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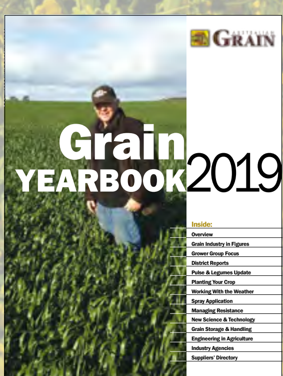

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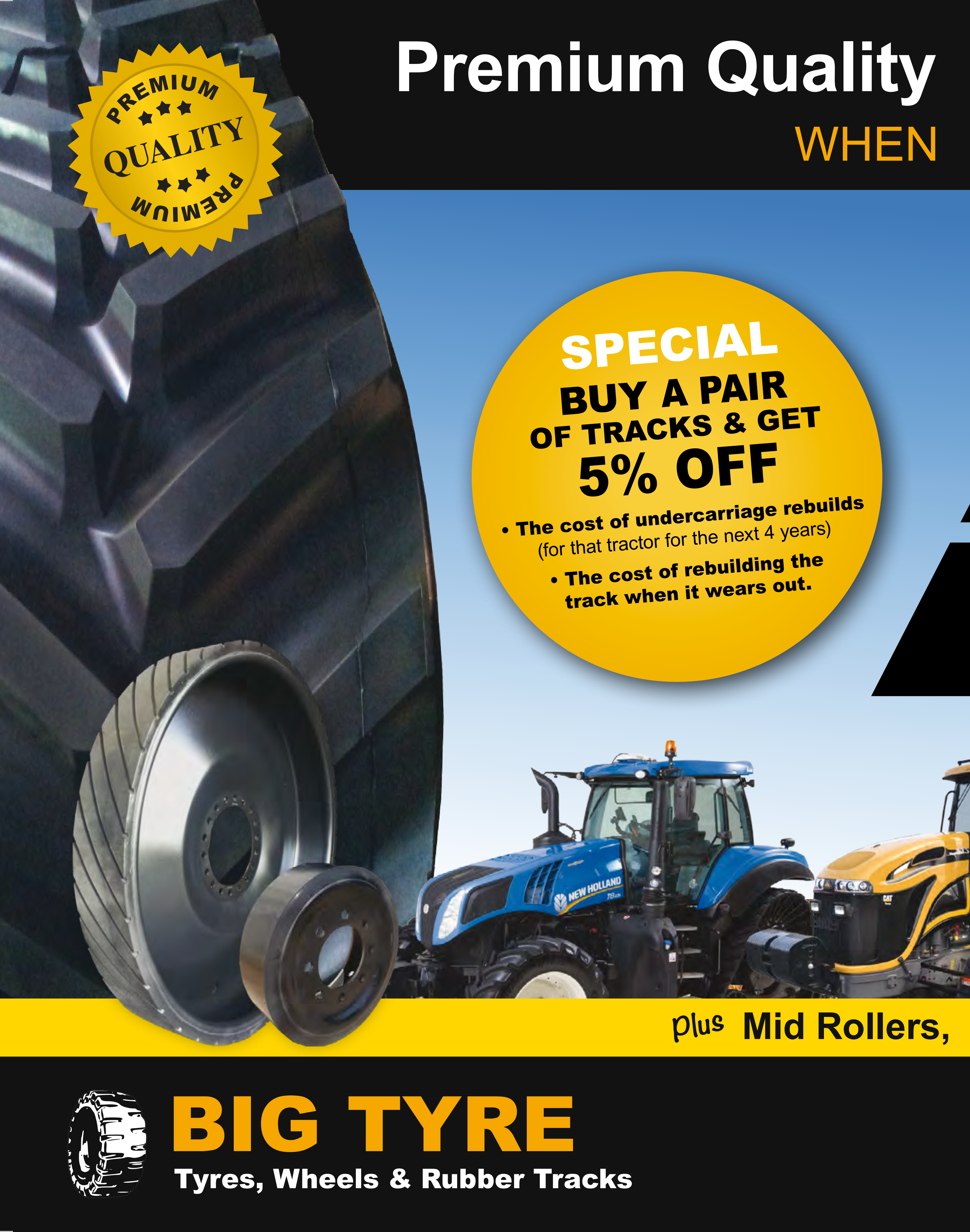
FRONT COVER – Emerging feed grain opportunities in South East Asia

Robert Fraser farms near Lake Bolac in Victoria's Western Districts. Robert has been growing dual purpose grain and graze crops (for example, Derrimut wheat pictured) for a number of years and looks forward to supplying feed grain into an emerging and expanding South East Asian market. See articles beginning on pages 19 & 34.



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Section 1

Overview

(PHOTO: Quenten Knight, Agronomy Focus)

CONTENTS

Australia area ('000 ha) and production ('000 tonnes) of major winter and summer crops planted for grain during 2018

	NSW		VIC		QLD		SA		WA		TAS		AUSTRALIA TOTAL	
2018–19	**Area**	**Prodn**	**Area**	**Prodn**	**Area**	**Prodn**	**Area**	**Prodn**	**Area**	**Prodn**	**Area**	**Prodn**	**AREA**	**PROD'N**
Wheat	1800	1800	1400	1950	400	400	1850	2950	4700	10,150	9	48	**10,159**	**17,298**
Barley	600	630	770	1100	70	95	820	1535	1750	4916	9	34	**4019**	**8310**
Oats (for grain)	200	140	130	140	39	21	47	80	215	500	3	7	**634**	**888**
Triticale	25	38	5	7	2	3	17	17	10	15	1	2	**60**	**82**
Sorghum#	150	375	1	2	385	924			1	2			**537**	**1303**
Maize#	18	162	1	6	30	159			2	12			**51**	**339**
Rice#	10	104											**10**	**104**
Canola	190	152	300	300	1	1	200	260	1200	1464	2	3	**1893**	**2180**
Sunflowerseed#	10	14			8	9							**18**	**23**
Soybean#	16	27	1	1	9	14							**26**	**42**
Peanuts#					6	17							**6**	**18**
Cottonseed#	174	524			106	297							**280**	**821**
Lupins	50	38	30	20			40	35	380	600			**500**	**693**
Field peas	39	29	50	35			70	50	20	38			**179**	**152**
Chickpeas	22	22	20	32	200	190	25	25	8	12			**275**	**281**
Faba beans	8	13	70	55	4	7	85	120	3	4			**170**	**199**
Mung beans#	34	21			68.0	66.0							**102**	**87**
Navy bean#					5	7							**5**	**7**
Lentils	7	5	125	105			160	200	11	13			**303**	**323**
TOTAL	**3353**	**4094**	**2903**	**3753**	**1333**	**2211**	**3314**	**5272**	**8300**	**17,726**	**24**	**94**	**19,227**	**33,150**

Estimate for summer crop harvested in 2019. Principal source: ABARES.

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

	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20 (forecast)
PRICES RECEIVED (excl GST)							
Wheat	159.8	151.7	140.1	117.1	142.9	150.0	156.4
Barley	167.9	175.6	159.0	123.6	177.6	215.4	223.0
Canola	144.1	130.6	137.9	145.0	140.1	148.7	155.7
Lupins	176.4	149.3	185.0	141.4	137.6	140.2	147.1
Oats	156.0	183.1	224.0	176.8	151.4	237.7	212.9
Sorghum	177.2	178.0	162.3	140.8	190.6	213.5	205.4
TOTAL GRAINS[a]	**149.9**	**147.0**	**141.9**	**122.9**	**143.6**	**157.8**	**160.1**
PRICES PAID (excl GST)							
Fuel & lubricants	221.1	207.9	167.9	175.7	198.2	214.8	209.8
Fertiliser	153.2	154.7	157.8	134.1	136.8	157.3	159.3
Chemicals	113.6	115.0	116.2	117.7	119.4	131.3	133.6
Seed	130.6	130.4	129.9	121.5	132.8	140.9	143.5
Electricity	185.7	176.4	178.9	181.9	200.1	204.3	208.9
Labour	163.5	166.3	168.6	171.5	174.8	178.4	182.5
Marketing	159.3	152.9	144.1	149.6	161.3	171.3	173.1
Interest paid	85.3	79.5	74.8	68.4	67.7	71.4	77.2
Insurance	195.2	198.5	201.3	204.7	208.7	213.0	217.8
Capital items	161.5	164.4	166.9	169.8	173.1	176.7	180.7
TOTAL PRICES PAID[b]	**147.3**	**145.5**	**143.5**	**143.2**	**147.7**	**154.1**	**157.9**
TERMS OF TRADE	**101.8**	**101.0**	**98.9**	**85.8**	**97.2**	**102.4**	**101.4**

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 Amelia Brown, ABARES

AT A GLANCE…

- The world wheat indicator price is forecast to increase by 1 per cent to US$242 per tonne in 2019–20.

Prices to increase before falling over the medium term

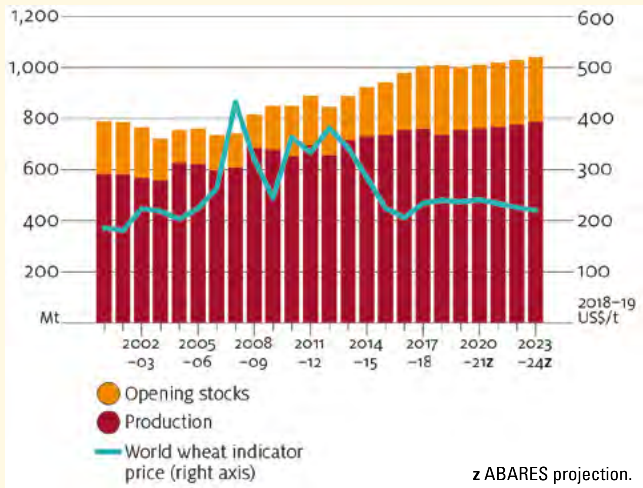
The world wheat indicator price (US no.2 hard red winter, fob Gulf) is forecast to average US$242 per tonne in 2019–20 – largely unchanged from the 2018–19 price. Despite a slight rise in global production, a decrease in stocks in major wheat-exporting countries is forecast to reduce tradeable supplies.

Over the medium term to 2023–24, world import demand for wheat is expected to continue increasing in line with population growth, changing diets and rising incomes. But prices are projected to fall gradually (in real terms) over the remainder of the projection period because of expected production increases in Argentina, the Black Sea region and India.

This is likely to result in world supply growing faster than demand.

World wheat production is forecast to increase between 2019–20 and 2023–24. World wheat prices are forecast to remain historically low over the same period.

World wheat supply and price, 2000–01 to 2023–24



z ABARES projection.

World production to increase over the medium term

In 2019–20 world wheat production is forecast to increase by 3 per cent to 755 million tonnes. This assumes average seasonal conditions in major wheat-producing countries. It also reflects small increases in areas planted and average yields in Australia, northern Europe and parts of the Russian Federation that were affected by dry conditions in 2018–19.

In 2023–24 production is expected to increase to 787 million tonnes, 7 per cent higher than in 2018–19. India is expected to continue to increase area planted to wheat in response to government policies that support increased wheat production. Area planted is also expected to increase in Argentina, where a reduction in export taxes has increased profitability of wheat production.

Area planted in other major producers is expected to remain relatively flat with increases in production to come from long-term productivity growth – particularly in Kazakhstan and parts of the Russian Federation, where average yields are comparatively low.

Australian planting to be determined by seasonal break

Area planted to wheat in Australia in 2019–20 will be highly dependent on rainfall. Prolonged drought conditions across eastern Australia led to extremely low soil moisture levels during the summer of 2018–19. Adequate and timely rainfall will be required for area planted to wheat to recover from the low levels of 2018–19.

High domestic grain prices are forecast to continue into 2019–20 until production levels become more certain. Domestic grain stocks are low following the drought-affected 2018–19 crop. Over the medium

Table 1: Australia and world outlook for wheat

	unit	2016–17	2017–18s	2018–19f	2019–20f
World					
Area	million ha	222	221	217	222
Yield	t/ha	3.4	3.5	3.4	3.4
Production	Mt	753	763	735	755
Consumption	Mt	735	738	747	754
Closing stocks	Mt	244	269	250	250
Trade	Mt	177	179	174	176
Stocks-to-use ratio	%	33.2	36.4	33.4	33.2
Price[a] – nominal	US$/t	197	229	240	242
Australia					
Area	'000 ha	12,191	12,237	10,159	12,141
Yield	t/ha	2.6	1.7	1.7	2.0
Production	kt	31,819	21,244	17,298	23,918
Export volume[c]	kt	22,057	15,492	10,152	14,210
Export value[c] – nominal	A$m	6,094	4,672	3,630	5,248
APW 10 net pool return – nominal	A$/t	268	308	348	344

a US no. 2 hard red winter wheat, fob Gulf, July–June. **b** In 2018–19 US dollars. **c** July–June years. **f** ABARES forecast. **s** ABARES estimate.
Sources: ABARES; Australian Bureau of Statistics; International Grains Council; US Department of Agriculture

Current season wheat planting intentions will be highly dependent on May–June rainfall. Over the medium term, planted wheat area for Australia is estimated to be around 12 million hectares.

term, area planted to wheat is forecast to return to pre 2018–19 levels of around 12 million hectares.

If there were favourable seasonal conditions leading into the 2019–20 planting window this would be likely to lead to above average area planted to wheat – reflecting a reduction in livestock numbers and greater availability of fallow land.

Wheat demand linked mainly to population growth

World wheat consumption is forecast to increase in 2019–20 and over the medium term due to increases in consumption of milling wheat and feed wheat.

Demand for milling wheat is projected to increase as a result of population growth, changing diets and rising incomes – particularly in developing countries. Milling wheat has few substitutes so the quantity demanded is relatively unresponsive to price changes.

But the demand for feed wheat is much more price sensitive. Global demand for all feed grains, including wheat, is projected to rise in the medium term because of projected higher meat and dairy production. But consumption of feed wheat will be determined by its competitiveness with substitute feed grains, particularly corn.

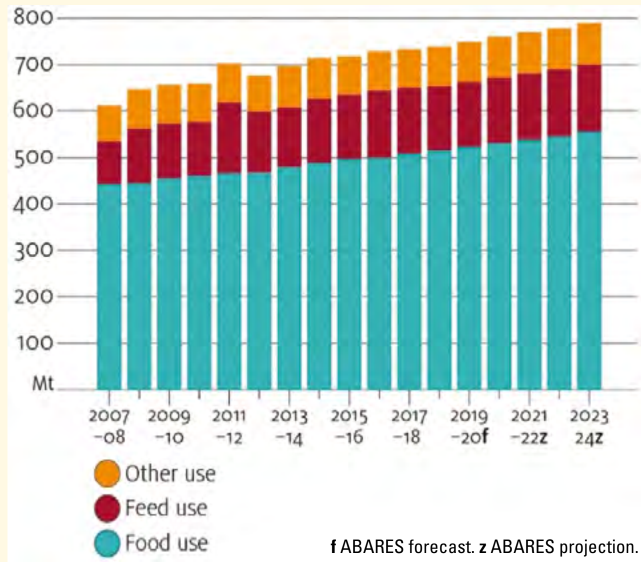
World wheat demand is forecast to grow between 2019–20 and 2023–24. Around two thirds of demand is made up of food use. Feed use makes up the majority of the remaining third.

World wheat trade to continue to break records

The volume of wheat traded is forecast to rise in 2019–20 to 176 million tonnes. This mainly reflects increased milling wheat imports by Asia, the Middle East and North Africa.

Recent export trends indicate that Black Sea wheat is gaining

World wheat demand, 2007–08 to 2023–24



f ABARES forecast. **z** ABARES projection.

acceptance in more price-conscious Asian markets such as Indonesia, Australia's biggest export market. But Black Sea wheat is unlikely to substitute for Australian wheat until its quality and protein content improve.

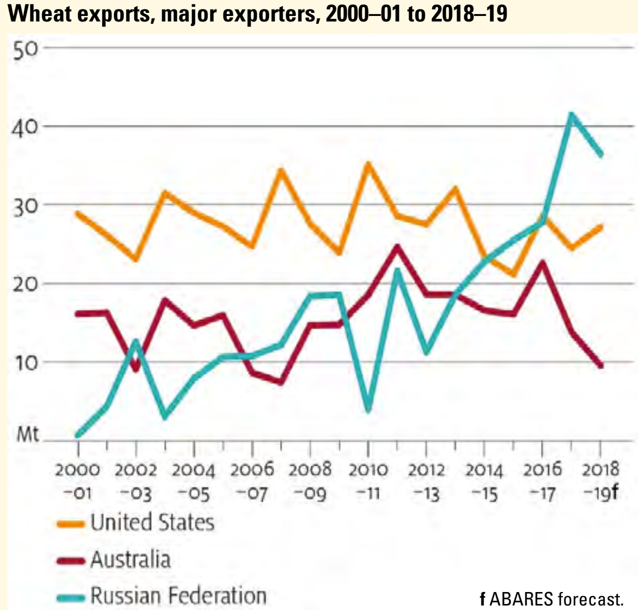
High-quality, high-protein milling wheat is used in noodles and high-end bakery products. Australia, Canada and the United States have historically produced wheat for these products, but improved varieties and management could lead to its production by other nations.

Demand for Black Sea wheat may also be affected by uncertainty about reliability of supply because the Russian Federation has previously restricted exports during drought.

Russian wheat exports dominating world trade

During the first half of the 2018–19 marketing year, Russian wheat exports were at record levels despite an estimated 12 million tonne (16 per cent) fall in production. This followed record production and exports in 2017–18.

Wheat exports, major exporters, 2000–01 to 2018–19



f ABARES forecast.

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The Russian Federation has a significant proximity advantage to many key export destinations relative to other major exporters like Australia and the United States. It also plans to maintain competitiveness by subsidising transportation to port by rail from distant regions between February and September 2019. It is unclear how long this policy will persist since exportable supplies are falling.

In the 10 years to 2017–18 Russian wheat production rose by 42 per cent, reaching a record 85 million tonnes. Favourable seasonal conditions boosted yields in 2017–18 but production fell in 2018–19, reflecting closer to average seasonal conditions.

Increased fertiliser use in recent years has led to increased yields, particularly in southern regions. According to the Ministry of Agriculture of the Russian Federation, fertiliser application increased by 33 per cent from 2013 to 2017. But average yields are still below those of other major producing countries like Canada, Ukraine and the United States.

Russian fertiliser application rates are estimated to be around half the world average but expected to continue rising over the medium term, particularly in regions where application rates are still very low.

Russian wheat exports increased significantly between 2000–01 and 2017–18 to a record 41 million tonnes. Over the same period US wheat exports fell.

Advances in farming practices and varieties are vital but the most important determinants of grain yield are rainfall and temperature.

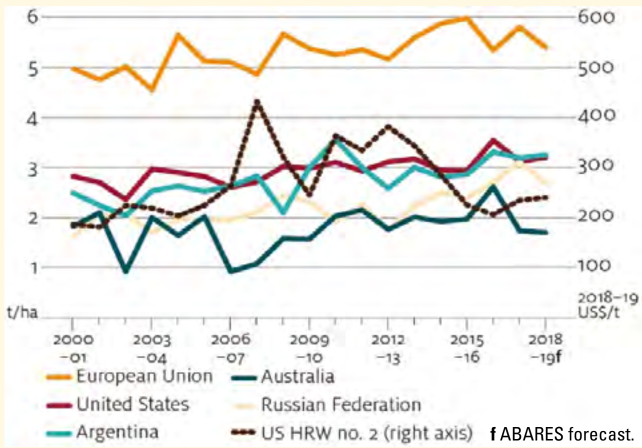
Opportunities and challenges

Climate variability and its impact on prices

A significant proportion of global yield increases are a result of technological advances in genetics and farming practices. But seasonal conditions are the major influencer of agricultural production.

Increasingly variable climatic conditions are likely to affect wheat yield trends. Further advances in wheat varieties and adoption of improved land and farm management practices will result in productivity gains. Rainfall and temperatures will continue to be the most important determinants of yield.

Average wheat yields and prices, 2000–01 to 2018–19



In the absence of long-term forecasts, ABARES assumes average seasonal conditions in major producing countries for its medium-term outlooks. But significantly above or below average seasonal conditions would be expected for at least one major producer during the next five years. World wheat markets are likely to be more sensitive to climate variability because the stocks-to-disappearance ratio for major exporters is projected to fall.

A fall in availability of exportable supplies combined with poor seasonal conditions, would be likely to result in a sharp response in world prices. This represents an upside risk for ABARES projections for the world wheat price. For example, in 2012–13 below average seasonal conditions resulted in a fall in yields in Argentina, Australia, the European Union and the Russian Federation, contributing to a 13 per cent increase in the world indicator price

Average wheat yields in major producing countries are highly variable from year to year depending on seasonal conditions. Low-yielding years tend to correspond with price increases. For example, in 2012–13 a fall in yields in Argentina, Australia, European Union and the Russian Federation corresponded with a 13 per cent increase in price

Argentina's record wheat crop to compete with Australian exports

In 2018–19 Argentine wheat production reached record levels. It surpassed Australian production for the first time since 2007–08, partly because Australian production was drought affected. Argentina's exportable supplies in 2018–19 will be competitively priced due to the depreciation of the Argentine peso. This low-cost wheat from Argentina is likely to compete strongly with Australian wheat exports, particularly in price-conscious Asian markets.

Over the medium term, Australia and Argentina are likely to experience either significantly above or below average seasonal conditions – resulting in fluctuating exportable supplies. Argentina will need to demonstrate it can reliably supply high-quality wheat if it is to effectively compete with Australia and maintain market share in key export markets.

ABARES 2019, Agricultural commodities: March quarter 2019. ■

Domestic and global coarse grain outlook

By Benjamin Agbenyegah and Nathan Pitts, ABARES

AT A GLANCE…

- The world coarse grains indicator price is forecast to rise by 3 per cent to US$228 per tonne in 2019–20.

Australian outlook

The drought affecting eastern Australia has reduced coarse grain production substantially and increased livestock feed use. In 2018–19 Australian production is forecast to have fallen by 9 per cent and exports of coarse grains by 5 per cent. Barley production is estimated to have fallen by 7 per cent to 8.3 million tonnes. Low soil moisture levels in New South Wales and Queensland resulting from an unfavourable growing season reduced grain sorghum production to 1.3 million tonnes.

In 2019–20 Australian coarse grain production is forecast to rise by 15 per cent to around 13 million tonnes, driven by an expansion in grain sorghum planting. Assuming improved seasonal conditions, barley production is forecast to increase by 6 per cent to 8.8 million tonnes and grain sorghum by 50 per cent to 2.0 million tonnes.

Over the medium term, Australian coarse grain production is projected to increase by 1.7 per cent per year to reach 13.4 million tonnes by 2023–24. Barley production is projected to reach 9.4 million tonnes and grain sorghum 2 million tonnes by 2023–24.

Exports of barley and grain sorghum are expected to increase, in line with production.

World outlook

Demand for feed and industrial use to increase prices

The world indicator price for barley (France feed barley, fob Rouen) is forecast to average higher in 2019–20 and continue to increase over the medium term to 2023–24. This is because growth in world supply is expected to be lower than growth in demand for feed and industrial use.

The world corn indicator price (US no. 2 yellow corn, fob Gulf) is also forecast to rise over the medium term, underpinned by strong demand growth in China.

Feed and industrial use to drive corn consumption

World coarse grain consumption is forecast to increase to a record high in 2019–20 and to continue to increase over the medium term. Growing populations and rising per capita incomes in emerging and developing economies are driving an increase in global meat consumption. Ongoing strong demand from livestock industries will increase the use of coarse grains for feed.

Demand for coarse grains is also being bolstered by biofuel policies that continue to encourage substitution of ethanol for fossil fuels.

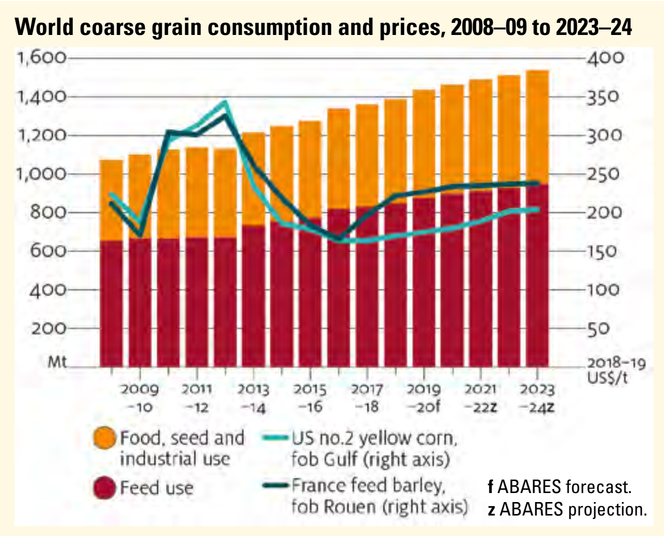
Forecast increases in world prices reflect growth in world coarse grain consumption. In 2018–19 world barley prices are expected to rise to US$233 per tonne in real terms and consumption to around 1.4 billion tonnes.

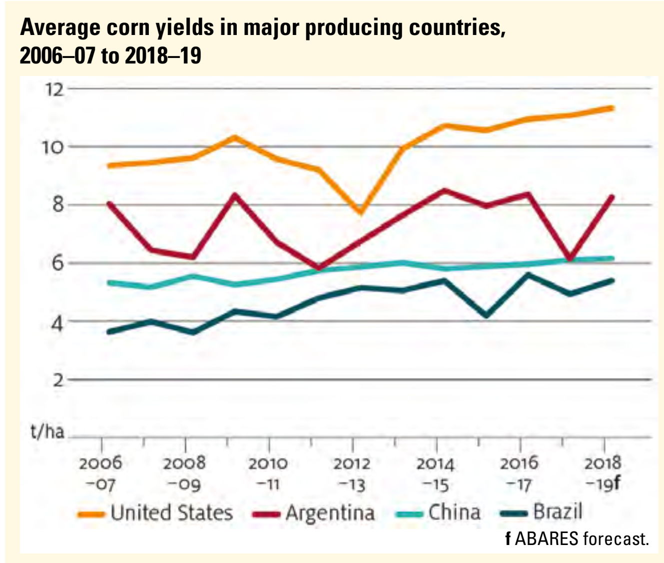
The demand for ethanol in China is expected to rise following the September 2017 announcement of a nationwide ethanol blending mandate. This is estimated to require 40 million tonnes of corn per year, drawn from Chinese reserves. Over the medium term, the effect of this policy on world prices will be marginal because China is not a major importer of corn. It is unclear if the blending mandate will change as China's corn stocks fall. If Chinese corn stocks are depleted, the policy would oblige China to import significant volumes of corn or ethanol, and put upward pressure on global corn prices.

Table 1: Outlook for coarse grains

	unit	2016–17	2017–18s	2018–19f	2019–20f
World					
Area	million ha	337	326	325	334
Yield	t/ha	4.2	4.2	4.2	4.1
Production	Mt	1,414	1,357	1,373	1,381
corn	Mt	1,212	1,076	1,099	1,092
barley	Mt	147	144	143	144
Consumption	Mt	1,353	1,374	1,400	1,436
corn	Mt	1,059	1,088	1,118	1,144
barley	Mt	149	148	141	147
Closing stocks	Mt	384	370	356	306
Trade	Mt	199	186	201	211
Stocks-to-use ratio	%	28.4	26.9	25.4	21.3
Corn price[a] – nominal	US$/t	157	160	170	179
Barley price[c] – nominal	US$/t	158	192	222	228
Australia					
Area total	'000 ha	6,359	5,285	5,300	5,582
Production total	kt	17,352	11,991	10,921	12,522
Export volume	kt	10,760	8,824	8,402	8,908
Export value – nominal	A$m	2,821	2,577	2,981	3,201
Price – nominal					
feed barley[e]	A$/t	174	253	291	300
malting barley[g]	A$/t	188	262	354	370
grain sorghum[h]	A$/t	238	323	361	348

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.





In 2018–19, global barley consumption is expected to fall due to lower production from major exporters and higher global prices. Barley consumption is forecast to recover in 2019–20 to 147 million tonnes, as availability improves with an assumed return to average seasonal conditions in major exporters. Consumption growth over the medium term will be driven by increasing demand for beer in Asia.

Production to partially meet growing demand

World production of coarse grains is forecast to remain largely unchanged in 2019–20. Falling Chinese corn production will be offset by increases in barley production in Australia, the European Union and the Russian Federation. In the short term, Chinese farmers are expected to shift towards producing soybeans rather than corn in response to higher Chinese import tariffs on US soybeans. Barley yields in Australia, the European Union and the Russian Federation are expected to recover as seasonal conditions improve after a poor 2018–19 season.

Over the medium term, world coarse grain production is projected to increase by under 2 per cent per year to around 1.5 billion tonnes by 2023–24. This is well below the 4 per cent annual growth rate in the 10 years to 2016–17. Higher barley production is expected in Australia, Canada, the Russian Federation and Ukraine in response to projected higher prices.

World corn production is projected to increase over the medium term because of an expansion in area planted, particularly in Argentina, Brazil, China and the US. This area expansion is subject to some uncertainty and will be affected by the relative profitability of cropping alternatives – particularly soybeans. Global yields are expected to increase only slightly, with minimal increases in Argentina, Brazil and China. In the US, yields are projected to follow trend growth.

Average corn yields in the US are relatively higher than those in Argentina, Brazil and China. Brazilian yields are the lowest among the world's major producing countries.

World barley price is forecast to trend upwards on the back of increased global demand for feed and industrial uses.

Challenges and opportunities

Climate variability and yields

Projected production growth over the outlook period assumes average seasonal conditions will prevail in the world's major coarse grain-producing countries. Most of the world's coarse grains are rain fed and production varies with seasonal conditions. Increased climate variability adds additional uncertainty to the production outlook.

Australian GM policies and export competitiveness

The Office of the Gene Technology Regulator has not issued any licences to grow GM coarse grain varieties in Australia, and some states and territories ban cultivation of all GM crops. As a result, Australia is less competitive with nations that have adopted the more productive GM varieties. A 2018 study found that GM biotechnology was responsible for additional global production of 405 million tonnes of corn in the 21

years to 2017. This was largely from yield improvements in Argentina, Brazil and the US.

A 2017 Productivity Commission inquiry into the regulation of agriculture recommended that state and territory governments end these moratoriums. This recommendation was supported by the Australian government in January 2019. Consistent Australia-wide policies on GM crops and permission to cultivate GM coarse grains would increase domestic productivity. This would improve Australia's competitiveness in price-sensitive export markets.

US–China trade dispute and coarse grain markets

Ongoing trade tensions between China and the US present a significant downside risk to per capita incomes and consumer confidence in China. This could lead to a dampening of Chinese demand for meat, which is otherwise projected to increase over the medium term. Chinese consumption accounts for around 30 per cent of global meat consumption. Any softening in demand could affect global demand for coarse grains for feed use.

Chinese anti-dumping investigation

An adverse finding in the Chinese Ministry of Commerce anti-dumping or countervailing duty investigations could result in duties being imposed on imports of Australian barley. This would reduce the competitiveness of Australia's barley in the Chinese market over the medium term.

ABARES 2019, Agricultural commodities: March quarter 2019. ■

World corn production and area planted is expected to increase over the medium term in China, Brazil, Argentina and the US.

Domestic and global oilseeds outlook

By Benjamin Agbenyegah, ABARES

AT A GLANCE…

- The world canola indicator price is forecast to remain largely unchanged at US$443 per tonne in 2019–20.

Australian outlook

Canola production to remain relatively low

In 2018–19 Australian canola production is estimated to have fallen by 41 per cent to 2.2 million tonnes. The fall is largely driven by an estimated 31 per cent reduction in area planted, to 1.9 million hectares. In Western Australia, relatively stronger prices for barley resulted in farmers shifting from canola to barley. In New South Wales and Victoria, unfavourable seasonal conditions constrained plantings.

In 2019–20 canola production is forecast to increase to around 3.7 million tonnes because area planted and yields are expected to return to more average levels. Australian canola exports are forecast to increase in line with production. Over the medium term, Australian production is projected to remain at roughly 3.7 million tonnes.

World outlook

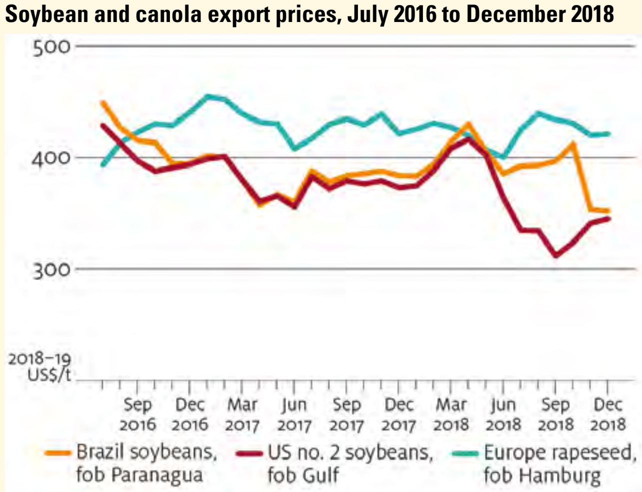
Oilseed prices to remain relatively low

In 2019–20 growth in the world supply of canola is expected to broadly align with demand. As a result, world canola prices are forecast to remain largely unchanged. Higher production is forecast in Australia, Canada and the European Union due to an expected expansion in area planted and some improvement in yields following hot and dry weather in 2018–19.

Over the medium term, canola prices are projected to fall until 2021–22 before rising moderately to US$430 per tonne (in real terms) in 2023–24. Despite the slight increase, prices remain lower than the 2018–19 forecast and well below the 10 year average to 2017–18 of US$535 per tonne (in real terms).

The world soybean indicator price (US no. 2 soybeans, fob Gulf) is forecast to fall by 8 per cent in 2018–19. This is due to the drop in Chinese demand resulting from the US–China trade dispute. The price is forecast to recover slightly in 2019–20, but projected record production

Soybean and canola export prices, July 2016 to December 2018



Source: International Grains Council.

Table 1: Outlook for oilseeds

	unit	2016–17	2017–18s	2018–19f	2019–20f
World					
Oilseeds					
Production	Mt	568	574	585	603
Consumption	Mt	549	571	584	600
Exports	Mt	170	168	169	170
Closing stocks	Mt	111	111	109	105
Indicator price **ba**	US$/t	389	385	355	362
Canola indicator price **bc**	US$/t	427	424	435	443
Protein meals					
Production	Mt	318	327	338	346
Consumption	Mt	311	333	332	341
Exports	Mt	88.0	88.0	90.0	92.4
Closing stocks	Mt	22.9	16.8	23.1	28.4
Indicator price **bd**	US$/t	348	325	310	323
Vegetable oils					
Production	Mt	185	195	200	202
Consumption	Mt	184	191	198	204
Exports	Mt	77.7	80.7	84.2	87.1
Closing stocks	Mt	19.7	23.7	25.9	23.9
Indicator price **be**	US$/t	837	850	784	817
Australia					
Oilseed production	kt	5,648	5,205	3,085	4,958
Oilseed exports	kt	3,923	2,494	1,926	2,839
Canola					
Area	'000 ha	2,681	2,729	1,893	2,690
Production	kt	4,313	3,669	2,180	3,685
Export volume **g**	kt	3,599	2,252	1,647	2,643
– nominal	A$m	2,128	1,306	952	1,638
Price **bi**	A$/t	530	512	553	569

a US no.2 soybeans, fob Gulf. **b** In 2018–19 US dollars. **c** Rapeseed, Europe, fob Hamburg, July–June. **d** Soybean meal, cif, Rotterdam, 45 per cent protein. **e** Soybean oil, Dutch, fob ex-mill. **f** ABARES forecast. **g** July–June. **h** In 2018–19 Australian dollars. **i** Delivered Melbourne, July–June. **s** ABARES estimate. **z** ABARES projection.
Sources: ABARES; Australian Bureau of Statistics; US Department of Agriculture.

To make up for the shortfall in protein meal as a result of China's trade dispute with the US, China turned to both Australia and Canada for extra canola imports.

in South America over the medium term will put downward pressure on prices. By 2023–24 the soybean price is expected to fall to US$347 per tonne (in real terms). If realised, this would be the lowest price since 2006–07.

At December 31, 2018, US soybeans were US$346 per tonne, Brazilian soybeans were US$349 per tonne and European canola was US$423 per tonne.

Demand driven by Chinese growth

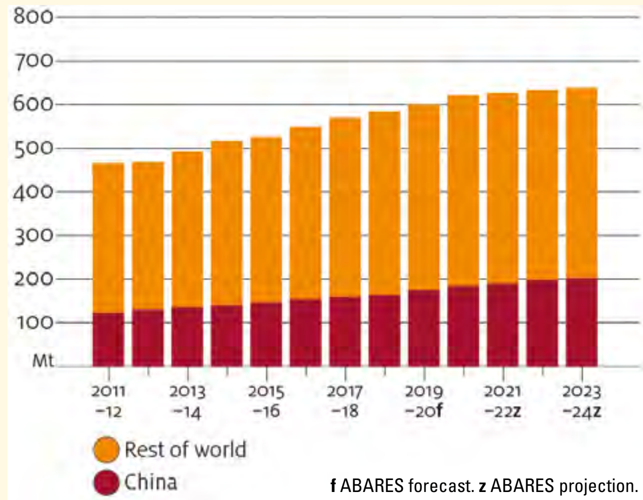
World oilseed consumption is forecast to rise, largely due to growing Chinese demand. Rising per capita income continues to lift Chinese demand for meat, resulting in increased demand for high-protein animal feed such as soybean meal. In the short term to 2019–20, a higher proportion of Chinese soybean consumption is expected to be sourced from ample domestic stocks rather than from increased imports.

At the beginning of 2018–19 China held around 25 per cent of world soybean stocks. Over the medium term, Chinese soybean consumption is projected to grow at 3.2 per cent per year to reach 128 million tonnes in 2023–24. Domestic supply is not projected to meet demand growth over this period, increasing demand for imports.

Population growth and rising incomes in other emerging and developing economies – particularly in the rest of Asia, Eastern Europe and the Middle East – will add to global demand growth.

Chinese oilseed consumption is projected to increase by 63 per cent from 2011–12 to 202 million tonnes in 2023–24. But world consumption is expected to rise by 20 per cent to 437 million tonnes during the same period.

World oilseed consumption, 2011–12 to 2023–24



f ABARES forecast. z ABARES projection.

Soybean trade diversion boosts canola exports

The 25 per cent additional tariff imposed by China on imports of US soybeans as part of the US–China trade dispute resulted in a significant drop in Chinese imports of US soybeans. This shortfall was only partially offset by increased imports from Argentina and Brazil. As a result, total Chinese soybean imports fell by 8 per cent in 2018. The fall in the world price of soybeans triggered by the trade dispute stimulated demand for US soybeans from the European Union and other countries.

To make up the shortfall of imported protein meal, China increased its imports of canola from Australia and Canada. In 2018–19 China's imports of canola are expected to rise by 19 per cent to 5.6 million tonnes. This stronger demand is expected to boost global imports of canola and rapeseed.

Oilseed production to grow in medium term

Global oilseed production is forecast to rise in 2018–19 to a record 585 million tonnes and a further 603 million tonnes in 2019–20. This increase will be dominated by expected increases in production in Argentina and Brazil. In contrast, world canola and rapeseed production are forecast to fall in 2018–19, following record production in 2017–18. Falling production is expected in Australia, Canada and the European Union because of reduced planted area and lower yields resulting from hot and dry conditions. In 2019–20 oilseed production is expected to rise due to area expansion and yield improvements.

Yields are assumed to return to more average levels provided growing conditions improve in Australia, Canada and the European Union.

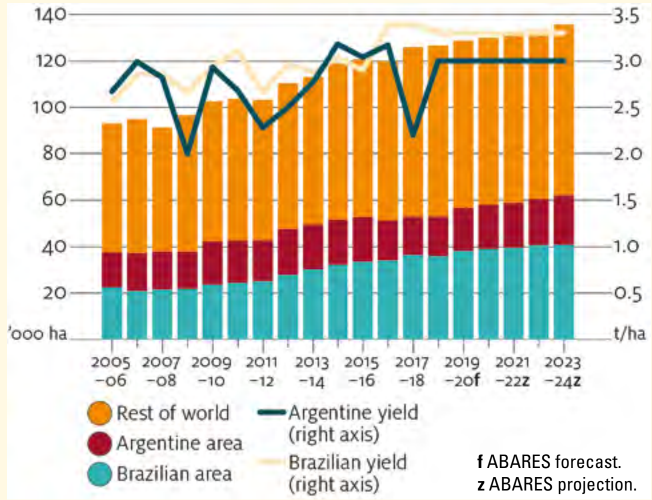
Although the world soybean price is projected to fall over the medium term, global oilseed production is projected to grow at an average of around 2 per cent per year to reach 638 million tonnes by 2023–24.

Increased soybean production in Argentina and Brazil will continue to drive this trend. Production increases are projected to occur largely through expanded planted area. This is because soybeans will remain relatively more profitable compared with alternatives such as corn. This is despite the Argentine government imposing an additional export tax of 28.5 per cent on soybeans and 25.8 per cent on both soybean meal and soybean oil until 2020.

Soybean yields in Argentina and Brazil are forecast to remain largely unchanged over the medium term because the uptake of the current generation of genetically modified soybean varieties is largely complete.

Relatively low prices and agronomic constraints are expected to result in limited growth in canola and rapeseed production in Canada, the European Union and India.

Soybean harvested area and average yield, Brazil and Argentina, 2005–06 to 2023–24



World soybean harvested area is projected to rise to around 135 million hectares in 2023–24, compared with 127 million hectares forecast in 2018–19. Soybean yields for Brazil and Argentina are projected to remain unchanged over the medium term.

The ongoing US-China trade dispute has lead to China importing more soybeans from Argentina and Brazil.

Challenges and opportunities

African swine fever poses downside risk

African swine fever has been spreading through China since August 2018. In the short term, the disease poses a high risk to forecast Chinese demand for animal feed. According to China's Ministry of Agriculture and Rural Affairs, at January 14, 2019 the disease had been recorded in pigs and wild boars in 24 provinces. The speed of the spread has slowed following restrictions on pig movements, but eradication of the disease in an industry comprised of around 26 million small-scale farmers presents a significant challenge for the Chinese government.

By mid-February 2019 more than 950,000 pigs had been culled through eradication programs. If the disease is not contained and the current rate of culling continues, China's pig population will be significantly reduced. This may lead to a fall in Chinese demand for animal feed.

US–China trade dispute distorting markets

US soybeans typically account for the majority of Chinese imports when the US marketing season commences in September. But in 2018 the ongoing US–China trade dispute resulted in US soybean prices being relatively higher for Chinese importers. In October 2018 Chinese soybean imports from the United States fell by 96 per cent to around 272,000 tonnes, compared with the same month in 2017.

But a significant increase in Chinese demand for South American soybeans has led to a rise in Argentine and Brazilian prices in 2018–19.

Chinese food and meal processors are substituting soybeans with other protein sources, including canola meal and dried distillers grains with solubles. As a result, China's canola imports are forecast to rise by 19 per cent in 2018–19 to 5.6 million tonnes, raising world exports to around 17 million tonnes. Any further escalation of the US–China trade dispute will negatively affect the price of and demand for soybeans. ■

ABARES 2019, Agricultural commodities: March quarter 2019.

Feed grains – a foothold for growth into South East Asia

By Rural Bank

By 2030, the spending power of Asia's middle class is expected to exceed that of the rest of the world combined. South Asia (including the Indian subcontinent) plays an important role in this growth story.

The feed grain deficit in South East Asian livestock markets is expected to increase by 10 million tonnes in the next decade and when combined with flour milling this deficit increases to 22 mt.

Trade with China tends to dominate discussion around the opportunities for Australian grain products in Asian markets. And, growth opportunities in India, Indonesia, Philippines and Vietnam should not be overlooked. There are also countries like Myanmar which, whilst small relative neighbouring economies, is expected to become next one million metric tonne ASEAN wheat importer.

But it is Indonesia that presents an interesting opportunity for Australian feed grain exports.

The partnership between Australia and Indonesia is a significant one, with a population in excess of 260 million people, Indonesia expected to become the world's seventh largest economy by 2030. In 2017–18 Australian wheat exports to Indonesia were valued at $1.4 billion.

Preferential trade agreement

An important component of the recently signed Indonesia-Australia Comprehensive Economic Partnership Agreement (IA-CEPA) for the Australian grains industry is the inclusion of a 500,000 tonne quota for the importation of feed grains from Australia. Feed grain imports are effectively banned under Indonesia's current import regulations. Australia will be the only country with formal access to the Indonesian feed grain market. So this new provision provides a significant opportunity for Australian feed grains, particularly feed barley.

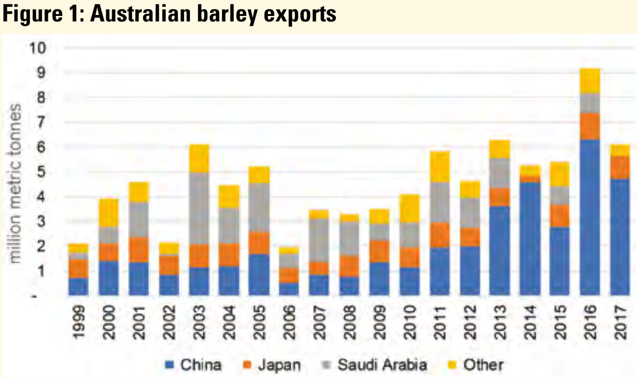
Over the 15 years to 2017, China's share of Australian barley exports has increased from 25 to 75 per cent making China a significant market for Australian barley (Figure 1). As China continues anti-dumping investigations into Australian barley imports, finding alternative markets for Australian feed barley has become increasingly important for the Australian grain trade.

Indonesia presents an opportunity for a alternative market for Australia's feed barley.

AT A GLANCE…

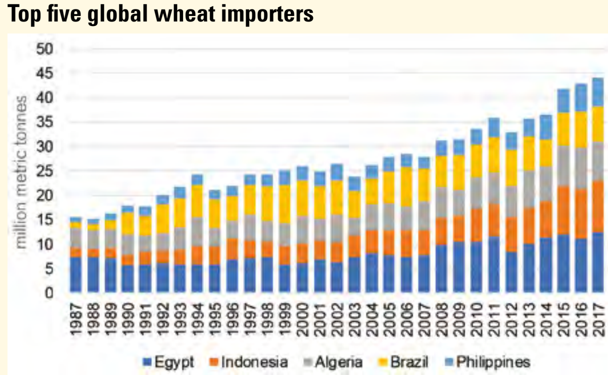
- The world oilseed indicator price is forecast to average lower in 2017–18, reflecting abundant stocks at the beginning of the year and another year of good harvests in major exporting countries.
- The recently signed Indonesia-Australia Comprehensive Economic Partnership Agreement (IA-CEPA) is a big opportunity for Australian grain growers;
- Indonesia's feed milling capacity exceeds the entire average Australian wheat crop, and a feed grain deficit across South East Asian livestock markets is expected to increase by 10 million tonnes into the next decade;
- The opportunity and challenge for Australian grain growers is to demonstrate how Australian feed grains can underpin its most affordable source of animal protein – poultry;
- Poultry products including eggs account for 64 per cent of Indonesia's animal protein consumption, and 95 per cent of the local stock feed requirement;
- The 500,000 metric tonne quota for Australian feed grains secured in the IA-CEPA provides a competitive advantage for Australian grain growers;
- Australia is the only country with approved access to the Indonesian feed grain market;
- Building on Australia's preferential access as a feed grain supplier to Indonesia – and connect into South East Asia with a middle class expected to exceed that of the rest of the world combined – we counter an over-reliance on trade into China;
- Indonesia is also a significant wheat consumer (see chart) with around 12 million tonnes of flour milling capacity;
- Australia is a major supplier of wheat into the Indonesian flour milling sector but this is being challenged by other exporters, particularly from the Black Sea region; and,
- The Australian grain industry must look at ways to increase market share by creating value rather than eroding it.

Figure 1: Australian barley exports



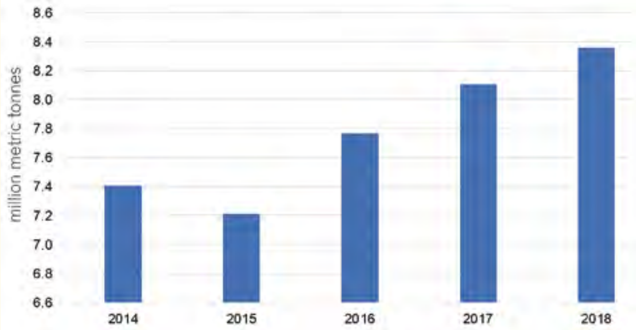
Source: Australian Crop Forecasters, ABS.

Top five global wheat importers



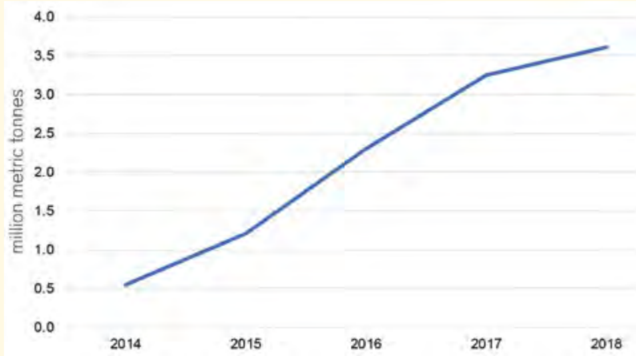
Source: US Department Agriculture.

Figure 2: Indonesian milling wheat consumption



Source: Indonesian Flour Mills Association.

Figure 3: Russian and Ukraine combined wheat exports to Indonesia



Source: AgriCensus.

As the most affordable source of animal protein in Indonesia, poultry plays an important role in local diets. Poultry products including eggs account for 64 per cent of Indonesia's animal protein consumption, and 95 per cent of the local stock feed requirement. Feed barley is effective in ruminant diets yet unlocking access to this market may require a level of education on the benefits of Australian feed barley and to best utilise it.

Indonesia is also a significant wheat consumer (Figure 2), with 11.8 mt of flour milling capacity in 2017 across 28 mills, up from only four mills in 1998. Indonesia plays an important role as a competitive supplier of flour to South East Asia, and exports of flour-based products are growing in both volume and value. As a major supplier of wheat to Indonesia's flour mills Australia plays an important role in the success of Indonesia's flour milling sector.

Australia's falling market share

Unfortunately, Australia's market share in Indonesia has fallen from 50 per cent to just 24 per cent in 2018, this loss is driven in part by increased competitiveness and availability of alternative products particularly from the Black Sea (Figure 3), and in part by successive years of below average crops and smaller exportable surpluses.

Growth in exports of Indonesia's wheat-based products, contributes to growth of accompanying products like palm oil, coconut sugar and chilli, thus supporting Indonesia's local agricultural industries. But Indonesia must remain competitive, and whilst local flour millers recognise the superior quality of Australian product competitive pricing remains important. Further improvements in the quality of wheat from regions like the Black Sea and improvements in Indonesia's understanding of alternative wheat sources remains an ongoing risk for Australian market share into Indonesia.

Indonesia is well known for its flour milling capability – it is also a significant consumer of feed grains. With 25.5 mt of feed milling capacity across 103 mills, Indonesia's feed milling capacity exceeds the entire average Australian wheat crop. In 2019, feed consumption across the livestock and aquaculture markets is expected to reach 20.4 mt, the majority of which supports the local poultry industry.

It is a great milestone to see the IA-CEPA signed, but Australia doesn't have the scale to be a sole supplier of grain to Indonesia and therefore must ensure activities to increase market share do so in ways that create value rather than eroding it.

Although Australia is well positioned geographically to meet some of this demand, some fear exists that Australia will need to find production gains in order to benefit from the full magnitude of the opportunity.

There is an undeniable opportunity for Australia to build on our economic partnership with Indonesia, and we look forward to seeing how the benefits unfold when the agreement comes into force. This is expected in late 2019. ■

Poultry is the most affordable source of animal protein in Indonesia and accounts for 95 per cent of the stockfeed consumed.

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 2018 for example, is an estimate for the crop harvested in the 2018–19 financial year.
- (Mt = 1,000,000 tonnes) (Kt = 1000 tonnes)

CONTENTS

The 2018 drought reduces national grain crop production to a 10-year low

Drought conditions in the eastern Australian states, including South Australia, decimated the 2018–19 national grain crop to a production level not seen since 2007. The winter crop is estimated to have decreased around 20 per cent on the previous season and is expected to tip the scales at about 30.4 million tonnes. Thanks to better than expected yields in Western Australia, national winter crop production for 2018–19 was above late-season expectations. But winter crop yields in other states were well below average resulting in significant falls in the production of all the major winter crops:

- Wheat fell by 19 per cent to 17.3 mt;
- Barley by 7 per cent to 8.3 mt; and,
- Canola by 41 per cent to 2.2 mt.

Amongst other winter crops, chickpea production is estimated to have fallen by 76 per cent to 281,000 tonnes and oats by 21 per cent to 888,000 tonnes.

Due to dry conditions at sowing, the winter crop area in 2018–19 is estimated to have fallen by 18 per cent to 18.2 million hectares.

The 2018–19 summer crop

Drier and warmer than average seasonal conditions in the cropping regions in Queensland and northern New South Wales during December and January 2018, reduced summer crop prospects for the 2018–19 season. Dryland summer crop plantings were reduced in the latter part of the sowing window as soil moisture levels and yield prospects declined.

The total area planted to summer crops is estimated to have decreased by 23 per cent to around 1.0 million hectares.

Total 2018–19 summer crop production is forecast to decrease by a third on the previous season to around 2.7 mt.

The total area planted to grain sorghum is estimated to have risen marginally in 2018–19 to 537,000 hectares. Late season planting was minimal because of low soil moisture levels and unfavourable seasonal conditions in Queensland.

Generally unfavourable conditions in most summer cropping regions are expected to constrain the average yield. Summer crop production in 2018–19 is forecast to fall by 9 per cent to 1.3 mt.

The area planted to cotton is forecast to have fallen by 44 per cent to 280,000 hectares. This is due to extremely low water levels in irrigation dams serving cotton-growing regions and low soil moisture levels preventing the planting of dryland cotton.

As a result, cotton lint and cottonseed production is forecast to fall by around 42 per cent on the previous season.

Rice production is forecast to fall by 83 per cent to 104,000 tonnes because of low water allocations and high water prices in southern NSW.

Source: ABARES *Australian Crop Report*, February 2019. ■

Australian canola production fell by more than 40 per cent in 2018–19.

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

Year	Unit	NSW	Vic	Qld	SA	WA	Australia
2009–10	kt	7787	5889	1617	7035	12,943	35,344
2010–11	kt	14,784	7625	1821	9316	8044	41,672
2011–12	kt	11,952	7352	2329	7371	16,600	45,670
2012–13	kt	11,123	6886	2156	6470	11,243	37,934
2013–14	kt	9773	6773	1516	7221	16,510	41,878
2014–15	kt	10,445	5117	1464	7439	14,662	39,197
2015–16	kt	11,624	3568	2104	6105	14,206	37,687
2016–17	kt	15,510	9513	3159	10,661	17,737	56,678
2017–18**s**	kt	7228	7652	1463	6945	14,619	37,963
2018–19**s**	kt	2867	3744	717	5273	17,712	30,406

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
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	712	3205	687	2250	1412	5505
2013–14	568	2317	559	1469	1139	3847
2014–15	435	2044	696	2134	1149	4263
2015–16	412	1656	624	1821	1054	3562
2016–17	662	2286	566	1280	1247	3667
2017–18**s**	614	2262	711	1814	1335	4103
2018–19**f**	419	1238	606	1475	1034	2743

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.

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5.78 m	*6.35 - 8.70 m*	*7.00 m*	*7.00 m*	*9.50 m*

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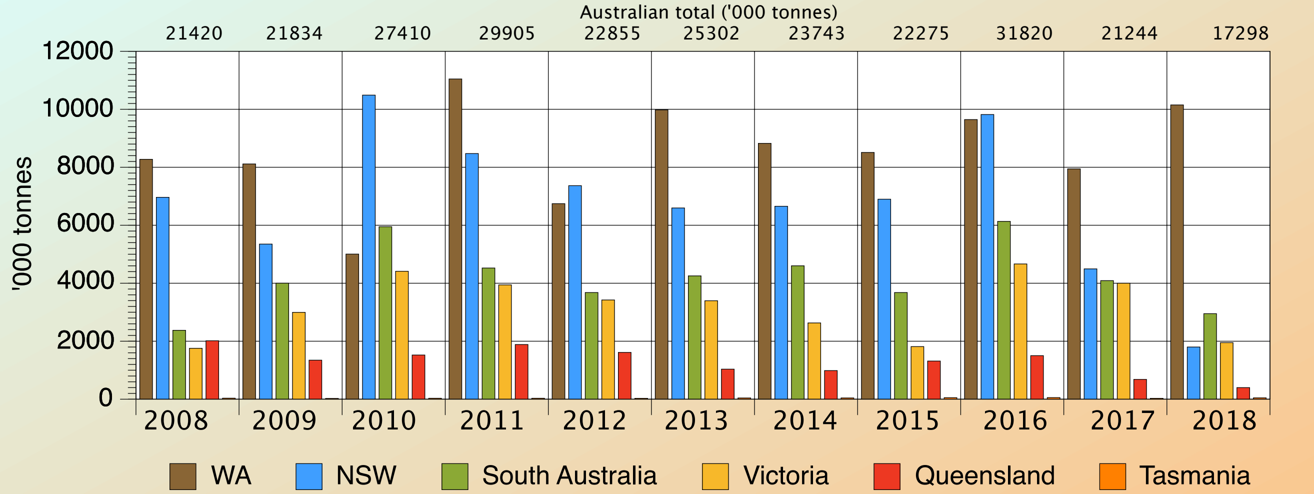
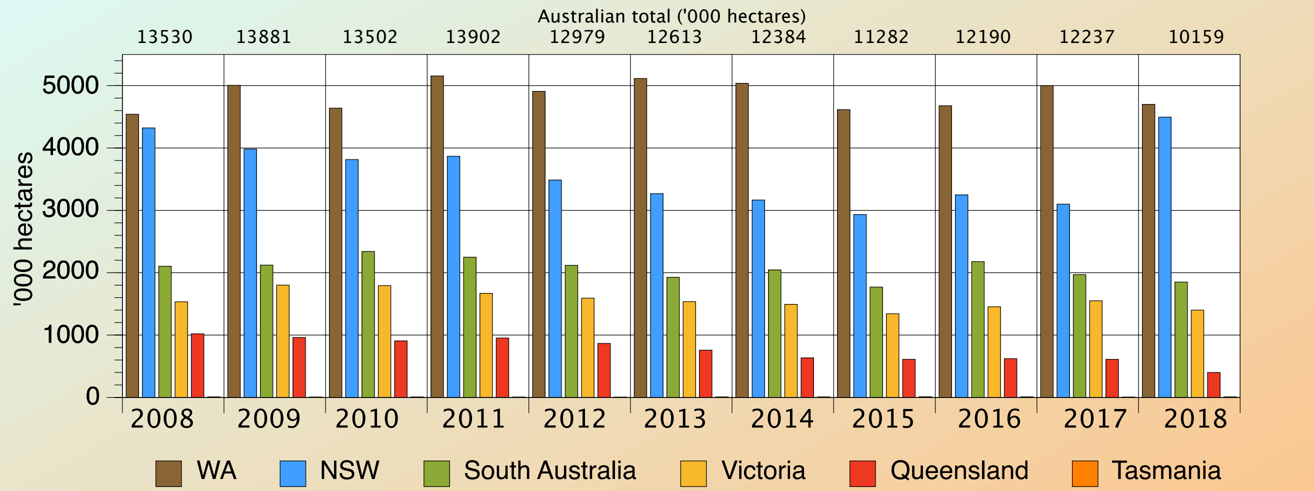
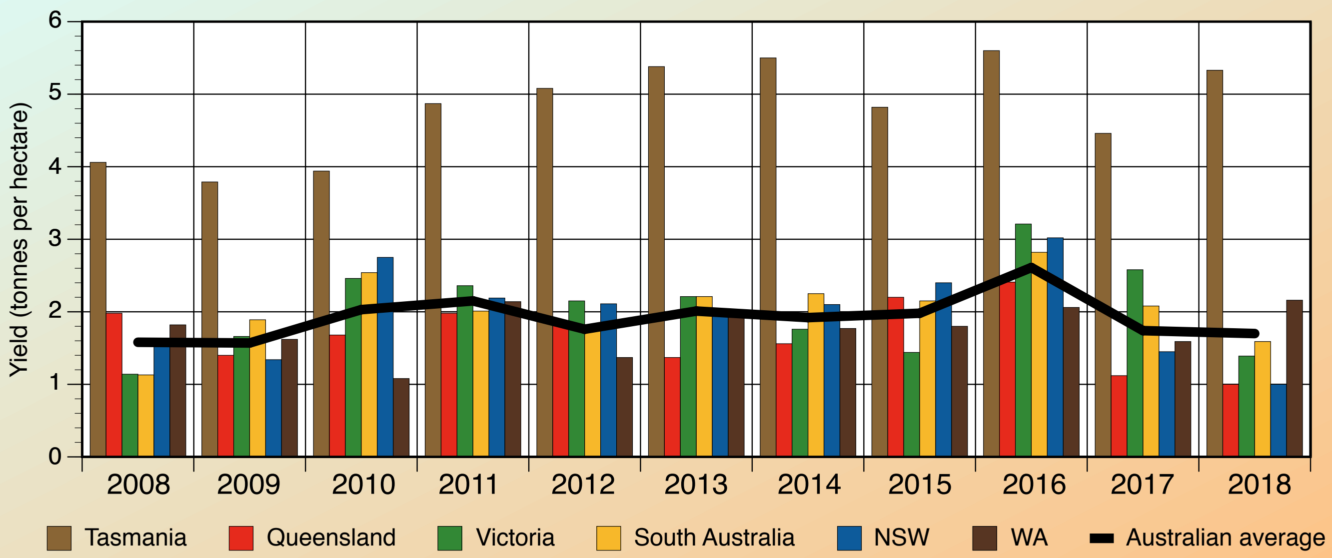
Total Australian wheat production



Total Australian wheat area



Average Australian wheat yields by state



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Australian wheat production, domestic disposal and exports (Kt)

	2014	2015	2016	2017	2018
Opening stocks	5678	5680	4608	5986	4129
Production	23743	22275	31819	21244	17298
Availability	29421	27955	36427	27230	21427
Total domestic use	7154	7231	7805	7609	9000
Stockfeed, Human, Indus	*6590*	*6621*	*7193*	*6973*	*8420*
Seed	*564*	*610*	*612*	*635*	*580*
EXPORTS					
Wheat (incl. grain & flour)	16587	16116	22636	15492	10152
Price APW10 net pool (A$/t)	$334	$326	$268	$308	$348
MAJOR DESTINATIONS					
China	930	1366	1859	1024	na
Japan	904	899	970	924	na
Korea, Rep. of	1048	1203	1050	1061	na
Malaysia	906	835	1065	789	na
Thailand	466	409	432	470	na
Indonesia	4377	3648	4833	3306	na
Vietnam	1262	1328	2024	1371	na
Iran	269	102	0	0	na
Egypt	427	288	135	172	na
United Arab Emirates	99	166	331	167	na
Yemen	928	915	977	610	na
Kuwait	381	403	466	444	na
Saudi Arabia	13	16	7	14	na
Oceania (NZ, Fiji, PNG)	903	898	869	968	na
CLOSING STOCKS (Kt)	**5680**	**4608**	**5986**	**4129**	**2275**

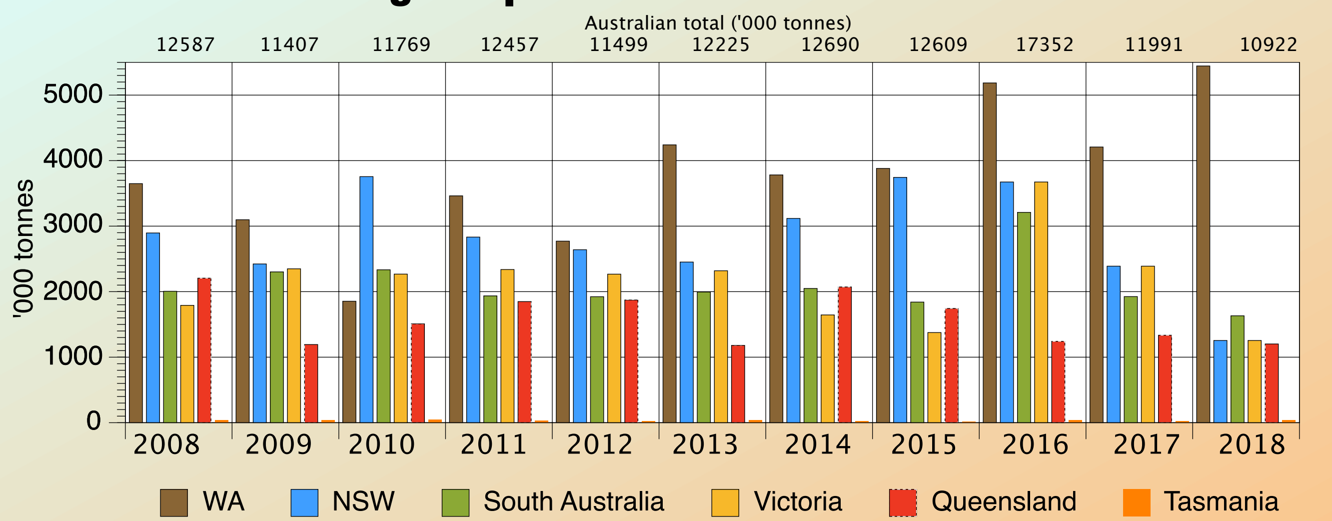
Wheat production & area by state

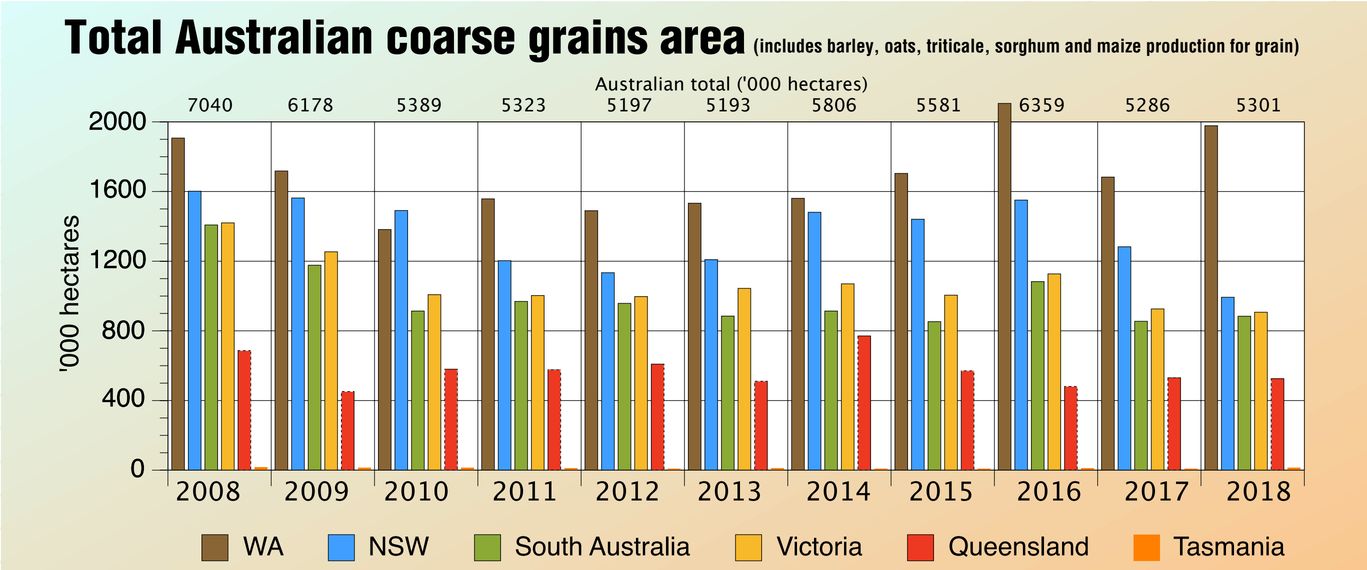
		2014	2015	2016	2017	2018
NSW:	**Prod. (Kt)**	6654	6898	9819	4495	1800
	Area ('000 ha)	3166	2933	3248	3100	1800
Vic:	**Prod. (Kt)**	2631	1815	4665	4000	1950
	Area ('000 ha)	1493	1342	1454	1550	1400
Qld:	**Prod. (Kt)**	987	1316	1502	683	400
	Area ('000 ha)	634	611	622	610	400
WA:	**Prod. (Kt)**	8824	8511	9645	7945	10150
	Area ('000 ha)	5038	4616	4678	5000	4700
SA:	**Prod. (Kt)**	4602	3679	6133	4090	2950
	Area ('000 ha)	2045	1770	2178	1970	1850
Tas:	**Prod. (Kt)**	44	53	56	30	48
	Area ('000 ha)	8	11	10	7	9

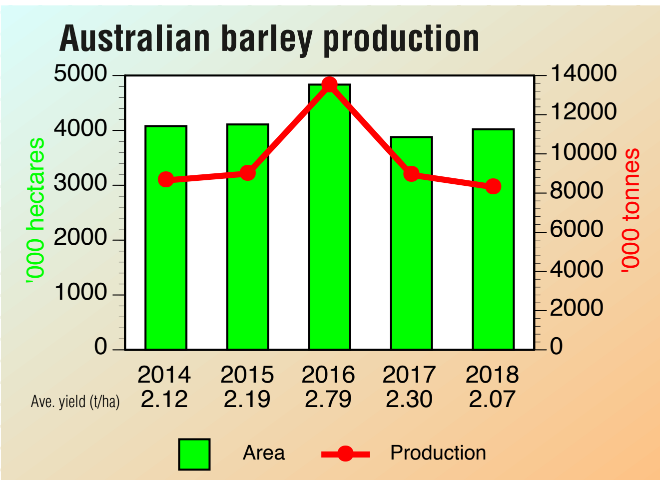
Barley production & area by state

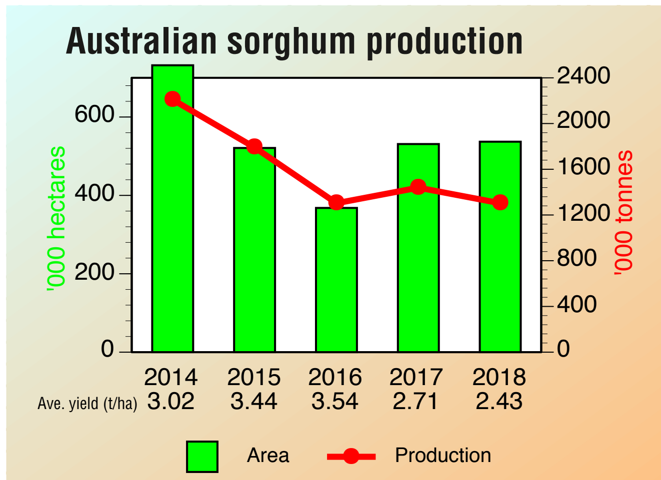
		2014	2015	2016	2017	2018
NSW:	**Prod. (Kt)**	1869	2528	2832	1185	630
	Area ('000 ha)	882	966	1056	790	600
Vic:	**Prod. (Kt)**	1374	1107	3083	2100	1100
	Area ('000 ha)	916	844	946	800	770
Qld:	**Prod. (Kt)**	253	372	436	120	95
	Area ('000 ha)	125	138	149	88	70
WA:	**Prod. (Kt)**	3192	3248	4120	3705	4916
	Area ('000 ha)	1308	1384	1694	1400	1750
SA:	**Prod. (Kt)**	1941	1719	3002	1800	1535
	Area ('000 ha)	840	769	981	795	820
Tas:	**Prod. (Kt)**	17	16	33	17	34
	Area ('000 ha)	5	6	8	5	9

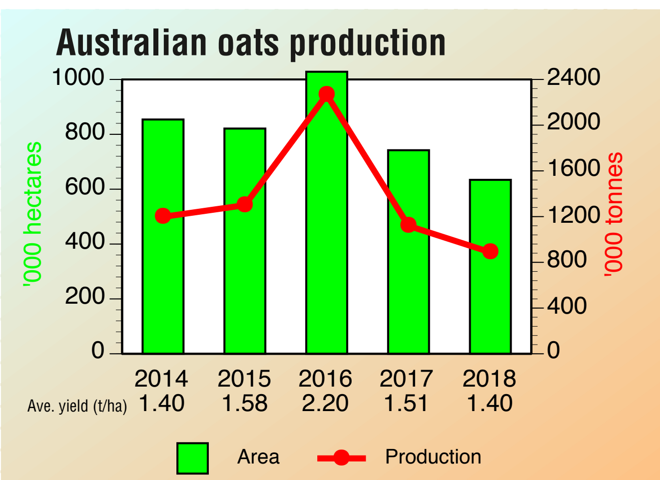
Australian coarse grain production (includes barley, oats, triticale, sorghum and maize production for grain)







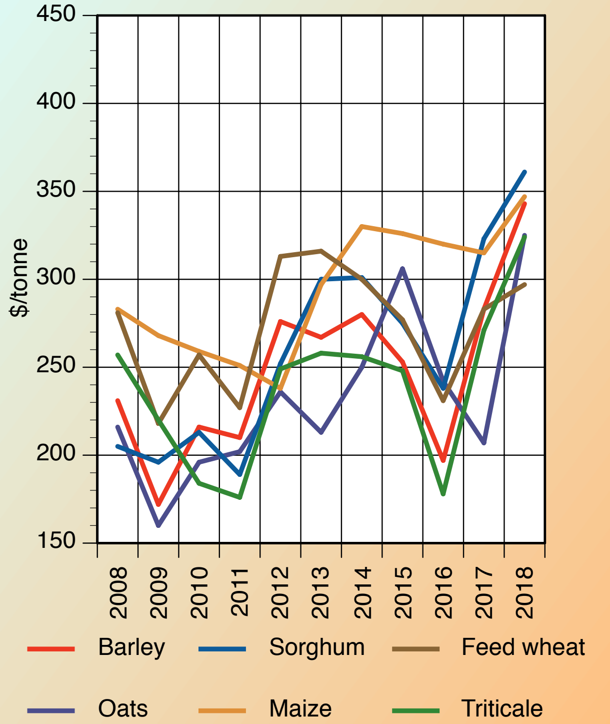




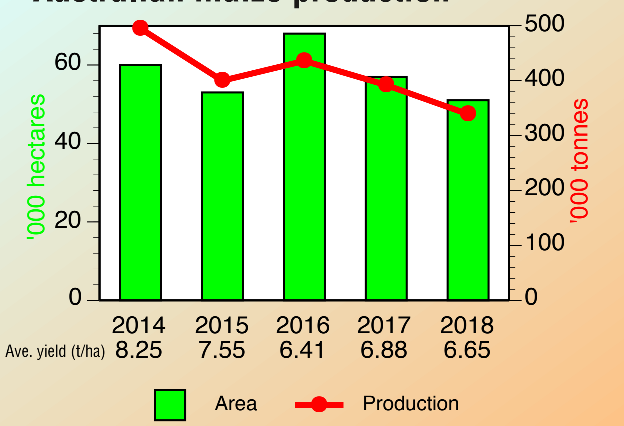
Supply and disposal of Australian coarse grains (Kt)

	2014	2015	2016	2017	2018
BARLEY					
Production	8646	8992	13506	8928	8310
Domestic use, +/- stocks	2438	3494	3969	931	636
Exports	6208	5498	9537	7997	7674
OATS					
Production	1198	1300	2266	1119	888
Domestic use, +/- stocks	914	1094	1845	769	654
Exports	284	206	421	350	234
SORGHUM					
Production	2210	1791	994	1439	1303
Domestic use, +/- stocks	1005	716	265	1035	913
Exports	1205	1075	729	404	390
MAIZE					
Production	495	400	436	392	339
Domestic use, +/- stocks	437	359	363	320	282
Exports	58	41	73	72	57
TRITICALE					
Prod'n, use & stocks	143	127	150	114	82
TOTAL PRODUCTION	**12691**	**12609**	**17352**	**11991**	**10922**
TOTAL EXPORTS	**7756**	**6821**	**10760**	**8824**	**8355**

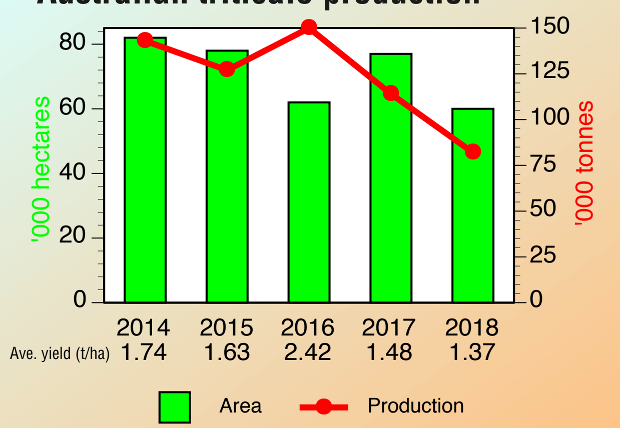
Australian coarse grains domestic feed prices ($/tonne delivered capital city)



Australian maize production



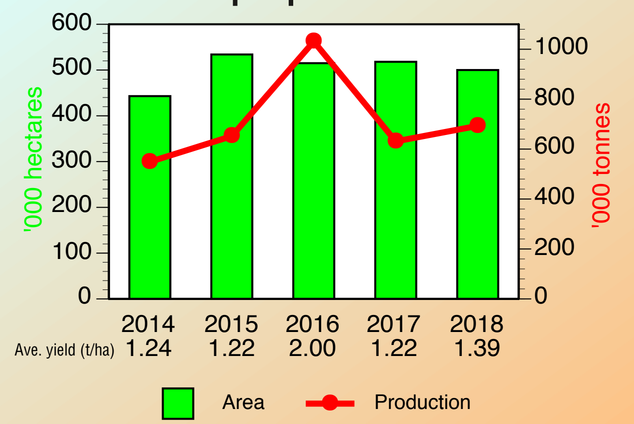
Australian triticale production



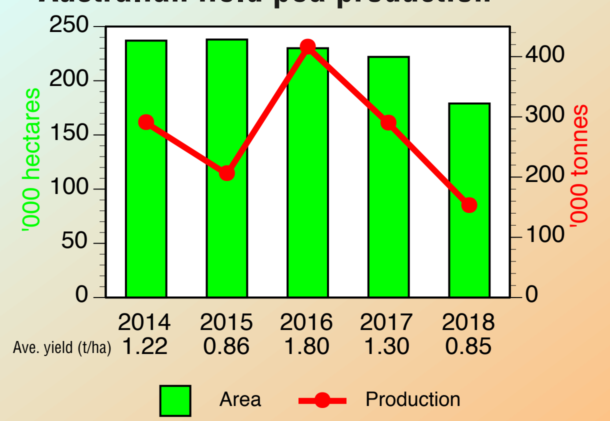
Supply and disposal of Australian pulses (Kt)

	2014	2015	2016	2017	2018
LUPINS					
Production	549	652	1031	631	693
Domestic use, +/- stocks	306	398	636	249	na
Exports	243	254	395	382	na
FIELD PEAS					
Production	290	205	415	289	152
Domestic use, +/- stocks	122	71	147	142	na
Exports	168	134	268	147	na
CHICKPEAS					
Production	555	875	2004	1148	281
Domestic use, +/- stocks	-108	-270	-289	387	na
Exports	663	1145	2293	761	na

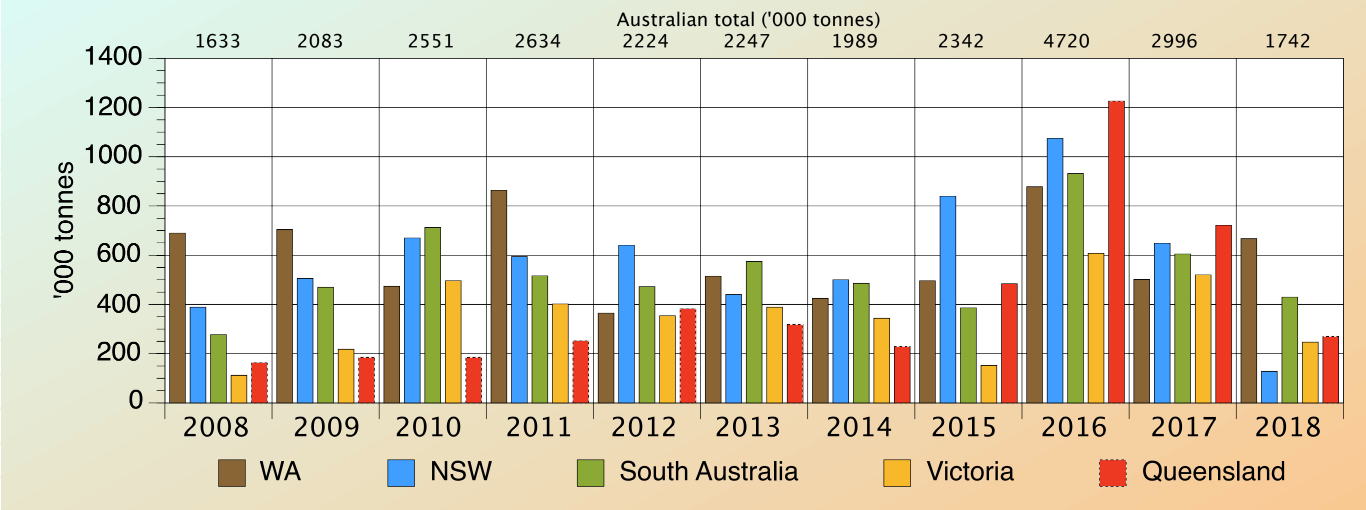
Australian lupin production



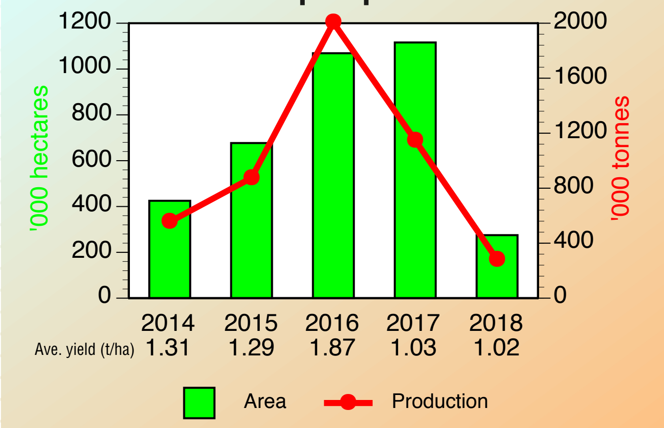
Australian field pea production



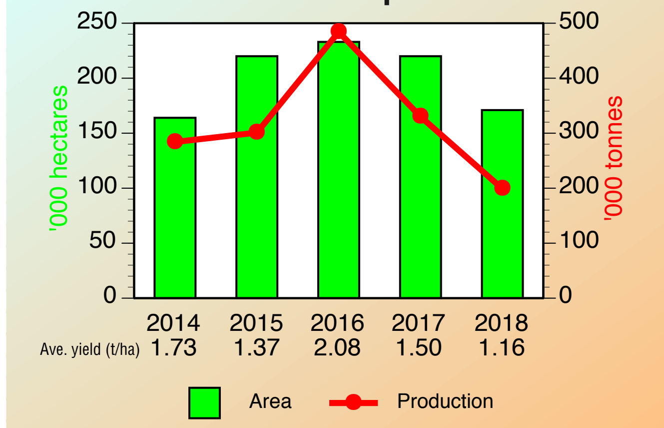
Total Australian pulse production



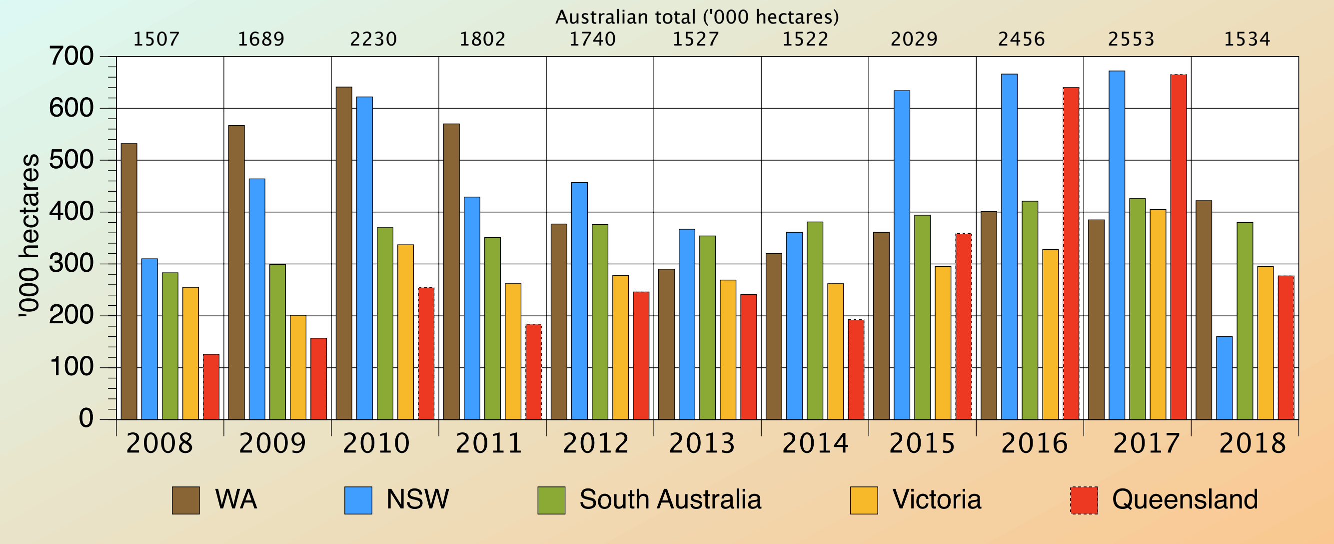
Australian chickpea production



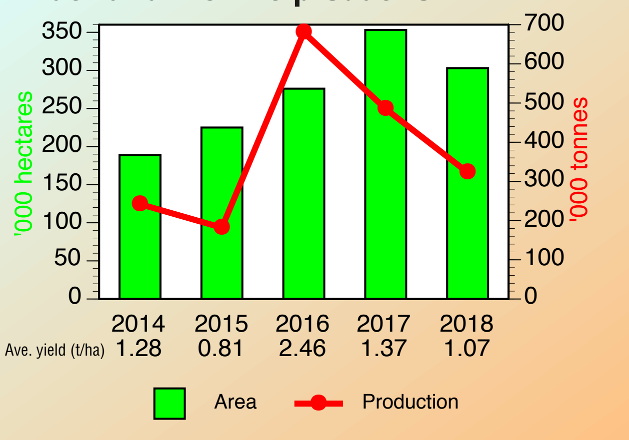
Australian faba bean production



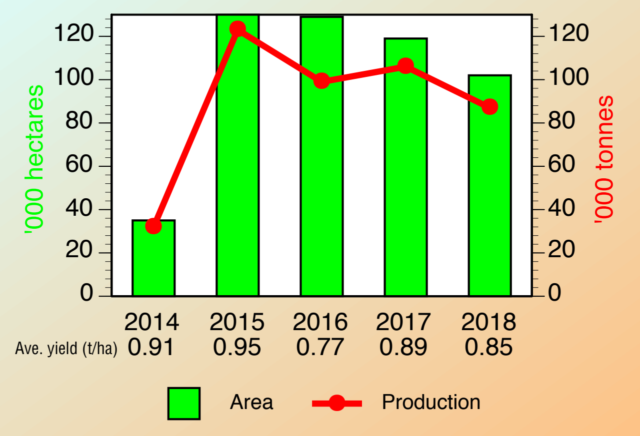
Total Australian pulse area



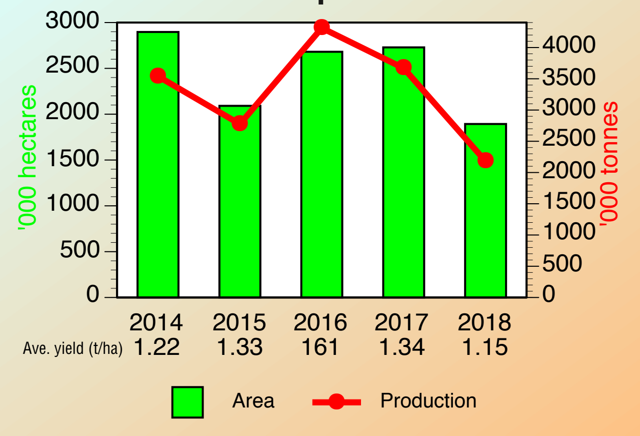
Australian lentils production



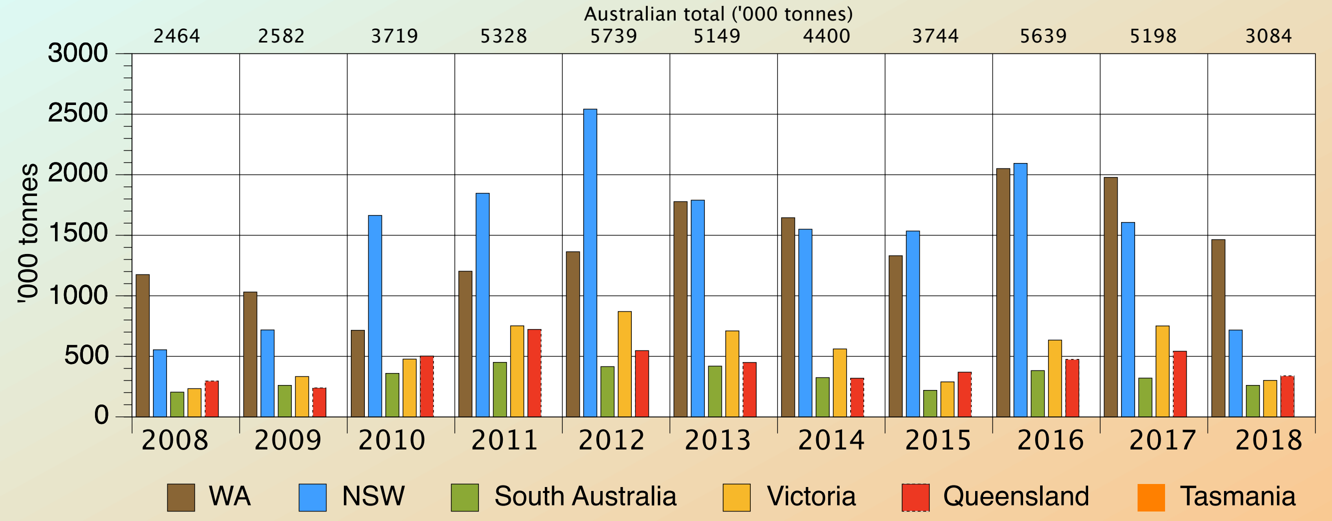
Australian mung bean production



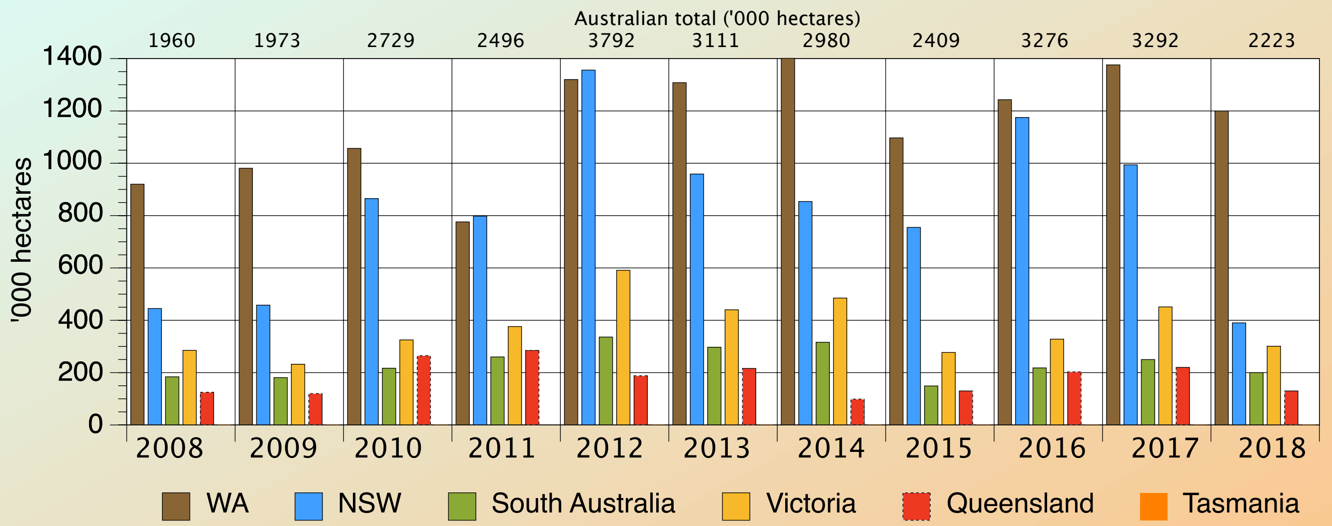
Australian canola production



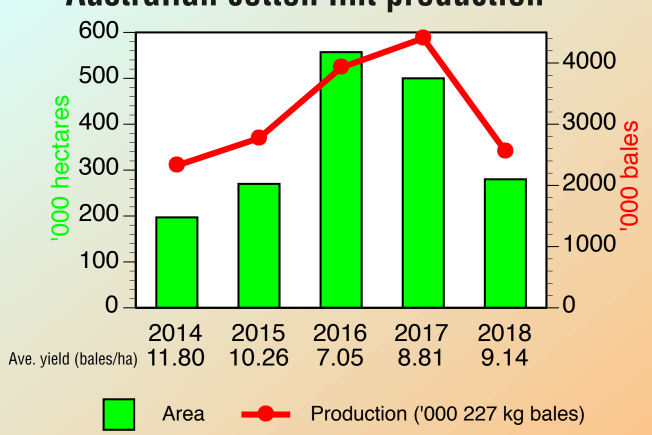
Total Australian oilseed production



Total Australian oilseed area

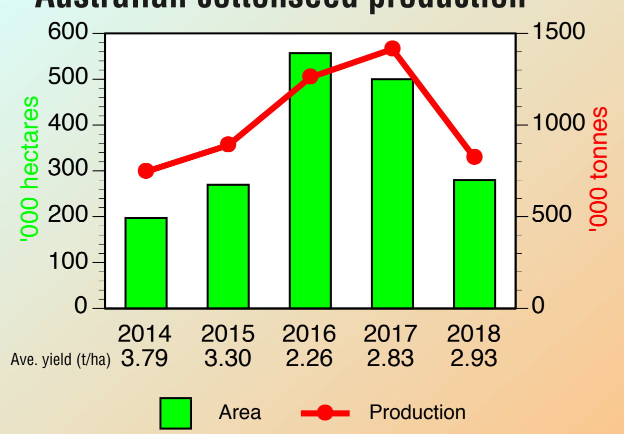


Australian cotton lint production

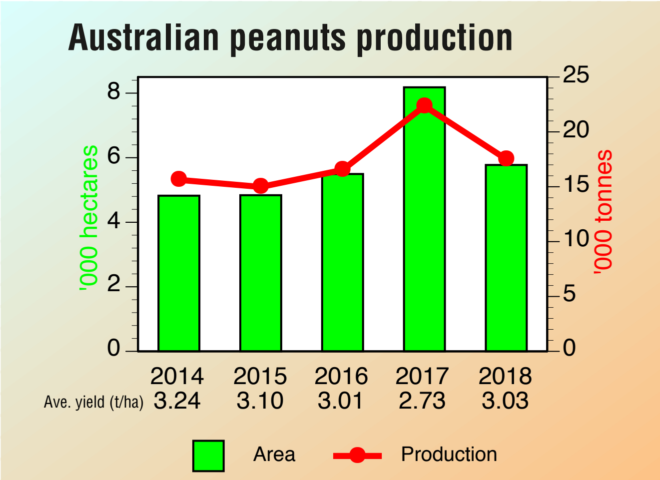


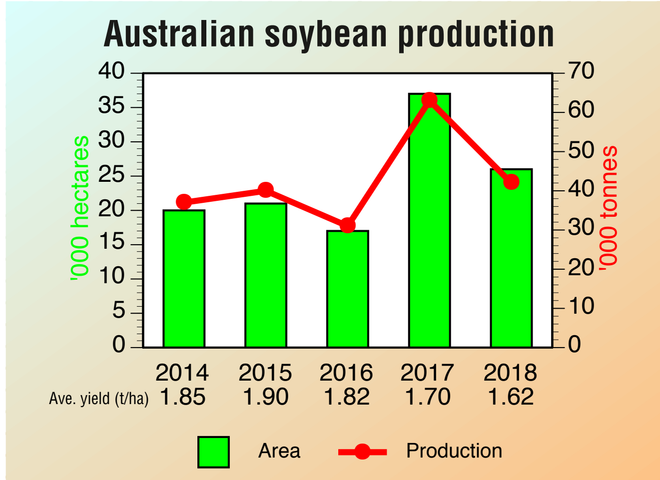
(Includes irrigated and dryland production)

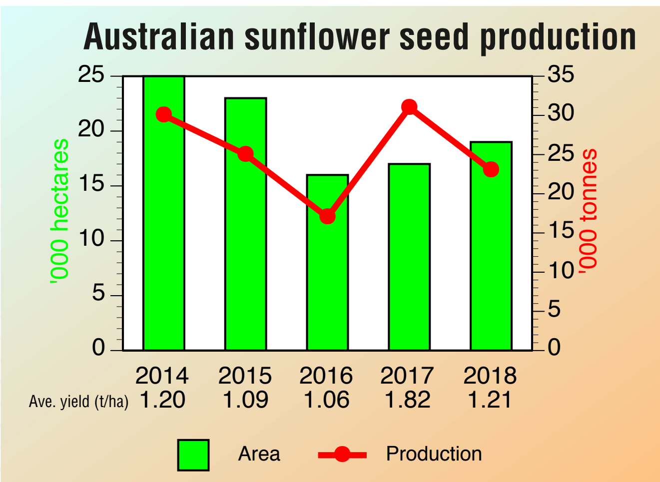
Australian cottonseed production



(Includes irrigated and dryland production)







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

	2014	2015	2016	2017	2018
Seed production	3540	2775	4314	3668	2180
Domestic use	915	1088	972	900	600
Price (A$/t)	$484	$542	$530	$512	$553
EXPORTS					
Seed	2445	1946	3599	2252	1647
Oil	159	154	148	159	na
Meal	37	23	6	0	na

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

		2013	2014	2015	2016	2017	2018
OILSEEDS	**Canola**	3194	2445	1946	3599	2252	1647
	Cotton seed	464	167	147	316	234	262
	Peanuts	3.2	3.0	3.4	4.6	4.5	na
	Soybeans	9.0	2.2	4.8	3.4	3.1	na
	Sunflower seed	0.5	0.2	0.3	0.2	0.1	na
	TOTAL (Kt)	**3671**	**2617**	**2101**	**3923**	**2494**	**1926**
OILS	**Canola**	152	159	154	148	159	na
	Cotton seed	3.0	4.3	5.2	12	22	na
	Peanut	0.7	1.2	1.0	0.2	0.3	na
	Safflower & Sunflower seed	0.2	0.1	0.4	1.2	0.9	na
	Soybeans	2.1	5.0	4.2	4.4	1.9	na
	Olive	4.9	4.4	4.8	3.8	3.7	na
	Other	19	19	17	26	39	na
	TOTAL (Kt)	**181**	**193**	**188**	**197**	**228**	**na**
OILSEED MEALS	**Cotton seed**	36	22	0.2	12	5.3	na
	Soybeans	2.0	1.4	1.5	5.2	6.8	na
	Canola	42	37	23	6.1	0.0	na
	Other	44	38	24	7.8	0.9	na
	TOTAL (Kt)	**124**	**99**	**48**	**31**	**13**	**na**

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

	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19f
Wheat	227	313	316	300	277	231	283	297
Barley	210	276	267	280	253	197	283	343
Oats	202	236	213	250	306	242	207	325
Triticale	176	249	258	256	248	178	271	324
Maize	251	238	297	330	326	320	315	347
Sorghum	189	252	300	301	275	238	323	361
Rice (average return to growers)	270	260	340	395	419	313	430	463
Lupins	232	340	345	292	362	277	269	274
Field peas	295	406	419	413	449	328	297	467
Chickpeas	457	394	352	567	784	833	760	676
Sunflower seed (at crusher)	551	570	660	756	652	1125	900	1331
Soybeans	510	468	538	588	569	780	853	1085
Canola	513	548	556	503	532	559	540	574

Gross value of Australian grain production ($A million)

	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19f
Wheat	6775	7154	7998	7124	6170	7366	6003	5131
Barley	1723	2063	2453	2417	2277	2658	2524	2850
Oats	255	265	268	300	398	547	232	288
Triticale	50	43	32	37	32	27	31	26
Maize	113	120	116	163	130	140	123	118
Sorghum	423	562	384	666	492	237	464	471
Rice	248	302	279	273	115	252	271	48
Lupins	228	156	216	160	236	285	170	190
Field peas	101	130	143	120	92	136	86	71
Chickpeas	308	320	222	315	685	1669	872	190
Canola	1759	2270	2129	1782	1476	2412	1982	1250
Sunflower seed	16	22	12	23	16	19	28	31
Soybeans	27	33	17	22	23	24	54	46
Peanuts, linseed, safflower seed	38	33	26	26	19	26	33	36
TOTAL	**12063**	**13470**	**14294**	**13428**	**12160**	**15798**	**12871**	**10745**

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

	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19f
Wheat (incl. flour)	6378	6776	6103	5547	5120	6094	4672	3630
Barley (incl. malt)	1875	1626	2199	2137	1790	2427	2303	2717
Oats	47	83	80	106	97	151	104	121
Sorghum	299	364	253	424	364	212	138	112
Maize	24	50	36	30	22	32	31	31
Rice	427	459	490	506	397	171	364	288
Lupins	86	143	125	119	97	136	146	105
Field peas + Cow peas	93	89	67	91	86	109	69	65
Chickpeas	384	533	297	414	1013	1921	1047	300
Cotton seed	195	219	168	75	69	137	89	123
Canola	1344	2094	1929	1349	1097	2128	1306	952
TOTAL (includes minor export grains)	**11598**	**12869**	**12296**	**11352**	**10754**	**14510**	**10914**	**8941**

Drought is a 'disruptor' to our wheat market share in South-East Asia

Drought has proven to be an added 'disruptor' to Australia's wheat export market share in South-East Asia, which is already under pressure from rising competition from lower cost suppliers, according to South-East Asian grains expert Oscar Tjakra.

South-East Asian grains expert, Oscar Tjakra.

Visiting Australia from Singapore in March to give first-hand insight into Australia's most important wheat markets, Oscar, who is research analyst with Rabobank's Asian operations, says while South-East Asia poses strong growth prospects for wheat demand, the region is firmly in the sights of competitor Black Sea (Russia, Ukraine and Kazakhstan) wheat exporters who have ramped up their export programs to South-East Asia.

Drought has already impacted exports

And the drought in eastern Australia, he says, has seen others step up to fill in Australia's supply deficit.

"For example, Indonesia, which usually takes around four to five million tonnes of Australia's wheat, has booked in a large wheat shipment from Argentina of about one million tonnes for delivery in the first half of 2019," he says, "which will be their largest volume on record for this period."

While Argentina has exported into South-East Asia on and off over the years, Oscar warns this shipment paves the way for it to potentially gain market share in the future.

"But the Black Sea region poses as the biggest threat to Australia's market share in South-East Asia," he says, "with Australia's share of South-East Asian wheat imports falling from 50 per cent in 2011, to around 40 per cent in recent years. And in 2019 it could drop to 30 to 35 per cent, with drought-reduced volumes."

But Oscar – who met with farmers throughout Australia's major grain-growing areas, including the Western Australian wheatbelt and New South Wales' Riverina – says, there are strong growth opportunities for Australian feed wheat, and potentially feed barley and sorghum, in light of the recent trade agreement with Indonesia.

Wheat usage in food in the region is also expected to rise, with the Indochina region of Myanmar, Cambodia, and Laos holding particularly strong prospects.

Strong demand prospects

Oscar says wheat demand over the next five years in South-East Asia is expected to be strong and is forecast to rise by three per cent per year. This would represent an increase in demand for wheat of four million tonnes by 2023.

Driving this demand is the young demographic – with half of the population in the region expected to be aged 29 and below by 2025 – and the increase in household food expenditure as out-of-home consumption rises and consumers increasingly crave convenience.

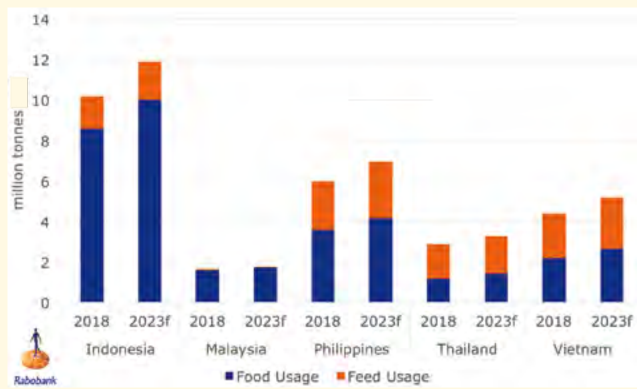
"This is a region that is already home to 650 million people, with a combined GDP of US$2.8 trillion," he says. "And it is on track to become the fourth-largest economy in the world by 2030 after the US, China and EU," he says.

"As incomes rise, packaged and processed foods start to replace some of the basic food products and this is driving the rise in demand for biscuits, cakes, bread and pastries."

And it is this category which is expected to exhibit the strongest growth, he says.

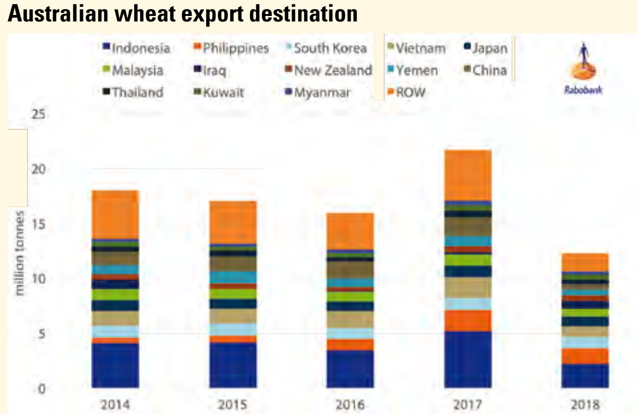
"Meanwhile, noodles – which have traditionally been made from Australian-grown wheat – are not expected to exhibit strong demand growth, as consumers instead look for more convenient food to snack on. Albeit, this market will continue to grow in absolute volume terms."

SE Asian* wheat consumption is forecast to increase by 4 million tonnes from 25.1 mt in 2018 to 29.1 mt in 2023



*Indonesia, Malaysia, Philippines, Thailand, Vietnam.
Sources: Euromonitor, Rabobank 2019.

Australian wheat export destination



Sources: UN Commtrade, Rabobank 2019.

Feed wheat, Oscar says, represents a smaller proportion of wheat usage compared to food, but demand is growing particularly in the Philippines, Vietnam, Thailand and Indonesia.

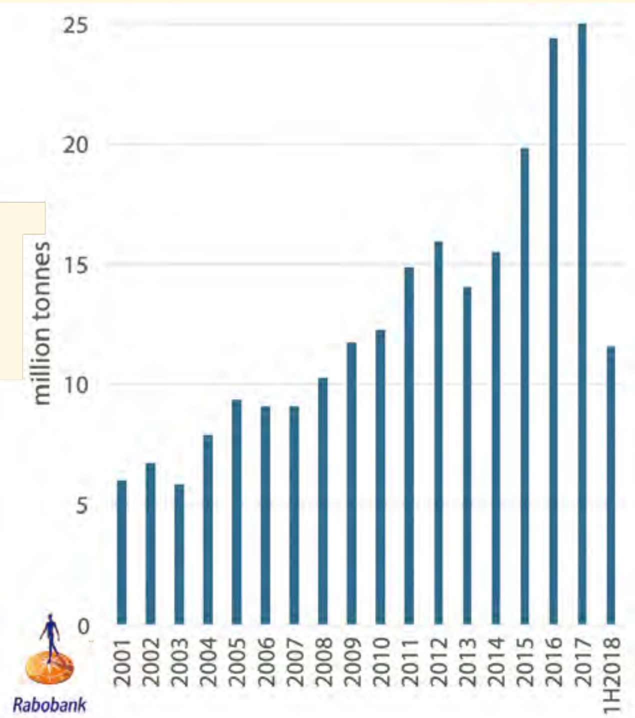
"The signing of the trade deal with Indonesia, Australia's largest wheat export market, will see Australia have a 500,000 tonnes per annum feed grain quota, which will increase by five per cent per annum to include wheat, barley and sorghum," he says.

While the appetite is currently not there for barley and sorghum as a feed source in Indonesia, Oscar says he hopes the market can be developed.

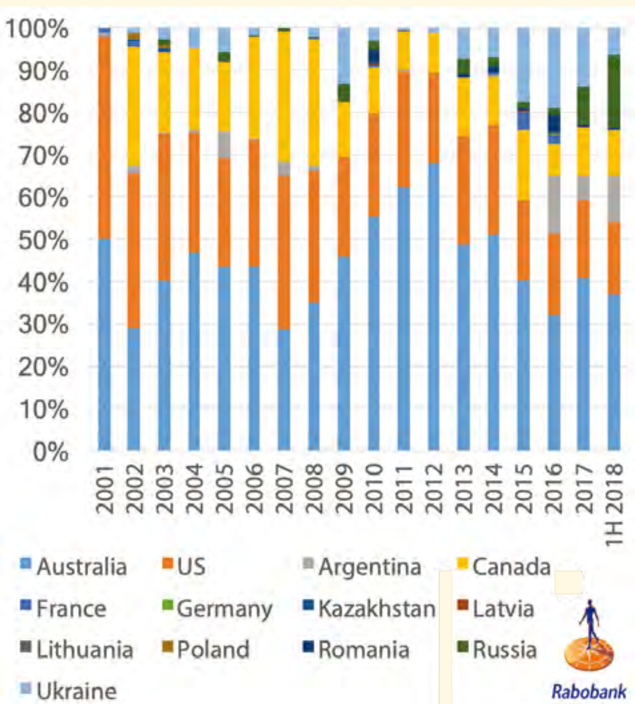
But the question, he says, is whether Australian farmers want to grow feed grains as "they want to get the best price for what they plant in the ground".

Wheat trade to southeast Asia*

*Total export volumes from major exporters to southeast Asia**



*Major exporters market share in southeast Asia**



*Indonesia, Malaysia, Philippines, Thailand, Vietnam.
Sources: UN Commtrade, Rabobank 2019.

Increasing competition

Oscar says the drought in eastern Australia in 2018 put a "big price gap between Australian wheat and its competitors". But that competition from alternative suppliers into South-East Asia has been rising in recent years, as other origins boast a lower cost of production.

"For example, in 2018 the average wheat landed cost – which includes FOB and the freight cost – for the Black Sea region into South East Asia was around US$235 per tonne, compared to Australia's US$250 per tonne," he said, "with Australia's supply chain costs, in particular, higher than their competitors."

Oscar says the other factor at play is the overcapacity in wheat mills across South-East Asia.

"Wheat millers in the five major South-East Asian countries – Indonesia, Malaysia, Thailand, Vietnam and the Philippines – are under-utilised by around 50 per cent, which results in tight milling margins," he says. "To overcome the tight milling margins situation, millers try to reduce their cost of production by blending wheat from different origins to get the mix of flour they want. For example, they can buy Black Sea wheat and blend it with Canadian wheat."

This helps in an environment where mills are also very price sensitive, he says.

"South-East Asia still has a lot of people on low incomes who really care if there is a five per cent increase in the price of wheat flour, which makes it very hard for the mills to pass on to the customer," he says.

Implications for Australia

Oscar says while the backdrop for wheat demand growth in South-East Asia is positive, there are challenges for the Australian sector supplying to the region.

"The Australian industry is really at a crossroads, as to whether it increases its quantity – by increasing yields, including increasing the supply of feed wheat – or maintains its value proposition as a high quality producer," he says.

"To do this, intelligence needs to be gathered around the characteristics of Australian wheat that are either highly valued or that are required by a different users, and this needs to be communicated between growers and the market."

Maintaining competitiveness at a farm-level is also crucial, he says, aided by improving efficiency throughout the supply chain.

Oscar Tjakra, who is responsible for covering grains and oilseeds for Rabobank in South- East Asia, was previously senior vice president of freight research with Oldendorff Carriers Singapore, where he led supply and demand research into global grains and oilseeds. ■

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							
2016	1.3	18.4	0.0	19.7	5.4	13.9	0.4
2017	0.4	18.5	0.0	19.0	5.3	12.8	1.0
2018	1.0	19.1	0.0	20.4	5.5	14.2	0.8
Australia							
2016	4.6	31.8	0.0	36.4	7.8	22.6	6.0
2017	6.0	21.2	0.0	27.2	7.6	16.8	4.1
2018	4.1	17.3	0.0	21.4	9.0	10.1	2.3
Canada							
2016	5.2	31.7	0.1	37.0	10.0	20.2	6.9
2017	6.9	30.0	0.1	37.0	8.9	21.9	6.2
2018	6.2	31.8	0.1	38.0	9.2	23.0	5.9
China							
2016	80.5	128.9	4.8	214.1	117.3	0.9	101.7
2017	101.7	134.3	3.8	239.8	123.5	1.0	115.4
2018	115.4	131.4	3.9	250.7	127.8	1.2	121.8
EU-28							
2016	17.1	144.2	6.0	167.3	126.5	27.6	13.1
2017	13.1	151.4	5.9	170.4	127.2	23.6	19.6
2018	19.6	137.9	6.1	163.6	128.4	21.2	14.1
India							
2016	15.3	86.0	6.2	107.5	97.3	0.4	9.8
2017	9.8	98.5	0.9	109.2	95.7	0.5	13.0
2018	13.0	99.7	0.4	113.1	95.8	0.3	17.0
Russia							
2016	5.7	72.5	0.3	78.5	40.2	27.8	14.6
2017	14.6	85.1	0.2	99.9	43.1	41.3	15.6
2018	15.6	71.7	0.3	87.6	42.4	35.2	10.1
Ukraine							
2016	3.5	26.8	0.0	30.4	10.4	18.1	2.5
2017	2.5	27.0	0.1	29.5	10.3	17.7	1.6
2018	1.6	25.0	0.0	26.6	9.1	16.5	1.0
United States							
2016	26.6	62.8	3.2	92.6	31.8	28.7	32.1
2017	32.1	47.4	4.3	83.8	29.3	24.5	30.0
2018	30.0	51.3	3.8	85.1	30.1	26.3	28.7
Total world supply and demand for wheat (Mt)							
2016	224.2	754.1	175.7	978.3	737.8	175.7	248.4
2017	248.4	763.5	175.2	1011.8	741.1	175.2	270.7
2018	270.7	734.9	171.1	1005.6	741.8	171.1	263.8
Total world supply and demand for coarse grains (ie. total of corn, barley, sorghum, oats & rye) (Mt)							
2016	349.5	1414.6	172.6	1936.7	1379.3	198.6	358.8
2017	358.8	1357.0	187.7	1903.5	1371.4	183.3	348.8
2018	348.8	1371.9	193.4	1914.1	1406.1	198.8	309.2
Total world supply and demand for wheat and coarse grains (Mt)							
2016	573.7	2168.7	348.3	2915.0	2117.1	374.3	607.2
2017	607.2	2120.5	362.9	2915.3	2112.5	358.5	619.5
2018	619.5	2106.8	364.5	2919.7	2147.9	369.9	573.0

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)
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	225	735	711	243	52	34	170	211
2016	222	754	738	248	56	33	176	197
2017	221	763	741	271	57	36	175	229
2018	218	735	742	264	48	35	171	240

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
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	31.8	32.1	133.3	144.2	86.0	14.5	15.0	14.0	15.8	25.6	72.5	20.6	26.8	62.8	754
2017	18.5	21.2	30.0	134.3	151.4	98.5	14.5	14.8	19.6	15.5	26.7	85.1	21.5	27.0	47.4	763
2018	19.1	17.3	31.8	131.4	137.7	99.7	13.5	15.0	21.0	14.2	25.5	71.6	20.0	25.0	51.3	735

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.

Major world wheat trading regions/countries (Mt)

	2014	2015	2016	2017	2018
IMPORTS					
Brazil	5.4	6.7	7.3	7.0	7.5
EU 28	6.0	6.9	5.3	5.8	7.5
FSU 12	7.7	7.4	7.2	8.2	8.6
Japan	5.6	5.6	5.8	5.8	?
Mexico	4.6	4.7	5.5	5.3	?
Middle East	21.3	19.9	18.1	18.3	18.5
Northern Africa	25.4	27.8	28.3	27.4	26.7
Southeast Asia	19.9	24.6	26.9	25.9	25.5
EXPORTS					
Argentina	5.3	9.6	13.8	12.2	14.0
Australia	16.6	16.1	22.6	16.8	10.1
Canada	24.2	22.1	20.1	21.9	24.0
EU 27	35.4	34.7	27.4	23.3	23.0
US	23.5	21.2	28.6	24.5	26.3
Russia	22.8	25.4	27.8	41.4	37.0
Ukraine	11.3	17.4	18.1	17.8	16.5
Others	20.0	23.5	18.0	17.7	20.2
TOTAL WHEAT TRADE (Mt)	**159.1**	**170.0**	**176.4**	**175.6**	**171.1**

World durum wheat production and trade

	2014	2015	2016	2017	2018
PRODUCTION (Mt)					
Algeria	1.3	2.2	1.9	2.0	3.2
Australia	0.5	0.5	0.6	0.5	0.3
Canada	5.2	5.4	7.8	5.0	5.7
EU 28	7.6	8.5	9.8	8.7	8.7
India	1.3	1.2	0.9	1.1	1.0
Kazakhstan	2.0	2.1	2.1	2.0	2.0
Mexico	2.0	2.0	2.3	2.1	1.5
Syria	0.8	1.4	1.0	0.9	0.6
Turkey	3.3	4.1	3.6	3.8	3.6
United States	1.5	2.3	2.8	1.5	2.1
Other	8.8	9.1	7.4	8.8	9.2
WORLD TOTAL PROD'N (Mt)	**34.3**	**38.8**	**40.2**	**36.4**	**37.9**
MAJOR IMPORTERS (Kt)					
Algeria	1748	1701	1869	1445	1200
EU 28	2828	2482	1983	1319	1250
Japan	205	198	246	189	250
Morocco	633	805	829	863	800
United States	908	392	399	985	900
Venezuela	407	339	215	514	400
MAJOR EXPORTERS (Kt)					
Australia	102	176	282	233	180
Canada	5680	4354	4601	4001	3800
EU 28	1207	1365	1383	1099	850
Kazakhstan	133	160	288	714	652
Mexico	1039	1484	1033	1035	700
Turkey	101	98	72	135	130
United States	773	616	589	466	700
WORLD TOTAL TRADE (Kt)	**9291**	**8721**	**8678**	**8388**	**7653**
Semolina component (Kt)	*390*	*400*	*419*	*420*	*420*

Summary of world statistics for coarse grains

	2014	2015	2016	2017	2018
Area (million ha)	326	323	337	326	325
Production (Mt)	1312	1259	1415	1357	1372
Total use (Mt)	1277	1255	1379	1371	1406
Closing stocks: World (Mt)	247	251	359	349	309
Closing stocks: US (Mt)	47.0	51.3	62.2	57.9	50.8
Stock to use ratio (%)	19.3	20.0	26.0	25.5	22.0
Trade (Mt)	174	185	199	183	199

World coarse grains production by region and country (Mt)

	2014	2015	2016	2017	2018
Argentina	36.8	38.4	48.6	39.3	53.9
Australia	12.7	12.6	17.4	12.0	10.9
Brazil	87.7	69.1	101.6	85.1	97.4
Canada	22.2	68.6	26.6	26.2	26.2
China	222.7	231.5	270.9	266.6	265.1
EU 28	170.7	152.7	152.8	152.5	147.0
India	43.1	38.7	43.5	47.1	42.7
Mexico	32.7	32.4	33.3	33.1	31.3
Nth Africa & Mid. East	26.7	32.8	24.9	28.6	31.4
Russia	40.4	37.4	40.8	41.7	35.1
Southeast Asia	26.8	27.5	29.3	29.8	29.5
Sub-Saharan Africa	61.1	52.7	68.0	63.7	61.0
Turkey	9.4	14.2	10.8	12.3	13.6
Ukraine	39.4	33.4	39.2	34.1	44.0
United States	377.2	367.1	402.6	384.4	379.9
Other	98.6	50.0	104.7	100.6	103.1
WORLD TOTAL (Mt)	**1308**	**1259**	**1415**	**1357**	**1372**
Corn Total	1016.2	972.2	1123.3	1076.2	1101.2
Barley Total	144.4	150.0	150.6	145.3	140.1
Sorghum Total	64.4	62.2	60.9	58.0	58.8
Oats Total	22.9	22.4	24.2	23.8	22.4

Major world barley and sorghum producers (Mt)

	2014	2015	2016	2017	2018
BARLEY					
Argentina	2.9	4.9	3.3	3.7	4.5
Australia	8.7	8.6	13.5	8.9	8.3
Canada	7.1	8.2	8.8	7.9	8.4
China	1.8	1.9	1.7	1.8	1.9
EU 28	60.6	62.1	59.9	58.8	56.2
Russia	20.0	17.1	17.6	20.2	16.7
Turkey	4.0	7.4	4.7	6.4	7.4
Ukraine	9.4	8.7	9.9	8.7	7.4
United States	4.0	4.8	4.3	3.1	3.3
TOTAL WORLD PROD'N (Mt)	141.7	149.6	147.1	143.7	140.7
SORGHUM					
Argentina	3.5	3.4	3.4	3.0	2.8
Australia	2.2	1.8	1.0	1.4	1.3
India	5.4	4.2	4.6	4.9	3.7
Mexico	6.3	5.6	4.6	4.5	4.6
Sub-Saharan Africa	28.1	23.2	26.0	22.2	22.9
United States	11.0	15.2	12.2	9.2	9.3
TOTAL WORLD PROD'N (Mt)	66.2	61.4	63.4	57.7	56.9

World coarse grains trade by region and country (Mt)

	2014	2015	2016	2017	2018
MAJOR IMPORTERS					
China	25.7	17.5	16.1	16.5	13.3
EU 28	9.2	14.2	15.6	18.9	22.9
Japan	16.7	17.1	17.0	17.6	17.3
Malaysia	3.2	4.1	3.5	3.7	4.0
Mexico	11.6	15.0	15.2	16.5	17.3
North Afr & Middle East	34.1	32.9	34.2	39.2	38.5
Saudi Arabia	11.3	14.8	11.5	12.1	13.5
South Korea	10.2	10.2	9.3	10.2	10.4
United States	3.4	3.9	3.4	2.9	3.0
Vietnam	6.7	8.7	8.6	9.7	11.1
MAJOR EXPORTERS					
Argentina	21.4	25.2	29.1	26.1	33.3
Australia	7.8	6.8	10.8	8.8	8.3
Brazil	34.5	35.4	31.6	25.4	29.0
Canada	3.6	4.7	4.8	5.8	5.6
EU 28	15.1	11.0	8.1	7.9	7.0
Russia	9.2	8.5	8.6	11.5	8.0
Ukraine	24.2	21.5	26.9	22.5	33.0
United States	56.4	59.2	64.5	67.3	62.6
TOTAL WORLD TRADE (Mt)	**174**	**185**	**199**	**183**	**199**

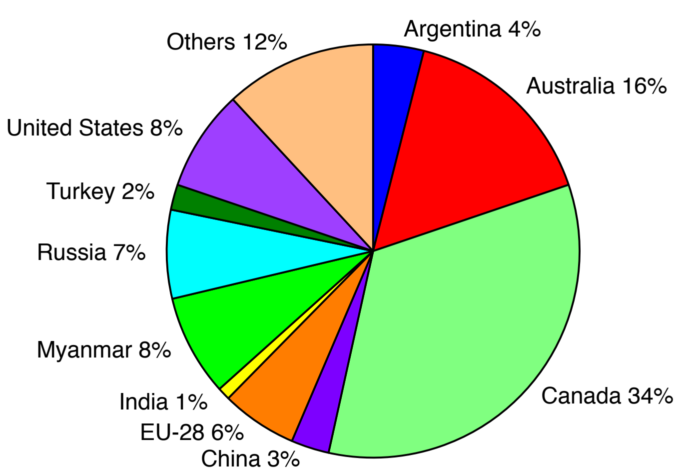
World sorghum trade by region and country (Kt)

	2014	2015	2016	2017	2018
MAJOR IMPORTERS					
Chile	98	134	54	49	100
China	10162	8284	5209	4436	700
Kenya	117	54	146	141	150
EU28	131	119	194	486	800
Japan	903	649	561	594	600
Mexico	29	661	548	98	500
South Sudan	87	19	36	148	150
Sudan	120	200	120	150	200
MAJOR EXPORTERS					
Argentina	954	772	457	296	200
Australia	1205	1075	-729	404	390
China	9	23	34	43	40
Nigeria, Kenya & Ethiopa	248	166	248	311	225
Ukraine	156	119	164	123	120
United States	9269	7928	6022	4961	2600
TOTAL EXPORTS (Kt)	**12588**	**9891**	**7686**	**6489**	**3892**

World barley trade by region (Kt)

	2014	2015	2016	2017	2018
MAJOR IMPORTERS					
Algeria	723	864	533	439	250
Brazil	489	551	737	584	650
China	9859	5869	8104	8144	7500
EU 28	269	315	447	231	400
Iran	1900	1700	2200	2700	3000
Japan	1097	1154	1197	1253	1100
Jordan	759	902	759	788	600
Libya	1001	1324	1084	438	300
Saudi Arabia	8200	10400	8400	7700	8500
Tunisia	483	696	501	674	650
Turkey	332	146	291	598	300
United Arab Emirates	393	668	501	263	500
Others	4589	2998	4819	4023	4085
MAJOR EXPORTERS (feed and malting)					
Argentina	1599	2836	2696	2103	3100
Australia	6208	5498	9537	7997	7674
Canada	1386	1147	1809	1868	2200
EU 28	10642	8644	5683	5857	5300
Kazakhstan	475	776	821	1411	2000
Russia	5807	3735	3629	5661	4700
Ukraine	4332	4673	5337	3188	4200
United States	291	161	125	102	100
TOTAL EXPORTS (Kt)	**30094**	**27587**	**29573**	**27835**	**27835**

Major exporters as a percentage of average annual world trade in pulses, 2015–18



Average world trade in pulses (2015–18) was 16.2 million tonnes

World pulse trade and type (Kt)

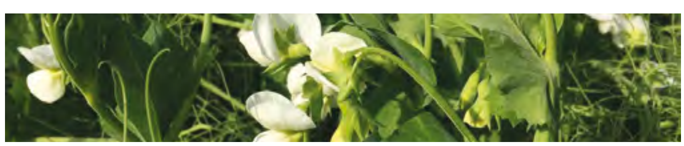
	2015	2016	2017	2018
MAIN IMPORTERS				
EU-28	1143	1113	1119	1395
CIS	76	86	100	100
North & Central America	1029	1093	1269	1390
South America	567	729	644	645
Near East Asia	2159	2103	2534	2146
Far East Asia	8837	9673	9889	7154
India	*5409*	*5089*	*5398*	*1453*
Africa	1789	1537	1666	1660
Oceania	39	39	44	44
MAIN EXPORTERS				
Argentina	515	664	625	560
Australia	2098	3833	2730	1541
Canada	5906	5679	5385	5320
China	499	636	465	423
EU-28	815	1337	1150	860
India	218	176	140	319
Myanmar	1107	1293	1425	1421
Russia	926	962	1250	1385
Turkey	311	318	340	492
United States	1167	1460	1335	905
Others	2268	1953	1940	1741
TOTAL WORLD TRADE (Kt)	**15802**	**16548**	**17505**	**14900**
TYPE OF PULSE TRADED				
Field (Dry) peas	4910	5515	6550	5600
Lentils	3529	3043	3370	2800
Chickpeas	2358	2311	2895	1860
Kidney beans	1729	1693	1375	1300
Urd/Mungbeans	1092	1908	1400	1400
Broad beans	805	829	930	940
Others	1381	1249	985	1000
TOTAL WORLD TRADE (Kt)	**15802**	**16548**	**17505**	**14900**
TOTAL WORLD PULSE PRODUCTION (Kt)	**77573**	**81799**	**82000**	**81500[f]**

World chickpea trade and production (Kt)

	2015	2016	2017	2018
MAIN IMPORTERS				
Algeria	45	51	52	na
Bangladesh	212	166	167	na
Egypt	34	25	23	na
EU-28	141	138	141	na
India	970	877	876	na
Pakistan	311	406	426	na
United Arab Emirates	101	117	119	na
United States	49	60	61	na
MAIN EXPORTERS				
Australia	1145	2293	761	na
Canada	152	108	116	na
India	188	121	120	na
Russia	326	239	230	na
United States	46	124	125	na
TOTAL WORLD TRADE (Kt)	**2358**	**2311**	**2895**	**1860**
WORLD CHICKPEA PRODUCTION (Kt)	**11299**	**12258**	**13906**	**15447**

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

	2015	2016	2017	2018
MAIN IMPORTERS				
Bangladesh	385	350	351	na
China	784	1091	1100	na
Cuba	66	81	80	na
EU-28	203	201	205	na
India	1997	2292	2300	na
Pakistan	123	132	133	na
Turkey	361	398	399	na
United Arab Emirates	40	35	37	na
United States	143	117	119	na
Others	741	754	916	na
MAIN EXPORTERS				
Argentina	70	94	94	na
Australia	143	225	170	na
Canada	2652	3948	3087	na
EU-28	368	723	722	na
Russia	589	702	705	na
United States	439	563	562	na
TOTAL WORLD TRADE (Kt)	**4910**	**5515**	**6550**	**5600**
WORLD FIELD PEA PRODUCTION (Kt)	**10835**	**14020**	**14194**	**12202**



World major oilseeds production, trade and type (Mt)

	2015	2016	2017	2018
PRODUCTION				
Africa	16.36	18.84	19.46	18.65
Argentina	63.10	60.16	42.52	59.99
Australia	3.74	5.64	5.20	3.08
Brazil	99.02	117.59	124.61	121.16
Canada	24.91	26.25	29.10	28.46
China	53.48	54.92	59.49	59.78
EU-28	32.44	31.96	34.98	32.74
FSU-12	34.39	39.91	40.47	45.80
India	29.37	36.32	33.99	34.04
Southeast Asia	4.65	4.59	4.52	4.47
Turkey	2.28	2.76	3.17	3.35
United States	115.88	126.94	131.48	134.00
Other countries	44.49	46.97	47.24	47.51
TOTAL WORLD PRODUCTION	**524.11**	**572.85**	**576.23**	**593.03**
PRODUCTION BY TYPE				
Canola	68.74	69.43	74.00	70.91
Cottonseed	35.81	39.08	44.98	43.45
Peanut	40.42	44.16	44.94	41.86
Soybean	313.77	349.31	340.47	360.08
Sunflower	40.30	48.01	47.40	51.46
Other oilseeds	25.07	22.86	24.44	25.27
TOTAL WORLD PRODUCTION	**524.11**	**572.85**	**576.23**	**593.03**
WORLD OILSEEDS TRADE				
Canola	14.35	15.80	16.13	17.01
Cottonseed	0.71	0.84	0.94	0.80
Peanut	3.55	3.75	3.60	3.57
Soybean	132.57	147.50	152.96	154.20
Sunflower	2.01	2.46	2.50	2.40
Other oilseeds	0.17	0.26	0.17	0.18
TOTAL WORLD TRADE	**153.36**	**170.61**	**176.30**	**178.16**

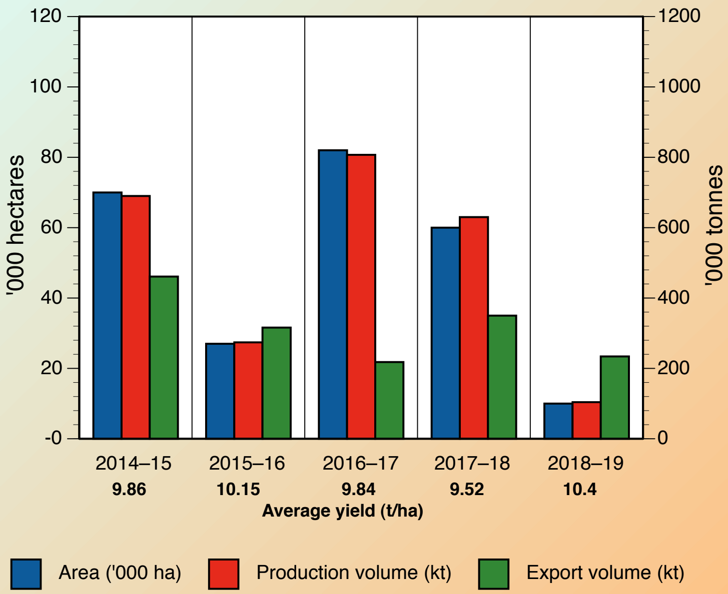
World canola production and trade (Mt)

	2015	2016	2017	2018
MAIN PRODUCERS				
Australia	2.77	4.31	3.67	2.18
Canada	18.38	19.60	21.30	20.30
China	14.93	13.12	13.30	13.02
EU-28	22.00	20.64	22.12	19.80
FSU-12	3.26	2.84	4.60	5.63
India	5.92	6.84	6.63	6.30
United States	1.31	1.41	1.42	1.60
Others	1.39	1.04	1.24	1.30
TOTAL PRODUCTION	**69.96**	**69.80**	**74.28**	**70.13**
MAIN EXPORTERS				
Australia	1.95	3.60	2.25	1.65
Canada	10.31	11..23	10.30	10.0
Ukraine	1.42	1.72	2.44	2.70
MAIN IMPORTERS				
China	3.74	4.42	4.50	4.90
EU-28	3.32	5.51	4.43	4.50
Japan	2.21	2.52	2.53	2.54
Mexico	1.41	1.62	1.53	1.30
Pakistan	1.20	1.01	0.82	1.0
TOTAL CANOLA TRADE	**14.00**	**17.12**	**16.04**	**16.10**

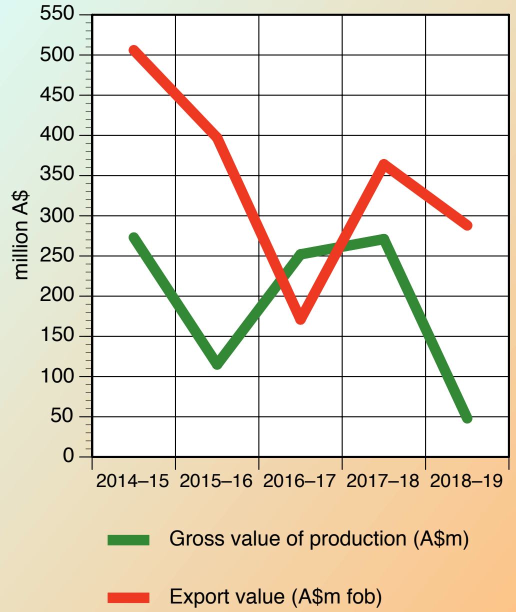
World cottonseed production (Mt)

	2015	2016	2017	2018
MAIN PRODUCERS				
Australia	0.89	1.26	1.41	0.82
Brazil	1.94	2.30	3.02	3.85
China	8.60	8.80	10.80	10.78
FSU-12	2.34	2.20	2.34	1.63
India	11.00	11.46	12.31	11.46
Pakistan	3.05	3.34	3.55	3.34
United States	3.67	4.87	5.83	5.26
Others	4.32	4.85	5.72	6.31
TOTAL PRODUCTION	**35.81**	**39.08**	**44.98**	**43.45**

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%)
2013–14	161	479	479	116	24	41	429
2014–15	161	480	475	121	25	39	420
2015–16	159	473	473	121	26	44	386
2016–17	162	491	483	150	31	47	387
2017–18	163	495	483	163	33	47	408
2018–19	163	502	492	172	34	47	395

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
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	147.8	2.1	109.7	38.7	7.9	12.6	6.8	11.7	19.2	7.1	27.4	**491**
2017–18	0.46	32.7	8.2	148.9	2.0	112.9	37.0	7.8	13.2	7.5	12.2	20.4	5.7	28.4	**495**
2018–19	0.08	35.0	7.5	148.5	2.0	116.0	37.3	7.7	13.1	7.5	12.1	20.7	7.1	29.1	**502**

In this section the rice crop is the year of planting. (The 2018–19 figure is therefore a forecast of the Australian rice harvest in March–April 2019.)

Section 3

Grower Group Focus

CONTENTS

THIS SECTION BROUGHT TO YOU IN ASSOCIATION WITH:

Ripper Gauge – investigating soil amelioration on the 'other' soil types

At a glance…

- Deep ripping – to either 30 or 60 cm to loosen the soil with a straight or angled shank tyne to reduce soil compaction.
- Mouldboard ploughing – traditional mouldboard plough to invert soil to 30 cm to bury surface soil that is severely water repellent.
- Plozza plough – developed by farmers in the West Midlands region to provide a low-cost option to invert and bury water repellent soil, and is very effective in gravelly soil types.
- Maximum tillage – newer tillage equipment on the market that rips and cultivates the soil to an approximate depth of 30 cm.

WEST MIDLANDS GROUP
our knowledge hub

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About: The West Midlands Group grew from a natural resource management (NRM) group to focus on the management of non-wetting soils prevalent in the region encompassing the shires of Dandaragan, Coorow, Moora and Gingin in WA's northern agricultural region.

Formed in 2010, the group now has around 120 members and is involved in a wide range of cropping and livestock based projects.

Sponsors: Summit Fertilizers, Farm Weekly, Rabobank, CBH Group, Tronox, Syngenta, Landmark, AFGRI, Bayer CropScience, RedMac Machinery, GrainGrowers, Intergrain, KLK Farms, Pacer Legal, Primaries, RSM, CSBP, Pacific Seeds, Case IH.

Why do the trial?

Soil amelioration practices have been well adopted across the agricultural regions of WA in the past 5–10 years. The use of deep ripping to reduce soil compaction, mouldboard ploughing, rotary spading, and 'Plozza' ploughing to reduce soil water repellence have led to significant increases in grain yield for many growers – but not all. The use of lime to correct soil acidity, particularly sub-soil acidity by incorporating with soil amelioration practices, has been generally very effective at increasing grain yield.

But much of this research and grower practice has been on the deeper sandplain soil types found in each region of WA. Following the success of soil amelioration on this soil type, growers are considering how these practices will go on some of the 'other' dominant soil types across Western Australia, such as the gravel and clay-based soil types.

This project is evaluating the grain yield response of each soil type to a range of soil amelioration strategies available to growers in each region.

How was it done?

Twenty demonstration sites were established across the agricultural region of Western Australia in 2018 by seven grower groups that are currently collaborating on this project with the West Midlands Group.

The soil types tested range from loamy sands

The 'Plozza' plough in action – a modified one-way plough that was developed in the West Midlands region with large diameter discs to turn soil over to a depth of 40 cm.

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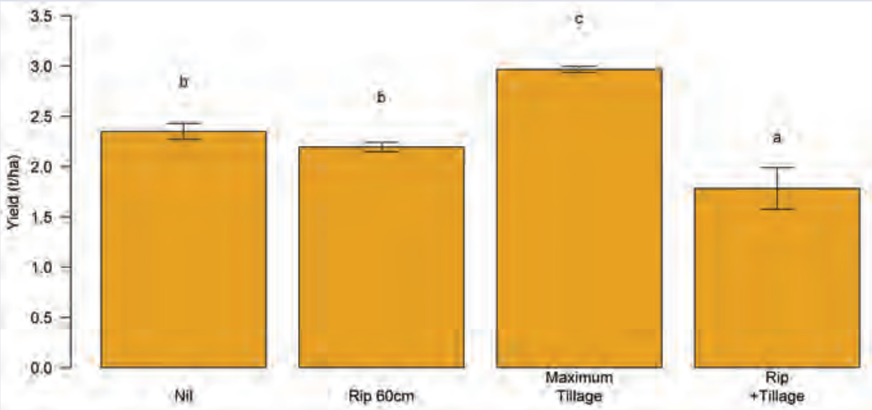
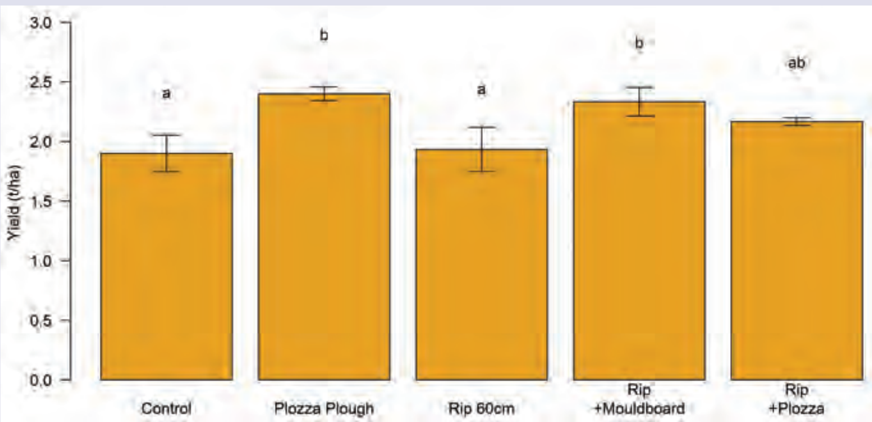
FIGURE 1: Grain yield was highest following maximum tillage on a deep sandy gravel soil near Neridup in the Esperance region of WA



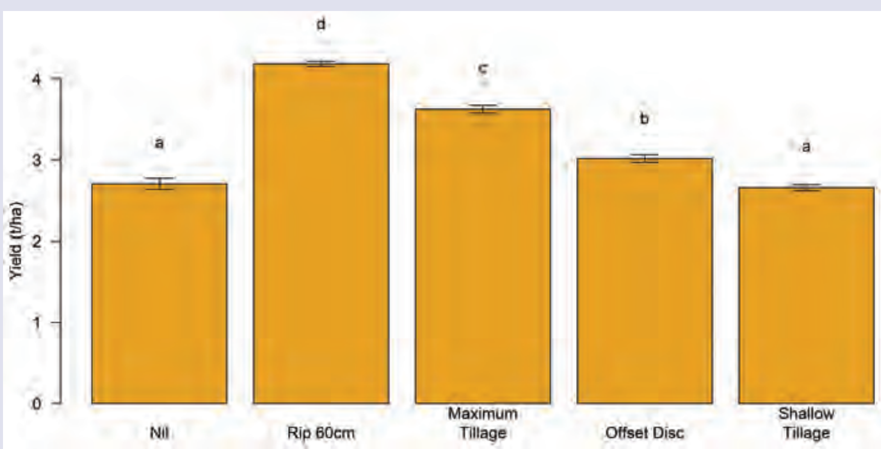
Error bars denote the standard error of treatment means, lower case letters denotes a significant difference between treatments (P<0.05).

FIGURE 2: Grain yield was highest following Plozza ploughing and rip + mouldboard treatments on a gravelly duplex soil near Broomehill in the Great Southern region of WA



Error bars denote the standard error of treatment means, lower case letters denotes a significant difference between treatments (P<0.05).

FIGURE 3: Grain yield was highest following ripping to 60 cm on a loamy sand soil at Kalannie in the Eastern Wheatbelt of WA



Error bars denote the standard error of treatment means, lower case letters denotes a significant difference between treatments (P<0.05).

through to gravel and sand duplexes, forest gravels, and clay soil types.

Each site was selected based on the low amount of knowledge available on how they will respond to each soil amelioration practice.

The four standard treatments that were tested against a control include:

- Ripping to 30 cm;
- Ripping to 60 cm;
- A combination of ripping and tillage; and,
- 'Maximum tillage'.

For each of these treatments, plant growth was monitored during the season and grain yield measured using yield mapping at harvest. The sites were mostly sown to cereal crops in 2018, with seeding, spraying, and harvest completed by the participating grower. The crop husbandry at each site was similar to the rest of the paddock.

What happened?

There was no clear winner for the most effective amelioration treatment across all sites in this project. Rainfall varied significantly across the sites in 2018, with some sites being very dry and others being above average.

Instead, a trend emerged where the different soil amelioration methods were most effective in different soil types. The sandy soil types, including duplex and loamy types, responded greatest to deep ripping treatments which was similar to the knowledge previously collected on the sandplain soil type.

The gravel-based soils tended to be more responsive to tillage treatments that had a greater level and depth of disturbance, such as the maximum tillage or plozza plough treatments. Loosening of the soil allows for greater root exploration of these typically tougher soil types, but also could have led to greater mineralisation and availability of nutrients.

On the downside, it was reported at many sites that increasing the level of tillage intensity caused a large increase in weed numbers that were hard to control in cereal crops in the 2018 season. This was exacerbated where above average growing season rainfall was received, and successive germinations of annual ryegrass occurred.

The clay based soils tended to be more variable in response to amelioration, and this can be partly due to the hardness of the soil and the inability of ripping equipment to penetrate the

soil. In one case, good growing season rainfall would have reduced the benefit of deep ripping as soil moisture was not limiting crop growth during the season.

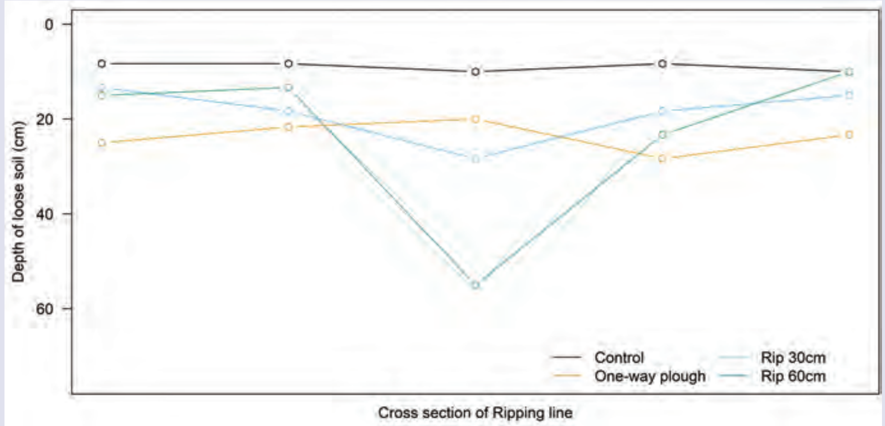
This project also exposed some of the management issues that need to be resolved when considering ameliorating these 'other' soil types.

For instance, the dry autumn experienced in 2018 meant that many of the soil types were extremely dry and hard, and penetration of the deep ripping equipment at some sites was very low.

At one site in the lower rainfall eastern wheatbelt, ripping was delayed until springtime following a fallow period to allow for adequate soil moisture to allow for effective deep ripping to occur. Taking consistent measurements during the growing season was also an issue at some of the sites in 2018 on gravel based soils that had many obstructions in the soil due to the presence of loosened rock.

This project will continue for the 2019 and 2020 seasons to follow the impact of each amelioration treatment over time. In particular, it will be interesting to follow the maximum tillage treatments at each site to see if they continue to be the highest yielding treatment – or if the results from 2018 are short-lived.

FIGURE 4: A typical cross-section view of the soil disturbance caused by ripping and tillage treatments compared to the control treatments for the ripper gauge project



Where ripping occurred, the rip line is located in the middle of the figure.

To sum up

The *Ripper Gauge* project will give some direction for growers to determine the soil amelioration method that will provide the greatest yield benefit on some of these 'other' main soil types in each region of WA.

This project has also highlighted that there can be significant challenges encountered when ameliorating these 'other' soil types. The presence of gravel and hardness of the soil pose severe restrictions on how and when soil can be ameliorated.

This has informed grower decisions, with novel ways being developed to manage this, including ripping at the end of a fallow period to enable greater ripping depth. Crop rotation post soil amelioration also needs to be considered to manage the potential increase in weed burden that can come with some soil amelioration options.

Acknowledgements: This project "9176102 – demonstrating the benefits of soil amelioration and controlled traffic practices across a broad range of soil types in Western Australia" is a GRDC Investment.

This project is a collaboration between the West Midlands Group, Mingenew-Irwin Group, Liebe Group, Corrigin Farm Improvement Group, FACEY group, Southern Dirt, Stirlings to Coast Farmers, Merredin and Districts Farm Improvement Group, and South East Premium Wheat Growers Association. ■


THE BEST OILS WEREN'T GOOD ENOUGH.

Improving farm profits with longer season wheat crops

By Helen McMillan and Neil Fettell

At a glance…

- Early sown, long season material did very well in 2018 considering the season (Growing Season Rainfall was one of the lowest on record).
- More options are available to growers who have the opportunity to sow wheat to coincide with earlier rain and the need to start earlier due to a large cropping program.
- The trial is planned to run again in 2019 with the aim to test earlier sowing dates than 2018.

Why do the trial?

Growers in central and southern NSW are interested in sowing wheat earlier than the traditional May sowing window.

Sound evidence of how varieties perform in the region when sown earlier were not being delivered by the National Variety Trials (NVT). For example in 2017, only two of the 25 NVT trials termed "early season" were sown in April – and these were late in the month on April 27 and April 29.

This pattern was similar in earlier seasons where only about 5 per cent of the early season NVT trials were sown in April – and usually in the last week.

Some early season sowing background

There are a number of drivers contributing to local growers' interest in sowing earlier:

- Advances in summer fallow management, which have led to improved soil water storage and sowing opportunities;
- Declining frequency and magnitude of traditional autumn breaks and winter rainfall but some increase in summer rain;
- Improvements in no-till seeding technology, with greater moisture seeking abilities and more accurate seed placement;

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Region: CWFS is an independent, not-for-profit, farmer driven organisation operating in an area covering 14 million hectares in the lower rainfall, mixed farming regions of Central West NSW.

Formed in 1998, the group has over 300 members made up of farmers, private and public sector advisers, researchers and stakeholders.

Sponsors: GRDC, NSW DPI, GrainCorp, ADM.

- An increase in farm size and sowing programs which have lengthened the sowing program for many growers; and,
- Improved understanding of pre-emergent herbicide use in early sowing.

To ensure crops flower in the preferred window, earlier sowing requires a change in phenology and hence in variety, and most Australian breeding programs have recently increased their emphasis on developing varieties with a vernalisation and/or photoperiod response.

These responses can hold a variety in the vegetative state until it has either met its vernalisation (cold) and/or photoperiod (light) requirements before moving into reproductive stages.

The outcome of this is a variety that can be sown earlier and can delay flowering until after the frost risk period.

Traditionally, winter wheats have been grown in higher rainfall sections of the wheatbelt, although recent research has shown that varieties such as EGA Wedgetail could perform well in lower rainfall areas when grown on long fallow.

But more generally, quicker developing winter varieties – strong vernalisation (Vrn) sensitivity and insensitive photoperiod (Ppd) – were found to be best suited to early sowing in medium to low rainfall environments.

Longsword was the first variety of this type and was released in 2017 by AGT. Other breeding programs have varieties close to release.

How was the trial done?

To test the optimum sowing time for long season wheat cultivars three target sowing dates were used:

- Before April 25 (Time of Sowing 1);
- May 8 (TOS 2); and,
- May 23 (TOS 3).

Supplementary irrigation to ensure establishment was carried out.

The trial locations were Rankins Springs and Condobolin.

Twelve wheat varieties were tested: Longsword, Scepter, Trojan, Condo, Illabo, DS Bennett, Bolac, LPB14-0392, DS Pascal, Kittyhawk, Wedgetail and RGT Accroc.

Sowing and watering dates at Rankins Springs and Condobolin

	Rankins Springs		Condobolin	
	Sowing	Watering	Sowing	Watering
TOS 1	19/4/18	19-23/4/18	23/4/18	1/5/18
TOS 2	7/5/18	8-9/5/18	9/5/18	16/5/18
TOS 3	22/5/18	n/a	25/5/18	14/6/18

TABLE 1: Rankins Springs mean yield (t/ha) – TOS x Variety

Yield (t/ha)	Apr 19	May 7	May 22
Bolac	2.31[a]	2.17	1.63
Condo	1.82	2.28[a]	1.39
DS Bennett	2.47[a]	2.53[a]	1.85
DS Pascal	2.22	2.00	1.71
Illabo	1.92	2.24	1.32
Kittyhawk	2.20	2.20	1.60
Longsword	2.23	**2.57[a]**	1.78
LPB14-0392	2.24	2.15	1.49
RGT Accroc	1.98	1.72	1.70
Scepter	2.35[a]	**2.57[a]**	1.79
Trojan	2.09	2.42[a]	1.55
Wedgetail	2.04	2.06	1.44

Lsd = 0.29. Bold = highest yield, yields that are followed by the same letter are not significantly different.

What happened?

Rankins Springs trial: Optimum time of sowing long season wheat

Growing Season Rainfall (April 1 – Sept 30) for Rankins Springs was 68.5 mm. There was a significant interaction between sowing time and wheat variety when comparing yield at Rankins Springs (Table 1).

Longsword and Scepter, sown on May 7, were the highest yielding varieties in the trial. But the yield results were not significantly different to DS Bennett, Bolac or Scepter sown on April 19 and Condo and Trojan sown on May 7 (these are indicated in the table as numbers followed by the same letter).

There was a significant interaction between sowing time and wheat variety when comparing protein at Rankins Springs (Table 2). Wedgetail sown May 22 was the highest protein on 16.1 per cent (indicated by **bold**) with Bolac sown at the same time achieving the second highest protein on 15.3 per cent.

The AgGrow Agronomy spring field walk images of the Rankins Springs TOS trials (see below) help explain why the longer season, 'quick winter' wheat varieties performed well in 2018.

The quicker wheat varieties such as Condo are progressing towards grain ripening – indicated by less green. The longer season wheats – such as Longsword and Scepter – are less developed and are still quiet green.

The longer season wheats were able to utilise the 53 mm of rain that fell in October but it was too late to benefit the shorter season varieties.

These photos were taken at the AgGrow Agronomy spring field walk on September 26, 2018 at Rankins Springs. **(All images by Shirley Fettell)**

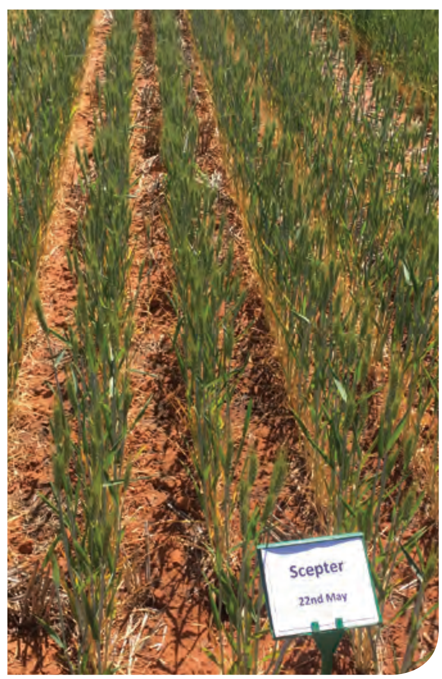
Condo TOS 1 – April 19, 2018.

Longsword TOS 1 – April 19, 2018.

Scepter TOS 1 – April 19, 2018.

Condo TOS 3 – May 22, 2018.

Longsword TOS 3 – May 22, 2018.



Scepter TOS 3 – May 22, 2018.

TABLE 2: Rankins Springs protein (%) – TOS x Variety

Protein (%)	Apr 19	May 7	May 22
Bolac	12.9^{hi}	13.5^{ef}	15.3^{b}
Condo	11.3^{qr}	11.3^{qr}	11.7^{op}
DS Bennett	12.9^{hi}	13.0^{gh}	13.3^{fg}
DS Pascal	12.0^{no}	13.3^{fg}	13.6^{e}
Illabo	12.3^{lm}	12.4^{klm}	14.6^{cd}
Kittyhawk	12.6jk	13.5^{ef}	14.5^{d}
Longsword	12.1^{mn}	13.1^{gh}	12.5^{jkl}
LPB14-0392	11.7^{op}	12.7^{ij}	14.8^{c}
RGT Accroc	13.8^{e}	14.8^{c}	14.7^{cd}
Scepter	10.4^{r}	11.2^{r}	11.1^{s}
Trojan	11.3^{qr}	11.7^{p}	11.5^{pq}
Wedgetail	14.8^{c}	$14.^{5d}$	**16.1^{a}**

Lsd = 0.25. Bold = highest yield, yields that are followed by the same letter are not significantly different.

Condobolin: Optimum time of sowing long season wheat

Growing season rainfall (April 1 – Sept 30) for Condobolin was 63.4 mmr. The Condobolin trial was irrigated with drippers to ensure germination, and it was also flood irrigated on August 8 to ensure it would make it through to harvest.

There was no interaction between sowing time and wheat variety at Condobolin in 2018, therefore TOS and variety were analysed separately.

The earlier TOS achieved the highest yield at Condobolin, averaging 2.44 tonnes per hectare (Table 3) and the highest yielding varieties were Longsword and Scepter both with an average of 2.73 tonnes (Table 4).

There was no interaction between wheat variety and water treatment in this trial (results not shown).

TABLE 3: Mean yield across three TOS dates at Condobolin

	Yield (t/ha)
TOS 1	2.44^{a}
TOS 2	2.28^{b}
TOS 3	1.65^{c}
Lsd	0.427

TABLE 4: Mean yield of varieties at Condobolin

Variety	Yield (t/ha)
Bolac	2.01^{cde}
Condo	2.17^{c}
DS Bennett	2.01^{cde}
DS Pascal	1.92^{def}
Illabo	2.09^{cd}
Kittyhawk	1.86^{def}
Longsword	**2.73^{a}**
LPB14-0392	1.94^{cdef}
RGT Accroc	1.72^{f}
Scepter	**2.73^{a}**
Trojan	2.44^{b}
Wedgetail	1.82^{ef}

Lsd = 0.25. Bold = highest yield, yields that are followed by the same letter are not significantly different.

To sum up

- Early sown, long season material did very well in 2018 considering the season.
- Late October rain would have had an impact on final yield and variety rankings. This was seen at Rankins Springs where the longer season varieties did well compared to the shorter season wheats.
- Early sowing worked best, but some of the late varieties did well due to late watering for germination.
- Lack of significant frost events in 2018 could help explain why the mid-season wheat varieties performed similar to long season varieties.
- Longsword did better than slower wheat varieties at Condobolin, which wasn't the case at Rankins Springs.
- More options are available to growers who have the opportunity to sow wheat to coincide with earlier rain events and the need to start earlier due to a large cropping program.
- The trial is planned to run again in 2019 with the aim to test earlier sowing dates than 2018.

CWFS would like to thank Barry Haskins and the team at AgGrow Agronomy for hosting the trial sites.
Finally CWFS would like to thank farmers and GRDC for their support and contributions to agricultural research in the Central West.

Further information on this trial: Helen McMillan
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Project code: CWF1804-001SAX ■

Earlier (pre-May) sowing trials in the Central West are showing great promise.

Vale Dr Neil Fettell

It is with great sadness that CWFS – and the entire Australian grain industry – farewells a colleague, mentor and dear friend, Neil Fettell. After a long illness, Neil died on March 16, 2019.

Neil was a founding member of CWFS in 1998 and a strong advocate for agricultural research in the Central West region for most of his life. His passion focused on cropping and farming and he was particularly interested in what contribution research could make to improve agriculture. His impact on agriculture is indisputable and he was regarded as a leader in his field by his peers and organisations such as GRDC and CSIRO to name a few.

Neil received a NSW Agriculture Staff Award in 2000 and the 2002 GRDC *Seed of Light* Award for excellence in communication and extension.

Neil graduated with First Class Honours in Agriculture at the University of Sydney and embarked on a career with NSW DPI in 1974 after winning a CSIRO scholarship to study how to maximise phosphorus use by dryland wheat in the Condobolin region. Neil then completed a masters and doctorate in science.

Neil has been a GRDC panel member, part-time lecturer at the University of New England and recently worked as a Senior Research Advisor for CWFS. He was respected by all who knew him and he had the rare ability to comfortably address farmers at a field day as well as present papers to the scientific community.

Neil's brilliant mind and beautiful nature will be missed – he was always so generous with his time and advice, never failing to calmly help where he could. Heartfelt condolences are extended to Neil's family. He was a wonderful man.

Knockdown and double knock control of common sowthistle in fallow

By Northern Grower Alliance[1]

At a glance…

- Currently there are no effective alternatives to glyphosate for consistent one-pass knockdown control of common sowthistle;
- NGA has researched various alternatives. The control levels from all strategies improved on seedling to rosette weed stages compared to later growth stage application;
- A range of options provide effective control of seedling to rosette-staged common sowthistle when followed with a paraquat 2nd knock application;
- The double knock program of glyphosate + 2,4-D followed by paraquat for flaxleaf fleabane also provides consistent management of common sowthistle;
- Double knocks of Basta followed by paraquat have the most consistent common sowthistle control, but may only be appropriate in sensitive areas or in optical spray situations due to cost; and,
- Sharpen as a 2nd knock option has provided similar levels of common sowthistle control to paraquat at 1.6 to 2.4 L/ha.

Why do the trial?

Management of common sowthistle (*Sonchus oleraceus*) has increased in difficulty over the past 10 to 15 years across most of the grain growing areas of northern NSW and southern Qld.

The reasons for this are varied but include: The weed appears to have adapted to emergence at any time of the year; The seed is easily wind dispersed with reinfestation of 'clean paddocks' a constant challenge; and, Glyphosate tolerance and resistance levels have continued to increase.

It is clear that the industry can no longer rely on applications of glyphosate alone for common sowthistle control in fallow. The NGA research undertaken during 2016 to 2018 has been to screen alternative herbicides for potential as standalone options on small weed stages but more likely as 1st knock applications in a double knock herbicide program.

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About: Northern Grower Alliance (NGA) is an Incorporated Association that was established in 2005 by six leading northern region consultants – Michael Castor, Robert Long, Drew Penberthy, Greg Rummery, Greg Giblett and Peter McKenzie – who were representing the interests and needs of growers involved in six separate grower groups across southern Qld and northern NSW. The NGA provides a regional capacity for industry-driven, applied agronomic research into the challenges of grain production.

The scope or direct area of influence from NGA now covers around 1.5 million hectares of cropping. NGA is currently working on a five year project, fully funded by GRDC, focusing on the validation and adoption of new agronomic practices in the region.

Funding body: GRDC.

A double knock approach is where two different weed management strategies are employed in a sequential fashion to achieve a high level of weed control.

How was the trial done?

Two distinct series of knockdown trials have been conducted:

- **Evaluation of alternatives to glyphosate for use as a 1st knock**
  The focus of this work was to identify whether existing fallow herbicide registrations may provide a viable alternative to glyphosate, either when applied alone or as part of a double knock strategy.
  In 2016 and 2017, paraquat was applied as the 2nd knock treatment.
  In 2018, a mixture of paraquat (Gramoxone 250) + saflufenacil (Sharpen) was applied.
- **Evaluation of alternatives for use as a 2nd knock**
  The focus of this activity was to screen for alternatives to paraquat for use as a 2nd knock treatment in an attempt to improve the consistency of double knock control but also to reduce the high level of resistance selection pressure on paraquat.

What happened?

Evaluation of alternatives to glyphosate for use as a 1st knock

Initial work evaluated a range of tank mixtures with glyphosate. But unless marginal control was achieved from the glyphosate component – either a marginal rate under prevailing conditions or weeds exhibiting glyphosate resistance – the risk was that all treatments provided complete control as 1st knocks.

Subsequent research in 2016–2018 evaluated the majority of options in the absence of glyphosate. A total of 24 different 1st knock approaches have been evaluated. A range of chemistry has been evaluated with Group I chemistry such as Tordon, Amicide 625 and Starane Advanced providing useful activity.

Table 1 shows the results from the most consistent 1st knock treatments. All listed treatments were evaluated together in six trials.

Basta (200 g/L glufosinate) at the rate of 3.75 L/ha was only included at two of the six trial sites in Table 2.

It achieved complete control at one site and 99.9 per cent at the second. Basta 3.75 L/ha significantly increased control to Glyphosate CT 1.0 L/ha at one of the two sites.

A total of 24 first knock alternative herbicides were tested on common sowthistle in fallows across northern NSW (Mullaley pictured) and southern Qld.

Mixtures of Group G herbicides (for example, Sharpen – 700 g/kg saflufenacil) with glyphosate were evaluated. They did not provide the consistency of control of treatments listed in Table 2, particularly when followed by paraquat.

A 2nd knock application of Gramoxone 250 (250 g/L paraquat) was applied to all 1st knock treatments at a rate of 1.6 or 2.0 L/ha.

Mean control from all treatments listed in Table 1 when double knocked was 99–100 per cent. There was no significant difference in control between any of the treatments, in any trial.

Tables 2 and 3 show the results when targeting elongating staged common sowthistle.

Table 2 shows the results from the 1st knock applications alone.

Table 3 shows the same treatments when followed by a 2nd knock with Gramoxone at 1.6 or 2.4 L/ha (depending on trial).

TABLE 1: Summary of efficacy from 1st knock applications on seedling to rosette-staged common sowthistle, 2016–2017

1st Knock Treatment	% Control (1st knock alone)		Comparison to Glyphosate CT @ 1.0 L/ha (applied alone)	
	Mean of 6 trials	Range	Significantly poorer control	Significantly improved control
Glyphosate CT 1 L/ha (450 g/L glyphosate)	60	40–84	NA	NA
Glyphosate CT 2 L/ha (450 g/L glyphosate)	70	35–97	-	4 trials
*Tordon 75-D 1 L/ha (300 g/L 2,4-D + 75 g/L picloram)	78	9–98	-	4 trials
*FallowBoss Tordon 1 L/ha (300 g/L 2,4-D + 75 g/L picloram + 7.5 g/L aminopyralid)	77	18–100	-	5 trials
Starane Advanced 0.6 L/ha (333g/L fluroxypyr)	49	6–90	1 trial	2 trials
Amicide 625 1.8 L/ha (625 g/L 2,4-D amine) + Hasten 1%	80	35–100	-	4 trials

The treatments were assessed around five weeks after application (range 20 to 64 days).
***Note:** Tordon 75-D and FallowBoss are both registered for use in fallow at a rate of 1.0 L/ha, but common sowthistle is not separately listed as a weed controlled under this use pattern. Lower rates of both products are registered for use in wheat and sowthistle is listed as a weed controlled at these lower rates.

TABLE 2: Summary of efficacy from 1st knock applications alone on elongating-staged common sowthistle, 2016–2017

1st Knock Treatment	% Control (1st knock alone)		Comparison to Glyphosate CT @ 1.0 L/ha applied alone	
	Mean of 6 trials	Range	Significantly poorer control	Significantly improved control
Glyphosate CT 1 L/ha (450 g/L glyphosate)	86	73–99	NA	NA
Glyphosate CT 2 L/ha (450 g/L glyphosate)	96	92–100	-	2 trials
*Tordon 75-D 1 L/ha (300 g/L 2,4-D + 75 g/L picloram)	91	75–99	1 trial	2 trials
*FallowBoss Tordon 1 L/ha (300 g/L 2,4-D + 75 g/L picloram + 7.5 g/L aminopyralid)	94	91–100	1 trial	2 trials
Starane Advanced 0.6 L/ha (333g/L fluroxypyr)	84	70–99	2 trials	-
Amicide 625 1.8 L/ha (625 g/L 2,4-D amine) + Hasten 1%	94	82–100	1 trial	2 trials
Basta 3.75 L/ha (200 g/L glufosinate)	90	71–97	-	4 trials

The treatments were assessed around five weeks after 1st knock application (range 21 to 49 days).
***Note:** Tordon 75-D and FallowBoss are both registered for use in fallow at a rate of 1.0 L/ha, but common sowthistle is not separately listed as a weed controlled under this use pattern. Lower rates of both products are registered for use in wheat and sowthistle is listed as a weed controlled at these lower rates.

Key points: Alternative 1st knocks

Seedling to rosette stage of sowthistle

- Variable control with glyphosate alone but improved control with increased glyphosate rates;
- Group I (phenoxy) options generally provided good suppression but not consistent control;
- Group I product differences were clearly evident from 1st knock applications alone;
- Consistent and high levels of control (99 to 100 per cent) achieved when either glyphosate or the Group I options listed in Table 2 were double knocked with paraquat; and,
- Basta is encouraging, either alone or double knocked, but cost prohibitive for broadacre application.

Elongating stage of sowthistle

- No treatment provided acceptable control when applied alone;
- Overall, the most consistent suppression was achieved with Basta. But there was poorer control when applied alone than other options in two of six trials;
- Basta double knocked with paraquat was the most consistent option and should be considered for optical spray uses;
- Group I options were encouraging, but only when double knocked; and,
- Starane Advanced at 0.6 L/ha provided the least suppression of the listed group I herbicides when applied alone or when double knocked with paraquat.

Evaluation of alternatives for use as a 2nd knock

Paraquat has been the key active ingredient used as the 2nd knock option and can provide effective management of a wide range of grass and broadleaf weeds. But it is clear we require other options to use in this management window:

- To avoid the more rapid selection of paraquat resistance; and,
- To provide options that may improve weed control in situations where paraquat efficacy is not adequate.

Key points: Alternative 2nd knocks

- Evaluation in 2016 showed improved efficacy from Sharpen as a 2nd knock treatment compared to other group G options or Basta;
- Sharpen performance has been more consistent when used in a 2nd knock application, with no regrowth evident in any of these trials;
- Dose response to Gramoxone 250 was

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relatively flat from 1.6 – 2.4 L/ha but apparent in situations of marginal control; and,

- Negligible dose response to Sharpen with similar performance to Gramoxone 250 at 1.6 – 2.4 L/ha.

To sum up

Inconsistent levels of in fallow control of common sowthistle with glyphosate alone are now commonplace.

Results from these trials reinforce the need to use robust glyphosate rates, avoid spraying under stressed conditions and target small weed stages. There are no obvious direct replacements for glyphosate as a standalone knockdown option.

However, group I herbicides such as Tordon 75-D, FallowBoss Tordon and Amicide 625 have provided equivalent or improved control when followed by a paraquat double knock.

For situations near sensitive crops or where cost isn't the major constraint (for example when applied via an optical sprayer), Basta has provided effective management when used as the 1st knock in a double knock strategy. But previous trial activity has shown inconsistent results on flaxleaf fleabane and a range of summer grass species when Basta was used as 1st knock in a double knock strategy.

Sharpen can be a very effective option on small common sowthistle but levels of regrowth are commercially concerning when used alone or in mixture with glyphosate. Results from this series of trials has also shown inconsistent double knock results when Sharpen + glyphosate is the first application.

In contrast, Sharpen has been very consistent when used as 2nd knock alternative to paraquat or in mixture with paraquat. Level of control from Sharpen at 17–26 g/ha has been at least equivalent to that achieved with paraquat at 1.6–2.4 L/ha. But paraquat is a better option in mixed grass and broadleaf fallow situations.

Alternative second knock herbicides were also evaluated by the NGA for the control of common sowthistle in fallow.

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The research undertaken as part of this project is made possible by the significant contributions of growers through both trial cooperation and the support of the GRDC, the authors would like to thank them for their continued support.
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Project code: NGA00004

TABLE 3: Summary of efficacy from double knock applications on elongating-staged common sowthistle, 2016–2017

1st Knock Treatment	% Control (1st knock alone)		Comparison to Glyphosate CT @ 1.0 L/ha Double knocked with paraquat	
	Mean of 6 trials	Range	Significantly poorer control	Significantly improved control
Glyphosate CT 1 L/ha (450 g/L glyphosate)	80	50–100	NA	NA
Glyphosate CT 2 L/ha (450 g/L glyphosate)	89	62–100	-	2 trials
*Tordon 75-D 1 L/ha (300 g/L 2,4-D + 75 g/L picloram)	97	82–100	-	3 trials
*FallowBoss Tordon 1 L/ha (300 g/L 2,4-D + 75 g/L picloram + 7.5 g/L aminopyralid)	96	77–100	-	3 trials
Starane Advanced 0.6 L/ha (333 g/L fluroxypyr)	86	56–100	-	-
Amicide 625 1.8 L/ha (625 g/L 2,4-D amine) + Hasten 1%	93	77–100	-	3 trials
Basta 3.75 L/ha (200 g/L glufosinate)	99	97-100	-	3 trials

The treatments were assessed around five weeks after 1st knock application (range 21 to 49 days).
The 2nd knock applications were applied at 7 to 19 days after the 1st knock.
***Note:** Tordon 75-D and FallowBoss are both registered for use in fallow at a rate of 1.0 L/ha, but common sowthistle is not separately listed as a weed controlled under this use pattern. Lower rates of both products are registered for use in wheat and sowthistle is listed as a weed controlled at these lower rates.

TABLE 4: Summary of efficacy from second knock applications on common sowthistle, 2017–2018

2nd Knock Treatment	% Control		Comparison to Gramoxone @ 1.6 L/ha	
	Mean of 8 trials	Range	Significantly poorer control	Significantly improved control
Untreated (1st knock only)	87	60–100	4 trials	—
*Gramoxone 250 0.8 L/ha (250 g/L paraquat)	94	76–100	3 trials	1 trial
Gramoxone 250 1.6 L/ha (250 g/L paraquat)	98	94–100	NA	NA
Gramoxone 250 2.0 L/ha (250 g/L paraquat)	99	96–100	—	—
Gramoxone 250 2.4 L/ha (250 g/L paraquat)	99	98–100	—	—
Sharpen 17 g/ha + (700 g/kg Saflufenacil) + Hasten 1%	100	98–100	—	1 trial
Sharpen 26 g/ha (700 g/kg Saflufenacil) + Hasten 1%	99	97–100	—	1 trial

The treatments were assessed around five weeks after the 2nd knock application.
The 2nd knock applications were applied at 7 to 19 days after the 1st knock.
Note: All treatments received the same 1st knock application in each trial. The most common treatment was a mixture of glyphosate with 2,4-D amine, with the rates varying with the weed stage, environmental conditions and grower/adviser recommendations. 2nd knocks were targeted for application at around 7 to 14 days after the 1st knock. Mean interval was 11 days.
*Label rates for Gramoxone are 1.2 to 2.4 L/ha. A rate of 800 mL/ha was included in trials as a 'failure rate'.

Section 4

District Reports

Reviews of the 2018–19 season

CONTENTS

National overview

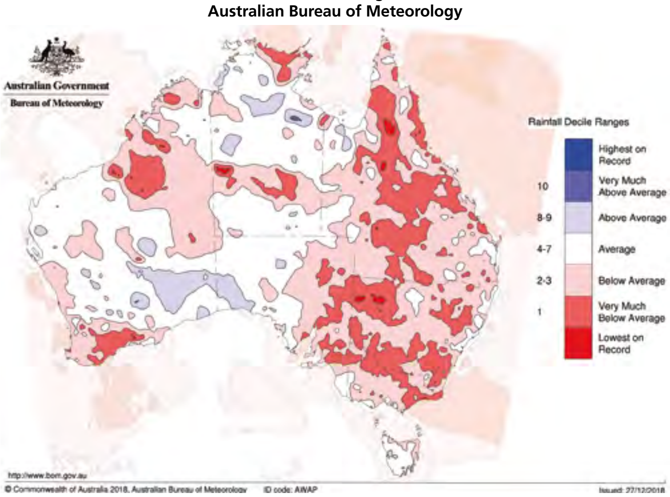
With well below average rainfall recordings – on top of very moderate stored soil moisture levels – the 2018–19 season was one of the toughest for many years for eastern states' grain growers. Fortunately, in the west, it was a vastly different story.

After a patchy start, much of the Western Australian grainbelt enjoyed very timely spring rainfall and generally mild late season conditions. This resulted in a bumper crop for WA growers with total grain deliveries estimated at a touch under 18 million tonnes – the second biggest on record for the state.

WA growers also enjoyed excellent prices thanks to strong feedgrain demand out of the eastern states. Feed-lots and other intensive animal industries needed to look to the west to source grain.

The Growing Season Rainfall decile chart below depicts a continent of two halves. The eastern states are almost entirely blanketed in pink or red hues indicating below average through to lowest on record rainfall for the April 1 through November 30, 2018 period. The chart shows that the western half of the country fared much better in terms of average rainfall over this winter crop growing period. And with the very soft finish, a lot of excellent crops were produced.

Australian rainfall decile April 1 to November 30, 2019
Distribution based on grided data
Australian Bureau of Meteorology



The drought conditions continued into the 2018–19 summer period resulting in large reductions in the area planted to both dryland and irrigated summer crops.

Western Australia

Western Australia's final grain production for the 2018 season is estimated at 17.9 million tonnes – the second highest on record with a value of just under $7 billion dollars. Earlier predictions of 14 mt following the dry spring and several severe frost events were eclipsed by a nearly 4 mt turnaround over most parts of the state, due to the late 'soft finish' with mild temperatures during grain fill prior to harvest.

Clay spreading non wetting sands on the Warakirri property, 'Lobethal' to the east of Condingup on WA's south coast.
(PHOTO: Quenten Knight)

TABLE 1: 2018 WA crop production estimates (tonnes) – GIWA

Port zone	Wheat	Barley	Canola	Oats	Lupins	Pulses	State total
Kwinana	4,960,000	2,520,000	560,000	295,000	140,000	5,000	**8,480,000**
Albany	1,150,000	1,560,000	320,000	245,000	45,000	1000	**3,321,000**
Esperance	1,340,000	790,000	300,000	20,000	15,000	25,000	**2,490,000**
Geraldton	2,700,000	265,000	270,000	15,000	370,000	2000	**3,622,000**
Totals	**10,150,000**	**5,135,000**	**1,450,000**	**575,000**	**570,000**	**33,000**	**17,913,000**
Compared to 2017 harvest	+33.60%	+35.10%	–23.70%	+19.80%	+26.70%	–26.70%	**+25.50%**

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: 2018 WA crop yield estimates (t/ha) – GIWA

Port zone	Wheat	Barley	Canola	Oats	Lupins	Field pea
Kwinana	1.87	3.60	1.19	2.00	1.08	0.50
Albany	1.47	2.60	1.14	1.88	1.13	0.33
Esperance	2.63	2.26	1.43	2.00	1.50	1.25
Geraldton	2.93	2.41	2.08	1.50	1.94	2.00
Averages	**2.23**	**2.72**	**1.46**	**1.85**	**1.41**	**1.02**

Total tonnage for the Kwinana port zone was up 2.2 mt from 2017 and Geraldton port zone up 2 mt from 2017. The Esperance and Albany port zones were both down from 2017 with a decrease of 0.5 mt for Esperance port zone and 0.2 mt for the Albany port zones. This was a reflection of the poor growing season in the western and northern areas of the Esperance port zone and the east Albany port zone.

The standout crop in 2018 was barley with an average grain yield of 3.19 tonnes per hectare which was well above recent averages.

The percentage of barley making malt grades was also up by nearly 10 per cent on historical averages, with a record total tonnage produced of just over 5 mt.

This is the fourth time Western Australia has produced 10 mt or more of wheat and three of those years were in the past seven years – including a trend over that time of declining planted area.

Only 54 per cent of the crop area in Western Australia was wheat in 2018 – the lowest on record.

Grain weight was high in most regions of the state. This was a function of the soft slow finish to the season. Screenings were generally low except for some very high yielding barley varieties such as Planet when grown on the eastern fringes of the medium rainfall regions.

In the southern regions of the state there were reasonable tonnages of malt grade barley downgraded to feed from germ end stain due to rain and humidity during grain-fill and prior to harvest.

Wheat grain protein was lower than in recent years, influenced mainly by the dilution from higher than expected yields. A noticeable recent trend is that wheat grain protein is more likely to hold up on ameliorated soils where crops are more able to use the available soil moisture 'bucket'. This gives growers more confidence in fertilising for maximum potential.

Around 40 per cent of all barley deliveries made malt grade which is about 10 per cent more than normal. The percentage of malt grade deliveries were nearly 50 per cent in the Albany port zone, although this was biased by a greater percentage of feed barley production acquired privately in the zone than other regions of the state.

There is a large area of ameliorated soils in the Geraldton Zone with very positive grain yield spin-offs. (PHOTO: Peter Norris)

Canola oil quality was down slightly from recent years and generally lower than expected by growers considering the soft cool finish to the season. Most oil percentages were in the mid 40s rather than the high 40s. Canola grain yields were very erratic in 2018 with no single factor influencing the final result and this may have contributed to average oil percentages being lower than recent years.

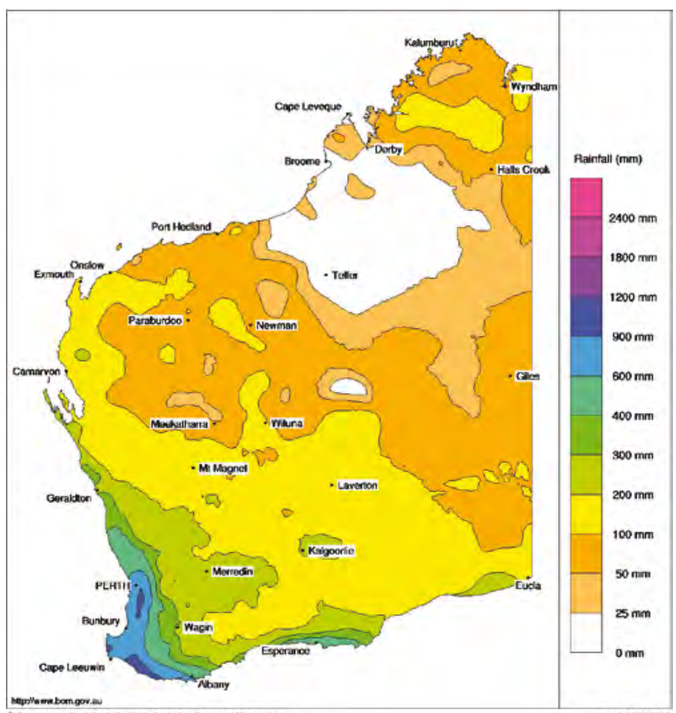
Lupin area continues to climb on the back of the more determinate rather than indeterminate growth habit types recently released. These new varieties have more suitable adaptation in the southern areas and whilst producing less growth, are very good yielders for grain. The only downside is the prevalence of more split seed in the harvest sample, which appears somewhat to be due to variety, and possibly to higher yields requiring more manganese.

Milling oat demand continues to increase and Western Australia's reputation for producing a premium product was again enhanced with most milling grade oats delivered or privately acquired of very high grain quality.

Field peas continue to be grown in small quantities in the southern regions of the state. Many crops were hit by frost and produced low grain yields, although in the absence of frost, grain yields were good. The smaller areas of lentil, faba bean and chickpea are growing, although still too small to report on.

Western Australia rainfall totals (mm) April 1 to November 30, 2019

Australian Bureau of Meteorology



Geraldton Zone

Total grain production in the Geraldton port zone exceeded all expectations leading in to harvest, as little rain fell in the region after mid-August. The zone produced just over 3.5 mt of total grain – 2 mt more than 2017. The season was set up well with good stores of subsoil moisture from summer rains and was heading for a record until the tap was turned off. Many growers feared the worst, as the start to the season

was later than normal, and for crops like canola much later than they would have preferred. It was expected that crops would turn their toes up when the heat came on in the spring

It was the lack of significant heat shock and very unseasonal mild temperatures which contributed to the turnaround in final grain yield.

Many growers commented that it was their best result with very minimal costs. There were significant areas of fallow or sprayed out crop from 2017 and this contributed to enabling crops to yield more than expected. The most significant contribution allowing crops to achieve good yields on very little growing season rainfall has been the large area of ameliorated soils in the region.

The estimated 500,000 hectares of ameliorated soils each year is skewed heavily in the northern regions of the state. These areas of ameliorated country allow crops to more effectively utilise stored moisture and the 2018 growing season is testament to this production practice.

The Midlands

The Midlands region of the state was very good from west to east. The eastern regions had one of their best years in recent times. Coupled with very good grain prices this resulted in a huge turnaround for those growers hit by the very dry conditions in 2017.

The very western areas of the region did not perform as well, as waterlogging during August played a big part on leaching nutrients below the root zone and heavier soils were too saturated to recover in the spring.

Many growers struggled with grain protein in the region. One speculation as to the cause of low protein is that a variety can be a "lazy accumulator" which means it struggles to extract and mobilise enough nitrogen to support adequate grain protein during grain-fill. Another thought is that we are now regularly obtaining very high grain yields in cereals and canola, with few legumes in the system, meaning that old calculated rates of applied nitrogen may need re-evaluating.

Yet another view is that growers are making increasingly sophisticated risk management decisions, finessing the financial rewards of yield vs protein in the recent high price conditions.

Machinery operator Linus Schueler from Warakirri Cropping – located to the east of Condingup on WA's South Coast – in an impressive 2018 crop of Scepter wheat. (PHOTO: Quenten Knight)

Kwinana West

The Kwinana West region had a record grain production year where daily delivery records and total delivery records were recorded for many CBH receival sites. Despite the record receivals of grain, in general the supply chain responded to the logistical challenge.

Grain quality was generally good, reflected in the greater confidence growers have in the higher rainfall regions to fertilise for maximum potential yield.

Kwinana East

The Kwinana East zone had a good year rather than a very good year as far as tonnages were concerned. The season was looking excellent until mid-August, with many growers taking more risks than usual with input costs on the back of the previously poor year, and with prices being higher than normal.

The season looked to "cut out" in August and crops were on the slide in September with estimates revised down as each week passed without rain. Crops were going white and some of the barley was damaged by frosts. Then, just in time, there was good general rain in the region during early October which allowed the wheat to recover to some extent and return close to average grain yields.

Western Albany

Cereal crops in the West Albany region were excellent with some very high yields recorded in both wheat and barley. The start to the season was difficult with several very severe wind events and good rains falling later than in the northern regions of the state. The growing conditions were warm once crops emerged and when the rain cranked up in August most crops were able to handle the waterlogging better than normal.

Total growing season rainfall for the region was about average or below average with most cereal crops yielding well above average. Grain protein was lower than normal simply due to dilution from the very high yields.

The canola suffered more from the difficult start to the season – as was the case for most of the southern regions – and never recovered to yield anywhere near what would normally be expected.

Southern Albany

The Southern Albany region bore most of the brunt of the very windy conditions at the start of the season and many growers were writing off the year as early as July. Just as many were looking to 2019 the rain started in August and the turn-around was incredible. Many cereals in the region ended up yielding close to average and whilst canola never really recovered, those areas that were re-sown to barley yielded well enough to recover much of the extra costs.

Snails in canola are emerging as a concern for many of the growers in the region. Canola rotations are tight with many paddocks barley/canola/barley/canola being the most profitable rotation. This rotation is at risk if snails are not controlled well enough to keep numbers down to very low levels in the sample.

Eastern Albany (Lakes Region)

The Lakes district did not have a good year with very low rainfall recorded, resulting in ongoing and challenging feed and water conditions. Whilst most enterprises either broke even or returned a small profit, there was a lot of frustration that more could not be made of the good prices. Nevertheless, water use efficiencies were off the scale for grain production as they often are with lower rainfall, if the rain falls when needed.

The comment from experienced farmers in the region was "in the old days we wouldn't have produced any crop at all in a year like this". Modern farming practices have contributed to growers being able to make the most of just about whatever the season presents, and the 2018 season is testament to the skills and resilience of the Lakes district communities.

Esperance Zone/South Coast

The Esperance port zone finished up with another good year despite a very difficult start. Wind, low rainfall and frost in the eastern regions of the zone contributed less to the region's production than normal. The poor year in the east and north of the zone resulted in about 500,000 tonnes less than in 2017, which was a record year.

Grain yields in the central regions of the zone were exceptional with many wheat and barley crops yielding more than 5 tonnes per hectare. Grain protein was generally low in these crops as it was in many of the high yielding regions of the state.

Canola was disappointing and yielded below expectations for a range of reasons. Canola is still a relatively immature crop compared to wheat and barley. For canola to achieve consistent yields in a range of seasons requires a high level of management as one or two "slip-ups" can result in grain yields not returning close to potential.

Green peach aphid caused a lot of damage in canola crops during 2018 and while most growers realise the green bridge over summer is contributing to the problem, growers along the coast that keep green feed going for stock are probably not going to change what they are doing. Consequently, some growers are considering reducing their exposure to canola and increasing the areas of pulses as a break crop.

The region leads the way with adoption and trialling of pulse crops. Whilst there were some unexpected problems with crops such as lentils with herbicide interaction with waterlogging, the increase in area planted to pulses is projected to keep going up.

GIWA gratefully acknowledges the support of DPIRD, CBH, CSIRO and contributions from independent agricultural consultants and agronomists in the production of this report. Report supplied February 8, 2019

Grain Industry Association of WA Crop Report February, 2019

South Australia

Total South Australian grain crop production in 2018–19 is estimated at 5.3 million tonnes from a crop area of 3.5 million hectares. The five-year averages are 8.3 mt of grain from 3.8 million hectares respectively. Drought and frost reduced grain yields and a large area of crop was cut for hay.

Final crop production was higher than that estimated during early spring of 2018 due to more favourable late spring conditions on Eyre Peninsula and Central and Southern Yorke Peninsula.

Harvest progressed rapidly in early November, but above average rainfall and cool conditions in many areas caused significant delays in the last half of November and early December.

Yields were highly variable, depending on rainfall, soil type and frost damage with most districts having below to very much below average yields. But the Southern Yorke Peninsula, Lower Eyre Peninsula and the Mid and Lower South East achieved average to above average yields.

Some farmers on Eastern Eyre Peninsula, Upper North, Mid North and Southern Mallee did not harvest enough grain to provide seed for this season's crops.

Crop damage from widespread frosts in late September and early October was worse than expected in the Upper North, Mid-North, Murray Mallee and Upper South East. Despite significant areas being cut for hay there were still areas of frost damage, particularly in wheat and pulse crops.

Strong winds and hail in late November damaged unharvested canola, barley and lentil crops in a number of districts.

Grain quality generally good

But wheat grain quality was generally good in most areas with moderate to high protein and low screenings.

Barley yields were higher than expected in a number of districts, while wheat yields were often lower, due to drought and frost.

Barley quality was generally good, with low screenings and high

SOUTH AUSTRALIA 2018–19 WINTER CROP PRODUCTION (tonnes) AND AREA (hectares) AGAINST THE 5 YEAR AVERAGE

Crop		5-year average	State total 2018–19
Wheat	ha	2,198,700	1,960,200
	tonnes	4,909,300	2,982,700
Durum	ha	56,000	41,200
	tonnes	149,800	68,920
Barley	ha	802,400	793,300
	tonnes	2,081,800	1,470,800
Oats	ha	80,000	75,700
	tonnes	158,300	112,250
Rye	ha	8100	5300
	tonnes	8500	3150
Triticale	ha	27,900	29,400
	tonnes	51,300	32,670
Peas	ha	98,800	65,700
	tonnes	130,300	51,720
Lupins	ha	70,100	62,800
	tonnes	86,000	57,950
Beans	ha	69,200	62,600
	tonnes	115,800	74,980
Chickpeas	ha	20,200	33,600
	tonnes	27,300	23,870
Lentils	ha	135,800	149,800
	tonnes	228,700	171,680
Vetch	ha	26,900	28,400
	tonnes	17,900	5760
Canola	ha	247,200	193,100
	tonnes	335,200	236,000
Hay (not in total)	ha	236,600	436,000
	tonnes	1,055,800	1,297,000
STATE TOTALS	**ha**	**3,843,400**	**3,499,300**
	tonnes	**8,300,200**	**5,292,450**

test-weights. A lower percentage than normal of malting varieties were classified as malt, mainly due to high grain protein levels. Some malt classifications were changed to increase the percentage of malt, but these were generally minor.

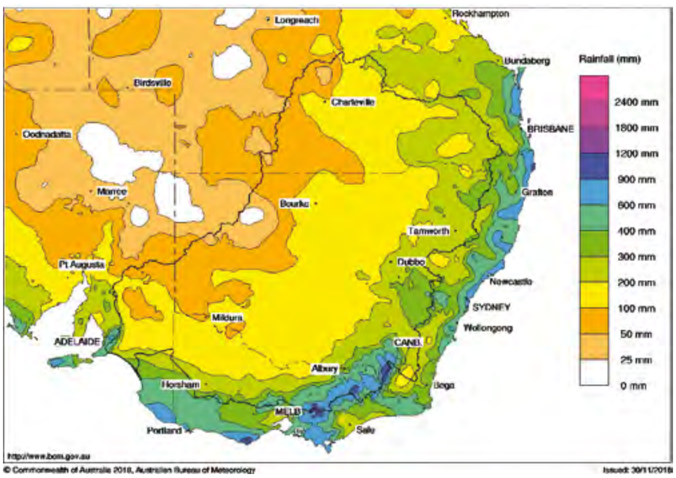
Canola yields were highly variable being higher than expected in some districts and very poor in others. But grain quality was generally good with high grain oil content in most districts.

Pulse crops generally performed poorly in most districts with low yields and small grain size. The exception being bean and pea crops on Lower Eyre Peninsula and the Lower South East.

Grain cleaning was required to reduce snail numbers on the Yorke Peninsula with some loads downgraded.

Summer weeds germinated following rainfall in late November and early December 2018 in most districts. Some farmers began spraying in mid-December but dry hot conditions in late December and early January stressed or dried-off most weeds.

Murray–Darling Basin rainfall totals (mm)
April 1 to November 30, 2019
Australian Bureau of Meteorology



Western Eyre Peninsula

There were significant areas of Western Eyre Peninsula affected by frost during the season. Most of the worst affected paddocks were cut early for hay. There was some grain yield loss from frost but this was generally small and within farmer expectations.

Crop yields were better than early season estimates, and crops in most areas achieved around 70 per cent of average yields. With the high grain prices, this resulted in close to average returns in many districts.

Crops on sandy soils which germinated early achieved well above average yields, while those on the red flats around Nunjikompita, Wirrulla and Poochera yielded average to slightly below average. Later sown crops and those on grey calcareous soils performed poorly.

Wheat quality was generally very good with high protein and low screenings. Much of the crop achieved H1 or H2 classification.

Barley yields were generally well above average and most grain was of high quality with good grain weights and low screenings. In many cases grain protein levels were too high for malt classification with grain delivered as Feed 1.

Pea and canola yields were variable depending on soil type. Where crops did not suffer frost damage, peas yielded around 1.5 tonnes per hectare on lighter textured soils but only around 0.5 tonnes on the heavier soil types. Similarly, canola yields were good on lighter textured soils (1.5 to 2.5 tonnes) but very poor on heavier flats (0.2 to 0.5 tonnes per hectare).

Summer weeds germinated quickly following November rain and many farmers began spraying them as soon as they had finished harvest.

Lower Eyre Peninsula

Weather conditions frustrated harvesting efforts, causing significant delays. Strong winds and hail in late November caused significant damage to isolated standing canola and barley crops, but the area affected was relatively small as a proportion of the overall crop.

Harvest was around 80 per cent complete in late December with canola, barley and pulses harvested. Farmers only began harvesting wheat in mid to late December and most were not finished until early January.

Yields were generally above average, with some exceptionally high yields reported. This resulted from well above average August rainfall and a widespread rainfall event delivering 10 to 15 mm in late September.

There were many reports of canola yields over 2.0 tonnes per hectare with some paddocks yielding as much as 3.0 tonnes. Oil content was also high and in the range of 44 to 46 per cent.

Cereal yields have been above average and many farmers reported yields in excess of 4.5 tonnes per hectare with some as high as 6.0 tonnes.

Grain quality was generally excellent, with good test weights, low screenings and high protein. Most grain achieved ASW or APW grades at delivery depending on variety, with some loads achieving AH. The late rainfall and humid conditions resulted in weather damage and downgrading toward the end of harvest.

A significant proportion of the barley met malt specifications even in districts not known for producing malting barley.

Yields from pulse crops were highly variable depending upon time of sowing and species. Lupin yields were generally below average (in the order of 1.0 to 1.3 tonnes per hectare), lentils yielded around the long-term average and bean and pea yields have been well above average with many crops yielding 2.0 to 3.0 tonnes per hectare.

Eastern Eyre Peninsula

Strong winds and hail in late November on the Eastern Eyre Peninsula caused isolated but significant damage to standing canola and barley crops – the area affected was relatively small as a proportion of the overall crop.

Crop yields were highly variable depending upon rainfall, soil type, sowing time and frost damage. Crops at Buckleboo, Kimba and the Cleve Hills generally yielded better than other districts, with some exceptional yields above 2.5 tonnes per hectare. Later sown districts near Kielpa, Rudall and Wharminda had generally low yields.

On average, wheat and barley yields were below the long-term average, ranging from 1.0 to 2.0 tonnes.

Grain quality was generally very good with high test weights, high proteins and low screenings. Most of the wheat was graded as ASW or better at delivery. A large proportion of malting barley varieties achieved malting grade, but protein levels were too high for malting in some loads.

Canola yields were good given the season, and many paddocks yielded over 1.0 tonne per hectare with oil contents above 44 per cent.

Pulse yields were highly variable. Lentils around Cleve yielded 0.4 to 0.5 tonnes per hectare and lupin and pea crops, not affected by frost, yielded 0.5 to 1.0 tonnes.

Crops were poor in the Franklin Harbour district and many paddocks were not harvested.

In some areas of SA, baling failed crops was not an option due to a shortage of hay-making contractors.

There were significant areas of frost damage in crops and the worst of these paddocks were cut early for hay. Yield losses from frost damage in reaped crops were similar to farmer expectations.

Summer weeds germinated quickly following November rainfall and many farmers began spraying these as soon as harvest was completed.

Upper North

Harvest was completed by the end of December, but numerous weather delays extended harvest by two to three weeks, particularly in the southern part of the Upper North district.

Some farmers in the northern part of the district did not harvest enough grain for seed.

Crops on heavy clay soils yielded very poorly – some of these areas were not harvested at all.

Frost in the last week of September and early October damaged crops in low-lying areas in the south of the district, with peas, canola and some wheat being affected. Worst affected areas were cut for hay. Approximately 20 per cent of crops in the southern part of the district were cut for hay.

Many failed crops in the northern part of the district were grazed by livestock.

In the western part of the district, pulse yields were affected by drought and wind damage and were well below average. But cereal yields were higher than expected, particularly on lighter soils and most crops produced good quality grain.

In the eastern part of the district, barley yields were approximately 50 to 60 per cent of average and of reasonable grain quality, although a lower percentage than normal of malting varieties made malt quality, being too high in protein.

Wheat crops were more severely affected by frost and drought and many crops yielding less than 30 per cent of average.

Bean crops were very short and yielded well below average although grain quality was reasonable. Lupin crops performed poorly.

Lentil and pea crops were affected by frost and the dry conditions so most yielded well below average.

Canola crops yielded below average but better than expected in many areas. Rain in late November caused plants to re-grow after windrowing or desiccation so a second desiccation was required in some crops.

Mid North

Frost damage to wheat and barley was worse than expected in the Mid North – and combined with drought stress – yields were well below average. Some areas damaged by frost had never been frosted before this season.

Worst affected areas were cut for hay, but significant areas of frosted crops were not cut, due to poor growth, unavailability of hay-making equipment or unwillingness of farmers to cut more hay.

Wheat grain quality was good with high protein and low screenings. Some grain test weights were slightly low.

Despite slightly higher grain proteins in barley, a higher than expected proportion of malting varieties made malting grade. Some barley varieties performed well with high yields and good grain quality.

Approximately 20 to 25 per cent of the total crop area was cut for hay, with hay yields 40 to 50 per cent of average.

Pulse crops generally performed poorly with low yields and small grain size. Pea crops were frosted and produced small grain while lentil crops yielded poorly. Faba bean and lupin crops yielded well below average with high grain losses at harvest.

Canola yields varied depending on variety and time of sowing and went 0.2 to 1.0 tonne per hectare.

In the 2019–20 season, more Clearfield varieties and slightly more hay is likely to be sown.

Lower North

Around 30 per cent of the Lower North crop area was cut for hay, due to frost damage, drought stress or estimated better returns from hay compared to grain.

Compared to average yields, wheat yield was 45 to 50 per cent; barley 50 per cent and pulses 25 to 30 per cent.

Peas yielded the highest of the pulse crops.

Wheat had high protein and low screenings. Barley grain protein was higher than normal.

Lentil crops were thin and not able to be picked up during harvesting resulting in yields of 0.5 to 1.0 tonnes per hectare.

Bean crops yielded well below average at 0.6 to 0.8 tonnes per hectare.

There were high chickpea grain losses from shattering during harvest.

Canola yields were well below average due to the warm dry finish to the season and were of average oil content.

Due to a high demand and low availability of straw, most paddocks that had reasonable amounts of biomass have been cut and baled.

Farmers have started planning for the 2019 season and are indicating a small reduction in pulse area, some reduction in fertiliser inputs and concerns regarding herbicide residues.

Yorke Peninsula

Isolated instances of small hail through Northern and Central Yorke Peninsula damaged canola crops causing 30 to 50 per cent yield losses.

Yields across the district were highly variable with most crops on Northern Yorke Peninsula being slightly to well below average. Central Yorke Peninsula yields ranged from below average on the coast to average in central areas. Yields on Southern Yorke Peninsula were generally average to above average.

Some H1 and H2 quality wheat was reaped where high rates of nitrogen fertiliser or chicken litter was applied. Some crops were of only ASW quality, as there were limited opportunities in the growing season to apply nitrogen fertiliser.

Grain protein was variable, but screenings were very low in all cereals, except for barley grown on shallower soils.

A high percentage of malt varieties were classified as malt. Some receival standards were changed, but overall, screenings were low and protein acceptable to make malt standards.

Grain cleaning was required to reduce snail numbers.

There were isolated reports of etiella (insect) damage in lentils that missed a late insecticide application.

Ascochyta blight was very low in chickpeas due to the dry spring. But it did pose a high risk earlier in the vegetative/foliar crop stages.

Chickpea seed size was larger than in previous years with the majority of seed being larger than 8 mm, owing to the mild November finish.

Central Hills & Fleurieu Peninsula

Yields were highly variable. Cereals ranged from 0.25 tonnes per hectare in the drier regions to 5.0 tonnes in wetter zones. Canola yields were low at 0.25 to 0.30 tonnes per hectare and pulses were also low at around 1.0 tonne.

Around 25 per cent of the cereal crops were cut for hay.

Grain quality was also highly variable. Where grain yields were average to above average, quality was high but in lower rainfall areas, quality was poor with high levels of screenings.

Kangaroo Island

Canola crops yielded around 20 per cent above average on KI and grain quality was also good.

Cereal yields were around average although strong winds in mid-December caused some damage to unharvested crops. Cereal grain quality was variable with some downgrading due to staining and sprouting caused by rain in mid-December.

Bean crops yielded 40 to 50 per cent below average.

Lower Murray

Yields were variable across the Lower Murray ranging from very poor and not worth harvesting on very hard stony soils, to crops on sandier soils able to fill some grain using subsoil moisture. Some crops with poor yield potential were grazed.

Pulse and canola crops yielded poorly because of frost and dry conditions.

In general, the crops cut for hay because of drought or frost damage were more profitable than those left for grain. Most hay is of extremely high quality due to the dry conditions and will be profitable for farmers.

Crops sown using no-till and as part of a sound rotation, generally yielded much better than those sown late in conventional systems.

Windy conditions continued to cause problems in paddocks that struggled to establish cover resulting in significant areas of soil erosion visible in the landscape.

Northern Murray Mallee

Yields in the Waikerie district were below average with some areas not harvested. Cereal yields averaged between 0.2 to 0.6 tonnes per hectare in this area – or about 25 per cent of the longer-term district average.

Loxton and Alawoona cereal yields averaged between 0.6–1.0 tonnes per hectare – around 50 per cent of district average.

Some crops were damaged by frost, and crops on deep sands, shallow soils over stone and heavy clay flats all yielded poorly, due to moisture deficiencies.

Grain quality was variable but most grain was of good quality with high grain protein and average screenings levels. Grain protein in most malting variety barley crops was too high to be classified as malting grade.

Pulse crops, vetch and canola sown around Loxton and Alawoona generally yielded very poorly – below 0.3 tonnes per hectare.

Although grain yields were below average, farmers in the eastern and southern parts of the district were able to sell some grain at high prices.

Very little hay was cut across the district as there was insufficient bulk in most crops.

Southern Murray Mallee

Many farmers were surprised how well crops performed in the Southern Murray Mallee given the dry season. High grain prices compensated to some extent for low yields.

Frost damage was significant across the district while late-sown crops did not establish well and yielded poorly.

High fodder prices – or the need for fodder on their farm – led many farmers to cut crops for hay where there was enough bulk.

Some crops were grazed for sheep feed rather than left for harvest.

Pulses and canola yields were very poor and some farmers did not harvest crops deemed uneconomical.

Grain quality was of reasonable quality, with high barley and wheat grain protein.

Strong winds have caused significant soil erosion particularly on pasture paddocks where plants failed to establish well and have since been over-grazed due to paddock feed shortages.

Upper South East

Canola yields were variable in the Upper South East and generally yielded below average. Around 30 per cent of canola crops experienced shattering due to wind in direct headed canola with up to 30 per cent grain loss as a result. Approximately 35 per cent of canola crops were frosted with losses ranging from 10 to 100 per cent.

Bean yields were generally below average, due to waterlogging and dry spring weather with some varieties yielding better than others. Despite lower yields some varieties were of better grain quality and achieved higher prices. But many bean samples were downgraded due to discolouration from weather damage.

Lupins yielded below average due to a lack of moisture and significant frost damage.

Barley yields were average with yields reduced by frost and lack of spring rainfall. Between 20 to 30 per cent of barley crops were frosted with an average of around 30 per cent losses in those paddocks. Whilst some barley made malt grade, most was downgraded to feed grades.

Wheat yields were below average; more crops were frosted than expected and grain quality was affected by weather damage and sprouting. Around 15 per cent of wheat had yield losses of 30 to 40 per cent due to frost.

Later-harvested wheat crops were more severely affected by weather damage, and seed germination and vigour tests to assess viability will be essential where these crops have been kept for seed.

Oat crops yielded below average due to a lack of moisture resulting in lightweight grain. Blight Stripe – an unusual bacterial infection – was reported in oats.

Overall, the early-sown crops out-performed late-sown crops, despite frost damage.

Lower South East

Canola yields in the Lower South East were well above average and of exceptional grain quality.

Bean crops were also above average despite lodging of many crops due to strong winds.

Barley yields were above average with good quality grain.

Wheat yield was above average, but quality was affected by weather.

Light frost events occurred during 2018 but were early enough to not result in any crop damage.

PIRSA Crop and Pasture Report, January 15, 2019.

Victoria

Due to drought conditions, winter crop production in Victoria in 2018–19 is estimated to have decreased by more than 50 per cent on the previous season to around 3.7 million tonnes. The harvested area is also estimated to have fallen by around 13 per cent because many growers opted to cut crops for hay.

Wheat production was less than half of the 2017 production weighing in at around 2.0 mt. The average wheat yield declined to around 1.39 tonnes per hectare.

Barley production and yield fell by similar percentages to be an estimated 1.1 mt and 1.43 tonnes per hectare respectively.

Canola production was particularly hard hit by the drought and decreased by around 60 per cent on the 2017 season. The area planted to canola also fell by about a third to 300,000 tonnes.

ABARES Australian Crop Report, February, 2019.

The 'sun set' on many winter crops in the Victorian Mallee.
(PHOTO: Gen Clarke, BCG)

Major winter crop estimates, Victoria, 2018–19

	Area ('000 ha)	Yield (t/ha)	Production ('000 t)
Wheat	1400	1.39	1950
Barley	770	1.43	1100
Canola	300	1.00	300

New South Wales

NSW was also ravaged by drought in 2018 with an estimated 60 per cent drop in winter crop production compared to the previous year to around 2.9 million tonnes in 2018–19. This was the smallest winter crop since 1994–95. As in Victoria, there was a significant fall in harvested area because many crops planted for grain production were cut for hay.

Wheat production was around 1.8 mt, reflecting a third less average yield and a 42 per cent fall in harvested area.

Barley production was down about 50 per cent to around 630,000 tonnes at an average yield of just over 1.0 tonne per hectare.

With very few regions in NSW with any sort of planting opportunity – and then a poor season – canola production in 2018–19 fell by around 75 per cent on 2017 to an estimated 152,000 tonnes. Significant frost events resulted in a further loss of canola area and production as many frost damaged crops were cut for hay.

The average canola yield in 2018 was the lowest in 10 years at an estimated 0.80 tonnes per hectare.

Major winter crop estimates, NSW, 2018–19

	Area ('000 ha)	Yield (t/ha)	Production ('000 t)
Wheat	1800	1.00	1800
Barley	600	1.05	630
Canola	190	0.80	152

NSW 2018–19 summer crop

Seasonal conditions during December 2018 and January 2019 were generally unfavourable for summer crop planting. Below to very much below average rainfall and prolonged heatwave conditions depleted soil moisture levels and reduced yield prospects for dryland crops.

The area planted to summer crops in NSW in 2018–19 is estimated to have decreased by about a third on the previous season to 419,000 hectares. This reflects both low supplies of irrigation water and insufficient soil moisture for planting dryland crops.

Total 2018–19 summer crop production is forecast to fall by around 45 per cent on the previous season to around 1.2 mt.

Grain sorghum planted area was estimated at around 150,000 hectares – or 17 per cent below the 10 year average.

December and January rainfall was below average and prolonged heatwave conditions in late December and January further depleted soil moisture levels.

Yields are forecast to be below average, resulting in grain sorghum production of 375,000 tonnes – 13 per cent lower than in 2017–18.

Area planted to cotton in 2018–19 is estimated to have declined by 44 per cent to 174,000 hectares. Current season production is forecast to fall by 43 per cent to 371,000 tonnes of cotton lint and around 524,000 tonnes of cottonseed.

The average cotton yield is forecast to increase slightly because the area planted to lower yielding dryland cotton fell from 106,000 hectares last year to zero this year.

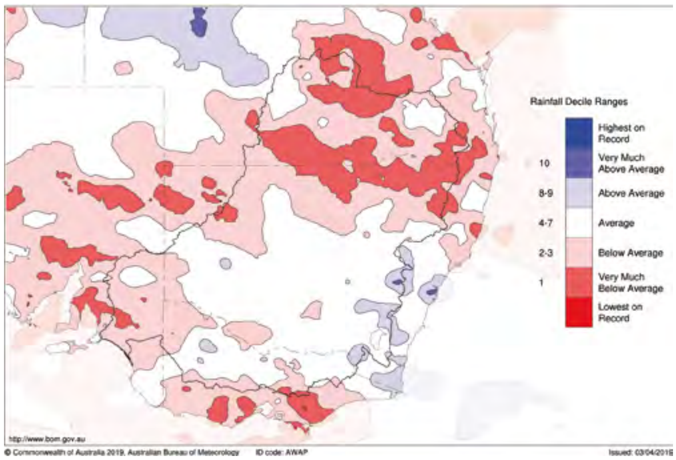
The area planted to rice is estimated to have fallen by 83 per cent to 10,000 hectares in 2018–19. This again reflects low irrigation water allocations. As a result, rice production is also forecast to fall by more than 80 per cent on the previous season to 104,000 tonnes.

Major summer crop forecasts, NSW, 2018–19

	Area ('000 ha)	Yield (t/ha)	Production ('000 t)
Grain sorghum	150	2.50	375
Cotton lint	174	2.13	371
Cottonseed	174	3.01	524
Rice	10	10.38	104

ABARES Australian Crop Report, February, 2019.

Murray–Darling Basin rainfall deciles October 1 to March 31, 2019
Distribution based on grided data
Australian Bureau of Meteorology



Queensland

Drought conditions in Queensland pushed 2018–19 winter crop production down to about half of the previous season to an estimated 717,000 tonnes. This was largely driven by a significant fall in the area and production of chickpeas. The estimated total Qld winter crop production is the lowest since 1994–95.

Wheat production is estimated to have fallen by more than 40 per cent to 400,000 tonnes. Harvested wheat area fell by about a third to 400,000 hectares with an average yield of 1.00 tonne per hectare.

Some good looking late planted sorghum still to be harvested on the eastern Downs in 2019.
(PHOTO: Hugh Reardon-Smith)

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Grazing failed cereal crops on the eastern Darling Downs during the 2018 spring. (PHOTO: Hugh Reardon-Smith)

Chickpea production fell by 70 per cent on the previous season to 190,000 tonnes. The lingering drought and frost damage, particularly in Central Queensland, caused significant production losses.

Barley production fell by around 22 per cent compared to the 2017 season to 95,000 tonnes. Harvested barley area fell by a similar percentage to 70,000 hectares.

Major winter crop estimates, Qld, 2018–19

	Area ('000 ha)	Yield (t/ha)	Production ('000 t)
Wheat	400	1.00	400
Barley	70	1.35	95
Chickpeas	200	0.95	190

Qld 2018–19 summer crop

Seasonal conditions in December 2018 and January 2019 were unfavourable in cropping regions in Queensland. Rainfall in most cropping regions was very much below average and temperatures above average. These conditions reduced soil moisture levels to below average in most cropping regions and a below average area planted to dryland summer crops. Additionally, yields are expected to be below average.

Area planted to summer crops in Queensland is forecast to fall by 15 per cent in 2018–19 to around 606,000 hectares. This reflects a significant fall in area planted to cotton.

Area planted to cotton is estimated to have declined by 44 per cent to 106,000 hectares in 2018–19. Cotton production is forecast to fall by 39 per cent to 210,000 tonnes of cotton lint and around 297,000 tonnes of cottonseed in 2018–19. The average yield is forecast to increase by 9 per cent because area planted to lower yielding dryland cotton fell from 58,000 hectares last year to zero this year.

Area planted to grain sorghum is forecast to increase marginally to 385,000 hectares in 2018–19, which is well below the 10-year average of 407,000 hectares. Production is forecast to fall by 8 per cent to 924,000 tonnes in 2018–19. The average yield is expected to fall by 9 per cent.

Major summer crop forecasts, Qld, 2018–19

	Area ('000 ha)	Yield (t/ha)	Production ('000 t)
Grain sorghum	385	2.40	924
Cotton lint	106	1.98	210
Cottonseed	106	2.80	297

ABARES Australian Crop Report, February, 2019.

Section 5

Pulse & Legumes Update

CONTENTS

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(PHOTO: Kathi Hertel, NSW DPI)

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Domestic and global pulses: State of play

AT A GLANCE…

This pulse update has been prepared by Pulse Australia, and the Grains Industry Market Access Forum (GIMAF), with the support of the Australia–India Council, to inform the Australian pulse value chain about the trends and drivers in the global and domestic pulse market.

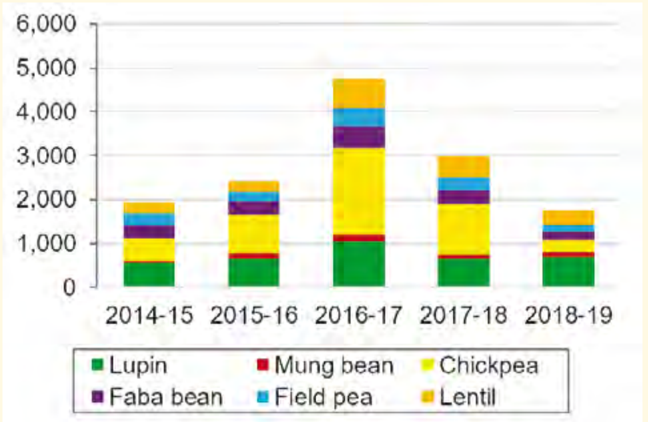
- The Australian 2019 pulse plantings are likely to be tempered by climate and market access concerns.
- After a difficult start, the 2018–19 Indian rabi (northern hemisphere winter pulse crop) production is down 7 to 8 per cent on last year.
- India is expected to return as a pulse buyer in 2019–20, but not to the same pre-tarrif levels.
- Other than faba beans, global pulse supply is adequate.

For Australian pulse producers, the 2018 season was one of two halves. If you were in the half dealing with lentils and chickpeas, it's probably a year best forgotten. Excess stocks particularly in the case of lentils, kept prices soft, while dry conditions left many chickpea paddocks fallow, and many silos empty.

If you were in the half growing and trading peas, lupins and faba beans, you've probably done OK as strong demand for feed supported market opportunities and prices throughout the season. If you specifically took the punt on faba beans, you will have experienced decile 10 pricing of $800 per tonne (and higher) as the global shortage on faba beans drove prices to record levels. Global export supplies are expected to be extremely limited during the first half of 2019.

The 2018 season delivered one of the lowest levels of Australian pulse production in recent years, largely driven by the dramatic reduction in chickpeas.

Figure 1: Recent Australian pulse production ('000 tonnes)



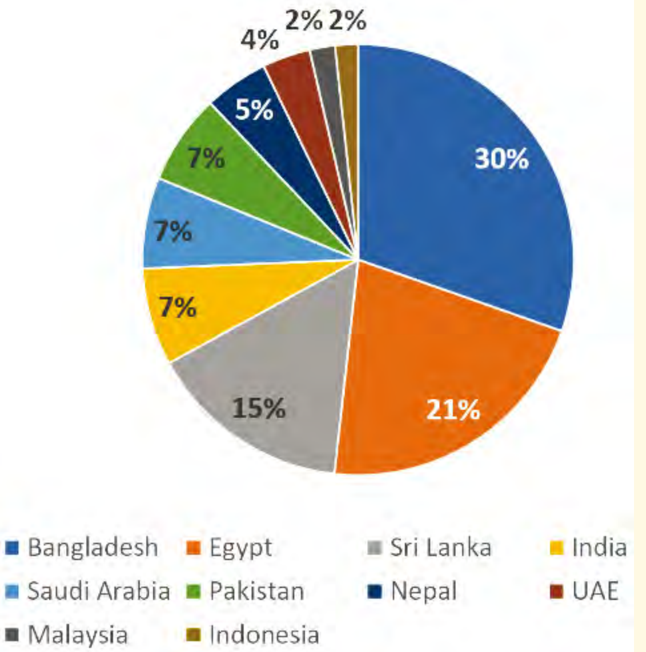
Australian exports (Table 1) have been impacted both by the lower supply domestically – particularly of chickpeas – and the greater domestic demand for feed. Saudi Arabia stepped in to buy more faba beans, despite near record prices, most likely on the realisation that supplies will run out. Faba beans are highly unlikely to maintain their current price levels as Baltic and UK supplies recover from their respective weather disasters of the previous season.

Table 1: Australian pulse exports, 2017 vs 2018

	Oct–Dec 2017	Oct–Dec 2018	Per cent change
Chickpeas	430,142	73,636	–83%
Lentils	141,207	60,236	–57%
Peas	51,527	32,615	–37%
Faba beans	56,857	64,836	+14%

Notwithstanding the reduction in overall exports, the restrictive trade options for India has created opportunities for growth in alternate markets, as indicated in Figure 2.

Figure 2: Top 10 Australian pulse export destinations Oct–Dec 2018



Source ABS

It is still too early to make any sort of projection for the coming season, with subsoil moisture either non-existent or severely depleted in most pulse growing areas at this time. But ongoing shortages of feed, with low stocks, should provide a strong price base for higher protein pulses (lupins, peas and faba beans) in the short term.

Global supply and demand factors

The competitive position for pulses needs to be seen in the context of the current cereal supply and demand, particularly wheat, and, with the exception of faba beans, pulse supplies are seen globally to be in a comfortable (some may say "too comfortable") position.

But the Indian trade restrictions have created new and/or stronger trade flows into alternate markets.

China

China has proved to be a strong buyer for excess supplies of Canadian peas, as the protein supply matrix in China has been impacted by the US soybean trade issues. China pulse consumption is reported to be growing at 200,000–300,000 tonnes per annum as China increases their fractionation capacity, as well as shifting more pulses into the feed market (in lieu of soy).

There has also been growing interest in China for Australian peas (as well as lupins and faba beans), but we tend to be uncompetitive compared to Canada with domestic feed demand for peas locally keeping prices firm.

India

Notwithstanding China, our fate for the coming year lies with **India**. Before getting into the uncertainties of trade policy and Indian elections, let's look at some facts.

Pulse demand in India remains relatively constant. Over time, we can foresee a reduction in per capita consumption as more and more of the population move up the protein hierarchy towards high value and better-quality pulses, and beyond, to increasing meat consumption. New generation Hindus are gradually adopting western diets and accepting a change from 'vegetarianism' to 'flexitarianism'.

This change in diet is perhaps best summed up by: "If Grandma is not at the table, then a bit of meat is OK".

But this macro trend is unlikely to impact overall pulse demand in the near term.

On the supply side, after a slow start to the rabi (2018–19 winter) pulse season, with delayed plantings, the overall production is estimated to be slightly down on the previous (record) season but generally OK, particularly for chickpeas and lentils. Rainfall in the pulse growing areas had been sufficient to sustain the crops, although some areas experienced cooler than average temperatures, which retarded growth and flowering.

From a very dry start, rainfall for the first six weeks of the year in Madhya Pradesh (the major pulse growing region) was about 46 per cent down on average.

The just harvested rabi crop is estimated to be down around 8 per cent on the last year's above average sized crop.

All eyes will now look to the kharif (northern hemisphere summer) seeding period (July) to see what local farmers do with mungbean, black matpe beans and pigeon pea.

Combined with stock in storage, Indian supplies are expected to be sufficient to meet demand – at least for the remainder of 2019. But it should be noted that that much of the stock held centrally by the governments and/or their agents is being held in poor storage conditions and there are plenty of reports around of 5–10 per cent insect damage.

As uncertain as Indian weather and pulse stock levels and quality are to predict, they are probably more certain than Indian trade policy at the moment.

The new Indian fiscal year (starting April 1) brought no relief in minimum support pricing and/or import policies. As was expected, the quantitative restrictions on pea imports has been extended.

But of more importance is the current Indian elections. Much of the Indian trade policies of the past 12 months have been designed to placate the Indian farming sector, which tends to be a major constituency of the ruling BJP. As we are seeing in Australia at present, with our own elections, politicians are keen to make 'policy on the run' to appease certain sectors. How this plays out for Indian farmers over coming months, only time will tell.


Other than a global scarcity of faba beans, worldwide pulse supplies are currently adequate.

Advice from the Australian Agriculture Counsellor in Delhi is that India is unlikely to open its doors widely to pulse imports until late 2019 early 2020, when current stocks begin to look depleted. But the 2019 summer (kharif) crop, and prospects for the winter (rabi) crop around the time of our pulse harvest will also have a strong bearing.

Pakistan

Pakistan was a saving grace importer for Australia last year, but this may not be the case in 2019. When India effectively shut its doors to chickpeas in late 2017, a significant deficit in Pakistan of up to 600,000 tonnes provided the ideal alternate market for Australian chickpeas. This served to keep demand and prices strong through 2018.

But the Pakistan chickpea crop to be harvested in April is likely to more closely match domestic demand, so expect subdued import demand and pricing.

Global pulse trading has changed

The pulse trading world of today has taken on a very changed complexion since the heady days of 2015–16.

Changes in attitudes

The strong and rapid shift to domestic supply for India has seen some interesting – and most likely irrevocable – changes to the Indian pulse trade.

Buyers have long applauded the consistent and high quality of Australian and Canadian pulses. But with these supply lines effectively severed, Indian buyers have been driving higher and more consistent quality needs back down the supply chain to domestic suppliers and to those with whom India has favourable trading arrangements (Myanmar and some African countries).

Some reports are that this is working and that quality of pulses from these sources has improved. This has also been supported by reported investment in grading and sorting equipment by Indian processors.

The implication is that India, and some of their supplying countries, are lifting their game.

While Australia and Canada may have set the quality benchmark, we need to keep lifting the quality parameters of Australian pulses.

Changes in latitudes

The 2015–16 season had the impact of opening many eyes to the opportunity presented by India when the monsoon fails. Consequently, we saw supply lines strengthen between west Africa, Ukraine and other former Soviet states, and India 'wooing' some of these supplying markets with trade agreements.

The implication of this is that when trade resumes (hopefully in 2020), the competitive framework will have shifted, and Australia will find itself competing with more lower cost supply options into India.

The bottom line

The global pulse supply situation is looking reasonably comfortable (with the exception of faba beans), so globally, growers (driven as much by India as by climate) have led a recalibration of areas sown, or likely to be sown, to pulses.

This should see a return to more typical/long term average prices for pulses for the coming seasons.

The start of the Indian fiscal year (April 1) hasn't heralded any positive import and domestic policy changes for pulses for the coming year. Hopefully the Indian elections will also provide a circuit breaker to the policy on the run ramifications which Australian pulse producers have borne the brunt of in recent times.

By June we should know where we stand. We will have a clearer view about India from both a trade policy and pulse supply perspective and we will also have a better handle on global pulse supply prospects.

Longer term, the prospects for pulses are very bullish. It's hard to pick up a paper or scroll through a food website without picking up on the macro trend towards plant protein – and pulses are at the front and centre of this trend.

The GRDC is very active in ensuring Australia can grow and retain its position in the global plant protein market, with significant current investment in:

- Pulse agronomy in the south;
- *Pulse Check Groups* in the north;
- New pulse investment in WA; and,
- Embarking on a major market scan and outlook project to shape a robust pulse strategy (breeding and agronomy) for the future.

Pulse Australia is heavily involved in these projects. PA is providing leadership with the *Pulse Check Groups* from the Burdekin to the Murray as well as communication support for the southern pulse agronomy project. PA is also leading the pulse market interface of future strategy development.

and one more thing on global pulse trade ...

Australia has joined Canada in co-sponsoring a United States action with the WTO in relation to Indian minimum support pricing (MSP) and knock-on trade policies

And in early March 2019 it was reported that the US has been successful in gaining a WTO ruling challenging Chinese MSP for farmers for wheat and rice. This is likely to have an impact on the Indian WTO action.

This won't change things for this year, but it will hopefully make the Indian government think more carefully about future market intervention actions. ■

Successful pulse crops, acidic soils and getting the inoculant right

Research is offering hope to grain growers who have been limited in their ability to successfully grow pulse crops on acidic soils. New strains of rhizobia with improved acid tolerance have shown promise in field trials, lifting the prospects of commercialisation and a subsequent expansion of faba bean and lentil crops into areas with acidic soils.

Profitable production of pulses is dependent on successful nodulation of the crop, so growers inoculate seed with rhizobia bacteria that stimulate the production of nodules on the plant roots which fix atmospheric nitrogen for the pulse crop. This free source of nitrogen ensures a healthy pulse plant with little or no reliance of nitrogen from the soil, and also delivers excess nitrogen that supports crop production in subsequent years.

But the current commercial strains of rhizobia are typically much more sensitive to acid soils than the host legume plant, so a Grains Research and Development Corporation (GRDC) research investment has been testing the performance of alternative strains of rhizobia that have been identified with improved acidity tolerance.

New rhizobia strains for faba beans and lentils

Research leader Ross Ballard, from the South Australian Research and Development Institute (SARDI) – a division of Primary Industries and Regions SA – says field trials over the past three years have demonstrated the effectiveness of the new strains in nodulating faba beans and lentils on acidic soils.

Ross says the new strains of rhizobia have resulted in a dramatic improvement in nodulation compared to commercial strains when applied at recommended rates of inoculation in acid conditions. Increases in faba bean nodulation of about 30 per cent have been consistently measured with the new strains where soil pH is less than 5.0 when measured in calcium chloride.

"The new strains are improving nodulation and ultimately that results in better crop vigour early in the growing season, as well as improved nitrogen fixation and yield," he says.

Ross, who has been undertaking the rhizobia trials with fellow SARDI researcher Liz Farquharson, says further evaluation of the strains will be undertaken during 2019 and that a new strain for faba bean (and possibly lentil) could be commercially available in 2022, subject to further positive results.

It is envisaged that these new strains may enable expansion of pulses onto more acidic soils than has previously been possible. "We are aiming for reliable nodulation where soil pH is 4.5 when measured in calcium chloride," Ross says.

Liming and inoculant rate is critical

The development of new rhizobia strains will be a stop-gap measure to manage soil acidity, and should not be seen as a replacement for liming, according to Ross.

"Even with good inoculation practices on acid soils, nodulation can remain below potential and rhizobial colonisation and survival in the soil is limited, so the addition of lime is still needed."

Liming to raise soil pH also corrects nutritional deficiencies and toxicities that more broadly limit crop performance.

Until the improved strains are commercially available, growers are also advised they can improve their chances of successful nodulation in acidic soils by doubling the rate of inoculant.

SARDI's Ross Ballard says field trials over the past three years have demonstrated the effectiveness of the new rhizobia strains in nodulating faba beans and lentils on acidic soils. (PHOTO: GRDC)

Doubling the inoculant applied as a peat slurry increased nodulation by 52 per cent and grain yield by 41 per cent in a faba bean trial at Wanilla on SA's Eyre Peninsula.

"Doubling the rate also provides a practical way of improving nodulation where pulses are sown for the first time, especially on hostile soils," says Ross.

Ross encourages growers to test a small batch of seed inoculated with peat slurry to ensure seeder blockages don't occur, especially with any increase in inoculation rate.

Collaborating with SARDI on the acid-tolerant rhizobia studies have been The University of Adelaide, Agriculture Victoria, AgGrow Agronomy in New South Wales, and the Western Australian Department of Primary Industries and Regional Development.

Compatibility of rhizobial inoculants

In other related research, the compatibility of rhizobial inoculants with some commonly used herbicides, fungicides, insecticides and fertilisers is being tested in the laboratory to determine the effects of these additives on rhizobial survival.

Ross says particular care needs to be taken where rhizobia are applied with pesticides on seed, especially where it is to be sown into acidic soils.

"Rhizobia are best applied last and as close as possible to sowing. And where pesticide application is necessary, granular rhizobial inoculant may provide a better option, reducing direct exposure of the rhizobia to the pesticide."

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

Ross Ballard's GRDC Grains Research Updates paper on *Pulse rhizobia performance on acid soils* can be viewed on the GRDC website via https://goo.gl/75XVEu.

Further information on pulse crop inoculation is contained in a number of practical GRDC resources, including the popular *Inoculating Legumes Guide* (https://grdc.com.au/GRDC-Booklet-InoculatingLegumes) and a GrowNotes Legumes and Nitrogen Fixation Tips and Tactics fact sheet.

GRDC Project Codes: UA000138, DAS00128

CSU research: Making the most of water to boost faba bean yield

AT A GLANCE…

- Graham Centre research shows sowing date and irrigation timing are crucial to maximise the yield and water productivity of faba beans.
- Irrigation during flowering and post-flowering phase is the key for increasing faba bean yield.
- CSU research aims to help farmers grow more using less water.

Sowing date and irrigation timing are crucial to maximise the yield and water productivity of faba beans, according to research from the Graham Centre for Agricultural Innovation.

Faba bean is a legume used to fix nitrogen in the soil and is also a disease break-crop. But production in the semi-arid areas has been highly variable due to variable year-to-year rainfall.

The research by Dr Keteme Zeleke from the Charles Sturt University (CSU) School of Agricultural and Wine Sciences used field experiments and simulation modeling to examine how a mid-flowering faba bean cultivar performed under different sowing dates and watering regimes in south-eastern Australia.

Keteme said the research shows irrigation during the flowering and post-flowering phase is the key for these faba bean cultivars.


Dr Keteme Zeleke from the Charles Sturt University School of Agricultural and Wine Sciences.


Irrigation during and post flowering is the key to increasing faba bean yields.

"The crop is least sensitive to water stress during the vegetative stage, as it can recover and still result in high yield if there is no soil moisture stress during the reproductive stage," Keteme said.

"Sowing date had significant effect on the yield of rain-fed faba bean, while the effect on irrigated faba bean is less clear as early sown faba bean can have too much vegetative growth, lodging and disease pressure.

"Faba bean sown in the third week of May can yield as much as the one sown in the third week of April, if irrigated during the reproductive stages.

"Simulation results show that under rain-fed conditions, sowing in the first week of May or in the first week of June, instead of in the first week of April, decreased grain yield by 26 and 52 per cent, respectively."

As producers struggle with low water allocations, the research also provides some important information about how best to target irrigation in faba bean production in south-eastern Australia.

"Although it received 28 per cent less water, the faba bean crop that was irrigated only during the reproductive stage gave a similar grain yield as the fully irrigated faba bean crop," Keteme said.

"Simulation modelling also showed that additional irrigation applied from mid-September to the end of October increased grain yield by 23 per cent relative to the rain-fed treatment, while additional irrigation from mid-August to the end of September resulted in only 13 per cent increase."

This research "Growth and yield response of faba bean to soil moisture regimes and sowing dates: Field experiment and modelling study" was published by Keteme and Dr Claas Nendel in the journal *Agricultural Water Management*.

Earlier field experiments and modelling studies by Keteme have also shown the significant role of sowing time, cultivar choice and irrigation in increasing canola and wheat grain yields and water productivity. ■

Section 6

Planting Your Crop

CONTENTS

NDF Disc Planters

NDF Disc Planters

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Discs can have multiple crop establishment benefits

AT A GLANCE...

Growers: Chris and Kym Ross.
Location: Gairdner, South Coast, Western Australia.
The farming enterprise: The 2000 hectare farm is 100 per cent cropping. Wheat and canola are the main crops.
Growing season rainfall: 450 mm.
Soil types: Light sands to heavy clays.
Seeding system: 18 metre K-Hart bar with Yetter coulters, K-Hart low profile discs with 4-inch (100 mm) soft-type press wheels, variable rate Ezee-On bin, RTK.

Chris Ross approaches his farming system with a philosophy of simplicity, and that principle is certainly followed in his seeding program and equipment. The cropping rotation on the Ross family property at Gairdner is canola/wheat, which has been working well for more than 12 years.

The program is planted using a K-Hart bar on a 12 metre tramline system, with Yetter coulters and K-Hart low profile double discs.

"The only thing I've changed on the bar is to put on bigger discs, so I can get more wear out of them," Chris says. "I also went from a 3-inch to a 4-inch press wheel, because the low-profile openers are quite heavy, and in the light country we would go through sections where we'd seed too deep."

Chris also used to have liquid placement between the twin discs; however, "that was all too messy", so he moved the Flexi-N behind the press wheel and it seems to be working well.

"We're only laying it on the top and in our type of country, because of our rain events, I don't think it's an issue," Chris says. "I have tried deep banding and I have found the yield benefits aren't great enough for what it costs."

Reduced disturbance with discs

Chris is a firm believer that by reducing soil disturbance with his K-Hart machine, he has fewer weeds germinate, which results in cleaner crops. He uses Boxer Gold and Sakura with good results.

"The shift to discs – albeit with a higher chemical rate – has resulted in really weed good control," Chris says. "The less you disturb the ground the better – if you're ripping it up and throwing dirt everywhere, you're also throwing seeds everywhere."

In tough starts such as 2018, with multiple wind events resulting in the need for many growers to reseed, Chris believes reseeding with a disc machine is a far better proposition than a tyne machine as it creates less soil disturbance, less erosion and dries out the soil less.


Chris Ross believes in his environment there are multiple benefits from using discs, including less disturbance, which is beneficial for soil erosion, as well as improved weed control and trafficability in wet seasons. (PHOTO: CussonsMedia)

"That's the advantages of discs, especially in a dry start year like 2018. If we wanted to go back and reseed, we're not disturbing the ground again," Chris says. "Anyone that's using a tyne implement at the moment, on a hard start like this, if they go back over it again, they're just causing another problem on these fragile sandy soils."

While too much moisture after seeding was not a problem in 2018, in other seasons South Coast growers are faced with large rain events that can result in challenging conditions for in-crop spraying. But Chris finds with their reduced tillage, that paddocks are more trafficable because there are fewer boggy areas.

Less horsepower needed

Another advantage of his disc system is that Chris does not need a large tractor to pull his bar.

"I think the system that I'm using is low horsepower orientated and it's probably not high maintenance either. Yes, there's a lot of nuts and bolts, but we don't seem to work on it any more than anybody else," Chris says.

Chris uses a turbo coulter that digs a channel, which is good for moisture harvesting in the dry years, while in a wet year when water harvesting is not required the coulters can be reversed so they cut through the stubble rather than dig a channel. On his low profile openers system, depth control is set by the press wheels.

"In most years, especially on the sandplain, it's the depth control that's the important part, as we rely on the small 10 to 20 mm rain events to fill that channel and germinate the crop," Chris says.

"The main advice, I think, is to not sow too deep – when we've got normal seasons with moisture, the shallower you sow the better."

Stubble management

To ensure the discs do not ride up onto the stubble, Chris advises spending the time to make sure the coulters are lined up properly with the discs. In 2017, they had good establishment even when sowing into 4 tonnes per hectare wheat stubbles.

"If you're travelling at 10 to 12 km per hour in a high residue stubble, you can ride up on the stubble," Chris says. "So you have to make sure you've got the coulters lined up well with the double disc openers to make sure those double disc openers stay in the soil, and we try to stay between two and four centimetres deep."

Disc performance on heavier country

While many growers consider discs a less attractive seeding system in heavier soils, Chris has found his disc system still performs well on his heavier soil types.

"You look on the ground and find there's a bit of wheat laying on top and you think, 'Oh no, I'm not getting into that', but then you're very surprised at harvest time as it all comes up eventually," Chris says.

"So, you're probably wasting a bit of seed as the heavier country doesn't need to be sown as thick."

Chris does not really see any disadvantages with his system, although he has observed crops sown with discs seem to be slower to grow than crops sown with tyne systems.

"We can seed on the same day, germination seems to be the same but tyne-sown crops seem to get away a lot quicker – perhaps it is the mineralisation of nitrogen," Chris says.

While the Ross family have run a no-till system for about 25 years, Chris believes the addition of some tillage into his system will be beneficial to level his paddocks. He also says that adding tillage would assist in incorporating their lime.

For more information contact Chris Ross 0428 371 007, cjross59@gmail.com

Source: *Seeding Systems – Case studies of growers in WA*. This publication was prepared by CussonsMedia on behalf of the GRDC see www.grdc.com.au

IN SUMMARY…

- Discs create less disturbance, which is beneficial for soil erosion, weed control and trafficability in wet seasons;
- Aim to sow shallow for best establishment; and,
- Discs perform well in sands and heavier soil types.

The Yetter turbo coulter digs a channel, which is good for moisture harvesting in the dry years. In a wet year when water harvesting is not required, the coulters can be reversed so they cut through the stubble rather than dig a channel. (PHOTO: CussonsMedia)

Since purchasing the K-Hart, Chris has increased the disc size to improve wear and increased the press wheel from 3-inch to 4-inch, because the low-profile openers are quite heavy and in the light country they could sow too deep. In addition, he moved the Flexi-N placement from between the twin discs to behind the press wheel. (PHOTO: CussonsMedia)

Think again before 'lighting up' heavy stubbles before planting

Grain growers confronting the situation of high levels of crop stubble following a good season, are encouraged to consider options other than burning paddocks in the lead up to seeding.

Ken Flower, lecturer at The University of Western Australia's (UWA) School of Agriculture and Environment and Institute of Agriculture, who has conducted farming systems research with Grains Research and Development Corporation (GRDC) investment, stressed the importance of retaining stubble to ensure good soil moisture retention and crop establishment, and to minimise soil erosion.

He also said there were ways to maximise pre-emergent herbicide efficacy in areas with heavy stubble loads.

"High stubble levels can cause issues for growers when sowing crops, but it can be managed," Ken said.

"Particularly in drier areas, retaining stubble has proven yield benefits, largely from additional moisture retention leading into and during the early part of the growing season.

"Trials conducted over about 30 years by Department of Primary Industries and Regional Development (DPIRD) researcher Glen Riethmuller, at Merredin in WA's eastern grainbelt, showed an overall average annual five per cent yield improvement where stubble was retained.

"There was a yield increase in most years of these trials, and this increase was even greater than five per cent in high yielding years."

Managing heavy stubble at seeding

Ken said to manage heavy stubble loads at seeding time, growers should make sure there were no 'pinch points' on the seeder bar where stubble could accumulate, and that tynes were spaced as wide apart as possible.

"Consider using coulters on the front of the seeder – these can cut through the residue and allow the tynes to pass through the stubble more easily," he said.

"Growers have also used 'stubble tubes' attached to the front of the tyne, particularly with curved tynes, to help with the flow of stubble.

"Also, if you have thick stubbles, row spacings of 25 to 30 cm (10 to 12 inches) will work better than narrower row spacings.

"Seeding between the previous year's stubble rows, with 2 cm auto-steer on the tractor, will also help with managing thick stubble."

Ken said that to ensure maximum herbicide efficacy in areas where there was heavy stubble, water rates should be as high as possible.

"Significant amounts of herbicides can be intercepted by thick stubble and some chemicals like pyroxasulfone (Sakura) can remain on the stubble and still result in good weed control when washed off by rain up to two weeks after application."

Ken said heavier than usual cereal stubbles could immobilise (lock up) some surface applied soil nitrogen, and in these situations, growers might benefit from deep placement of nitrogen at seeding time, away from the decomposing stubbles.

"There are also some nutritional implications from burning stubble, including the loss of nitrogen, potassium and sulfur," he said.

Ken said that, other than ensuring maximum soil moisture retention, the other main benefit of preserving stubbles was preventing wind erosion of topsoil and organic matter.

He said options other than burning whole paddocks included windrow burning if stubble had been windrowed at harvest and using livestock to graze stubbles.

"For the 2019 season many growers have planned to do windrow burning for weed seed control and already cut their stubble low at harvest time, which helps with stubble management. Burning the windrows will reduce stubble loads to manageable levels," Ken said.

"Research has shown that windrow burning reduces stubbles by 40 to 60 per cent, but clearly this operation has to be carried out under carefully managed conditions to ensure the whole paddock doesn't burn.

"Grazing paddocks with livestock can also reduce stubble loads slightly, but in some cases grazing with large numbers of sheep can loosen stubble material and actually make conditions worse at seeding time."

More information about managing higher stubble loads is available from research conducted under the GRDC initiative Maintaining Profitable Farming Systems with Retained Stubble, also known as the 'Stubble Initiative'. ■

Some WA growers need to manage high stubble loads heading into the 2019 cropping season. (PHOTO by GRDC)

Seed testing critical for 2019 crop success

Testing cereal and pulse seed for germination and vigour could be one of the best investments growers make in the lead up to the 2019 winter crop plant.

Seed quality plays a critical role in maximising emergence and early crop growth, and unsupported assumptions over the quality of retained seed can prove a costly mistake if crop establishment is poor.


Steven Simpfendorfer.

New South Wales Department of Primary Industries (DPI) senior plant pathologist Steven Simpfendorfer encourages growers to undertake certified germination and vigour testing at least two months before sowing so that an alternate seed source can be arranged if required.

He said testing was especially important if growers planned to use seed retained from the 2017 harvest or from crops impacted by drought, frost or late October rain in 2018.

Determining seed vigour is critical

"Vigour and germination tests provide an indication of the proportion of seeds that will produce normal seedlings and this helps determine seeding rates," he said.

"As a result of poor seasonal conditions across eastern Australia in 2018, particular attention should be given to determining vigour of retained seed for sowing in 2019.

"The potential shortage of planting seed in 2019 means many growers may be in the situation of sowing seed retained from harvest in 2017 and storage conditions during this extended period are likely to have impacted on the germination and vigour of retained seed.

"Vigour will be even more important if growers plan to increase sowing depth to capture an earlier sowing opportunity through moisture seeking."

While sowing rates can be increased to compensate for small reductions in seed germination, Steven said nothing could be done to alleviate the impact of poor seed vigour.

"After a below average to poor winter crop season in the eastern states in 2018, recovery in 2019 starts with growers planting the best available seed possible," he said. "Seed supply will be tighter than usual in 2019 so just because a seed source – such as from the 2017 harvest – is all a grower has on hand, does not mean it will be the best choice to sow in 2019."

In addition to germination and vigour, Steven said retained seed should also be tested for purity/weed seeds and disease pathogens.

Those growers sourcing planting seed from outside their immediate region are being urged to use a quality assured seed supplier which will ensure grain quality (purity, germination and vigour) is tested against a code of practice.

A comprehensive GRDC Fact Sheet outlining issues with retaining seed after challenging seasons is available from the GRDC website at *https://bit.ly/2WkCBuE*.

The fact sheet outlines how growers can test their own seed or a range of commercial providers of both germination and vigour tests are available. ■

Getting the seed deep and onto moisture without busting the field wide open

Once upon a time there seemed to be an 'end' to our planter production season – at least that was the case back in the early days of NDF Disc Planters.

Fast forward 15 years and things are very different. With such a big footprint of NDF Disc Planters across Australia, there is now a continuous cycle of quotes and sales, and of course, the all-important production of the machines and ultimately the commissioning of the planters at our customers' farms.

The NDF 12 metre 3PL Dryland Planter can seed deep into moisture with minimal soil disturbance.

"We believe this is a result of growers looking over the fence and realising the NDF planters are getting some pretty good results," Dale Foster of NDF says. "I was recently at Daniel Wegener's place on Queensland's Darling Downs and Daniel mentioned that he was very pleased with the capability to plant when he wanted to plant."

"Even when others around me can't plant, the NDF is not busting it all open like a tyne machine would," Daniel said.

"Most people plant on planting rain whereas we like to plant on deep moisture and have the crop's roots down beforehand. We're finding it challenging that it's currently a bit dry – but we're liking the challenge. We're learning what the NDF is capable of."

A good option in drier conditions

Daniel Wegener isn't the only one seeing the results. The feedback is clear that growers are seeing the NDF machines get crops up on marginal moisture and they are realising that NDF Disc Planters are an attractive option in the drier conditions as well.

Released at Ag Quip 2018, the NDF 12 metre 3PL Dryland Planter is getting some pretty keen interest for the same key reason: The ability to get seed into deep moisture without busting the soil open and thereby saving moisture.

The Dryland planter is the well proven NDF SA650 fitted with vacuum seed metering, optional trash whippers and optional Delta Force.

The beauty of the electric drive Precision Seeding vacuum singulation units are that they can be fitted to any existing NDF SA-650 disc openers. Some NDF customers have already done that.

Depending on your specific needs, seed supply options include bar-mounted hoppers that gravity feed to the seed metering unit or a larger air-fed hopper to keep the seed metering unit primed. ■

Growers are seeing that NDF Disc Planters get crops up on marginal moisture.

Section 7

Working With the Weather

CONTENTS

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New understanding of the drivers behind hot and dry seasonal conditions

By Katherine Hollaway

Predicting temperature extremes and dry conditions over spring and summer is vital for agriculture, water supplies, bushfire risk and human health. But to make accurate predictions the Bureau of Meteorology needs to better understand the climate drivers behind such extremes.

Bureau researchers have recently identified how wind patterns in the stratosphere around Antarctica can drive hot and dry conditions over southern Queensland and northern New South Wales.

This research was undertaken by the *Forewarned is Forearmed* (FWFA) project, which is part of the Federal Government Rural R&D for Profit program. FWFA is supported by the Bureau, a range of Rural R&D Corporations, Universities and state government agencies.

While most weather systems like storms, rain and high pressure systems are found in the troposphere – the relatively turbulent first layer of the atmosphere – the stratosphere above it is known for its stable air flows. Commercial airplanes target this layer to find jet streams for a smooth and efficient flight.

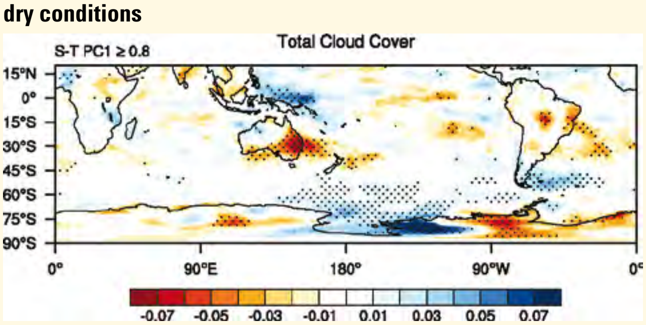
A key feature of the stratospheric circulation is the development of the wintertime polar vortex, whereby Antarctic circumpolar westerly winds (extending up to 40–50 km altitude) seasonally strengthen from autumn to winter as the polar cap region cools. The vortex weakens and breaks down during late spring as the polar cap warms up. In some years the vortex warms up and breaks down early, which can lead to hot and dry conditions on Australia's surface during late spring–summer.

An early breakdown of the wintertime polar vortex can lead to hot and dry spring and summer conditions in eastern Australia.

The early weakening of the polar vortex results in a strong downward air flow and a lack of clouds over eastern Australia (Figure 1) via another large-scale circulation that Australian farmers already know – a negative Southern Annular Mode (SAM) – according to Bureau researcher Dr Eun-Pa Lim.

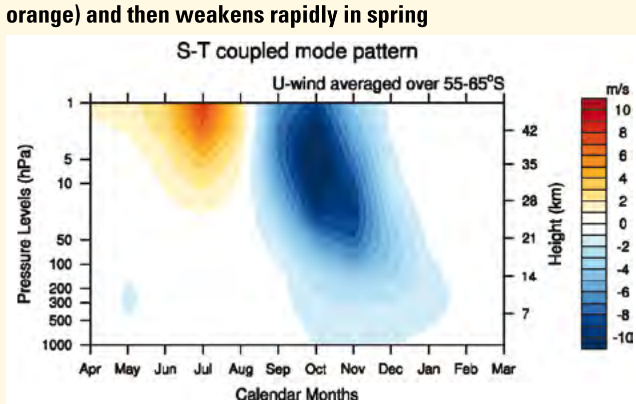
"A negative SAM is responsible for bringing hot and dry conditions to eastern Australia in our warm seasons," says Eun-Pa. "Anything we can do to improve our ability to predict SAM will help people on the land to prepare for and manage these conditions. The long time-scale of the polar vortex weakening – which spans several months – means if we can capture it in our model, we can potentially predict low SAM conditions during late spring as early as late winter."

Figure 1: A strong weakening of the polar vortex and the associated negative Southern Annular Mode leads to an abnormally strong downward air flow and a lack of clouds (orange indicates less than average cloud cover) over eastern Australia, which results in higher than average temperatures and dry conditions



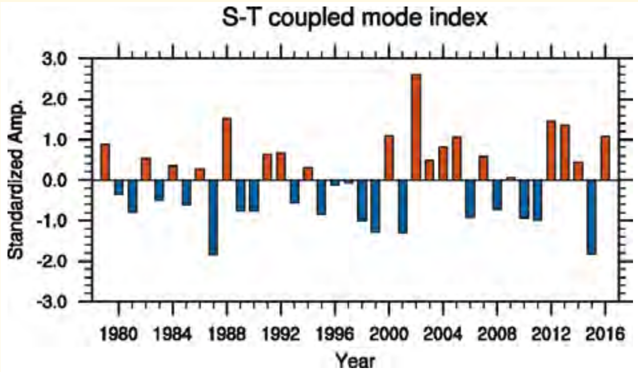
This plot shows the cloud cover variation in late spring-early summer following the early break down of the polar stratospheric vortex.

Figure 2: When the abnormal polar vortex weakening happens, generally the vortex is abnormally strong during winter (shown in orange) and then weakens rapidly in spring



The process of weakening of the westerly winds descends after September (blue). Exact timings of the strengthening of the winter polar vortex and its subsequent weakening in spring to early summer can vary year-to-year. Wind (m/s) is measured as being stronger or weaker than the average.

Figure 3: The Bureau has developed the S-T coupled mode index to identify polar vortex weakening (in red) and strengthening (in blue) events



The strongest vortex weakening event on record occurred in 2002 (based on monthly average wind data from April 2002 to March 2003 compared to wind data of all years).

What is a polar vortex?

Both the northern and southern hemispheres have polar vortex variations in the upper stratosphere, and its year-to-year variation is at its strongest during winter in the northern hemisphere and during spring in the southern. Eun-Pa says that although the polar vortex is probably a less well-known climate driver in the southern hemisphere (SH), it is often in the news in the northern hemisphere as the cause of extreme cold events across Europe and North America.

Defined as a band of very strong westerly winds, the stratospheric polar vortex in the Southern Hemisphere typically peaks in winter every year, then weakens and migrates poleward and downward as the season progresses and completely breaks down by December. As the wind signal in the stratosphere descends and interacts with winds closer to the earth's surface, it is known as stratosphere-troposphere coupling (S-T coupling).

While weakening of the polar vortex is a normal part of its seasonal cycle every year, when an abnormal polar vortex weakening event occurs, this seasonal evolution speeds up and the vortex breaks down earlier than usual.

The abnormal weakening of the polar vortex and its downward coupling in spring to summer can be visualised in Figure 2. During winter the westerly winds associated with the SH polar vortex are stronger than usual in the upper stratosphere (as shown in orange), which can allow more atmospheric waves to propagate from the lower atmosphere into the stratosphere. Because these vertically propagating waves act to weaken the upper stratospheric westerlies, the polar vortex starts to weaken from early spring.

As the vortex weakens over time, the weakening signal descends (shown in blue). The impact is felt at ground level from October to January.

Impact on Australia's climate

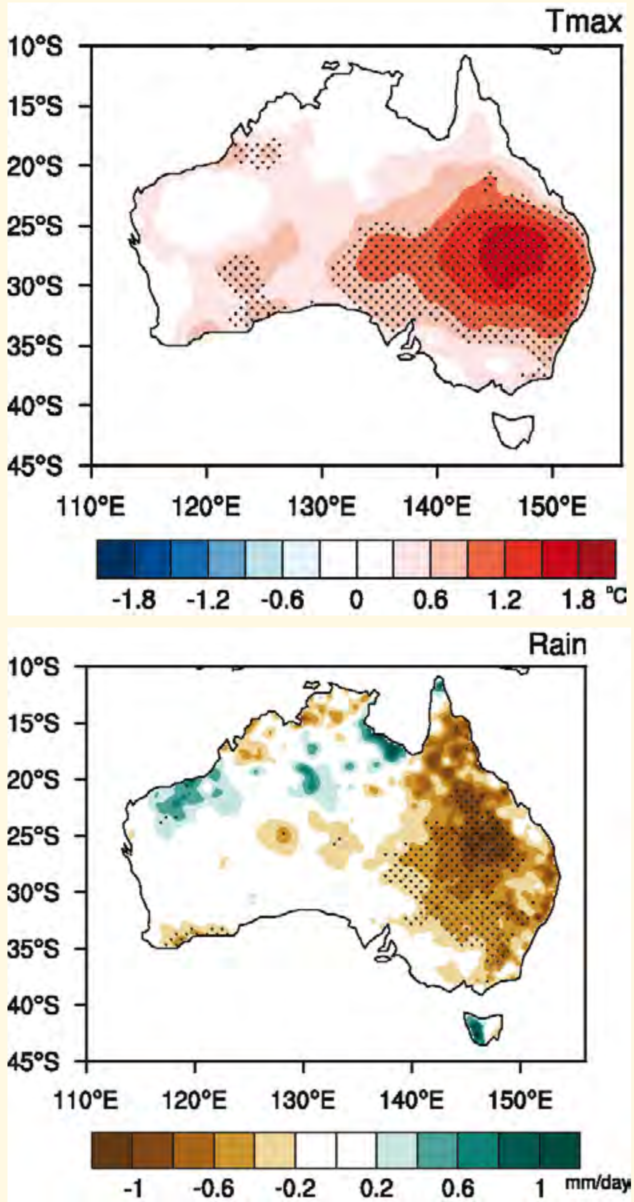
Developing an index to measure polar vortex weakening and strengthening has been a vital part of the Bureau's recent research and has made it possible for them to study the impact of these events on Australia's seasonal conditions.

"The Bureau has developed the stratosphere-troposphere (S-T) coupled mode index to identify these events and quantify their strength," says Eun-Pa. The index is based on monthly average wind data (1979–2017) over the Antarctic sub-polar region (55° to 65° South) at all available vertical levels from the surface to 50 km altitude.

The index allows the Bureau to measure whether the polar vortex weakening is progressing at its usual pace. A high index means unusual weakening which leads to faster vortex breakdown.

The strongest weakening event occurred in 2002 (Figure 3), which was related to the strongly negative SAM in spring 2002 that is believed to have played a more important role in driving hot and dry conditions than the relatively weak El Niño observed in the same year.

Figure 4: The October to January mean maximum daily temperature is between 1.2° and 1.8°C warmer and rainfall is 0.4 to 1.2 mm per day lower over southern Queensland and northern NSW during the nine identified polar vortex weakening years than in all the other 29 years between 1979–2017



Findings from the polar vortex research are pointing to a more informed and proactive decision making environment for farmers.

Hot conditions

The Bureau's S-T coupled mode index also highlights other less dramatic, but still significant, polar vortex weakening/strengthening events. By comparing historic temperatures and rainfall for the October to January period with the index the Bureau has found a very strong correlation between the polar vortex weakening and hot and dry seasonal conditions in southern Queensland and northern NSW.

For instance, maximum temperatures (Tmax) in the nine polar vortex weakening years (Index ≥ 0.8) were 1.2° to 1.8°C warmer over southern Queensland and northern NSW than in the other 29 years studied between 1979 and 2017 (Figure 4). At the same time rainfall was 0.4 to 1.2 mm per day lower – that's around 12 to 36 mm a month.

"When you consider the seven hottest years (the top 20 per cent) – they are over four times more likely to occur when it is a polar vortex weakening year than a non-weakening year," says Eun-Pa.

"The research demonstrates that the Antarctic polar vortex is an important driver of heat and rainfall extremes in subtropical eastern Australia during late spring to summer.

"The Bureau's new ACCESS-S seasonal forecast system has a high level of skill in predicting S-T coupling from the beginning of September, which will improve our ability to predict temperature and rainfall extremes for the spring and early summer in polar vortex weakening years," she said.

This particular result of the Bureau's research implies that if land managers can be warned in September that they are likely to face hot and dry conditions through to January due to the polar vortex weakening, it will put them in a better position to make timely decisions such as how to manage livestock numbers, pastures and their supply of supplementary feed.

"Lastly, since the beginning of spring 2018 the stratospheric polar vortex has been stronger than usual, which is likely to have somewhat mitigated the hot and dry conditions promoted by the development of El Niño over Queensland and northern NSW. This was something we could be thankful for during the tough dry spring of 2018," Eun-Pa said.

Australian Grain **acknowledges the funds provided by GRDC, CRDC, SRA, AgriFutures, MLA and the Australian Government to support the work undertaken within the Managing Climate Variability Program.**

Further information: Eun-Pa Lim, 03 9669 4000, E: eun-pa.lim@bom.gov.au ■

Getting ahead of weather extremes

Agriculture is highly dependent on weather and when extreme events are on their way, Australia's farming community turns to the Bureau of Meteorology for information. Getting this information far enough ahead can make a big difference in the ability of farmers to reduce risk.

With this in mind, the Bureau and a number of research partners are working with agricultural industries to develop new forecasting tools that will improve the lead time in predicting extreme events.

Extreme events can be expensive and at worst can lead to loss of life. A sudden cold snap can kill freshly shorn sheep or new-born lambs. A prolonged dry spell can wipe millions off the value of a grain harvest. Extreme heatwaves stress livestock, drop milk production and destroy horticultural crops.

In many cases, being able to predict these conditions can enable farmers to prepare and potentially reduce the impact on their business. For instance, livestock can be moved to sheltered paddocks ahead of cold and wet conditions or to higher ground if extreme rainfall is predicted. In hot conditions, timely irrigation can limit the impact on crops and sprinkler systems can help cool livestock.

The *Forewarned is Forearmed* (FWFA) project aims to identify the type of extreme events that impact on agriculture and improve the delivery of forecasts to land managers. The project is working with representatives from the grains, dairy, red-meat, rice, sugar, cotton, viticulture and pork industries.

Through a series of consultations with industry representatives, the Bureau of Meteorology and its research partners have identified the types of extreme events that impact on farm business profitability. Their task is to test whether the Bureau's models can successfully predict these extreme events ahead of time and develop new tools to deliver these forecasts.

The project is focusing on three key areas, extremes of heat, cold and rainfall, starting initially with heat.

Extreme heat

The years 2009 and 2014 commenced with extreme heat events and in 2009 these contributed to the devastating Black Saturday bushfires. Record high maximum temperatures across much of eastern Australia in January 2019 have proved challenging for livestock and have damaged fruit and vegetable crops.

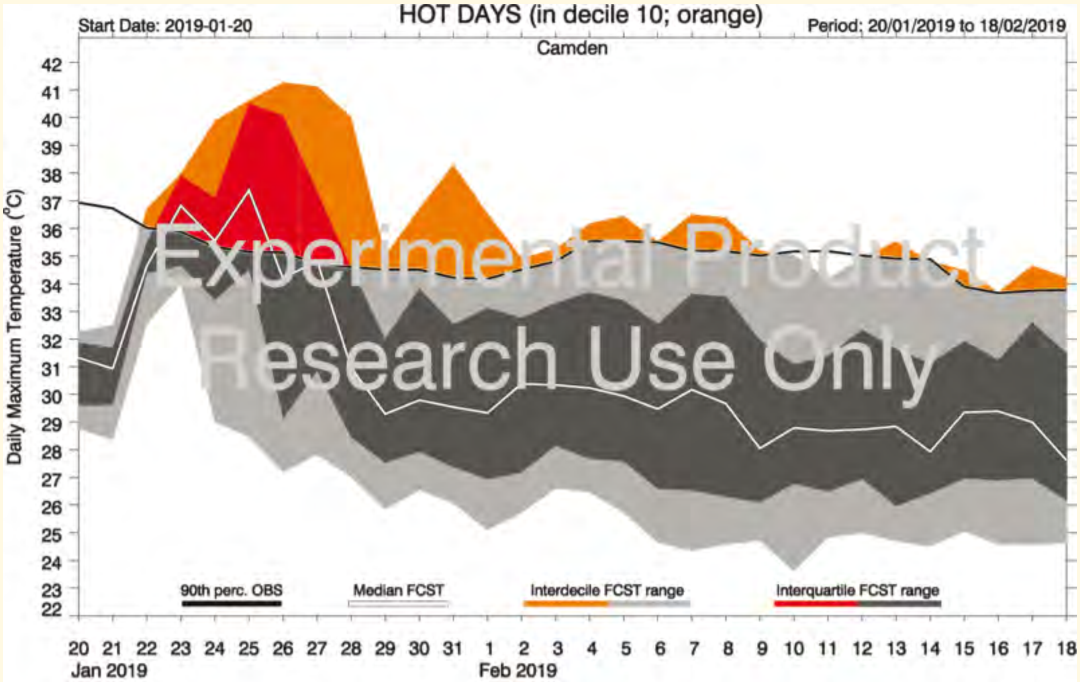
While current temperature forecasts project seven days into the future, the Bureau is testing a seasonal climate model extending to time frames ranging from two weeks to three months.

One prototype with broad application would allow users to identify extreme heat events up to four weeks ahead.

The 'plume forecast' displays possible temperature scenarios for the coming month presenting them as a median, 25th to 75th percentile and 10th to 90th percentile forecasts (Figure 1). The chart also shows the historic observed 90th percentile – just 10 per cent of days are hotter than this threshold for that time of year. When the forecast plume exceeds the 90th percentile for observed temperatures, the forecast is highlighted in orange or red depending on the likelihood of an extreme heat event.

This type of forecast can be useful across a broad range of agricultural industries from those who need to mitigate the impact of heat on livestock, manage irrigation supplies or simply to plan activities around avoiding the hottest part of the day.

Figure 1: Prototype plume forecast of daily maximum temperatures for Camden, New South Wales



The 28-day forecast (above) shows the median forecast (50th percentile, white line), the 25th to 75th percentile forecast (dark grey) and 10th to 90th percentile forecast (light grey). Forecasts that exceed the historic observed 90th percentile maximum temperature threshold temperatures (black line) are highlighted in orange or red depending on the likelihood.

Other extreme heat prototypes developed by the Bureau include maps of heat waves and numbers of hot days; as well as charts of temperature projections and the temperature-humidity index for specific stations.

Seasonal rainfall

Another prototype takes seasonal planning a step further. For instance, the current Bureau seasonal forecast for rainfall provides the probability of rainfall being above or below median; that is two categories – drier or wetter than the long-term median. The prototype provides a more detailed forecast showing the probability of rainfall across five decile ranges (Figure 2).

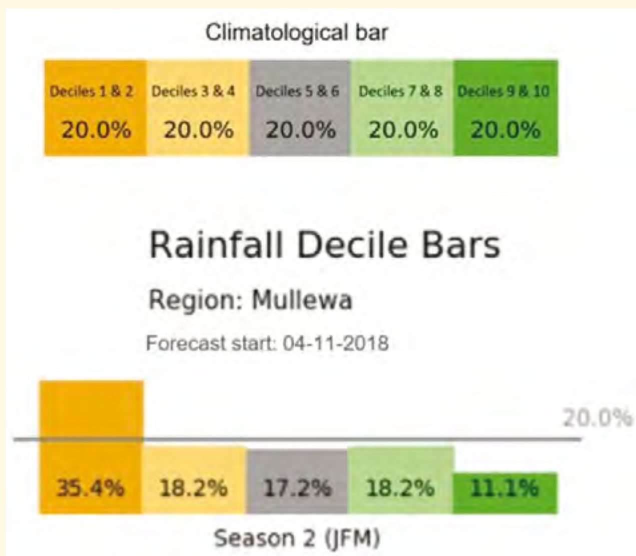
These forecasts can offer a better understanding of the potential for dry conditions. On a seasonal time-scale they could give growers time to adjust their cropping program if there was a particularly dry start forecast for the season.

For instance, in 2010 Western Australia had a very dry start to the season despite most of the rest of Australia enjoying a relatively wet year. Better information could reduce financial losses by enabling growers to select more drought tolerant crops, reduce fertiliser inputs and elect to fallow more paddocks.

The prototypes are currently being tested with industry reference groups and will be modified in response to user feedback. New prototypes will also be added. The first products are expected to be released on the Bureau's website in early 2021.

The *Forewarned is Forearmed* project is supported by funding from the Australian Government Department of Agriculture and Water Resources as part of its Rural R&D for Profit program. Project research partners: Bureau of Meteorology, South Australian Research and Development Institute, University of Melbourne, University of Southern Queensland, Birchip Cropping Group, Agriculture Victoria, Monash University and Queensland Department of Agriculture and Fisheries. Rural R&D Corporation partners: Meat & Livestock Australia, Dairy Australia, Wine Australia, Sugar Research Australia, Grains Research & Development Corporation, Agrifutures Australia, Cotton Research & Development Corporation and Australian Pork. ■

Figure 2: An example forecast issued in November 2018 for the Jan-Feb-Mar rainfall season for Mullewa, Western Australia



The above forecast suggests a shift in the odds towards an increased chance for the rainfall season to be in decile 1–2 and a reduced chance of having a decile 9–10 season. This is seen by comparing the forecast probability with the usual (climatological) probability of 20 per cent for each category. The chance of being in the lower two deciles has increased from 20 to 35 per cent and the chance of having a really wet season is halved.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New and improved AgriClime offer now available for 2019 season

AGRICLIME CHANGES – AT A GLANCE...

- The Rainfall Threshold has been changed to be a 1 in 5 year low-rainfall event (previously 1 in 10), based on 20 years of historical data, meaning there is a greater chance of a payout.
- A payout is triggered at an entry point (the Rainfall Threshold) and maxes out at an exit point (the Exit Point) whereby a maximum cash-back of 30 per cent is paid (previously 15 per cent).
- The payout works on a linear scale, so the less rainfall the more cash-back.
- The Grid Cell size is now 5 X 5 km² or 25 km² meaning that the Grid Cell is smaller and rainfall data is much more accurate to a farm level.

Fourth generation Mallee farmer Jarrod Munro received a cash-back in 2018. For Jarrod's story visit: *www.syngenta.com.au/agriclime*

Registration is now open on a new AgriClime offer for 2019, designed to give growers the confidence to invest in a better crop. Growers who spend $15,000 on two or more participating Syngenta products are eligible for up to 30 per cent cash-back, if the minimum rainfall threshold isn't met for their nominated paddock. Under the old offer this was capped at 15 per cent.

The chance of receiving a cash-back has also improved. Based on 20 years of rainfall data, the chance of a cash-back is now 1-in-5 years, instead of 1-in-10 years previously.

"We truly believe in AgriClime as a tool to help growers better manage risk and to provide them the confidence to invest in a better crop through the use of our quality products," AgriClime Program Manager Angus Rutherford said.

Sharing the risk

"We want growers to have a bumper season, every season, but in case this doesn't happen we want to share this risk with growers."

More than $850,000 has been made in cash-back payments to growers since the program was introduced in 2016.

Last year, one-in-four registered growers in NSW and Victoria received a cash-back. In fact, 89 per cent of all AgriClime payments nationally were made to those NSW and Victorian growers, where the drought was at its worst*.

But Angus said he understood there were growers who were disappointed they didn't receive a cash-back.

"There were two main factors, firstly, the rain that arrived in October in some areas – that was sadly too late for the crops – but pushed growers over their rainfall threshold," he said.

"Secondly, the grid cell size for rainfall recording – 25 km x 25 km (125 km²) – under the old offer was too big, meaning it was not always reflective of on-farm rainfall.

"We know some growers were unhappy and that's why we have made key changes to the 2019 program."

Accordingly, the grid cell size for 2019 has been reduced to 5 x 5 km.

As always, AgriClime is free to register, includes 16 products from the Syngenta range and is quick and simple on our new platform.

Growers or their advisors simply need to nominate whether to participate in the August-September 2019 offer, or the September-October 2019 offer.

"We would love to see all growers back for AgriClime in 2019 as we look to give you confidence to invest in a better crop," Angus said.

AgriClime products: Affirm, Amistar Xtra, Axial, Boxer Gold, Cruiser 350, Dual Gold, Karate Zeon, Miravis, Moddus Evo, Spray.seed, Talinor, Uniform, Vibrance.

New: Inclusion of Axial Xtra, Cruiser Opti and Elatus Ace (pending APVMA registration).

Visit *agriclime.syngenta.com.au* for more info.

***No registrations were received from Queensland growers in 2018.** ■

Better ryegrass control than 'tri mixes' – especially in drier seasons

AT A GLANCE…

Boxer Gold was developed by Syngenta for tough conditions. For more than a decade it has helped growers control annual ryegrass, including Group D resistant populations, over millions of hectares.

- Price repositioning in 2018 means it's now even more affordable (under $30 per hectare).
- A unique propriety formulation of Prosulfocarb and S-metolachlor (J and K herbicide Groups), makes Boxer Gold an important tool for resistance management.
- More consistent, robust control of hard to control annual ryegrass in less than ideal moisture planting conditions, means Boxer Gold can deliver better overall value compared with trifluralin and triallate mixes.

The value for money herbicide for annual ryegrass (ARG) control, Boxer Gold, found its way onto many new farms in the tough 2018 season thanks to a significant price reduction. The herbicide will again earn its keep in 2019 as a better option than 'tri mixes'.

Positioned at under $30 per hectare (at a 2.5 litres per hectare rate) Boxer Gold represents great value for those wheat and barley growers who want more dependable control than trifluralin and triallate mixes.

"With the lower price point, growers and agronomists have some very good reasons to rethink their position on ARG management, if they haven't already," Syngenta Senior Product Lead, Garth Wickson said.

Garth says Boxer Gold has demonstrated several key agronomic advantages over trifluralin and triallate.

"Trial data across key cropping regions of Australia highlights that while trifluralin and trifluralin/triallate tank-mixes can deliver good ryegrass control, their performance can sometimes be variable as their efficacy is impacted more by weather conditions and different soil types," Garth said.

"In side-by-side comparisons the trials have shown that Boxer Gold delivers a high level of ryegrass control without being prone to the same degree of variability in sub-optimal conditions.

"It's a more robust solution to the ARG problem that allows growers to achieve consistently better results with less likelihood of seasonally induced failures causing weed numbers to blowout."

Affordability, reliability, consistency and flexibility are all important points for growers to consider when choosing herbicides.

Boxer Gold offers control of ARG Group D herbicide resistant populations, as well as silver grass, stone crop (Crassula spp.), toad rush and useful suppression of barley grass.

A flexible-to-use product, application can be changed to suit seasonal conditions. Registered usage patterns include:

- Pre-emergent, applied up to seven days prior to mechanical incorporation by the sowing operation (IBS);
- A split application of 1.75 litres per hectare pre-plant followed by 750 mL per hectare post-plant; and,
- Post-emergent, one-to-three leaf-stage for ARG (suppression).

To expand the weed spectrum even further, Garth advises that Boxer Gold can be tank-mixed with trifluralin or Monza. ■

A reduced price and a proven, reliable performer against annual ryegrass makes Boxer Gold a popular choice for growers in tough seasons.

Section 8

Spray Application

CONTENTS

THIS SECTION BROUGHT TO YOU IN ASSOCIATION WITH:

Seeing green on green: A new way to look at weed control

By Guillaume Jourdain, Bilberry

AT A GLANCE…

- Green on green camera technology is now used on farms. This will lead to important financial and farm management benefits for growers.
- Growers need to not only understand the benefits – but also the limitations – of new technologies such as green on green weed detection.

Two optical camera systems to spray weeds have been on the market for several years – WEEDit and WeedSeeker. These systems are now commonly used in Australia for green on brown applications. A number of start-up companies (such as Bilberry), large corporations and universities are now developing systems with green on green capability – that is, being able to identify a weed in a growing crop and selectively spray the weed.

The technology used by the various companies in this green on green space is similar: Artificial intelligence with cameras – sometimes RGB/colour cameras and sometimes hyperspectral cameras.

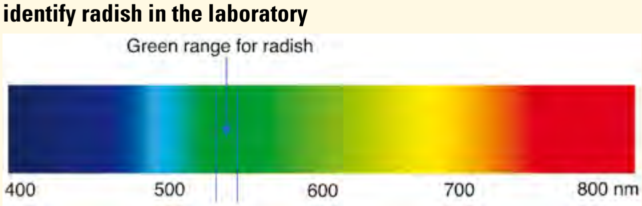
Using artificial intelligence (AI) to detect weeds

Finding machine-based methods to recognise weeds within crops has interested high-tech companies and researchers for a very long time. The first patents on this topic date back to the 1990s.

The main approach was to differentiate weeds from crops thanks to their colour and shape. Through mathematical formulas, a range of colours and a range of shapes for each weed can be identified. In other words 'conventional' algorithms – which set out a process, or the rules to be followed by the machine – to identify the weed, can be created.

Figure 1 shows a very simplified example. Conventional algorithms can identify radish in the laboratory because the weed colour sits within a specific green range.

Figure 1: A simplified example using conventional algorithms to identify radish in the laboratory



Green on green technology developers

- Bilberry – a French AI based start-up that specialises in cameras for recognising weeds (subject of this article).
- Blue River Technology – acquired by John Deere in September 2017 for more than US$300m, developing a See and Spray technology. This involves a spraying tool with smart cameras, trailed by a tractor, that can spray weeds very accurately at about 10 km per hour.
- Ecorobotix – a Swiss based start-up developing an autonomous solar robot that kills weeds. Ecorobotix is also developing the camera technology.
- AgroIntelli – a Danish company developing an autonomous robot to replace tractors, that will also include camera technology spraying capacity.
- Bosch – a German company becoming more involved in agriculture and has a project called *Bonirob,* a weed-killing robot with smart cameras.

This is all very well in the laboratory under controlled conditions with constant light, no wind, all crops and weeds are from the same variety and are not stressed etc. But paddock conditions are completely different.

The sun can be high or low, in your back or in your eyes, there can be clouds, there can be shadows from the tractor/sprayer cabin or from the spraying boom, crops can be damp in the morning which creates sun reflections, the soils always have different colours and so on.

It's clear that conventional algorithms cannot work in field conditions. Enter artificial intelligence as a game changer.

Bilberry cameras on an Agrifac 48 metre self-propelled sprayer.

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Artificial intelligence – and especially deep learning – is another way of working on images to recognise different objects. It is now the most widely used technology for computer vision when it comes to complex images such as recognising weeds within crops or on bare soil.

Deep learning is part of the 'family' of machine learning and is inspired by the way the human brain works. Deep learning often uses the architecture of deep neural networks.

The learning part can be either supervised or unsupervised.

Research on deep learning started in the 1990s. In the past few years deep learning applications have become much more widely used. And there are three main reasons for this. The recent advent of:

- Plenty of data;
- High computing power; and,
- Powerful algorithms.

With these three 'advances' deep learning is now applicable in many situations and is especially relevant in agricultural applications.

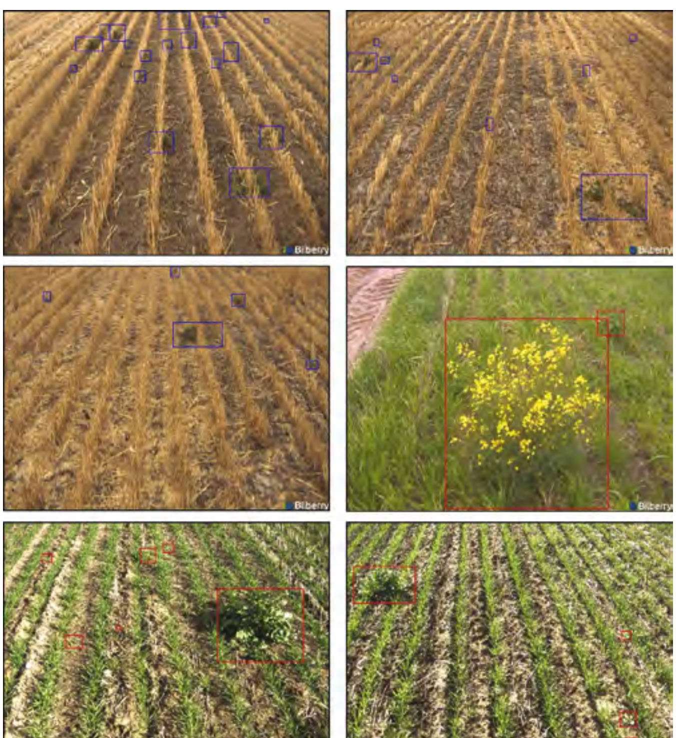
Two of the most important steps with AI and deep learning in agricultural applications are data gathering and paddock testing. And these two steps largely happen in the field.

What is especially complex and important about data gathering is to be able to capture the diversity of in-field situations.

Research and results at Bilberry

Bilberry was founded in January 2016 by three French engineers with the idea to use artificial intelligence to help solve problems in agriculture. The main product from Bilberry is now embedded cameras on sprayers. These cameras scan the paddocks to recognise the weeds and then control the spraying in real time to spray only on the weeds and not the whole paddock.

Bilberry also develops cameras that recognise weeds along railway tracks. The technology is similar, with just a higher speed (60 km per hour) as well as day and night applications.



Weed detection on bare soil (three first pictures) and wild radish detection in wheat (three last pictures) – Images taken from Bilberry cameras – results in real time

The biggest focus for us developing this product is now on Australia, with several sprayers already equipped with Bilberry cameras. One of the reasons for this focus is the huge interest among Australian growers and agronomists towards green on green spot spraying.

One camera every three metres is mounted on the spray boom along with computing modules (to process the data) and switches (to distribute power and data to each camera).

In the cabin, there is one screen to control the system.

Results to date

Three algorithms are now validated and can be used by growers in the field – two of these are particularly focused on Australian growers:

- Weeds on bare soil detection (using AI, but same application as WEEDit or WeedSeeker\);
- Rumex (dock weed) in grasslands; and,
- Wild radish in wheat (especially when weeds are flowering).

It is important to note that large chemical savings are made with the cameras, however it is also a very interesting tool to fight resistant weeds, potentially enabling the use of products that cannot be currently used in-crop due to either cost or crop impact.

The photographs taken by the Bilberry cameras show weed detection on bare soil and wild radish detection in wheat.

Main features of the Bilberry camera

The cameras are used at up to 25 km per hour speed and can be used on wide booms – currently the widest boom used is 49 metres, but could be more if needed. This creates very high capacity. Theoretically the camera capacity can be calculated as:

25 km per hour x 48 metres = 120 ha/hour

In real spraying conditions, capacity is of course lower, as the speed is not always 25 km per hour and the sprayers need to be refilled.

Test field after spraying with dye.

Summer spraying in Australia (NSW example)

One Agrifac 48 metre boom is equipped with cameras on a farm in New South Wales. Before the cameras were used by the grower and his team, a comparative test was made with current camera sprayer technology. It was then decided to use Bilberry cameras as much as possible on the farm.

The cameras have been used since the beginning of the 2018-2019 summer spraying season. Table 1 below outlines the main 'numbers' over a three week spraying period.

Table 1: Figures from the 2018-2019 summer spraying season

Total area sprayed	Ha/day	Ha/hour	Chemical savings
6199 ha	413 ha	75 ha	93.5%

The carrier volume used was generally set at 150 litres/ha.

It is very important to note that the chemical savings are directly linked to the extent of weed infestation in the paddocks. A paddock with high weed infestation will get little savings whereas a paddock with low weed infestation will get high savings.

Spraying dock weeds in grasslands (Netherlands)

In the Netherlands, a 36 metre Agrifac boom is equipped with Bilberry cameras and uses an algorithm to spray dock weeds on grasslands. A rigorous testing process earlier was used to ensure the algorithm was working properly.

Once the grower validated that the algorithm was working, it was used during the whole spraying season. About 500 hectares were sprayed during the season, and the average chemical savings were above 90 per cent. The cost of the chemical is about €50 ($80) per hectare for this application which means €45 ($72) per hectare in chemical savings with the use of cameras.

Future machine capabilities

Obviously, the biggest focus is to develop new weeding applications (which means new algorithms) to be able to use the cameras more often.

Other important development focuses we have right now include:

- Working at night (already working on railway tracks, but not on sprayers).
- Working at 30 km per hour.
- Delivering a weed map after a spray run (already working on railway tracks, but not on sprayers), to compare with the application map.
- New weed applications.

In the future, we believe that every time the sprayer goes in the field, the cameras should be able to bring value to the grower. Sometimes it would mean direct application (for instance for weed spraying) and other times it would mean building maps (maps to give growth stage throughout the paddock or disease status or anything that could help growers and agronomists do their job).

We will also look into algorithms for modulating nitrogen and fungicide applications.

In a completely opposite direction, spraying with cameras will generate a lot of data. The data will be very precise (because the data is saved with the GPS coordinates) and will give agronomists and farmers new tools to improve their overall farm management strategies.

Further opportunities for growers

Cameras that detect green on green bring multiple new possibilities for growers. The most important and immediate consequences are new possibilities to fight resistant weeds and impressive chemical savings and reduced herbicide environmental load.

The potential to reduce the area of crop sprayed with in-crop selective herbicides, may also assist by reducing stress on stress interactions that are sometimes associated with in-crop herbicide use.

It is also very important to note that, as for any new technologies, it will only work well if growers get to know the technology, how it works, its limitations and possibilities. The first and most important thing for growers will be to be very attentive to the results of each spraying:

- First, are all weeds killed? and,
- Second, how much did I save?

The cameras might work perfectly on 90 per cent of your paddocks, and for some reason not perform as well on 10 per cent. This can definitely be corrected by more 'training' of the algorithms but to correct an algorithm the designer of the cameras must be made aware there is an issue.

Acknowledgements: Presenting this green on green technology has been possible thanks to the interest and passion of the GRDC Update coordinators and the support of the GRDC to bring me to Australia to present at the Updates. I would also like to express my thanks to the first growers that believed in Bilberry in Australia.

More information: Guillaume Jourdain. Email: guillaume@bilberry.io

Drift mitigation, efficacy and 2,4-D

By Bill Gordon, spray application specialist

AT A GLANCE…

- All spray applications must comply with the directions on the product label or APVMA approved permit. Applicators need to be aware of the recent changes to how 2,4-D must be applied.
- Applicators need to carefully select appropriate nozzles to meet the new spray quality requirements for products containing 2,4-D (on updated labels or according to APVMA approved permits).
- When using a very coarse spray quality or larger, an increase in the application volume may be required to ensure the target weeds receive appropriate spray coverage.
- Be aware that nozzle selection has a greater impact on drift reduction than an adjuvant will.
- APVMA approved permits exist that allow for the application of certain products containing 2,4-D through OSST (Optical Spot Spraying Technology, such as WeedIT and WeedSeeker) provided the weed cover does not exceed 10 per cent and other permit requirements are met.

On October 3, 2018 the Australian Pesticides and Veterinary Medicines Authority (APVMA) suspended all labels of products containing the herbicide 2,4-D and replaced them with a permit (PER87174) outlining new instructions for how the products must be used. Many manufacturers have already updated their labels to reflect the new instructions.

In summary, the new 2,4-D labels, or existing permits provide updated instructions such as:

- A mandatory requirement to apply products containing 2,4-D with a Very Coarse (VC) spray quality. During summer from October 1 to April 15 there is an advisory statement to use an Extremely-Coarse (XC) or Ultra-Coarse (UC) spray quality in cereals, fallow and pasture. Clearer definitions for recognising inversion conditions are included on the label or APVMA approved permit.
- Mandatory no spray zones (downwind buffers) to aquatic areas and terrestrial vegetation (typically less than 50 metres for ground application) have been included.
- Specific instructions and larger no spray zones included for aerial applications.
- Additional record keeping requirements, including boom height.

Wider selection of nozzles

The GRDC nozzle selection guides have been updated to include a wider selection of nozzles that can produce very coarse, extremely coarse and ultra-coarse spray qualities.

For most operators, there will be very few low-pressure air induction nozzles that will be able to produce a very coarse spray quality or larger at reasonable pressures – unless they consider a 04 orifice size or larger – which may require a significant increase in application volume.

To maintain reasonable pressures and application volumes, most operators will need to consider high pressure air induction nozzles, which have a minimum operating pressure around 3 bar, and ideally should be run at 5 to 6 bar pressure.

For growers operating Pulse Width Modulation (PWM) systems there has also been a new GRDC nozzle selection guide for PWM. This has been produced to assist owners of this technology with nozzle selection to meet new label requirements. There are several nozzle choices for PWM systems to achieve a very coarse spray quality or larger.

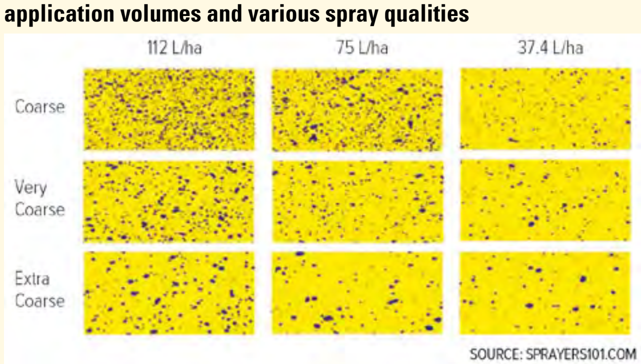
Determining suitable application volumes

The move to larger droplets may have implications on efficacy if spray coverage is not maintained. When using a very coarse spray quality or larger, the minimum application volume for fully translocated products – such as 2,4-D – should be 70 litres per hectare in low stubble environments. In heavier stubble, this should be increased to at least 80 litres per hectare.

Where hard to wet weeds such as flax leaf fleabane exists, trial work conducted by Northern Grower Alliance (NGA) has shown that when using 2,4-D, efficacy was maintained, even when using ultra coarse spray quality.

When moving to a coarser spray quality it may be useful to assess spray coverage using water sensitive paper (WSP) to determine if the application volume you are considering is appropriate for the stubble load present. Useful instructions for using WSP can be found in the GRDC GrowNote on *Spray Application for Grain Growers.*

Figure 1: Spray coverage on water-sensitive paper at three application volumes and various spray qualities



Tank mix and adjuvant effects on drift potential

Tank mix and adjuvant selection can impact on droplet size and drift potential, but their effect on the droplet spectrum is not as great as that of the nozzle type itself.

Recent droplet size analysis funded by GRDC was conducted by the Centre for Pesticide Application and Safety (CPAS) at their wind tunnel

Table 1: Comparison of driftable fines (less than 150 microns) for all tank mixes by nozzle type

	% of volume < 150 microns for all treatments		
Nozzle type	**Average**	**Range**	**Relative to AIXR 110-02**
TeeJet TT 110-02	26.65%	16.37–37.94%	3.29% (ie. 3.29 x AIXR)
TeeJet TT 110-02	8.11%	5.19–13.21%	100%
TeeJet TT 110-02	1.40%	0.78–2.28%	17% (ie. more than 80% less than AIXR)

Table 2: Adjuvant impact on per cent volume less than 150 microns averaged across nozzle types and tank mixes

Product/s	% of volume less than 150 microns in diameter	Relative to average % less than 150 microns for all nozzles (100%)	Ranking for drift reduction (1–4)
AMS	10.67	99%	3
AMS + LI-700	11.94	98%	3
AMS + Hasten	13.52	111%	4
BS1000	13.26	109%	4
Dead Sure	8.80	72%	1
Hasten	14.13	116%	4
Kombo	10.47	86%	2
LI-700	12.39	102%	3
Liberate	11.01	90%	2
Average of all nozzles and tank mixes	12.05	100%	

facility at the University of Queensland, Gatton. This work measured the impact of a range of common summer fallow tank mixes, with and without the addition of common adjuvants, on the spray quality and the driftable fraction produced through three different nozzle types.

Treatments used in this study consisted of nine different herbicides, applied alone and in two or three way tank mix combinations, with or without the addition of eight different adjuvants.

Each treatment was evaluated for the impact on the droplet sizes produced by three different nozzle types (TeeJet TT, TeeJet AIXR and TeeJet TTI) operated at 4 bar pressure. Tables 1 and 2 summarise a selection of the data generated from this study.

When comparing the nozzle tested there was a difference of between 2.31 times and 2.92 times as much of the volume existing as droplets less than 150 microns between the best tank mix and adjuvant combination and the worst tank mix and adjuvant combination. But the values obtained for each nozzle type did not overlap, meaning the nozzle type had a greater influence on the reduction of driftable droplets than the adjuvant or tank mix did.

As the initial spray quality increased, the impact of formulation and adjuvant became relatively smaller.

With the new 2,4-D application requirements, a move to coarser spray qualities will impact on potential spray coverage of target weeds. Total application volumes will need to be increased. (PHOTO: Brad Collis)

A TTI nozzle (extremely coarse spray quality) with any adjuvant added to the tank mixes had less than half the driftable fines than an AIXR (coarse spray quality) with the best drift reduction adjuvant added.

Where product labels or APVMA approved permits for products including 2,4-D require the use of a very coarse spray quality or larger, choose an adjuvant that provides the greatest increase in efficacy. Where an adjuvant can demonstrate both increased efficacy and drift reduction, it is a logical choice in areas where sensitive crops exist.

Table 2 illustrates the average impact of various adjuvants on the percentage of the volume existing as droplets less than 150 microns, averaged across all nozzle types and all tank mixes.

A simple ranking system from 1 to 4 has been included, with a ranking of 1 indicating the best drift reduction properties.

In Table 2, the values around 100 per cent in the third column are relatively neutral on the production of driftable fines (droplets less than 150 microns in diameter). Adjuvants with values above 100 per cent tend to increase driftable fines and adjuvants with values less than 100 per cent tend to reduce driftable fines.

Permits to apply 2,4-D using Optical Spot Sprayer Technologies (OSST)

The APVMA has issued a permit (PER87570) that allows for the application of certain products containing 2,4-D through OSST, provided the permit conditions are fully met.

While the WeedIT and WeedSeeker setups currently produce a coarse spray quality, their use has been granted under permit for certain products containing 2,4-D provided the weed cover is not more than 10 per cent and other label requirements – including record keeping – are adhered to. Operators of these systems must only use registered products covered by the permit.

To sum up

Like all things in agriculture, application technology is also constantly changing, both in the equipment available and the rules and regulations governing how we can use the products that are available.

It is the grower and applicators responsibility to stay informed about their legal requirements and to seek out information and equipment that will help them maintain efficacy and work within the legal framework.

Make use of the various GRDC publications related to nozzle selection, drift management and application technology.

Acknowledgements: The droplet size research undertaken by the Centre for Pesticide Application and Safety (CPAS) at the University of Queensland was made possible by the support of the GRDC. The author would like to thank them for their continued support.

For more information: Bill Gordon, Bill Gordon Consulting Pty Ltd. Ph: 0429 976 565; Email: bill.gordon@ispray.com.au

Using residual (pre-em) herbicides and disc seeders in winter crops

By Cindy Benjamin, WeedSmart

The Liverpool Plains of northern NSW is a hot spot for herbicide resistance. Growers have been doing battle with glyphosate and Group A and Group B resistant ryegrass since the early 2000s, along with high levels of glyphosate resistance in milk thistle and rising resistance in feathertop Rhodes grass, barnyard grass and liverseed grass.

Well-known private agronomist, Peter McKenzie, is working with growers in the region to integrate the use of pre-emergent herbicides into their winter cropping program.

"Pre-emergents are a useful tool to have in the weed control toolbox," says Peter. "But we need to use them effectively when we decide to pull them out of the toolbox.

"These herbicides have a place in both the winter and summer cropping programs provided they are well-supported with several other tactics. We need to be chipping weeds, using the optical sprayers for first and second knocks to make more economical use of herbicide, mowing verges and getting into harvest weed seed control."

Private agronomist, Peter McKenzie recommends having a range of weed control tactics in place before pre-emergent herbicides are strategically added to the winter program.

Applying pre-ems and disc seeders

When all these other tactics are in place, Peter reckons that's the time to consider the strategic use of pre-emergent herbicides.

Up to 80 per cent of Liverpool Plains growers are using disc seeders to handle high levels of crop residue when seeding winter crops, and to take

If weeds are surviving key herbicides such as glyphosate, testing these plants for susceptibility to other modes of action is a good first step while you implement a range of other tactics such as harvest weed seed control to drive down weed numbers.

advantage of limited planting opportunities. Peter says this presents some challenges, particularly when using pre-emergent chemistry for ryegrass control, but it can still be done effectively in certain circumstances.

Although most product labels recommend knife points and press wheel planters for ryegrass pre-emergents, the use of disc seeders is often not 'off-label'. But growers must be aware that herbicide companies are unlikely to accept any responsibility for crop damage that may occur if the seeder does not achieve sufficient soil throw to separate herbicide from the seed line. As always, read the label carefully and ask for advice.

Should I use pre-ems in a paddock with weedy patches?

Short answer: Possibly.

Longer answer: Satellite imagery is a great way to identify and map weedy patches, using services such as Satamap. Once the patches are mapped it is easier to manage these patches differently.

One effective way is to harvest these areas lower, and using a homemade or commercial chaff chute to concentrate weed seeds onto the inhospitable environment of controlled traffic farming wheeltracks. Using this approach, glyphosate resistant ryegrass patches can be dramatically reduced in one season – down by 70 to 75 per cent.

Not only can this drive down the weed numbers for the following year, it can also make summer post-emergent spraying more effective because the chaff reduces the amount of dust thrown up by the sprayer tyres.

An alternate strategy for patches where harvest weed seed control is not practical is to apply a pre-emergent prior to the first spring storms to the patches that have been previously mapped.

This is likely to substantially reduce the weed pressure over the following summer. Access to an optical sprayer (or chippers) can be very cost-effective in quickly cleaning up any escapes.

Why do I need to be particularly careful with ryegrass pre-ems in winter cereals?

Short answer: There can be serious unintended consequences (crop injury) even when all efforts have been made to correctly apply the herbicide, especially if heavy rain falls soon after planting.

Longer answer: Trying to remove a grass weed from a cereal crop can be difficult. It's a balance between having enough herbicide available in the soil moisture to control the weed, but not enough to cause damage to the crop. The crop can tolerate higher levels of herbicide than the weed, but where extreme conditions occur, poor weed control or crop damage can result.

Under dry conditions, herbicides with low solubility are likely to be 'safe' to the crop but may fail to give effective weed control. Herbicides with higher availability in the soil moisture can give better weed control under these drier conditions, but may cause more crop injury under high available soil moisture conditions.

Where crop injury occurs, it is generally a combination of short term waterlogging and inadequate seed separation from the herbicide in the soil. Low disturbance disc seeders, incorrect planter set up and or shallow planting depth are often implicated. Crop injury is normally worse on lighter soil types, all other things being equal.

So what are the options?

Short answer: Do some herbicide resistance testing and find out what herbicides will work. Then assess the risks.

Longer answer: Resistance testing is the best way to find out what does work – you probably already have a good idea about what doesn't! On a weed-by-weed basis, work out the best-bet control options throughout the year and for several years into the future.

Learn about the pre-emergent herbicide properties, particularly the plant-back periods, mobility in the soil, interaction with stubble and breakdown behaviour of the products you want to use. Talk to your agronomist and other growers about scenarios that have worked well.

For instance, deep-planted chickpeas can be a good option for residual herbicide use. There is also the option of swapping discs for tynes on some seeders to target a specific weed problem in a paddock with products that require effective soil throw out of the furrow. Regardless of the seeder type, it is also important to understand the interaction of the chosen herbicide with stubble.

If you use a disc seeder and decide to not use pre-emergents in your winter crops, then ensure you take advantage of the benefits of the disc seeder to achieve better crop establishment and more competitive crops. More crop, less weeds!

If you are considering adding pre-emergent herbicides to the weed control program on your farm, the free, online Diversity Era course is a great way to learn more and avoid the pitfalls. Check it out at www.diversityera.com/courses/pre-emergent-herbicides-101

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

Section 9

Managing Resistance

CONTENTS

Crazy science, star footballers and 2,4-D: A combination hard to resist

By Peter Newman, Australian Herbicide Resistance Initiative

If I took a star footballer, say Dustin Martin from the AFL, and cut off one of his arms, chances are he wouldn't function too well as a footballer anymore – although knowing Dusty, he would probably work out a way around it!

If I then sewed his arm back on so it worked perfectly, he would be back to his Brownlow medal-winning best.

This is sort of what happens with 2,4-D in wild radish and explains why metabolic resistance is not the mechanism of wild radish resistance to 2,4-D. We now know this thanks to some painstaking research by AHRI researcher, Danica Goggin with funding from the Australian Research Council and Nufarm.

The short story here is that resistance in wild radish to 2,4-D is not metabolic resistance. The longer story is much more interesting and explains how this works in wild radish, and how 2,4-D tolerance in grass plants is (partially) through a metabolic process.

AHRI researcher, Danica Goggin.

To demonstrate this, a cartoon series has been developed to show you what is going on in plants that do and don't have metabolic resistance.

The cartoons were prepared by Danica to help the rest of us understand some pretty complex and crazy science.

2,4-D metabolism in grasses and cereal crops

Ever wondered how grasses tolerate 2,4-D while broadleaf plants can't? One of their weapons is P450 enzymes.

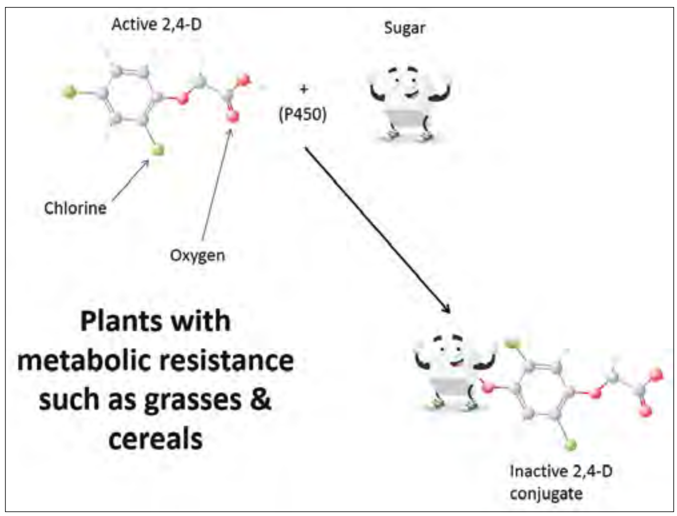
P450 is short for cytochrome P450 mono-oxygenase.

In other words, they are enzymes that add an oxygen (in the form of hydroxyl) onto a molecule. In this case, as you can see in the 'cartoon' below, when 2,4-D enters a grass plant, the P450 enzyme adds an oxygen to the carbon ring and then a different enzyme called a GT (glucosyl transferase) binds the sugar to this oxygen molecule.

Now we have a great big molecule that doesn't look or act much like 2,4-D anymore and it no longer works as a herbicide.

If you have very keen powers of observation you will also see in the cartoon that during this process one of the chlorines moves from position four to position five on the carbon ring. So, we could now call it 2,5-D.

The 2,5-D in this diagram has a big sugar bound to it, stopping it working, and other studies have shown that 2,5-D (without a sugar bound to it) also has no herbicidal properties.



2,4-D in plants without metabolic resistance such as wild radish

Danica's research was focused on understanding if wild radish could tolerate 2,4-D by metabolic resistance mechanisms. She found that it couldn't and is unlikely to in the future. Danica studied 13 populations of wild radish, two susceptible populations and 11 with 2,4-D resistance.

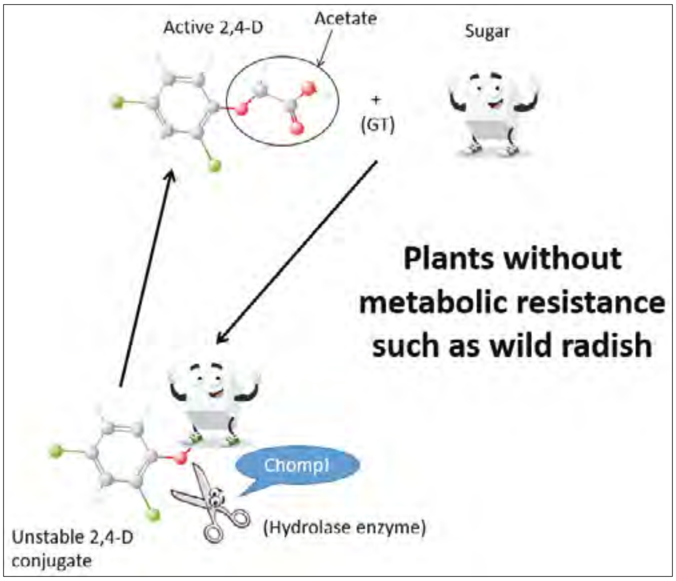
The cartoon on the next page shows that something super cool happens when 2,4-D enters the wild radish plant. The GT enzymes knock the acetate off the carbon ring and join a sugar onto the freed-up oxygen sticking off the ring. We now have the 2,4-D carbon ring with a sugar bound onto the side.

Now this is the cool bit. The plant then snips this sugar back off the carbon ring with a pair of scissors (called a hydrolase), the acetate joins back on and voila, 2,4-D is returned to its original state and it can wreak havoc as a herbicide.

This is a normal function in the plant. Remember that 2,4-D is an auxinic herbicide – they mimic naturally occurring auxins in the plant.

Auxins regulate growth and the plant needs to keep the auxins at the right level by switching them on and off again.

One of the ways plants do this is by the process mentioned above. Joining on a sugar to switch it off for a while, then cutting the sugar off to make it active again.



You may wonder why we bother to understand herbicide resistance at this level of detail. Well once in a while it has a pay-off and this is a good example.

Scientists have recently developed 2,4-D tolerant cotton and soybean using a bacterial gene to modify 2,4-D.

If metabolism isn't causing 2,4-D resistance, then what is?

In some earlier research, Danica Goggin found that reduced movement of 2,4-D between cells was the mechanism of 2,4-D resistance. But it is never that easy – there is just about always another mechanism.

Danica then went on to test another 10 populations of 2,4-D resistant wild radish and found that four of them had reduced movement of 2,4-D and six had something else.

The 'something else' mechanism is the focus of more research by Danica and others. It looks to be something to do with auxin perception, and more research will confirm exactly what is going on.

To sum up

This is some pretty crazy science that is helping us understand our oldest herbicide – 2,4-D.

If we could cut off a footballer's arm and sew it back on again we could regulate their ability as a player.

In the same way, all plants regulate auxin (and 2,4-D). The difference between resistant wheat and wild radish is that wheat P450s can act on 2,4-D, while radish P450s cannot.

Wild radish has had to find another – sneakier way – to become resistant.

For more information go to the AHRI website: *https://ahri.uwa.edu.au*

Trifluralin resistance is different – recessive inheritance

By Peter Newman, AHRI

We once thought that the genetics of eye colour was simple. Both parents have blue eyes, therefore, all of their children will have blue eyes. Easy peasy! Then science progressed and we realised that it isn't actually that simple because several genes are involved.

The genetics of herbicide resistance was simple. One parent is resistant to a herbicide, therefore, all of the offspring will be resistant because the gene is dominant or semi-dominant. This is true for almost all cases of herbicide resistance and was easy to understand.

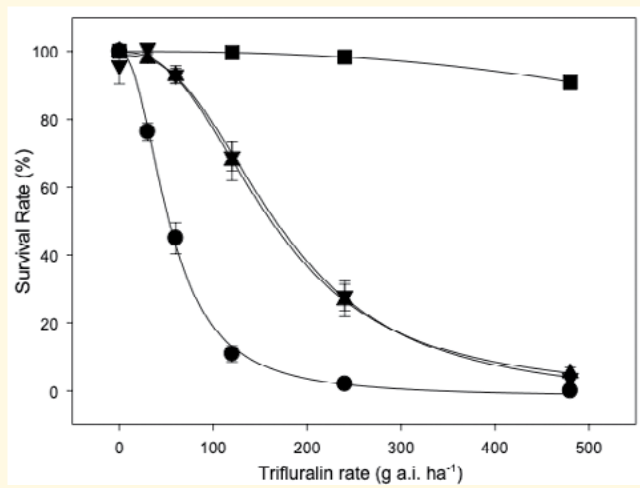
Until now.

AHRI PhD student, Jinyi Chen, studied the inheritance of trifluralin resistance with target site resistance in ryegrass. She found that resistance is single gene recessively inherited. This means that both parents must have a copy of the resistance gene for the progeny to be resistant.

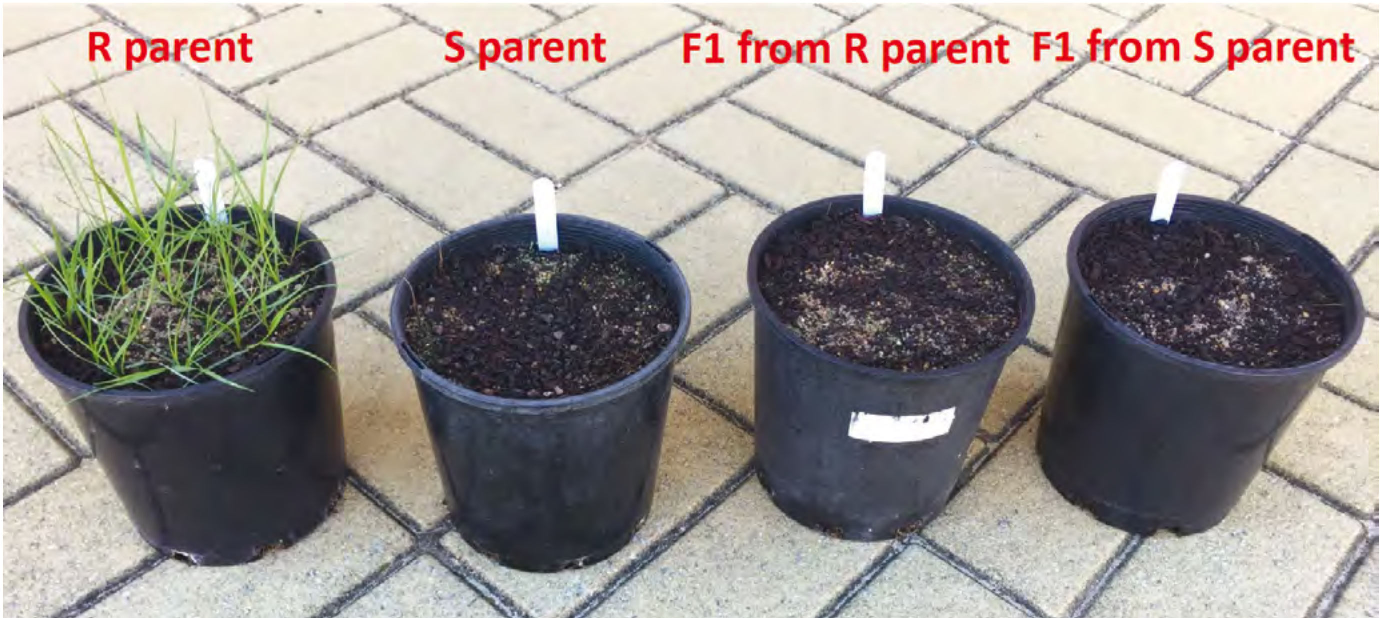
Recessive resistance inheritance is rare in the world of herbicide resistant weeds. Nearly all other cases of target site herbicide resistance involve semi-dominance.

This could be part of the reason why trifluralin resistance in ryegrass was slower to evolve than other types of herbicide resistance. But there is always more than one resistance mechanism.

FIGURE 1: Survival (%) of four populations of ryegrass at a range of trifluralin rates (gai/ha)



Circles = AA – susceptible parent.
Squares = aa – resistant parent.
Triangles (up and down) = Aa – two populations of offspring (the F1 progeny).



Offspring from resistant and susceptible ryegrass parents after trifluralin treatment at 480 g per hectare.

Trifluralin kills ryegrass and other grass weeds by stopping cell division. When cells divide, microtubules pull the chromosomes apart so that each new cell has its own set of chromosomes. Trifluralin interrupts these microtubules. In a previous edition of *AHRI Insight*, we featured Jinyi Chen's research that describes this target site resistance mechanism.

Recessive trait

This new research by Jinyi has now confirmed that this target site mutation is inherited as an incomplete recessive nuclear trait.

Let's break that term down a bit, shall we?

A recessive trait is one where both parents must have a copy of the mutation for it to be expressed in their offspring. Only offspring that have two copies of the recessive trait will express it.

In this case, we are talking about the alpha-tubulin gene.

Let's call the normal gene 'A' and the gene with the mutation that causes trifluralin resistance 'a'.

A normal, susceptible weed will, therefore, have the genes AA.

The resistant plant will have the genes aa.

In this study, Jinyi crossed AA with aa.

Therefore, all of the resultant progeny was Aa.

AA x aa = Aa Aa Aa Aa

If the gene was completely recessive we know that none of these offspring would be resistant to trifluralin.

Incomplete

Now let's introduce the word 'incomplete'.

Incomplete recessive means that the Aa progeny will have trifluralin resistance somewhere in between the susceptible (AA) and resistant (aa) parent – and that is exactly what Jinyi found.

The dose-response curves (Figure 1) illustrate this point.

While the F1 progeny have slightly higher survival to trifluralin than the susceptible population, you will notice from the chart that normal field rates of trifluralin will control this population.

F2, crossing F1 offspring with each other

Now, what happens when we cross the F1 offspring with each other?

Aa x Aa = AA, Aa, Aa, aa

What would you expect from these F2 offspring?

- AA should be susceptible to trifluralin;
- Aa should have low-level trifluralin resistance but normal field rates would kill it; and,
- aa should be high-level trifluralin resistance.

And that is pretty much what Jinyi found. The only complication being that rate matters in this field of research.

What does it all mean?

Recessive traits spread more slowly through a population than the dominant trait, which is great news. But…

- Ryegrass must cross-pollinate and is the world champion weed when it comes to spreading its gene pool around; and,
- This is for target site trifluralin resistance only, there is always another mechanism! More research by Jinyi has also described non-target site trifluralin resistance in ryegrass.

To sum up

This is excellent, interesting research that shows that target site trifluralin resistance in ryegrass is different from almost all other examples of herbicide resistance in terms of the way that it is inherited.

But unfortunately, this is not enough to stop the spread of trifluralin resistance.

There is always another resistance mechanism! ■

Robotic reality opens up chipping and microwave potential

By Cindy Benjamin, WeedSmart

If a herbicide resistant weed never sets seed then it won't be long before the resistance is eradicated. This is easy to say, but has been mighty hard to achieve because it is so time consuming.

Enter now the power of robotic weed control. Frequent scouting for, and removal of small weeds, is now a practical reality with a commercial robotic platform available for broadacre cropping operations.

Tom Holcombe, SwarmFarm Robotics Field Operations Lead says the theory has been proven recently in trials in Central Queensland, where weed blow-outs in fallows on two sites were brought under control using repetitive herbicide applications.

Tom Holcombe, SwarmFarm Robotics Field Operations Lead sees optical weed-seeking microwave units on a robotic platform as the next big thing in non-chemical weed control.

The two sites were on separate properties in the Springsure district of Central Queensland. One site was 44 hectares of fallow at 'Kilmore', following dryland sorghum, with weeds managed from August 2017 to March 2018. The other was 28 hectares at 'Denlo Park', following dryland cotton, with weeds managed from October 2017 to March 2018.

"To control weeds present in high numbers at both sites we decided that the robots would spray on a fortnightly basis to regain control," says Tom.

"This regular and repetitive spraying achieved excellent control at each of the sites, avoiding the need to cultivate."

Over a period of eight weeks of routine, fortnightly spraying with knockdown herbicides using a Weedit mounted on the robot, the weed density dropped from the initial 20 per cent of the area – when it was considered out of control – down to approximately two per cent of the trial area.

Repetitive herbicide applications brought this weed blow-out under control in just eight weeks of intense management using a robotic sprayer.

Having several small microwave units teamed with the Weedit sensors and mounted on a robotic platform removes time and power constraints.

This use pattern would be considered impractical and inadvisable in a conventional herbicide spraying program. The robotic platform made it possible, and it was effective due to the continual knocking of the same weeds until death was achieved and seed set prevented.

A commercial robotic platform also brings the opportunity to use optical weed sensing technology in conjunction with non-herbicide weed control tactics such as chipping and microwaving.

Both SwarmFarm (with Queensland state government funding) and The University of Western Australia (with GRDC funding) have shown that optical sensing works well with a chipping tyne implement that is activated only when a weed is 'spotted'. This makes cultivation for weed control site-specific and is compatible with zero-till farming.

Another prototype that SwarmFarm developed within the Queensland government's Strategic Cropping Land Mitigation funded project was a small microwave unit that activates only when a weed is present (as detected using a Weedit sensor).

"There has been a lot of interest in the potential of microwave for weed control, but the power and time involved has kept this technology out of reach," says Tom. "Having several small units teamed with the Weedit sensors and mounted on a robotic platform opens up a whole new set of opportunities.

"Time is no longer a constraint because the robot can stop and apply the necessary treatment without keeping an operator and tractor tied up, and the more often it is used, the smaller the weeds will be – needing less time and power to kill them."

The power constraint is also more realistic than trying to apply a 'blanket' microwave treatment across a whole paddock. Since only a few units on a multi-unit bar are likely to be activated at any one time, the power draw is far less and small weeds are much easier to kill than large weeds.

"There is also a soil health benefit given that the weeds can be controlled without affecting the soil biota of the whole paddock," he says.

"We are particularly keen on the development of a microwave rig now that we have proven the potential for this technology to be a very effective double-knock to take out weeds that survive a herbicide treatment, and even for its application on organic farms to dramatically reduce the reliance on cultivation," says Tom.

For more information about managing patches of herbicide resistant weeds, visit the Weedsmart website: *www.weedsmart.org.au* ■

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Gesaprim*
Hammer*
Logran* B-Power Midas* Intervix*
Sharpen* Raptor* WG
Flame* 240g/L Cheetah* Gold
Precept* Destiny* OnDuty*
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Keep fungicide resistance front of mind in 2019

Australian grain growers are advised to prepare and implement an integrated disease management strategy in 2019 to protect their crops and counter the increasing threat of fungicide resistance.

Fungicide resistance is a significant and costly nation-wide issue for the grains industry. Several cases of fungicide resistance and reduced sensitivity to fungicide – in which resistance does not reach the level of field failure of a fungicide application – have now been recorded.

Pivotal in combating the scourge of fungicide resistance and prolonging the life of available chemistries is the employment of a combination of tactics which reduce the reliance on fungicides for disease control.

Researchers at the Centre for Crop and Disease Management (CCDM) – a national research centre co-supported by Curtin University and the GRDC – are therefore encouraging growers to adopt a multi-pronged disease management strategy this year.

CCDM Fungicide Resistance Group leader, Fran Lopez-Ruiz, who features in a new GRDC video about the status of fungicide resistance (*http://bit.ly/2HB7vM0*), says a key element of an integrated management strategy is the use of crop varieties with high disease resistance ratings.

"In my view, genetic resistance is the most important component. Growers are advised to choose varieties with high levels of resistance to diseases," Fran says.

Disease resistance ratings are available via the GRDC's National Variety Trials website, *www.nvtonline.com.au*.

"Good rotation of our crops is another tool which helps to create a dynamic environment within our farming systems, making it hard for disease to adapt."

The strategic use of fungicides is also important in reducing the risk of pathogens developing resistance and prolonging the lifespan of the limited chemistries available.

"If you use the same chemical season after season you are asking for trouble and this applies to any other disease management strategy that is overused," Fran says. "We need to rotate chemicals with different modes of action and also mix those different modes of action to create a very dynamic environment."

CCDM Fungicide Resistance Group leader, Fran Lopez-Ruiz, features in a new GRDC video about the status of fungicide resistance across Australia. (PHOTO: Melissa Williams)

The CCDM receives more than 1000 crop samples per year for fungicide resistance testing, and growers and advisers should contact the CCDM's Fungicide Resistance Group at frg@curtin.edu.au if they suspect fungicide ineffectiveness this year.

Fran says that by working with growers to get a clearer idea of what is happening in the paddock, CCDM researchers can assist the grains industry in making more informed decisions around strategic chemical use. ■

Make hard water easy

Farmers and agronomists alike are heralding the arrival of Outright 770 spray adjuvant as a game-changer, particularly in hard-water conditions which can render herbicides such as glyphosate significantly less effective.

By using adjuvant Outright 770, the knock-down rate is much more immediate with a greater amount of the herbicide being absorbed by weeds and other invasive plants.

Outright 770 has been developed by Australian company, Vicchem, specifically tailored for Australia's unique conditions with a results-based focus.

Vicchem technical director for more than 20 years, Peter Jones, said hard water often contained calcium or magnesium ions which could interact with glyphosate to form insoluble complexes, rendering it inactive.

"However, hard water can be managed with Vicchem's summer adjuvant range because the ammonium sulphate in Hot-Up, Outright 770 and Assert prevents this interaction, instead forming glyphosate-ammonium which is readily dissolved and absorbed," Peter explained.

Another benefit to busy farmers is the simple delivery for a more comprehensive result. Marshall Rodda, from Tarranurk near Jeparit (Victoria), embarked on a large-scale summer weed program after the December rainfall in 2018 with immediate results in terms of efficiency and smackdown of a variety of weeds, melons and bindi, using a combination of broad-spectrum glyphosate, Ester and Garlon, boosted with Outright 770.

"Outright 770 made it easier and quicker to spray by simply pumping the 3-in-1 adjuvant into the tank. No lugging bags of ammonium sulphate made it a much smarter and quicker option," Marshall said. ■

A new spray adjuvant can counter the calcium or magnesium ions in hard water and make herbicides more effective.

Section 10

New Science & Technology

CONTENTS

THIS SECTION BROUGHT TO YOU IN ASSOCIATION WITH:

Consistent spacing is the aim with seed singulating technology

Brad Jones is continually looking at how he can do things better on his farm at Tammin in the central wheatbelt region of Western Australia. If he can develop ideas without taking on all the risk, that is even better. Brad hails from the Darling Downs in Queensland, and it was his experience with seed singulation technology in cotton, corn and sorghum in the Sunshine State that made him want to bring the technology to WA.

The idea was to reduce the financial risk of growing expensive hybrid canola by lowering the seeding rate through seed singulating technology. So, a partnership to develop a bar with seed singulating technology for WA conditions was formed between the Jones's Bungulla Farming, Precision Ag Solutions and Ground Breaker Precision Agriculture, which is a division of Toowoomba Engineering.

From Brad Jones's perspective, having the three different partners in the collaboration is exciting, allowing some of the risk to be shared as well as providing the opportunity to learn, be involved and have good, practical input into a new system.

"You get access to their skills and because they work quite extensively up and down the east coast, they've got exposure to lots of different soil types, farming systems, crop types, and it's about trying to pick the best out of each one and put it into play in our system," Brad explains.

Seed singulation and how it works

Seed singulation involves accurately spacing seeds an equal distance apart so they can best withstand challenging conditions – such as heat or moisture stress – because they have got space to grow.

"We are ideally looking to create about 15 cm between each canola plant, give or take a few centimetres either side – it is really like looking at the tag when you buy seedlings at the nursery which says to space them 15 cm apart – it is the same principle," Brad says.

Ideally, Brad is looking to evenly sow his canola so seeds are spaced about 15 cm apart, much like when purchasing seedlings at a nursery and the tag says to space them 15 cm apart. (PHOTO: CussonsMedia)

Brad Jones from Bungulla Farming (left) and Danny Weier from Precision Ag Solutions are working together with Ground Breaker Precision Agriculture to develop a bar with seed singulation technology. (PHOTO: Cussonsmedia)

Danny Weier from Precision Ag Solutions is providing the precision technology advice to the partnership, which will determine what type of seed meter they will use on the machine.

"The idea of a seed meter from a singulation perspective is that it is a flat plate with round holes, and we use a vacuum to basically suck as many seeds into the hole as we can possibly fit, and then from there, as it moves around the meter, we use a singulation device to knock off any of the excess seeds," Danny says.

"As the plate rotates around the meter, when it gets to the drop point above the seed tube, the vacuum basically ceases, and the seed releases from the plate and drops directly through the seed tube into the ground.

"The vacuum then picks up on the other side and basically continues again, so we pick up more seeds, singulate them and drop them."

Seed singulation with a small, light-weight canola seed is quite difficult compared with larger and heavier seeds such as corn, as there are more variables between seed release and it hitting the ground. In addition, it has been difficult to accurately count the seeds, but now Danny believes they are achieving about 92 per cent accuracy.

"It's not about being exact in your seed placement, it's about being more consistent," Danny says.

"I guess we can expect that with canola, we're probably never going to see the spacing accuracy we can achieve with corn and sorghum with a singulation device. But we believe that we're on the right track to be able to consistently place canola at depth and spaced evenly apart."

The Ground Breaker Precision Planter is set up with a leading tyne that breaks the seed trench open and contains the fertiliser, whether it be granular or liquid, which is banded below the seed.

The row spacing is 30 cm.

While the original version had a Precision Planter metering system (plastic plate), version two (pictured) is trialling two different seed meters and technology options. The front 10 seeder units are Monosem Seed Meters (metal plates) with Ag Leader SureDrive Electric Drives and the back 10 seeder units are Precision Planting vSet Seed Meters with Precision Planting vDrive Electric Drives. (PHOTO: CussonsMedia)

Don't push seeding rates too low

The group first trialled the seed singulator technology in 2016 and in 2018 they were testing version two, which is a 6 metre frame bar which can have two 3 metre wings attached to take it out to 12 metres.

"In 2016 we had a really good result, and we got our seeding rates down as low as 600 grams. Then in 2017, we pushed again for low seeding rates and we had a freak storm with up to 75 mm of rain in one event, in a very short, sharp fall, which sealed the soil over," Brad says.

"The lesson we learnt was not to push our rates too low, because we gave ourselves no room for error. So in 2018 we moderated that back and came back to a population of about 260,000 seeds per hectare, which works out to be 1.0 kg per hectare."

Brad also believes it was a mistake to lower their fertiliser to match the lowered population, as they probably have not provided the plant with the nutrition it needs to reach its full potential.

Plastic vs metal metering plates

While the original version had a Precision Planter metering system (plastic plate), version two is trialling two different seed meters and technology options. The front 10 seeder units are Monosem Seed Meters (metal plates) with Ag Leader SureDrive Electric Drives, and the back 10 seeder units are Precision Planting vSet Seed Meters with Precision Planting vDrive Electric Drives.

Canola seed is sucked into the small holes of the Monosem Seed Meters by a vacuum and as the plate rotates around the meter, when it gets to the drop point above the seed tube, the vacuum ceases and the seed releases from the plate and drops directly through the seed tube into the ground. (PHOTO: CussonsMedia)

But at this stage there is no clear winner in terms of improved germination or ease of use, with the seed singulation technology being trialled in both canola and wheat in 2018.

"With the original generation one bar, we found that we were getting a lot of issues with static electricity, and that was coming from a plastic seed plate, whereas the Monosem is stainless steel, so that's taken away some of that risk," Brad says. "On the flip side of that, the Monosem is a harder system to change plates between crops, so there is a trade-off.

"But we're just finding our way and it will get better. It's just a matter of us learning how to change the plates between canola and wheat."

Trialling wheat too

While Brad believes it will be difficult to justify a seed singulating bar for one crop, he thinks as growers eventually shift to growing hybrid wheats there will be increased interest in the technology. He also has spoken to Philipp Horsch (from the German-based Horsch farm machinery company), who says good results are being achieved from singulating wheat in Europe.

"We also trialled wheat in 2018, and the thoughts are that in the future there will be hybrid wheats here, and the cost of those hybrid wheats are expensive too, so it's the same theory as what we're trying to do with our canola," Brad says.

In terms of seeding bar, the Joneses run a DBS (Deep Blade System) on their farm, which is known for having good seeding depth control.

"The DBS is a fantastic system – it's well proven and in 2018 had DBS and the singulation technology in the same paddock as part of a trial, and we did seed counts and biomass imagery and things like that," Brad says.

"It's really hard to tell because in 2018 it all went in dry, and when it rained it all came up at once – so we couldn't really put an answer to which is the best one yet."

Future plans

In the future, Brad would like to use a seeding system where both the fertiliser and the seed are placed in a more precise manner to optimise all of their inputs.

"I would actually like a system which is available in Europe now: Each seed goes down, fertiliser goes down with it, so you actually match your seed to your fertiliser in very close proximity. This is instead of the random way of application now where you can singulate your seed and be quite precise – but not your fertiliser," Brad says.

For now, he will continually look forward: As Winston Churchill said: "It is wise to look ahead but it is difficult to look further than you can see."

For more information contact Brad Jones, 0427 632 244, brad@bungulla.com.au and Danny Weier, 0497 292 258, danny@precisionagsolutions.com.au

Source: *Seeding Systems – Case studies of growers in WA*. This publication was prepared by CussonsMedia on behalf of the GRDC (see www.grdc.com.au) ■

New technology to chip away at weeds

A new mechanical weeding machine is quickly attracting keen interest from grain growers across Australia. The prototype was developed by agricultural engineers and researchers from the University of Western Australia (UWA) and the University of Sydney, with Grains Research and Development Corporation (GRDC) investment.

The machine has been designed using a cultivator bar where tynes are raised above the ground in a standby position, ready to chip the weeds out of the ground the moment they are detected with weed-sensing technology.

UWA School of Engineering agricultural engineer Andrew Guzzomi said the 'rapid response' tyne system was designed to chip out weeds at densities of one plant per 10 square metres, while travelling at 10 kilometres per hour.

This simple yet groundbreaking technology will allow growers to control weeds in summer and winter fallows with greater flexibility for use in situations that restrict the use of herbicide application, such as wind, heat, surface temperature inversions and herbicide resistance.

"Its ability to handle a vast range of weeds, at varying growth stages, is likely to reduce the number of 'passes' required to manage fallow weeds, compared with current herbicide practices," Andrew said.

"This will help to mitigate its slower travel speed and narrower coverage, when compared with spray equipment.

"Another benefit is that the mechanical weeding machine's periodic tilling action – that is appropriate for use in low-density weed population situations – will allow it to be coupled to low horsepower tractors."

University of Sydney director of weed research Michael Walsh said the machine had effectively killed summer and winter annual weeds that had been targeted in field testing, regardless of the growth stage of the weeds.

"It is highly effective on both broadleaf and grass weeds, and soil disturbance is potentially low," Michael said.

"With a significantly reduced need for follow-up herbicide use, the system is an efficient tactic suitable for inclusion in an integrated weed management system."

The tynes are raised 'in standby' above the ground ready to chip the weeds the moment they are detected with weed-sensing technology.

Andrew Guzzomi says the 'rapid response' tyne system was designed to chip out weeds at densities of one plant per 10 square metres, while travelling at 10 kilometres per hour.

The efficacy of the technology relies on accurate weed detection, with optical detection systems incorporated into the six-metre prototype.

In a bid to allow the technology to be made commercially available to growers, the project is moving into commercialisation.

Further information: Andrew Guzzomi, UWA. E: andrew.guzzomi@uwa.edu.au or Michael Walsh, University of Sydney. E: m.j.walsh@sydney.edu.au ■

Using off-farm data to improve on-farm decision making

One of Australia's leading precision agriculture (PA) experts believes there is powerful potential for grain growers and farm advisers to combine publicly available off-farm data, from sources such as Google Earth Engine (GEE) , Digital Earth Australia (DEA) and the Open Data Cube (ODC) initiative, with data from farm machinery to improve decision-making in the paddock.

University of Sydney Associate Professor Brett Whelan – who heads the country's longest-running PA research laboratory – said the pool of publicly available off-farm data was rapidly increasing and could complement farm-generated data to produce a powerful, predictive model to guide farm decisions, such as nitrogen (N) budgets.

University of Sydney Associate Professor Brett Whelan believes growers can benefit from combining off-farm data with on-farm information to guide decision-making in the paddock. (PHOTO: GRDC)

His work is part of the Future Farm 2 project, which is a GRDC investment with support from CSIRO, the University of Sydney, the University of Southern Queensland, the Queensland University of Technology and Agriculture Victoria.

Lowering the risk behind management decisions

A goal of this project is to create fast, flexible decision-aid software that can remove some of the risk from N management decisions for growers, by using various data streams to generate informed recommendations for fertiliser application.

"On-farm generated data on cropping, soil type and nutrients from individual growers within a locality could provide the framework for powerful models that can quickly adapt and improve from year-to-year," Brett said.

"If we incorporate that with big data about weather and environmental conditions from off-farm data sources this could help inform decision-making and reduce risk about managing nitrogen application in regard to expected soil moisture availability to optimise yield and quality."

He said the challenges were in fusing the data together to create information that was meaningful and had practical applications for growers.

"Combining large data sets generated by off-farm sources for analysis of the drivers of variability in crop performance and profit, rather than just using individual paddock data, can be very powerful," Brett said.

"Putting this data together effectively can help growers more accurately estimate yield potential and match input requirements to crop responses."

Brett said low cost information that was relatively accessible for growers included yield monitor data, vehicle performance data, and publicly available data such as satellite-based imagery.

"The majority of farms already use global navigation satellite systems, and yield monitors are becoming standard equipment on harvesters so the yield mass, grain moisture and elevation data available during harvest comes at a low cost," he said.

"Likewise, performance data is routinely recorded by newer tractors and self-propelled implements. Data on variation in fuel use and other relevant operational parameters can be used in novel ways, for example using power output or fuel use while working with ground-engaging implements can allow growers to map changes in soil type."

Brett said this increasing use of digital data in agriculture was being led by a combination of improvements in sensor development, computing power, data storage/delivery, data analysis techniques and reduced costs.

Won't break the bank

"These things have fuelled greater interest in data and its potential to help us on-farm. This in turn has been the catalyst for an increasing number of off-farm data sources being made publicly available at costs that won't break the bank."

For example, the GEE, DEA and ODC platforms provide access to a range of data layers for studying the earth's resources, according to Brett.

These extremely large and useful data sets curate data for things such as seasonal crop and soil variability, which allows us to compare the information from year-to-year which could be an invaluable tool for growers when it comes to better informed decision-making."

This increase in the availability of digital data and processing capabilities has resulted in better data fusion techniques and machine learning as agriculture searches for new insights.

"There have been significant developments in machine learning analytical methods, which differ from mechanistic or process-driven models commonly used in cropping because they use data-driven approaches to discover relationships between variables," Brett said.

"On-farm data from sensors currently used in precision agriculture, along with what will be an increasing variety of sources, volumes and scales and structures of off-farm data (from other local and regional farms and non-farm domains) can now be input into analysis and decision-making back on-farm.

"Growers and farm advisers need to be aware there are increasingly affordable, relevant off-farm sources for data that can genuinely inform what they are doing in the paddock.

"Ideally, we want to reach a point where the process of acquiring data is automated through to analysis and formulation of recommendations with the farm manager or adviser then having input when it comes to choosing and implementing the management options."

Brett said sources of affordable off-farm data included options such as: CSIRO, the Bureau of Meteorology's Gridded Daily Data; NASA's Soil Moisture Active Passive (SMAP); Geoscience Australia's Australia-wide airborne geophysical survey (AWAGS); and European Space Agency (ESA) Sentinel 2 – for land mapping and climate change.

For more information go to *https://bit.ly/2lpZbOU*

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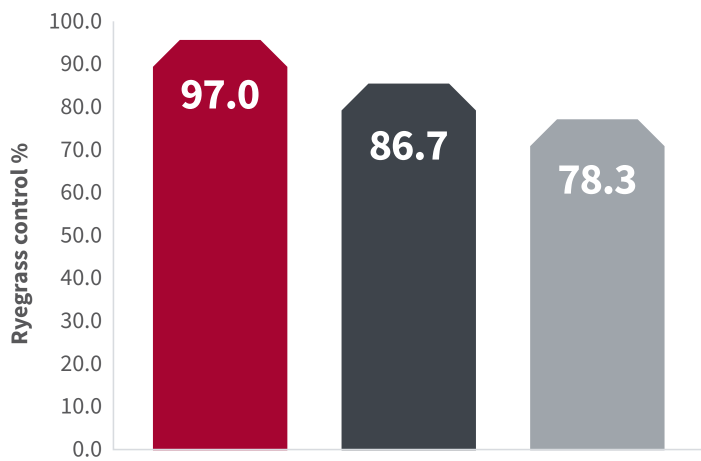

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BAYER

Colour blind technology

Since the origination of ISOBUS technology over 15 years ago, the agriculture industry has been finally given the choice to make true 'colour-blind' decisions. Farmers were once limited to purchasing a tractor and matching all future implement purchases to the same brand – or for those who chose to select off branded implements, faced a future of never ending cab clutter. A new screen came with every implement whether it be for steering, control or monitoring.

Dickey-john have been involved in the development of ISOBUS products since 2004 and have recently released their latest offering of ISOBUS controller – 'ISO6 IntelliAG'.

Suitable for seeding, spreading and spraying, this retrofittable solution gives users the choice to fit a fully customisable control and monitoring solution. ISO6 follows on from the current Dj IntelliAG but has been enhanced with a simpler user interface, more detailed graphical symbols and up to eight channels of control enabling it to retrofit to most air seeders, planters and spreaders.

Dickey-john offer a full suite of control and monitoring systems, hydraulic drives, hydraulic and liquid valves, sensors and harnessing solutions to easily create the complete compatible package. Cambut Holdings, the Australian distributor and Dj dealer for over 30 years, also add the back-up and local technical support.

Integration and compatibility

"Customers demand integrated and compatible solutions," says Mike Wright, Managing Director of Cambut Holdings. "Farmers these days require more than just a control or monitoring system. They require compatibility to be able to document their planting programs using their existing John Deere or CNH software.

"Ten years ago, customers were content with rate control. Now as agronomy and record keeping solutions are so advanced, users need to be able to accurately apply prescriptions rates of seed and fertiliser varying across the field. The ability to capture and store data is a must.

"With our ISO6 solution, we make a complicated task simpler. The users need everything to be simple – let's say backpacker simple," Mike points out.

With so much labour being required from seasonal or backpacker labour, Mike believes that a simple user interface is as important as the reliability.

"We have been integral in making the design and operation of our controllers and monitors simpler. Dickey-john has built some of the most reliable electronic equipment since the beginning of planter monitors in the 1980s. We have made sure over all this time that our engineers haven't overcomplicated things.

"The Dickey-john ISO6 gives you a quality-built product with the compatibility you need. You can run it through your JD2630, JD4640, Case Pro700, New Holland IntelliView IV, Agco or any other ISO compatible screen – so we are truly colour-blind," Mike says. ■

New discovery could help crops cope better in salty soils

New research published in *Nature Scientific Reports* has found that a hormone produced by plants under stress can be applied to crops to alleviate the damage caused by salty soils. The team of researchers from Western Sydney University and the University of Queensland identified a naturally-occurring chemical in plants that reduces the symptoms of salt stress in plants when applied to soil, enabling the test plants to increase their growth by up to 32 times compared with untreated plants.

Salinity is a huge issue across the world, affecting more than 220 million hectares of the world's irrigated farming and food-producing land. Scientists have long tried to find ways to breed salt-tolerance or develop methods to remove salt, and this new research is promising in its potential to reduce the damage in crop plants that results from salt.

Naturally occurring compound discovered

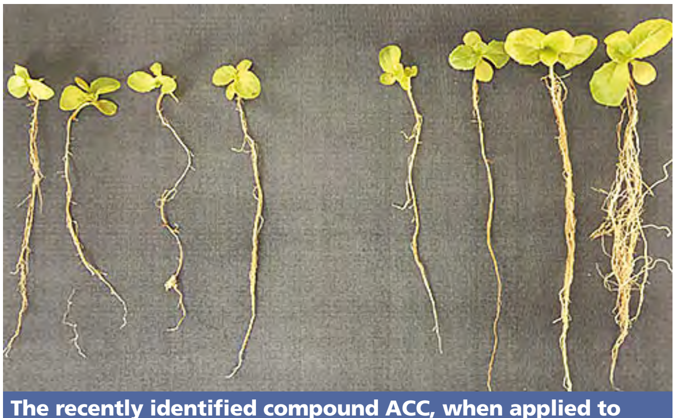
"We identified a compound called ACC that occurs naturally in plants when they become stressed by drought, heat or salty conditions," said Dr Hongwei Liu from the Hawkesbury Institute for the Environment at Western Sydney University.

By applying ACC to crops planted into salty soils, it created conditions that prevented the formation of the compounds that cause plant damage under salty conditions and increased beneficial soil enzyme and microbial activity. These effects enabled the plants to cope with the salt and increased the growth of lettuce plants by nearly five times and model plants by over 30 times.

"There is very significant potential for this compound in enabling us to manage crop production in otherwise-unusable soils," said Prof Peer Schenk, School of Agric and Food Sciences at the University of Qld.

"Growers have traditionally used a range of long-term and slow-acting materials such as gypsum, manures, tillage and other methods to reduce the exposure of plants to the salts in soils but these are costly, frequently ineffective and work to limited benefits over years or decades," he said.

One of the major benefits of ACC is that it is naturally produced by plant roots and therefore contributes to long-term soil health, plant-microbe relationships and carbon storage. ■



The recently identified compound ACC, when applied to lettuce growing in salty soils, increased growth five-fold.

Section 11

Grain Storage & Handling

CONTENTS

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DAVIMAC

Grain storage and seed quality: Strategies to ensure good establishment

By Philip Burrill, DAF – Qld

AT A GLANCE…

- Planting seed is the most valuable grain stored on farm. Each month, check storages for pests and monitor grain temperatures;
- Clearly identify/number each silo and keep up-to-date storage records;
- Keep seed varieties pure. Clean out silos, augers and trucks to prevent contaminating seed with other varieties that have different maturities and disease resistant levels;
- A cone-based silo, with aeration cooling, that is sealable when a fumigation is required, is the ideal farm seed storage. Locate silos in the shade or paint white to reduce seed temperatures;
- Warm grain temperatures and higher seed moisture contents in storage, are major causes of poor seed germination and vigour. Invest effort into achieving effective aeration cooling; and,
- To minimise pest damage, apply a registered grain protectant treatment to seed at harvest time. When sieving and probe traps detect pests, fumigate with phosphine in a sealable silo.

Planting seed is the most valuable grain you will ever store on-farm. The consequences of allowing seed to deteriorate while in storage can be very costly. Poor crop establishment usually leads to reduced yield potential and problems with more in-crop weeds.

At times complete crop planting failures occur due to the use of seed that had low germination and vigour. Poor storage conditions such as warm grain temperatures, higher grain moisture content and damage by storage insects (weevils) can have a major impact on seed quality.

In dry times, the more common practice of planting deeper into soil moisture makes it critical we do our best to look after seed vigour quality during storage.

If possible, avoid keeping seed that has suffered weather damage prior to harvest, as seed viability falls more rapidly during its time in storage. Always test seed for germination and vigour well before planting time. Also, check seed prior to harvest for the presence of smut/bunt diseases.

Seed storage silos and equipment

For bulk seed storage, aim to use a cone-based silo that is easy to clean/wash out, has aeration cooling fans fitted and is sealable so effective fumigations can be carried out when required.

Storages & equipment to maintain seed quality

- Clearly number each silo and keep up-to-date storage records of where each variety is stored.
- Also record monthly insect and temperature checks, etc. A blackboard painted section on the silo base is also helpful.
- Bright reflective silo walls, or painted white walls will help reduce grain temperatures in the silo.
- Locate seed silos in the shade if possible, for example on the south/east side of larger silos or sheds.
- Aeration cooling is important. Operate fans using a good quality aeration auto-controller for best results.
- Silo roof venting – a removable 'chinaman's hat' vent fitted to the silo top fill point – can provide effective venting for a silo while seed is stored under aeration cooling.
- Good quality silo – invest in a sealable silo designed for effective fumigations when required. Silo should meet the AS2628 sealing standard when purchased new.
- Silo hygiene – easy to clean or wash out the inside of the silo to reduce contaminating a seed line with other grains or varieties. This also reduces carryover of insect pests in grain residues.
- Have ladders on silos to provide access to the top of silos to take samples for seed quality testing, using a probe to measure grain temperature, checking for insects with probe traps, and undertaking fumigation activities.
- Grain protectant treatments for storage pests or fungicide seed treatments – use spray equipment and augers that are easy to calibrate for accurate dosage and provide uniform coverage on seed.
- Detecting insect pests – use an insect sieve, insect probe traps, a grain temperature probe, plus a storage note book or iPad to keep monthly records of pests found, seed treatments, etc.

Seed silos fitted with aeration cooling and designed as sealable for effective fumigations.

Rice weevil (*Sitophilus oryzae*) is a serious pest of stored seed.

Managing pests and maintaining seed quality

Fumigations and use of grain protectant insecticides are only two of the five key tools used to maintain planting seed quality and achieve reliable insect pest control. Combining the five practices outlined below forms the foundation for successful seed storage.

Top five practices for successful seed storage

SECTION 11 GRAIN STORAGE & HANDLING
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1. Aeration: Correctly designed and managed, it provides cool grain temperatures and uniform grain moisture conditions. Aeration reduces storage problems such as moulds and insect pests, plus helps maintain seed quality, germination and vigour.
2. Hygiene: A good standard of storage hygiene is crucial in keeping storage pest numbers to a minimum. Good hygiene for silos, augers and trucks reduces the risk of seed contamination.
3. Monitoring: To prevent serious damage, undertake monthly checking of seed in storage for insect pests (sieving / trapping) as well as checking grain quality and temperature. Keep monthly storage records, including any grain treatments applied.
4. Fumigation: In Australia, only fumigant gases (e.g. phosphine) are registered to deal with live insect pest infestations in stored grain. To achieve effective fumigations the storage/silo must be sealable – gas-tight to hold the gas concentration for the required time. Note – phosphine fumigations, used according to the label, does not damage seed germination.
5. Grain protectants: Grain protectant insecticide sprays provide another line of defence against storage pests. Prior to storage, treat cereal grain planting seed held on farm with a registered grain protectant. Use according to label directions.

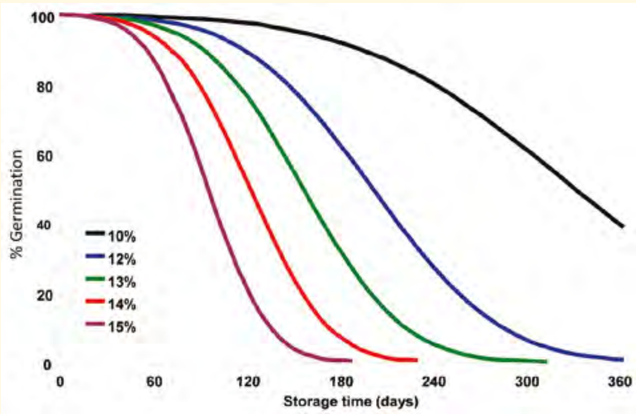
Warning: Grain protectant notes do not apply to the grains industry

in Western Australia where their use is restricted. In all cases, product labels are to be used to determine correct use patterns.

Seed storage – cool and dry

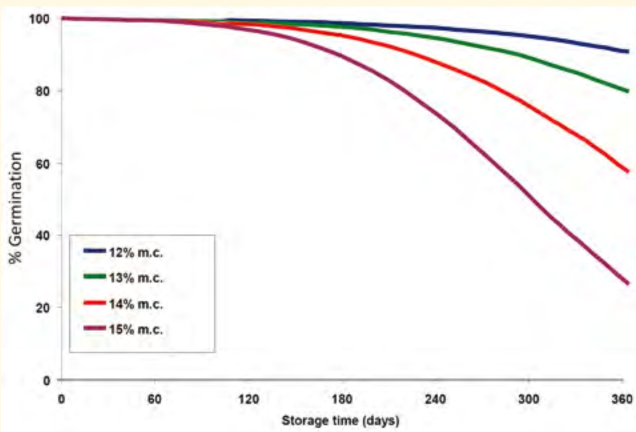
Figures 1 and 2 below show the impact over time of storage temperatures (30°C and 20°C) and grain moisture contents of 10, 12, 13, 14 and 15 per cent on the germination viability of wheat seed. Clearly, storing dry seed (10–12 per cent moisture content), under cool conditions (15–20 °C), are worthwhile targets to aim for to maintain seed germination quality.

FIGURE 1: Influence of moisture contents (10 to 15 per cent) on percentage germination of wheat stored at 30°C



Source: CSIRO – SGRL.

FIGURE 2: Influence of moisture content (12 to 15 per cent) on percentage germination of wheat stored at 20°C



Source: CSIRO – SGRL.

Additional seed management strategies

Cool grain temperatures in storage and low moisture content seed are two critical factors for maintaining good seed germination and vigour quality. Aeration cooling systems play an important role.

Aeration research trials have shown it is feasible that we should aim to achieve grain temperatures under 23°C in summer and less than 15°C in winter.

To monitor seed/grain temperatures in storage, use a hand-held temperature probe, or fixed cables inside silos such as OPI grain cables. Be aware that some cables with sensors measuring both temperature and relative humidity may suffer damage to the relative humidity sensor following a phosphine fumigation. Phosphine gas is corrosive and will damage exposed electrical components.

A typical phosphine fumigation to kill all storage pests, needs to achieve a minimum of 200 ppm phosphine gas concentration for at least 10 days. This will only be achieved in a well-sealed silo.

Planting seed held on-farm should in most cases be treated with an insecticide 'grain protectant' at harvest time (not WA) to reduce storage pest insect problems (for example, Conserve Plus with Reldan).

For smut and bunt disease control, seek good advice on what fungicides to treat your planting seeds with. Some fungicides can shorten seedling coleoptile length. Spend time with your contract seed grader and understand exactly what they are doing with your planting seed.

Only treat seed you will plant, as you cannot sell fungicide treated planting seed to any grain markets.

Further information:
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Hermitage research facility, Warwick Qld. Email: philip.burrill@daf.qld.gov.au

GRDC Fact Sheet – Saving weather damaged grain for seed.
GRDC booklet – Aerating stored grain – Cooling or drying for quality control.
Kondinin Research report: Planting seed treatments – armour against insects and diseases.
Dow AgroSciences – Conserve Plus Grain Protector.
Bayer CropScience – K-Obiol EC Combi.

The author/s acknowledge the RD&E support from GRDC. 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 industry collaborators. ■

A probe trap and insect sieve used for regular grain inspections.

Looking inside grain bags

By Aidan Sinnott, South East Premium Wheat Growers' Association (SEPWA)

AT A GLANCE…

- The use of grain bags across Australia is on the increase to assist in harvest logistics;
- Anecdotal quality issues in malt barley attributed to grain bag storage is yet unproved;
- Industry buyers of malt barley hesitant to purchase malt barley stored in grain bags;
- Very little data is available which looks at conditions inside the bag; and,
- Data so far suggests that quality of wheat and barley is not affected when stored in grain bags in the short term.

There has been a lot of conjecture relating to the quality of grain which has been stored in bags for extended periods of time. SEPWA is nearing the end of an 18-month project to investigate grain quality factors – moisture, temperature, germination, and colour – and market liability risks associated with the use of silo bags in the Western Australian grain export supply chain.

In the past five years the use rate of grain bags has increased dramatically. The key driver for this is the logistical advantage of rapid harvest followed by on-site storage of grain.

Farmers have found silo bag use to be vital in areas such as moisture and grain quality management as well as potentially capturing freight cost advantages.

Grain bags are now a proven tool for harvest management – and particularly in the Esperance region of WA.

But there is a gap in local technical data on best practice guidelines and potential grain quality risk factors when using grain bags. In a proactive approach to a potentially negative market response – and to ensure maximum on-farm supply chain flexibility – SEPWA has conducted a research project to assess potential effects on grain quality associated with silo bags and to point to the best practice strategies.

This project has closely monitored numerous grain bags during the 2017–18 and 2018–19 harvest seasons to assess them for grain quality implications. The process has involved the documentation of best practice logistics and harvest management.

Figure 1: Ambient temperature, shallow and deep grain bag readings during the 2017–18 summer, Salmon Gums

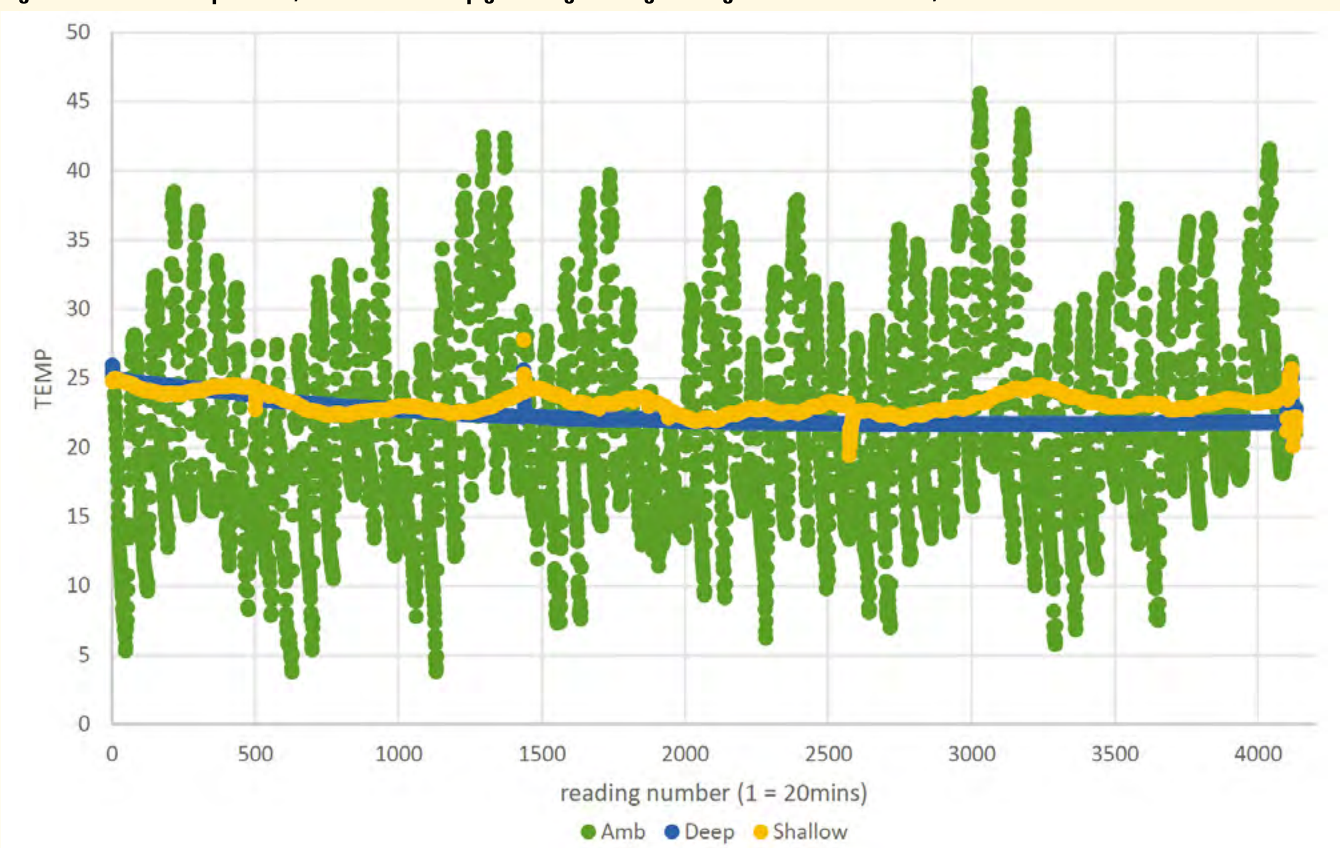

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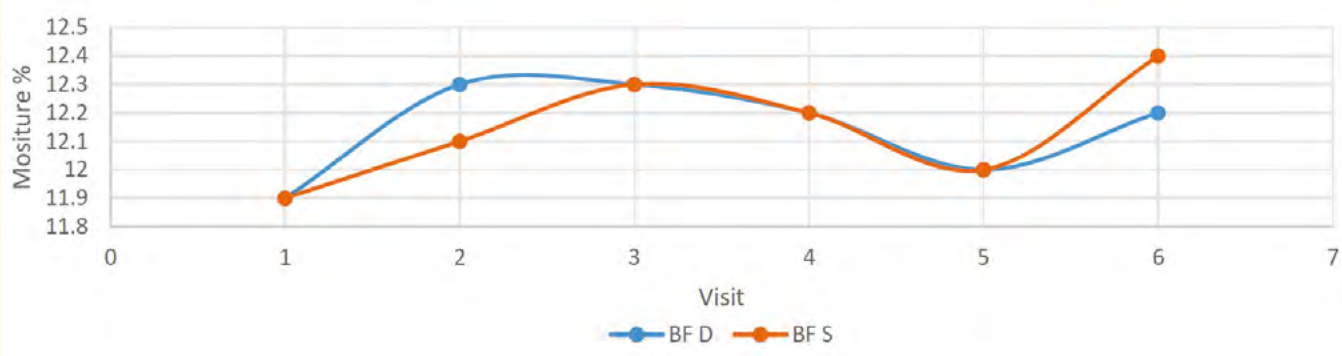
Figure 2: Moisture readings during the 2017–18 summer, Salmon Gums (Boomerang Farms, BF)



How the trials were done

SEPWA tested eight silo bags in total in 2017–18, seven of which were barley and one wheat. The bags were located across an area including Salmon Gums, Cascade and Munglinup. The geographic spread of silo bags tested across the region was deemed to be important due to the variety of climatic conditions between these areas.

The bags were laid on different dates but SEPWA staff were at the location within a week, taking the first sample.

Sampling method followed CBH parameters and protocol for grain stored in bags. CBH provided SEPWA with a grain spear for the trial work.

After the initial round of sampling, it was decided that the measurements of temperature required more rigorous analysis and SEPWA purchased Tinytags to monitor the temperature inside and outside the bag. A Tinytag was placed under shade on a star picket beside the bag, and a probe with two Tinytags set at 30 cm and 120 cm was inserted into the silo bag.

The loggers measured and recorded temperature every 20 minutes for the duration of the grain being in the bag.

What we found

The effects of ambient temperature over summertime could be expected to play a large part in grain temperature within the silo bag. But the data collected over the course of the trial shows that the effects are minimal.

The data shown in Figure 1 was collected from a bag located on a farm west of Salmon Gums from November 22, 2017 through to January 18, 2018. The chart shows the ambient temperature (green points), grain temperature at the shallow depth (yellow) and, the grain temperature at deep depth (blue).

From when the sensors were installed, the grain temperature within the silo bag decreased over time, and particularly at depth. The variety was LaTrobe barley which was put in the bag at 11.9 per cent moisture.

The shallow temperature fluctuated with ambient temperature relative to the deep temperature. Interestingly, while there were six days during this period with temperatures exceeding 40°, there were also six nights which were around 5°.

Overall, for 67 per cent of the time over the 71 days, the ambient temperature was lower than the grain temperature within the bag.

The grain moisture pattern shown in Figure 2 was generally the case in most of the silo bags.

Interestingly when comparing wheat and barley bags in similar locations, it appears that wheat grain has a much lower temperature than that of barley.

Bags containing Mace wheat (moisture going in was 13.3 per cent) and LaTrobe barley (moisture of 10.3 per cent going in) were under very similar weather conditions due to their proximity. The average ambient temperature at both sites was 19.9° over 38 days.

From the measurements it appears that the wheat is heating up and the barley is cooling down to get to the average ambient temperature.

Germination tests

One of the focal points of this trial was to test the germination of barley post storage in bags. To assess this, CBH ran germination tests on both the initial and final grain samples used in the trial (Table 1).

Table 1: Germination results of barley stored in grain bags for varying periods of time over the 2017–18 summer

	Initial sample (%)	Final sample (%)	Days in bag
Salmon Gums North (MASG)	100	100	32
Salmon Gums West (BF)	100	100	74
Cascade (MR)	100	100	61
Munglinup (MA)	99	100	60

It appears that there would be very little, or zero, effect on germination percentage under the conditions looked at over the harvest of 2017 and 2018. Further work is being conducted in the post 2018 harvest, grain bags are under scrutiny for longer periods of time, i.e. storage periods of over 3 months.

Acknowledgments: Many thanks to the growers who were involved; Gerard and Terry Antonio, Murray Ayers, Mark Walters, Mark Roberts, and Gary Walters. Also, thanks to Kim Thornton and Renee Dowsett at CBH Chadwick for lending SEPWA a grain spear, allowing access to an Infratec, and organising germination tests on samples at the laboratory. GRDC Project Number: 9176003.

Section 12

Engineering in Agriculture

CONTENTS

THIS SECTION BROUGHT TO YOU IN ASSOCIATION WITH:

THE Davey Group

Replacing steel coulters with liquid

By Greg Butler, South Australian No-Till Farmers Association

AT A GLANCE...

- The AquaTill Liquid Coulter has significant residue cutting capacity and is especially useful for seeding into matted and damp residues;
- The liquid coulter is well suited to wide row planting greater than 36 cm (15") and can deliver compatible liquid fertilisers such as UAN; and,
- The AquaTill Liquid Coulter is currently in the early stages of commercialisation.

AquaTill technology uses a fine stream of liquid travelling at three times the speed of sound that can cut through living or decaying plant material such as crop stubble. The liquid stream is generated using an ultra-high-pressure (UHP) pump operating at more than 50,000 psi (3800 bar).

An evaluation of AquaTill UHP waterjet cutting technology for use as a liquid coulter in no-till seeding has confirmed it has high cutting capability on wheat straw and is a 'great fit' for residue handling in no-till planting applications.

SANTFA conceived the AquaTill 'Liquid Coulter' as a means of slicing cleanly through moist residue using aqueous liquid fertiliser. (PHOTO: Greg Butler)

The potential value of this technology – conceived and initially developed by SANTFA – is reinforced by new data showing it is particularly effective in wet stubble and soft soil environments normally considered the most challenging for seeding/planting operations and in which traditional mechanical coulters often fail.

The technology was found to operate most efficiently when wet residue was placed under moderate compression, providing a valuable pointer to development of machinery to apply this technology in the field.

Waterjet cutting technology is well suited to wider row spacings, where a given cutting capacity can be achieved with relatively less water per hectare. Results from this research, undertaken by the Agricultural Machinery Research and Design Centre at the University of South Australia and funded by GRDC, indicate that a nominal 150 litres per hectare volume of water could sustain straw stem cutting capacities of up to 12.5, 19 and 35 tonnes per hectare at 300 mm, 500 mm and 1000 mm row spacing respectively.

When used as a liquid coulter, an AquaTill unit is set up so the high-velocity cutting stream penetrates vertically downwards, slicing through surface residue to allow clean access to the underlying soil.

> *The AquaTill Liquid Coulter demonstrated a high potential for crop residue cutting and is confirmed to be a great technology fit for assisting residue handling in no-till planting applications, particularly in wet stubble and soft soil environments where traditional mechanical coulters fail* – Agricultural Machinery Research and Design Centre, University of South Australia.

How the research was done

Residue cutting capacity is defined as the quantity of biomass residue (tonnes per hectare) able to be fully cut under a specific set of conditions.

The project selected four machine factors (pressure, nozzle size, stand-off distance and speed) and three straw factors that could realistically be controlled in the field for evaluation in laboratory experiments.

The aim was to quantify residue loads that might be expected to be adequately cut under different conditions. The researchers then set out to evaluate the machine factor relationships affecting the efficacy of UHP waterjet nozzles cutting cereal stubble loads under conditions representative of no-till field conditions at seeding.

This was done using multiple layers of uniform straw stems calibrated to a known stem load quantity (tonnes per hectare). This provided a repeatable basis for generating data on the technology's residue cutting capability.

The straw was laid in stubble-holding trays, designed and built by the research team, each with three separate chambers able to hold 25, 40 or 50 mm depth of uniform stubble stems, between a top and bottom interlocking plate assembly. This configuration allowed a large number of cutting locations to be assessed in each test.

Once they were uniformly filled with straw stems, the chambers designed with open-ended longitudinal slots to accommodate the waterjet, were able to be compressed to an adjustable level of up to 62

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Figure 1: Top view of holding tray after cutting with top plates fitted (left) and removed (centre). The bottom sections are designed to locate the straw stem axes at 90° (centre) and 30° (right)

per cent. Two trays were built, one that oriented straw at 30° to the line of cutting and one that held it at 90° to the direction of travel (Figure 1).

The experiments were conducted using 2016-season baled wheat straw that had been stored under cover and which had not been subject to wetting. An average of 33, 53 and 66 stems were required to uniformly fill the three chambers in each tray before any compression was applied. A constant number of straw stems per chamber depth was part of the methodology used to increase the uniformity of chamber samples and the efficiency of experimental runs. It also enabled assessment of cutting capacity based on a known number of stems.

The cutting process was carried out by driving the straw-holding trays at a given speed through a stationary waterjet cutting nozzle operating at specific pressures and flow rates.

The height of each straw tray was accurately set to achieve a known nozzle stand-off distance – the distance between the nozzle and the residue – with the cutting slot carefully centred to the nozzle orifice and aligned to the travel direction.

The first series of tests assessed the impact of straw stem moisture content, stem compression status and stem orientation on the cutting capability of the AquaTill jet at a set operating pressure (55 kpsi/379 MPa). Nozzle orifice size was 0.2 mm, stand-off distance 5 mm and travel speed 6 km per hour.

The moisture content of the air-dried stems averaged around 8 per cent (wet basis), which became the dry straw moisture reference. Wet straw was generated by immersing bunches of prepared stems in water.

The wetting treatment increased the straw stem moisture content to 69 per cent on average, which revealed the high capacity of wheat straw to absorb water (an average of 2.2 times its dry weight).

The effect of pressure on straw cutting capability was also assessed.

What we found

Our results show that residue compression strongly influences cutting performance. This has major implication for the design of machinery for field use of liquid coulter technology.

The impact of compression on cutting efficacy is explained by the fact that the gaps (spaces) between and within stubble diffuse the energy density and coherence of the UHP waterjet, resulting in significant loss in jet power.

This effect is highest under loose stem conditions and least under tightly compressed stem conditions.

Another mechanism likely to enhance waterjet cutting in compressed straw is the greater exposure efficiency of stems held under pressure with their flattened sides exposed to the jet and unable to move away during cutting.

These data also suggest that timing paddock use to target moist residue can significantly assist with maximising cutting capacity, especially under compressed residue conditions.

Its ability to perform better in damp conditions represents a critical advantage for this technology because wet residue typically poses the greatest seeding-time challenges to mechanical cutting – such as by a coulter disc blade – and is the common cause of residue hair-pinning that can result in significant crop establishment losses.

This means AquaTill has a particularly good fit in addressing current residue handling limitations under no-till cropping.

Straw compression and nozzle stand-off distance

Compressing straw stems is the most effective way to maximise the cutting capacity of a given waterjet nozzle. Our tests revealed that:

- Increasing the compression level from minimal to a maximum of 62 per cent doubled the cutting capacity. It is possible to compress straw beyond 62 per cent but the amount of energy required rapidly increases;
- A significant portion (60 per cent) of the full benefit was achieved by just 22 per cent compression, which suggests that the benefits are from reduction in air spaces between the straw and restriction in straw stem movement during cutting; and,
- Applying 50 per cent compression results in 90 per cent of the cutting capacity achieved at 62 per cent compression.

The main implication of these findings is that any machine using this technology in the field will need to be able to apply a certain amount of pressure to the straw at the point of cutting in order to maximise waterjet cutting efficiency.

If this optimum pressure varies in different paddock environments, adjustability may be required, particularly since compressing beyond the optimum is likely to increase cost and may induce other stubble management issues such as raking.

While further investigation of interactions between compression level, speed and nozzle size is needed, these results reveal no detectable impact of nozzle stand-off within the 5 to 70 mm range under the experimental conditions.

This finding is very positive, since a short stand-off distance could prove problematic in the field, while being able to set the nozzle further away from the stubble surface may open the way for simpler design options and reduced costs.

Cutting capacity and water consumption

We also tested the impact of nozzle orifice size and travel speed on the cutting capacity of wet straw stems under a specific set of settings. These settings were: 90° angle, 55 kpsi (379 MPa) pressure, 10 mm stand-off and 50 per cent compression. The results show:

- The cutting capacity significantly improves with greater orifice size, with a 26 tonnes per hectare increase in cutting capacity over the range of nozzles; and,
- Faster speeds tend to reduce cutting capacity, especially with larger nozzle sizes, but not in proportion to the speed change. For instance, halving the speed from 12 to 6 km per hour and doubling exposure time and water consumption resulted in a 6–29 per cent increase (18 per cent on average) in cutting capacity under the larger nozzles (0.009" – 0.012"); significantly more than the 2–10 per cent increase (6 per cent on average) under the smaller nozzles (0.006"–0.008").

Relating nozzle size to water use per hectare at a given row spacing provides a useful perspective on the relationship between cutting capacity, speed and nozzle size.

The water consumption per hectare for each nozzle was calculated based on their nominal flow rate of 55 kpsi/379 MPa (data supplied by Flow International) and the travel speed at 300 mm, 500 mm and 1000 mm nozzle spacing to provide summer and winter crop planting contexts.

Given constant water consumption and with nozzles operated under equal pressures, travelling at a higher speed with a larger nozzle results in a greater cutting capacity than travelling at a lower speed with a smaller nozzle.

Importantly, more power is required to achieve the higher flow rates of the larger nozzles.

Acknowledgements: The board, members and R&D Dept of SANTFA; Flow International Corporation; National Landcare Program; The research undertaken as part of this project was made possible by the contributions of growers through trial cooperation and support of the GRDC; University of South Australia; and, South Australian Grains Industry Trust.

For more information: Greg Butler greg@santfa.com.au ■

Harvester-integrated weed control has high impact whatever way you look at it!

Whether you have a horizontal iHSD impact mill or are looking to get into this technology with the newly-released vertical configuration, you can rest assured that the kill rate of both configurations has been independently proven to be 98 per cent for annual ryegrass.

Dr Michael Walsh, Director Weed Research, Faculty of Science, The University of Sydney has been testing the efficacy of impact mills on weed seeds since the early days of development of the Harrington Seed Destructors.

"The vertical configuration of the iHSD mills could change the direction of the chaff flow through the mills and this could affect the processing of the chaff and potentially the efficacy of weed seed destruction," he says.

"Having previously shown that the horizontal iHSD impact mill can achieve at least 98 per cent weed seed kill, we were keen to repeat the test for the vertical mill configuration."

During the 2018 harvest, a wheat crop at Broomehill (about 300 km southeast of Perth, WA) was used to test the vertical mill. Twelve 20 metre strips were marked out in the wheat crop where there was no annual ryegrass present. These plots were used to test the efficacy of the vertical mill at three different harvester speeds: 4, 6 and 8 km per hour.

As each plot was harvested, 5000 dyed annual ryegrass seeds were introduced into the chaff stream directly above the inlet to the righthand

New features include mechanical drive, vertical configuration, rear hatch (pictured) and stone trap to reduce costs and improve reliability.

Left: Without harvest weed seed control. Right: With iHSD harvest weed seed control. Weed seed destruction was 98 per cent or better at three operating speeds – 4, 6 and 8 km per hour.

side mill. The processed chaff from each plot was collected in large, fine-mesh bags attached to the righthand side outlet chute.

To determine the weed seed survival rate from each plot, Dr John Broster's team at Charles Sturt University, Wagga Wagga processed subsamples from each of the 12 bags of chaff. The chaff was thinly spread on trays, covered lightly with potting mix and watered every day for four weeks to stimulate the germination of any surviving annual ryegrass seed. Each day annual ryegrass seedlings present were counted and removed from the trays.

"The result of this testing was a weed seed kill rate of at least 98 per cent for the vertical iHSD impact mill, regardless of the harvester operating speed of 4, 6 or 8 km per hour," says Michael. "This level of weed seed destruction is equivalent to that of the horizontally mounted mills that we have tested previously.

"From this result we can be confident that provided the harvester is set up to efficiently collect annual ryegrass seed at harvest, growers using either configuration of the iHSD can expect to achieve this very high rate of weed seed destruction."

Harvester-integrated weed control solutions

Peter Newman, Western Extension Agronomist with the Australian Herbicide Resistance Initiative (AHRI) and WeedSmart, says there is keen interest amongst Australian growers in harvester-integrated weed control solutions.

"Growers are looking at price and weed seed control efficacy," he says. "This new configuration of the iHSD provides several new features that will benefit growers, including the ability to easily check for grain loss by opening a rear hatch and disengaging the iHSD belts, the large cavity under the sieves effectively prevents bridging and the stone trap will help to prevent any foreign objects from entering and damaging the mill.

"The vertical configuration uses the same cage mill for seed destruction as the earlier horizontal version but is mechanically-driven rather than hydraulic, significantly reducing the cost, making the iHSD more attractive to growers," Peter said.

Following the invention of the HSD by WA grower Ray Harrington and development by UniSA with investment from GRDC, the iHSD has undergone further development by SKF Engineering and DeBruin Engineering, together with national distributor, McIntosh Distribution.

McIntosh & Son dealer principal (southern branches) Devon Gilmour says the vertical, mechanical iHSD's direct-drive system is easy to use and maintain, can be retro-fitted on a wide range of harvester models and is easily fitted on-farm.

Impact mills have a proven high weed seed kill rate, making them a very effective, non-herbicide tool in the fight against herbicide resistant weeds. Harvesters fitted with impact mills can spread crop residue more evenly, reducing the loss or redistribution of nutrients, making them an attractive proposition for growers.

For more information about harvest weed seed control of herbicide resistant weeds, visit the WeedSmart website: www.weedsmart.org.au ■

Impact mills integrated into harvestors have a proven high weed seed kill rate and can spread crop residue more evenly, reducing the loss or redistribution of nutrients.

Trial network to deepen strategic tillage knowledge

Widespread field trials are generating information that will help grain growers decide which strategic tillage methods may be best suited to different soil types on their farms.

The first year of Grains Research and Development Corporation (GRDC) *Ripper Gauge* trials across the Western Australian grain belt showed deep ripping to a depth of 60 cm generally produced the highest grain yields on sandy soils, and more intensive tillage treatments tended to produce the best results on gravel-based soils.

The trials, that started in 2018, are being coordinated by the West Midlands Group (WMG) and conducted by local grower groups at 20 demonstration sites over three years in all WA port zones. A large range of soil types are being tested, including loamy sands through to gravel and sand duplexes, 'forest gravels' and clay soil types.

Machinery used according to local 'adaptation'

Treatments included ripping to 30 cm, deep ripping to 60 cm, 'maximum' tillage and a control (no amelioration). Machinery used varied according to what was locally available from growers.

This project will continue for the 2019 and 2020 cropping seasons to follow the impact of each amelioration treatment over time and in different seasonal conditions.

GRDC grower relations manager – west, Lizzie von Perger, said soil amelioration practices such as deep ripping, mouldboard ploughing and rotary spading could remove soil constraints and increase crop yields and had become increasingly popular on Western Australian grain farms in recent years.

"However, knowledge is still limited about the benefit and longevity of these practices on a number of soil types," she said.

"This project aims to evaluate and demonstrate the impact of soil amelioration on a wide range of soil types that are common in the WA grainbelt."

WMG executive officer Nathan Craig said results from the first year of the project showed grain yield responses to soil amelioration methods tended to be associated with broad soil types, rather than with geographical areas.

"The sandy soils, including duplex and loamy types, mostly responded best to deep ripping treatments. Ameliorating the compacted soil layer of sandplain soils has already been shown to significantly increase yields in most seasons on WA grain farms," he said.

"The gravel-based soils, that are often harder and shallower than the sandy soils, tended to be more responsive in the trials to maximum tillage treatments that had the greatest level and depth of soil disturbance.

"Maximum tillage treatments involved both ripping and aggressive disc tillage, in one pass, to loosen soil to a depth of 30 cm."

Nathan said that there were some exceptions to these general rules, and some sites where treatments produced no grain yield responses.

"The soil types that did not respond to the soil amelioration methods were varied and located across different port zones but were generally in areas that experienced above average growing season rainfall," he said.

Nathan said the treatments – especially the maximum tillage treatments – contributed to increased weed numbers at many of the sites due to soil disturbance triggering weed germination.

"Increased weed numbers may have competed with crops, many of which were cereals, for soil moisture and nutrients to reduce the grain yield benefit of these treatments," he said

"This sparked discussion from growers visiting the sites, with many suggesting that some canola varieties might be better to grow than cereals immediately following soil amelioration due to more robust herbicide packages being available for them."

Nathan said the project also highlighted that gravelly and hard types of soils could significantly restrict how and when those soils could be ameliorated.

More information about addressing soil constraint and soil amelioration practices is available in GRDC videos and podcasts discussing outcomes from the five-year collaborative Soil Constraints – West initiative.

More information: Nathan Craig, West Midlands Group executive officer Mob: 0438 924 208; E: eo@wmgroup.org.au ■

Results from the first year of widespread field trials showed that grain yield responses to different strategic tillage methods tended to be associated with broad soil types, rather than with geographical areas. (PHOTO: Evan Collis Photography)

Section 13

Industry Agencies

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Ph: 13 28 46 – Web: www.business.gov.au

Australian Pesticides and Veterinary Medicines Authority (APVMA)

18 Wormald St, SYMONSTON, ACT, 2609
PO Box 6182, KINGSTON ACT 2604
Ph: 02 6210 4701
Interim office address: 246 Beardy St, ARMIDALE, NSW, 2350
Email: enquiries@apvma.gov.au – Web: www.apvma.gov.au

Australian Government Department of Agriculture and Water Resources

GPO Box 858, CANBERRA ACT 2601
Ph: 02 6272 3933 – Freecall: 1800 900 090
Web: www.agriculture.gov.au

Australian Plague Locust Commission

Unit 7, 50 Collie St, FYSHWICK ACT 2609
GPO Box 858, CANBERRA ACT 2601
Toll call (within Australia): 1800 635 962 – Fax: 02 6272 5074
Email: aplc@agriculture.gov.au
Web: www.agriculture.gov.au/pests-diseases-weeds/locusts

Department of Foreign Affairs and Trade

R G Casey Building, John McEwen Crescent, BARTON ACT 0221
Ph: 1300 555 135 – Fax: 02 6261 3111 Web: www.dfat.gov.au
Secretary: Frances Adamson
Deputy Secretary – Trade, Investment and Business Engagement Group: Christopher Langman

Department of Agriculture and Water Resources – Levies

18 Marcus Clarke St, Canberra City
Locked Bag 4488, KINGSTON ACT 2604
Free call: 1800 020 619 – Free fax: 1800 609 150
Email: levies.management@agriculture.gov.au
Web: www.agriculture.gov.au/ag-farm-food/levies
Chief Financial Officer: Emily Canning

National Residue Survey

Department of Agriculture & Water Resources
18 Marcus Clarke St, Canberra City
GPO Box 858, CANBERRA ACT 2601
Ph: 1800 420 919 – Fax: 02 6272 4023
Director National Residue Survey: Ian Reichstein
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 St, Phillip ACT 2606
PO Box 200, WODEN ACT 2606
Ph: 1300 651 010 (9am to 5pm, Monday to Friday) Canberra time
Registrar: Frances Roden
Email: eservices@ipaustralia.gov.au – Web: www.ipaustralia.gov.au

Biosecurity Plant

18 Marcus Clarke St, 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 St, Canberra City
GPO Box 858, CANBERRA ACT 2601
Ph: 1800 900 090
Web: www.agriculture.gov.au/animal

State Agriculture Departments

NSW Department of Primary Industries

161 Kite St – 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 Jobs, Precincts and Regions Victoria

1 Spring St – GPO Box 4509, MELBOURNE VIC 3001
Ph: (03) 9651 9999
Email: customer.service@ecodev.vic.gov.au
Web: www.djpr.vic.gov.au

Department of Agriculture and Fisheries (Qld)

41 George St – GPO Box 46, BRISBANE QLD 4001
Customer Service Centre: 13 25 23
Interstate – Ph: 07 3404 6999 – Fax: 07 3404 6900
Email: info@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 St – GPO Box 1671, ADELAIDE SA 5001
Ph: 08 8226 0995 – Email: pirsa.customerservices@sa.gov.au
Web: www.pir.sa.gov.au

Department of Agriculture and Food, Western Australia

3 Baron-Hay Court, South Perth WA 6151
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Email: enquiries@dpird.wa.gov.au
Web: www.agric.wa.gov.au

Tasmanian Department of Primary Industries, Parks, Water and Environment

1 Franklin Wharf – GPO Box 44, HOBART TAS 7001
Ph: 03 6169 9021
Email: Information@dpipwe.tas.gov.au
Web: www.dpipwe.tas.gov.au

Department of Primary Industry and Resources, NT

Berrimah Farm, Makagon Rd, Berrimah, Northern Territory 0828
GPO Box 3000, DARWIN NT 0801
Ph: 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
Chairman: John Woods
Managing Director: Dr Steve Jefferies
Email: grdc@grdc.com.au – Web: www.grdc.com.au

AgriFutures Australia

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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 St – 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: Ian Taylor

Dairy Australia

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Ph: 03 9694 3777 – Fax: 03 9694 3733
Web: www.dairyaustralia.com.au
Executive Officer: Brad Granzin – Mob: 0431 197 479

Meat & Livestock Australia (MLA)

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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: Jason Strong
Email: managingdirector@mla.com.au

Australian Pork Limited

Level 2, 2 Brisbane Ave 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

SA Research and Development Institute (SARDI)

Plant Research Centre, 2b Hartley Grove, Urrbrae SA 5064
GPO Box 397, ADELAIDE SA 5001
Ph: 08 8303 9400 – Email: pirsa.sardi@sa.gov.au
Website: www.pir.sa.gov.au/research

Sugar Research Australia

50 Meiers Rd – 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

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GPO Box 4177, SYDNEY NSW 2001
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Email: feedback@wool.com – Web: www.wool.com
Chief Executive Officer: Stuart McCullough

CSIRO Enquiries

Private Bag 10, CLAYTON SOUTH, Vic 3169
Ph: 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
Acting Director CSIRO Agriculture – Dr Michael Robertson
Email: michael.robertson@csiro.au

Related Cooperative Research Centres

Pork CRC Ltd

PO Box 466, WILLASTON, SA 5118
Ph: 08 8313 7684 – Fax: 08 8313 7686
Email: Geoff.crook@porkcrc.com.au – Web: www.porkcrc.com.au
Chief Executive Officer: Geoff Crook

International agencies

Australian Centre for International Agricultural Research (ACIAR)

38 Thynne St, 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: Professor Andrew Campbell

International Center for Agricultural Research in the Dry Areas (ICARDA)

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Director General: Aly Abousabaa

International Maize and Wheat Improvement Center (CIMMYT)

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Director General: Martin Kropff

Associated Industry

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Email: lab.vic@agrifood.com.au – Web: agrifood-srp.com.au

Australian Fertiliser Services Association (AFSA)

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Executive Officer: Krysteen McElroy
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Email: bkmcelroy22@outlook.com – Web: www.afsa.net.au

Australian Herbicide Resistance Initiative

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The University of Western Australia
35 Stirling Hwy, CRAWLEY WA 6009
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Director: Professor Hugh Beckie
Ph: 08 6488 4615
Centre Manager: Ms Lisa Mayer
Email: lisa.mayer@uwa.edu.au

Australian Lot Feeders' Association

Level 5, 131 Clarence St – 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: Bryce Camm
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

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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
Email: enquiry@asf.asn.au – Web: www.asf.asn.au
President: Michael Leader
General Manager: Osman Mewett

Barley Australia

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Web: www.barleyaustralia.com.au
Executive Chairperson: Megan Sheehy
Email: megan.sheehy@barleyaustralia.com.au

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Email: info@beangrowers.com.au
Web: www.beangrowers.com.au

Centre for Legumes in Mediterranean Agriculture (CLIMA)

The University of Western Australia,
35 Stirling Hwy, 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

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40 Macquarie St, BARTON ACT 2600
Ph: 02 6273 2733
Web: www.croplife.org.au
President: Paul Luxton, Syngenta Australia Pty Ltd
Chief Executive Officer: Matthew Cossey

Farmsafe Australia

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Locked Bag 9, KINGSTON, ACT 2604
PH: 02 6269 5622
Email: info@farmsafe.org.au – Web: www.farmsafe.org.au
State Farmsafe contacts:
Queensland: 07 4774 0522
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

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Locked Bag 4396, KINGSTON ACT 2604
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Email: info@fertilizer.org.au – Web: www.fertilizer.org.au
Executive Manager: Stephen Annells

Grains & Legumes Nutrition Council

Level 1, 40 Mount St, 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: Luke Skerman
Executive Officer: Meg Kummerow

Nuffield Australia

PO Box 1021, NORTH SYDNEY NSW 2059
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Email: enquiries@nuffield.com.au – Web: www.nuffield.com.au
Chief Executive Officer: Jodie Dean
Chairman: Andrew Fowler

Peanut Company of Australia

133 Haly St – PO Box 26, KINGAROY QLD 4610
Ph: 07 4162 6311 – Fax: 07 4162 4402
Email: peanuts@pca.com.au – Web: www.pca.com.au

Plant Health Australia

Level 1, 1 Phipps Close, DEAKIN ACT 2600
Ph: 02 6215 7700
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 St, 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:
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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

57 Yanco Ave – 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 Ave – 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 St, Canberra City
GPO Box 858, CANBERRA ACT 2601
Ph: 1800 900 090
Web: www.agriculture.gov.au

Tractor and Machinery Association of Australia

442 Auburn Rd, HAWTHORN Vic 3122
Ph: +62 0467 002 322
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

GrainCorp Operations Ltd (Sydney)

Level 28, 175 Liverpool St, 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
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Ph: 08 8304 5000 – Fax: 08 8231 1249 – Freecall: 1800 018 205
Email: viterra.aus@viterra.com – Web. www.viterra.com.au
Gayfer House,30 Delhi St, 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 St, Sydney
PO Box H224, AUSTRALIA SQUARE NSW 1215
Ph: 02 8973 3625 – 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 O'Connell St, SYDNEY NSW 2000
Ph: 02 9235 2155
Email: admin@graintrade.org.au – Web: www.graintrade.org.au
Chief Executive Officer: Pat O'Shannassy

Grower Groups

AgVance Farming Pty Ltd

48 Station St, QUIRINDI NSW 2343
Ph: 02 6746 2336

Birchip Cropping Group Inc. (BCG)

PO Box 85, BIRCHIP Vic 3483
Ph: 03 5492 2787
Email: info@bcg.org.au – Web: www.bcg.org.au
Chief Executive Officer: Chris Sounness

Central West Farming Systems

NSW DPI Condobolin Agricultural Research & Advisory Station
1 Fifield Rd – PO Box 171, CONDOBOLIN NSW 2877
Chief Executive Officer: Diana Fear
Ph: 02 02 6895 1025 – Mob: 0488 951 001
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Conservation Agriculture & No-till Farming Association (CANFA)

PO Box 2014, DUBBO NSW 2830
Chair: Gavin Tom
Ph: 0428 621 075 – Email: gaveltom@hotmail.com
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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

Corrigin Farm Improvement Group Inc. (CFIG)

PO Box 2, CORRIGIN WA 6375
Executive Officer: Veronika Crouch, Mob: 0476 046 100
Email: cfig@cfig.asn.au – Web: www.cfig.asn.au

Eyre Peninsula Agricultural Research Foundation (EPARF)

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226 McKenzie Rd – PO Box 31, MINNIPA SA 5654
Ph: 08 8680 6200 – Fax: 08 8680 5020
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Facey Group

40 Wogolin Rd – PO Box 129, WICKEPIN WA 6370
Ph: 08 9888 1223
Email: admin@faceygroup.org.au – Web: www.faceygroup.org.au
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FarmLink Research Limited

361 Trungley Hall Rd – PO Box 521, TEMORA NSW 2666
Ph: 02 6980 1333
Chief Executive Officer: Cindy Cassidy
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Grain Growers Limited

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PO Box Q1355, QUEEN VICTORIA BUILDING NSW 1230
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Email: enquiry@graingrowers.com.au
Web: www.graingrowers.com.au/
CEO: David McKeon
General Manager, Policy & Research: Luke Mathews

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 St

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
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Research & Extension Manager: Sarah Noack
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Executive Officer: Sandy Kimber
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Web: www.farmingahead.com.au

Liebe Group

PO Box 340, DALWALLINU WA 6609
Ph: 08 9661 1907
Executive Officer: Bec McGregor
Email: admin@liebegroup.org.au – Web: www.liebegroup.org.au

Mallee Sustainable Farming Inc.

Program Manager: Tanja Morgan
7b Byrne Crt, MILDURA Vic, 3500
M: 0429 395 918 E: admin@msfp.org.au
Web: www.msfp.org.au

MacKillop Farm Management Group (MFMG)

PO Box 1364, NARACOORTE SA 5271
Chief Executive Officer: Meg Bell
Ph: 0433 499 630 – Email: ceo@mackillopgroup.com.au
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Mingenew Irwin Group

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Ph: 08 9928 1645 – Fax: 08 9928 1540
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Chief Executive Officer: Kathryn Fleay
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Web: www.mig.org.au

Northern Grower Alliance

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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

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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)

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Web: www.santfa.com.au
President: Callum March
Mob: 0429 657 585 – Email: president@santfa.com.au

South East Premium Wheat Growers Association (SEPWA)

PO Box 365, ESPERANCE WA 6450
Executive Officer: Niki Curtis
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Email: eo@sepwa.org.au – Web: www.sepwa.org.au

Southern Farming Systems Ltd

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Chief Executive Officer: Jon Midwood
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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

Victorian No-Till Farmers Association

17 Darlot St – PO Box 1397, HORSHAM Vic 3402
Ph: 03 5382 0422 or 0402 216 267
Email: accounts@vicnotill.com.au – Web: www.vicnotill.com.au
Business Manager: Penny Stemp
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WANTFA

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Email: admin@wantfa.com.au – Web: www.wantfa.com.au
Executive Director: David Minkey – Mob: 0417 999 304
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West Midlands Group

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Executive Officer: Nathan Craig
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Yorke Peninsula Alkaline Soils Group

61–63 Main St, MINLATON SA 5575
Ph: 08 8853 2241 – Fax: 08 8853 2269
Project and Funding Coordinator: Kristin Murdock
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 14

Suppliers' Directory

AGRICULTURAL CHEMICALS

4Farmers: www.4farmers.com.au
Axial – Syngenta: www.syngenta.com
Boxer – Syngenta: www.syngenta.com
Cognito – Syngenta: www.syngenta.com
Corteva Agriscience: www.corteva.com
Deluge – Victorian Chemicals: www.vicchem.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
Sparex: www.sparex.com

ELECTRONIC EQUIPMENT/PRECISION AG
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
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
Agridry: www.agridry.com.au
Ahrens: www.ahrens.com.au
Allied Grain Systems: www.alliedgrainsystems.com.au
Aurora: www.auroraagencies.co.nz
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
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

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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