figure 3: Forecast yields for wheat and canola, as estimated by remote sensing in late September 2017



depicted in Figure 2. Figure 4 illustrates the capacity to generate crop yield maps for the entire state.

From listening to the needs and concerns of growers, the App was constructed to be paddock specific providing insights about historical yield potential, plant available water in real time and yield potential for the season.

To sum up

The digital revolution won't allow us to stand still in providing information to Australian agriculture.

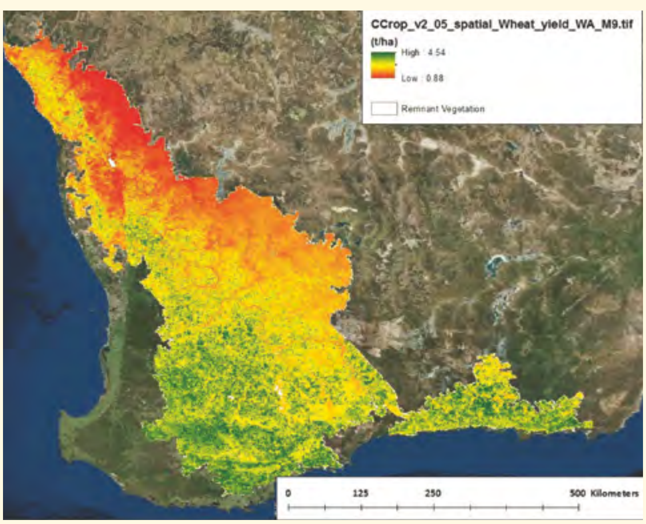
CSIRO has created new digital products for agriculture about crop production, crop species, crop yield, soil moisture and soil type. Outputs from these digital products can be delivered at paddock, farm, regional and national scales, in near real time.

These products mean farmers will be able to quickly and seamlessly understand and monitor a crop, like never before.

The challenge is to engage the agricultural industry and explore how they can best use these sources of data and package that information into a useful format.

Further information: See https://research.csiro.au/digiscape/ ■

Figure 4: Wheat yields forecast in late September 2017 for every paddock across the WA grainbelt



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- Onsite bulk storage capacity ranges from 500 litres to 110,000 litres with custom builds available beyond this volume.
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- Steel manufacturing gives strength and durability in the harsh Australian conditions.
- Minimal onsite engineering required for tank placement and can be customised to suit applications as required.
- Self-bunded tanks are easily delivered to site and are relocatable.

Cost benefits and quality control

Purchasing bulk fuel creates better pricing opportunities while onsite fuel storage will give you control over supply and supply reliability.

You will also have more control of fuel quality by engaging a quality fuel supplier that meets your fuel quality expectations. You can order direct from terminal to tank to eliminate any questionable secondary storage facilities.

This also means you can avoids retail sites that may be purchasing product from multiple suppliers and holding the fuel in underground tanks which does not always guarantee fuel quality.

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For more information contact 1300 4 LOWES or see www.lowespetrol.com.au ■

Self-bunded – or double walled – fuel storage tanks offer price, reliability, safety and quality advantages.

Section 11

Grain Quality

CONTENTS

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Knowing what gives Aussie grain the edge in Asian flour markets

By Dr Ken Quail, AEGIC

The Australian Export Grains Innovation Centre's Pilot Mill in Sydney is at the centre of efforts to increase awareness of the importance of wheat and flour quality for bread and noodles in Asia. The four-storey commercial-grade flour mill – which is located at the famous former Bread Research Institute of Australia laboratories in North Ryde – is being used to educate wheat industry players about flour production and how end-products are influenced by the quality of different types of wheat.

Understanding how grain quality affects end-products is crucial for Australia to effectively meet customer needs in key Asian markets.

This applies to everyone in the wheat industry – especially grain traders, food manufacturers, wheat breeders and flour millers.

Australian wheat has unique quality attributes which give it an edge for certain end-products, especially Asian noodles. Australian wheat is valued for a wide range of products both internationally and domestically.

BENEFITS OF AUSTRALIAN WHEAT

- **Safe:** Mycotoxins rare
- **Clean:** Low levels of foreign material.
- **Dry:** Low moisture = better value grain by weight. Storage is safer in hot climates.
- **White:** Bright, clean flour at higher extraction rate.
- **Functional:** Great for noodles and bread.

Australia wheat is food-safe and clean (low screenings) with low moisture, which are key selling points in export markets.

On top of that, our wheat has a white seed coat, in contrast to red wheats from other parts of the world such as North America, which have a dark seed coat. White wheats produce flours that are bright with a higher extraction rate, which is valued by customers.

Asian noodles

One of the most important selling points of Australian wheat is its functionality for Asian noodles. Our wheat is known for producing noodles with bright colour and excellent colour stability – very important attributes in most Asian markets. Noodles made with Australian wheat also have excellent firmness, elasticity and mouthfeel.


Australian wheat produces noodles with bright, stable colour and excellent texture. These are key quality attributes demanded by the Asian market.

Australian wheat has a unique combination of starch and protein attributes that contribute to noodle texture.

For the specialist udon market in Japan we select specific wheats that have, what is referred to as high swelling starch. This special type of starch makes the noodles softer, but more importantly contributes the elastic or chewy texture referred to as mochi mochi by the Japanese. Not all noodle markets want this feature for their noodles, and Australia caters for this through classification and a production of a range of wheat varieties.

The greatest strength of Australian wheat for noodles is the combination of bright stable colour and texture characteristics. No other wheat supplier has been successful in delivering wheat consistently with this combination of quality attributes.

Bread and other baked products

Australian wheat is in demand for bread and baked products in Asia, but there is an opportunity for the Australian industry to improve access to these markets through enhanced market research and development of our wheat supply.

In Australian bread making systems, our wheat performs well with good dough strength and good extensibility for processing, resulting in excellent oven spring and loaf volume.

Good flour colour results in bright, white crumb colour. The high water absorption of the flour gives bakers good flour yields. Australian wheat is also excellent for artisan style bread and ideally suited for the production of whole wheat baked products.

For Asian baking systems with extended fermentation and high fat and sugar levels, wheat from North America is preferred. Bread markets in Asia represent a high value market and the challenge and opportunity for Australia is to address these requirements.

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Ahrens Rural

For Asian bread baking systems, North American wheats are preferred. This is a high value market which Australia needs to explore with wheat varieties more suited to Asian quality requirements.

AUSTRALIAN WHEAT FOR BREAD

- **Strong and well-balanced:** Good loaf volume
- **Bright colour:** Good flour colour = bright and white bread. Excellent for whole wheat products.
- **High water absorption:** Good flour yields for bakers.

Keeping the industry informed

It is very important that the Australian grains industry is properly informed about Australian wheat and its unique features.

By providing education on the unique quality attributes of our wheat and how these attributes result in products that consumers want to eat, AEGIC is helping the Australian industry to deliver the best possible product to customers. This improves the long-term value of Australian wheat.

Wheat shipped to Asia returns a value of over $3.5 billion a year – a value well worth protecting.

Dr Ken Quail is the General Manager, Research and Technical Services at the Australian Export Grains Innovation Centre (AEGIC). See http://aegic.org.au

THE TOP SEVEN MARKETS FOR AUSTRALIAN WHEAT (based on five year average per annum shipped 2013 to 2017)

- Indonesia 4.1 million tonnes (mt)
- Vietnam 1.5 mt
- China 1.3 mt
- Korea 1.0 mt
- Japan 0.9 mt
- Philippines 0.9 mt
- Malaysia 0.9 mt

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BACK TO BAKING SCHOOL

A recent education session at AEGIC's commercial-scale Pilot Mill in Sydney was attended by senior grain traders, wheat breeders, food manufacturers and flour millers from around Australia.

Over two days, the participants – many of whom already had long experience in the Australian wheat industry – increased their understanding of how differences in wheat quality affect the flour milling process and how this relates to noodle and bread quality.

Having access to AEGIC's four-story flour mill was extremely valuable for attendees, providing the opportunity for "hands on" learning. The training also includes practical baking and noodle making sessions, and lectures on wheat varieties, quality testing, and export markets.

AEGIC's training strengthened industry capacity and established strong linkages between AEGIC and industry partners.

AEGIC'S PILOT MILL

- AEGIC's Wheat Quality and Flour Milling: The Basics course is available to the Australian industry on scheduled dates (next date: August 20–21). Location: North Ryde, Sydney.
- Places are strictly limited but courses can be organised outside scheduled times when there is demand.
- Separate training course Commercial Baking: The Basics is also available.
- AEGIC's North Ryde facility was formerly known as the Bread Research Institute of Australia and has a 70 year history of enhancing capacity in the Australian grains industry.

Some comments from attendees

Darryl Borlase, Senior Trading Manager with ADM Trading Australia, said the training helped him understand the wheat milling process.

"In my current role as a wheat trader and Wheat Quality Australia council member, the course has provided me with a better understanding of the types of flour produced and the technical aspects of quality measurement," he said.

"The course also provided excellent information on end-product use and what Australian wheat is used for in our export markets. I have no hesitation in recommending the course to anybody who has dialogue or interaction with customers that are using Australian wheat."

Sam Napier, Senior Wheat Trader with Cargill Australia, said the AEGIC Pilot Mill was "very valuable".

"The course gave me a greater understanding of the end-customer, and also specific requirements between customer segments," he said. "I would recommend that all members of the Australian grain supply chain attend this course."

Arnotts R&D New Technologies Scientist Sarah Herbert said the course was interesting and informative to her and her four colleagues who attended.

"We certainly benefitted and improved our knowledge base by attending the course and would recommend it to anyone who needs a good grounding and more understanding about wheat and flour milling," she said.

Hannah Foster, Wheat Technician Lead with breeding company Intergrain, said the training was of "immense value".

Beer helps bring barley production back to Kangaroo Island

By Andrew Spence

A chance meeting, a new variety and the booming craft beer industry is helping to put barley back on the map in one of Australia's most pristine natural environments.

Barley had virtually disappeared from the grain fields of Kangaroo Island in South Australia because of low prices and the lack of suitable varieties until Coopers Brewery maltings manager Dr Doug Stewart struck up a conversation with Kangaroo Island Pure Grain (KIPG) chair Neil Pontifex and convinced him to grow the new Westminster variety.

Coopers has since bought more than 1000 tonnes of the barley from KIPG and will next month begin turning it into a specialised single origin malt for the craft beer industry.

"It was a chance meeting between our chairman Neil Pontifex and Doug (Stewart) that got the ball rolling and it's resulted in us growing quite a few tonnes for Coopers," Kangaroo Island Pure Grain Chief Executive Shane Mills said.

"The variety of barley and the price the growers were getting wasn't really that great so it dropped away for a number of years.

"The advent of Westminster, which is suited to the island's environment and the interest from Coopers has changed that."

Westminster was developed in the United Kingdom and achieved malting accreditation there and in Europe in 2007. It was accredited in Australia for malting in 2013 and has grown well in cooler, wetter regions such as southwest Victoria, Tasmania and now Kangaroo Island. Its medium fermentability makes it suitable for domestic and export quality brewing malts.

Kangaroo Island is Australia's third biggest offshore island and has long been regarded as one of the world's most pristine natural environments. It is also known for its premium food and abundant wildlife.

Doug Stewart said many growers are targeting the malt industry so they're now picking the Westminster malting variety.

"They're trying to get that level of protein between 9 and 12 per cent to get that $30 to $40 premium per tonne over feed so it's worth chasing," Doug said.

Mills said any grain that didn't meet the higher standards imposed on malting barley could also be easily on sold locally because there was strong demand for feed barley on Kangaroo Island.

"That's the beauty of it and we're getting a small premium from Coopers, which helps compensate us for the freight costs of shipping it across the water," he said.

"It's something that our growers are quite keen on, it fits our crop rotations very nicely so if we can continue it and perhaps grow it that would be ideal."

Largest Australian-owned brewery

Based in the South Australian capital Adelaide, Coopers is the largest Australian-owned brewery and opened its $65 million malting facility in November 2017. It has since ramped up production to about 80 per cent of its 55,000 tonne a year capacity. The brewery plans to use about a third of its malt production for its own beers while selling a third to Australian brewers and exporting the remainder.

Coopers has already been selling a single origin pale and ale malt made from Commander barley grown at Roseworthy in the Northern Adelaide Plains. It will release its first heritage malt made from South Australian Schooner barley at the end of April, 2018.

Australia produces on average around 2.3 million tonnes of malting barley and 6 million tonnes of feed barley each year. The quality of Australian malting barleys is considered among the highest in the world.

Doug said Coopers targeted South Australian barley because it was a South Australian brewer, locally grown barley was of a high quality and sourcing grain from nearby growers kept freight costs down.

Barley grain being steeped at the Coopers Malting Plant in Adelaide. (PHOTO: John Krüger)

Coopers Brewery Maltings Manager Doug Stewart in the new malting facility. (PHOTO: John Krüger)

He said Coopers would begin malting the Westminster barley from Kangaroo Island in May or June, 2018.

"It's been a really nice story the way it's unfolded," Doug said of the experience with KIPG.

"Because of the high rainfall on Kangaroo Island they can grow that European style long season barley and achieve some excellent yields.

"We'll make a pale malt and an ale malt. It's a lower enzyme variety so it will leave a lot of that mouth feel and body in the beer and a lot of craft brewers are using Westminster at the moment."

The rise of craft brewing

Barley Australia Executive Chairperson Megan Sheehy said the rise of craft brewing had created a small opportunity for growers.

She said brewers needed to be prepared to pay a premium, particularly for heritage varieties such as Schooner, because they were outclassed and were at a significant yield disadvantage compared with more modern varieties.

"There are many examples of growers out there who are passionate about beer and malting barley and do it for the love of the industry," Megan said.

"It definitely is trending and there are opportunities but they are not on the big scale and they're probably quite tricky to manage and coordinate.

"It's great to see Coopers having their malt house open now and having the ability to provide a service to the craft market."

Coopers is also making malt aimed at the Asian export market from barleys such as Scope, La Trobe and Spartacus, which are suitable to be blended with rice or corn sugar adjuncts.

It has so far sent about 2000 tonnes of malt to Thai Beverage in Thailand to be used in Chang beer and is in talks with a number of Asian brewers. ■

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The production and characterisation of value added pulse flakes

By Stephen Cork[1,2], Chris Blanchard[1,2], John Mawson[1,3] and Asgar Farahnaky[1,2]

AT A GLANCE…

- For pulses to play a role in sustainable and healthy food systems, key constraints through innovations in pulse-based food processing need to be addressed.
- Research into material properties of pulses may reduce costly trial-and-error product development for ready to eat products.
- Current research focus is to quantify how pre-treatment, forming and secondary processes affect flaking performance and product quality of pulse flakes.

Pulses are the mature, edible dry seeds of non-oilseed, legume plants, with significant nutritional, health and environmental benefits. Pulses are high in protein, low in fat and glycaemic index and are great sources of fibre, minerals and B vitamins. Pulse consumption has been shown to protect against certain cancers, high cholesterol, type 2 diabetes and obesity. Pulse crops add nitrogen (N) to soil keeping soils fertile and are water efficient.

The significance of pulses was recognised with the Food and Agriculture Organization of the United Nations (FAO UN) declaring 2016 the International Year of the Pulse, promoting the role of pulses in the sustainable supply of healthy food. Australia is one of the major exporters of pulses, yet many Australians do not meet the recommended dietary intake of one to three serves per week.

In developed countries, pulses contribute only 1 per cent of the calorie intake and 2.2 per cent of the protein intake. Low consumption of pulses has been attributed to the time and effort required to prepare and deactivate anti-nutritional factors (ANF), which typically involve soaking and boiling for over one hour and the need to modify sensory attributes such as texture and flavour.

Approximately 60 per cent of Australian pulses are exported for predominantly human consumption, of which 25 per cent of these exports are to India. The recent tariffs imposed on pulse imports to India highlights the need to diversify Australian pulse markets.

Developing our domestic pulses processing innovation capability is one way to decrease exposure to the risk of relying on a limited number of large international commodity markets.

To improve market stability and growth of Australian grown pulses, such as chickpeas and faba beans, investment in processing innovation is required. Increasing consumption of pulses will offer the key benefits of improved health outcomes, sustainable agricultural practices and economic growth for Australia. In the past, the per capita consumption of pulses in many areas of the world has been in decline. More recently, a


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Table 1: Top innovative pulse markets

Innovation criteria	India	USA	Canada	EU	Australia
Health and wellness claims	19	19	14	14	17
Product line diversity	12	11	9	7	6
New product	16	15	16	17	19
Rating scale	Excellent 20	Very good 16	Good 12	Fair 8	Low 4

Table 2: Composition comparison of selected pulses and cereals

	Selected pulses		Cereal comparison	
Composition % d.b.	Chickpeas	Faba beans	Wheat	Maize
Total carbohydrate %	52–71	67	75–83	71–84
Starch %	30–56	34–36	63–72	54–74
Total dietary fibre %	6–25	16–29	9.9–14.6	9–15
Protein %	19–27	26–36	8–17	8–14
Major protein type	Mostly globulins		Mostly glutelin and prolamin	

Sources: Ambigaipalan et al. (2011); Guillon and Champ (2007); Güzel and Sayar (2012); Haard et al. (1999); Hall et al. (2016); Hejdysz, Kaczmarek, and Rutkowski (2016); Hoover, Hughes, Chung, and Liu (2010); Kouris-Blazos and Belski (2016); Marengo et al. (2016); Rosa-Sibakov et al. (2016); Serna Saldívar (2010).

better understanding of the benefits of pulses, and the demand and level of innovation have increased (Table 1).

While the health benefits of pulse consumption are being used to promote pulse consumption (Table 1), the product line diversity in Australia is still lower than in other countries. India, as the largest producer and consumer of pulses, is the most established pulse market.

But there is scope for improved product line diversity and new product development. The 'ready to eat' breakfast foods have a global annual value of more than US$33 billion annually. Cereal flakes make up a third of the ready to eat breakfast food market and are processed using many of the pre-conditioning and secondary processes used for other ready to eat foods. The use of flaking to add value to pulses is not new with patents for bean flakes being established from the early 1900s, at the same time when corn flakes were developed.

Pulses have very different chemical compositions compared to cereals. Table 2 summarises the range of published carbohydrate and protein contents of selected pulses and cereals on a percentage dry basis.

Cereals are very high in starch and also contain glutelin proteins which assist with modification of structure and texture.

Pulses have significantly more fibre and lysine rich globulin proteins than cereals. These differences contribute to their increased cooking time requirement and impact on their processing properties.

Research into pulse flakes will improve the scope for pulses as breakfast or snack food, meeting consumer demand for healthy, whole foods, a clean ingredient label with the convenience of shelf stability and reduced cooking time. Knowledge of the adaptation of established cereal flaking processes to pulses will facilitate processor uptake of flaked pulses and release into the ready to eat food market. This project aims to understand the impact of key processing parameters on the quality of flaked pulses.

The project described here is a collaboration between CSU's Functional Grains Centre, Woods Foods (a family owned pulse processor located in Goondiwindi) and Uncle Toby's. The aim of this project is to develop technology that will allow Australian pulses to be processed and delivered to domestic and international markets as high value food products. The success of projects such as this will provide Australian pulse growers with more options for marketing their pulses which will result in pulse production becoming a more profitable option.

How the research was done

Triplicate batches of 8 kg Australian desi chickpeas were provided by Woods Foods, processed using the Uncle Toby's pilot scale plant, applying the following conditions:

- **Pretreatment:** Dehulled and split desi chickpeas heated at 90–98°C for six minutes with one of three steaming times: one, three or five minutes.
- **Forming into flakes:** Roller gap set to two different widths.
- **Roasting:** Roasting and drying with a fluidised bed dryer at 150°C or 200°C.

The resulting flakes were analysed and the following quality parameters assessed: Size (micrometre), strength (texture analyser), colour (colour meter), degree of starch cooking ((DSC), rapid visco analyser (RVA)), and microstructure (scanning electron microscopy (SEM)).

What we found

It was found that short steaming times and a heating time of six minutes were sufficient to soften the split chickpeas for rolling into flakes. Roasting was able to produce a 'bubbling' appearance similar to that seen on the surface of pappadams. SEM revealed an intact cell matrix consisting of fibrous walls, a protein matrix and starch granules.

Textural analysis demonstrated that the flakes become weaker with increased processing and are able to take up fluid more rapidly. Thermal and pasting analysis found that an approximately 50 per cent degree of cooking was achieved by this process.

To sum up

Innovation in manufacturing is required for pulses to be part of contemporary western diets. Due to the differences in composition between cereals and pulses, research into the application of common cereal processing methodologies, such as flaking, will enable the development of processes suitable for pulses.

Suitable pre-processing parameters that allow for the formation of pulse flakes have been identified. These flakes have maintained significant micro structural features present in unprocessed chickpeas, but with some significantly different forms and textural properties. Being partially cooked, these products will require less preparation compared to a raw chickpea.

1 School of Biomedical Sciences, Charles Sturt University, Wagga Wagga, NSW;
2 ARC Industrial Transformation Training Centre for Functional Grains (FGC) and Graham Centre for Agricultural Innovation, Charles Sturt University, Wagga Wagga, NSW;
3 School of Agricultural and Wine Sciences, Charles Sturt University, Wagga Wagga, NSW.

SECTION 3 GRAIN QUALITY
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Section 12

Grain Storage & Handling

CONTENTS

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What's new in grain storage? A fumigations and grain protectant update

By Philip Burrill, Greg Daglish and Manoj Nayak, DAF Qld

AT A GLANCE…

- ProFume (sulfuryl fluoride gas) applied by licenced fumigators to control storage pests in cereal grains, is valuable when rotated with phosphine fumigations to manage insect pest resistance.
- ProFume trials show that longer fumigation times of 7–10 days are required to control the full life cycle of storage pest insects when grain temperatures are below 25°C.
- In larger silos (150–2000 tonnes) recirculating fumigation gases within the sealed silo using a small fan, helps ensure rapid, uniform distribution of phosphine, or ProFume (sulfuryl fluoride gas).
- Without recirculation during fumigation, it can take two to five days before the fumigant gas reaches all areas in a large silo, resulting in significant volumes of grain and insect pests being exposed to low amounts of gas.
- Seek good advice prior to applying any grain protectant treatment. Set up grain protectant spray application equipment to achieve good coverage and the correct dose rate.

Key storage management tools

Fumigations and strategic use of grain protectant insecticides are only two of the five key tools used to maintain grain quality and achieve reliable pest control results. Combined, they form the foundation of successful grain storage. Successful grain storage is crucial to a producer building a reputation as a reliable supplier of quality grain. Key aspects of successful grain storage are:

- **Aeration:** Correctly designed and managed, it provides cool grain temperatures and uniform grain moisture conditions. Aeration reduces problems with moulds and insect pests in storage, plus maintains grain quality attributes such as germination, pulse seed colour, oil quality and flour quality.
- **Hygiene:** A good standard of storage facility hygiene is crucial in keeping background pest numbers to a minimum and reducing the risk of grain contamination.
- **Monitoring:** Monthly checking of grain in storage for insect pests (sieving/trapping) as well as checking grain quality and temperature. Keep a monthly storage record to record these details, including any grain treatments applied.

SECTION 12 GRAIN STORAGE & HANDLING
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Flat grain beetle (*Cryptolestes spp.*).

- **Fumigation:** In Australia we now only have gases (fumigation) to deal with insect pest infestations in stored grain. To achieve effective fumigations the storage/silo must be sealable – gas-tight (AS2628) to hold the gas concentration for the required time.
- **Grain protectants:** Used on specific parcels of grain like planting seed held on farm, or bulk grain where potential grain buyers have agreed to its use, grain protectant sprays provide another line of defence against storage pests.

ProFume use in Australia

ProFume (sulfuryl fluoride gas) has only been available for use in Australia for a relatively short time (10 years). Phosphine fumigation products have been used to control grain pests for well over 50 years.

Initially registered and sold in Australia by Dow AgroSciences, ProFume is now manufactured and supplied by Douglas Products based in America. A-Gas Rural based in South Australia has the importing and distribution rights for ProFume. They also provide specialist product and safety training to licenced fumigators, allowing them to purchase and undertake ProFume fumigations.

One of the main drivers for use of ProFume is the continued development of phosphine resistance in storage pests over the past 30 plus years in Australia. Thankfully, for most grain producers, the current levels of phosphine resistance for most storage pest species still allows for complete control when fumigating in correctly sealed, gas-tight silos and when used as specified on the product label.

About 10 years ago one of the flat grain beetle species, known as the rusty grain beetle (*Cryptolestes ferrugineus*) developed a very high level of phosphine resistance at a number of eastern Australian sites. To control infestations of strongly resistant rusty grain beetles, most bulk handlers and a number of farm storage sites have been able to utilise ProFume.

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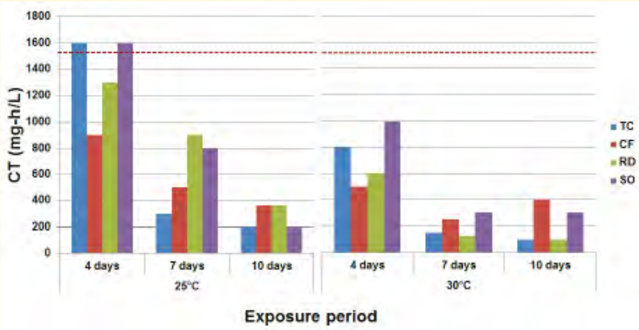
Figure 1: ProFume gas concentrations and time required at 25 and 30°C for complete control of the rust-red flour beetle (TC), rusty grain beetle (CF), lesser grain borer (RD) and rice weevil (SO)



(Red dotted line is the 1500 CT limit for grain application)

When should I consider using ProFume?

- Phosphine fumigation failure. If live flat grain beetles (*Cryptolestes spp*) are found in grain after a well managed fumigation, consider using a ProFume fumigation.
- Fumigation resistance management. As for most ag chemical use, aim for a rotation of products and active ingredients to combat pests. If phosphine fumigations are often used for pest control at your grain storage facilities, consider a plan to use ProFume every third year in rotation with phosphine.

Key features of ProFume

- ProFume active ingredient is 998 g per kg sulfuryl fluoride. Each gas cylinder holds 56.7 kg.
- Only licenced fumigators with ProFume training can purchase and apply ProFume.
- Registered for use on cereal grains, NOT pulses or oilseeds.
- Requires a gas-tight (sealable silo) storage to hold the specified gas concentrations for the required time.
- Bulk grain treatment costs range from around $3–$6 per tonne excluding GST, depending on tonnage and travel.
- The 'eggs' of storage pests are usually the hardest life cycle stage to kill with ProFume. Longer fumigation times are required.
- Cooler grain temperatures below 25°C, typical for aerated grain, also require longer fumigation times.

Fumigation time and grain temperature have the largest impact on successful pest control results with ProFume (see Figure 1).

Achieving reliable results and practical steps for ProFume fumigation

- Use only in gas-tight silos and storages. Pressure test silo, repair any leakage points.
- Avoid last minute, rushed 'short' fumigations. Longer fumigation times in a well-sealed storage provide effective pest control to all life cycle stages including the egg stage.
- Grain at temperatures below 25°C, fumigation times of 7–10 days would be recommended for effective pest control (see Figure 1).
- ProFume (sulfuryl fluoride) is a 'heavy' gas. Its vapour density = 3.5 (air = 1). ProFume gas is typically applied into the top headspace of a silo. Discuss placement of a sealable fitting at the top of your silo with your licenced fumigator in preparation for fumigation.
- Recent field trials suggest that due to ProFume vapour density, there may be significant benefits to using recirculation during fumigation. This can reduce the tendency for this heavy gas to fall and sit at much higher concentrations at the bottom of the silo or storage, leaving insects at the top exposed to much lower concentrations during fumigation.
- Follow all safety requirements as outlined by the licenced fumigator, including leaving fumigation warning signs and safety tape barriers in place. Aeration fans if fitted on storages simplify the venting requirements following fumigation. After venting and prior to grain movement, fumigators will test gas safety levels and 'clear' the grain. Keep copies of fumigation documentation.

Fumigation of larger silos (150 to +2000 tonnes)

The first step – ensure 'gas-tight storage'

To control live insect pests in grain the only registered products in Australia are now a range of gases. These are most often various phosphine fumigation products, and sometimes sulfuryl fluoride gas (ProFume). The controlled atmosphere method is also effective, using either carbon dioxide or nitrogen gas, but is mostly used for pest control in organic grains.

For any fumigation to be effective at controlling storage pests, the insects need to be exposed to a given gas concentration 'C', for a specified length of time 'T'. If this C x T exposure requirement is not met during the fumigation, it is common to see survival of various insect life cycle stages. With these fumigation failures, live insect pests quickly appear in the grain within days or weeks.

This is why it is critical for Australian grain producers who store grain for more than a month, to have at least two or more sealable, gas-tight storages that meet the Australian silo sealing standard (AS2628).

A storage that is not gas-tight does not allow the fumigation C x T exposure level to be reached in all parts of a silo, large or small. Achieving reliable pest control results is not possible with gas leakage and air dilution. As well as not killing the pests, selection and development of resistant insect populations is the additional negative outcome of poor fumigation attempts.

To achieve effective fumigations, silos must be pressure tested to check they are sealed – gas-tight. This ensures they hold high gas concentrations for the required time to kill pests.

Checking a large silo is ready for fumigation – useful equipment for pressure testing

- Portable leaf blower, or small aeration fan, used to add air to silo for pressure tests. High volume, low pressure air is required. Standard air compressors are generally not suited to this task.
- 50 mm poly fitting, including a 50 mm shut-off value, fitted into external section of silo aeration ducting. Using this port to blow air into silo.
- Plastic tube manometer, or better, a digital manometer (eg. Extech HD 755 Differential pressure manometer 0–0.5 psi). Aiming to measure within the range of 0–4 inches water gauge (w.g.) (0–1000 Pa).

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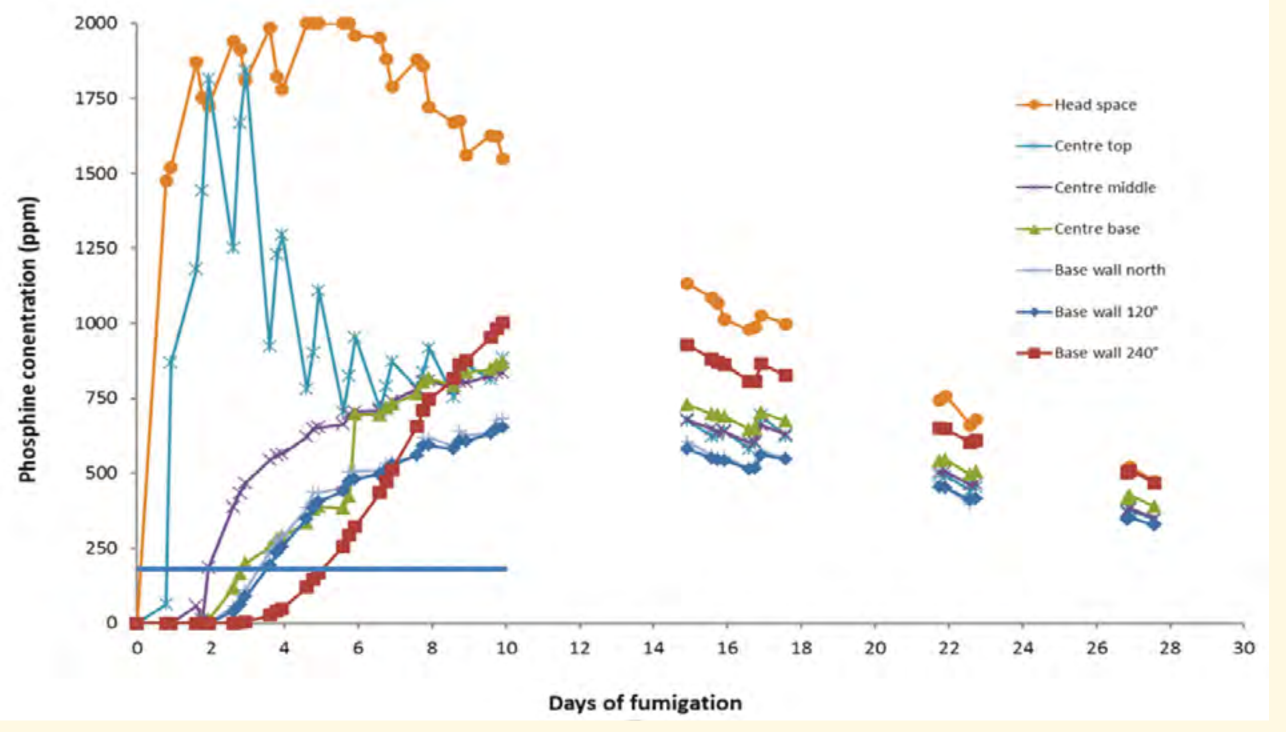
Figure 2: Phosphine gas concentrations at seven points in a silo during fumigation of 1420 tonnes of wheat. Phosphine blankets were placed in the silo headspace with no recirculation. It took as long as five days for all grain at the silo base to reached at least 200 ppm gas concentration.



- Spray bottle containing water and detergent, to check for leaks. Often you can hear or feel air leaks from large silos during the pressure test.

Pressure test – methods

New silos should be pressure tested by the silo supplier or manufacturer when completed on site. They should pass the Australian standard test (AS2628) to show they are sealable to a standard to allow for effective fumigations.

Sealable silos should then be pressure tested at least once a year to check for suitability for fumigations. Ideally pressure test when a silo is full of grain. This places grain pressure on all silo surfaces and outlets, which is the condition the silo is in when you are fumigating.

Pressure tests should not be conducted in the heat of the day, when the sun is heating the silo's external steel surfaces and warming/expanding the air inside the silo. The pressure test results under these conditions are meaningless. Ideally test in the early morning before the silo is being warmed. A windy day is also difficult, as silo surfaces are pushed around. Hook up the digital manometer, or plastic tube manometer to the silo when the silo is fully sealed. This will quickly show if pressures inside the silo are stable. If stable, a reliable pressure test can be conducted to test the silo seal quality and for any leakage points.

For small silos the pressure tests can be carried out by using a short burst (5–15 seconds) from the small aeration fan fitted to the silo. For larger silos a portable leaf blower to push air into the silo via a fitted 50 mm port can be used to initially pressurise the silo for a test. The pressure decay (250 down to 125 Pa) can be checked using one of three options – the silo's oil bath relief valves, a length of 20 mm clear plastic tube in a 'U' shape with water in it (manometer), or a digital manometer connected to the silo. See GRDC Fact Sheet: 'Pressure testing sealable silos'. http://storedgrain.com.au/pressure-testing/

A small fan (F370 – 0.37 kW) used during the first five days of fumigation to recirculate phosphine to give rapid uniform gas distribution in 1423 tonnes wheat. See Figure 3.

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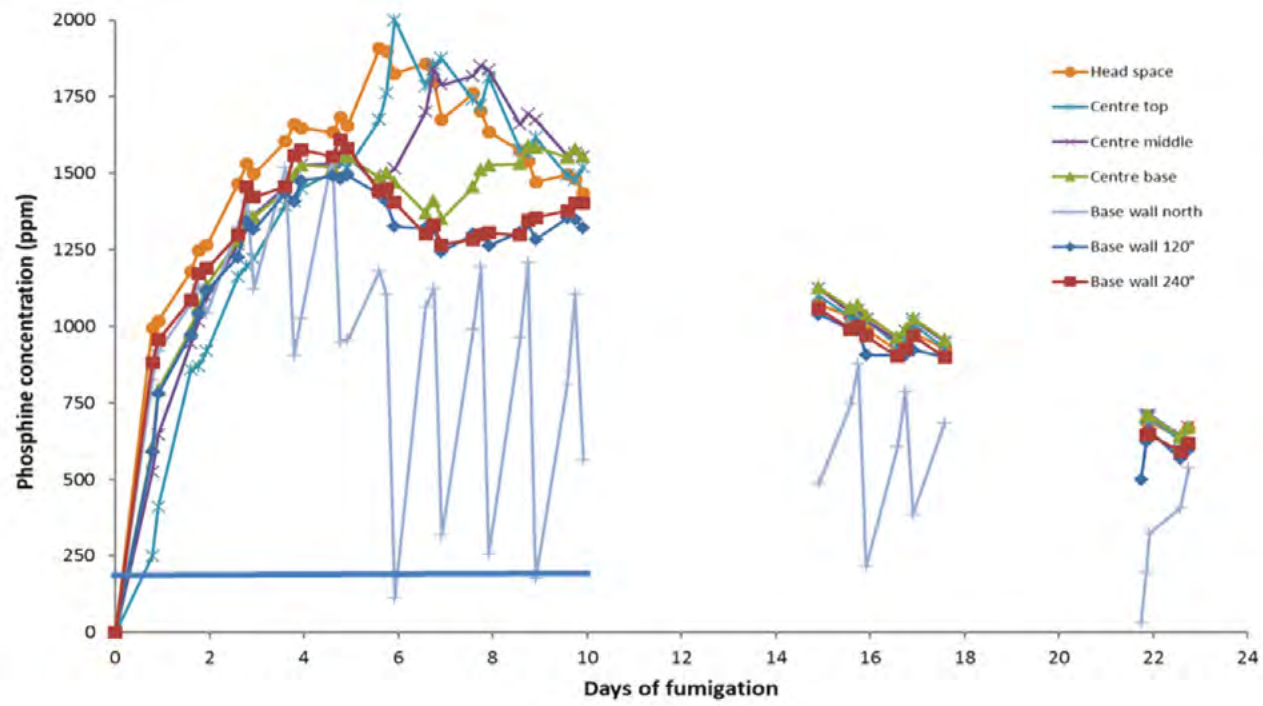
Figure 3: Phosphine gas concentations in a silo (1420 tonnes of wheat) where a small fan was used to draw gas from blankets in the silo headspace and pump it into the silo base via aeration ducts for the first five days of fumigation. Gas concentration in all areas of the silo reached over 800 ppm within the first 24 hours.



Common leakage points for large sealable silos

- Silo roof vents not sealing – maintenance or design problems.
- Silo grain fill point at top of silo not sealing – damaged rubber seals on lid, or sealing plate.
- Grain outload auger at base of silo – leaking seal plate.
- Bottom silo access manhole into silo – damaged seals, or poor design.
- Sealing plate covers for the aeration fan's intake, often poor design.
- External aeration fan ducting, or the aeration fan itself not well sealed.
- For all cone based silos, weight of grain in the silo can break the seal of the bottom outlet – poor design.

Fumigation recirculation – why is it important for fumigation of larger silos over 150 tonnes

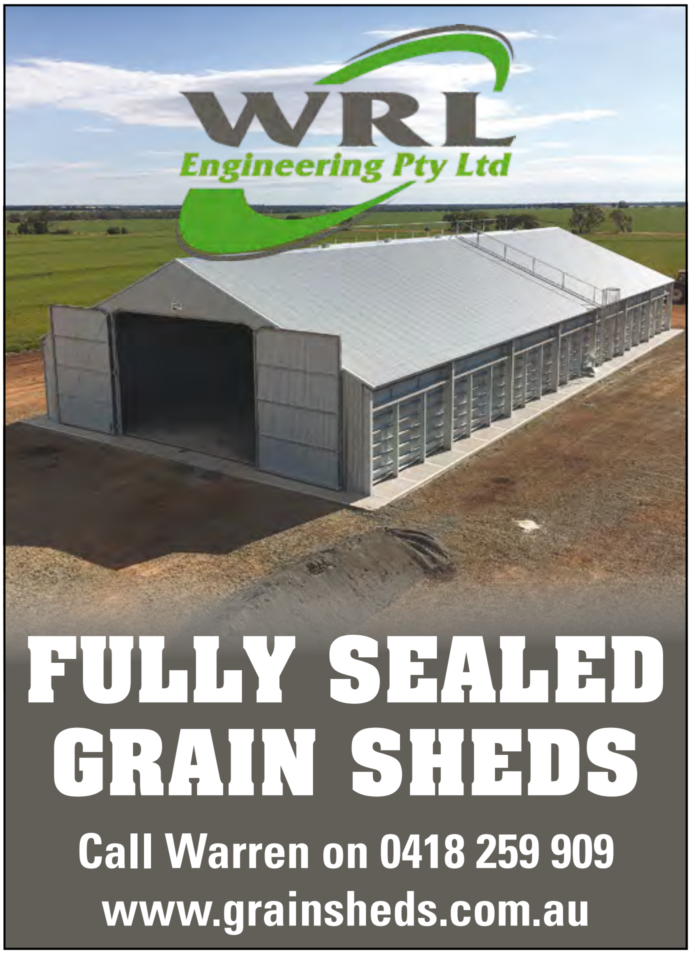
During fumigation, phosphine gas is typically liberated over five to six days from tablets or blankets that have been placed in the silo. But this gas only moves slowly, taking about 24 hours to travel six metres through grain.

If you are fumigating a medium to large silo (150–2000 tonnes) the gas may take two to five days to reach all parts of the silo. In large silo fumigations this may result in some grain, at the furthest distance from tablets, only getting six days of phosphine gas instead of the required 10 days or longer exposure period. Six days is not enough time to kill all the life cycle stages of the pests.

One example of a typical phosphine fumigation required to kill all pests, is a minimum of 200 ppm phosphine gas concentration for at least 10 days. See horizontal blue line in Figure 2.

Options for fumigation recirculation

- For all fumigation recirculation systems, the sealable silo needs to be gas-tight so there is no gas leakage during the fumigation. In Figure 2, 'Base wall north' shows the impact of a leak at the silo manhole, causing large daily fluctuations in gas concentrations.



Spray application equipment designed for good coverage by applying treatment at two points in the auger

- Phosphine blankets or tablets can be placed in the 'silo headspace' along with a small fan connected to the headspace via 90 mm pipe plumbing coming down the silo wall from the roof. Phosphine gas is drawn from the headspace and pumped into the base of the silo via both aeration ducts (see Figure 3).
- For ground level application of tablets or blankets, a sealable 'phosphine box' can be plumbed into this system, either a moveable box, or mounted permanently on each silo.
- Using a fan to force the phosphine gas movement around in silos during fumigation is generally recommended, rather than relying on a passive 'thermosiphon' approach. For medium and large silo fumigations, 150 tonnes or greater, or silos storing smaller grain sizes (eg. millets, canola, lentils etc.) that reduces air movement, fan force recirculation rather than thermosiphon is advised. Fan forced recirculation may also assist where the grain type (eg. oilseeds) typically absorbs higher amounts of phosphine during fumigation.

Equipment for fumigation recirculation

- Sealable silo – gas tight, that passes a pressure test.
- Plumbing pipes (90–100 mm) from silo roof to ground level. Use quality pipe, fittings and seals that will ensure many years of safe, gas-tight fumigations.
- Small fan (eg. Downfield F370 – 0.37 kW) to recirculate air. In most case this fan size will be suitable for both small and large silos. In trials (Figures 2 and 3) this fan size provided a complete silo air change every 12 hours for the full silo holding 1420 tonnes of wheat.
- Fittings for fan intake and outlet. Flexible hoses (50–100 mm) couplings and gate valves.

Fumigation recirculation – operations

- Pressure test the silo to check for leaks.
- Follow all label directions and place tablets/blankets in the 'headspace' or 'phosphine box'.
- Run small recirculation fan for first five days of fumigation. Leave silo sealed for remaining days of fumigation exposure period as label requires (eg. 7, 10, 20 days).

Notes

There are benefits to using the silo 'headspace' to locate the blankets or tablets. The large surface area of grain in the headspace provides safe, large easy access for liberated gas to penetrate and diffuse into the grain.

Licenced fumigators commonly choose to use 'gas' formulations of phosphine to undertake fumigations in large silos and other storage types, rather than using the solid phosphine formulations of blankets or tablets. An example is Cytec's ECO$_2$FUME containing 20 g per kg phosphine in carbon dioxide handled in 31 kg liquefied gas cylinders.

While applying the full dose of phosphine gas on day one into a storage has benefits, in many cases the use of a recirculation systems is valuable to provide rapid, uniform gas concentration distribution throughout the storage.

Warning

Always seek advice from a suitably qualified professional before fitting fumigation recirculation systems to silos/storages. Some systems that are currently sold are not recommended because of unsafe design features.

Phosphine is not only a toxic gas, but can be flammable and explosive if restricted in a small area, or used in a manner that causes gas concentrations to rise quickly to high levels. Follow label directions and seek advice.

Grain protectant sprays update

Warning

Grain protectant notes below do not apply to the grains industry in Western Australia where their use is restricted. In all cases, product labels are to be used to determine correct use patterns.

When to use grain protectants

- Grain protectant sprays are not to be used to disinfest grain. When live insects are detected, fumigation in a sealed silo is required for effective control.
- Typically, protectant sprays are applied to clean cereal grain at harvest time as grain is augered into storages, providing storage pest protection for three to nine months. Protectants are effective at controlling insects as they invade or emerge from eggs within grain during storage.

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- With many domestic and export markets seeking grain supplies which are 'pesticide residue free' (PRF), always talk to potential grain buyers/traders prior to applying grain protectant sprays.
- With the exception of some chlorpyriofs-methyl products in lupins in Victoria only, NO protectant sprays can be applied to pulses and oilseeds.

Common 'on-farm' uses for grain protectants

- Planting seed held on-farm – wheat, barley, oats.
- Grain held for an extended time in non-sealable storages (not suited for fumigation) and grain buyer has agreed to grain protectant use that is in line with directions for use on the registered product label.
- Grain held on-farm as feed for livestock with agreement from livestock agent or buyer and is in line with directions for use on the registered product label.

Grain protectant choices

Examples of two products, which include a partner product, to control the main storage pest species:

1. **Conserve Plus Grain Protector –** that is 100 g per litre spinosad, 100 g per litre s-methoprene. Used in combination with a compatible organophosphate (OP) product such as chlorpyrifos-methyl (Reldan), or fenitrothion

   For label and details on product use, see: http://www.conserveonfarm.com.au/en

Key recommendations

- Always add the OP partner to Conserve Plus so rice weevil (*Sitophilus oryzae*) is controlled.
- Spray equipment calibration and application care are critical to achieve correct dose and uniform coverage on grain.
- If treated grain is exposed to light, for example a semi open grain shed, cover the grain surface with a tarp or 80–90 per cent shade cloth. Sunlight breaks down Conserve Plus over time
- Take care to read notes on the website (above) and seek advice when purchasing Conserve Plus.

2. **K-Obiol EC Combi,** synergised grain protectant – that is 50 g per litre deltamethrin, 400 g per litre piperonyl butoxide. Used in combination with an organophosate (OP) partner eg. chlorpyrifos-methyl or fenitrothion.

   For label and details on product use, see: https://www.environmentalscience.bayer.com.au/K-Obiol/About%20K-Obiol

Key recommendations

- To control rice, maize and granary weevils (*Sitophilus spp*.) add a recommended partner (eg. OP) to the tank mix.
- To ensure effective pest control and that MRLs are not exceeded, calibrate spray equipment and aim for even treatment/coverage on grain.
- Grower users are required to complete a brief (approx. 60 minutes) online training course to be an 'approved user' prior to purchase of K-Obiol EC Combi. See above website.

Insect resistance management

If possible, aim to rotate chemical active ingredients for storage pest control at your storage facility. An example, two years use of Conserve Plus product combination, followed by one or two years of K-Obiol EC Combi.

Please read and follow all label recommendations and ensure that the product is registered for use in your state prior to application of any product.

Application for grain protectants

Grain protectant application requires care to achieve the correct dose and uniform grain coverage. This leads to effective pest control results and ensures MRLs are not exceeded.

- Auger's grain transfer rate. Ensure you have good understanding of the grain flow rate, tonnes per hour, for the particular height the auger will be operating at.
- Calibrate your spray application unit with water and check appropriate nozzles and spray pressure are used to achieve the required application of one litre of spray mixture per tonne of grain.

Further information:

GRDC booklet – Fumigating with Phosphine other fumigants and controlled atmospheres http://storedgrain.com.au/fumigating-with-phosphine-and-ca/

GRDC Fact sheet – Pressure testing sealable silos – http://storedgrain.com.au/pressure-testing/

A-Gas rural – ProFume – https://www.agasaustralia.com/products-services/a-gas-rural-fumigation-supplies-services/products/profume/

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GRDC video – Fumigation recirculation http://storedgrain.com.au/fumigation-recirculation/

Dow AgroSciences – Conserve Plus Grain Protector http://www.conserveonfarm.com.au/en

BAYER CropScience – K-Obiol EC Combi https://www.environmentalscience.bayer.com.au/K-Obiol/About%20K-Obiol

The authors acknowledge the Plant Biosecurity Cooperative Research Centre, of which GRDC is a partner, specifically projects PBCRC3036 and PBCRC3150 under which the fumigant research was conducted. The authors would also like to thank DAF's Postharvest research team members, GRDC's national grain storage extension team, along with valued support from growers and other industry collaborators.

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GOOD ADVICE TO GROWERS: DON'T ACCEPT BAD ADVICE ON GRAIN STORAGE

Australia's grain growers are playing a vital role in safeguarding the nation's access to global grain markets worth more than $12 billion.

By using only registered treatments in on-farm storages and adhering to label directions and rates, growers are protecting Australia's reputation as a supplier of high quality, clean grain.

Growers and other industry personnel are being reminded not to accept any "poor advice" regarding treatments for grain storages but continue to abide by industry regulations and product labels, as lucrative international market access would be jeopardised if unregistered or off-label chemicals were used.

Chris Warrick, who heads up the Grains Research and Development Corporation (GRDC) Grain Storage Extension Project, says products used for structural treatments must be registered for that purpose and accepted by the intended grain buyer.

"Do not use any product in grain storages which is not registered for that purpose and always follow label directions and rates – do not accept any advice to the contrary," Chris says.

Chris says residual chemistry from off-label application in stored grain may even find its way into other export industries, including meat and processed goods.

Grain hygiene and structural treatments are the first line of defence against insect pests, but product choice is critical.

"Diatamaceous Earth (DE) products such as Dryacide are a non-chemical option which control all common grain storage insect pests," Chris says.

"Because DE products have a physical effect on the insects rather than a chemical effect there is no known resistance issues."

GRDC Manager Pests, Dr Leigh Nelson, says the GRDC and its industry partners commend growers for their responsible approach to treating grain storage structures.

"Our growers recognise the importance of Australia maintaining its reputation for supplying international markets with grain of the highest quality," Leigh says.

GRDC Grain Storage Extension Project leader Chris Warrick demonstrates using Diatamaceous Earth (DE) as a structural treatment. (PHOTO: Peter Botta, PCB Consulting)

"They continue to do the right thing in terms of best practice treatment of on-farm storages, and by doing so are protecting their livelihoods and those of all grain growers."

To assist growers in their ongoing efforts to store and treat grain correctly, the GRDC has produced a Grain Storage GrowNotes publication, available at https://grdc.com.au/grain-storage-grownotes.

Further grain storage information is also available on the GRDC Stored Grain Information Hub at http://storedgrain.com.au. In addition, the GRDC Storedgrain app is now available from the Apple App Store or Google Play.

Growers who wish to contact their regional grain storage expert can call 1800 WEEVIL (1800 933 845).

Getting the system and economics right

By Peter Botta, PCB Consulting

AT A GLANCE…

- Planning for a storage system is vital to ensure growers can meet current and future needs, a system must be 'fit for purpose', to enable growers to outload a quality product and maximise their investment.
- The cheapest form of storage will be the one that suits your system, the grain being stored and the length of time it's stored.
- Permanent on-farm storage is a 25+ year investment – it's worth taking the time to do the numbers, consider the options and make informed decisions.
- Managing the storage system requires a systematic approach, a range of tools can and need to be implemented to enable success.

As growers across Australia continue to expand on-farm grain storage, the question of economic viability gains significance. There are many examples of growers investing in on-farm grain storage and paying for it in one or two years because they struck the market at the right time. But are these examples enough to justify greater expansion of on-farm grain storage?

The GRDC grain storage extension team conducts approximately 100 grower workshops every year throughout Australia and it's evident that no two growers use on-farm storage in the exact same way. Like many economic comparisons in farming, the viability of grain storage is different for each farming business. Spending money on grain storage infrastructure may or may not be the next best investment for that particular business.

For this reason, everyone needs to do a simple cost benefit analysis for their own operation before making the storage investment.

What do you want to achieve with your storage?

When comparing systems and thinking about investment decisions, growers need to consider their ultimate goal with a view to the future, and be sure that the system they settle on will actually allow them to do what they need and what the market requires. The common mistake made when grain storage is purchased is whether or not it is fit for purpose. This is particularly the case where storage is purchased with the intention to fumigate and when aeration is added to an existing system or purchased with new storage.

Essentially a systems approach to grain storage includes:

- Grain and system hygiene;
- Insect control;
- Grain quality control;
- Grain insect eradication; and,
- Monitoring.

Achieving a good result in all of these areas may mean attention to detail in the case of hygiene, and for insect eradication, having sealable gas-tight sealed storage is the only way to achieve this properly.

The key to ensuring success relies on getting the planning right, getting the right information and knowing the investment will do what it needs to do.

Peter Botta advises that grain storage systems need to be 'fit for purpose'.

Comparing on-farm grain storage

To make a sound financial decision, we need to compare the expected returns from grain storage versus expected returns from other farm business investments, such as more land, a chaser bin, a wider boomspray, a second truck or paying off debt and so on.

The other comparison is to determine if we can store grain on-farm cheaper than paying a bulk handler to store it for us.

Calculating the costs and benefits of on-farm storage will determine a return-on investment (ROI) figure, which can be compared with other investment choices and a total cost of storage to compare to the bulk handlers.

Cheapest form of storage

The key to a useful cost–benefit analysis is identifying which financial benefits to plan for and costing an appropriate storage to suit that plan. People often ask: "What's the cheapest form of storage?" The answer is the storage that suits the planned benefits.

Short term storage for harvest logistics or freight advantages can be suited to grain bags or bunkers. But if flexibility is required for longer term storage, gas-tight and sealable silos with aeration cooling allows for both grain quality control and insect control.

Benefits

To compare the benefits and costs it's best to work everything out on a basis of dollars per tonne.

On the benefit side, the majority of growers will require multiple financial gains from storing grain to make money out of it.

These might include harvest logistics or timeliness, market premiums, freight savings or cleaning, blending, or drying grain to add value.

Costs

The costs of grain storage can be broken down into fixed and variable. The fixed costs are those that don't change from year to year and have to be covered over the life of the storage. Examples are depreciation and the opportunity or interest cost on the capital.

Table 1: Cost/benefit template for grain storage

Storage gains	Calculation	Example ($/t)	Scenario 1 ($/t)	Scenario 2 ($/t)
Harvest logistics/timeliness	Grain price x reduction in value after damage % x probability of damage %	$16.20		
Marketing	Post harvest grain price – harvest grain price			
Freight	Peak rate $/t – post harvest rate $/t	$20.00		
Cleaning to improve the grade	Clean grain price – original grain price – cleaning costs – shrinkage			
Blending to lift average grade	Blended price – ((low grade price x %mix) + (high grade price x %mix))			
Total benefits	Sum of benefits	$36.20		
Capital cost	Infrastructure cost / storage capacity	$155.00		
Fixed costs				
Annualised depreciation cost	Capital cost $/t / expected life of storage eg 25yrs	$6.20		
Opportunity cost on capital	Capital cost $/t x opportunity or interest rate eg 8% / 2	$6.20		
Total fixed costs	Sum of fixed costs	$12.40		
Variable costs				
Storage hygiene	(Labour rate $/hr x time to clean hrs / storage capacity) + structural treatment	$0.23		
Aeration cooling	Indicatively 23c for the first 8 days then 18c per month/t	$0.91		
Repairs and maintenance	Estimate eg. capital cost $/t x 1%	$1.51		
Inload/outload time and fuel	Labour rate $/hr / 60 minutes / auger rate t/m x 3	$0.88		
Time to monitor and manage	Labour rate $/hr x total time to manage hrs / storage capacity	$0.24		
Opportunity cost of stored grain	Grain price x opportunity or interest rate eg 8% / 12 x No. months stored	$7.20		
Insect treatment cost	Treatment cost $/t x No. of treatments	$0.35		
Cost of bags or bunker tarp	Price of bag / bag capacity tonne			
Total variable costs	**Sum of variable costs**	**$11.32**		
Total cost of storage	**Total fixed costs + total variable costs**	**$23.72**		
Profit/Loss on storage	**Total benefits – total costs of storage**	**$12.48**		
Per cent return on investment	**Profit or loss / capital cost x 100**	**8.1%**		

The variable costs are all those that vary with the amount of grain stored and the length of time it's stored for. Interestingly, the costs of good hygiene, aeration cooling and monitoring are relatively low compared to the potential impact they can have on maintaining grain quality.

One of the most significant variable costs – and the one that is often overlooked – is the opportunity cost of the stored grain. That is, the cost of having grain in storage rather than having the money in the bank paying off an overdraft or term loan.

Doing the sums

Table 1 can be used as a template to figure out the likely economic result of on-farm grain storage for each individual business. Each column can be used to compare various storage options or scenarios including type of storage, length of time held or paying a bulk handler.

While it's difficult to put an exact dollar value on each of the potential benefits and costs, in most cases a calculated estimate will be good enough to determine if it's worth more thorough investigation.

If we compare the investment of on-farm grain storage to other investments and the result is similar, then we can revisit the numbers and work on increasing their accuracy.

If the return is not even in the ball park, we've potentially avoided a costly mistake. But on the flip-side, if after checking our numbers the return is favourable, we can confidently proceed with the investment.

To sum up

Unlike a machinery purchase, grain storage is a long term investment that cannot be easily changed or sold. Based on what the grain storage extension team are seeing throughout Australia, the growers who are taking a planned approach to on-farm grain storage – and doing it well – are being rewarded for it.

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

For more information or advice on grain storage, contact the GRDC grain storage extension team.
National Hotline 1800 weevil (1800 933 845)
QLD and northern NSW – Philip Burrill philip.burrill@daff.qld.gov.au
Southern NSW, VIC, SA and TAS – Peter Botta pbotta@bigpond.com
WA, Ben White – ben@storedgrain.com.au
Project coordinator – Chris Warrick info@storedgrain.com.au ■

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Section 13

Engineering in Agriculture

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THE Davey Group

Farming leads adoption of driverless vehicles

By Dr Khasha Ghaffarzadeh, Research Director, IDTechEx

Robots are becoming uncaged, mobile, collaborative and increasingly intelligent and dexterous, moving beyond their traditional strongholds to bring automation to previously inaccessible tasks. Agriculture is also no exception and is being quietly transformed by this rising new robotics.

Evolution towards full navigational autonomy

Agriculture is the leading adopter of autonomous driving technology despite all the hype around driverless cars. Real time kinematic GPS (RTK-GPS) forms the backbone of this outdoor navigational technology with its centimetre level positional accuracy.

First came tractor guidance, helping drivers drive more accurately and relieving some of the pressure of maintaining driving accuracy. Next came autosteer, giving the operator the ability to program a map into the tractor and let it navigate autonomously.

In agriculture, more than 210,000 RTK GPS receivers were sold worldwide in 2016. We project that this number will rise to 335,000 by 2023.

Autosteer will be the fastest growing use case, variable rate equipment will also see accelerated growth. This trend will be boosted as receiver prices continue to fall. The receiver technology is becoming increasingly commoditised. The uptake will also be helped by increased uptake in precision agriculture practices. The full ecosystem is finally coming together with more reliable variable rate equipment such as seeders, spreaders and sprayers.

We project that some 330,000 VRT units will be sold worldwide in 2023 – up from a mere 40,000 or so in 2015.

Master-and-slave

Technology is now evolving towards full autonomy. Master-and-slave (or follow-me) systems are being trialled, enabling one driver to guide a fleet, thus boosting the driver's productivity.


The challenge is to convince farmers to pay for and adopt this new technology.

Next will come manned yet fully autonomous tractors (level 5). This has already been technologically demonstrated. Here, the vehicle's sensing suite has to be expanded to enable it to avoid collision and operate even when the GPS signal is lost.

The next stage will potentially be unmanned autonomous tractors. In fact, in 2017, we saw the first public demonstrators for such vehicles.

But currently the farmers want to stay in charge, so the cab is likely to be kept in the design. But in the long term, the meaning of staying in charge will change, transiting from driving the vehicle to, for example, remote fleet operation/management.

In general, agriculture is well suited to autonomous mobility – farms are semi-structured, sparsely-populated environments and so are simpler to autonomise than general driving on congested roads. There is also a commercial incentive to reduce the wages bill.

But the challenge is to convince farmers to pay for the technology and to adopt it. Indeed, farmer conservatism and the general characteristic of the agriculture market will turn this potentially revolutionary technology into an evolution.

Taking the driver out of the equation?

Taking the driver out of the equation can have profound consequences for the way we envisage agricultural machinery. The well-established notion that bigger is better has its origins in the need to enhance the productivity of the driver but this notion loses some of its relevance if farm vehicles become autonomous and unmanned.

Navigational autonomy could initiate a major transition from large, heavy, fast and expensive vehicles towards fleets of agricultural robots. These agrobots would move slowly, giving extra attention to plants; and they would be light weight, eliminating soil compaction. They would also have to be inexpensive in order to compensate for their lower individual productivity through fleet operation.

Not a done deal – yet

Many small robots have been developed at the research level and a few have been commercially launched and sold. The machine designs are not the done deal yet. In fact, there is still some way to go:

- These robots often only work on highly structured farms and on crops with limited height;
- They take action using mechanical means which can be slow otherwise they will need to carry tanks of water and chemicals which adds to size and weight; and,
- The cost of data capture is relatively high compared to other methods such as drones.

But we are only at the beginning of the beginning here. Indeed, the rise of small mobile robots is not limited to just agricultural machinery.

Take, for example, vehicles used in material handling. Here, small robots are being commercially developed to carry loads inside facilities.

These mobile robots can autonomously navigate with no reliance on guiding infrastructure (for example, magnetic tapes). They will become increasingly able and authorised to share spaces with humans, intelligently navigating their way and avoiding objects.

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What's happening Down Under with autonomous vehicles?

By Brian O'Connell

In late August 2017, the impressively futuristic Autonomous Concept Vehicle was on show at AgQuip in northern NSW. As Case IH Australia New Zealand marketing manager Pete McCann explained, the ACV is a glimpse into the future for agriculture and proof of the impact that technology is having on our industry. Indeed, the concept vehicle was initially created by Case IH to demonstrate available technology as development unfolded and to initiate customer feedback on the need for future autonomous products.

And feedback there was!

I was able to spend some time with Rob Zemenchik, Case IH's Global Product Manager for Advanced Farming Systems (AFS). Rob provided an intriguing overview of the planning behind the concept development and the possibilities going forward. All this it must be said, couched in very practical, 'muddy boots' terms.

The features on the autonomous tractor offer growers more control, more monitoring capabilities and more cost savings through greater efficiencies with tasks like tillage, planting, spraying and harvesting.

Rob explained that the not-on-board operator could supervise the activities of multiple machines via a tablet or desktop computer while completing other tasks, and a number of autonomous tractors could work together on the one task or on multiple tasks simultaneously.

The ACV's onboard system can automatically account for implement widths and plots the most efficient paths depending on terrain, obstructions and other machines in the vicinity.

And all that sounds really good but, I hear you say, all this depends on the operator and the multiple machines being able to communicate.

And in this country wireless communication can be problematic, if not non-existent. A fact that Rob had been made very much aware of.

"Throughout the world we invariably encounter areas that have poor cellular coverage. And for most of us, satellite systems are still cost prohibitive. Farming is largely rural, so this predicament isn't going away. But there are systems already on the market and advances under evaluation that will satisfactorily solve this challenge," explained Rob.

Meet the mesh network

My technical savvy when it comes to improving on a poor cell phone signal, largely involves standing on a high place. So, it was with both surprise and a degree of satisfaction that I learned from Rob that there is such a thing as a 'mesh network'.

Ring-lock mesh fences we understand and mesh networks are not entirely dissimilar.

Wireless mesh networks were originally developed for military applications in remote areas and/or battle zones. A stand-alone network is established such that every node (or router) in the network can serve as a router for every other node (like the panels in a mesh fence). In that way, even in the event of a failure of some nodes, the remaining nodes continue to communicate with each other and amplify the signal, creating a blanket of strong Wi-Fi coverage.

The ACV offers a glimpse into the future for agriculture.

Seems that even if you don't have the budget of the US Army, you will soon be able to afford to install a mesh network – certainly around your paddock and in the near future, around your farm. You can go off-grid for both your power and your communication needs.

Having launched the ACV, Case IH is now shifting into the pilot phase of the project. This means on-farm trials in a number of environments and locations around the world. And to accelerate the commercial timeline, Rob explained that they are investigating an array of autonomous packages that, with some modification, could be integrated into current machines.

"Automated end-of-row turns is an example of the type of technology we could start to implement. It is very plausible that we will see several aspects of our autonomous technology commercialised within the next five years," said Rob.

In this way Case IH could equip a traditionally cabbed vehicle with off-road autonomy components so that operators could move field-to-field as they do today, but enact autonomy in full once they arrive at the next field.

Further into the future, the car industry will devise much of the on-road solution which agriculture could leverage.

Componentry becoming much more affordable

And the benefits of this leverage are already being realised. Rob spoke of an ongoing reduction in the cost of much of the sensor technology.

"Some of the components we required when we started the autonomy project five years ago cost over $100 – now they're under $3," said Rob. "This greatly enhances the commercial viability and value to our customers.

"We expect this trend to continue. Gordon Moore, founder of computer chip manufacturer Intel, said in the 1960s that computing power doubles annually. That has largely held true and the price for that power has similarly gone down.

"The rate of adoption of technology is accelerating. What started out as yield mapping and guidance in the 1990s is rapidly moving toward remote fleet management and connected support services, to be followed by autonomy. What used to be generational considerations now happen over a few growing seasons with a phased-in approach." ■

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Low cost machinery modification lines up resistant weeds

When you know something works there is a great incentive to find solutions to any problems that might stand in the way of its implementation. The knowledge that harvest weed seed control really works has fuelled the journey that Yerong Creek (NSW) growers, Warwick and Di Holding, have taken to see the practice implemented on their farms, in every crop, every year.

Over a decade ago they used windrow burning as a way to control annual ryegrass plants that had evaded in-crop selective herbicides. Warwick says they saw great results but stopped due to the additional workload and fire risks.

"When ryegrass numbers started to build up again we knew we had to get serious about stopping seed set in these resistant plants," says Warwick. "We knew narrow windrow burning was effective so we started there, but we were always looking for other ways that didn't mean extra work or create fire hazards."

In 2013 Warwick built a narrow chute for the header and they dedicated themselves to narrow windrow burning (NWB) in their canola crops, which represent 25 per cent of their cropping land, for three or four years. During this time they also used NWB in some wheat and lupin crops, but the risk of burning the whole paddock and fire escapes was a real concern.

Warwick Holding has coined the term 'weed-lining' to describe the site-specific practice of treating dense germinations of weeds in tramlines following harvest using a chaff deck system.

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Modified an old trailing boom

To reduce the time associated with lighting the rows, and to keep traffic on the CTF tramlines, Warwick modified an old trailing boom to carry three gas burners to light the windrows at intervals while travelling along the rows rather than across them. This saved time but there were still fire risks, especially in paddocks with a heavy stubble load from previous seasons.

In addition to the fire risks Warwick and Di also noticed stubble cover was dramatically reduced, variation in soil moisture was affecting planting and it appeared that nutrients were being concentrated into the narrow windrows.

To get away from these disadvantages the Holdings invested in two EMAR chaff decks designed to place weed seed-laden chaff from the harvester onto permanent wheel tracks, which they used for the first time in the 2016 harvest across their 2000 hectares property and 700 hectares contract farming area. This coincided with 2016 being a very wet winter that resulted in a big blow-out of ryegrass in the wheat crop.

In the following faba bean crop Warwick did everything possible to reduce weed numbers and contain seed set.

Instead of returning to wheat in 2018 as he usually would, Warwick plans to implement a double break crop tactic by following the faba bean with canola.

Chaff decks suit controlled traffic

The Holdings have been controlled traffic farming since 2006 using three-metre centres so the chaff deck system suits their system perfectly, delivering the weed-laden chaff onto permanent, bare wheel tracks.

"When I went to *WeedSmart Week* in WA in 2016 we visited Gary Lang at Wickepin and Trevor Syme at Bolgart and could see the results of using chaff decks in their farming systems, which are similar in many ways to

To get away from the disadvantages associated with narrow windrow burning, Warwick and Di Holding invested in two EMAR chaff decks designed to place weed seed-laden chaff from the harvester onto permanent wheel tracks.

ours," says Warwick. "The idea of dropping weed seed onto wheel tracks every year was very appealing, along with only having to deal with the chaff fraction while still having the straw spread across the paddock.

"The chaff deck system ticked all the boxes for us so when we returned home we ordered two – one for each of our harvesters," he says. "One added benefit that we hadn't counted on is that the chaff on the wheel tracks reduces the amount of dust that is generated when spraying and we are seeing better herbicide efficacy as a result."

The chaff decks concentrate the weed seeds in the hostile environment of the wheel tracks, making it easier to deploy tactics that specifically target the (predominantly resistant) weeds that might germinate in the wheel tracks.

"Many other growers who have used chaff decks for several years have assured us that most of the weed seed just rots away after harvest but we are not yet confident enough in this happening," says Warwick. "We had quite significant germination of weeds in the tramlines after our first harvest with the chaff decks and we decided to spray these 'weed-lines', which represent just eight per cent of the paddock."

Re-jigged the old bar to create 'weed lining'

Warwick dismantled the gas burners he had installed on the old bar to light up narrow windrows and has re-jigged the bar to carry spray lines with nozzles to spray out six tramlines (three sets) in one pass.

"I call it 'weed lining' and use it as a cost-effective way to do site-specific weed control," he says. "We have found that the weeds growing in the tramlines are more advanced than those growing in the paddock, so having the weed lining spray bar means I can get on early, before the frosts, and treat the weeds in the tramlines when they are small without wasting herbicide on the rest of the paddock.

"A blanket spray that would cost $48 per hectare is replaced with a weed lining spray costing $3.84 per hectare."

Being such a low-cost operation means that it is practical and economic for the Holdings to treat multiple germinations of weeds if necessary to ensure each application is as effective as possible and results in reduced weed numbers.

"Seeing the weeds germinate in the tramlines is also encouraging in a way because you can really see that the chaff deck is capturing the resistant weed seed and putting it where you can deal with it effectively," Warwick says.

From tynes to disc seeding

A move from tyne to disc seeding has meant that Warwick now uses minimal trifluralin and as a result has seen an increase in ryegrass survivors in wheat crops. The annual ryegrass on the farm is resistant to Group A dims and fops along with some Group B resistance and some resistance to glyphosate in non-crop areas.

Warwick is targeting glyphosate resistance with double-knock and chipping to remove resistant plants before they enter the cropping areas.

Black oats is evolving resistance to Group A on some of their heavier clay soils.

Following the second year of harvesting with chaff decks Warwick has noticed that the chaff material is rotting better in the thicker, two-season chaff rows. The reduced dust levels continue to provide greater efficacy for the summer spraying program.

Warwick and Di generously hosted other farmers and agronomists on their farm as part of *WeedSmart Week* 2017 in Wagga Wagga. Plans are underway for *WeedSmart Week* 2018 to be held in August in Moree NSW.

For more information about harvest weed seed control options, visit the WeedSmart website: www.weedsmart.org.au ■

Using an old trailing boom Warwick rejigged the bar to carry spray lines with nozzles to spray out six tramlines (three sets) in one pass. They have found that the weeds growing in the tramlines are more advanced than those growing in the paddock, so having the weed lining spray bar means he can get on early, before the frosts, and treat the weeds in the tramlines when they are small without wasting herbicide on the rest of the paddock.

A history of engineering innovation

From the Sunshine Harvester and the stump-jump plough through to harvest weed seed collection, autonomous farm vehicles, drones and robots – Australian farmers have led the agricultural world in practical engineering innovations and adoption. The challenging physical, economic and social environments confronting our farmers have changed little since the days of the early settlers. But what is constantly evolving on the engineering front are very clever, practical and effective methods to help keep farmers in business.

The following is a short pictorial stroll down agricultural engineering's memory lane.

The Sunshine Harvester

The stripper-harvester changed Australian and international grain harvesting techniques. This machine could strip, thresh, winnow and bag grain. The stripper-harvester increased grain yields and cut down on the amount of physical labour, as well as the time needed to harvest.

Each harvester was built using hundreds of parts, many of which were manufactured at the Sunshine Harvester Works just west of Melbourne. The factory was established by Hugh Victor (HV) McKay.

HV McKay came from a farming family at Drummartin in Victoria. During the mid-19th century, he was one of a number of Australians to successfully build and test a stripper-harvester. With help from his father and brother, HV built a harvester using parts of other machines and scraps of material he found on the family farm. After successfully testing the harvester, HV patented his design in March 1885.

The economic depression of the 1890s ruined HV's fledgling agricultural implements manufacturing business. In 1893, he set about improving the design of his harvester and rebuilding his devastated company. McKay named his improved harvester, the Sunshine. By the end of the 1890s, his Ballarat based business was a success.

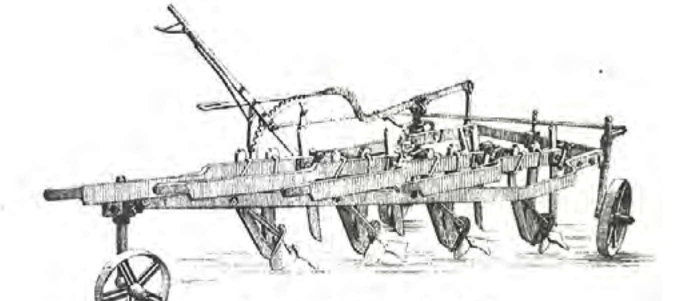
This Sunshine stripper harvester is an Australian invention, the first commercially successful ones being manufactured by HV McKay in 1884. As such they represent a significant step in the technological evolution of Australian-developed harvesting equipment. This small harvester has a 5-foot cut and was drawn by six horses.
(PHOTO: National Museum of Australia)

The stump-jump plough

Over the years there has been much controversy over who really invented the stump-jump plough. Although many others claim to be the inventors they were, according to the Stott family, copies of James Stott's stump-jump plough with minor modifications made to them.

Perhaps the most commonly held belief is that it was invented by James Winchester Stott of Alma who had migrated to Geelong in Australia from Aberdeen, Scotland, in 1851.

When early settlers began to open up and clear the land for farming, the invention of the stump-jump plough was of tremendous help. Stump removal could occur at a later time without hindering the farmer's task of growing crops.



STUMP JUMPING PLOUGH
MADE BY Mr J.W.STOTT, OF ALMA. 1881
Diagram No3

The stump-jump plough was hailed as a farming revolution and allowed the mallee lands in many parts of Australia – previously thought to be too difficult to work – to be cultivated.

Source: The Stott family website – www.stottfamily.id.au ■

Many claim that Richard Bowyer Smith of Kalkabury, SA, can be credited with the first stump-jump plough design. In August 1876 Richard and his brother Clarry demonstrated their vixen three furrow stump jump plough (pictured) which could cope with obstacles where set-ploughs would fail. Clarry Smith manufactured stump-jump ploughs at Ardrossan, SA from 1880 to 1935.
(PHOTO: The Institution of Engineers, Australia)

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Email: ian.reichstein@agriculture.gov.au
Web: www.agriculture.gov.au/nrs

Office of the Gene Technology Regulator

GPO Box 9848, CANBERRA ACT 2601
Ph: 1800 181 030 – Fax: 02 6113 8303
Email: ogtr@health.gov.au – Web: www.ogtr.gov.au
Gene Technology Regulator: Dr Raj Bhula

Office of Rural Financial Counselling

GPO Box 858, CANBERRA ACT 2601
Ph: 1800 686 175
Web: www.agriculture.gov.au/ag-farm-food/drought/assistance/rural-financial-counselling-service

Plant Breeder's Rights Office
(located within IP Australia)

Discovery House
47 Bowes Street, Phillip ACT 2606
PO Box 200, WODEN ACT 2606
Ph: 1300 651 010
Registrar: Frances Roden
Email: eservices@ipaustralia.gov.au – Web: www.ipaustralia.gov.au

Biosecurity Plant

18 Marcus Clarke Street, Canberra City
GPO Box 858, CANBERRA ACT 2601
Ph: 1800 900 090
Web: www.agriculture.gov.au/biosecurity
First Assistant Secretary: Marion Healy

Biosecurity Animal

18 Marcus Clarke Street, Canberra City
GPO Box 858, CANBERRA ACT 2601
Ph: 1800 900 090
Web: www.agriculture.gov.au/animal
First Assistant Secretary: Tim Chapman

State Agriculture Departments

NSW Department of Primary Industries

161 Kite Street, Orange
Locked Bag 21, ORANGE NSW 2800
Ph: 1800 808 095 – Fax: 02 6391 3336
Email: nsw.agriculture@dpi.nsw.gov.au – Web: www.dpi.nsw.gov.au
Director General: Scott Hansen

Department of Economic Development, Jobs, Transport and Resources Victoria

1 Spring Street, MELBOURNE 3001
GPO Box 4509, Melbourne VIC 3001
Ph: (03) 9651 9999
Email: customer.service@ecodev.vic.gov.au
Web: www.economicdevelopment.vic.gov.au/

Department of Agriculture and Fisheries (Qld)

41 George Street, Brisbane
GPO Box 46, BRISBANE QLD 4001
Customer Service Centre: 13 25 23
Interstate – Ph: 07 3404 6999 – Fax: 07 3404 6900
Email: callweb@daf.qld.gov.au – Web: www.daf.qld.gov.au
Follow us on Facebook and Twitter:
Queensland Agriculture and @QldAgriculture
Director General: Beth Woods

Primary Industries and Regions SA (PIRSA)

L 14, 25 Grenfell Street, Adelaide
GPO Box 1671, ADELAIDE SA 5001
Ph: 08 8226 0995 – Email: pirsa.customerservices@sa.gov.au
Web: www.pir.sa.gov.au

SA Research and Development Institute (SARDI)

Grains Research: Dr Peter Appleford, Ph: 08 8303 9400
Climate Risk: Dr Peter Hayman, Ph: 08 8429 0426
Crop Improvement: Dr Tim Sutton, Ph: 08 8429 0787
Crop Disease Management: Dr Jenny Davidson, Ph: 08 8429 2228

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Insect Pest Management: Greg Baker, Ph: 08 8429 0933
Farming Systems: Dr Nigel Wilhelm, Ph: 08 8429 0846
Food Safety & Innovation: Dr Steven Lapidge, Ph: 08 8429 0724
New Variety Agronomy: Andrew Ware, Ph: 08 8688 3417
Pastures: Dr Alan Humphries, Ph: 08 8429 0376
Email: pirsa.sardi@sa.gov.au – Website: www.pir.sa.gov.au/research

Department of Agriculture and Food, Western Australia

3 Baron-Hay Court, South Perth WA 6151
Locked Bag 4, BENTLEY DELIVERY CENTRE WA 6983
Phone: +61 (0)8 9368 3333 Fax: +61 (0)8 9474 2405
Email: enquiries@dpird.wa.gov.au
Web: www.agric.wa.gov.au

Tasmanian Department of Primary Industries, Parks, Water and Environment

1 Franklin Wharf, Hobart
GPO Box 44, HOBART TAS 7001
Ph: 03 6165 3225
Email: AgriGrowth@dpipwe.tas.gov.au
Web: www.dpipwe.tas.gov.au

Department of Primary Industry and Resources, NT

Berrimah Farm, Makagon Road, Berrimah, Northern Territory 0828
GPO Box 3000, DARWIN NT 0801
Phone: 08 8999 2006 (Business hours)
Email: info.dpir@nt.gov.au – Web: www.dpir.nt.gov.au

Research & Development

Research and Development Corporations

Grains Research & Development Corporation

Level 4, East Building, 4 National Circuit, BARTON, ACT 2600
PO Box 5367, KINGSTON ACT 2604
Ph: 02 6166 4500 – Fax: 02 6166 4599
Chairman: John Woods
Managing Director: Dr Steve Jefferies
Email: grdc@grdc.com.au – Web: www.grdc.com.au

AgriFutures Australia

Building 007, Tooma Way, Charles Sturt University
Locked Bag 588, WAGGA WAGGA NSW 2650
Ph: 02 6923 6900
Email: info@agrifutures.com.au – www.agrifutures.com.au
Managing Director: John Harvey

Cotton Research & Development Corporation

2 Lloyd Street, Narrabri NSW 2390
PO Box 282, NARRABRI NSW 2390
Ph: 02 6792 4088 – Fax: 02 6792 4400
Email: crdc@crdc.com.au – Web: www.crdc.com.au
Chair: Richard Haire
Executive Director: Bruce Finney

Dairy Australia

Level 3, HWT Tower, 40 City Road, Southbank, Vic 3006
Locked Bag 104, FLINDERS LANE VIC 8009
Ph: 03 9694 3777 – Fax: 03 9694 3733
Web: www.dairyaustralia.com.au
Farm Profit and Innovation: Chris Murphy

Meat & Livestock Australia (MLA)

Level 1, 40 Mount Street, North Sydney NSW 2060
PO Box 1961, NORTH SYDNEY NSW 2059
Ph: 02 9463 9333 – Free call: 1800 023 100 – Fax: 02 9463 9393
Email: info@mla.com.au – Web: www.mla.com.au
Managing Director: Richard Norton
Email: managingdirector@mla.com.au

Australian Pork Limited

Level 2, 2 Brisbane Avenue Barton ACT 2600
PO Box 4746, KINGSTON ACT 2604
Ph: 1800 789 099 – Fax: 02 6285 2288
Email: apl@australianpork.com.au Web: www.australianpork.com.au
Chief Executive Officer: Andrew Spencer

Sugar Research Australia

50 Meiers Road, Indooroopilly, 4068
PO Box 86, INDOOROOPILLY Q 4068
Ph: 07 3331 3333 – Fax: 07 3871 0383
Email: sra@sugarresearch.com.au – Web: www.sugarresearch.com.au

Australian Wool Innovation Limited

Level 6, 68 Harrington Street, The Rocks, Sydney NSW 2000
GPO Box 4177, SYDNEY NSW 2001
Ph: 02 8295 3100 – Fax: 02 8295 4100
Email: feedback@wool.com – Web: www.wool.com
Chief Executive Officer: Stuart McCullough

CSIRO Enquiries

Private Bag 10, CLAYTON SOUTH, VIC 3169
Phone: 1300 363 400 Mon-Fri 9:00am–4:00pm EST
Email: csiroenquiries@csiro.au – Web: www.csiro.au

Grain-related CSIRO

www.csiro.au/en/Research/AF
Director CSIRO Agriculture – John Manners Ph: 02 6246 4001

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Related Cooperative Research Centres

Pork CRC Ltd

PO Box 466, WILLASTON, SA 5118
Ph: 08 8313 7683 – Fax: 08 8313 7686
Email: roger.campbell@porkcrc.com.au – Web: www.porkcrc.com.au
Chief Executive Officer: Dr Roger Campbell

International agencies

Australian Centre for International Agricultural Research (ACIAR)

38 Thynne Street, Fern Hill Park, Bruce ACT 2617
GPO Box 1571, CANBERRA ACT 2601
Ph: 02 6217 0500 – Fax: 02 6217 0501
Email: aciar@aciar.gov.au – Web: aciar.gov.au
Chief Executive Officer: Andrew Campbell

International Center for Agricultural Research in the Dry Areas (ICARDA)

PO Box 114/5055, BEIRUT, LEBANON 1108-2010
Ph: +961 1 843472/813303 – Fax: +961 1 804071/01-843473
Email: icarda@CGIAR.org – Web: www.icarda.org
Director General: Aly Abousabaa

International Maize and Wheat Improvement Center (CIMMYT)

Apdo. Postal 6-641, 06600 Mexico, D.F., MEXICO
Ph: +52 55 5804 2004 – Fax: +52 55 5804 7558
Email: r.munoz@cgiar.org – Web: www.cimmyt.org
Director General: Martin Kropff

Associated Industry

Agrifood Awareness Australia Limited

PO Box E10, KINGSTON ACT 2604
Ph: 02 6269 5620 – Fax: 02 6273 3968

AgriFood Technology

260 Princes Highway, Werribee
PO Box 728, WERRIBEE VIC 3030
Ph: 1800 801 312 – Fax: 03 9742 4228
Email: lab.vic@agrifood.com.au – Web: agrifood-srp.com.au

Australian Fertiliser Services Association (AFSA)

Company Secretary: Neil Henry
PO Box 10, GLENTHOMPSON. 3293.
Mob: 0418 562 570 – Email: henfert@bigpond.com
Executive Officer: Krysteen McElroy
Ph: 0408 655 108
Email: bkmcelroy22@outlook.com – Web: www.afsa.net.au

Australian Herbicide Resistance Initiative

School of Agriculture and Environment
The University of Western Australia
35 Stirling Highway, CRAWLEY WA 6009
Ph: 08 6488 7870 – Web: www.ahri.uwa.edu.au
Director: Professor Stephen Powles
Ph: 08 6488 7833 – Fax: 08 6488 7834

Email: stephen.powles@uwa.edu.au
Centre Manager: Ms Lisa Mayer
Email: lisa.mayer@uwa.edu.au

Australian Lot Feeders' Association

Level 5, 131 Clarence Street, Sydney
GPO Box 149, SYDNEY NSW 2001
Ph: 02 9290 3700 – Fax: 02 9290 2808
Email: info@feedlots.com.au – Web: www.feedlots.com.au
President: Tess Herbert
Chief Executive Officer: Christian Mulders

Australian Oilseeds Federation Inc

PO Box H236, AUSTRALIA SQUARE NSW 1215
Ph: 02 8007 7553 – Fax: 02 8007 7549
President: Rob Wilson
Treasurer: Lachlan Herbert
Web: www.australianoilseeds.com

Australian Research Council

Level 2, 11 Lancaster Place, Canberra Airport ACT 2609
GPO Box 2702, CANBERRA ACT 2601
Ph: 02 6287 6600 – Fax: 02 6287 6601
Email: info@arc.gov.au – Web: www.arc.gov.au
Chief Executive Officer: Professor Sue Thomas

Australian Seed Federation Limited

Unit 1, 20 Napier Close, Deakin ACT 2600
PO Box 3572, MANUKA ACT 2603
Ph: 02 6282 6822 – Fax: 02 6282 6922
Email: enquiry@asf.asn.au – Web: www.asf.asn.au
President: Steve Brill
Chief Executive Officer: Bill Fuller

Barley Australia

PO Box 263, GOODWOOD SA 5034
Ph: 0400 156 088
Email: info@barleyaustralia.com.au
Web: www.barleyaustralia.com.au
Executive Chairperson: Megan Sheehy
Email: megan.sheehy@barleyaustralia.com.au

Bean Growers' Australia Limited

82–86 River Road, Kingaroy QLD 4610
PO Box 328, KINGAROY QLD 4610
Ph: 07 4162 1100 – Fax: 07 4162 4706
Chief Executive Officer & Export Manager: Lloyd Neilsen
Email: lneilsen@beangrowers.com.au
Email: info@beangrowers.com.au
Web: www.beangrowers.com.au

Centre for Legumes in Mediterranean Agriculture (CLIMA)

The University of Western Australia,
35 Stirling Highway, CRAWLEY, WA 6009
Mailbox M080
Ph: 08 6488 2505 – Fax: 08 6488 1140
Email: reception-clima@uwa.edu.au – Web: www.clima.uwa.edu.au
Director: Prof. William Erskine

CropLife Australia

Level 1 Maddocks House
40 Macquarie Street, BARTON ACT 2600

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Ph: 02 6273 2733
Web: www.croplife.org.au
President: Paul Luxton, Syngenta Australia Pty Ltd
Chief Executive Officer: Matthew Cossey

Farmsafe Australia

NFF House, 14-16 Brisbane Avenue, BARTON ACT 2600
Locked Bag 9, KINGSTON, ACT 2604
PH: 02 6269 5622 – Fax: 02 6273 2331
Email: info@farmsafe.org.au – Web: www.farmsafe.org.au
Secretary: Sarah McKinnon
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State Farmsafe contacts:
Queensland: 1300 737 470
New South Wales: 02 9478 1000
Victoria: 1300 882 833
Western Australia: 0402 611 290, Email: admin@safefarms.net.au
Tasmania: Email: info@pass.org.au

Fertilizer Australia

Level 1 Maddock House, 40 Macquarie St, BARTON ACT 2604
Locked Bag 4396, KINGSTON ACT 2604
Ph: 02 6273 2422
Email: info@fertilizer.org.au – Web: www.fertilizer.org.au
Chairman: Jim Mole

Grains & Legumes Nutrition Council

Level 1, 40 Mount Street, NORTH SYDNEY NSW 2060
Ph: 1300 472 467 (Australia only) or 02 9394 8661
Email: contactus@glnc.org.au – Web: www.glnc.org.au
General Manager: Dr Sara Grafenauer

Grains Research Foundation Ltd (GRFL)

PO Box 299, SOUTHTOWN QLD 4350
Mob: 0447 763 852
Email: admin@grf.org.au – Web: www.grf.org.au/
Chairman: Damien Scanlan
Executive Officer: Meg Kummerow

Nuffield Australia

PO Box 1021, NORTH SYDNEY NSW 2059
Ph: 02 9463 9229
Email: enquiries@nuffield.com.au – Web: www.nuffield.com.au
Chief Executive Officer: Jodie Dean
Chairman: Andrew Fowler

Peanut Company of Australia

133 Haly Street, KINGAROY QLD 4610
PO Box 26, KINGAROY QLD 4610
Ph: 07 4162 6311 – Fax: 07 4162 4402
Email: peanuts@pca.com.au – Web: www.pca.com.au
Chief Executive Officer: John Howard

Plant Health Australia

Level 1, 1 Phipps Close, DEAKIN ACT 2600
Ph: 02 6215 7700 – Fax: 02 6260 4321
Email: info@phau.com.au – Web: www.planthealthaustralia.com.au
Chairman: Steve McCutcheon
Executive Director and CEO: Greg Fraser

Toll Free Exotic Plant Pest Hotline 1800 084 881

Pulse Australia Ltd

Level 10, Farrer House 24–28 Collins Street, MELBOURNE Vic 3000
PO Box H236, AUSTRALIA SQUARE NSW 1215
Email: admin@pulseaus.com.au
Chief Executive Officer: Nick Goddard, Ph: 02 8007 7553
Email: nick@pulseaus.com.au – Web: www.pulseaus.com.au
Industry Development Managers:
Northern region (Qld & northern NSW)
Paul McIntosh, Mob: 0429 566 198 Email: paul@pulseaus.com.au
Southern region (central & southern NSW)
Phil Bowden, Mob: 0427 201 946 Email: phil@pulseaus.com.au

Ricegrowers' Association of Australia

NIP 37, Yanco Avenue, Leeton
PO Box 706, LEETON NSW 2705
Ph: 02 6953 0433 – Fax: 02 6953 3823
Email: rga@rga.org.au – Web: www.rga.org.au
President: Jeremy Morton
Executive Director: Graeme Kruger

Ricegrowers' Limited – trading as SunRice

NIP 37, Yanco Avenue, Leeton
Locked Bag 2, LEETON NSW 2705
Ph: 02 6953 0411 – Fax: 02 8916 8350
Email: mdelgigante@sunrice.com.au – Web: www.sunrice.com.au
Chairman: Laurie Arthur
Chief Executive Officer: Rob Gordon

Sustainability and Biosecurity Policy

18 Marcus Clarke Street, Canberra City
GPO Box 858, CANBERRA ACT 2601
Ph: 1800 900 090
Web: www.agriculture.gov.au

Tractor and Machinery Association of Australia

1743 Malvern Road, GLEN IRIS VIC 3146
Phone: 03 9813 8011 Fax: 03 9813 8055
Email: info@tma.asn.au – Web: www.tma.asn.au
Executive Director: Gary Northover

Grain Marketing & Handling Organisations

AWB

Ph: +61 3 9268 7200
Toll Free Grower Services Centre 1800 4 GRAIN (1800 447 246)
GPO Box 58, MELBOURNE VIC 3001
Email: growerservicecentre@awb.com.au – Web: www.awb.com.au

Cargill Australia

Ph: +61 3 9268 7200
GPO Box 58, MELBOURNE VIC 3001
Web: www.cargill.com.au

GrainFlow

Toll Free Grower Services Centre 1800 4 GRAIN (1800 447 246)
Web: www.grainflow.com.au

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Brian 0427 722 925 Graeme 0427 700 779 Ron 0427 293 653 Stewart 0457 922 001

GrainCorp Operations Ltd (Sydney)

Level 26, 175 Liverpool Street, SYDNEY NSW 2000
GPO Box A268, SYDNEY SOUTH NSW 1235
Ph: 02 9325 9100 – Fax: 02 9325 9180
Email: enquiries@graincorp.com.au – Web: www.graincorp.com.au
Chairman: Graham Bradley AM
CEO: Mark Plamquist

Viterra

Level 1, 186 Greenhill Road, Parkside SA 5063
GPO Box 1169, ADELAIDE SA 5001
Ph: 08 8304 5000 – Fax: 08 8231 1249 – Freecall: 1800 018 205
Email: viterra.aus@viterra.com – Web. www.viterra.com.au

Australian Grain Exporters Association (AGEA)

Australian Grain Exporters Association (AGEA)
PO Box 6156, Highton Vic 3216
Executive Officer: Ian Desborough
Ph: 0418 853 881
Email: agea@agea.com.au – Web: www.agea.com.au
President: Lyndon Asser

CBH Group

Gayfer House,30 Delhi Street, WEST PERTH WA 6005
Toll Free Grower Service Centre 1800 107 759 (SA, NSW, VIC, QLD)
Ph: 08 9237 9600
Web: www.cbh.com.au

Australian Securities Exchange (ASX) Limited

20 Bridge Street, Sydney
PO Box H224, AUSTRALIA SQUARE NSW 1215
Ph: 02 9227 0197 – Fax: 02 9227 0667
Email: grainfutures@asx.com.au Web: www.asx.com.au/grainfutures
Enquiries: Kristen Hopkins, Manager, Commodities Sales

Grain standards/rules/contracts

Grain Trade Australia Ltd

PO Box R1829, Royal Exchange, NSW 1225
Level 7, 12–14 O'Connell Street, SYDNEY NSW 2000
Ph: 02 9235 2155 – Fax: 02 9235 0194
Email: admin@graintrade.org.au – Web: www.graintrade.org.au
Chief Executive Officer: Pat O'Shannassy

Grower Groups

AgVance Farming Pty Ltd

172 Henry Street, QUIRINDI NSW 2343
Ph: 02 6746 2336

Birchip Cropping Group Inc. (BCG)

PO Box 85, BIRCHIP Vic 3483
Ph: 03 5492 27873
Email: info@bcg.org.au – Web: www.bcg.org.au
Chief Executive Officer: Chris Sounness

Central West Farming Systems

1 Fifield Road/PO Box 171, CONDOBOLIN NSW 2877
Chief Executive Officer: Di Parsons
Ph: 02 6895 1007 – Mob: 0408 655 205 – Fax: 02 6895 2688
Email: diana.parsons@dpi.nsw.gov.au

Conservation Agriculture & No-till Farming Association (CANFA)

PO Box 2014, DUBBO NSW 2830
Chair: Gavin Tom
Ph: 0428 621 075 – Email: gaveltom@hotmail.com
Secretary: Anne Williams
Ph: 02 6825 6212 – Mob: 0428 177 225
Email: magomadine2@bigpond.com
Treasurer: John Shepherd
Ph: 02 6882 4723 – Mob: 0414 661 445
Email: john@canfa.com.au – Web: www.canfa.com.au

Conservation Farmers Inc (CFI)

266 Margaret Street, TOOWOOMBA QLD 4350
PO Box 1666, TOOWOOMBA QLD 4350
Ph: 07 4620 0146 – Fax: 07 4641 7460
Email: office@cfi.org.au – Web: www.cfi.org.au
Executive Officer: Bernard O'Brien

Corrigin Farm Improvement Group Inc. (CFIG)

PO Box 2, CORRIGIN WA 6375
Group Coordinator: Veronika Crouch
Mob: 0476 046 100
Email: cfig@cfig.asn.au – Web: www.cfig.asn.au

Eyre Peninsula Agricultural Research Foundation (EPARF)

SARDI, Minnipa Agricultural Centre
Box 31, MINNIPA SA 5654
Executive Officer: Dot Brace
Ph: 08 8680 6200 – Fax: 08 8680 5020
Email: eparf31@gmail.com

Facey Group

40 Wogolin Rd, WICKEPIN WA 6370
PO Box 129, WICKEPIN WA 6370
Ph: 08 9888 1223
Email: admin@faceygroup.org.au – Web: www.faceygroup.org.au
Executive Officer: Sarah Hyde

FarmLink Research Limited

361 Trungley Hall Road, TEMORA NSW 2666
PO Box 521, TEMORA NSW 2666
Ph: 02 6980 1333 – Fax: 02 6978 1290
Chief Executive Officer: Cindy Cassidy
Email: farmlink@farmlink.com.au – Web: www.farmlink.com.au

Grain Growers Limited

Level 19, 1 Market Street, SYDNEY NSW 2000
PO Box Q1355, QUEEN VICTORIA BUILDING NSW 1230
Freecall 1800 620 519 – Ph: 02 9286 2000 – Fax: 02 9286 2099

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Email: enquiry@graingrowers.com.au
Web: www.graingrowers.com.au
General Manager – Policy & Innovation: David McKeon
General Manager – Industry Development: Michael Southan

Grain Orana Alliance Inc (GOA)

PO Box 2880, DUBBO NSW 2830
Ph: 0400 066 201
Email: admin@grainorana.com.au – Web: www.grainorana.com.au
Chief Executive Officer: Maurie Street

Grower Group Alliance (GGA)

PO Box 1081, BENTLEY DC, WA, 6983
Executive Officer: Annabelle Bushell
Ph: 08 6180 5759
Email: admin@gga.org.au – Web: www.gga.org.au

Hart Field Site Group Inc.

PO Box 939, CLARE SA 5453
Ph: 0427 423 154
Email: admin@hartfieldsite.org.au – Web: www.hartfieldsite.org.au
Chairman: Damien Sommerville
Mobile: 0417 850 587
Email: chairperson@hartfieldsite.org.au
Research & Extension Manager: Sarah Noack
Mobile: 0420 218 420
Email: trials@hartfieldsite.org.au
Executive Officer: Sandy Kimber
Mobile: 0427 423 154
Email: admin@hartfieldsite.org.au

Kondinin Group

Head Office: 613–619 Wellington Street, PERTH WA 6000
PO Box 78, LEEDERVILLE WA 6902
Free Ph: 1800 677 761 – Fax: 08 6263 9177
Web: www.farmingahead.com.au

Liebe Group

PO Box 340, DALWALLINU WA 6609
Ph: 08 9661 0570 – Fax: 08 9661 0575
Executive Officer: Bec McGregor
Email: admin@liebegroup.org.au – Web: www.liebegroup.org.au

Mallee Sustainable Farming Inc

Work Days: Mon-Thurs
1/2103 Fifteenth St, IRYMPLE VIC 3498
PO Box 843, IRYMPLE VIC 3498
Email: admin@msfp.org.au – Ph: 03 5024 5835
Web: www.msfp.org.au
Executive Officer: David Bone
Email: david.bone@msfp.org.au – Ph: 03 5024 5835

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www.the-gate.com.au the gate

MacKillop Farm Management Group (MFMG)

Limestone Coast, South Australia
PO Box 534, KEITH SA 5267
Executive Officer: Charlie Crozier
Ph: 0427 775 822
Email: ccrozier@mackillopgroup.com.au
Web: www.mackillopgroup.com.au

Mingenew Irwin Group

PO Box 6, MINGENEW WA 6522
Ph: 08 9928 1645 – Fax: 08 9928 1540
Email: admin@mig.org.au
Chief Executive Officer: Kathryn Fleay
Mob: 0427 281 007 – Email: ceo@mig.org.au
Web: www.mig.org.au

Northern Grower Alliance

Level 1, 292 Ruthven St, TOOWOOMBA Qld 4350
PO Box 78, Harlaxton Qld 4350
Ph: +61 7 4639 5344 – Email: admin@nga.org.au
Chief Executive Officer: Richard Daniel
Mobile: 0428 657 782 – Email: richard.daniel@nga.org.au
Web: www.nga.org.au

Partners in Grain Alliance

Web: www.partnersingrain.org.au

Riverine Plains Inc

PO Box 214, MULWALA NSW 2647
Ph: 03 5744 1713
Executive Officer: Fiona Hart
Email: info@riverineplains.org.au – Web: riverineplains.org.au

SANTFA (South Australian No-Till Farmers Association Inc)

PO Box 930, BERRI SA 5343
Admin contact: admin@santfa.com.au Fax: 08 8125 6502
Web: www.santfa.com.au
President: Sam Venning
Mob: 0427 200 879 – Email: president@santfa.com.au

South East Premium Wheat Growers Association (SEPWA)

PO Box 365, ESPERANCE WA 6450
Executive Officer: Niki Curtis
Ph: 08 9083 1152 – Fax: 08 9083 1100 – Mob: 0447 908 311
Email: eo@sepwa.org.au – Web: www.sepwa.org.au

Southern Farming Systems Ltd

23 High Street, INVERLEIGH, VIC 3321
Ph: 03 5265 1666 – Fax: 03 5265 1678
Email: office@sfs.org.au – Web: www.sfs.org.au
Chief Executive Officer: Jon Midwood
Email: jmidwood@sfs.org.au

SPAA Society of Precision Agriculture Australia Inc

PO Box 3490, MILDURA VIC 3502
Ph: 0437 422 000 – Fax: 1300 422 279
Email: info@spaa.com.au – Web: www.spaa.com.au
Executive Officer: Nicole Dimos
Email: nicole@spaa.com.au

SECTION 14 INDUSTRY AGENCIES
THIS SECTION BROUGHT TO YOU IN ASSOCIATION WITH
EXCEL Agriculture
Gyral 60 YEARS

Victorian No-Till Farmers Association (VNTFA)

17 Darlot Street, HORSHAM VIC 3402
PO Box 1397, HORSHAM VIC 3402
Ph: 03 5382 0422
Email: info@vicnotill.com.au – Web: www.vicnotill.com.au
Executive Officer: Kerry Grigg
Ph: 0429 820 429 – Email: Kerry@vicnotill.com.au

Walgett Special One Grain (WSOG)

58 Fox Street, WALGETT NSW 2832
PO Box 496, WALGETT NSW 2832
Ph: 1300 28 12 28
Email: admin@specialonegrain.com.au
Web: www.specialonegrain.com.au

WANTFA

Leeuwin Centre, CSIRO, 65 Brockway Rd, Floreat WA 6014
Private Bag 5, WEMBLEY WA 6014
Ph: 08 9383 7630
Email: admin@wantfa.com.au – Web: www.wantfa.com.au
Executive Director: David Minkey – Mob: 0417 999 304
Email: david.minkey@wantfa.com.au

West Midlands Group

3468 Dandaragan Rd, Dandaragan WA 6507
PO Box 18, DANDARAGAN WA 6507
Ph: 08 9651 4008
Email: admin@wmgroup.org.au
Executive Officer: Nathan Craig
Mob: 0438 924 208 – Email: nathan.craig@wmgroup.org.au

Yorke Peninsula Alkaline Soils Group

61–63 Main Street, MINLATON SA 5575
Ph: 08 8853 2241 – Fax: 08 8853 2269
Project and Funding Coordinator: Kristin McEvoy
Mob: 0400 283 015
Email: projects@alkalinesoils.com.au
Web: www.alkalinesoils.com.au

Government Grants

For special circumstances assistance administered by DAFF go to:

Web: www.agriculture.gov.au/ag-farm-food/drought

GrantsLINK (for assistance with federal grants for community projects) see:

Web: www.business.gov.au/assistance – Ph: 13 28 46

Section 15

Suppliers' Directory

AGRICULTURAL CHEMICALS
4Farmers – www.4farmers.com.au
Axial – Syngenta: www.syngenta.com
Boxer – Syngenta: www.syngenta.com
Cognito – Syngenta: www.syngenta.com
Deluge – Victorian Chemicals: www.vicchem.com
Dow AgroSciences: www.dowagro.com
Envoy – Victorian Chemicals: www.vicchem.com
FMC: www.fmccrop.com.au
Hasten – Victorian Chemicals: www.vicchem.com
Hot-Up – Victorian Chemicals: www.vicchem.com
Precept – Bayer CropScience: www.bayercropscience.com.au
Roundup Ultra Max – Sinochem: www.roundupag.com.au
Roundup PowerMax – Nufarm: www.nufarm.com.au
Sakura – Bayer: www.sakuraherbicide.com.au
Sharpen – BASF: www.agro.basf.com.au
Spray Seed – Syngenta: www.syngenta.com
Speedy 250 – Kenso: www.kenso.com.au
Valor – Sumitomo: www.sumitomo-chem.com.au
Velocity – Bayer CropScience: www.bayercropscience.com.au

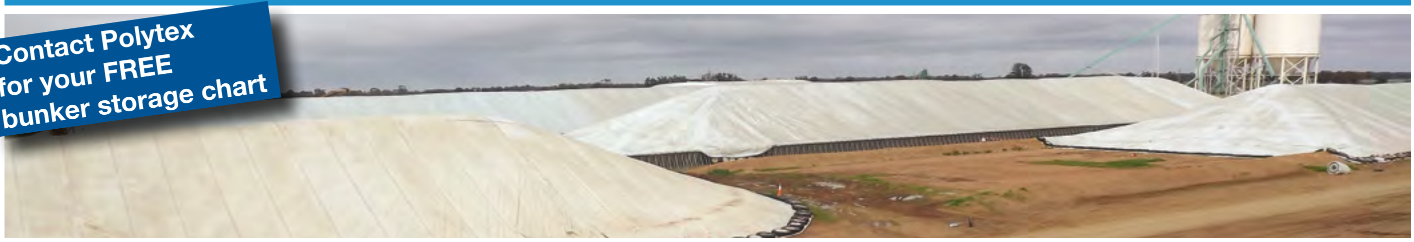
AG MACHINERY PARTS & TUNING
Australian Tuning: www.agritune.com.au
Big Tyre: www.bigtyre.com.au
Next Instruments: www.nextinstruments.net

CONTAINER RECYCLING
drumMuster: www.drummuster.com.au
Schuetz: www.schuetz.net

EDUCATION
C-Qual: www.c-qual.com
CSIRO: www.csiro.au
Kondinin Group: www.farmingahead.com.au

ELECTRONIC EQUIPMENT/PRECISION AG
Advanced Farming Systems – Case IH Agriculture: www.caseih.com
Agmaster: www.agmaster.com
Graintec Scientific: www.graintec.com.au
Infratec Sofia: www.foss.com.au/sofia
John Deere: www.johndeere.com.au
Outback Guidance: www.outbackguidance.com
Perten Instruments: www.perten.com

TARPAULINS FOR AGRICULTURE
BUNKER COVERS – GROUND SHEET – BIRD NETTING – SHELTERS – HAY COVERS
Contact Polytex for your FREE bunker storage chart



Phone: 1300 059 003 – Fax: 1300 858 626
Email: info@polytex.net.au
www.polytex.net.au
POLYTEX TARPAULINS

Sparex: www.sparex.com
TACS Australia: www.tacs.com.au
Trimble: www.trimble.com/agriculture

EMPLOYMENT
The Gate: www.the-gate.com.au 0408 717 459

ENERGY
Ergon: 1300 736 349
Essential Energy: www.essentialenergy.com.au
Mobile Energy: www.mobileenergyaustralia.com.au

FERTILISERS & SOIL HEALTH SERVICES
Amorsil – Nutrifert: www.nutrifert.com.au
BASF: www.basf.com.au
Bioag: www.bioag.com.au
Big N – Incitec Pivot: www.incitecpivot.com.au
Charlie Carp: www.charliecarp.com
EasyATS – Incitec Pivot: www.incitecpivot.com.au
Easy N – Incitec Pivot: www.incitecpivot.com.au
Evergol Prime – Bayer: www.evergolprime.com.au
Granulock – Incitec Pivot: www.incitecpivot.com.au
Hibrix: www.hibrix.com.au
Indigo Agriculture: www.indigoag.com
Microbials: www.microbials.com.au
Nutrilab: 07 4671 5155
Omnia Nutriology: www.omnia.net.nz
Phosyn Analytical: www.yaraphosyn.com
Superior Fertilisers: www.superiorfertilisers.com.au
Verno FG – Tanuki: www.tanuki.com.au
Victorian Chemicals: www.vicchem.com
Zinc – Yara: www.yara.com.au
Zincstar – Impact Fertilisers: www.impactfert.com.au

FINANCE & INSURANCE
NAB Agribusiness: www.nab.com.au
Achmea: www.achmea.com.au

GRAIN STORAGE & HANDLING
Aeration Control Australia: www.ia-group.com.au
Agridry: www.agridry.com.au
Agrishelter: www.agrishelter.com.au/
Ahrens: www.ahrens.com.au
Allied Grain Systems: www.alliedgrainsystems.com.au
Aurora: www.auroraagencies.co.nz
Convey-All: www.convey-all.com
CSW Chaser Bins: www.cswag.com.au
CustomVac: www.customvac.com.au
Cyclone Silos (One Steel): www.onesteelcyclone.com.au
Ellis & Son: Freecall 1800 808 769
Grainline Augers: www.grainline.com.au
Jaylon: www.jaylon.com.au
Kotzur: www.kotzur.com.au
LeverLink: www.leverlink.com.au
Polytex: www.polytex.net.au
SCT Logistics: www.sctlogistics.com.au
Tapex: www.tapex.com.au
Widespan Sheds: www.sheds.com.au
WRL Engineering: www.wrltoolboxes.com.au

HARVESTERS & COMBINES
Case IH Agriculture: www.caseih.com
Chesterfield: www.chesterfieldaustralia.com.au
Claas: www.landpower.com.au
John Deere: www.johndeere.com.au/combines
New Holland Agriculture: www.newholland.com

INSECT MANAGEMENT
AgBiTech: www.agbitech.com
Bioglobal: www.bioglobal.com.au
Helicovex – Organic Crop Protectants: www.ocp.com.au
Pyrinex Super – Adama: www.adama.com

IRRIGATION
Ezyflo Agricultural: www.ezyflo.net.au
Padman Stops: www.padmanstops.com.au
Valmont Irrigation: www.valley-au.com

LP GAS & FUEL
Lowes Petroleum: www.lowespetrol.com.au

MACHINERY MANUFACTURERS & DISTRIBUTORS
Case IH Agriculture: www.caseih.com
Claas: www.landpower.com.au
Flexicoil: www.flexicoil.com.au
John Deere: www.johndeere.com.au
Neil's Parts: www.neils.com.au
New Holland Agriculture: www.newholland.com

REAL ESTATE
Colliers International: colliers.com.au/agribusiness

SEED SUPPLIERS & PLANT BREEDERS
Australian Grain Technologies: www.ausgraintech.com
Canola Breeders: www.canolabreeders.com.au
Nufarm: www.nufarm.com.au
Nuseed: www.nuseed.com
Nuseed Roundup Ready Canola – Nufarm: www.nufarm.com.au
Roundup Ready Canola – Monsanto: www.monsanto.com.au
Seednet: www.seednet.com.au

SEED TREATMENT
Dividend – Syngenta: www.syngenta.com.au
Emerge – Syngenta: www.syngenta.com.au

SOIL & PLANT ANALYSIS
Phosyn: www.yaravita.com

SPRAYERS & SPRAYER EQUIPMENT
Case IH Agriculture: www.caseih.com
Croplands: www.croplands.com.au
Goldacres: www.goldacres.com.au
John Deere: www.johndeere.com.au
Simplicity Australia: www.simplicityaus.com.au

TILLAGE MANUFACTURERS & DISTRIBUTORS
Boss Engineering: www.bosseng.com.au
Bourgault: www.bourgault.com
C and C Machining: www.candcmachining.com
Case IH Agriculture: www.caseih.com
Excel Agriculture: www.excelagr.com.au
Farmgard: www.farmgard.co.nz
Flexicoil: www.flexicoil.com.au
Gessner Industries: www.gessner.com.au
Gyral: www.gyral.com.au
John Deere: www.johndeere.com.au
K-Line: www.k-line.net.au
Manutec: www.manutec.com.au
NDF: www.ndf.com.au
Serafin: www.serafinmachinery.com.au
The Davey Group: www.thedaveygroup.com.au

TANK CLEANERS
All Clear – Agnova: www.agnova.com.au

TRAVEL & RECREATION
Barcoo Ski Lodge – Victorian Alps ski and summer resort
Dinner Plain Central Reservations: 1800 670 019
Charlton's Tackle & Bait: 07 3818 1677
Greenmount Travel: 07 4659 3555 www.greenmounttravel.com.au

WEED MANAGEMENT AT HARVEST
Accufire: www.accufire.com.au

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