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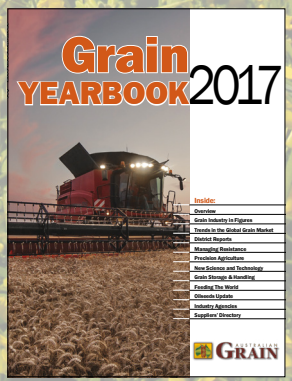

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FRONT COVER – WORKING AROUND THE CLOCK BRINGS IN A RECORD HARVEST
Australian grain production records have tumbled on the back of a cool and wet 2016 spring. Official estimates put the 2016–17 winter crop at nearly 59 million tonnes – almost 30 per cent above our previous best.

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The Challenger pictured was tuned by Advantage Tuning on the Beef Road between Middlemount and Dysart late last year. Previously, the machine was using 90 litres per hour at a 100 per cent engine load, and was physically unable to move up to a higher gear. After a tune and service from Advantage Tuning it was able to utilise an additional two gears, and is now operating at 300 rpm lower than prior to the tune.

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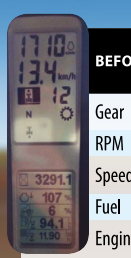
CASE STEIGER 435 WITH AS TESTED IN THIS CONFIGURATION

The customer experienced a significant fuel saving along with a vast improvement in drivability through removing the power hop. The machine could not physicall pull the implement in a higher gear at this speed, until it was tuned for this application. Please note the first picture of the gauges is prior to tuning. This represents an overall fuel saving of 42%.



BEFORE TUNE	
Gear	- 12th
RPM	- 1710
Speed	- 13.4 km/hr
Fuel	- 94.1 Lt/hr
Engine load	- 107%

AFTER TUNE, SAME GEAR/ SAME SPEED	
Gear	- 12th
RPM	- 1720
Speed	- 13.4 km/hr
Fuel	- 73.3 Lt/hr
Engine load	- 80%

AFTER TUNE, +TWO GEARS/ SAME SPEED	
Gear	- 14th
RPM	- 1230
Speed	- 13.5 km/hr
Fuel	- 54.6 Lt/hr
Engine load	- 65%

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Section 1

Overview

The 2016–17 winter crop was the biggest Australia has ever produced. Silos, sausage bags, bunkers, grain bins – even holes in the ground – bulged with more than 58 million tonnes (mt) of winter grains.

National wheat and barley production were both the biggest crops on record at 35.13 and 13.4 mt respectively while canola tipped the scales at an equal record high of 4.1 mt. These harvest numbers reflect generally magnificent spring conditions for optimal crop growth. Some regions had too much of a good thing with waterlogged crops and high disease pressure while frost damage also took its toll in some regions of Western and South Australia.

But the total 'wash-up' was exceptional. The old winter crop production record was back in 2011–12 when 45.7 mt were harvested – this was smashed by almost 30 per cent – and off about 350,000 fewer hectares than that sown in 2011.

This tells us that we're getting better at growing our winter crops and given a favourable spring, some fantastic yields are possible.

The 2016–17 summer brought with it the usual mixed bag of heat waves and erratic storm rains, particularly during January and February. But after a difficult season, summer crop production will be around 4.2 mt of grain – slightly better than the 10 year average.

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Big yields in 2016 and implications for soil nutrition this year **25**

THIS SECTION BROUGHT TO YOU IN ASSOCIATION WITH:

Australia area ('000 ha) and production ('000 tonnes) of major winter and summer crops planted for grain during 2016

	NSW		VIC		QLD		WA		SA		TAS		AUSTRALIA TOTAL	
2016–17	Area	Prodn	Area	Prodn	Area	Prodn	Area	Prodn	Area	Prodn	Area	Prodn	AREA	PROD'N
Wheat	3500	11,375	1550	5200	735	1925	5125	10,000	2000	6600	7.4	34	12,917	35,134
Barley	870	2697	940	3200	95	300	1325	4200	800	3000	5.3	17	4035	13,414
Oats (for grain)	322	477	154	440	25	31	341	750	63	175	4.4	7.4	909	1880
Triticale	50.0	148.0	10.0	28.0	1.0	3.0	10.0	13.0	25.0	55.0	0.6	1.3	97	248
Sorghum#	140	406			300	800	1.0	2.0					441	1208
Maize#	21.0	189.0	5.0	55.0	43.0	217.0	1.0	6.2					70	467
Rice#	85	865	0.2	2.0	1.0	4.0							86	870
Canola	510	842	355	700	1.0	1.7	1240	2200	220	400	1.0	1.8	2327	4144
Sunflowerseed#	15.0	20.0			11.0	10.0	3.0	3.0	0.1	0.1			29	33
Soybean#	16.0	29.0	0.6	1.0	11.0	18.0							28	48
Peanuts#					7.0	19.0							7	19
Cottonseed#	328	900			229	555							557	1455
Lupins	51	66	33	60			361	805	70	100			515	1031
Field peas	50	85	49	100			31	55	100	175			230	415
Chickpeas	300	495	16	28	475	850	4.3	7.4	19	27			814	1407
Faba beans	30	78	120	220	1.4	2.5	5.2	11	100	260			256	571
Mung beans#	50.0	44.0			80.0	67.9							130	111
Navy bean#					5.0	6.0							5	6
Lentils	1.3	2.4	111	200					142	420			254	620
TOTAL	6339	18,718	3344	10,234	2020	4809	8447	18,052	3539	11212	18	60	23,707	63,081

Estimate for summer crop harvested in 2017. Principal source: ABARES.

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

	2011–12	2012–13	2013–14	2014–15	2015–16	2016–17	2017–18 (forecast)
PRICES RECEIVED (excl GST)							
Wheat	114.6	158.3	159.8	151.7	144.7	123.7	131.9
Barley	131.7	173.4	167.9	175.6	155.8	126.6	133.6
Canola	133.1	142.1	144.1	130.6	142.4	137.9	140.2
Lupins	118.7	173.5	176.4	149.3	148.2	132.8	140.5
Oats	147.7	172.9	156.0	183.1	183.1	151.1	147.8
Sorghum	111.6	148.9	177.2	178.1	154.0	126.0	130.7
TOTAL GRAINS	115.7	147.9	149.9	147.0	142.0	125.4	129.9
PRICES PAID (excl GST)							
Fuel & lubricants	228.2	216.8	221.1	196.8	177.1	175.5	175.5
Fertiliser	165.5	157.9	153.2	154.7	157.8	165.0	164.1
Chemicals	112.6	110.3	113.6	115.0	116.2	117.5	119.2
Seed	116.4	128.0	130.6	130.4	129.1	122.5	125.8
Marketing	154.1	153.5	159.3	152.9	148.3	149.1	152.0
Interest paid	114.9	96.4	85.3	79.5	75.6	72.3	74.1
Rates & taxes	152.9	156.4	160.6	163.4	165.6	168.0	171.2
Insurance	185.8	190.0	195.2	198.5	201.3	204.2	208.1
Other overheads (incl. labour)	148.3	151.7	155.8	158.5	160.7	163.0	166.1
Capital items	153.2	157.0	161.5	164.4	166.9	169.5	172.8
TOTAL PRICES PAID*	147.2	145.1	145.5	146.7	149.8	150.6	153.3
TERMS OF TRADE	78.6	101.9	103.0	100.2	94.8	83.3	84.7

Note: Terms of trade is the ratio of the index of prices received and the index of prices paid by farmers. * Excludes livestock costs, fodder, breeding stock etc. Sources: ABARES, ABS

Domestic and global wheat outlook

By Sarah Smith, ABARES

AT A GLANCE…

- Wheat prices are projected to remain low in the short to medium term because of abundant world supplies and competition from other feed grains on the global market.
- World production of wheat is forecast to decline in 2017–18 but increase in the medium term as average yields return to historical trends.
- Australian wheat production and export volumes are forecast to fall from large volumes in 2016–17.

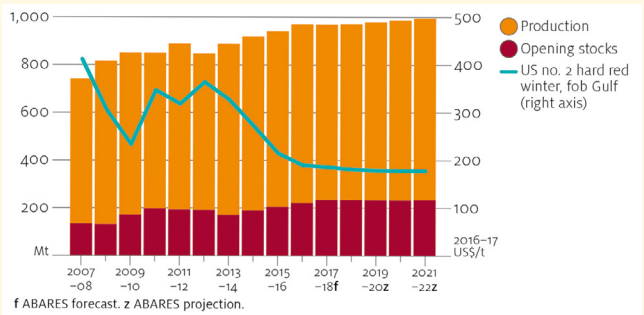
Outlook for Australian wheat to 2021–22

Wheat production to increase modestly in medium term

The area planted to wheat is forecast to fall by one per cent in 2017–18 to 12.8 million hectares. This is because favourable returns to canola, pulses and sheep are expected to result in increased competition for planting area. The final area planted to wheat will depend on climatic conditions leading into and during the planting window (usually between March and June), when cropping decisions are made.

Assuming average seasonal conditions, wheat production is forecast to fall from 35 million tonnes (mt) in 2016–17 to 24 mt in 2017–18. This reflects yields returning to trend after exceptional seasonal conditions in most wheat-producing areas resulted in record yields in 2016–17.

Wheat area and production, Australia, 2010–11 to 2021–22



f ABARES forecast. z ABARES projection.

In the medium term, the area planted to wheat is projected to contract marginally. Despite low prices, wheat is an important rotational crop and will continue to be used in cropping mixes. Total winter cropping area faces competition from livestock production, particularly of sheep. Favourable returns to lamb and wool are projected in the medium term. But wheat production is projected to increase modestly to 25 mt in 2021–22. This is because a gradual increase in average yields from productivity improvements is projected to offset the reduction in planted area.

Wheat export shipments to decline

The volume of wheat exports is forecast to fall by 8 per cent in 2017–18 to 21 mt from the 23 million tonne forecast in 2016–17. Record production is expected to boost export shipments in 2016–17.

World import demand is strong, supported by low prices and poor-quality domestic harvests in China and India. In the final six months of

Monthly wheat exports to India, Australia, January 2015 to December 2016

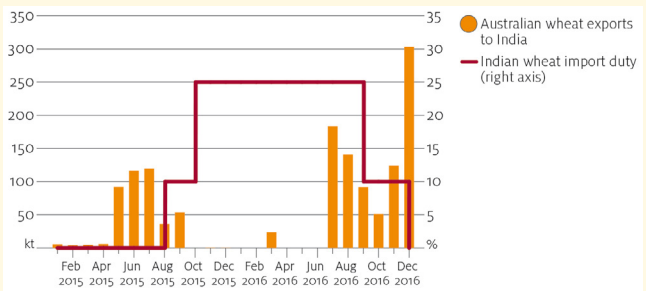


Table 1: Australia and world outlook for wheat

	unit	2014–15	2015–16s	2016–17f	2017–18f
World					
Area	million ha	221	225	222	221
Yield	t/ha	3.30	3.28	3.38	3.32
Production	Mt	730	737	750	735
Consumption	Mt	715	720	737	735
Closing stocks	Mt	205	221	234	234
Trade	Mt	153	164	167	165
Stocks-to-use ratio	%	28.6	30.8	31.8	31.9
Price**a** – nominal	US$/t	266	211	190	190
Australia					
Area	'000 ha	12,384	12,793	12,917	12,773
Yield	t/ha	1.92	1.89	2.72	1.88
Production	kt	23,743	24,168	35,134	23,979
Export volume**c**	kt	16,571	15,777	22,784	20,872
Export value**c** – nominal	A$m	5,547	5,120	6,479	5,914
APW 10 net pool return – nominal	A$/t	326	303	270	277

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

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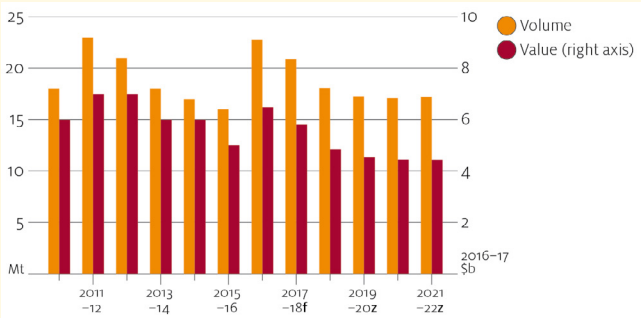
2016, Australia exported large volumes of wheat to India. The Indian Government reduced the wheat import duty from 25 per cent to 10 per cent in September 2016 before eliminating it completely in December 2016.

These changes were driven by a domestic shortage of milling quality wheat following the lower-quality harvest and a drawdown in stocks. Milling wheat demand from India is expected to remain strong until at least March 2017, when the Indian domestic harvest will commence.

In 2017–18 the volume of Australian wheat exports is expected to fall but remain relatively high due to ample supplies from the previous season. The combination of reduced export volumes and weak international prices is forecast to result in a 9 per cent reduction in the value of exports in 2017–18 to $5.9 billion.

Towards the end of the outlook period, export volumes are projected to stabilise at around 17 mt. Demand for milling wheat in China, Indonesia and the Republic of Korea – Australia's largest export markets – is expected to strengthen in line with population growth. But Australian exports will continue to face competition from other major exporters. Low international prices are expected to cause the value of exports to fall to around $4.4 billion in 2021–22 in real terms.

Wheat exports, Australia, 2010–11 to 2021–22



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World indicator price expected to remain low

The world wheat indicator price (US no. 2 hard red winter, fob Gulf) is forecast to average US$190 a tonne in 2017–18, largely unchanged from the forecast average for 2016–17. If realised, this will be the lowest annual average price since 2001–02 in real terms.

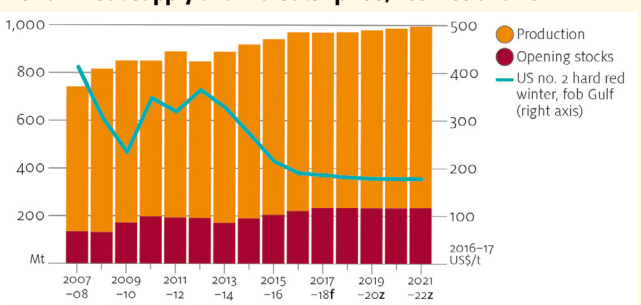
The world indicator price is expected to continue to face downward pressure in 2017–18 because of large carry-over stocks and relatively high forecast production. Four consecutive years of record global production have resulted in a significant accumulation of stocks, particularly in exporting countries. In 2017–18 production is forecast to fall year-on-year. Assuming average seasonal conditions, yields will return to trend and production will be the third-highest on record.

A major production shock would be an upside risk to international wheat prices, particularly for milling wheat. Compared with feed wheat, which faces strong competition from corn and barley, milling wheat has few substitutes and relatively inelastic demand.

In the medium term, prices are projected to decline further in real terms. The area planted to wheat is projected to fall in high-cost producing regions in response to continued low prices. But global production is projected to continue to increase over the medium term because of productivity improvements, particularly in Argentina and the Black Sea region.

Ample exportable supplies are expected to be available to satisfy increasing import demand from a growing world population unless there is a major disruption to supply over the next five years. A strong US dollar over the outlook period will continue to affect the competitiveness of US wheat exports and place downward pressure on the world indicator price.

World wheat supply and indicator price, 2007–08 and 2021–22



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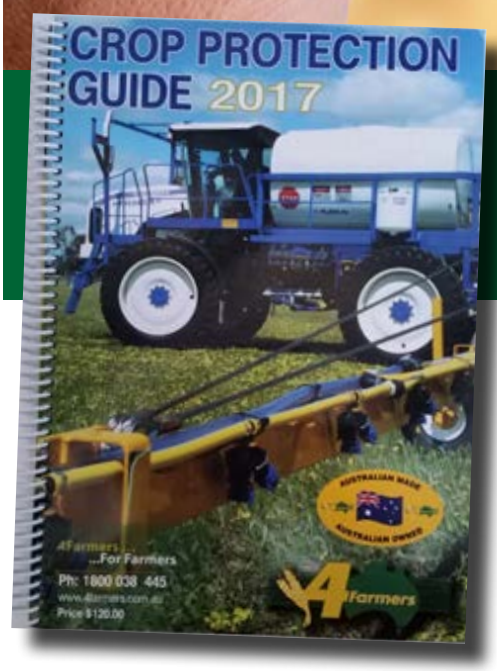

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World wheat production forecast to fall in 2017–18 but increase in the medium term

Wheat production is forecast to fall by two per cent in 2017–18 to 735 mt, reflecting falls in planted area and average yields. In 2017–18 the average yield is expected to fall from the 2016–17 record that was achieved because of favourable seasonal conditions in most wheat-producing regions.

Over the medium term, the area planted to wheat is expected to remain largely unchanged. High-cost producers are expected to respond to several years of low prices by reducing the area planted, particularly in Australia, Canada and the United States. In other major producing regions, the incentive to plant wheat is expected to remain strong because of either supportive government policies or favourable exchange rates relative to the US dollar.

Average yields are projected to continue trending upwards in the medium term, particularly in emerging economies such as Argentina, the Black Sea region and India. As a result, global production is projected to increase to more than 760 mt by 2021–22.

In Argentina, wheat production is expected to rise in 2017–18 and increase further in the medium term to 2021–22. The area planted to wheat is forecast to increase by two per cent in 2017–18, following 20 per cent growth in 2016–17. Those changes reflect supportive regulation enacted by the Argentine Government in 2015, including the elimination of wheat export taxes and quantitative restrictions. Gains in average yields are also expected to continue in Argentina over the medium term because of increased use of fertiliser and pesticides.

In the Black Sea region – Kazakhstan, the Russian Federation and Ukraine – production is forecast to fall by seven per cent in 2017–18 to 106 mt.

An increase in area planted is expected to be more than offset by a fall in the average yield from the 2016–17 record that resulted from exceptional seasonal conditions. In the medium term, production is projected to rise as a result of yield improvements despite a relatively stable planted area.

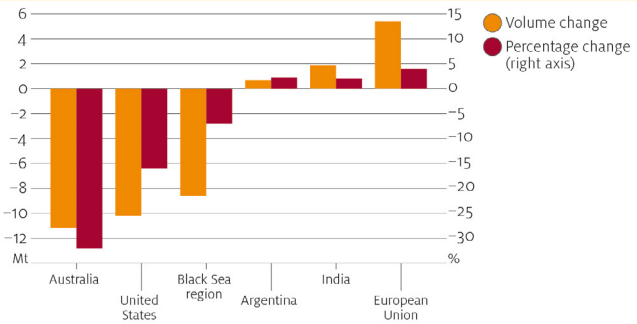
EU production is expected to recover in 2017–18. This follows the low-yielding, poor-quality harvest in 2016–17 that resulted from unfavourably wet conditions. Increasing yields in the medium term are projected to just offset a reduction in area planted to wheat.

Indian production is forecast to increase by two per cent in 2017–18, largely because of an increase in the area planted. In late 2016 the Indian Government announced the withdrawal of all 500 and 1000 rupee banknotes, estimated to make up 86 per cent of cash in circulation. With less than eight weeks to exchange the obsolete notes, acute cash shortages raised concerns that the purchase of seed and fertiliser would be disrupted. But good soil moisture during the planting window, following the return of typical monsoonal conditions, is likely to offset any negative impact.

US wheat production is forecast to fall in 2017–18, reflecting a fall in yields from the record in 2016–17 and a significant decline in planted area. Area planted to wheat is forecast to contract to its smallest in 100 years, driven by large declines in the hard red winter plantings.

In the medium term, area planted to wheat is expected to remain below historical averages.

Forecast change in wheat production, 2017–18



World wheat consumption projected to grow

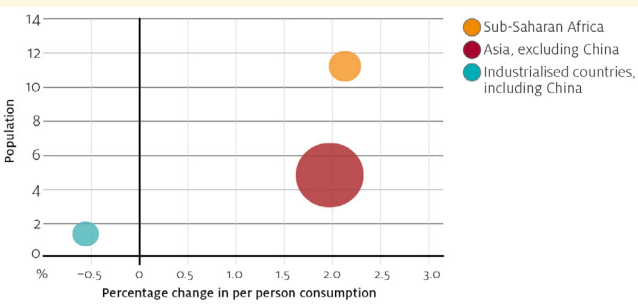
World wheat consumption is forecast to remain largely unchanged in 2017–18 at 735 mt. Growth in wheat for human consumption is expected to offset a reduction in feed wheat use. Over the medium term, world wheat consumption is projected to increase by around one per cent a year to 762 mt in 2021–22.

Human consumption represents around two-thirds of total world wheat consumption and is projected to rise by one per cent a year over the medium term. Most of this increase is expected to stem from population growth, with only a modest increase in per person consumption. But patterns of consumption are expected to differ around the world.

Asian countries, excluding China, are expected to make the largest contribution to the volume increase of wheat for human consumption. Human consumption in these countries is expected to grow as a result of the projected increase in population and per person consumption in line with increasing incomes and changing diets.

Sub-Saharan Africa is projected to contribute less to the global increase in human consumption because of a smaller population base. This is despite the expectation that per person consumption and population will grow strongly. Industrialised countries, including China, are expected to make an even smaller contribution to the change in global human consumption of wheat because population growth is projected to be more modest and per person consumption to fall.

Contribution to global change in human consumption of wheat, by region, 2017–18 to 2021–22



Note: Circle size represents the total increase in consumption volume.

Feed wheat consumption is typically the more variable component of total wheat consumption because of the availability of substitutes. Feed wheat use is forecast to fall by 5 per cent in 2017–18 to 145 mt. Ample supplies of corn and feed barley underpin considerable competition in the feed grain market. Total feed grain demand is projected to grow

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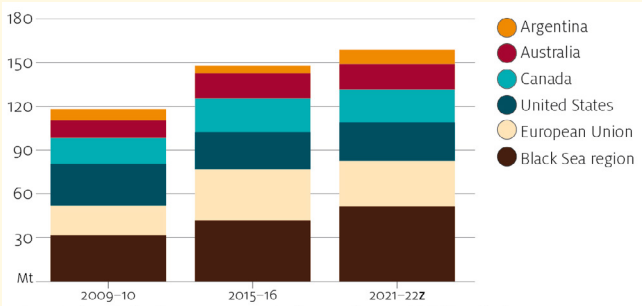
Within the next 5 years, it's projected China will hold nearly half of the world's wheat stocks.

in the medium term because of a projected increase in meat and dairy production in major livestock-producing regions. Feed wheat use is projected to increase moderately by 2021–22, but it will continue to face competition from other feed grains.

Wheat exports from major exporters, 2009–10 to 2021–22a



a Export volume is the three-year average to the year shown. z ABARES projection.

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Wheat trade to fall year-on-year but remain historically high

The volume of wheat traded internationally is forecast to fall by one per cent in 2017–18 from the record in 2016–17 to 165 mt. Production in major exporting countries is forecast to fall in 2017–18. But exportable supplies including stocks remain historically high.

Over the medium term, improved production is projected to support increased export volumes in all major exporting countries, especially in the Black Sea region. In 2016–17 the Russian Federation overtook the European Union to become the largest global exporter of wheat. Russian exports are projected to remain strong over the medium term because of government investment in port capacity and export infrastructure combined with a projected expansion in production.

Growing global consumption and low prices are expected to drive increasing wheat imports over the medium term, particularly in Africa and Asia. These two regions are net importers of wheat and are projected to increase their wheat consumption over the medium term.

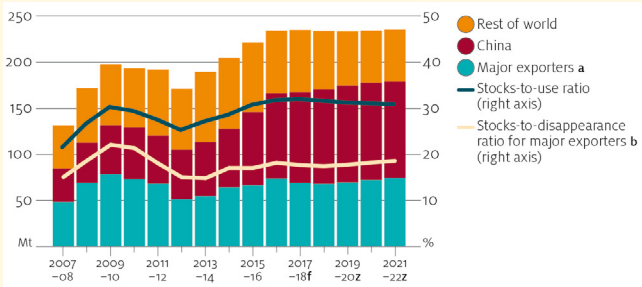
World wheat closing stocks to remain large

World wheat closing stocks are expected to be largely unchanged over the outlook period. Increasing global consumption is expected to be met with growth in global production. The Chinese Government's grain reserve and price support policies encourage domestic production of wheat. Chinese domestic production is projected to remain large and outstrip consumption over the medium term. This will add to growing stocks. By 2021–22 China is projected to hold 45 per cent of the world's stocks. Stocks in the rest of the world are projected to decline in the medium term but remain large.

The stocks-to-use ratio is projected to decline to 2021–22 because world consumption is expected to grow while world stocks remain unchanged. But the stocks-to-disappearance ratio for major exporters is expected to rise. This is because stocks in major exporting countries are projected to rise at a faster rate than domestic consumption plus exports.

A high stocks-to-disappearance ratio is an indication of ample exportable supplies that are more likely to enter the global market if prices rise markedly. Comparatively, stocks in the rest of the world are more likely to be consumed domestically.

World wheat closing stocks, 2007–08 to 2021–22



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

Source: ABARES 2017, Agricultural Commodities: March quarter 2017. CC BY 3.0. ■

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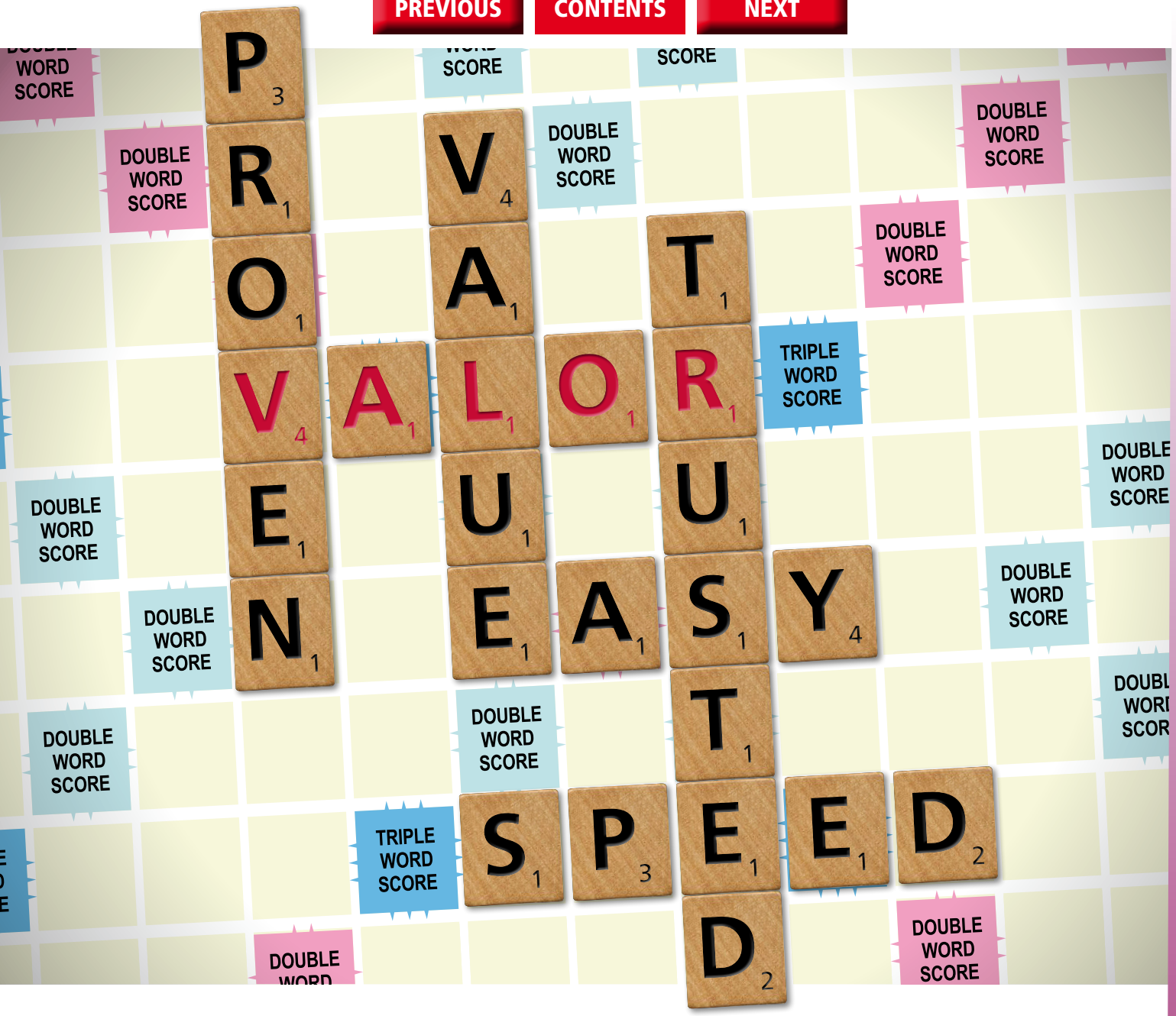

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Domestic and global coarse grain outlook

By Amelia Brown, ABARES

AT A GLANCE…

- World coarse grain indicator prices are forecast to remain historically low in 2017–18 and over the medium term, reflecting abundant world grain stocks.
- Consecutive years of increasing production have resulted in record world stock levels.
- Australian coarse grain production and exports are forecast to fall in 2017–18 but to increase over the medium term.

Outlook for Australian coarse grains to 2021–22

Production to decrease in 2017–18

Total area planted to coarse grains is forecast to fall by 6 per cent in 2017–18 to 5.2 million hectares. This mainly reflects an expected fall in area planted to barley as growers respond to lower barley prices by shifting production to pulse and oilseed crops. Increased competition from livestock production is also expected to constrain area planted to coarse grains. In 2017–18 barley production is forecast to fall by 37 per cent to around 8.5 million tonnes (mt), largely reflecting a return to average yields following the record highs achieved in 2016–17.

Area planted to grain sorghum is forecast to increase in 2017–18 following a significant decline in 2016–17. Demand for grain sorghum for ethanol production is expected to provide some incentive to increase area planted – particularly in southern Queensland, given that the Queensland Government's ethanol mandate came into effect in January 2017.

China's demand for feed grain is expected to weaken over the medium term. But demand for Australian grain sorghum for the production of baijui – an alcoholic spirit distilled mainly from grain sorghum – is expected to grow, providing an alternative market.

Over the medium term, area planted to coarse grains is projected to increase to around 5.7 million hectares by 2021–22. Barley yields are projected to increase by around one per cent a year, reflecting productivity growth, but planted area is expected to remain relatively stable. Total barley production is projected to reach 9 mt by 2021–22.

Area planted to grain sorghum is forecast to increase in 2017–18 after falling sharply in 2016–17 in response to higher cotton prices. Over the medium term, area planted to grain sorghum is forecast to increase modestly.

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Exports record

Total coarse grain exports are forecast to fall in 2017–18, reflecting decreased production. Record high barley production in 2016–17 – combined with Australian barley being competitively priced on the world market – is forecast to lead to record volumes exported in 2016–17.

In 2016–17 exports of Australian grain sorghum are forecast to fall by around 40 per cent. This reflects a forecast 39 per cent fall in production combined with lower feed demand in China, Australia's largest export market. Exports in 2017–18 are forecast to increase in line with increased production.

Australian coarse grain exports are projected to increase gradually over the medium term to 8.0 mt in 2020–21, mainly reflecting growing world demand for feed grain in the livestock sector. Demand for malting barley and grain sorghum for distilling is projected to remain strong over the medium term.

Table 1: Outlook for coarse grains

	unit	2014–15	2015–16s	2016–17f	2017–18f
World					
Area	million ha	325	320	324	319
Yield	t/ha	4.02	3.90	4.11	4.02
Production	Mt	1,306	1,250	1,331	1,282
corn	Mt	1,014	961	1,040	992
barley	Mt	142	149	144	140
Consumption	Mt	1,255	1,266	1,307	1,316
corn	Mt	964	979	1,015	1,021
barley	Mt	143	146	146	145
Closing stocks	Mt	245	246	256	247
Trade	Mt	186	165	186	184
Stocks-to-use ratio	%	19.5	19.4	19.6	18.7
Corn price**a** – nominal	US$/t	174	168	155	157
Barley price**c** – nominal	US$/t	204	173	153	155
Australia					
Area total	'000 ha	5,806	5,802	5,552	5,192
Production total	kt	12,691	12,571	17,215	12,193
Export volume	kt	7,756	6,844	8,560	6,307
Export value – nominal	A$m	2,697	2,280	2,372	2,106
Price – nominal					
feed barley**e**	A$/t	252	237	179	185
malting barley**g**	A$/t	282	274	213	234
grain sorghum**h**	A$/t	301	261	213	221

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.

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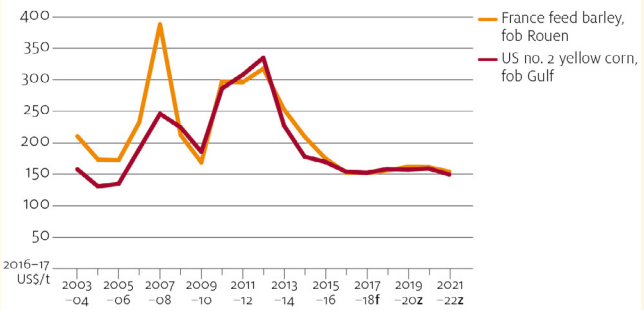
World record supplies to continue to pressure prices

The 2017–18 world coarse grain indicator price (US no. 2 yellow corn, fob Gulf) is forecast to be US$157 a tonne, largely unchanged from the average price in 2016–17.

The world indicator price for barley (France feed barley, fob Rouen) is forecast to average one per cent higher in 2017–18 at US$155 a tonne. These low prices reflect abundant world coarse grain supply and relatively weak demand for coarse grains for industrial use.

World coarse grain indicator prices, 2003–04 to 2021–22



f ABARES forecast. z ABARES projection.

Consecutive years of increasing production have resulted in record world stocks of coarse grains, which is forecast to result in continued low prices. Area planted to coarse grains in 2017–18 is expected to decline in response to lower prices – particularly in the US, Canada and Australia.

In Argentina, devaluation of the peso and removal of export restrictions have improved the competitiveness of Argentine corn on the world market. This has resulted in domestic producers increasing production of coarse grains, particularly corn. Over the medium term, production and exports from Argentina are projected to increase.

In the five years to 2021–22 the rate of growth of global coarse grain demand, particularly corn for industrial use, is expected to be slower than between 2006–07 and 2015–16. The expansion of the US ethanol industry will be limited over the outlook period as a result of US biofuel policies and constraints on ethanol consumption. Demand for coarse grains for livestock feed has trended upwards since 2009–10, reflecting increasing demand for livestock products in developing countries.

This is expected to be the main source of growth in world coarse grain consumption over the outlook period.

World coarse grain prices are forecast to remain at historically low levels over the medium term because growth in supply is projected to increase to balance growing demand. Demand for livestock feed is expected to increase over the outlook period, driven predominantly by expanding world livestock industries. Demand for grain for human consumption is also expected to increase over the medium term in line with population growth and rising incomes in developing countries.

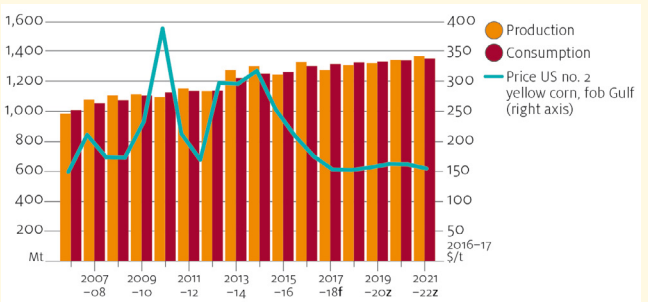
World coarse grain stocks are projected to fall in the short term – providing some support for prices – but to recover towards the end of the outlook period.

Global production

In 2017–18 world production of coarse grains is forecast to fall by three per cent to 1.28 billion tonnes, reflecting a reduction in area planted. Area planted to corn, particularly in the US and China, is forecast to contract in response to lower prices.

Over the remainder of the outlook period, growth in world coarse grain production is projected to resume and reach 1.37 billion tonnes in 2021–22.

World coarse grain use, 2006–07 to 2021–22



f ABARES forecast. z ABARES projection.

Corn

World corn production is forecast to fall by five per cent in 2017–18 to 992 mt because lower prices are expected to lead to a contraction in area planted in major producing countries. Corn production in the US is forecast to fall by seven per cent to 359 mt in 2017–18. This fall reflects a reduction in area planted and yields returning to the long-term average after reaching record highs in 2016–17.

In Argentina, area planted to corn in 2017–18 is forecast to fall to

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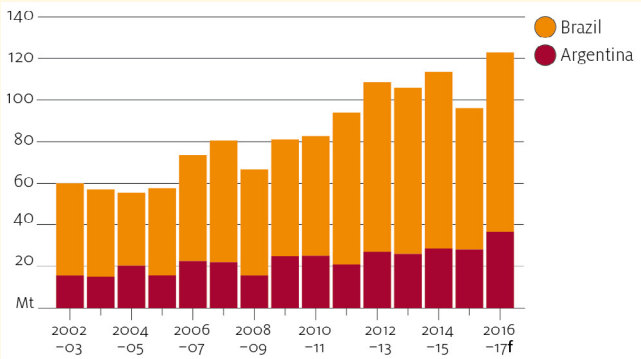
4.4 million hectares. This is two per cent lower than the record set in 2016–17 but would be the second-highest level on record, resulting from producers continuing to take advantage of the Argentine Government's decision to remove export restrictions and taxes on corn. Average yields in Argentina are assumed to fall slightly from 2016–17, with overall production forecast to be marginally lower.

Brazilian corn production has increased by 70 per cent over the past 10 years, boosted by record harvests of its safrinha (second-season) crop. The crop is expected to account for two-thirds of 2016–17 production.

Second-season crop yields have been trending upwards but are more susceptible to production risks than first-season crop yields. This is because the safrinha crop is planted after the soybean harvest, and if the soybean harvest is delayed the chance of sufficient rainfall throughout the safrinha growing season decreases. Safrinha planted area is expected to continue to increase over the projection period as a result of the Brazilian Government's minimum price guarantee programme.

Corn production in Brazil is forecast to increase by around one per cent in 2017–18 to a record 86.5 mt.

Corn production, Argentina and Brazil, 2002–03 to 2016–17



f ABARES forecast.

Production of corn in China is forecast to fall for the second consecutive year in 2017–18 to around 206.6 mt, reflecting a further decline in area planted. In 2016–17 area planted to corn fell in response to the Chinese Government's March 2016 removal of the corn price support scheme. The scheme had resulted in a large build-up of domestic corn stocks and a sharp increase in imports of cheaper alternatives such as barley and sorghum.

Over the medium term, world corn production is projected to increase from 2018–19 onwards to around 1.1 billion tonnes in 2021–22. Production increases are expected to come mainly from yield improvements because availability of land for crop expansion in major developed countries is limited

Corn consumption is projected to increase in line with growing world population and rising incomes in developing countries, leading to increased demand for meat and consequently for feed grains in the livestock sectors.

Barley

World barley production in 2017–18 is forecast to decline by three per cent, reflecting a fall in area planted and an assumed return to average yields. Production decreases in Australia and Canada will be partially offset by production increases in the European Union.

EU production is forecast to increase by two per cent in 2017–18, with yields assumed to return to average after poor seasonal conditions in 2016–17. Area planted to barley is forecast to remain largely unchanged from the previous year.

World barley production over the medium term is projected to increase as area planted to barley increases modestly and average yields continue to trend upwards.

Area planted to barley in Australia, Canada and the European Union is expected to remain largely unchanged, reflecting low prices.

Area planted in Argentina and the Black Sea region is expected to increase modestly over the medium term, reflecting supportive government policies.

Demand for barley is forecast to increase in line with world population growth and rising incomes in developing countries, leading to increased demand for meat and consequently feed grains. Increasing world beer consumption is expected to result in the continued increase in demand for malting barley.

Global consumption

World consumption is forecast to remain at 1.3 billion tonnes in 2017–18 and continue to grow over the medium term. This mainly reflects an increase in demand for feed grains in world livestock production. Industrial use of barley is also expected to grow but at a slower rate, largely reflecting the increase in demand for malting barley for beer production.

Corn

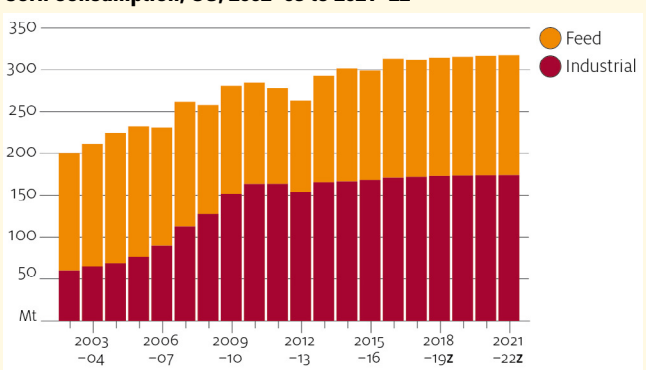
World consumption of corn is forecast to increase by only one per cent in 2017–18, largely as a result of the slowdown in use of corn for industrial purposes.

In 2017–18 US corn consumption is forecast to fall marginally from a record high, reflecting a reduction in demand. Growth in US corn consumption over the medium term is expected to be driven primarily by demand from the livestock sector as production of beef, pork and broiler meat continues to increase.

Growth in US corn consumption was strong over the decade to 2015–16, primarily as a result of the US Government Renewable Fuel Standard (RFS) programme.

The RFS programme ensures US consumption of ethanol will continue to increase, but the rate of growth is expected to remain relatively low over the medium term.

Corn consumption, US, 2002–03 to 2021–22



z ABARES projection.

Corn consumption in China is forecast to increase by two per cent to 231 mt in 2017–18. This reflects an expected increase in use of corn in livestock feed following Chinese Government measures to reduce national corn stocks. It removed the domestic corn price support scheme

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in early 2016 – which improved corn's competitiveness – and is paying subsidies to encourage use of domestic corn.

Over the medium term, world consumption of corn is projected to increase by around one per cent a year to 1,046 mt by the end of the outlook period.

This is expected to be driven by growth in world livestock production in response to growing world population, evolving diets and higher incomes – especially in developing countries, particularly in China.

Barley

World consumption of barley is forecast to fall by around one per cent in 2017–18, reflecting decreased production and abundant supply of feed grain substitutes, such as wheat and corn. Demand for malting barley is forecast to remain strong as beer consumption continues to increase, particularly in East Asia.

Consumption of barley in China is forecast to fall by 13 per cent to 6.1 mt in 2017–18, reflecting policy changes that encourage use of domestic corn over imported feed grains. Demand for malting barley remains strong and consumption is expected to increase in 2017–18.

Over the medium term, consumption of barley is projected to increase by around 1 per cent a year to 152 mt in 2021–22. This growth is expected to be driven by demand for malting barley as a result of increasing world beer consumption and increased demand for barley in livestock feed during the outlook period.

Global trade in coarse grains

World trade in coarse grains is forecast to fall by one per cent to 184 mt in 2017–18. Trade in corn and barley is expected to be lower than the high levels associated with record global production in 2016–17. US corn exports are forecast to fall by around 13 per cent in 2017–18 to 49 mt. This is expected to be partially offset by increased exports from Argentina and Brazil. World trade in barley is forecast to remain unchanged as lower exports from Australia are offset by the return of EU exports to normal levels after poor seasonal conditions reduced supply in 2016–17.

Over the medium term, world trade in corn is projected to increase – primarily reflecting increased demand for livestock feed. World trade in barley is projected to grow to 33 mt in 2021–22.

This mainly reflects expected growth in world demand for barley for malt production. Demand for barley for use in feed grains is also projected to grow but at a slower rate than for malt production.

World stocks

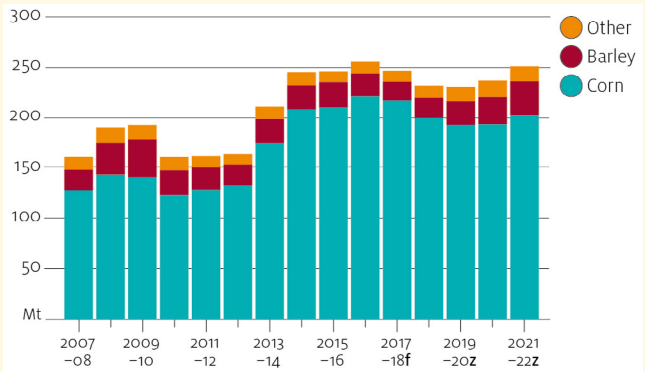
World coarse grain closing stocks are forecast to fall by five per cent in 2017–18 to 247 mt as continued growth in world coarse grain consumption outpaces production.

World closing stocks of corn are forecast to fall by four per cent in 2017–18 to 217 mt. This fall mainly reflects a drawdown of stocks in China, the European Union and the US.

World closing stocks of barley are forecast to fall by 20 per cent in 2017–18 to 19 mt, reflecting forecast lower production in major producing countries.

Over the medium term, world coarse grain stocks are expected to tighten in the first three years of the projection period as consumption growth outpaces increases in production. Towards the end of the projection period, stocks are expected to increase slightly as projected increases in production exceed consumption.

World coarse grain stocks, 2007–08 to 2021–22



f ABARES forecast. z ABARES projection.

Source: ABARES 2017, Agricultural Commodities: March quarter 2017. CC BY 3.0. ■

Domestic and global oilseeds outlook

By James Fell, ABARES

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.
- Over the outlook period to 2021–22 prices are projected to fall because of a continuation of strong yield gains and area expansion in South America.
- Production is expected to rise over the outlook period due to growth in South America. This is despite a projected price-led drop in planted area in other key soybean- and rapeseed-producing countries.
- In Australia, canola plantings are forecast to rise in 2017–18, reflecting better returns to producers compared with other cropping alternatives.

Outlook for Australian oilseeds to 2021–22

Price incentives to support canola plantings

Area planted to canola is forecast to increase in 2017–18, reflecting favourable expected relative prices in the upcoming planting window. In contrast to wheat and barley, local canola prices have risen compared with March 2016. But actual area planted to canola will depend on the timing of rainfall in autumn, with early rainfall supporting plantings. Assuming an average yield of 1.3 tonnes per hectare, production is forecast to fall by one per cent to 3.7 million tonnes (mt) in 2017–18 after record yields in 2016–17.

Over the medium term, increases in the sheep flock are projected to reduce area planted to canola. This follows an initial increase in area planted in 2017–18 in response to strong canola prices. Assuming modest yield growth in line with historical trends, production is projected to remain largely unchanged at 3.7 mt in 2021–22.

Domestic consumption of canola is projected to continue growing over the medium term, reflecting local oil and meal demand. But Australia's overall oilseed meal production is insufficient to meet domestic oilseed meal requirements. Over the medium term, imports of oilseed meal are projected to increase by one per cent a year to 808,000 tonnes, driven by demand from Australia's growing meat and dairy industries. But growth is expected to be slower than in recent years due to above average cottonseed production.

Prices of wheat, barley and canola, March 2016 to January 2017

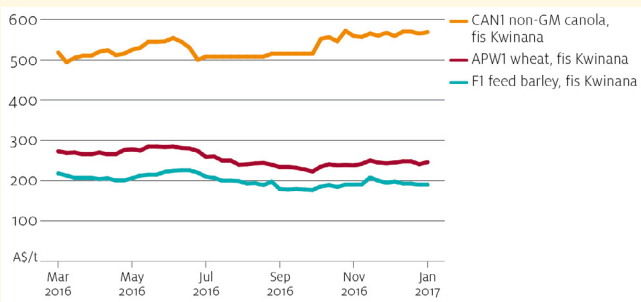


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Table 1: Outlook for oilseeds

	unit	2014–15	2015–16s	2016–17f	2017–18f
World					
Oilseeds					
Production	Mt	537	522	555	555
Consumption	Mt	517	526	546	556
Exports	Mt	147	153	157	158
Closing stocks	Mt	93	89	97	96
Indicator price **ba**	US$/t	418	373	390	382
Canola indicator price **bc**	US$/t	424	415	425	418
Protein meals					
Production	Mt	299	306	320	324
Consumption	Mt	294	305	318	326
Exports	Mt	85	87	92	98
Closing stocks	Mt	15	17	18	16
Indicator price **bd**	US$/t	427	345	349	350
Vegetable oils					
Production	Mt	176	176	187	190
Consumption	Mt	173	178	186	190
Exports	Mt	77	75	78	80
Closing stocks	Mt	20	19	19	19
Indicator price **be**	US$/t	808	742	879	887
Australia					
Oilseed production	kt	4,376	3,923	5,709	5,373
Oilseed exports	kt	2,617	2,102	3,258	3,231
Canola					
Area	'000 ha	2,897	2,357	2,327	2,800
Production	kt	3,540	2,944	4,144	3,690
Export volume **g**	kt	2,445	1,946	3,063	2,849
– nominal	A$m	1,349	1,097	1,749	1,637
Price **bi**	A$/t	484	542	530	532

a US no.2 soybeans, fob Gulf. **b** In 2016–17 US dollars. **c** Rapeseed, Europe, fob Hamburg, July–June. **d** Soybean meal, cost insurance and freight, Rotterdam, 45 per cent protein. **e** Soybean oil, Dutch, free on board ex-mill. **f** ABARES forecast. **g** July–June. **h** In 2016–17 Australian dollars. **i** Delivered Melbourne, July–June. **s** ABARES estimate. **z** ABARES projection.
Sources: ABARES; Australian Bureau of Statistics; US Department of Agriculture

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Canola exports to remain strong

Australian canola exports are forecast to fall by seven per cent in 2017–18 to 2.8 mt, reflecting lower production. Over the medium term, canola exports are projected to remain around 2.8 mt, reflecting largely stable production and steady international demand.

The value of Australian canola exports is forecast to fall by six per cent to $1.6 billion in 2017–18, reflecting lower volumes. Over the outlook period to 2021–22, the value of Australian canola exports is projected to average $1.5 billion in real terms – 33 per cent above the 10-year average.

Market for Australian oilseed meals

Processing oilseeds transforms the seed into two products – meal and oil. Oilseed meal is used as a protein source in livestock feed and complements carbohydrate sources such as feed wheat, barley and grain sorghum. Demand for meal is driven by growth in the livestock sector. Meal is also used in aquaculture and pet food.

Oilseed meals include soymeal, canola meal, cottonseed meal, copra, palm kernel meal, peanut meal and sunflower seed meal. Each oilseed meal has different characteristics (for example, protein content, fibre content and digestibility).

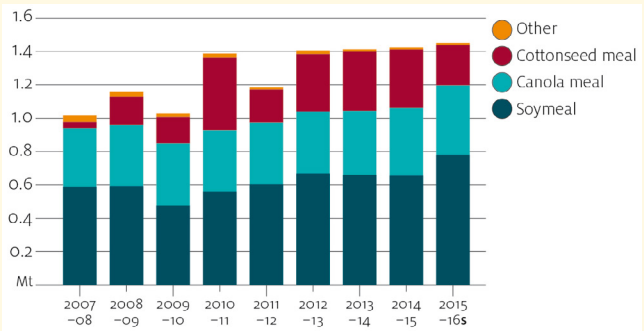
Soymeal prices are consistently higher than rapeseed (including canola) meal on international markets, and Australian importers prefer soymeal over any other protein meal.

Soymeal represents a large share of protein meal inputs in the pig and chicken meat industries as a result of its high crude protein content and high digestible energy content for those animals. Beef cattle diets comprise high fibre oilseeds and meals such as whole cottonseed or cottonseed meal. In Australia, the beef feedlot sector's proximity to cotton gins and processors increases the attractiveness of cottonseed and meal because of reduced transportation costs.

The main protein meal for the dairy industry is canola meal, with the majority of the herd in close proximity to major canola-producing and canola-processing regions in south-east Australia.

Over the decade to 2015–16 Australia's consumption of oilseed meal has risen by 40 per cent to an estimated 1.4 mt. Soymeal consumption is estimated at around 782,000 tonnes, canola meal at 415,000 tonnes and cottonseed meal at around 242,000 tonnes. The estimates for cottonseed meal include the meal-equivalent volume of whole cottonseed, which can be fed in a raw form after ginning.

Consumption of oilseed meal, Australia, 2007–08 to 2015–16



s ABARES estimate.
Note: Cottonseed meal includes meal equivalent of whole cottonseed used as feed.

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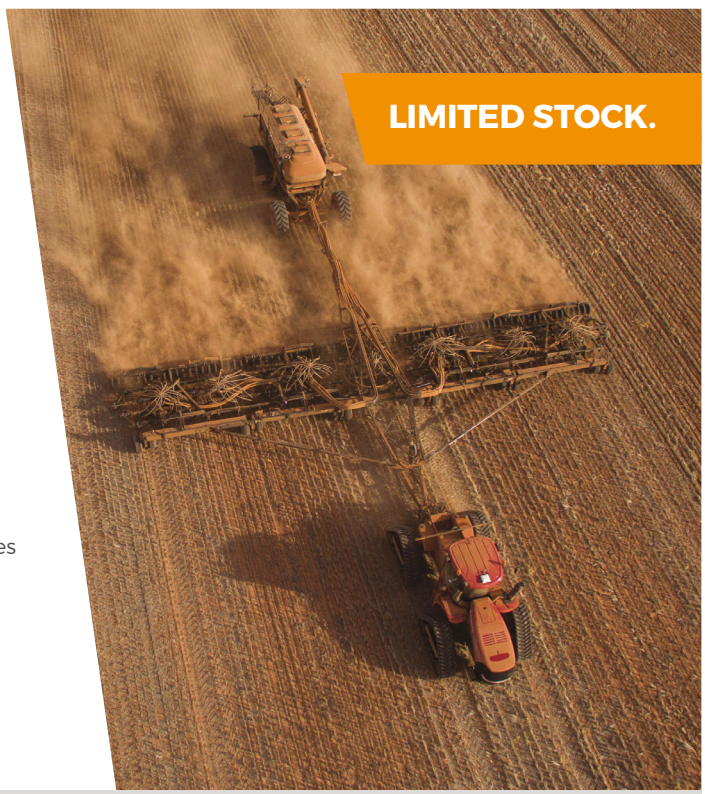

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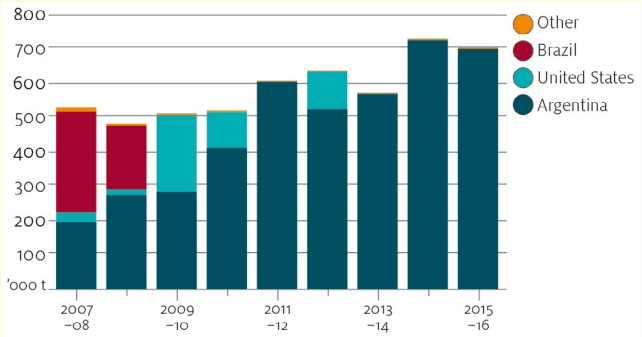
Australia produces mainly canola meal and cottonseed meal. Domestic production of oilseed meals is insufficient to meet demand and so is supplemented by imports. Soymeal fills the shortfall in local supply.

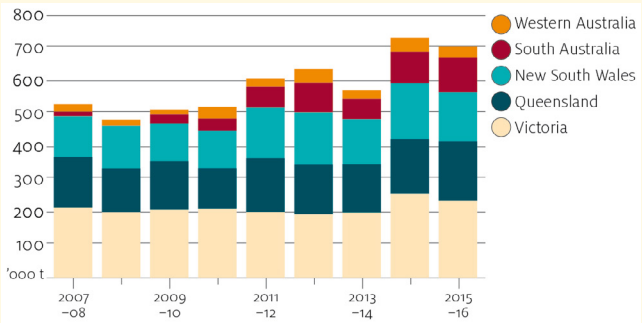
In 2015–16 Australia imported 706,000 tonnes of soymeal (mostly from Argentina) and only negligible volumes of other oilseed meals.

Australian soymeal imports, by country, 2007–08 to 2015–16



Over the decade to 2015–16 oilseed meal imports increased as protein meal demand rose with increases in chicken meat, egg and beef feedlot production. But the increase in imports was limited by a large increase in domestic cotton production, which enabled substitution to cottonseed meal.

Australian soymeal imports, by state, 2007–08 to 2015–16



Soymeal is mostly imported into the east coast states, where livestock feeding industries are based. Victoria is the largest importer of soymeal, with major livestock feed industries for chicken meat, layer hens, pigs and dairy. New South Wales and Queensland import significant volumes to meet the needs of the pig, chicken meat and layer hen industries and the beef feedlot sector.

South American production growth to push prices down

The world oilseed indicator price (US no. 2 soybeans, fob Gulf) is forecast to fall by two per cent in 2017–18 to average US$382 a tonne. An increase in supplies (opening stocks plus production) is expected to affect global soybean prices. This follows expected bumper 2016–17 oilseed crops in South America, which will be harvested through to June 2017.

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Bumper oilseed harvests in the current global crop will put prices under pressure but still above the 10-year average.

The world canola indicator price (Europe rapeseed, fob Hamburg) is forecast to fall by two per cent in 2017–18 to average US$418 a tonne, reflecting improved supplies of high oil-bearing oilseeds in major exporting and importing countries. Prices of vegetable oil are likely to be affected by improved harvests of palm oil in South-East Asia, following a recovery from earlier El Niño conditions. This is expected to reduce processing margins, and consequently, demand for canola.

Prices in real terms are projected to fall over the medium term despite a small upward turn towards the end of the outlook period. Continued expansion of area planted to oilseeds in South America and growth in yields are expected to affect prices. A small increase in prices towards the end of the period will be supported by growth in underlying demand for meal and vegetable oil.

A reduction in the area planted to soybean and rapeseed (including canola) is also expected in response to overall projected prices.

Oilseed prices in real terms are projected to fall but will remain above the 10-year average to 2007–08.

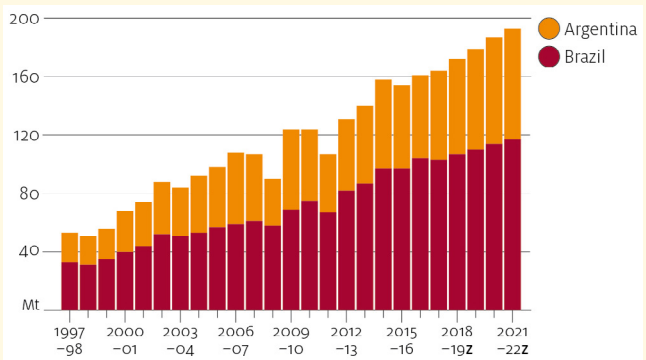
South America to drive oilseed production over medium term

World oilseed production is forecast to rise slightly in 2017–18 to 555 mt, largely due to increases in cottonseed and rapeseed production. Globally, rapeseed (including canola) production is forecast to increase by three per cent to 70 mt, mainly reflecting an assumed improvement in seasonal conditions in the European Union.

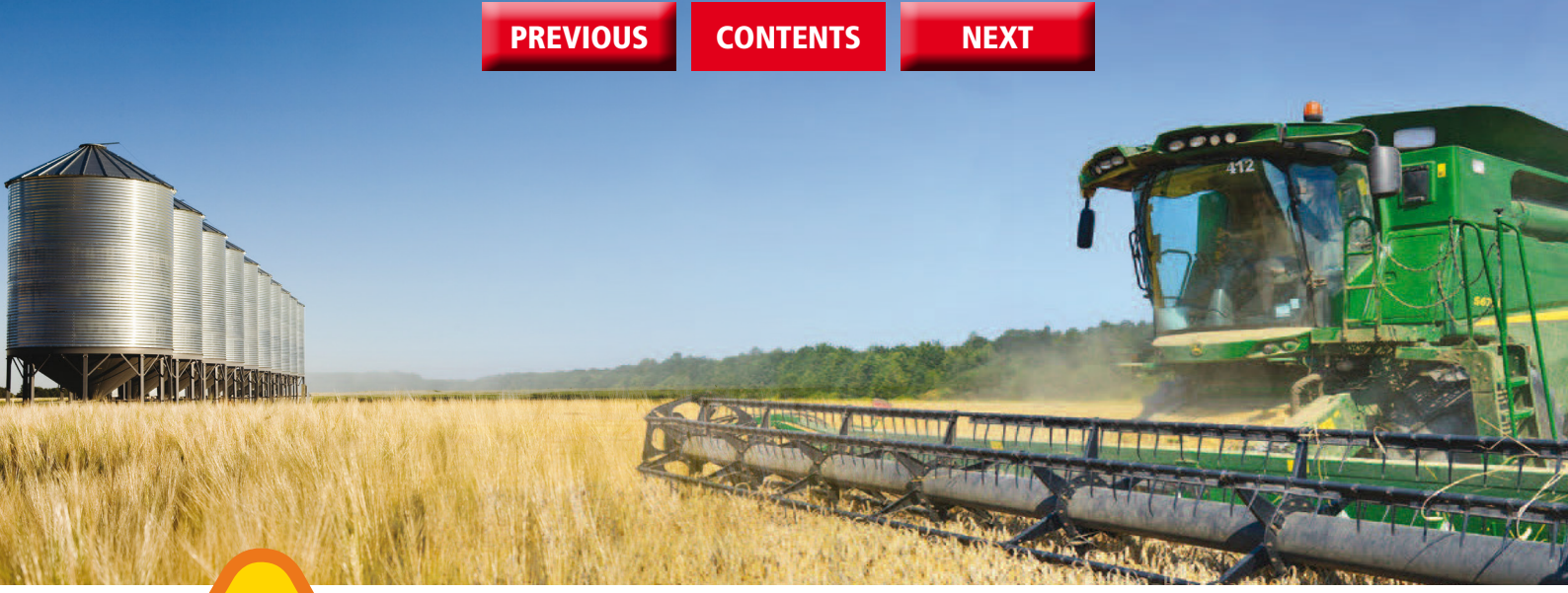
Over the medium term, global production is projected to continue its long-term upward trend. Soybeans dominate global oilseed markets.

In South America, soybean producers will continue a long-run trend to increase area planted. Average yields grew by two per cent a year in Brazil and four per cent a year in Argentina over the decade to 2015–16. In Argentina, production growth is expected to be boosted towards the end of the outlook period when export taxes are lowered. In Brazil, area

Soybean production in Brazil and Argentina, 1997–98 to 2021–22



z ABARES projection.



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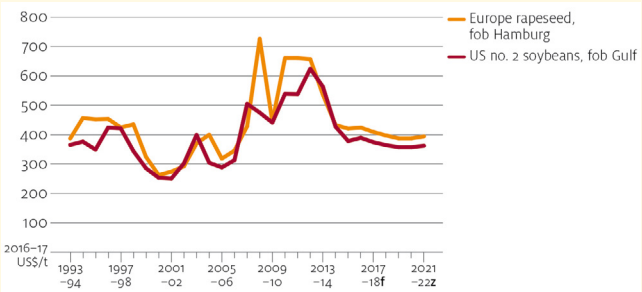
World oilseed indicator prices, 1993–94 to 2021–22



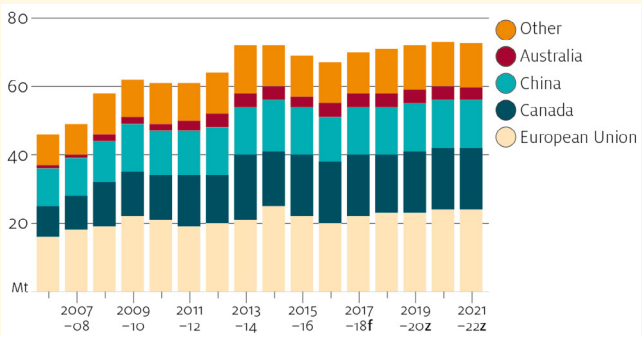
f ABARES forecast. z ABARES projection.

planted is projected to expand, but growth in area planted is projected to slow in response to low prices.

In contrast, area planted in the US is projected to fall in response to the overall weakening of prices over the medium term.

World rapeseed (including canola) production is projected to grow by one per cent a year to 73 mt by 2021–22 as a result of projected growth in yields. But world harvested area is projected to be lower over the medium term as low crop prices relative to sheep and beef cattle encourage a shift to livestock production where possible, particularly in Australia and Canada.

World rapeseed (including canola) production, 2006–07 to 2021–22



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Crush demand and ample supplies to underpin consumption

World consumption of oilseeds, predominantly for crush (processing use), is forecast to rise by two per cent to 556 mt in 2017–18. This is in response to ample supplies of oilseeds globally and generally favourable crush margins due to robust oilseed product demand.

Assumed continued growth in global livestock product demand is forecast to raise consumption of oilseed meal by three per cent in 2017–18 to 326 mt.

Soymeal is the largest component of world oilseed meal, with China as its top consumer. China's soymeal consumption grew by an average of 9 per cent a year over the decade to 2015–16. But this rate is projected to slow over the medium term as softer economic growth limits increases in consumption of livestock products.

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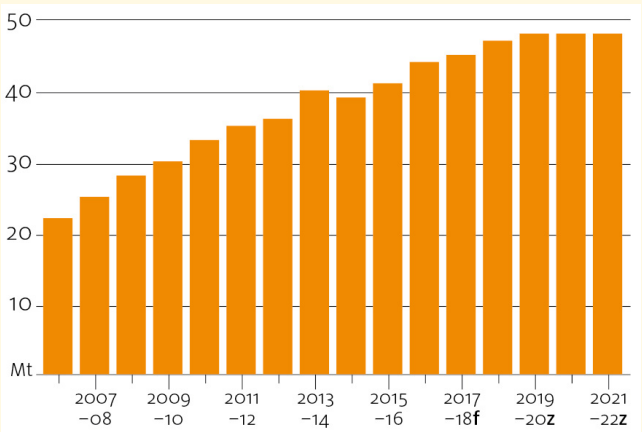
World vegetable oil consumption is forecast to rise by two per cent a year to 190 mt in 2017–18. This reflects an increase in food and industrial uses consistent with growth in recent years. Global food demand for vegetable oils has been increasing in line with population growth and rising incomes in developing economies.

Over the medium term, growing demand for vegetable oils and meal is expected to provide favourable incentives for processors to increase demand for oilseeds for crushing. Seed availability is expected to be ample. Consumption of oilseeds (mainly for crush) is projected to rise by two per cent a year to 608 mt in 2021–22.

For oilseed meals, assumed economic growth in developing economies is projected to raise demand for livestock products, which require protein meals as an input.

Global demand for vegetable oils for biodiesel and food use is projected to rise over the medium term. But growth is projected to slow significantly after 2019–20 as the current biodiesel policy framework in the European Union expires. US biodiesel production is expected to increase, using animal fats and recycled oils rather than vegetable oil.

World vegetable oil industrial use, 2006–07 to 2021–22



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Trade to rise, stocks to fall

World oilseed exports are forecast to increase slightly to 158 mt in 2017–18, supported by ample supplies in major exporting countries and growth in demand for soybeans in importing countries.

World rapeseed (including canola) trade is forecast to increase slightly to 14 mt, largely due to an increase in availability in Australia and Ukraine.

Trade in oilseeds over the medium term is expected to be shaped by large harvests in South America and importers' crush (processing) needs. World trade in oilseeds is projected to rise by one per cent a year to 167 mt in 2021–22. The reduction in soybean export taxes in Argentina is expected to increase export volumes from that country.

Over the outlook period, weak projected growth in demand for rapeseed in EU biodiesel production will dampen world trade in rapeseed (including canola).

This is because EU processors have shown a preference for imported vegetable oil – particularly palm oil and soy oil – over seed.

Stocks to fall but remain ample World closing stocks of oilseeds are forecast to decline slightly to 96 mt in 2017–18, reflecting a fall in global production and growth in consumption.

Of this total, rapeseed (including canola) stocks are forecast to fall slightly to 5.7 mt. Over the medium term, closing stocks are projected to decline but remain above the long-term average.

Source: ABARES 2017, Agricultural Commodities: March quarter 2017. CC BY 3.0. ■

Big yields in 2016 and implications for soil nutrition this year

AT A GLANCE...

- A series of nutrient trials conducted in high rainfall cropping zones in 2016 is showing high levels of nutrient removal with high yields.
- Lead researcher on this soil nutrition project, Dr Malcolm McCaskill, Soil Research Scientist with DEDJTR Victoria, previews some early results and discusses what will it take to restore soil fertility for 2017.

We have seen some eye popping nutrient removals recently in a new joint research project between GRDC, Agriculture Victoria, Southern Farming Systems, the MacKillop Farm Management Group and SARDI.

In some cases, the full replacement of these losses would require over half a tonne per hectare of urea and a quarter of a tonne per hectare of muriate of potash.

The project is examining the responses of wheat and canola to various nutrients and includes an 'All nutrients' and a 'Nil nutrients' comparison.

As part of our work, we sent samples of grain and stubble from the All and Nil treatments to the Nutrient Advantage laboratory for analysis.

At Inverleigh the wheat trial, in early November 2016, showed little visual difference between the Nil treatment (left) and the All treatment (right).

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Table 1: Nutrient replacement budgets following wheat at Inverleigh, Victoria, 2016

Crop component	Dry matter (t/ha)	Nutrient (kg/ha)					
		N	P	K	S	Cu	Zn
All treatment							
Grain	9.8	203	24	36	13	0.055	0.155
Stubble	10.8	62	5	196	11	0.057	0.039
Replacement if burned		254	26	114	20	0.077	0.171
Nil treatment							
Grain	9.6	159	22	33	10	0.098	0.108
Stubble	10.3	37	3	111	6	0.043	0.037
Replacement if burned		189	23	77	14	0.115	0.123

Note: N=nitrogen; P=phosphorus; K=potassium; S=sulphur; Cu-copper; and, Zn=zinc.
All = 133 kg/ha of N, 50 kg/ha of P, 50 kg/ha of K, 20 kg/ha of S, 1.1 kg/ha Zn and 2 kg/ha of Cu.
Nil = 30 kg/ha of N. Wheat grain yield is shown at 12% reference moisture, and stubbles at 100°C drying.

This exercise showed us that nutrient quantities in grain are highly variable.

We believe it is worth collecting grain samples at harvest and arranging nutrient balance analysis. Relying on standard values may lead to over or under fertilisation.

The following information is a selection of the data, showing nutrient replacement budgets for the All and Nil treatments.

In estimating nutrient replacement, we have used literature values to estimate the proportion of stubble nutrient lost during burning, but all other values are from field measurements.

The canola trial at Bool Lagoon, SA, in late October 2016, showing (from left to right) Nil, All potassium, All phosphorus, and All-micronutrients (copper and zinc). The trial showed grain yield responses to nitrogen, phosphorus and sulphur.

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Table 2: Nutrient replacement budgets following canola at Bool Lagoon, SA, 2016

Crop component	Dry matter (t/ha)	Nutrient (kg/ha)					
		N	P	K	S	Cu	Zn
All treatment							
Grain	1.9	63	13	17	6	0.219	0.060
Stubble	5.0	49	6	73	11	0.005	0.027
Replacement if burned		103	15	46	13	0.221	0.071
Nil treatment							
Grain	1.0	27	6	8	2	0.003	0.022
Stubble	2.2	11	2	32	7	0.002	0.014
Replacement if burned		36	7	21	7	0.004	0.027

Note: All = 251 kg/ha of N, 50 kg/ha of P, 50 kg/ha of K, 20 kg/ha of S, 1.1 kg/ha of Zn and 2 kg/ha of Cu.
Nil = 30 kg/ha of N. Canola grain yield is shown at 6 per cent reference moisture, and stubbles at 100°C drying.

Inverleigh, Victoria (Table 1)

This site was highly fertile before sowing. A wheat yield of 9.8 tonnes per hectare at 13.6 per cent protein was achieved in the All treatment, compared with 9.6 tonnes per hectare at 10.9 per cent protein for the Nil treatment.

Nutrient replacement was estimated at 254 kg per hectare of nitrogen, 26 kg per hectare of phosphorus and 114 kg per hectare of potassium for the All treatment.

Due to the site's high soil fertility, it would not be necessary to replace all this nutrient through fertiliser in the following year. Nevertheless, soil mineral nitrogen to a depth of 60 cm declined from 390 kg per hectare of nitrogen prior to sowing to 163 kg per hectare of nitrogen after harvest on the All treatment, and to 109 kg per hectare of nitrogen on the Nil treatment.

Table 3: Nutrient replacement budgets following canola at Tarrington, Victoria, 2016

Crop component	Dry matter (t/ha)	Nutrient (kg/ha)					
		N	P	K	S	Cu	Zn
All treatment							
Grain	5.4	176	26	36	19	0.247	0.174
Stubble	10.8	87	5	92	37	0.005	0.076
Replacement if burned		247	28	73	44	0.249	0.205
Nil treatment							
Grain	2.4	78	10	15	8	0.161	0.075
Stubble	7.4	39	2	71	21	0.004	0.027
Replacement if burned		109	11	44	23	0.162	0.086

Note: All = 215 kg/ha of N, 50 kg/ha of P, 50 kg/ha of K, 20 kg/ha of S, 1.1. kg/ha of Zn and 2 kg/ha of Cu.
Nil = 30 kg/ha of N. Canola grain yield is shown at 6 per cent reference moisture, and stubbles at 100°C drying.

Bool Lagoon, South Australia (Table 2)

The canola trial at Bool Lagoon showed significant (about double) yield responses in the All treatment compared with the Nil treatment.

The site was inundated for over four weeks, restricting nutrient uptake. A final nitrogen application was used in the All treatment shortly after the inundation finished.

Replacement nutrients for the All treatment were estimated at 103 kg per hectare of nitrogen, 15 kg per hectare of phosphorus and 13 kg per hectare of sulphur. These nutrients would need to be replaced for the 2017 growing season.

Replacement potassium was not recommended because no potassium responses were observed at the site and the soil showed high levels of available potassium (greater than 1000 mg per kg).

Tarrington, Victoria (Table 3)

The All treatment resulted in a high yielding canola crop (5.4 tonnes per hectare) on the well-drained site at Tarrington (near Hamilton) last year. The Nil treatment yielded 2.4 tonnes per hectare.

We estimated replacement nutrients for the All treatment at 247 kg per hectare of nitrogen, 28 kg per hectare of phosphorus, 73 kg per hectare of potassium and 44 kg per hectare of sulphur.

Post-harvest mineral nitrogen samples (0–60 cm) showed soil nitrogen levels had been depleted to 88 kg per hectare of nitrogen beneath the All treatment, compared with 380 kg per hectare of nitrogen before sowing.

Unless the harvested nutrients are replaced in 2017, crop yields may be similar to the Nil treatment of 2016.

Table 4: Nutrient replacement budgets following canola at Rutherglen, Victoria, 2016

Crop component	Dry matter (t/ha)	Nutrient (kg/ha)					
		N	P	K	S	Cu	Zn
All treatment							
Grain	0.7	23.0	3.9	5.3	1.8	0.008	0.017
Stubble	3.1	23.1	2.2	53.4	4.7	0.002	0.027
Replacement if burned		41.9	4.9	26.7	5.0	0.009	0.028
Nil treatment							
Grain	0.2	4.5	1.4	1.5	0.4	0.009	0.004
Stubble	0.7	2.1	0.3	7.7	1.1	0.001	0.003
Replacement if burned		6.2	1.5	4.6	1.1	0.009	0.005

Note: All = 396 kg/ha of N, 50 kg/ha of P, 50 kg/ha of K, 20 kg/ha of S, 1.1 kg/ha of Zn and 2 kg/ha of Cu.
Nil = 30 kg/ha of N. Canola grain yield is shown at 6 per cent reference moisture, and stubbles at 100°C drying.

Rutherglen, Victoria (Table 4)

Prolonged waterlogging followed by rapid drying of the soil during grain fill led to low canola yields, a low harvest index and small grain sizes in the Rutherglen trial.

Large amounts of nitrogen from the All treatment at this site are

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thought to have been leached or denitrified. Soil testing to a depth of one metre post-harvest showed there was only 29 kg per hectare more mineral nitrogen under the All treatment than the Nil treatment. Most of this was in the 60–80 cm layer.

Where there is a risk of nitrogen being leached through the profile, the safest place for nitrogen is in the plant and applied early.

To sum up

A focus on restoring fertility in 2017 will be essential for many growers who harvested high yielding crops in 2016.

Even in low yielding crops – like the Rutherglen site affected by waterlogging – there may have been significant leaching losses depleting mobile nutrients such as nitrogen and sulphur, or nitrogen losses through denitrification.

Across our two wheat trials, nutrient replacement was estimated at 22 kg N per tonne of grain, 3 kg P per tonne and 8 kg K per tonne. This includes an allowance for nutrient losses during stubble burning.

Across our four canola trials, nutrient replacement was estimated as 42 kg N per tonne of grain, 6 kg P per tonne and 20 kg K per tonne.

Nutrient removal rates (kg per tonne) in our study varied almost two-fold, so grain testing is advisable to understand your nutrient balance. If that is not possible, arrange soil testing to quantify nutrient depletion.

Funding for this project is from GRDC, Agriculture Victoria and IPNI. The research team includes Amanda Pearce (SARDI, Struan), Aaron Vague (Southern Farming Systems, Inverleigh), Brendan Christy (Agriculture Victoria, Rutherglen), Rob Norton (IPNI, Horsham), and Penny Riffkin (Agriculture Victoria, Hamilton).

THE NITROGEN TANK IS ON EMPTY

Early indications suggest many cropping systems are running low on nitrogen and will need significant applications of fertiliser before mid-winter to support yield and quality targets this season.

Check soil reserves

An analysis of deep N soil tests from the Nutrient Advantage laboratory is showing many paddocks are very low in soil nitrogen.

A total of 1201 soil samples (10–60 cm) from Queensland, New South Wales, Victoria and South Australia were analysed for nitrogen by the Nutrient Advantage laboratory in January and February 2017.

Of these, 46 per cent had less than 3 mg per kg of nitrate nitrogen. That's less than 25 kg per hectare of plant available nitrogen in the main root zone. In short the nitrogen tank is running on empty.

At this level, crop yields would be capped at around 1.5 tonnes per hectare of APW grade wheat or 1.75 tonnes per hectare of malting barley without nitrogen fertiliser assuming some contribution from mineralisation.

While there were some deep N tests with higher nitrogen levels, the average was 6 mg per kg of nitrate nitrogen and 1 mg per kg of ammonium nitrogen.

Deep N soil testing is the best way to quantify carry over nitrogen reserves from 2016 plus any mineralised nitrogen over summer so that a nitrogen fertiliser strategy can be set for this season.

Do not rely on the averages or gut feel. Arrange a soil test before sowing.

Account for mineralisation

Mineralisation from the organic pool is a major source of nitrogen for grain crops, but recent research shows we need to be careful not to over-estimate its contribution.

John Angus from CSIRO showed declining levels of nitrogen from mineralisation in modern continuous cropping systems in his 2013 research. He suggested that nitrogen fertiliser rates on dryland crops would need to double in about four decades to make up the deficit.

Mineralisation of nitrogen tends to be highest when soils are warm and wet. This is typically in late spring, while the crop demand for nitrogen tends to peak in late winter.

Potential mineralisation can be estimated using soil surface (0–10 cm) organic carbon and total nitrogen tests.

Consider yield potential

Following an excellent spring in most southern regions, subsoil moisture levels are likely to be at or ahead of the average for this time of year.

We have seen in past seasons how good levels of stored soil moisture can help with growing useful crops in quite dry years or getting the crop home in a tight finish.

Where good levels of subsoil moisture are available it makes sense to plan for good yields rather than delaying fertiliser applications.

Consider protein premiums

There have been some significant protein premiums on offer for wheat delivered in the 2016–17 season.

While it is impossible to predict the future, it is a good idea to set crops up so they have the potential to achieve high protein if it makes economic sense to do so.

Remember that the crop must first reach its yield potential before additional nitrogen can effectively increase grain protein.

Plan to supply early nitrogen

How do we ensure there is enough nitrogen in the crop's root zone before the peak demand period in mid-winter?

While we don't know what the 2017 season will be like, the current short term rainfall outlook from the Bureau of Meteorology is indicating that in-crop nitrogen application options may be limited.

There are a range of ways to supply high rates of nitrogen fertiliser with minimal risk.

Growers can pre-drill urea, band high rates of nitrogen away from the seed at planting, either as urea, liquid or gas or topdress soon after sowing.

Consider the potential for each timing and application method or use a combination of strategies.

Where soil profile nitrogen levels are very low, aim to supply most of the predicted crop nitrogen requirement by early tillering in cereals or 8-leaf stage in canola. If seasonal prospects improve or protein premiums increase, additional nitrogen can be topdressed later in crop.

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 2016 for example, is an estimate for the crop harvested in the 2016–17 financial year.
- (Mt = 1,000,000 tonnes) (Kt = 1000 tonnes)

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Biggest winter crop ever produced

Generally favourable seasonal conditions pushed Australian winter crop production in 2016–17 to a new record high of 58.9 million tonnes (mt). Every mainland state achieved record highs (Table 1).

For the major winter crops, wheat production is estimated to have been a record high of 35.1 mt, barley hit a record of 13.4 mt, canola an equal record of 4.1 mt and chickpea production also climbed to a record high of 1.4 mt.

A drier and warmer than average summer in Queensland and northern New South Wales have reduced prospects for national summer crop production in 2016–17. Unfavourable seasonal conditions lowered soil moisture levels and many growers missed the planting window for later-sown summer crops.

These hot and generally dry conditions up until early March also adversely affected yield prospects for dryland summer crops.

But generally good supplies of irrigation water mean favourable yield prospects for irrigated cotton and rice.

The total area planted to summer crops in 2016–17 is estimated to have been around 1.4 million hectares – an increase of 15 per cent on the previous season. This increase was driven by plentiful supplies of irrigation water and favourable planting conditions early in the planting window.

Total summer crop production in 2016–17 is forecast to be 4.2 mt (Table 2).

Area planted to cotton is estimated to have more than doubled in 2016–17 to 557,400 hectares with forecast production from the combined irrigated and dryland area of around 1.0 mt of lint. Approximately 1.5 mt of cotton seed is expected to be produced.

The area planted to grain sorghum is forecast to have fallen substantially to about 441,000 hectares, largely because of higher expected returns from growing cotton. Additionally, the season was not conducive to a later season planting. Sorghum production is forecast to be around 1.2 mt.

The area planted to rice is estimated to be almost four times higher in 2016–17 than the previous year because of an increase in the supply of irrigation water available to rice growers. Rice production is forecast to increase to 870,000 tonnes from 250,000 tonnes in 2015.

Source: ABARES *Australian Crop Report*, February 2017. ■

At nearly 59 million tonnes, national winter crop production in 2016–17 was our best ever and almost 30 per cent more than the previous record set in 2011–12.

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

Year	Unit	NSW	Vic	Qld	SA	WA	Australia
2007–08	kt	3,999	4,692	1,194	4,706	10,761	25,415
2008–09	kt	9,438	3,887	2,326	4,863	13,785	34,378
2009–10	kt	7,787	5,889	1,617	7,035	12,943	35,344
2010–11	kt	14,784	7,625	1,821	9,316	8,044	41,672
2011–12	kt	11,952	7,352	2,329	7,371	16,600	45,670
2012–13	kt	11,123	6,886	2,156	6,470	11,243	37,934
2013–14	kt	9,773	6,773	1,516	7,221	16,510	41,878
2014–15	kt	10,445	5,117	1,464	7,439	14,662	39,197
2015–16**s**	kt	11,408	4,156	2,149	7,174	14,666	39,608
2016–17**s**	kt	16,263	10,180	3,111	11,217	18,041	58,874

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
2007–08	398	1,668	791	2,877	1,199	4,567
2008–09	402	1,430	746	2,350	1,156	3,794
2009–10	381	1,405	514	1,342	903	2,764
2010–11	713	2,514	790	1,901	1,514	4,446
2011–12	757	3,064	783	2,379	1,558	5,494
2012–13	712	3,205	687	2,250	1,412	5,505
2013–14	568	2,317	559	1,469	1,139	3,847
2014–15	435	2,044	696	2,134	1,149	4,262
2015–16**s**	436	1,639	725	2,067	1,177	3,779
2016–17**f**	655	2,453	682	1,691	1,353	4,218

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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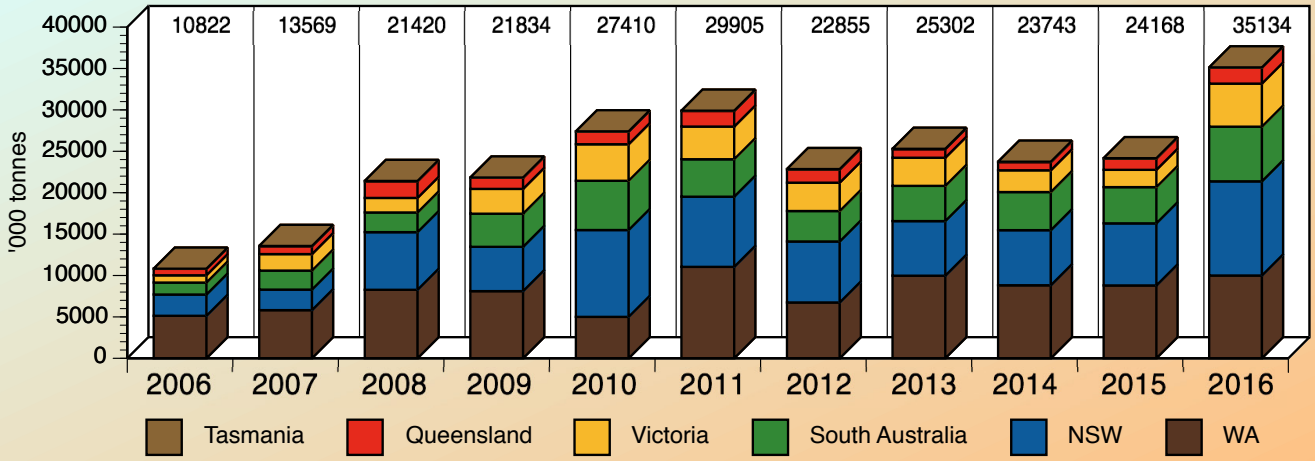
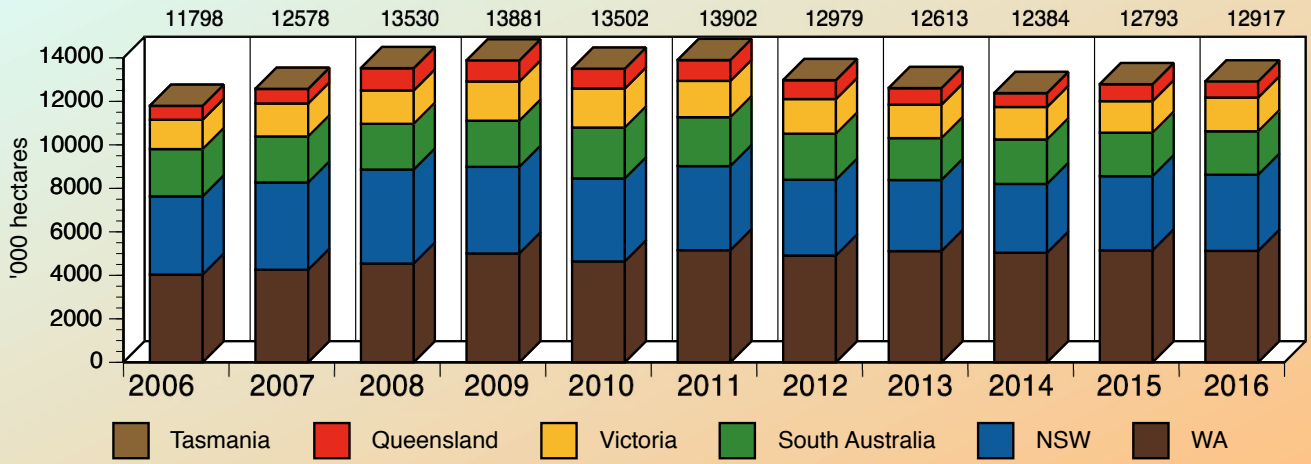
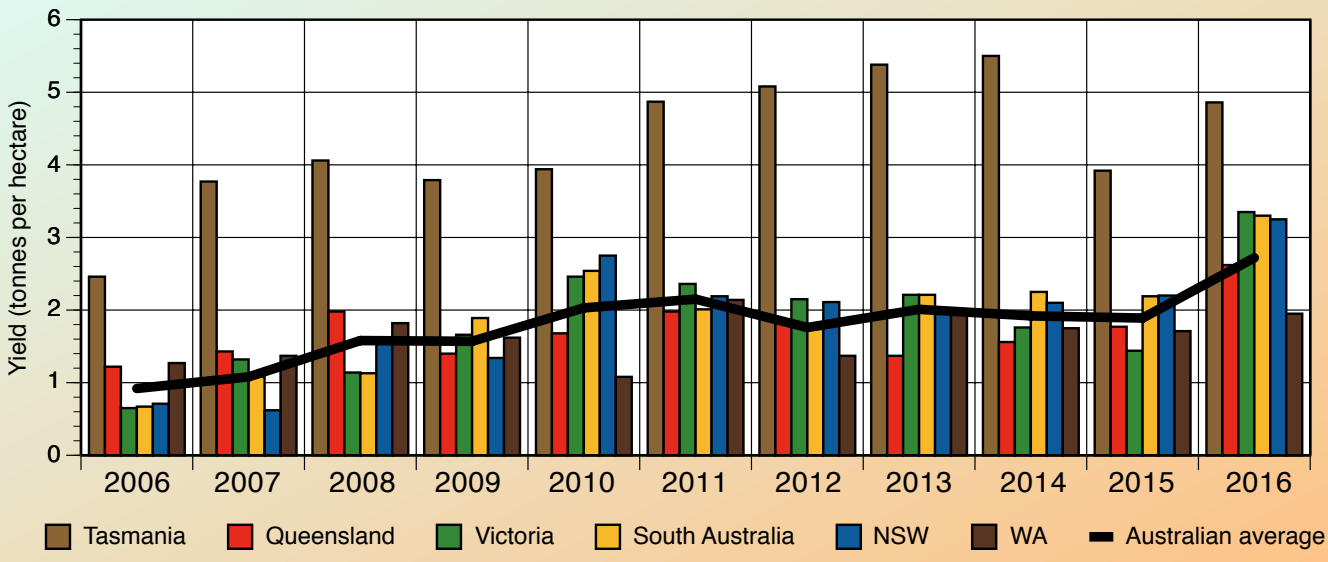
Total Australian wheat production



Total Australian wheat area



Average Australian wheat yields by state



Australian wheat production, domestic disposal and exports (Kt)

	2012	2013	2014	2015	2016
Opening stocks	7901	3040	3222	3240	4783
Production	22855	25303	23743	24168	35134
Availability	30756	28343	26965	27408	39917
Total domestic use	6451	6785	7154	6848	7960
Stockfeed, Human, Indus	*5820*	*6165*	*6514*	*6200*	*7310*
Seed	*631*	*619*	*640*	*648*	*650*
EXPORTS					
Wheat (incl. grain & flour)	21265	18336	16571	15777	22784
MAJOR DESTINATIONS					
China	1235	1491	930	1366	na
Japan	1178	882	904	899	na
Korea, Rep. of	1496	910	1048	1203	na
Malaysia	855	957	906	835	na
Thailand	475	387	466	499	na
Indonesia	4424	3720	4377	3648	na
Egypt	514	275	427	288	na
Iran	1292	849	269	102	na
Iraq	1771	959	155	53	na
United Arab Emirates	182	40	99	166	na
Yemen	722	1070	928	915	na
Kuwait	320	436	381	403	na
Saudi Arabia	409	377	13	16	na
Oceania (NZ, Fiji, PNG)	785	845	902	899	na
CLOSING STOCKS (Kt)	**3040**	**3222**	**3240**	**4783**	**9173**

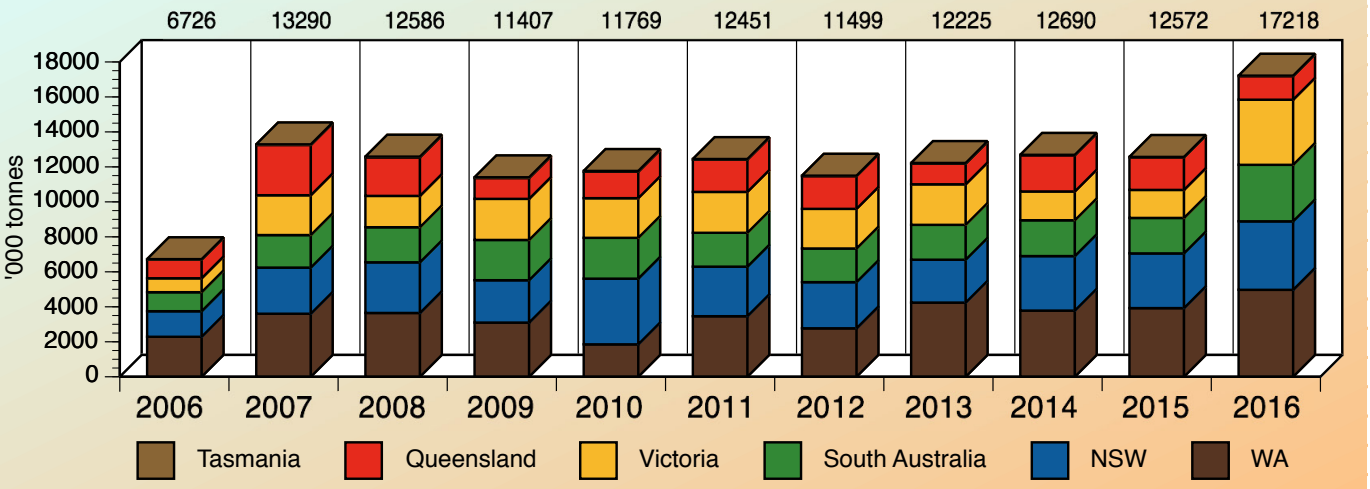
Wheat production & area by state

		2012	2013	2014	2015	2016
NSW:	Prod. (Kt)	7365	6596	6654	7500	11375
	Area ('000 ha)	3487	3269	3166	3410	3500
Vic:	Prod. (Kt)	3423	3396	2651	2085	5200
	Area ('000 ha)	1592	1536	1493	1450	1550
Qld:	Prod. (Kt)	1614	1036	987	1375	1925
	Area ('000 ha)	866	758	634	775	735
WA:	Prod. (Kt)	6744	9977	8824	8800	10000
	Area ('000 ha)	4909	5115	5038	5150	5125
SA:	Prod. (Kt)	3679	4254	4602	4376	6600
	Area ('000 ha)	2119	1927	2045	2000	2000
Tas:	Prod. (Kt)	30	43	44	32	34
	Area ('000 ha)	6	8	8	8	7

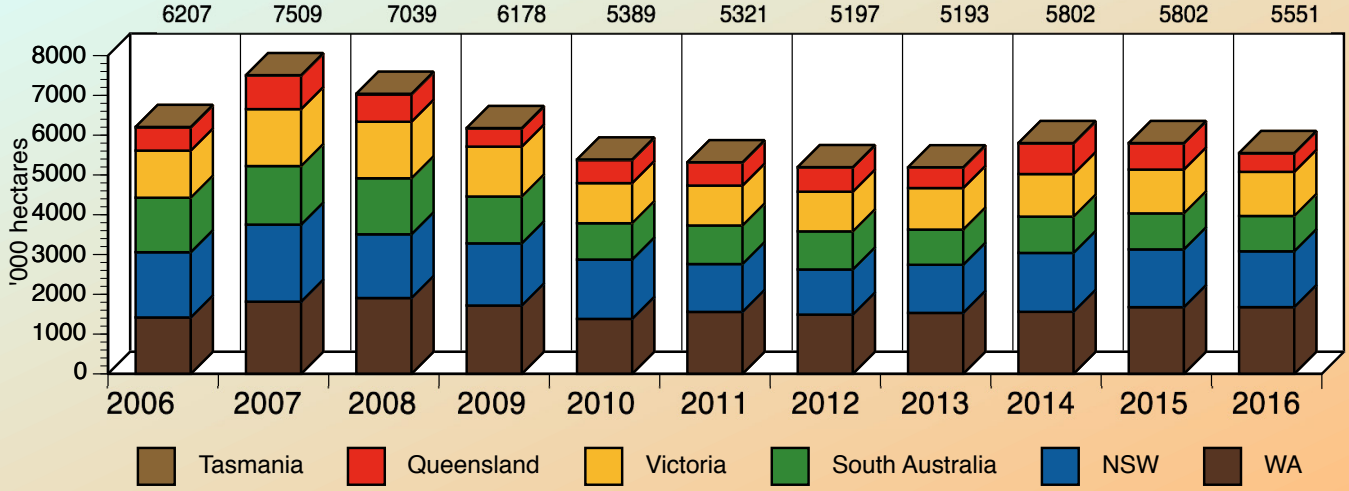
Barley production & area by state

		2012	2013	2014	2015	2016
NSW:	Prod. (Kt)	1286	1486	1869	1890	2697
	Area ('000 ha)	619	715	882	900	870
Vic:	Prod. (Kt)	1952	2036	1374	1350	3200
	Area ('000 ha)	854	919	916	940	940
Qld:	Prod. (Kt)	170	180	253	207	300
	Area ('000 ha)	90	106	125	100	95
WA:	Prod. (Kt)	2252	3556	3192	3250	4200
	Area ('000 ha)	1215	1258	1308	1350	1325
SA:	Prod. (Kt)	1794	1892	1941	1881	3000
	Area ('000 ha)	861	810	840	810	800
Tas:	Prod. (Kt)	17	25	17	15	17
	Area ('000 ha)	5	6	5	5	5

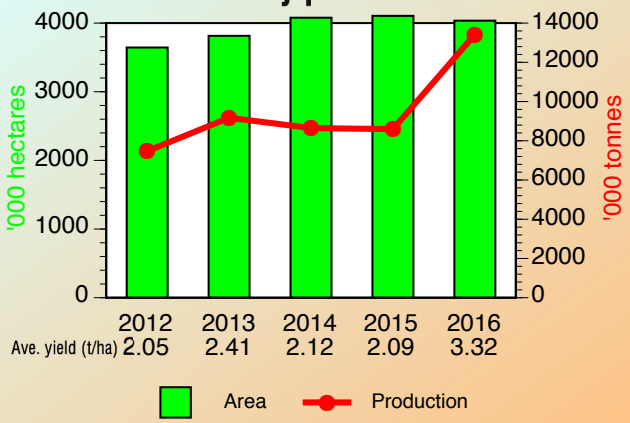
Australian coarse grain production (includes barley, oats, triticale, sorghum and maize production for grain)



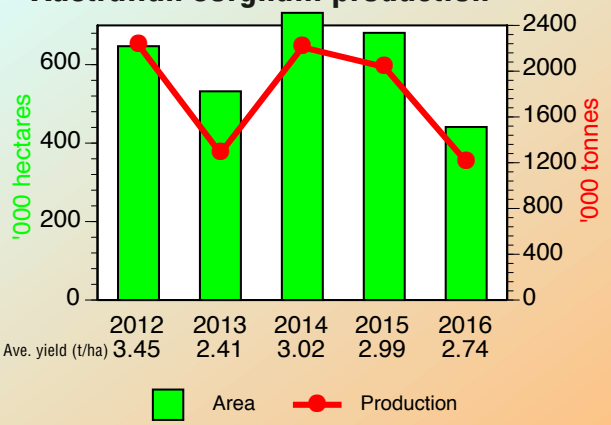
Total Australian coarse grains area (includes barley, oats, triticale, sorghum and maize production for grain)



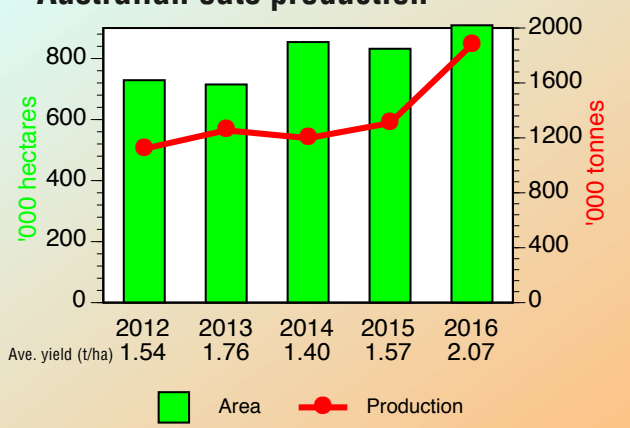
Australian barley production



Australian sorghum production



Australian oats production



Supply and disposal of Australian coarse grains (Kt)

	2012	2013	2014	2015	2016
BARLEY					
Production	7472	9174	8646	8593	13414
Domestic use & stocks	2182	2218	2714	2251	6025
Exports	5289	6957	5932	6342	7389
OATS					
Production	1121	1255	1198	1308	1879
Domestic use & stocks	884	1001	960	1035	1510
Exports	237	253	238	274	369
SORGHUM					
Production	2229	1282	2209	2037	1208
Domestic use & stocks	1060	1083	885	571	535
Exports	1179	1146	397	1638	673
MAIZE					
Production	506	390	495	439	467
Domestic use & stocks	347	401	331	432	338
Exports	106	106	60	64	129
TRITICALE					
Prod'n, use & stocks	171	126	143	195	247
TOTAL PRODUCTION	**11499**	**12227**	**12691**	**12572**	**17215**
TOTAL EXPORTS	**6760**	**7387**	**7756**	**6844**	**8560**

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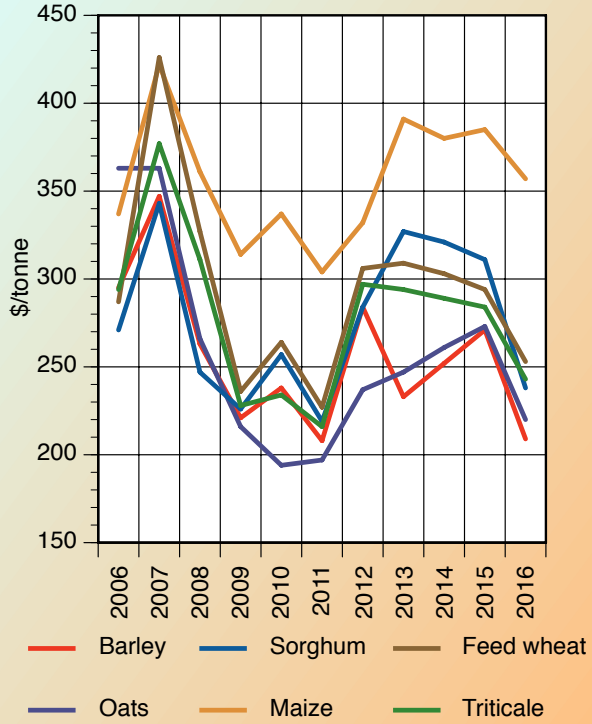
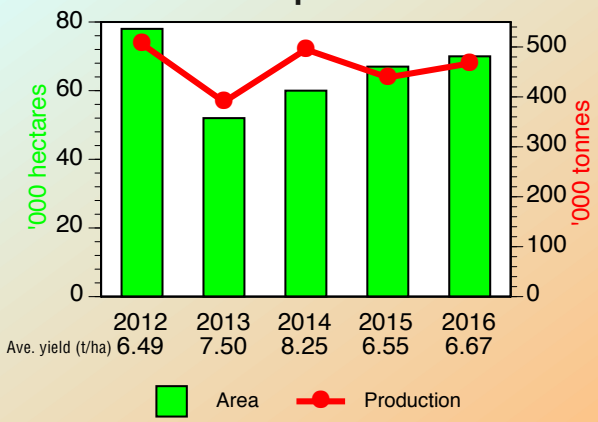
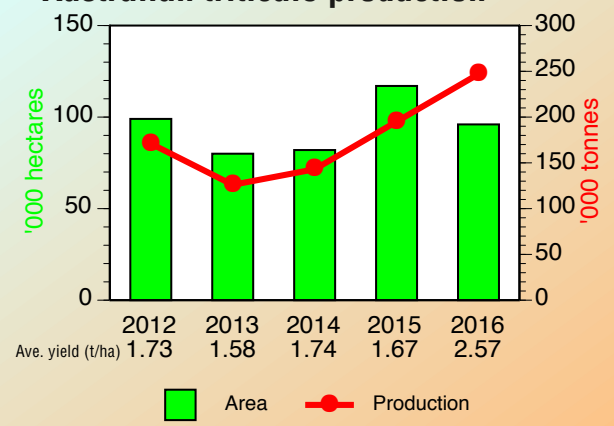
Australian coarse grains domestic feed prices ($/tonne delivered capital city)



Australian maize production



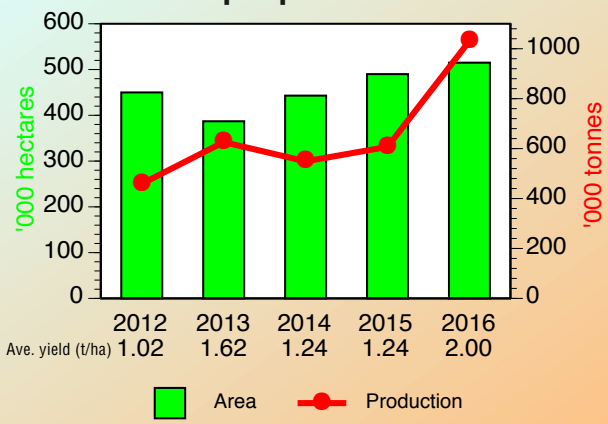
Australian triticale production



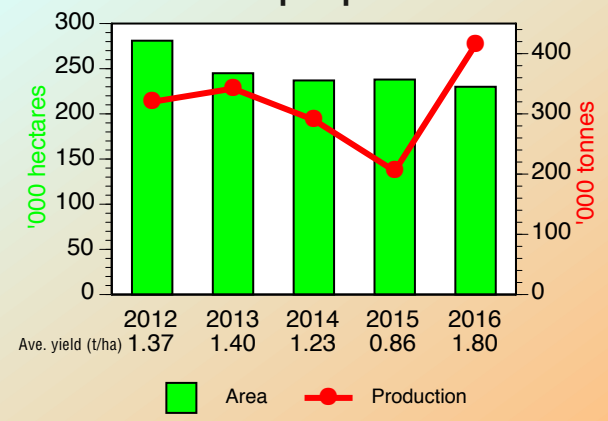
Supply and disposal of Australian pulses (Kt)

	2012	2013	2014	2015	2016
LUPINS					
Production	459	626	549	607	1031
Domestic use & stocks	290	310	306	244	436
Exports	416	274	270	220	595
FIELD PEAS					
Production	320	342	290	205	415
Domestic use & stocks	145	175	124	72	175
Exports	208	155	179	143	240
CHICKPEAS					
Production	813	629	555	1006	1407
Domestic use & stocks	1	0	1	1	28
Exports	852	562	674	1140	1379

Australian lupin production



Australian field pea production



SECTION 2 THE GRAIN INDUSTRY IN FIGURES

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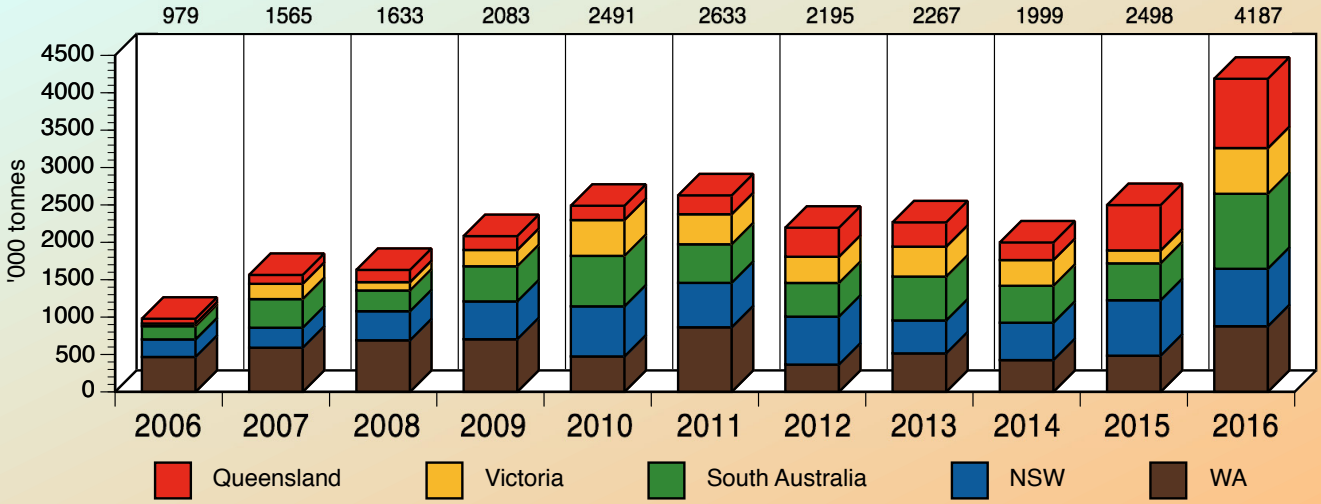
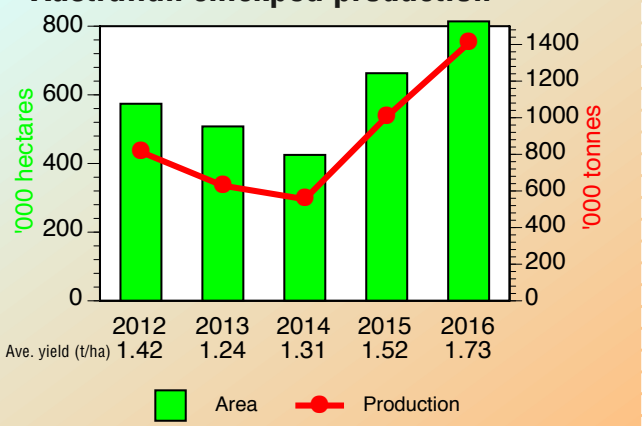
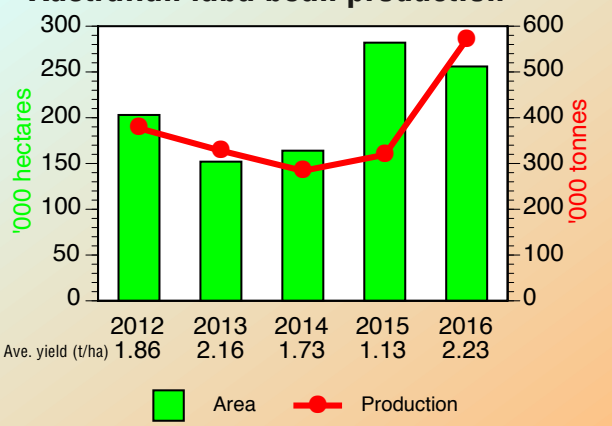
Total Australian pulse production



Australian chickpea production



Australian faba bean production



SECTION 2 THE GRAIN INDUSTRY IN FIGURES

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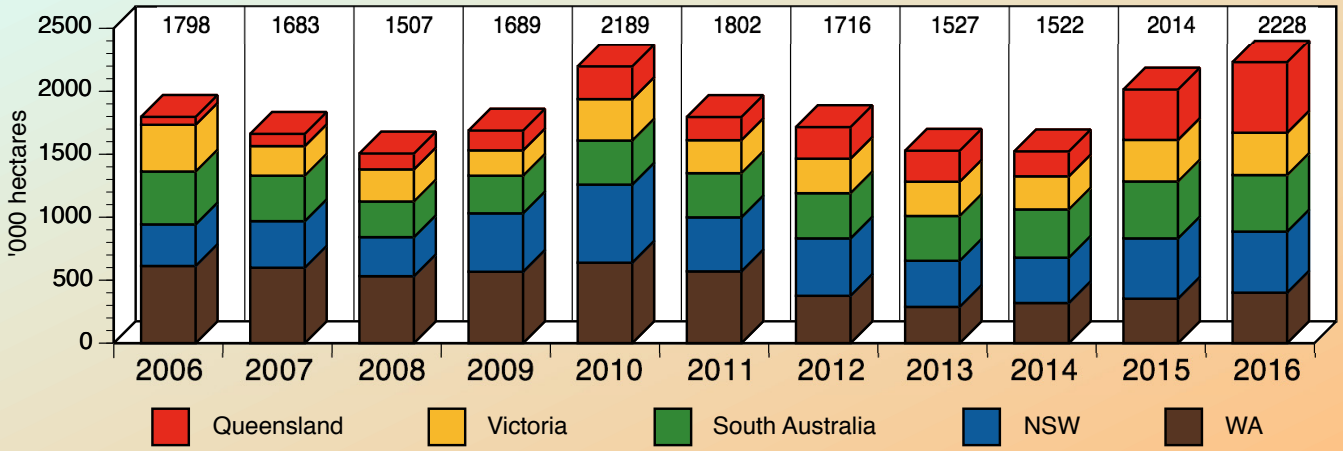
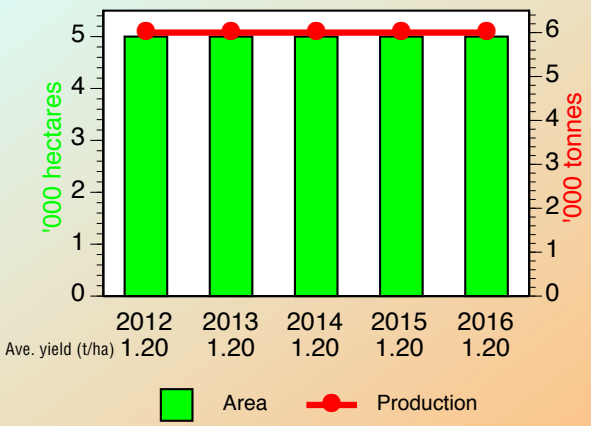
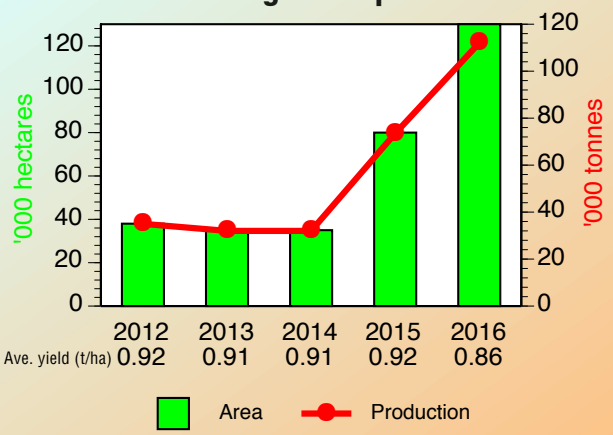
Total Australian pulse area



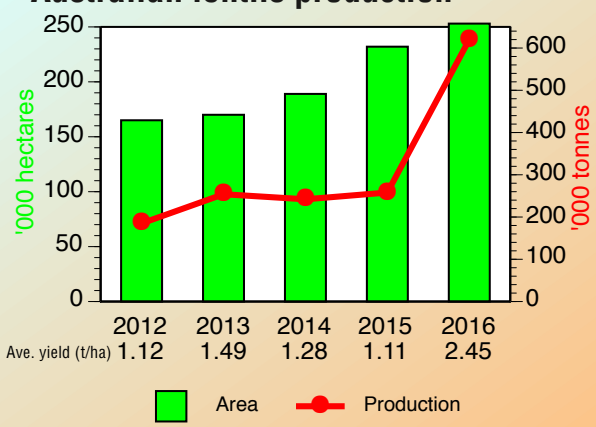
Australian navy bean production



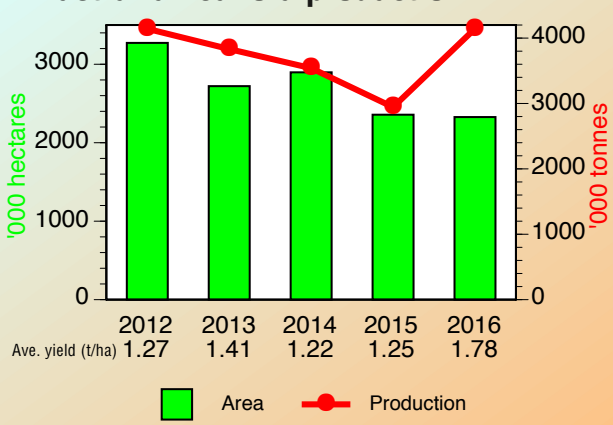
Australian mung bean production



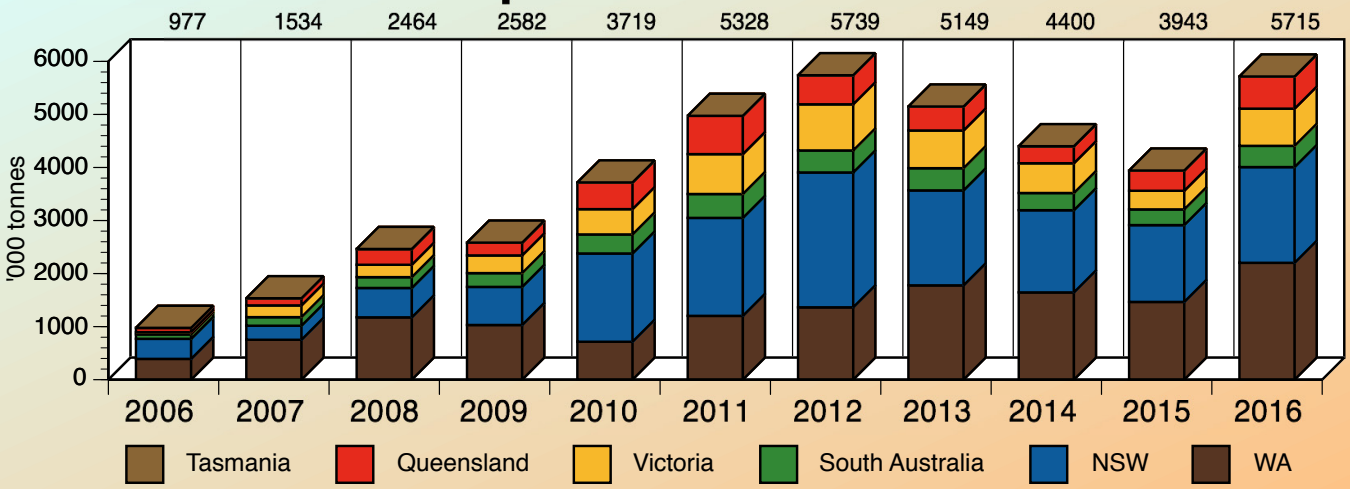
Australian lentils production



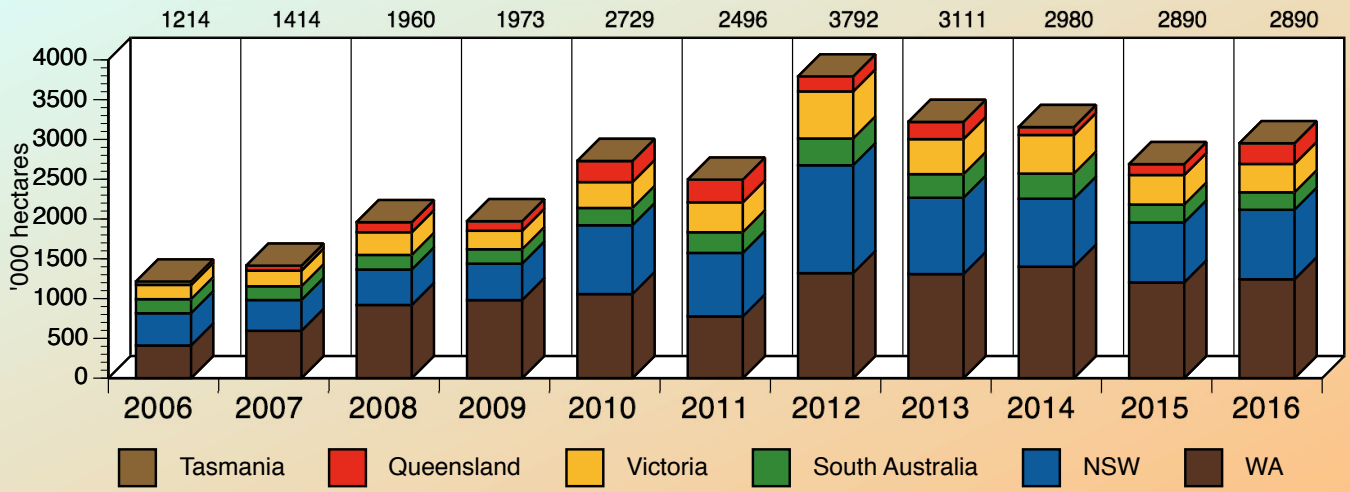
Australian canola production



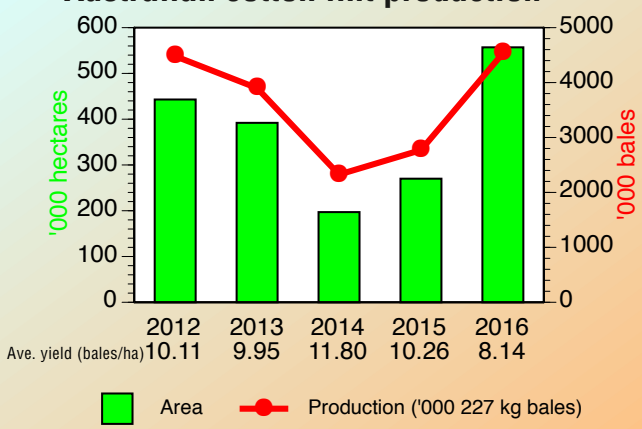
Total Australian oilseeds production



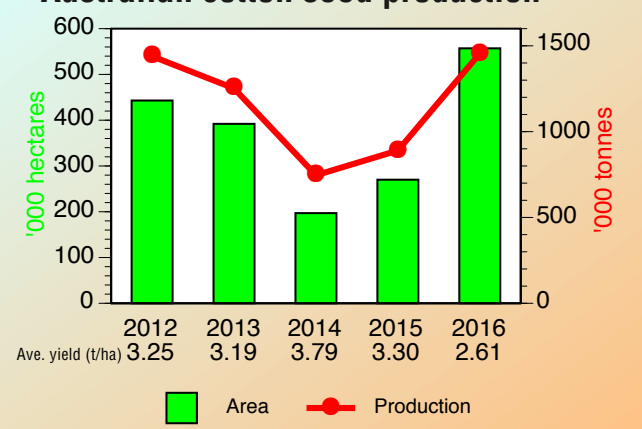
Total Australian oilseeds area



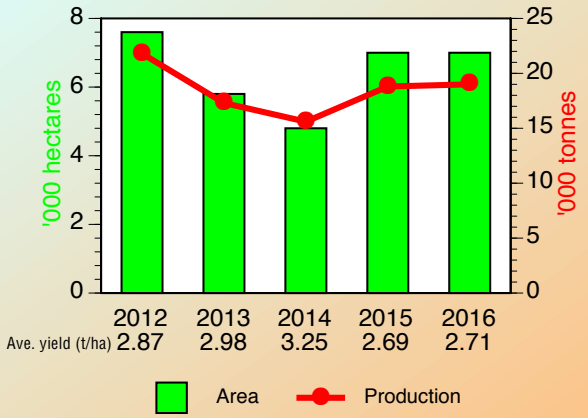
Australian cotton lint production



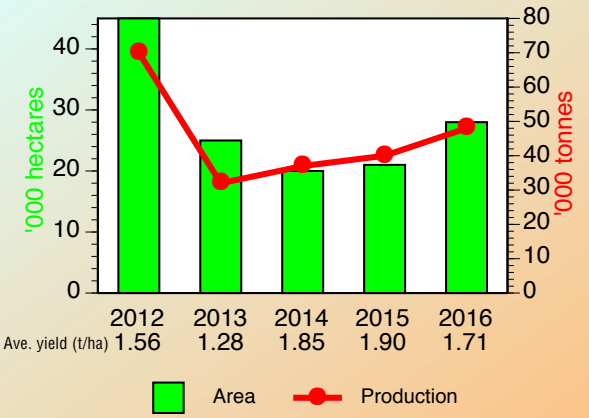
Australian cotton seed production



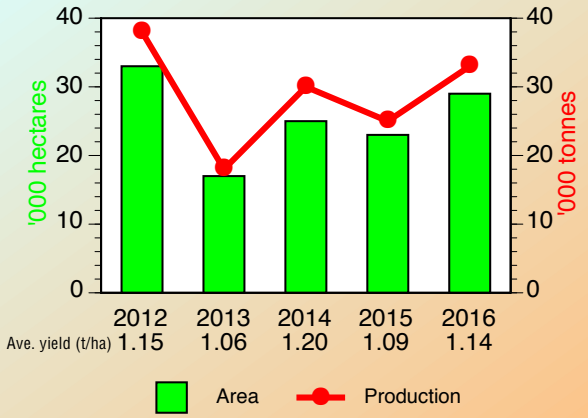
Australian peanuts production



Australian soybean production



Australian sunflower seed production



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

	2012	2013	2014	2015	2016
Seed production	4142	3832	3540	2944	4144
DOMESTIC USE	631	969	915	1088	na
Crushers	*596*	*557*	*560*	*na*	*na*
EXPORTS					
Seed	3488	3194	2445	1946	3063
Oil	116	152	159	154	na
Meal	41	42	37	23	na

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

		2011	2012	2013	2014	2015	2016
OILSEEDS	**Canola**	2323.0	3488.0	3194.0	2445.0	1946.0	3063.0
	Cotton seed	653.6	753.6	463.7	166.7	146.7	183.9
	Linseed	0.01	0.05	0.02	0.01	0.02	na
	Peanuts	2.9	2.8	3.2	3.0	3.4	na
	Safflower seed	1.2	3.1	0.9	0.4	1.6	na
	Soybeans	1.1	3.1	9.0	2.2	4.8	na
	Sunflower seed	0.61	0.95	0.51	0.17	0.27	na
	TOTAL (Kt)	**2982.3**	**4251.4**	**3671.6**	**2617.4**	**2103**	**>3300**
OILS	**Canola**	117.3	116.2	151.7	159.5	154.1	na
	Cotton seed	2.1	3.7	3.0	4.3	5.2	na
	Peanut	0.07	0.38	0.70	1.19	0.99	na
	Safflower & Sunflower seed	0.40	1.5	0.22	0.04	0.38	na
	Soybeans	0.18	1.4	2.1	5.0	4.2	na
	Olive	5.2	3.0	4.9	4.4	4.8	na
	TOTAL (Kt)	**140.4**	**146.0**	**181.3**	**193.4**	**169.7**	**na**
OILSEED MEALS	**Cotton seed**	42.1	42.6	35.8	22.5	0.17	na
	Soybeans	6.4	2.9	2.0	1.4	1.5	na
	Canola	21.6	41.2	42.2	36.9	22.9	na
	Sunflower seed	2.0	1.7	0.0	0.0	0.0	na
	Other	21.7	43.1	43.9	37.8	23.7	na
	TOTAL (Kt)	**93.8**	**131.5**	**123.9**	**98.6**	**48.3**	**na**

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

	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17f
Wheat	218	257	252	313	316	300	286	245
Barley	172	216	196	276	267	280	248	201
Oats	160	196	201	236	213	250	250	206
Triticale	220	184	175	249	258	256	237	189
Maize	268	259	223	238	297	330	366	328
Sorghum	196	213	201	252	300	301	261	213
Rice (average return to growers)	457	240	270	260	340	395	410	375
Lupins	249	268	232	340	345	292	290	260
Field peas	241	266	231	406	419	413	460	375
Chickpeas	443	404	457	394	352	567	656	841
Sunflower seed (at crusher)	696	567	551	570	660	756	652	612
Soybeans	551	501	472	468	538	588	560	640
Canola	440	544	500	548	555	503	549	532

Gross value of Australian grain production ($A million)

	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17f
Wheat	4765	7052	6775	7154	7998	7124	6918	8592
Barley	1356	1729	1723	2063	2453	2417	2132	2703
Oats	186	221	255	265	268	300	327	388
Triticale	120	65	50	43	32	37	46	47
Maize	88	92	113	120	116	163	160	153
Sorghum	296	412	423	562	384	666	531	258
Rice	90	174	248	302	279	273	103	326
Lupins	222	216	228	156	216	160	176	268
Field peas	86	105	101	130	143	120	94	156
Chickpeas	216	207	308	320	222	315	660	1183
Canola	840	1283	1759	2270	2129	1782	1617	2203
Sunflower seed	29	24	16	22	12	23	16	20
Soybeans	33	15	27	33	17	22	23	31
Peanuts, linseed, safflower seed	37	30	44	33	26	26	19	23
TOTAL	**8364**	**11625**	**12070**	**13473**	**14295**	**13428**	**12822**	**16351**

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

	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17f
Wheat (incl. flour)	3692	5516	6378	6776	6103	5547	5120	6479
Barley (incl. malt)	1093	1295	1875	1626	2199	2137	1790	1991
Oats	53	37	47	83	80	106	104	130
Sorghum	116	146	299	364	253	424	364	190
Rice	43	165	427	459	490	506	412	212
Lupins	115	89	86	143	116	119	97	208
Field peas + Cow peas	60	85	93	89	67	91	86	123
Chickpeas	255	213	384	533	297	414	1013	1304
Cotton seed	46	85	195	219	168	75	69	88
Canola	583	866	1344	2094	1929	1349	1097	1749
Other oilseeds	24	14	10	13	18	14	19	19
TOTAL	**6080**	**8511**	**11138**	**12399**	**11720**	**10782**	**10171**	**12493**

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USDA reports set the global market tone

By Peter McMeekin, Nidera Australia Origination Manager

AT A GLANCE...

- 2017 the lowest US wheat area for almost 100 years.
- Old crop global wheat stocks are a bearish influence.
- Bearish tone to continue if favourable conditions persist.

Action on most of the major global futures bourses in early April revolved around the United States Department of Agriculture Prospective Plantings and Grain Stocks reports that were both released on March 31.

Leading into the reports, grain stocks in the US were already at historically high levels and summer crop production in South America was at record levels, with estimates increasing almost daily. Nevertheless, the figures released on March 31 are extremely important from a fundamental perspective and will set the tone of the market as the northern hemisphere winter crop matures and the US summer crop gets planted.

The US grain stocks estimates for wheat, corn and soybeans were all above market expectations coming in at 45 million tonnes (mt), 219 mt and 47 mt respectively. It seems that demand for each commodity was less than the market had anticipated for the December to February quarter, leading to the bearish increase in stocks.

But it was the planting intentions of the US farmer that really grabbed the spotlight from the USDA report. The US corn planted area is estimated at 90 million acres (32.40 million hectares) – about one million acres below the average market estimate. This was also down four per cent – or four million acres – from last year, with 38 of the 48 estimating states reporting lower or unchanged intentions.

A wet spring could lead to a further decrease in corn area, but the large old crop stockpile will certainly provide a market buffer if that does eventuate.

The soybean planted area in the US is estimated at a record 89.5 million acres (36.22 million hectares). This was up six million acres, or seven per cent, on last year and a whopping 1.3 million acres above the average trade estimate. Compared to 2016, 27 of the 31 estimating states reported higher or unchanged intentions.

The 2017 winter wheat area in the US is estimated to be the smallest in almost a century.

Lowest US wheat area since 1919

The USDA estimated the 2017 'all wheat' planted area at 46.1 million acres (18.66 million hectares). This is down 4.1 million acres – or eight per cent – from 2016 and is the lowest total planted area in the US since records began in 1919.

The winter wheat area estimate was down nine per cent on last year at 32.7 million acres (13.23 million hectares), which puts it slightly higher than the 12.6 million hectares planted to winter wheat in Australia last year.

The Southern Plains region of the US received some very timely and favourable rainfall during March and this is likely to push yield estimates for the US wheat crop above the five year average. Whilst this will still mean that US ending stock will decrease for the first time in four years, the very high old crop stocks in the US, and the record global stocks, will cushion any market volatility.

The US winter wheat conditions are reported at 51 per cent good to excellent, down from 56 per cent at the same time last year – but the second best early April conditions in the past five years.

The reaction of futures on the Chicago Mercantile Exchange (CME) following the release of the March 31 USDA reports was mixed. The corn contract for May closed at 363 cents per bushel (c/bu) on April 5, which was up 5½ c/bu (around AUD$2.85 per tonne) in the four trading sessions since the report.

The May soybean contract fell 25¾ c/bu (approx AUD$12.45 per tonne) over the same period, close to a six month low for the nearby contract. The US planting intentions and the huge South American summer crop have been the primary influences.

Wheat did find some technical (rather than fundamental) support as the low planted area had already been factored into the market. In April 5 trading, the May contract closed at 427 c/bu, up 6 c/bu (about AUD$2.90 per tonne), since the March 31 report.

In reality, old crop wheat stocks in the US and across the globe, remain heavy and any bullish story from here hinges primarily on less than favourable northern hemisphere spring weather conditions and its manifestation in lower winter crop yields and/or poor summer crop establishment.

If favourable conditions persist, the bearish tone will most likely continue.

This report was submitted April 6, 2017.
For further information go to: www.nidera.com.au
or call the Nidera Grower Hotline on 1300 NIDERA.

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Wheat importer ending stocks shrink to a six-year low

By Stephanie Bryant-Erdmann, US Wheat Associates Market Analyst

AT A GLANCE…

- World wheat stocks to hit a record high.
- But the make-up of the countries holding these stocks has changed and this could lead to volatile futures prices.

In the April 2017 World Agricultural Supply and Demand Estimates (WASDE) report – and with six weeks then left in the 2016–17 marketing year – the USDA expected wheat world ending stocks to reach a record high 252 million tonnes (mt). This is up 4 per cent year over year and 22 per cent ahead of the five-year average.

The current marketing year factors in this report are well defined and the record large ending stocks are neither surprising nor new to those who follow the wheat industry.

But the position of those stocks has been quietly changing.

A change in 'stock-holders'

Historically, global wheat exporters – Argentina, Australia, Canada, the European Union (EU), Kazakhstan, Russia, Ukraine and the United States – have held roughly 30 per cent of global ending stocks. China has historically held one third of global endings stocks and the mostly net importers that remain have held about 37 per cent.

The five-year average breaks out with exporter stocks at 61 mt, China holding roughly 70 mt and the world's importers carrying out about 75 mt.

But the USDA expects that ratio to shift at the end of 2016–17.

With wheat importers tending to buy "just-in-time" to take advantage of low international wheat prices, ending stocks in these countries are the lowest in some years and only cover just over two months of consumption.

- Chinese ending stocks are expected to reach a record high 111 mt – or 44 per cent of global ending stocks.
- In wheat exporting countries, ending stocks are also expected to grow slightly to 74.0 mt, but the ratio will fall to about 29 per cent of global ending stocks.
- Carryout stocks in the world's wheat importing countries are expected to fall 16 per cent year over year to 67.1 mt. If realized, that would be 11 per cent below the five-year average and 27 per cent of global ending stocks – down 10 percentage points from the five-year average.

This decrease in carryout stocks is due in large part to a shift in purchasing behavior. Four consecutive record production years have enticed many buyers to adopt a "just-in-time" approach to take advantage of the lower prices and reduce storage costs where possible.

That is why ending stocks in the top 20 importing markets for wheat (excluding China) are expected to cover just over two months of consumption – six per cent below the five-year average.

Additionally, 28 countries (including the EU – the world's largest wheat consumer and normally a top wheat exporter) expect to have one month or less of domestic consumption in carryout stocks at the end of 2016–17, compared to the five-year average of 20 countries with one month or less of domestic consumption.

There are also 23 countries for which the USDA does not show ending stocks data. These countries import 6.09 mt of wheat annually and, with limited storage capacity, tend to buy "just-in-time."

With lower planted area and an expected return to trendline yields, world wheat production is poised to decrease in 2017–18. With importing country stocks drawn down to the lowest level since 2010–11, any supply shocks would increase price volatility in wheat futures markets.

China holds nearly half of world wheat stores

On paper, the world has ample wheat, but 44 per cent of that supply resides in China, which rarely offers wheat or flour for export.

After four consecutive years of larger global production and lower global wheat prices, many customers have minimal stocks on hand to weather supply shocks, and as one wheat buyer noted, "wheat (export) prices take the stairs down and the elevator up."

As always, weather is the wildcard, both in its direct effects on world wheat production and the wheat price impacts of any production problems with other major grains, especially corn and soybeans.

This report was submitted April 20, 2017.
For further information go to: www.uswheat.org

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

Supply and demand for wheat (by major producer)

	Opening stocks	Production	Imports	Total supply	Total use	Exports	Closing stocks
Argentina							
2014	2.5	13.9	0.0	16.4	6.3	5.3	4.8
2015	4.8	11.3	0.0	16.1	5.9	9.6	0.6
2016	0.6	16.0	0.0	16.6	6.2	10.1	0.3
Australia							
2014	3.2	23.7	0.0	26.9	7.1	16.6	3.2
2015	3.2	24.2	0.0	27.4	6.8	15.8	4.8
2016	4.8	35.1	0.0	39.9	8.0	22.8	9.2
Canada							
2014	10.4	29.4	0.5	40.3	9.1	24.2	7.0
2015	7.0	27.6	0.5	35.1	7.9	22.1	5.1
2016	5.1	31.7	0.5	37.3	10.2	20.0	7.1
China							
2014	65.3	126.2	1.9	193.4	116.5	0.9	76.0
2015	76.0	130.2	3.5	209.7	112.0	0.7	97.0
2016	97.0	128.9	4.0	229.9	118.0	0.8	111.1
EU-27							
2014	9.9	156.9	6.0	172.8	124.7	35.5	12.6
2015	12.6	160.0	6.9	179.5	129.9	34.7	14.9
2016	14.9	144.7	5.5	165.1	129.0	26.5	9.6
India							
2014	17.8	95.8	0.1	113.7	93.1	3.4	17.2
2015	17.2	86.5	0.5	104.2	88.6	1.1	14.5
2016	14.5	87.0	6.0	107.5	98.3	0.4	8.8
Russia							
2014	6.1	59.1	0.4	65.6	36.6	22.2	6.9
2015	6.9	61.0	0.7	68.6	37.1	25.6	6.0
2016	6.0	72.5	0.6	79.1	39.2	28.0	11.9
Ukraine							
2014	3.7	24.7	0.3	28.7	11.5	11.3	5.9
2015	5.9	27.3	0.0	33.2	12.2	17.4	3.6
2016	3.6	26.8	0.0	30.4	10.8	17.3	2.3
United States							
2014	16.1	55.1	4.1	75.3	31.3	23.5	20.5
2015	20.5	56.1	3.1	80.7	32.0	21.1	27.6
2016	27.6	62.9	3.0	93.5	33.0	27.9	32.6
Total world supply and demand for wheat (Mt)							
2014	194.9	728.1	164.4	923.0	705.4	164.4	217.6
2015	217.6	735.2	172.8	952.8	711.1	172.8	241.7
2016	241.7	751.4	180.7	993.1	740.8	180.7	252.3
Total world supply and demand for coarse grains (ie. total of corn, barley, sorghum, oats & rye) (Mt)							
2014	211.1	1308.0	186.1	1519.0	1272.1	186.1	246.9
2015	246.9	1251.1	164.0	1498.0	1250.8	164.0	247.3
2016	247.3	1346.1	191.4	1593.4	1335.4	191.4	258.0
Total world supply and demand for wheat and coarse grains (Mt)							
2014	406.0	2036.1	350.5	2442.0	1977.5	350.5	464.5
2015	464.5	1986.3	336.8	2450.8	1961.9	336.8	489.0
2016	489.0	2097.5	372.1	2586.5	2076.2	372.1	510.3

Summary of world statistics for wheat

	Area (million ha)	Production (Mt)	Use (Mt)	CLOSING STOCKS		Stocks to use ratio (%)	Trade (imports) (Mt)	Price US$ (Hard Red Winter, Gulf)
				World (Mt)	Major exporters (Mt)			
2008	223	685	645	172	69	27	137	271
2009	222	678	652	199	77	31	128	209
2010	218	652	659	194	74	29	126	317
2011	221	697	698	192	68	28	145	299
2012	215	655	677	169	50	25	141	348
2013	219	717	699	188	54	27	157	317
2014	222	728	705	218	50	31	159	266
2015	225	735	711	242	53	34	170	215
2016	222	751	741	252	56	34	177	190

World wheat production by region (Mt)

	Argen.	Aust.	Canada	China	EU 27	India	Iran	Kazak.	North Africa	Other FSU 12	Pakis.	Russia	Turk.	Ukraine	US	TOTAL WORLD
2009	11.0	21.8	26.8	115.1	138.3	80.7	12.0	17.1	17.0	14.2	24.0	61.8	18.5	20.9	60.4	678
2010	15.9	27.4	23.3	115.2	136.8	80.8	13.5	9.6	16.5	13.1	23.9	41.5	17.0	16.8	60.1	652
2011	14.5	29.9	25.3	117.4	137.4	86.9	12.4	22.7	18.4	13.8	25.0	56.2	18.8	22.3	54.4	697
2012	8.0	22.9	27.2	120.8	131.6	94.9	13.8	9.8	17.2	14.5	23.3	37.7	16.0	15.8	61.8	655
2013	9.2	25.3	37.5	121.9	143.2	93.5	14.5	13.9	19.7	15.6	24.2	52.1	18.8	22.3	58.1	717
2014	13.9	23.7	29.4	126.2	156.9	95.9	13.0	13.0	17.0	16.0	26.0	59.1	19.0	24.7	55.1	728
2015	11.3	24.2	27.6	130.2	160.0	86.5	13.8	13.7	19.9	15.9	25.1	61.0	22.6	27.3	56.1	735
2016	16.0	35.1	31.7	128.9	144.7	87.0	14.5	15.0	14.1	15.9	25.6	72.5	21.0	26.8	62.9	751

TABLE NOTES...

European Union 27 (EU 27) consists of Austria, Belgium, Bulgaria, 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)

	2012	2013	2014	2015	2016
IMPORTS					
Brazil	7.4	7.1	5.4	6.8	6.7
EU 27	5.3	4.1	6.0	6.9	5.5
FSU 12	7.2	7.4	7.7	7.4	6.0
Japan	6.6	6.1	5.6	5.6	5.8
Mexico	3.8	4.6	4.6	4.6	4.7
Middle East	20.9	20.7	21.3	19.2	17.7
Northern Africa	22.1	25.2	25.4	27.8	28.6
Southeast Asia	15.8	16.4	19.9	24.6	24.8
EXPORTS					
Argentina	3.7	2.3	5.3	9.6	10.1
Australia	21.3	18.3	16.6	15.8	22.8
Canada	19.6	23.3	24.2	22.1	20.0
EU 27	23.5	32.0	35.4	34.7	26.5
US	27.4	32.0	23.5	21.1	27.9
Russia	11.2	18.6	22.8	25.4	28.0
Ukraine	7.1	9.8	11.3	17.4	17.3
Others	26.8	20.5	19.9	23.9	24.4
TOTAL WHEAT TRADE (Mt)	**140.6**	**156.8**	**159.0**	**170.0**	**177.0**

SECTION 2 THE GRAIN INDUSTRY IN FIGURES

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World durum wheat production and trade

	2012	2013	2014	2015	2016
PRODUCTION (Mt)					
Algeria	3.0	2.5	1.3	2.2	1.7
Australia	0.5	0.5	0.5	0.5	0.6
Canada	4.6	6.5	5.2	5.4	7.8
EU 27	8.2	8.1	7.6	8.5	9.4
India	1.2	1.2	1.3	1.2	0.9
Kazakhstan	1.4	2.0	2.0	2.1	2.1
Mexico	2.1	2.3	2.3	2.3	2.5
Syria	1.5	1.5	0.8	1.4	1.0
Turkey	3.3	4.1	3.3	4.1	3.6
United States	2.2	1.6	1.5	2.3	2.8
Other	7.7	8.6	8.7	9.1	7.6
WORLD TOTAL PROD'N (Mt)	**35.7**	**38.9**	**34.5**	**39.1**	**40.0**
MAJOR IMPORTERS (Kt)					
Algeria	1613	1529	1748	1701	1800
EU 27	1453	1902	2828	2482	1850
Japan	197	212	205	200	200
Morocco	765	734	633	805	750
United States	667	819	908	382	350
Venezuela	424	440	407	340	300
Other	2285	2514	2561	2821	2726
MAJOR EXPORTERS (Kt)					
Australia	237	245	102	176	100
Canada	4289	4740	5680	4354	4000
EU 27	1390	1089	1207	1365	1400
Mexico	841	1275	1039	1484	1400
Turkey	1	4	101	98	90
United States	581	689	773	790	790
WORLD TOTAL TRADE (Kt)	**7404**	**8150**	**9290**	**8731**	**7976**
Semolina component (Kt)	*376*	*369*	*390*	*400*	*400*

Summary of world statistics for coarse grains

	2012	2013	2014	2015	2016
Area (million ha)	316	323	325	321	323
Production (Mt)	1135	1281	1308	1251	1346
Total use (Mt)	1138	1233	1272	1251	1335
Closing stocks: World (Mt)	166	211	247	247	258
Closing stocks: US (Mt)	23.5	34.3	47.0	51.3	63.0
Stock to use ratio (%)	14.6	17.1	19.4	19.7	19.3
Trade (Mt)	120	164	186	164	191

World coarse grains production by region and country (Mt)

	2012	2013	2014	2015	2016
Argentina	37.2	35.7	36.8	38.0	45.2
Australia	11.5	12.2	12.7	12.6	17.2
Brazil	84.2	82.6	87.7	69.1	94.0
Canada	24.4	28.7	22.0	25.6	25.6
China	212.2	225.4	222.7	231.8	227.8
EU 27	145.9	158.9	170.7	151.7	152.2
India	40.0	43.2	43.1	38.5	44.2
Mexico	28.9	32.0	32.7	32.4	33.2
Nth Africa & Mid. East	26.5	31.1	26.7	32.9	26.7
Russia	28.7	35.7	40.4	37.4	40.8
Southeast Asia	25.3	26.8	26.8	27.6	29.5
Sub-Saharan Africa	81.2	80.5	82.0	80.1	80.2
Turkey	11.1	13.1	9.4	14.3	10.9
Ukraine	29.5	40.0	39.4	33.4	39.2
United States	285.3	367.1	377.2	367.0	402.6
Other	63.1	68	77.7	58.6	76.7
WORLD TOTAL (Mt)	**1135**	**1281**	**1308**	**1251**	**1346**
Corn Total	873.2	991.4	1016.0	963.3	1053.8
Barley Total	130.8	145.0	144.4	149.0	149.1
Sorghum Total	57.2	58.8	64.4	62.5	61.9
Oats Total	21.1	23.8	23.0	22.6	24.0

Major world barley and sorghum producers (Mt)

	2012	2013	2014	2015	2016
BARLEY					
Argentina	5.0	4.7	3.9	6.0	4.6
Australia	7.5	9.2	8.7	8.6	13.4
Canada	8.0	10.2	7.1	8.2	8.8
China	1.6	1.7	1.8	2.0	2.1
EU 27	54.9	59.7	60.5	61.4	59.7
Russia	13.9	15.4	20.0	17.1	17.5
Turkey	5.5	7.3	6.3	8.0	6.7
Ukraine	6.9	7.6	9.4	8.7	9.9
United States	4.8	4.7	4.0	4.8	4.3
TOTAL WORLD PROD'N (Mt)	130.8	145.0	144.4	149.0	149.1
SORGHUM					
Argentina	4.7	4.4	3.1	3.0	3.0
Australia	2.2	1.3	2.2	2.0	1.2
India	5.3	5.5	5.5	4.2	4.8
Mexico	6.2	8.5	6.3	5.6	5.5
Sub-Saharan Africa	23.4	22.8	27.2	24.4	25.9
United States	6.3	9.9	11.0	15.2	12.2
TOTAL WORLD PROD'N (Mt)	57.2	58.8	64.4	62.5	61.9

World coarse grains trade by region and country (Mt)

	2012	2013	2014	2015	2016
IMPORTS					
China	5.6	12.4	25.7	17.5	13.1
EU 27	11.8	16.3	9.2	14.2	13.6
Japan	17.7	17.5	16.7	17.0	16.9
Mexico	7.7	11.3	11.6	14.9	15.8
Middle East & Northern Africa	23.5	30.7	34.1	32.8	36.6
Saudi Arabia	12.4	11.3	11.2	14.8	14.7
South Korea	8.3	10.5	10.2	10.2	9.9
Southeast Asia	8.0	10.7	12.9	15.2	13.6
United States	6.5	3.3	3.4	3.9	3.6
EXPORTS					
Argentina	29.5	16.6	21.5	25.3	28.7
Australia	6.8	7.4	7.7	7.3	7.3
Brazil	26.1	22.1	34.5	14.0	32.0
Canada	4.7	5.5	3.7	4.6	4.4
EU 27	8.9	7.8	14.0	13.1	7.7
Russia	4.4	7.1	8.7	9.0	8.7
Ukraine	15.5	24.1	24.3	21.2	24.1
United States	20.6	56.8	56.7	57.1	62.4
TOTAL WORLD TRADE (Mt)	**132**	**164**	**186**	**165**	**186**

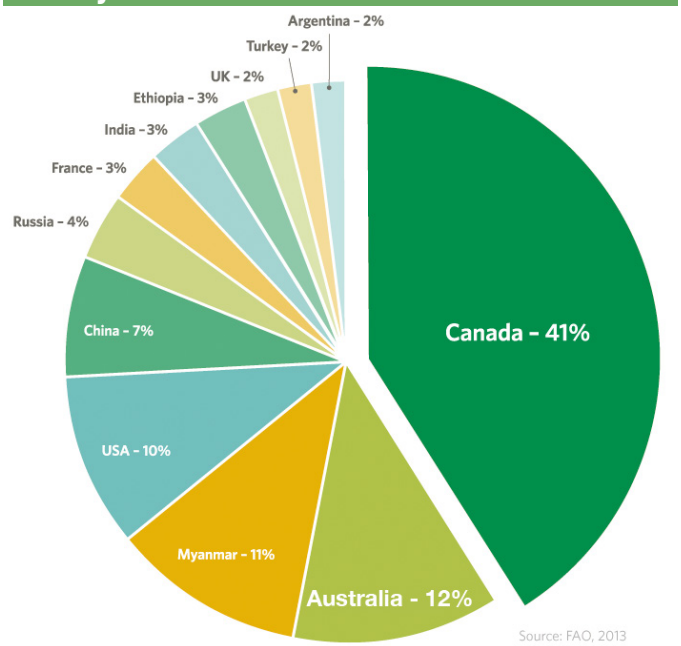
World barley trade by region (Kt)

	2012	2013	2014	2015	2016
MAJOR IMPORTERS					
Algeria	364	778	723	864	900
Brazil	369	338	489	551	500
China	2183	4891	9859	5869	5400
Iran	1100	1100	1900	1700	1600
Japan	1356	1294	1097	1154	1100
Jordan	831	997	759	902	800
Libya	573	681	1001	1324	800
Saudi Arabia	10200	8500	8200	10400	11000
Tunisia	762	456	483	696	600
United Arab Emirates	541	468	394	467	400
Others	3883	4324	5194	3548	4605
MAJOR EXPORTERS (feed and malting)					
Argentina	3647	2829	1599	2836	2000
Australia	5289	6957	5932	6342	7389
Canada	1316	1714	1386	1146	1700
EU 27	6501	4926	10642	8603	5900
Kazakhstan	151	501	476	776	1000
Russia	2366	2791	5807	3735	3600
Ukraine	2659	3827	4332	4673	5000
United States	163	336	291	161	150
TOTAL EXPORTS (Kt)	**22162**	**23827**	**30099**	**27475**	**27705**

World sorghum trade by country (Kt)

	2012	2013	2014	2015	2016
IMPORTS					
Chile	485	206	156	129	150
Colombia	707	194	40	39	50
EU27	254	208	125	130	140
Israel	50	85	11	23	15
Japan	1934	1034	876	673	750
Mexico	2090	501	11	500	850
New Zealand	92	29	5	10	15
Sudan	114	194	144	153	155
Others	1376	4016	9017	9570	5507
MAJOR EXPORTERS					
Argentina	3216	1114	1223	843	750
Australia	1179	1146	397	1638	673
China	32	11	9	21	20
India	236	82	111	62	32
United States	2064	4093	8951	8951	5950
TOTAL EXPORTS (Kt)	**7102**	**6467**	**11795**	**11227**	**7632**

Approximate percentage of world pulse trade by country



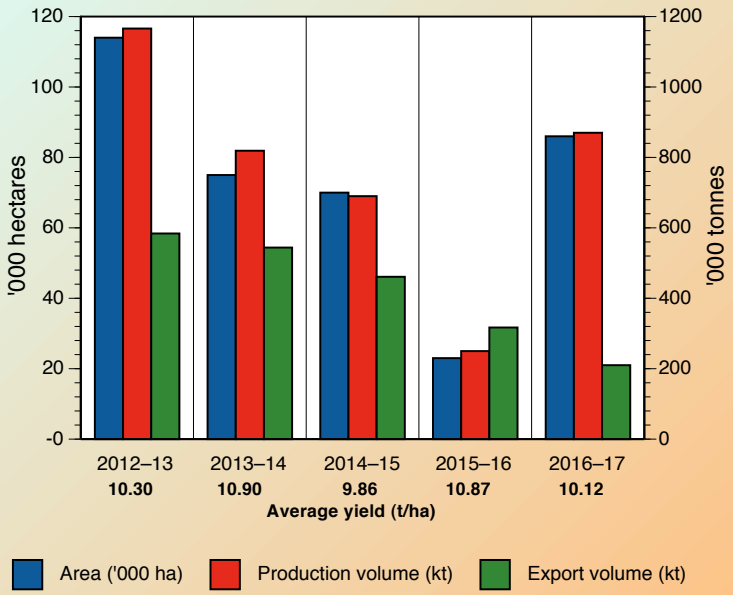
Major world pulse trade and production (Kt)

	2010	2011	2012	2013	2014	2015	2016
IMPORTS: Asia	3824	5072	**5773**	**5763**	**na**	**na**	**na**
India	*2304*	*3222*	*3816*	*3801*	*3900*	*4600*	*4000*
Africa	1088	927	**776**	**929**	**na**	**na**	**na**
Americas	1125	1138	**1394**	**1241**	**na**	**na**	**na**
Europe	1204	1108	**1242**	**1120**	**na**	**na**	**na**
United Arab Emirates	299	352	**238**	**391**	**na**	**na**	**na**
EXPORTS: Americas	6083	5889	**5333**	**6553**	**na**	**na**	**na**
Canada	*4307*	*4308*	*3367*	*4994*	*5982*	*5268*	*5834*
Asia	2644	1797	**2473**	**2642**	**na**	**na**	**na**
Europe	1065	1109	**1015**	**853**	**na**	**na**	**na**
Turkey	254	267	**248**	**233**	**na**	**na**	**na**
Australia	1437	1992	2167	1786	**1720**	**2091**	**3332**
TOTAL WORLD PULSE TRADE (Kt)	**12435**	**13401**	**13483**	**13988**	**13000**	**12931**	**13713**
PRODUCTION: Africa	9292	7575	12133	**12075**	**9207**	**na**	**na**
Americas	12543	10046	11983	**13312**	**13144**	**na**	**na**
Canada	*5347*	*4324*	*5315*	*6509*	*5828*	*6079*	*8400*
Asia	27009	28366	26737	**28792**	**30517**	**na**	**na**
India	*17236*	*17647*	*16704*	*18311*	*17150*	*16350*	*22140*
Europe	4357	4605	4017	**3794**	**4180**	**na**	**na**
Turkey	1345	1234	1290	**1257**	**1097**	**na**	**na**
Australia	2491	2633	2195	2267	1999	2498	4187
TOTAL WORLD PULSE PRODUCTION (Kt)	**70631**	**69257**	**75435**	**77670**	**77599**	**78000**	**79000**

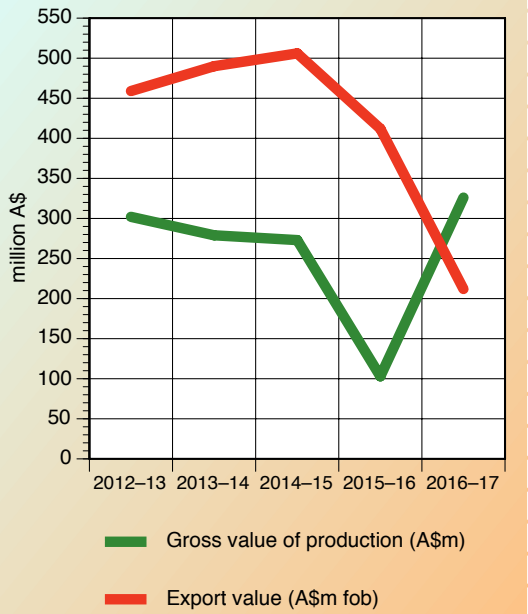
Major world oilseeds trade and production (Mt)

	2010	2011	2012	2013	2014	2015	2016
IMPORTS: Canola	10.49	13.10	13.00	16.30	14.10	14.00	15.10
Japan	*2.32*	*2.40*	*2.50*	*2.40*	*2.40*	*2.20*	*2.30*
Soybeans	88.76	93.45	95.90	113.50	126.80	134.10	139.50
China	*52.34*	*59.24*	*59.86*	*70.80*	*80.10*	*84.20*	*87.30*
EXPORTS: Canola	10.49	13.10	13.00	16.30	14.10	14.00	15.10
Australia	*1.55*	*2.562*	*3.51*	*3.19*	*2.45*	*1.95*	*3.01*
Canada	*7.21*	*8.69*	*6.71*	*9.20*	*9.00*	*10.10*	*10.10*
Soybeans	91.70	92.16	100.53	113.50	126.80	134.10	139.50
Brazil	*29.95*	*36.26*	*41.90*	*45.70*	*50.60*	*54.40*	*59.40*
United States	*40.96*	*37.15*	*35.85*	*44.60*	*50.80*	*54.10*	*54.90*
Sunflower seed	1.78	1.92	1.54	1.95	1.77	1.53	1.60
TOTAL WORLD OILSEEDS TRADE (Mt)	**108.36**	**111.03**	**118.11**	**133.50**	**146.50**	**153.33**	**157.00**
PRODUCTION: Canola	60.56	61.57	63.76	71.60	71.40	70.10	68.10
Australia	*2.36*	*3.43*	*4.14*	*3.83*	*3.54*	*2.94*	*4.14*
Canada	*12.79*	*14.61*	*13.87*	*18.60*	*16.40*	*18.40*	*18.40*
Soybean	264.25	240.49	270.70	284.60	320.50	315.20	341.00
Brazil	*75.30*	*66.50*	*81.50*	*86.10*	*96.20*	*95.40*	*107.00*
United States	*90.66*	*84.29*	*82.79*	*91.39*	*106.90*	*106.95*	*117.20*
Sunflower seed	33.07	39.68	35.75	43.34	40.73	41.45	44.00
TOTAL WORLD OILSEEDS PRODUCTION (Mt)	**460.97**	**447.70**	**475.82**	**504.18**	**537.00**	**522.45**	**555.16**

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%)
2011–12	160	467	456	107	23.5	40	590
2012–13	158	472	466	110	23.6	39	565
2013–14	161	478	479	112	23.4	43	429
2014–15	160	480	478	118	24.6	42	419
2015–16	159	472	473	117	24.7	39	386
2016–17	161	482	482	118	25.5	41	382

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

	Aust.	B-desh	Brazil	China	EU-27	India	Indon.	Japan	Myan.	Pakis.	Philip.	Thail.	US	Viet.	TOTAL
2011–12	0.92	33.7	7.9	140.7	2.1	105.3	36.5	7.8	11.4	6.2	10.7	20.4	5.9	27.1	**467**
2012–13	0.81	33.8	8.0	143.0	1.9	105.2	36.8	7.9	11.7	6.0	11.4	20.3	6.3	27.5	**472**
2013–14	0.57	34.4	8.2	142.5	1.8	106.7	36.3	7.9	11.9	6.8	11.9	20.3	6.1	28.0	**478**
2014–15	0.49	34.5	8.5	144.6	1.6	105.5	36.3	7.8	12.5	6.9	11.9	18.7	7.1	28.8	**479**
2015–16	0.18	34.5	7.2	145.7	1.8	104.3	36.2	7.6	12.2	6.7	11.3	15.8	6.1	28.5	**473**
2016–17	0.61	34.6	8.1	144.9	1.8	108.0	36.8	7.7	12.5	6.6	12.0	18.5	7.1	28.3	**482**

SECTION 2 THE GRAIN INDUSTRY IN FIGURES

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In this section the rice crop is the year of planting.
(The 2016–17 figure is therefore a forecast of the Australian rice harvest in March–April 2017.)

Section 3

Trends In The Global Grain Market

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A sea change in ocean freight rates for grain 52
Changes in Asian eating habits 54
The ins and outs of grain marketing 56
Seasonal farm finance:
The options, the pros and the cons 57

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A sea change in ocean freight rates for grain

By Peter McMeekin, Nidera Australia Origination Manager

Ocean freight is seldom mentioned when we talk about factors impacting grain values in Australia, but it is certainly worthy of discussion. Put simply, ocean freight is the cost to transport the product from the port of loading through to the port of destination, either in large bulk vessels or containers. It is a critical component of price and one which quite often determines Australia's competitiveness in the export market place.

There are many things which impact the ocean freight market and, like agricultural commodities, the good old supply and demand equation is foremost. The supply of ships is determined by the ratio of 'construction to destruction'. If more new ships are built and become available in the market compared to the number sent to the Asian scrap yards, then supply obviously increases.

The demand for ships is determined by the state of the world economy and the trade activity it generates. The more demand for imported goods across the globe, the more demand there will be for the ships to move those goods from the export origin to the import destination.

The cost of bunker fuel is critical

The other major component to consider is the operating costs of the vessel and the most significant in this category is the cost of bunker fuel. Bunker fuel is the generic term given to any fuel poured into a ship's bunkers to power its engines. Deep sea cargo ships typically burn the heavy, residual oil left over after gasoline, diesel and other light hydrocarbons are extracted from crude oil during the refining process.

Current ocean freight rates for grain are about half of what they were at the peak of the mining boom.

As you would expect, supply, demand and operating costs are continually changing and impacting prices, but never more so than in the past five years. Ten years ago ocean freight rates were very high, driven by the strong Chinese demand for mining products such as coal and iron ore. This of course drove the Australian mining boom.

But this also coincided with a period of high oil prices, and consequently high bunker prices.

Nevertheless, ship owners were partying big time as profitability had never been so high. Thinking this would never end, they commissioned the construction of many new builds and delayed the scrapping of the older vessels in their fleet.

As we all know, the party ended, and since 2012 we have seen a dramatic and global downturn in the demand for mining products. This slump coincided with a collapse in the price of oil, taking bunker fuel prices sharply lower. While this was happening, all those new builds commissioned by the ship owners during the boom started to complete and arrive in the market further increasing supply at a time when demand for ocean freight was poor.

To put this into perspective, at the market peak a typical voyage from Australia to China for a panama size vessel of around 50–60,000 tonnes, would have cost US$40–50 per tonne. At the market low, 12 to 18 months ago, the cost of that same voyage was under US$10 a tonne.

A significant fall in anyone's language, and realistically, unsustainable as this was well below the cost of construction and operation of the vessel. During this period we even saw shipping lines go bankrupt, the most notable being Hanjin Lines in South Korea.

In the past six months we have seen a resurgence in values with our example voyage above now (late April, 2017) back up to around US$20 per tonne – or double what it was at the lows.

The dominant driver in this market rally has been the resurgence in demand for mining products, strong global demand for agricultural products and increased bunker fuel costs with the oil price well up and trading off its lows. And, of course, the last of the new builds came into the market, with much fewer to follow as orders decreased due to the poor market conditions.

The market appears to have found some level of stability around current values, but as detailed above, ocean freight is a market which, like many things, is at the mercy of uncontrollable global economic factors.

To be fair, current values represent reasonable profits for owners and a sustainable cost for exporters – but then again, when have the markets ever been fair? ■

SECTION 3 TRENDS IN THE GLOBAL MARKET
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- Canola
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Changes in Asian eating habits

There are some 'specialty' crops being grown throughout Asia, and more particularly in China, where domestic demand is generally greater than the availability of good and consistent quality supplies of grain from these crops. These crops include oat, quinoa, chickpea and mungbean.

Currently, production of these crops in China is generally:

- In areas that are quite dispersed, and where the soil is largely barren and the land conditions relatively poor; and,
- Where production is very labour-intensive and greater mechanisation difficult to achieve.

Because incomes in the rural areas where various coarse grains and specialty crops are planted are relatively low, most of the young adults in these regions migrate to the cities for work. The farmers who are left planting the crops are mainly older people, between 55 to 60 years old.

Predictions are that in 20 years the areas for planting the specialty crops will face a situation where there will be very few farmers to do the work. Compounding this is the state's policy of land recuperation – much of the land will be left for ecological recovery.

Therefore, we can reasonably forecast that the production of various coarse grains and specialty crops in China will gradually decline.

But with the improvement of living standards, the dietary structure of the Chinese people is changing.

Miscellaneous grain crops

Chinese consumers are not satisfied with a single variety of staple food, such as rice or flour. They are instead focusing more on green, nutritious, healthy, and rare high-quality miscellaneous grain crops and the foods made from them. But the price of these crops is rising.

The production output of miscellaneous grain crops is not high, and the pollution of soil is affecting the quality of these crops.

China's demand for importing high-quality miscellaneous grain crops – and the food produced from them – will gradually increase.

Australia has abundant land resources for planting miscellaneous grain crops and the soil in Australia is safe and without pollution.

The high-quality grain crops produced in Australia, such as oat, quinoa, chickpea and mungbean will be appreciated by medium and high-end Chinese consumers, which provides an opportunity for Australian farmers to export their products.

At the same time, Chinese investors and entrepreneurs will be keen to invest in farms in Australia to plant the grain crops with high added values to match the demands from the Chinese market.

Besides raw materials, the further processed grain products from Australia are becoming very popular among the Chinese white-collar workers and middle class.

Putting cold milk onto cereals was never a traditional choice for breakfast for a Chinese person. But the fact that Weet-Bix have become popular in China is a good indication of the market potential of natural and healthy imported food in China.

Similar products such as pancake flour are appearing on the shelves of high-end supermarkets, online stores and the purchasing agents, called 'daigou'. Energy bars can also be found in the handbags of athletes and health-conscious women. ■

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MUNGBEAN EXPORTERS SET SIGHTS ON ASIA

Jonnie and Damien White from Australian Mungbean Co export to Asia and joined Food Leaders Australia on the AccessChina'16 trade tour.

Dr Damien and Jonnie White from Australian Mungbean Company joined AccessChina'16 – a 5-day trade delegation in October 2016 – to expand their networks and find out how they could develop existing export channels. The delegation was the initiative of the Toowoomba and Surat Basin Enterprise.

Jonnie said after she arrived in Shanghai that the scale of opportunity quickly became apparent as she toured major warehouses and e-commerce sites.

"Typically, what we're engaged in is producing mungbean seed for growers and helping them grow that seed into a commercial product, which we then process and clean and export to largely Asian markets around the world," she said.

"We hear the hype about how booming China is and how it's a massive market and massive opportunity."

The pair are part of a southern QLD project that is providing businesses with the tools, knowledge, information and assistance to further explore export markets.

"We've visited quite a few retail outlets, we've seen some big supply channel warehouses and we've also had a look at the new and emerging industry of e-commerce and places that support that," Jonnie said. "Alibaba was quite amazing."

Jonnie said after their trip, they were more aware of the changing ways consumers were buying their produce as well as the multiple outlets for getting products to customers.

"Every year we process and pack about 10–15,000 tonnes of mungbean, 98 per cent of which are for export markets. We want to go closer to the end customer, the paddock to plate scenario," she said.

Jonnie said the networking with other AccessChina'16 delegates was also valuable as a way to hear their experiences or opportunities for the China market.

"There's an existing market for mungbeans in China, we do export nearly 40 per cent of Australia's mungbeans for China as it is. It's more about what format it's currently coming into China in and whether we can do it better and do it differently and in the process, maintaining the value that our premium Australian mungbeans are achieving."

For more information see www.tsbe.com.au or www.foodleadersaus.com.au

TSBE and Food Leaders Australia are hosting Access Hong Kong in September 2017.

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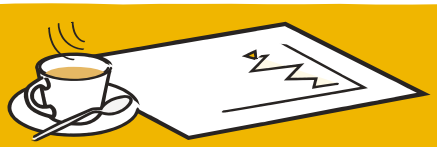

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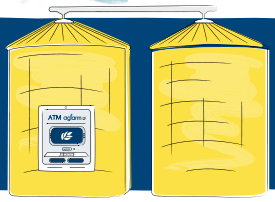

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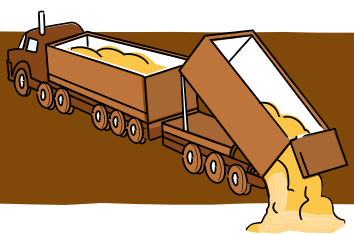

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The ins and outs of grain marketing

By Nathan Michael and Matt Noonan, Agfarm

Never before have grain growers had access to so much information at their fingertips. An infinite amount of data and commentary is available, covering all aspects of production, the weather, grain markets and futures markets. A large percentage of this is free. We have moved from what was once an information deficit, to an information overload.

The average farming enterprise is getting larger but the average number of people running those enterprises remains fairly static. How do you find time to filter through this information and come to a conclusion on the grain markets when you're busy working up ground, sowing, spraying, spreading fertiliser and harvesting?

Since deregulation of the market, the role of a grain marketer has gradually shifted from information provider, to deciphering and guiding informed decisions. Professional advice helps 'sort the wheat from the chaff'.

Grain marketers receive vast amounts of correspondence every week. Some of this correspondence offers market commentary, some offers export data, some offers price information. This is especially true April through July every year, when much of the world's wheat, corn and oilseeds are harvested. During this period futures markets can be very sensitive to any piece of data which analysts think may be relevant – such as a minor weather event in the US or a specific sale made out of the Black Sea. In truth, the majority of this information can just be 'noise' around the market.

A lot of this expert assistance is encapsulated in reports such as the 'Production and Sales Summary' opposite.

Sifting through this information and coming to an accurate feel or conclusion for the current market is the full time job of a grain marketer. The questions grain marketers often ask are:

- What size is the crop this season? Is it average, below average, large or extremely large?
- What impact will the size of the crop have on supply and demand factors?
- What are the short, medium and long term weather forecasts?
- How will these factors impact futures and physical markets worldwide?

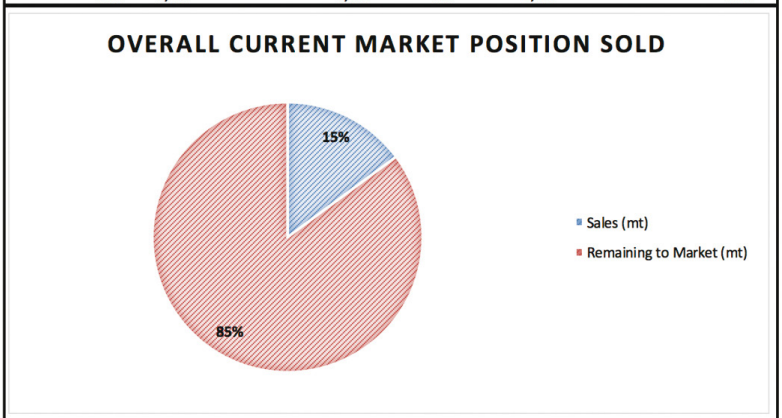
Adding to the market dynamic are on-farm factors such as monitoring grain quality and storage and cashflow. For time poor growers, a good investment is to enlist expert assistance to help deal with this market complexity.

Post deregulation, the reasonably simple selling options of putting your grain in the pool or selling for cash at the silo have been replaced by a rabbit warren of choices. There are now copious programs available – and all with different benefits and risks. And there are numerous companies providing varying types of options to market your grain.

You can choose monthly payments, advance

Production & Sales Summary

	Area Planted (ha)	Est Yields (mt/ha)	Est Production (mt)	Sales (mt)	Remaining to Market (mt)	Avg Price of Sales (GST Excl $/mt)	Sold Position (%)
Farm A							
Wheat	500	2.40	1,200	250	950	$242.00	21%
Barley	750	2.70	2,025	200	1,825	$190.00	10%
Canola	400	1.20	480	100	380	$520.00	21%
Total	1,650		3,705	550	3,155	-	15%

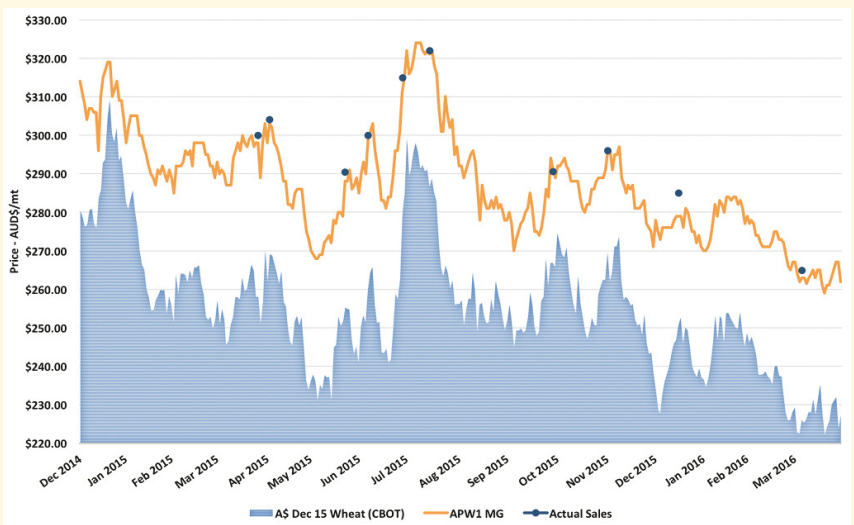


Mark-to-Market Position

	Sales Value (Ex GST)	Current Market ($/mt)	Unsold Value (Ex GST)	Total Potential Value (Ex GST)
Farm A				
Wheat	$60,500.00	$235.00	$223,250.00	$283,750.00
Barley	$38,000.00	$185.00	$337,625.00	$375,625.00
Canola	$52,000.00	$504.00	$191,520.00	$243,520.00
Total	$150,500.00		$752,395.00	$902,895.00

*** Current Market Pricing Based on Base Grades

Figure 1: Wheat pricing history with sales/volume versus market movements



payments, deferred payments and you can pay from $1 to $2 per tonne up to as much as $10 per tonne to have your grain sold. Just some of these marketing options include:

- Sell via traditional cash options at the silo;
- Online offer boards;
- Use of derivatives through straight sales or via pooled programs; or,
- Indexed selling products spreading the market exposure of varying periods.

In an effort to give growers more options and 'make things easier' the task of picking the right fit for the marketing of your commodities has expanded into unlimited options resulting in a difficult decision. A good grain marketer will help you decide which method is right for you and your specific situation, without wasting your time.

With this complex minefield of selling options a professional and trusted grain marketer can be a vital inclusion in your grain marketing toolbox.

What information should your grain marketer/consultant be providing?

- Communication and explanation of market intel/movements;
- Price discovery for cash sale options via forward contracts, harvest sales, post-harvest sales or which pool to be part of;
- Proactive communication when markets are at a good level to sell;
- Monitoring of cashflows and budgets to fall in line with your individual needs, whether it be for tax reasons or bills;
- Negotiate counterparty risk on your behalf; and,
- Provide historical analysis of your past performance to drive your future performance (for example, Figure 1).

These are just a few of the ways a grain marketer can help your business. With the ag industry increasing in complexity, the investment in a grain marketer can help you spend more time on the farm growing your crops while taking the 'noise' away from your business. ■

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Seasonal farm finance: The options, the pros and the cons

The primary producing industry operates around a few large pay days each year. It could come from the sale of livestock, the summer or winter crop harvest or a combination of all three. Regardless of the commodity or what time of the year it occurs, Australian farmers cannot rely on a regular weekly, fortnightly or even monthly pay day. Therefore, we look to different types of finance and financiers to make this ebb and flow income cycle a little easier for our businesses to manage.

Which financier do you use? That is a decision determined by you and your business needs. The following information helps identify what to look for and outlines some of the pros and cons of seasonal finance.

What is seasonal finance?

Seasonal finance is money lent for a 12 month period or less, which assists to manage your businesses short term working capital or cashflow requirements. Seasonal finance, generally speaking, is the same regardless of its title – working capital, overdraft, line of credit or input finance. The distinction mostly lies in some minor fee and operational differences.

Items traditionally placed on a seasonal finance facility are short term or annual bills associated with the livestock or crop life cycle, such as agri-chemical, fertiliser, fuel and livestock expenses. Your financier will usually want to see the facility repaid annually in some form.

This may be 'fully fluctuating' where you don't actually reach a $0.00 balance, but your credits equal more than your debits over a 12 month period.

Or, your financier may require a set amount by a certain date – whether that be after harvest or a livestock sale – before you can continue to drawdown on the facility.

Seasonal finance differs greatly from long term purchases. A long term purchase, like land, may require funding assistance anywhere from five to 30 years. Long term debt would generally be funded using 'term debt' and the repayment time frame suited to match the length of time you believe you need to pay it off.

How much do I require?

A few times each season – based on certain events like rain and grain prices – most primary producers sit down and work through a budget.

If we use grain production as an example, coupled with this budget is a cropping plan. How much fertiliser, fuel, water, seed, agri-chemical and staff you believe you will need to meet that budget, to make a profit and have a functioning enterprise.

As a rule, your seasonal finance facility should match your seasonal cashflow requirements based on that budget and that cropping plan.

It is important to consider interest and fees in your cashflow budget and seasonal finance request, as this will usually be paid with your seasonal facility.

Fees

The most common fees associated with seasonal finance are establishment or administration fees. These costs cover the financier's time and expenses associated with giving you a legally sound facility which seeks to protect the borrower and the lender from possible risks.

The facility documentation will outline each participant's obligations and rights.

It is worth noting, some seasonal finance facilities do have early repayment penalties, or a 'no drawdown fee', which is one to look out for when choosing your financier.

Where can I get it?

There are two common financiers – banks and rural merchandise operators. There is also a growing group of product retailers who are offering non-secured finance within their niche, such as fertiliser companies, grain bulk handing companies and other suppliers of specialist products and services.

How is it secured?

Seasonal finance is predominantly secured via a mortgage over the farm or other land assets, to the equivalent value of the seasonal requirement. As a guide, lenders using land as security generally look for equity greater than 60 per cent. This allows the lender and the borrower some headroom if unforeseen events – usually adverse weather – affects the repayment of the facility.

Comparing different seasonal offerings – pros and cons

The difference between seasonal offerings is usually related to the lender, their risk return expectations and appetite, or their speciality.

Banks vs rural merchandise stores

A loan through a bank allows you to purchase all your working capital needs with no product restrictions. Rural merchandisers understandably restrict product purchases to their own store. Banks are generally highly secured via land and have competitive headline rates. Rural merchandisers can be more expensive, due to less borrowing power and less security, but offer more flexibility, such as favourable pricing terms on products.

Bank repayments vary by lender, but all will be cash settled.

Merchandisers generally match payments to invoices automatically, so there is no monthly transfer of funds.

Due to the regulatory environment banks operate in, they are generally slower to act compared to a merchandise store.

Often the local bank manager doesn't have authority to modify a facility once agreed, whereas merchandisers are generally less regulated. This means funding can be easier and faster to obtain.

Another key difference is how a commodity is valued. For example, banks mostly recognise the value of a commodity in tangible cash, land or shares. Merchandise stores are more likely to look at the value of future livestock sales or harvest combined with cash, shares and land.

When comparing facilities, it is important to look for package fees and other costs throughout the year, as this will vary with all types of lenders.

Specialist seasonal lenders

As an alternate option, there is a growing group of specialist seasonal lenders. These are businesses which offer seasonal finance for a specific product they on-sell themselves, or are experts in handling. There are a number of livestock and cropping companies which offer such opportunities. Some of them are related parties of larger companies – others are standalone businesses operating in a niche field.

These companies can offer competitive, flexible deals because they are specialists in their field. But their offerings are generally specific to one production line – such as cereal grain but not corn, or dairy cattle but not beef – depending on their channel to market. Some of the limitations may be no cash withdrawal ability or being locked into one buyer.

But these businesses can often off-set some of these limitations with off-market sales opportunities, which may see a greater return.

Financier Comparison Summary

	Banks	Rural Merchandisers	Specialist Lenders
Flexibility	Moderate	High	High
Access to off-market pricing opportunities	Low	Moderate	High
Interest Rates	Low	High	Moderate
Costs	Moderate	Moderate	Moderate
Ease of Access	Low	Moderate	High

To sum up

So which financing option is better/best and what suits you more? In reality, all lenders have a place, and most farming enterprises utilise a combination of at least two. All of us focus on costs and fees and while this is important, don't forget to investigate what other opportunities your lending partner can provide. You may find access to off-market offers at better $ per tonne or cents per kg, flexibility to act quickly or a discount on products in-store, can outperform another's headline rate. ■

SECTION 3 TRENDS IN THE GLOBAL MARKET
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Section 4

District Reports

Reviews of the 2016–17 season and plans for 2017–18

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Western Australia

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State overview

"The tale of two seasons" and "the season that could have been" describes the somewhat unpredictable 2016 winter crop. Nevertheless, it resulted in Western Australian grain growers producing a record harvest with some areas of the state performing better than others.

Rain was a big factor in the success of the season, with a number of summer rain events boosting soil moisture to substantial levels. Regular April rain followed which enabled early sowing of crops. Optimism was high and, up until the end of August, the season was tracking very well in most regions.

Waterlogging along the south coast and south west districts of the Albany zone was significant. But most growers had ideal soil moisture levels, and crop growth in the main was advanced and substantial. The only downside for many was the very cool temperatures, with 2016 presenting the coldest winter for many years, and a longer cooler finish to the season.

Frost started occurring in early August in the eastern wheatbelt. With advanced growth, some crops suffered badly and more than usual for the time of year. Frosts were particularly damaging late September to mid-October in the Lakes districts of Kulin, Kondinin, Hyden and Lake Varley. Frost damage was also seen at Miling, Dalwallinu, Salmon Gums and many other regions.

The impact of the frosts has been difficult to assess, but GIWA estimates at least two million tonnes (mt) of grain was lost.

Considering the impact of frost, achieving the record 2016 harvest shows that the generally excellent conditions for crops – and subsequent yield potential – was underestimated across all districts. There were impressive canola yields in medium and low rainfall districts, good barley yields in the Kwinana West zone, and lupin yields in the Geraldton zone were also above average.

Despite pressure on protein levels, the quality of grain produced in 2016 was mostly excellent. There was some germ end staining in barley and frosted grains caused a small amount of wheat to be downgraded. Frost in the Kwinana East zone caused severe screening issues in barley to the extent that some were not of receivable quality.

The final total estimate of 18.2 mt of winter grains and oilseeds is a remarkable achievement for WA grain growers which could easily have been over 20 mt but for the frosts.

Geraldton

Northern Geraldton growers finished harvest in November and most had a very good year. Further south, harvest extended into early January with slow progress required in very heavy crops.

For 2017, it is unlikely much will change although there will be a small swing to more canola if the season provides an early sowing opportunity.

Canola was exceptional in all districts with very high to record yields and very high quality. Many growers recorded 2.3 to 2.4 tonnes per hectare averages over very large areas. March sown canola generally performed below that sown in April. The 'sweet' spot for sowing appears to be April 4 to 14 – or thereabouts.

The cool winter and spring was critical in achieving the high yields. August maximum temperatures were 4°C below average in Mullewa while they were 4°C above average in 2015.

Therein lies the difference in the two seasons.

Delays to nitrogen applications due to late deliveries produced some interesting results. Where applied on time, the nitrogen went to improve yield – while a 10 day delay caused protein rises of about 1.5 per cent.

For 2017, with stored soil moisture and an April start, canola area will rise by at least 10 per cent. A lot of effort is going into nutritional recommendations for cereals to maintain some profitability in the face of poor prices.

TABLE 1: 2016 WA crop production estimates – GIWA

Port zone	Wheat	Barley	Canola	Oats	Lupins	Field pea	State total
Kwinana	4,535,000	1,974,000	847,000	521,000	218,000	10,000	8,105,000
Albany	1,580,000	1,205,000	485,000	372,000	59,000	5,000	3,706,000
Esperance	1,362,000	846,000	501,000	19,000	18,000	20,000	2,766,000
Geraldton	2,688,000	142,000	317,000	14,000	419,000	1,000	3,581,000
Totals	**10,165,000**	**4,167,000**	**2,150,000**	**926,000**	**714,000**	**36,000**	**18,158,000**
Compared to 2015 harvest	10.5%	35.6%	39.3%	80.5%	58%	2.9%	22.6%

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: 2016 WA crop yield estimates (t/ha) – GIWA

Port zone	Wheat	Barley	Canola	Oats	Lupins	Field pea
Kwinana	1.66	3.95	1.85	2.66	1.76	1.08
Albany	1.92	2.55	1.54	2.94	1.53	0.83
Esperance	2.42	2.80	1.80	2.48	2.04	1.35
Geraldton	2.68	2.55	1.97	1.38	2.26	1.08
Averages	**2.17**	**2.96**	**1.79**	**2.36**	**1.99**	**1.08**

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The Midlands

Harvest results in the Midlands region were very good despite frost damage in a number of districts and many growers recorded their best harvest on record.

Canola performed brilliantly with yields at West Wubin of 2.3 tonnes per hectare average – just 100 kg per hectare behind wheat. Interest in growing canola will continue for 2017 with the area likely to rise by at least five per cent. The break crop percentage in the region could rise from 25–30 to 30–40 per cent. Any rise will take out lupin or wheat plantings.

Oil content was generally excellent with the majority of crops recording 49 to 51 per cent. The season was highlighted by the best yields coming from the poorer soil types on hills and poor yields in the valleys, highlighting the cool finish and impact of frost.

Lupins were high yielding with 2.5 to 3 tonnes per hectare common. For the first time in the region many loads were rejected at CBH for sclerotinia. Lupins had to be cleaned for delivery, showing the very high risk for sclerotinia in canola in 2017 if winter temperatures are warm.

Barley crops went very well despite the frost damage and overall performed better than wheat for frost damage. Even where damage was plainly visible, final paddock yields were excellent. Malt quality was achieved readily with most rejections being for germ end staining. Feed deliveries were rejected for protein or screenings. It is estimated that frost caused five to 25 per cent yield loss across the region.

Wheat protein was low. Blending pre-delivery was required and/or optimising post-harvest. Milling grades were achieved for the majority.

Oats achieved very high yields in the region but frost damage was also evident. Where export hay was delivering 10–11 tonnes per hectare of dry matter, grain harvest in uncut areas hit 4 to 5 tonnes per hectare.

Kwinana East

Yields were generally average to slightly below average in the Kwinana East zone. Spring rainfall was low, and combined with the frosts, caused crops to produce only average results.

Harvest was a bit longer than normal with a mix of good and poor crops causing a lot of pre-delivery blending to be required. Generally, grain protein was low and it was apparent there was caution around nitrogen applications and a lack of robust rotation. Overall, the soft finish was critical and forecast yields underestimated the final result.

Barley was worst affected by frost with average yields of around 1.5 tonnes per hectare. Quality was poor with many paddocks unable to achieve Feed 3 grades due to extreme light weight. Scope barley seemed the worst while Litmus seemed the best performer.

Wheat delivered similar results of around 1.5 tonnes per hectare and where frost was recorded, grain quality was poor.

Canola was the best crop in 2016 with top yields at 2 tonnes per hectare. East of Merredin in very early planted canola, yields hit 2.5 tonnes. Final averages across districts were close to 1.5 tonnes per hectare with good quality. When planted early, Stingray performed poorly.

The canola area potentially could rise by 10 per cent in 2017.

Field peas disappointed in 2016 and it's likely the area will decrease. There will be a strong swing to chickpeas where growers can find seed.

Lupin yields were average at around 1.2 to 1.3 tonnes per hectare.

Apart from isolated storm damage in late January/early February, where some growers received 150 to 200 mm of rain, most growers have good levels of soil moisture coming into the 2017 season.

Kwinana West

While the estimated frost damage/losses in hindsight seemed about right, yield for unaffected crops exceeded expectations.

Canola was exceptional, hitting 2.4 tonnes per hectare east of Merredin. Canola yielded close to cereal yields. Wheat recorded 5 tonnes per hectare in many paddocks.

Overall, wheat suffered the most frost damage, particularly compared with barley, although barley was mostly planted in less susceptible landscapes. Oats suffered frost damage as well.

Overall Kwinana West yields were well above average. There was a big variation in yields with the reverse of normal occurring – the hills yielded far more than the valley floors. Yields were high due to the cool, long finish without the usual heat shock. In western districts canola yields were close to 3 tonnes per hectare, wheat at 4.5 tonnes and barley to 5 tonnes per hectare.

Wheat quality was mixed with low protein and frosted grains causing issues. Screenings in affected barley crops reduced grain to Feed status.

The canola bubble will continue with the general perception that canola is the preferred crop to consider in 2017. Western districts will continue with RR canola and eastern districts will favour TT canola.

After the good summer rain across the district, the prospects for the 2017 grain crop are favourable.

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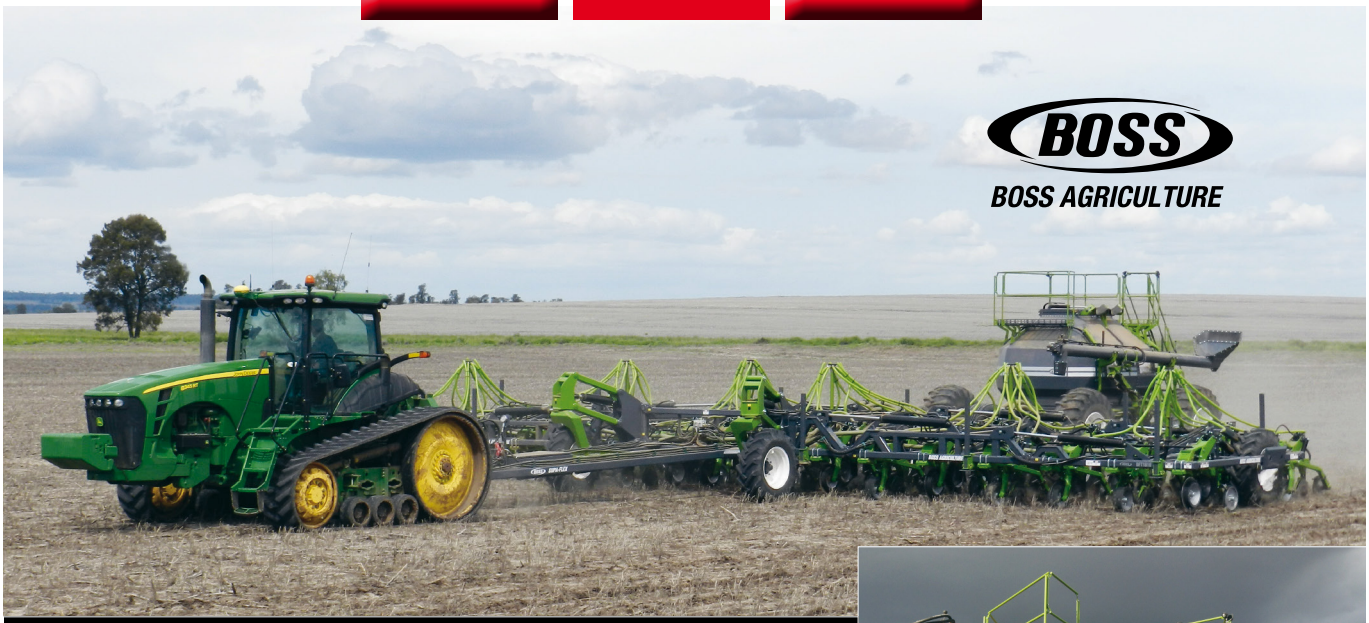

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Lakes region

Forecast yields from December turned out to be about right.

Yields north of the Lake Grace/Lake King road were lower than those south of the road. Northern recordings were more affected by frost with southern farms recording 2.7 to 2.8 tonnes per hectare for cereals.

In the Kondinin district yields were 200 kg per hectare better than in Kulin, which in turn was 200 kg per hectare better than Lake Grace. Most growers recorded average to below average yields. The potential, without frost, was far better.

Barley seemed to suffer more from frost than wheat, with Hindmarsh, Latrobe and Spartacus all recording significant damage.

Barley quality was mixed with a good percentage of loads making Malt grades but there were still a lot of Feed 3 deliveries.

Wheat yields were also below average from frost impact, but not as much as for barley yields. Protein content was anticipated to rise with the reduced yields but this did not occur. Protein was generally low but milling grades were achieved except where frosted grains were found.

Canola was the standout crop in 2016. Canola achieved similar yields to the cereals at about 1.2 tonnes per hectare. No one recorded exceptional yields with the best paddocks achieving 1.5 tonnes per hectare. Oil content was very high – at a minimum of 46 per cent – and many crops achieved 50 per cent. Canola remains the best bet for profitability in 2017. Provided the season starts with good moisture and continues in April, expect at least a 5 per cent rise in area.

Lupin yields were variable, with frost having a strong impact. Many crops only recorded one tonne per hectare in very bulky crops with poor pod set.

Field pea interest has dropped away with best yields of barely one tonne per hectare. There may be some take up of chickpeas in 2017.

Oat showed frost damage which was not anticipated because the crop is considered more tolerant to frost compared to cereals. Good crops achieved three tonnes per hectare but frosted crops had low grain weights and were poor yielding. The poor oat price outlook will likely reduce the area sown in 2017.

Albany

Yields were generally about or below average. Frosts and waterlogging were significant in reducing crop yields. Unaffected areas were exceptional but there was not enough of it to bring the yields up to above average. Wheat yields averaged 3 to 3.2 tonnes per hectare with paddocks ranging from 200 kg per hectare to 5 tonnes per hectare.

Wheat quality was generally good with frosted grain a problem for some. Protein content was very mixed. For 2017, Mace and Zen will be the main varieties.

Latrobe barley suffered far more frost damage than others with best yields to 3 tonnes per hectare and others at 4 plus tonnes per hectare. Frost and waterlogging again were the problem with yields ranging from 2.5 to 4 tonnes per hectare.

Oats performed poorly where frosted, which was unexpected, but overall yields were very good. With the current price outlook, the area of oats for grain is expected to fall significantly in 2017.

Canola was the standout in 2016 for yield and oil, though paddock averages were affected by waterlogging and frost.

Esperance

Harvest was completed by most growers before Christmas with a few going into early January. Grain deliveries continued throughout January from on-farm storage. The final production total for Esperance was 400,000 tonnes higher than forecast in early December. Cereal and canola yields were mostly underestimated with many growers very pleased with their final yields.

Damp weather saw a slow start to harvest, but from mid-November, the weather remained fine though cloudy and harvest pace improved. Many growers did not take a break in five to six weeks to get the harvest completed.

Yields across the board were higher than expected where frost had not had an impact. A lot of grain was lost due to frost but final production on the affected farms was close to the most recent five year average. Frost damage was mostly seen in the Salmon Gums, Grass Patch and Cascades districts. The impact and occurrence of frost was very random, though severe in some cases.

Waterlogging that occurred in the coastal districts throughout the season, reduced production in all crops. Away from the coast, yields and ultimate grain quality were very good.

Canola yields were again exceptional. The early planting opportunity and constant rain was ideal to promote high yields. Oil content was very high at 48 to 50 per cent. For 2017, the area is unlikely to change much as most growers have about the maximum area already sown to canola without risking disease and yield decline.

Wheat yields were above average, grain quality was very good, yet protein was low.

Barley yields were also above average. Some frosted crops produced high screenings and achieved feed grades but the strike for malt quality was above average.

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

Compiled from Grain Industry Association of WA crop reports

Northern agricultural region of WA

The 2016 season started quietly for most growers with a long dry summer across most of the landscape. But some growers were still counting the cost of the 2015 frost events. The frost damage did turn out worse than expected. High in the landscape sand areas with deep valleys were the worst affected. Farms dominated by this topography had significant losses. Severe frost damage was from Balla to Mingenew with a few other areas damaged as well.

There were a few thunderstorms that gave isolated wet strips with Morawa getting a 50 mm event around Christmas 2015. Some other areas also had isolated storm rainfall as well. Summer weeds were only a problem in these areas and elsewhere weeds numbers were very low.

Autumn was dry across the region but some areas had mid April rain with the north east fringes missing out on this event. This allowed the south west of the region to wet sow some broadleaf crops and gave a good knockdown opportunity for paddocks going to cereal crops.

A rainfall event starting on May 21 delivered a good rain across the whole region. Southern areas had double the rain of the northern fringe. The driest part of the region was the north eastern fringe with totals for the year as low as 50 mm in some locations. This made the region a real

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place of contrasts in 2016 with the southern areas having potential for well above average crop yields and the north east especting well below average.

Canola

Some canola in the north east did emerge and die but had enough ungerminated seed to get a viable stand after the May 21 rainfall event.

Seeding was generally completed by the end of May. Crops across the region were looking good and there was enough moisture to get all of the later sown crops germinated and growing.

By the end of May, canola crops were from just emerging to mid cabbage stage. The areas sown to GM canola was up and TT area planted was down. Overall canola area increased in 2016.

Insect pressure was light and some growers were opting out of the prophylactic insecticide sprays. Some crops were planted in very hot conditions and there were some lower stand densities due to drying soil and or associated fertiliser toxicity.

But canola crops were generally looking very good.

Lupin

Lupin crops at the end of May, were from emerging to 10 leaf. Lupins can emerge from reasonably deep and many crops were sown down onto moisture. Most deep planted crops emerged very well. Lupin area was down a bit in 2016 with some growers opting for GM canola.

Wheat

In late May, wheat crops were from just emerging to tillering. Crops were generally very clean with growers taking advantage of good pre sowing weed control. Wheat on wheat area was up so fungicides were required to go on with post em sprays.

By early June, most of the region had very good yield potential. Most growers were happy with the start except in the north eastern fringe which missed out on April rain.

June and July rainfall across our region was very good and temperatures were cool but crops were generally growing well. Some lighter soil types yellowed off with leaching rainfall and cool conditions. This problem generally only occurred on the low water holding capacity soils which are the lowest yielding in our area. Some growers added extra N to these soil type paddocks but they generally did not respond with any extra yield.

Above average prospects

Wheat crops at the end of July were from early grain fill to jointing and all crops looked very good. Powdery mildew and leaf rust were a problem in some crops and fungicides were applied to much of the crop. Yield potential in July was looking to be above average.

Canola crops were all from late flowering to early flowering stages and looked very good. Sclerotinia and aphids were the main concern at this stage. Fungicide was put on many crops in the west and aphid monitoring was happening very regularly through July and August.

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The cool 2016 spring helped produce some record crop yields for the district, particularly lupins.

Diamond back moths (DBM) were not an issue in July 2016 and small but frequent winter rains keep insects numbers very low.

Expectations for an above average season were underpinned by good soil moisture levels with enough to get crops through to late August.

Very cool September conditions helped crops fill grain very well even with low September rainfall totals. The wet July conditions also left some western crops looking washed out on sand soils. Crops on stronger soils coped well.

Cereal aphids were sprayed in some areas but very few aphids were sprayed in canola. Some lupin crops were sprayed for aphids which is unusual for our region.

Frost damage occurred in some areas. Some damage was seen early but we had to wait until harvest to see the full extent of this.

Harvest started in early October and the first growers were finished by mid November. Frost damage was recorded across the whole region. Most growers finished with 10–20 per cent loss from frost with a wide spread of losses around these numbers.

The 2016 season was the worst frost damage – with the most wide spread effects – that I have seen. A small upside on the frost damage for some, is that the events were early enough to wipe out some grains and leave others to form and fill normally. This meant only a small amount of quality downgrading across the landscape.

With this in mind the cool conditions through grain fill did have an upside and that is that crops that were not damaged were delivering record or close to record yields. This helped all growers into a good position with very high yields in all of the region with a couple of exceptions. The very east, and parts of the northern fringe, had lower in-season rainfall and yields were correspondingly lower.

The 2016 canola yields were exceptional with some paddocks of RR hybrids in the three tonnes per hectare range. Many growers have had their best canola averages ever and oil percentages were also the highest ever. Insects were not a problem with the frequent winter and early spring rain giving very low aphid and DBM numbers across the region.

Lupin yields saw record highs on many farms with the cool spring allowing podset for a very long period.

Barley yields were also record highs with some getting malt quality but most with very low protein and hitting the feed stack.

Wheat yields – where not frost damaged – were close to record highs. Quality was generally low due to high yields diluting protein. Grain weight and screenings were generally very good. Downgrading due to

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frosted grains was a problem on most farms but the majority had a small amount of lower value grain.

The frost damage to crops took the shine off the 2016 season but most growers were extremely happy with crop yields. One outcome from such a cool spring was to make us aware of how much heat stress and damage we have in most seasons and the yield reductions from it.

Peter Norris
Agronomy For Profit and Synergy Consulting, Geraldton

South Australia

SA state summary

Winter crops in 2016

Total grain production of 11.1 million tonnes in 2016–17 is a new record for South Australia, exceeding the previous record set in 2010–11 of 10.3 mt.

Harvest was about 85 per cent complete by the end of December 2016 with cool conditions, rainfall and heat waves delaying harvest. Lodged crops also slowed reaping.

Continued wet, humid conditions during January 2016 delayed the completion of harvest until early February in later districts.

Summer weeds also slowed harvesting and caused grain contamination in several districts, with grain required to be cleaned to meet receival standards. Some crops were desiccated or windrowed to aid harvesting and to minimise the risk of contamination.

The majority of the late harvested grain was weather-damaged and downgraded in quality.

Frost damage in the Mid and Upper North was more severe than anticipated with all types of crops being affected, reducing both yield and grain quality.

Average grain yields across most of the agricultural districts were excellent. In some districts, yields were double the long term average.

Yields on Kangaroo Island and the Lower South East were closer to average due to waterlogging in low lying areas during the season.

There was some downgrading of wheat, barley and pulses due to frost, discolouration and hail damage but generally the crop quality profile was better than expected given the number of rain events during harvest.

Wheat quality was generally good, although grain protein was lower than average in many districts, due to the well above average yields and impact of rain during harvest.

In many districts a higher proportion of barley than normal was classified as malt.

Durum grain was affected by black tipping, resulting in downgrading of some grain.

Lentil yields were well above average in most districts, but some crops on clay soils became waterlogged, reducing yield and grain quality.

Field peas performed very well, despite many being affected by frost in some districts. Many farmers reported that crops unaffected by frost were the highest yielding they have ever grown.

High snail levels were reported in many districts with pea crops being the worst affected. Snails contaminated some grain samples and clogged harvesting machinery.

Summer weeds slowed harvesting down and caused grain contamination in several districts. Some crops were desiccated or windrowed to aid harvesting.

Oaten hay yields were high in all districts, but quality was highly variable as a result of weather-delayed cutting, weather damage to early-cut crops and a reduction in nutritional value in very high yielding crops.

There was a large germination of summer weeds and volunteer cereals following December rains and many farmers sprayed to conserve soil moisture.

Pastures

Rain in December reduced the nutritional quality of dry pastures, but the germination of summer weeds and volunteer cereals provided good feed in most districts.

SOUTH AUSTRALIA 2016–17 WINTER CROP PRODUCTION (tonnes) AND AREA (hectares) AGAINST THE 5 YEAR AVERAGE

		5 year average	2016–17
Wheat	Area	2,226,900	2,237,700
	Prod'n	4,393,000	6,460,500
Durum	Area	64,200	55,200
	Prod'n	161,000	209,700
Barley	Area	878,600	799,300
	Prod'n	1,987,600	2,774,800
Oats	Area	78,000	94,600
	Prod'n	125,900	258,700
Rye	Area	8,500	10,500
	Prod'n	7,500	15,700
Triticale	Area	49,500	21,500
	Prod'n	75,400	58,130
Peas	Area	104,100	97,300
	Prod'n	124,400	176,100
Lupins	Area	67,800	76,800
	Prod'n	79,100	134,800
Beans	Area	69,000	75,500
	Prod'n	107,500	166,530
Chickpeas	Area	18,600	20,500
	Prod'n	22,000	34,360
Lentils	Area	103,900	169,600
	Prod'n	143,000	447,680
Vetch	Area	19,200	32,200
	Prod'n	11,500	34,800
Canola	Area	281,000	203,000
	Prod'n	375,200	372,900
Hay (not in total)	Area	225,500	258,800
	Prod'n	883,900	1,454,300
Total SA crop	**Area**	**3,969,200**	**3,893,700**
Total SA crop	**Prod'n**	**7,613,000**	**11,144,700**

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Stubbles also had a high amount of quality feed with large amounts of grain on the ground in many paddocks due to hail, wind damage and crop lodging.

There is now a lot of hay and grain stored on-farm for supplementary feeding of livestock.

Cropping intentions in 2017

Crop planning for the coming season indicates that the area sown to wheat will remain relatively stable but the area of barley, beans and hay (both export and domestic) will be reduced.

Canola plantings will increase in many districts but is likely to be limited by the shortage of seed supplies, particularly of hybrid varieties.

There is a planned increase in the area sown to pulse crops – particularly lentils and chickpeas.

Good meat and wool prices, along with poor cereal grain prices, are expected to see a greater emphasis placed on livestock enterprises in mixed farming systems, particularly in lower rainfall districts.

SA district summaries

Western Eyre Peninsula

2016 crops in review

- Harvest was finished in Western Eyre by the middle of December, with most grain delivered to receival points by the end of the month.
- Many farmers achieved record yields.
- Grain protein levels were better than expected given the excellent yields.

Lower Eyre Peninsula

2016 crops in review

- Most farmers finished harvest by the middle of January with almost all grain delivered to storage facilities by the end of January.
- Yields were well above average with some growers reporting their best yields ever.
- Grain protein was better than expected given the high yield, probably resulting from in-crop nitrogen applications and late season nitrogen mineralisation during warm, damp conditions in spring.

Eastern Eyre Peninsula

2016 crops in review

- While most of the harvest was finished by the end of December, cool conditions in December delayed completion of harvest into January in some areas of the Cleve Hills.
- Grain yields were well above average in areas around Wharminda, Arno Bay and Cowell.
- Frost had considerable impact on yields near Kielpa, Darke Peak and Mangalo.
- Protein levels were generally higher than expected given record yields in some areas.

Upper North

2016 crops in review

- The majority of farmers completed harvest by mid-January.
- A few farmers were still harvesting well into February, delayed by wet weather, weed contamination and lodged crops.

- Grain yields in the district were highly variable with frost and hail significantly reducing both yield and grain quality in some areas. Crops unaffected by frost or hail yielded double or more than double average yields.
- The majority of crops harvested after the heavy rains in late December were downgraded in quality but this was a relatively small percentage of total receivals.
- Hail-damaged crops have either been harvested or the stubbles slashed to avoid machinery blockages during seeding.

Mid North

2016 crops in review

- Harvest delays were very common in the later areas and harvest was still not completed at the end of February, particularly in areas hit by hail and/or frost.
- For farmers still harvesting in February a combination of poor grain quality, weed contamination and difficult to harvest crops, had reduced the urgency and enthusiasm to complete harvest.
- Grain yields of most crops unaffected by frost or hail were double the long term average.
- Hail-damaged crops with flattened stubble have either been harvested or managed in order to reduce machinery blockages at seeding. Some of these crops will most likely be burnt to make management easier.
- Grain quality has been mixed with low falling numbers and test weight in some crops and staining in others. In later finishing areas there was not much higher-quality grain.

Lower North

2016 crops in review

- Harvest delays continued during January in the later parts of the district with some growers only completing harvest towards the end of January.
- Grain yields for all crops were well above average with cereal crops 50 per cent or more above average, with the majority of grain being of good quality.

Yorke Peninsula

2016 crops in review

- Completion of harvest was delayed due to a combination of the later start, very high amounts of dry matter in paddocks, high yields and trying weather conditions. The majority of harvest was completed by the middle of January.
- Grain yields of all crops were well above average with most cereals yielding 50 per cent or more above average.
- Early-harvested crops had few quality problems while those wheat crops harvested after Christmas had low falling numbers and test weight resulting in downgrading to General Purpose (GP) and Feed.
- Barley crops harvested after Christmas were generally of poorer quality due to sprouting and reduced test weight. The majority still made a Feed 1 or Feed 2 grade.
- Most lentils were harvested prior to Christmas with the majority being of good quality. But crops harvested after this had higher levels of defective grain due to summer rainfall events.

Adelaide Hills, Fleurieu Peninsula and Kangaroo Island

Central Hills/Fleurieu

2016 crops in review

- Harvest was delayed into early February due to weather conditions.
- The quality of the last grain harvested was downgraded due to staining on cereals.
- Grain yields have been well above average for all crops despite losses prior to harvest from wind damage.

Kangaroo Island

2016 crops in review

- Harvest was very late due to grain moisture problems.
- Most wheat and beans harvested after Christmas were downgraded because of heavy rains and humidity causing discolouration or shot grain.

Lower Murray

2016 crops in review

- Wet weather throughout January delayed the end of harvest with many farmers still harvesting in mid to late January.
- Despite severe hail and wind damage in parts of the district, grain yields of all crops were well above average with cereal crops 70–80 per cent above the long term average and pulse and canola crops double the long term average.
- Wheat grain protein levels were lower than normal with most wheat classified as ASW.

Northern Murray Mallee

2016 crops in review

- Harvest was generally completed in the third week of January. This was three to four weeks later than normal, due to the late spring, summer rainfall events and some days of extreme fire danger.
- Many farmers reported their largest harvest ever, due mainly to the high yielding season, and the increased area of crop sown.
- Across the district wheat was estimated to average just below 2 tonnes per hectare, but quality was slightly down because of lower protein.
- Barley was estimated at just above 2 tonnes per hectare average with farmers delivering a reasonable amount of malt quality.

Southern Murray Mallee

2016 crops in review

- The 2016 harvest was drawn out to the end of January as a result of wet weather conditions.
- A small number of farmers were still harvesting in February.

Upper South East

2016 crops in review

- Harvest was mostly completed by the end of February with most crops yielding 30–50 per cent above average.
- Black tip affected late harvested wheat crops, resulting in some downgrading of quality.
- Above average summer rainfall has resulted in a high germination of

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summer weeds with farmers spraying during late January and February to conserve soil moisture.
- Grain prices were well below average except for canola, lentils and chickpeas.
- There are higher amounts of grain than normal being stored on-farm for future sale – particularly oats and lupins.
- A few bean crops were sprayed prior to harvest to prevent toxicity from lesser loose strife contamination. Bean yields were variable with high disease levels on red, sandy, clay-loam soils.
- There were some isolated infestations of Russian wheat aphid last season which were controlled with insecticide. Numbers remained low during spring due to the mild wet conditions.
- There is a risk that aphid numbers could build up over summer on volunteer cereals creating the potential for a 'green bridge' for pests and disease to carry-over into the new season's crops. Many farmers are planning to use insecticide in seed treatments to prevent future infestations of aphids.

Lower South East

2016 crops in review

- Most grain harvesting was completed by the end of February and harvesting of sub clover seed had begun.
- Yields of most crops were 20–30 per cent above average but some crops were not harvested due to wet conditions, particularly around Millicent.
- Barley and bean crops yielded above average, while canola and wheat yields were close to average. Canola oil content was slightly above average.
- Black tip affected late-harvested wheat crops with grain quality downgraded to feed.
- A small number of crops were infested with Russian wheat aphid but numbers were suppressed by cooler conditions and a wet spring.

PIRSA Crop and Pasture Report, March 2017

Victoria

Victorian Mallee

The 2016 Victorian Mallee season started slow with a late break but turned out to be one of the best years on record in terms of hay and crop yields thanks to a Decile 10 growing season, of which 70–150 mm fell in September alone.

Although the spring rainfall resulted in high yielding crops, it brought with it a number of diseases and pests including ascochyta/black spot in peas, leaf rust in barley and wheat crops and stripe rust in wheat. Stripe rust resistance broke down in some varieties where hot spot areas developed.

Those who held off spraying for aphid control were rewarded with good activity from beneficials. During spring there was an increase in Russian wheat aphids and damage was apparent in some crops. In pulses, heliothis, blue green aphids and etiella moths needed controlling.

As the season was advanced all year, growers were cutting oat and vetch hay one to two weeks earlier than normal and were faced with the logistical challenges that continual September rain delivered. The

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Wheat yielded in excess of 3.5 tonnes per hectare on a majority of farms in the Mallee.

hay market was good with high quality the important factor – but some growers lost out when rain fell on hay reducing quality.

Hay yields broke records but baling morphed into harvest meaning many farmers were juggling baling and harvest at the same time.

Severe lodging in barley crops caused issues at harvest, particularly in Compass barley which lodged and was also subject to head loss. Secondary green re-growth/tillers added to the frustration with some growers windrowing barley.

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Secondary tillers in barley challenged harvest logistics across the Mallee.

Yields for lentils were around 2.5 tonnes per hectare, while canola also responded well to the favourable spring yielding 2.5–3 tonnes. Cereals ranged from 4 to 6 tonnes per hectare.

Anecdotally, grain protein per cent was low across the region due to insufficient nitrogen amounts applied prior to the spring rainfall. The most common wheat quality was APW, but there were a few cases where H2 was reached.

Cereal grain prices were low at harvest time (and continue to be low) so farmers decided to purchase more silos, silo bags (plus machinery) and/or built bunkers in order to hold on to high quantities of grain in anticipation of a price increase.

Summer rain warranted weed spraying multiple times in some areas, but in other instances rainfall events were not sufficient to germinate all volunteer cereals. If there is not a significant break before sowing, this has the potential to cause in-season issues such as 'wharley'.

As we move in to the 2017 season, growers have been turning to burning paddocks in order to manage stubbles prior to sowing, and improve herbicide efficacy. For those that haven't burnt stubble – and to

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combat herbicide efficacy issues – they're increasing water rates to ensure good coverage.

The increase in mouse numbers has become more apparent as there are more paddocks being burnt. The number of mouse holes in some cases represent plague proportions – but a plague has not been declared. As a precaution, baiting has happened in the days and weeks leading up to sowing or in sync with sowing.

There's some concerns of disease carryover from last season. Growers will have to keep a close eye on crop health during the season. There's been a lot of soil sampling happening to determine soil water and nutrition status – adjustments to fertiliser budgets are being made as a result.

Ciara Cullen
BCG extension and communications manager

New South Wales

NSW state summary

Thanks to a very favourable season in most districts, total 2016 winter crop production in New South Wales is estimated to have increased by 43 per cent on 2015 to a record high of 16.3 million tonnes. This was driven by significant increases in the production of wheat and barley.

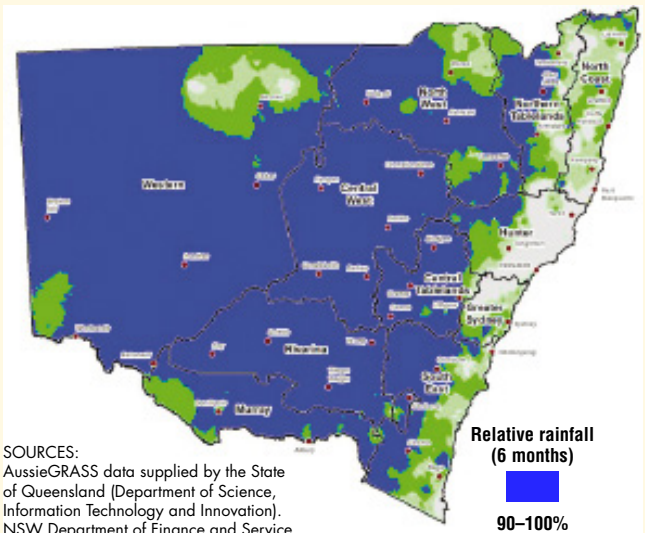
Wheat production is estimated to have increased by 52 per cent on 2015 to around 11.4 mt giving a state-wide average yield of a record 3.3 tonnes a hectare.

Barley production also soared by an estimated 43 per cent in 2016 to a record 2.7 mt, again reflecting a record yield of 3.1 tonnes a hectare.

Canola production is estimated to have increased marginally in 2016 to around 842,000 tonnes, despite a 9 per cent fall in planted area. This has given an average yield of 1.7 tonnes a hectare.

State-wide rainfall from June to December 2016, was well above average (see chart) and in a number of districts, waterlogging adversely affected crops. But overall, yields were still high in these affected regions.

Rainfall relative to historical records – June to November 2016



SOURCES:
AussieGRASS data supplied by the State of Queensland (Department of Science, Information Technology and Innovation). NSW Department of Finance and Service and NSW DPI.

The 2016–17 summer crop

Seasonal conditions in NSW during November and December 2016 were not favourable for dryland summer crop planting. Below average rainfall was accompanied by above average temperatures – and these unfavourable conditions continued into January.

High temperatures during January and February accelerated summer crop growth and increased crop water requirements. Dryland summer crops were stressed and yield prospects suffered. Even irrigated crops in the north were subject to heat damage. The area planted to 2016–17 summer crops in NSW is forecast to have increased on the previous summer by 50 per cent to 655,000 hectares. This is largely on the back of an increased supply of irrigation water – which growers mainly allocated to cotton and rice – and favourable planting conditions early in the planting window for dryland cotton.

During March 2017, rainfall was above average particularly in north eastern, northern, central and coastal NSW. This early autumn break allowed preparation for the winter crop to get underway as well as the planting of dual purpose cereals and canola.

Source: NSW DPI and ABARES *Australian Crop Report*

Liverpool Plains

The 2016 winter crop in review

The 2016 winter crops across the Liverpool Plains generally experienced a very good season – as did most of the national grain belt. This meant that headers were in high demand. Harvest weather was good with minimum storm activity.

Cereal yields were around average, and quality was good. Chickpea yields were also pleasing.

Summer crops

On our farm we planted 50 cm spacing sorghum which yielded well due to being under good storms in late December. We received our fair share of hot dry weather in January/February – but thanks to the long fallow – the sorghum held on.

Sorghum harvest underway on the Liverpool Plains.

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This year we experimented with 'multi-hybrid' planting – two varieties (Scorpio/Taurus) were planted based on soil types across the paddocks.

At the time of writing this report, Scorpio seems to be out performing Taurus by 0.8 tonnes per hectare, with yields averaging in the 7 to 8 tonnes per hectare range. But there are some small areas of low yielding sorghum of 4 to 5 tonnes.

On the Liverpool Plains sorghum has been below average with the severe summer heat and lack of rain at critical times. Exceptions to this were in the Bundella/Premer Valley and some crops at Blackville that were lucky enough to be under some good storms.

Otherwise yields varied from 2 to 3 tonnes per hectare at Mullaley through to 5 to 6 tonnes around Spring Ridge on good long fallows. Quality has varied too with a mixed bag of Sorghum 1 and Sorghum 2 across the Plains.

Dryland cotton was generally disappointing. Yields varied from 1.5–4.5 bales per hectare with most around the 2 to 3 bales per hectare mark. Quality is down with significant discounts expected once ginned

Sorghum yields on the Liverpool Plains have varied widely from 2 to 6 tonnes per hectare.

On the McGavin farm, 50 cm spaced dryland sorghum on long fallow, held on well through a difficult summer.

and classed. Strippers are scarce given the large dryland acreage around Moree.

Irrigated cotton is looking good with average yields expected due to long periods of high temperature and water application not keeping up with daily crop water use in January and February.

Prospects/trends in 2016

Winter plant will see plenty of durum and bread wheat go in – canola is also a popular choice. Faba bean area will be less than average while chickpea area will be up again on last year on the back of good prices for old and new crop.

Short fallows have a way to go before full profile is reached. Long fallows vary from 60–90 per cent full.

With this soil moisture scenario, the Liverpool Plains is in need of rain shortly to firm up winter crop planting.

Lauren McGavin
Precision Seeding Solutions, Premer

Queensland

Central Queensland

Winter crops 2016

Seasonal conditions: The proceeding summer to the 2016 CQ winter crop was extremely dry with little fallow rainfall, with the exception of some falls in March. And almost nothing fell during the normal planting window (April and May). This was in contrast to the uncharacteristically wet period that later developed between June to October. With rainfall totals of 310 mm at Clermont, 320 mm around Emerald, 270 mm at Rolleston and 225 mm around Biloela – there was plenty of moisture about.

With the start of the wet period in June – where 50–120 mm fell across the cropping areas of CQ – a late plant of wheat and chickpea was possible. Summer temperatures carried into May (34°C) with a very hot start to winter. Rain brought on more mild temperatures during spring

This crop of Reese wheat yielded 4.5 tonnes per hectare in the Wowan area (Callide Valley).

which extended flowering conditions and grain fill. There were few frosts with very little crop damage.

Wheat: Lack of planting rain in April and May delayed wheat planting until late June. Rainfall and low wheat prices (and very high chickpea prices) saw a below average area planted to wheat – approximately 100,000 hectares. Thanks to in-season rain, wheat yields were well above average at 2.5–3.5 tonnes per hectare.

Chickpeas: Most farmers hit the chickpea trifecta – high yields, excellent quality and high prices. A record 150,000 hectares (or more) was planted to chickpea with yields averaging 2–2.5 tonnes per hectare; prices were $900–$1100 per tonne port. CQ produced a chickpea crop worth an estimated $250 million.

Dry conditions in the main winter planting window left chickpea as the only planting option which contributed to the large area planted. The region ran short of fungicides and was one or two rainfalls away from disaster, with ascochyta blight and moulds present in many crops. Ascochyta was found on the Highlands and around Theodore. Moulds resulted in some loads being rejected. GrainCorp created a specialised low mould category to help deal with the issue.

Summer crops 2016–17

Seasonal conditions: The 2016–17 summer was hot and dry! There were patchy storms but no district-wide rain fell until March, which was after the sorghum planting window had closed. Cyclone Debbie deposited 100 mm on the northern and southern Highlands with 50 mm in the central part of the Highlands at Emerald. Extreme falls were recorded further east, with 225 mm near Dysart and 185 mm at Jambin. Between 300–800 mm fell on the eastern coastal ranges which resulted in severe flooding.

The Callide, Dawson, Mackenzie, Issac, Connors and Fitzroy valley cropping areas were effected by flooding running off the eastern ranges.

As of the third week in April the Fairbairn dam was 45 per cent full (595,787 ML)

Sorghum: There was very little sorghum planted in the Central Highlands or the Dawson Callide valleys – probably less than 30,000 hectares. Very low prices and dry conditions contributed to the negligible sorghum crop this summer.

Mungbeans: Dryland mungbean planting followed the same pattern as sorghum. A few thousand hectares of spring planted beans in the Dawson Callide had a good start but struggled with a dry hot finish, with below average yields and some crops were even abandoned. There was a small number of summer planted beans on the Highlands (under storms) and some more in the Callide, but areas were down on average.

Cotton: Between 5000–7000 hectares of dryland cotton got off to a great start on the Highlands but then encountered dry hot growing conditions and performed poorly – with many failing.

Irrigated cotton had a stellar year. Yields were 2 bales per hectare above average. Most yields on early planted cotton ranged from 9.5 to 11.5 bales. Later planted cotton is still experiencing a two bales yield advantage on average (but on lower yields) with a few quality concerns.

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This crop of Kyabra chickpeas (near Capella) yielded 2.5 tonnes per hectare, despite ascochyta blight infection.

2017 winter crop prospects

Currently (mid-April) there is a large area of fallow country in CQ (over 550,000 hectares), most with a good moisture profile from March rain. Much of this area is anticipated to be planted to wheat and chickpeas. The pricing situation favours chickpeas which will be the preferred crop.

It is anticipated last year's chickpea country will be planted to wheat and as much area planted to chickpea as possible (considering rotations), with any remaining cropping areas planted to wheat.

There could be 150,000 to 200,000 hectares of chickpea and 300,000 hectares of wheat.

Winter crop planting has already started in the northern Highlands with early April planted wheat going in straight after Cyclone Debbie.

Chickpea planting has not started yet but will kick off in a big way come May.

The large winter and chickpea crop will put pressure on fertilisers, fungicides, herbicides and seed supplies with the new ascochyta blight resistant chickpea variety PBA Seamer being popular. There could be in-season shortages of fungicides and insecticides if the chickpea crop is as large as anticipated and conducive climatic conditions occur.

All in all the 2017 CQ winter crop is shaping up to be another cracker, with already sufficient soil moisture to grow most crops through to harvest. Additional rain will be required to plant wheat. In-crop rain will add yield to almost assured crops and we could easily produce above average yields in 2017.

Alarmingly, there have been several stories of farmers who intend to grow back-to-back chickpea crops in 2017, many with the new ascochyta blight resistant variety PBA Seamer. Yes, chickpeas are our most profitable winter crop at the moment – BUT this is only single gene resistance which can break down quickly. Back-to-back cropping is an open invitation for resistance development.

Conveying this message to all stakeholders in the grains industry, and getting them to take ownership of good crop stewardship, will be a challenge moving forward.

Hard to manage weeds continue to pose a major threat to the cropping sector. This is particularly the case with low stubble levels, long fallows, missed summer crops and poor stubble left after 2016 chickpea crops.

Max Quinlivan
Experimentalist, Crop and Food Science
Qld Department of Agriculture and Fisheries

Darling Downs

Overview of the 2016 season

A difficult year of variable weather conditions has shaped the winter and summer seasons. Winter planting was late but good in-crop rain led to strong yields, with chickpeas leading the way with a record planting.

Winter 2016

The main crop of choice was chickpeas, with forward prices over $900 per tonne being offered, and the area was up 30 per cent with the cereal area dropping by a similar amount.

After the El Niño broke down last autumn, it took a while for the rain to start. This significantly delayed the winter crop planting. Deep planted chickpeas went in during May, but it took until late June for enough moisture to accumulate to allow general planting and this continued until late July. Mice were an early problem, along with pigs – especially in chickpeas.

As the season progressed, continuing rainfall built up moisture profiles for the summer but provided ideal conditions for disease. Almost every chickpea paddock was attacked by ascochyta, but with AVPMA permits issued following Pulse Australia input, there was just enough fungicide to go round and contain the disease.

Late in the season BGM (botrytis grey mould) appeared, but dry conditions arrived and helped stop the disease spread. But cereal crops showed little disease.

The end result was that not only did the chickpeas get away with disease, but returned on average 0.5 tonnes per hectare above the long term average leading to excellent returns – despite the extra fungicide costs.

Wheat and barley also yielded strongly, so the 2016 winter crop was a success.

Summer 2016–17

It is a tale of two summers. The spring plant started in mid-September with gritting and silage corn and sunflowers the first crops sown. These were followed by a very much reduced area of sorghum while the dryland cotton area doubled from 2015.

This was due to Bollgard 3's reduced restrictions and a strong cotton price compared to a weak sorghum price. This first plant though had to cope with some cool weather and the rainfall tap turning off after September, and all crops struggled, leading to some of the lowest yields seen for some time.

Irrigated mungbeans being harvested on the Darling Downs – there were weighbin tested crops at up to 2.84 tonnes per hectare.

Mungbeans have been the big winners this summer on the Darling Downs. Dryland crops are only coming in at about 0.7–1.5 tonnes per hectare, but with overhead rather than flood irrigation, irrigated crops are giving a very good return.

It was also very hot, and although there was some planting rain in January, growers had to be quick to establish crops. The main crop planted was mungbeans, due to favourable prices, along with some corn, dryland soybeans and sunflowers – but this was a later than usual planting.

These late crops did very well to survive a hot and dry January and February. And when exceptionally good rain arrived in March, capped off with the rain from Cyclone Debbie leading to 200–250 mm for the month, the crops responded. Mungbeans are now (mid-April) being harvested with overall fair yields, and the late sunflowers and soybeans look good. Late sown corn has generally coped well with disease, and overall insect pressure has been light to medium.

One pest that has increased this season is Rutherglen bugs, and it has moved into crops it does not normally attack.

Cotton yields are totally dependent on the amount of stored moisture and number of irrigations, with disappointing to average yields the result.

Overall the summer crop returns will only be average, as yields are low to average and prices low to good, depending on the crop. But in some cases it is a triumph to produce any crop at all. The biggest winner over the past 12 months appears to be the pulse crops.

Outlook for winter 2017

At the beginning of March the outlook was very poor, but with so much soaking rain in the month, winter prospects are now fair to good, and there will be another record planting of chickpeas. This is due to strong chickpea prices and weak cereal prices.

But there will be a lot of disease to cope with, especially as growers shorten rotations to fit the crop in.

Cropping trends

Chickpeas, mungbeans, soybeans and sunflowers have given the best returns this past 12 months, and that trend looks like continuing, along with cotton interest, again due to price. Cereals are being grown as much for rotation purposes as for stand alone profitability.

Hugh Reardon-Smith,
Agronomist Landmark Pittsworth

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Section 5

Managing Resistance

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Multiple resistance is a game changer for herbicide tolerant crops

American farmers seem to have regained the upper hand on glyphosate resistant Palmer amaranth and waterhemp, which had overwhelmed many crops from 2008 to 2012, but there are still some longer term challenges. Similar challenges face Australian growers.

Jason Norsworthy, professor of weed science at the University of Arkansas says that although many paddocks are cleaner than they have been for years, he doesn't believe that the current weed management practices are sustainable.

In the US, herbicide tolerant varieties and hybrids have come to dominate in the sown areas of cotton (89 per cent), soybean (94 per cent) and corn (89 per cent) across all regions. The soybean and corn growing regions overlap significantly and there are some regions where all three crops are grown.

Jason says many growers in the US are now only one or two herbicides away from having no herbicide control options for Palmer amaranth in either conventional or herbicide tolerant soybean crops.

"Four modes of action are already lost on many populations of Palmer amaranth," he says. "The multiple-resistance to these four modes of action is a real game changer for growers. It is simply not sustainable to use a herbicide or a technology until it breaks and expect to be able to switch to another option."

The practice of continuing to use a herbicide after resistance had established is one of the key reasons why many growers are in a serious predicament, according to Jason. He says that ALS (Group B) resistance has inevitably led to glyphosate (Group M) resistance, which has in turn led to PPO (Group G) resistance. It is only a matter of time before PPO (Group G) resistance is also widespread in weeds like Palmer amaranth.

Australian Herbicide Resistance Initiative (AHRI) director, Stephen Powles in a soybean trial plot in America overwhelmed with herbicide resistant Palmer amaranth (pigweed), a prime candidate for harvest weed seed control.

Jason Norsworthy, professor of weed science at the University of Arkansas says many growers in the US are now only one or two herbicides away from having no herbicide control options for Palmer amaranth (pigweed) in either conventional or herbicide tolerant soybean crops.

"PPOs are currently being applied both at planting and in-crop in soybean crops where there are few other herbicide options," he says. "This high selection pressure will inevitably lead to failure of the herbicide leaving growers with dicamba (Group I) products as their last resort."

The use of low rates of dicamba in corn crops has already exposed many weed populations to low dose selection to this mode of action and researchers have demonstrated full dose dicamba survivors can evolve in just three generations in Amaranthus spp.

Lessons for Australia

In Australia, there are almost as many species resistant to glyphosate (13 species) as are present in the US (15 species) – but there are not as many herbicide tolerant crop options.

Jason suggests that Australian growers continue to adopt diverse weed management practices, including harvest weed seed control, competitive crops, strategic tillage and pasture phases rather than over-relying on herbicide tolerant hybrids as they come available.

"We are encouraging American growers to look more toward non-herbicide practices to try to break the cycle of over-reliance on single herbicide modes of action," he says. "Once multiple resistance takes hold there really are less options available and most of them will have a production penalty, but if these practices are not adopted then production systems will fail."

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

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Spray small multi-resistant radish twice

Australian growers are regaining control over herbicide resistant weeds as a result of widespread adoption of integrated weed management systems. Australian Herbicide Resistance Initiative communications manager, Peter Newman, says many crops are cleaner than ever and growers should be acknowledged for their consistent efforts over many years to implement a wide range of herbicide and non-herbicide tactics to drive down the weed seed bank on their farms.

"There was a serious problem here (WA) over the past two decades and growers have now made managing herbicide resistance in weeds a component in every farming system," he says. "We were caught once, and had to learn the hard way. Hopefully growers in other areas will be able to take advantage of the experience and research that has helped WA growers get back in the driver's seat with weed control."

One piece of research that the GRDC's Regional Cropping Solutions Network in Geraldton requested in 2012 and 2013, has given growers additional confidence when managing herbicide resistant wild radish.

"The objective of the two-year study was to identify paddocks that had high populations of wild radish that was resistant to several herbicide groups," says Peter. "Although Velocity (pyrasulfatole + bromoxynil, Group H/C) was working well in most situations, growers were aware that if there was over-reliance on the one product that soon enough, that option would be gone."

"Some growers were using two or three shots of Velocity in a single growing season and they had little confidence in other herbicides due to their radish being multiple resistant."

The first year trial achieved a 22 to 36 per cent yield improvement when wild radish was controlled and the researchers established that the key strategy was to spray the wild radish as early as possible while avoiding any crop damage.

"Applying Velocity at the two-leaf stage of the wheat crop is safe for the crop and kills the majority of the small – one to two leaf stage – wild radish plants present," Pete says. "When this is followed with a second spray of a herbicide from another mode of action at the crop's five-leaf stage – when the radish is no bigger than four-leaf stage – the level of control is very high even in multi-resistant wild radish populations."

Spraying small radish twice is a proven tactic to combat multi-resistant populations.

Even multi-resistant wild radish plants succumb to a second herbicide spray provided the first spray is applied when the radish plants are small.

This strategy was tested on three properties in the Geraldton area in 2013 and proved very effective. Grant Thompson from Crop Circle Consulting and Landmark led the trial work in 2013 and says the result that was the most surprising was that there were many options available for use as the second spray.

Many options for second spray

The paddocks chosen for the trials all had known resistance to a wide range of herbicides from mode of action groups B, C, F and I.

"Provided the paddock was sprayed early with a product that did not damage the crop, it didn't make much difference what herbicide was used for the second spray," he says. "This was a great result for growers as it gave them more opportunities to rotate modes of action across the whole rotation.

"For example, growers may choose to use Jaguar (Group F/C) as the first spray in cereals and avoid using Velocity twice in the one season," he says. "Jaguar applied at one litre per hectare when the wheat is two-leaf and the radish is one to two-leaf is giving excellent control of the first cohort of weeds in most situations."

The trials also highlighted the importance of achieving excellent coverage with each spray. Grant stresses the importance of using the correct adjuvant, appropriate nozzles and not skimping on the water rate.

Treating the wild radish early was very important for preserving yield. Even with one early spray, all registered treatments doubled the grain yield over the nil treatment. The second spray helps achieve optimal weed control while remaining profitable.

In the two-spray system the herbicide applications cost $19 to $29 per hectare and achieved a yield benefit worth an average of $90 to $130 per hectare, and as high as $260 per hectare in very weedy situations.

Knowing the herbicide resistance profile of the weeds present helps growers to choose the mode of action herbicide most likely to give the best results. Herbicide resistance testing and an array of integrated weed management strategies are detailed on the Weedsmart website.

When followed with a harvest weed seed control tactic such as narrow windrow burning or chaff cart, the contribution of new seed to the weed seed bank can realistically be zero. Consistently applied over several seasons you can see the weed population driven right down and – if there are no weeds – there are no herbicide resistant weeds.

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

SECTION 5 MANAGING RESISTANCE
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Why do pre-em herbicides last so long before resistance bites?

By Australian Herbicide Resistance Initiative

Once in a while, someone comes along and asks a question that you have never given much consideration to.

Questions like:

- "Why does beer garden beer taste so bad?" or,
- "Why do hotels always give away piles of stuff except for what you actually need, like a toothbrush or a razor?" and,
- "Why do our pre-emergent herbicides last longer than our post-emergent herbicides before resistance bites"?

Sure, we had probably considered this question in the past, but many of us would have just assumed that the gene frequency for resistance to our pre-emergent herbicides was low.

But Gayle Somerville, who recently completed her PhD at AHRI, has looked at it in a different way and has come up with an alternative answer. She undertook detailed computer modelling to look at the population dynamics of annual ryegrass.

She found that pre-em herbicides are slow to evolve resistance for two main reasons:

- It's all about numbers. Pre-em herbicides such as trifluralin are short-lived in the soil and may only be exposed to about 20 per cent of the total ryegrass seedbank, whereas post-em herbicides are applied later in the season and may be sprayed over 40 per cent or more of the total seed bank. The more weeds a herbicide is exposed to the higher the chance of resistance; and,
- The post-em herbicide can protect the pre-em herbicides – like a double knock – killing any weeds that have survived the pre-em.

This will have major implications for our cropping future as we are now more reliant on pre-em herbicides and resistance to our post-em herbicides is becoming more common.

AHRI researcher Gayle Somerville.

Short-acting pre-em herbicides

Figure 1 below shows that a short-lived pre-emergent herbicide such as trifluralin is only exposed to a reasonably small number of ryegrass, whereas the post-emergent herbicide, applied much later in the growing season, is exposed to a greater number of ryegrass.

In simple terms, the pre-em herbicides are exposed to a small number

Figure 1: Ryegrass and exposure time to pre and post-emergent herbicides

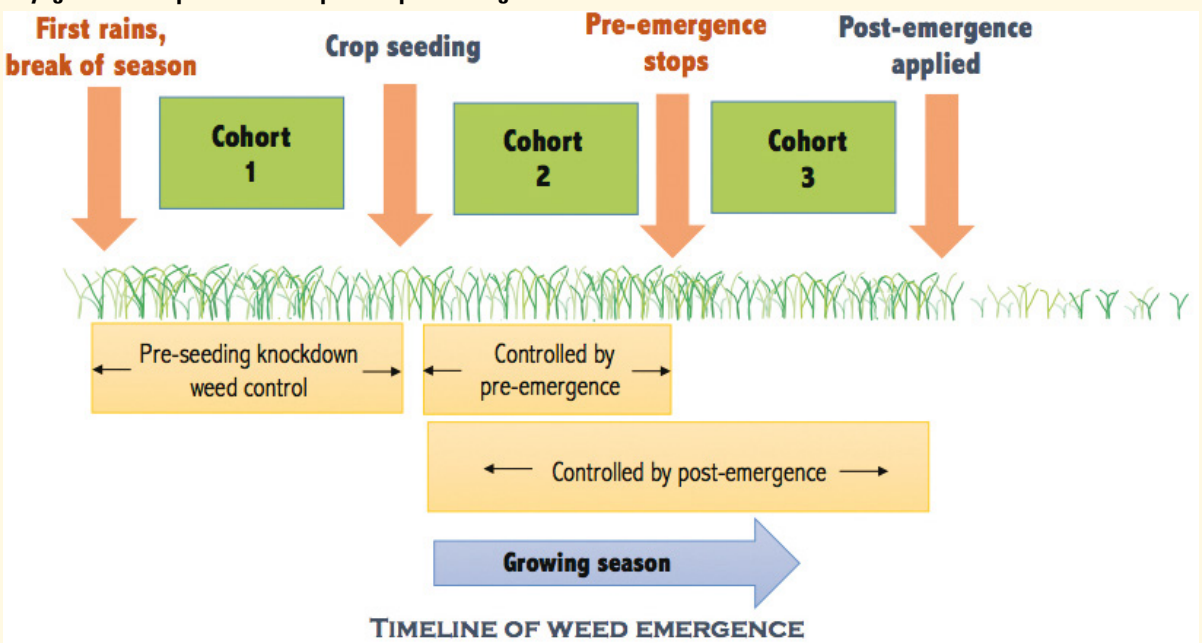


Figure 2: Ryegrass and longer persisting pre-emergent herbicides

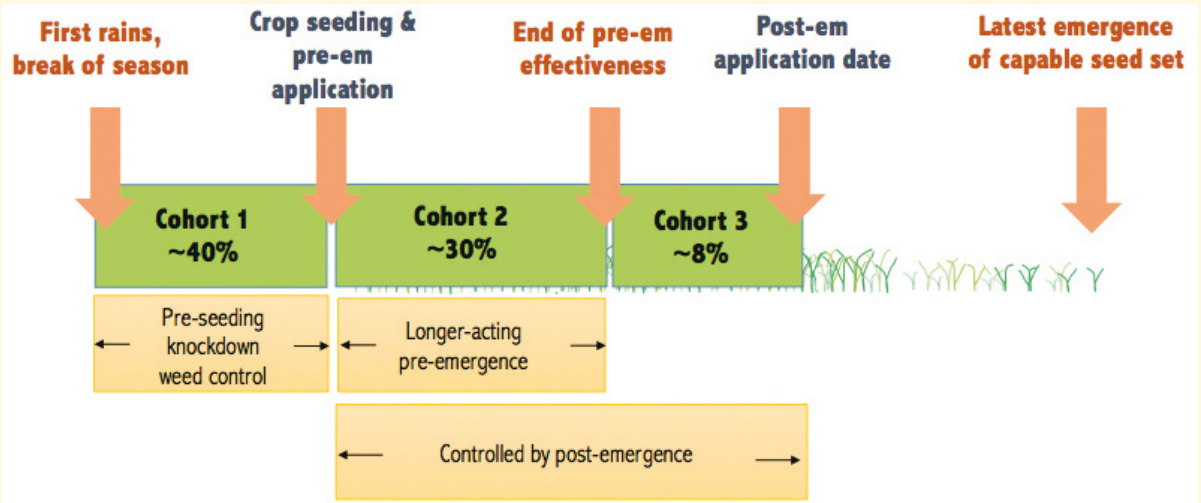
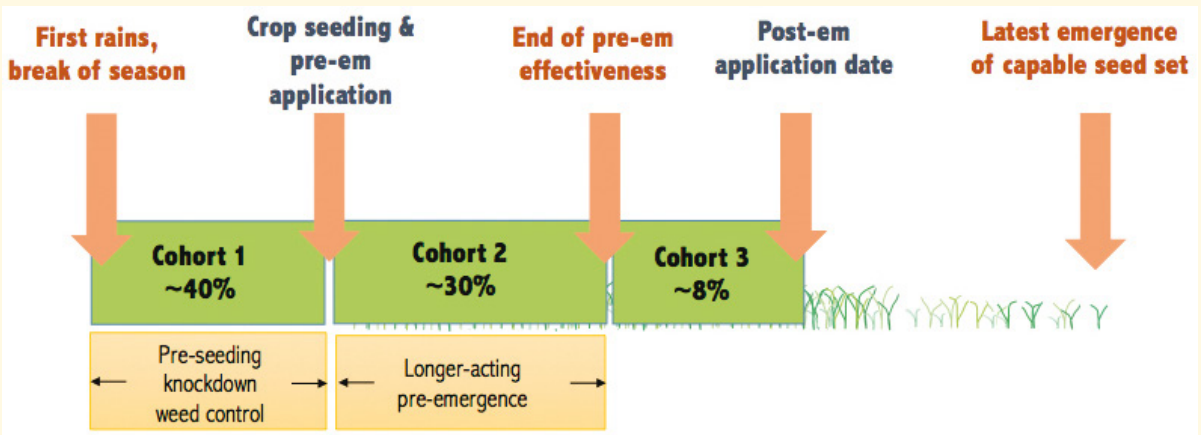


Figure 3: Ryegrass and longer persisting pre-emergent herbicides without a post-emergent option



of weeds and may get a double knock when a post-em is applied later, reducing the risk of resistance.

While the post-em is still working, resistance to the pre-em is unlikely. But this can all change if resistance evolves to the post-em herbicide.

The post-em herbicides are exposed to more weeds and late germinating weeds (Cohort 3) only get a single knock because the pre-em herbicide has worn off.

Longer-lived pre-em herbicides

If we now consider pre-em herbicides that persist longer in the soil such as Sakura or Boxer Gold, we see in Figure 2 that Cohort 3 is now much smaller. This is closer to being a double knock and the pre-em and post-em herbicides can look after each other a little more. There is still late germinating ryegrass that is only exposed to post-em herbicides but they are now fewer in number.

On the flip side, if a long acting pre-em is applied and there is no post-em herbicide option, there's an increased risk of resistance evolving to the pre-em as it's exposed to more weeds and there's no 'second knock' (Figure 3).

What about dry seeding?

When we dry/early sow, we don't get the opportunity to remove Cohort 1 with knockdown herbicides and we are totally reliant on our pre-em and post-em herbicides.

With no knockdown and widespread resistance to post-em herbicides such as Diclofop and Clethodim, we now have a lot of pressure on our pre-em herbicides.

To sum up

In the past in Australian cropping systems, we have often achieved a knockdown of weeds prior to seeding and we were fortunate enough to have effective pre-emergent and post-emergent herbicides to choose from.

Now our modern farming system often relies on early sowing without a knockdown, and resistance to many of post-emergent herbicides is common. We need to understand that while we are fortunate to have several effective pre-emergent grass herbicides, these herbicides are now under greater pressure.

Resistance to pre-emergent herbicides has evolved slowly in the past, but this may not be the case in the future.

Contributing authors: Gayle Somerville, Prof. Steve Powles, Dr Michael Walsh and Dr Michael Renton

Paper: Why was resistance to shorter-acting pre-emergence herbicides slower to evolve? ■

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Section 6

Precision Agriculture

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The what, where and why of weed sensing

By the Society of Precision Agriculture Australia

At the heart of 'weed sensing' is the use of a machine or instrument to detect a weed; a plant that shouldn't be there. It is achieved by an optical sensor directed at the ground, using light reflectance to detect the presence of a green plant/weed as the sensor unit lights it up.

Weed sensors are broadly used for:

- Optical Spray Technology (OST) – principally used for broad spectrum summer and fallow weed detection and spraying; and,
- In-crop weed detection – this is the sensing and identification of non-crop plants within the growing crop.

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In-crop weed detection is not as advanced, nor as widely used in broadacre applications, as optical spray technology.

Optical spray technology systems

There are two commercial OST units currently on the market. And there are a number of reviews available online comparing the WEEDit and Weedseeker units. The main points of difference are:

- WEEDit are generally tow-behind units to eliminate boom height variations. WEEDit uses one sensor eye with five lens controlling five nozzles per one metre spacing on the bar.
- Weedseekers can be fitted to tow behind or self-propelled sprayers. Weedseeker uses one sensor for each nozzle.

The capacity of your soils to store summer moisture and the incidence of summer rainfall are important considerations in contemplating purchase of an OST system. In many parts of southern

OPTICAL SPRAY TECHNOLOGY

Benefits

- Significant reduction in chemical usage with resultant cost savings.
- Timeliness of spraying weeds at a smaller, younger stage at higher water volumes when plants are more susceptible to lower chemical rates.
- Cost effective alternative to blanket spraying operations.
- Cost effective alternative to summer tillage operations and therefore potential increased protection of fragile soils and retention of soil nutrients, summer moisture and organic matter.
- More environmentally sustainable than tillage options.
- Reduction in community exposure to farm chemicals.
- Ability to use higher rates strategically on hard to kill weeds.
- Spraying in otherwise adverse spraying* conditions e.g. higher Delta T.
- Use in low light or night time operation.
- Fewer fills per day and therefore improved spray work rate.

Limitations

- High cost of spray system and bar (approx. $4000 per metre).
- Some spray bars have needed increased engineering because of high maintenance requirements.
- Increased number of trips over paddocks in summer for optimum moisture saving, requiring extra labour.

IN-CROP WEED SENSING

Benefits

Drones and aircraft

- Drones are used to produce maps on a needs basis.
- Price of suitable drones is reducing.
- Can produce high resolution imagery.
- Ease of use of drone and software controlling drones.
- Relative rapid turn around time for production of paddock maps.
- Predominantly using NDVI imagery and patching by eye or creating spray prescription maps.

Satellite

- Satellite image maps are very cheap per unit area.
- Satellite maps are quality controlled for data - altitude, angle and luminosity.

H sensor technology

- In testing phase but exciting new possibility with capacity to 'learn' new weeds and expand its database of weeds.
- Future capacity to operate on the fly, similar to OST systems.
- There are a number of groups working in this space globally.

Limitations

- Sensing and spray application are two separate paddock operations (plus a possible ground-truthing trip).

Drones and aircraft

- Limited flight time and tight flight weather conditions required.
- Requirement for high speed internet connection for upload of images for processing.
- Inconsistency and lower quality of data from drones requiring higher processing due to variations caused by clouds, time of day – sun angle, camera angle, yaw and pitch in the drone flight, and luminosity at time of flight.

Satellite

- Cloud cover at satellite fly-over, delays timely production of images and extended periods between satellite images.

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Correction Services

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WEEDit spray bar with sensors on the left and nozzles on the right.

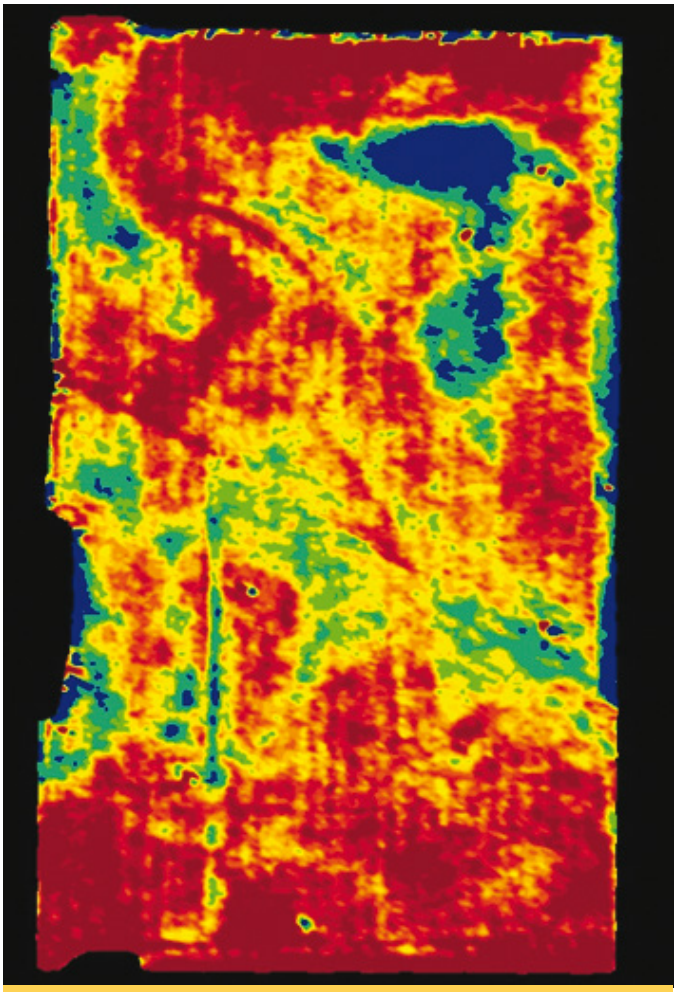
Australia, where the farming system is able to store significant summer rain in the subsoil, the French-Schultz yield potential model and experience shows that a third or more of this moisture is available for the following crop; boosting yield and or grain quality.

OST systems use Near Infar Red (NIR) and red light sensing technology to detect living green material on the ground.

In response to the presence and absence of living green plant material the sensor controls nozzles on a boom spray, switching on and off as it detects green plant material and in this way spraying only those areas of a paddock covered by weeds. The manufacturers claim an 80 per cent reduction in chemical usage in a normal summer spraying operation.

In the accompanying case study, Robin Schaefer – who farms Bulla Burra in low-rainfall country near Loxton, SA – receives about a third of his rainfall out of the growing season (an average of 172 mm GSR).

Summer active weeds such as melons, heliotrope, fleabane, skeleton weed and caltrop quickly deplete soil moisture reserves. Saving summer moisture for use in six months time often determines the success or failure of Robin's crops.



NDVI image of a field pea crop with patches of brome grass, wild oats and ryegrass. Grass weed patches are represented by high NDVI in blue and green.

Farmers will debate and delay spraying summer weeds 'until more weeds are up' because of the cost of blanket sprays. James Hunt (CSIRO) confirms that controlling summer weeds early saves moisture and nutrients – control should start promptly (10 days) following germinating rains.

The OST systems are a cost effective means of controlling weeds early without excess cost. In the Bulla Burra case, it often means another weed control pass over summer.

In-crop weed sensing technology

NDVI technology has been used in a range of crops and environments for limited application of mapping of weed populations in-crop. There is promising on-going work with a SPAA project investigating the Agricon H Sensor – a weed ID and mapping system.

NDVI maps can be generated from tractor mounted sensors, UAVs or aircraft with NDVI cameras, or from airborne image service providers.

Remote and proximal sensors measure vegetation indices – most

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commonly the normalised difference vegetation index (NDVI) – and can be used to discriminate weed infestations from weed-free crop.

Sensing platforms can include satellite, aeroplane, UAV, and vehicle mounted sensors such as Greenseeker, N-Sensor, Crop Circle and Crop Spec. These sensors are not connected to nozzles sprayers but used to map weed populations for later treatment.

Mapping and spraying of weeds identified in-crop is then a separate paddock operation to the sensing.

Maps produced by these techniques identify the location and extent of weed infestations but not the weed species.

The success of this approach and the weed densities detected are affected by differences in growth rates of weed and crop, time of emergence, differences in vigour, timing of flowering and maturity.

Mark Branson, Stockport, SA, uses a rotary wing UAV to scan and photograph a paddock for weeds. The flight may produce 500 high resolution colour digital images, which are uploaded to a suitable image processing provider (eg Drone Deploy) for specialised processing.

A digital geo-referenced image of the paddock is produced from which weed zones are identified by eye and can be 'zoned' in a spray prescription map or sprayed by 'patching' out by eye. The UAV flight time is limited by battery life.

The success of this is restricted to early crop stage; nevertheless Mark is able monitor trends in weeds population.

Machine vision weed sensors will be the next generation of sensors that advance the capability of site specific weed management. They identify weeds within a growing crop based on shape parameters from high resolution images. Crop and weed shape features are extracted from the image and compared to a database for classification.

There are a number of groups working in this space globally. A SAGIT funded project is currently investigating the capability of the H-Sensor for application in South Australian cropping systems.

Developed in Germany by Agricon, it is designed to identify weeds within a growing crop. It uses leaf shape and size parameters to classify different plants into different shape classifications. The sensor can directly control a sprayer or can be used to generate a map for later use.

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CASE STUDY – Robin Schaefer, Bulla Burra, Loxton SA

Robin moved into weed sensing technology with the purchase of a WEEDit at the end of 2013. Since then it has been used for the past three seasons in summer weed control across the farm.

Robin said their focus on sustainability and farm performance over a large cropping program is what led them to buy a WEEDit optical spot sprayer.

The 11,000 hectare yearly cropping program presents some challenges such as being able to target problem weeds but to also maintain operational efficiency when running one self propelled sprayer over such a large area.

The WEEDit was considered not only for the ability to save on the overall chemical costs but for the capability of targeting harder to control problem weeds such as fleabane, skeleton weed and feathertop Rhodes grass. These typically require higher chemical rates to control but a blanket spray would be uneconomical to apply over such a large area.

The WEEDit, being a separate unit, could also support and compliment the use of the self propelled sprayer.

The key benefits of the WEEDit at Bulla Burra:

- Ability to selectively spray over a large area.
- Higher rates can be used more economically on harder to kill weeds.
- Allows spraying to occur in more marginal conditions where a blanket spray could not be justified.
- Overall chemical cost savings which vary depending on the season and weed cover.
- It allows earlier blanket spraying on smaller weeds as the WEEDit can clean up remnants assisting with reduced herbicide resistance.
- Potential for improved paddock water use efficiency with the eradication of tough weed populations that can otherwise be drawing moisture.
- Less risk of chemical trespass.

Robin suggests that on its own this machine may not significantly influence overall profit but due to many variables (eg. summer rainfall) it has been difficult to quantify.

Robin Schaefer.

Being able to save time when spot spraying to cleaning up after blanket sprays – as well as relieving the burden on the sole spray unit – are some of the factors influencing profit.

Some of the barriers that Robin believes may impact others implementing this technology are mainly around the cost of the technology and being able to leverage from the investment effectively. Robin considers it is important to buy a WEEDit according to the size of the farm to help manage the capital investment.

In the environment of the SA Mallee, the machine did have mechanical issues that have largely been worked through and fixed. Some of the ongoing problems include dust on the lenses or struggling to detect weeds that are stressed and have low chlorophyll levels.

There can also be problems with false sensing due to infrared light from sunlight causing "miss-fires".

Robin suggested that through much of the post harvest summer, a full time labour unit is employed on the WEEDit. This is due to the slower speed at which the WEEDit operates – 18 km per hour instead of the usual blanket spray speeds of 28 to 32 km per hour.

There has also been an increase in the amount of complexity involved with running the WEEDit.

Despite the high capital costs and economic variability year to year, the WEEDit is "a no-brainer economically" as a profit driver for Bulla Burra when integrated alongside the self propelled sprayer. ■

Variable Rate Technology – is it for me?

Precision Agriculture (PA), using Variable Rate Technology (VRT) is seen by some grain growers as an obvious and on-going gradual progression in refining their farm management program. But others are either daunted by the new technology, or can't see the benefits outweighing the cost of purchasing new machinery.

VRT involves developing a management strategy to vary inputs rather than applying them as a blanket rate at paddock scale.

The required technology and machinery is easier to use and more affordable than ever before, but many growers are still sitting on the fence when it comes to adopting PA. Their usual causes for reticence include: the expense in getting new machinery, paying for expertise support, difficulty in understanding the technology, access to technical support, and the amount of time needed to learn and implement the technology.

The technology

There are many ways to utilise VRT, but all methods require spatial information and software to apply the input in variable rates at the desired location. And so, the Global Navigation Satellite System (GNSS) that encompasses the global network of satellites such as GPS (US), GLONASS (Russia), Galileo (EU) and Compass (China) as well as other regional systems, are key to generating the location data.

Geographical Information Systems (GIS) is the software that stores, manages and allows you to manipulate spatial data.

These are the two key technologies that underpin VRT.

While GNSS allows producers to identify field locations so that inputs can be applied at the correct rate on a specific area, GIS technology allows users to store field input and output data as separate layers in a digital map and to retrieve and utilize the data for future input allocation decisions.

Where do I start?

VRT can be expensive to set up, but a major expense which is not generally budgeted for is the time required for implementation. Time is required to learn the software, analyse data to underpin decision-making and to make sure the equipment is working.

Because every paddock has multiple inputs, analysing data to make decisions on rates and zoning can become very complex. Having a goal in mind when you go into VRT helps to simplify the process. Time can be saved by outsourcing the work to a consultant – but there is still a level of understanding needed by the person operating the machinery and hardware to implement VRT.

To reduce the investment cost during implementation, it is important to make the most of low cost data sources such as yield data and satellite and biomass imagery before investing in a farm survey (such as EM).

Issues at time critical points in the season can be frustrating and costly. Therefore, it is recommended to begin implementation when time isn't critical to the operation, such as spreading ameliorants over summer. This way a manager will build confidence with the hardware and be much more prepared for what can go wrong come seeding.

How do I know I am making the right decision?

Evaluation is key to making sure that VRT is worth doing. Ground-truthing via soil testing, setting up strip trials and collecting yield data on the go at harvest will enable economic evaluation of the VRT program.

Visit www.grdc.com.au and download a free copy of *Variable Rate Technology: Maximising returns for WA grain producers* as well as other PA research. ■

GROWERS SHARE VARIABLE RATE TECHNOLOGY INSIGHTS

Progressive grain growers are working with rapidly changing technology and an overview of the approaches being taken by some of them is contained in a new case study booklet. GRDC Western Regional Grower Services manager Roger States said *Variable Rate Technology: Maximising returns for Western Australian grain producers* showcased some of the tactics used by growers to increase productivity and profitability using VRT.

"The publication is an initiative of the GRDC Regional Cropping Solutions Networks (RCSN) in the Geraldton and Esperance port zones and was produced by the South East Premium Wheat Growers Association (SEPWA)," he said.

"It features growers based mostly in these two zones and showcases their approaches to VRT, which involves developing a management strategy to target inputs rather than applying them as a blanket rate at paddock scale.

A new case study publication, produced as part of a GRDC RCSN initiative in WA, stresses that having a goal in mind when adopting variable rate technology (VRT) helps to simplify the process. (PHOTO: GRDC)

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New precision ag products

Field-IQ System helps save time and lessen fatigue

Farmer Justin Harris enjoys more time, increased ease of use, and less fatigue by adding the Field-IQ System to his air seeder

Pairing the Field-IQ System with the CenterPoint RTK Correction Service and Autopilot System allowed Justin to air seed 10–20 per cent more land each day.

Justin is a fifth generation farmer. His farm is a combination of family owned and leased land, and has been in his family for about 100 years. Located about 150 km north of Adelaide, he farms 2500 hectares of wheat, malting barley, and lentils.

For the past two years Justin has been using the Trimble FmX integrated display and Autopilot automated steering system on his air seeder, and the Trimble CenterPoint RTK correction service (via his local Koch Ag Services RTK network) on his air seeder, harvester/combine, and sprayer.

Automatic shut off

Starting in April 2012, Justin began using Trimble's Field-IQ crop input control system on his Simplicity air seeder and found the automatic shut off function a huge time saver.

"My disc seeder sows at 12.5 km per hour, which is pretty fast, so you don't have a lot of time at the ends to turn around," said Justin. "With Field-IQ, the seed and fertiliser shut off automatically, and that saves me a lot of time."

Justin also enjoys the advanced features of the FmX display, and the convenience of using only one screen in the cab for all his precision agriculture functions. Previously he had used Topcon for seeder control and Trimble's FmX display for steering, but now he uses the FmX display for everything.

"Now that it's all integrated, I have only one screen to look at, which is good. I don't have to be a computer guy and understand how all the screens work. I know how the FmX works, and having Field-IQ on it makes it easy to use," said Justin. "It performs excellently."

With the addition of the Field-IQ system to his Trimble products, Justin enjoys more convenience since he only views one screen now, and finds he is less fatigued.

"I am definitely not as tired at the end of the day. Having the auto shut off and only one console is easy. I feel relaxed and get a lot done –160 to 240 hectares a day. That's about 10–20 per cent more than what I was doing in the past," said Justin.

Justin believes the prescription maps and variable rate applications that are available with the Field-IQ system will make a yield difference in coming seasons. ■

TMX-2050 display solves a communication challenge

Display's user-friendly features, sharp visuals, and modern layout wins farmer over

Problem

Canadian farmer Daryl Stefek recently purchased a new Fendt tractor, but found it did not communicate with his current guidance display. As a result, he purchased an intermediary system that allowed his display and tractor to communicate with each other. Unfortunately, he felt the intermediary system was complicated, hard to use, had poor functionality, and was out-dated.

Solution/benefit

Since Trimble products are compatible with thousands of vehicle makes and models, Daryl's reseller Dey's Equipment Centre, suggested he try the Trimble TMX-2050 display, and Daryl is very pleased he did.

"The display is awesome," Daryl says. "So far we've only used the display for planting potatoes but it's been great. With the display – and Trimble's CenterPoint RTK correction service – there are no wasted passes and you're not burning extra fuel by overlapping."

The TMX-2050 display is built on the popular Android operating system which offers an intuitive interface.

"The layout is very user friendly, and it's beautiful to look at compared to anything else I've seen. It's like looking at a tablet and having that right in the tractor with you. It makes our previous display seem old fashioned. The picture is much clearer and nicer and it's more up to date. I also like having a MapQuest map on the screen. I've never seen that on anyone else's equipment. We're pretty impressed with it," Daryl said

The home screen of the TMX-2050 display includes Trimble's Connected Farm dashboard, which provides one central location for viewing key information impacting farm operations such as rainfall totals, weather forecasts, commodity tracking, fleet data, field operations, irrigation monitoring and control, and more.

"I like that you can get online and check the weather and that type of thing. I plan on using the dashboard feature a lot," said Daryl.

"I don't like being on two different systems because they don't communicate with each other. I'm pretty sure that from here on out, we'll probably switch to Trimble." ■

Daryl Stefek is impressed with the user-friendly display.

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Section 7

New Science & Technology

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Genetically modified food and the second Green Revolution

By Mervyn Piesse, Global Food & Water Crises Research Program, Future Directions International

AT A GLANCE…

- Just as the Green Revolution was made possible by multiple technologies, such as higher-yielding food crops, more efficient irrigation, fertilisers and pesticides, the second Green Revolution will be made possible by numerous innovations.
- While the Green Revolution is arguably still ongoing in parts of the world – most notably sub-Saharan Africa – other regions have reached a barrier and a new wave of research and development is required if agricultural production is to sustainably increase.
- Genetic modification has mainly been applied to crop production where it is mainly used for the control of pests and disease. In livestock it is used to speed up the rate of maturation or make animals more resistant to disease.
- Diligent testing, regulation and oversight of genetically modified food will help reduce any possible associated risk.

The genetic modification of food is heavily politicised and there are numerous arguments for and against the practice. Proponents of genetically modified (GM) food claim that it will increase food security, primarily by making agriculture more efficient – while detractors argue that the technology is potentially dangerous and the cultivation of GM food could have unforeseen consequences that will ultimately prove detrimental to food security.

By examining the use of GM in plant and livestock agriculture, this article considers both sides of the debate. Ultimately, some varieties of GM food have the potential to strengthen global food security while others are likely to be self-defeating in the long-term.

Some background

Genetic engineering, which involves the modification of the genetic makeup of living organisms, has been practiced for over 40 years and commercial applications have been available for the past two decades.

Biotechnology, of which genetic engineering is a part, is a relatively young field and it is yet to reach its full potential. But equally, the possibility of unintended or unforeseen problems arising from the technology remains and it would be irresponsible to rush into the widespread production of GM food without first testing the safety of each product.

Just as the first Green Revolution was composed of multiple innovations that improved agricultural production, the second Green Revolution will also be made up of many technologies, one of which is likely to be genetic engineering.

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The Green Revolution

The Green Revolution refers to a series of research and development projects that increased agricultural production globally. Prior to the beginning of this process, in the 1930s, there were fears that the world was facing a Malthusian future in which the population would grow faster than the food supply.

Despite increased land scarcity and the population roughly doubling, the Green Revolution ensured that cereal crop production increased three-fold. This increase in agricultural productivity was driven by international research organisations, such as the International Maize and Wheat Improvement Centre, the International Rice Research Institute and the Consultative Group on International Agricultural Research. Much of the research conducted by these organisations was, and continues to be, state-funded. Private companies now conduct significant biotechnology research, which is often profit motivated.

This distinction, between public and private interests, informs a large part of the argument against the adoption of GM food. As private interests are perceived to be more profit-oriented there are fears that they will be less inclined to act in the public interest.

While these international research institutes are mainly focussed on the development of high-yielding crop varieties, other improved inputs, such as fertiliser, irrigation and pesticides, also drove agricultural production increases during the Green Revolution.

But not all outcomes from the Green Revolution were positive and solutions to these challenges are yet to be adopted in many parts of the world. Unintended consequences relating to unsustainably high water, pesticide and fertiliser use have degraded landscapes. Some of the reduction in yield growth since the mid-1980s is associated with this.

Crops that are widely grown in sub-Saharan Africa, such as sorghum, millet and cassava, which many poorer, smallholder farmers continue to grow, largely went without any major increase in yield.

The first Green Revolution is not yet complete in sub-Saharan Africa. Many subsistence farmers are yet to adopt mechanised farming practices. They are also yet to switch to higher-yielding crop varieties, improved irrigation systems and increased fertiliser use. Sub-Saharan Africa is in an enviable position. It can learn from the mistakes made elsewhere, such

Staple crops such as sorghum in Sub-Saharan Africa have largely missed the benefits of the Green Revolution.

as the overuse of groundwater and fertilisers that have left many regions of the world in a far less secure position. The region stands to benefit from the advances made in precision agriculture, which allow for more targeted use of water and fertiliser.

While sub-Saharan Africa is still able to reap rewards from the first Green Revolution, other parts of the world have reached a barrier.

Agricultural research and development programs are required to lift yields and identify new methods of sustainable farming that can produce more food with fewer inputs. Without continued effort to secure the food supply for future generations, global food security is likely to come under pressure. Over the course of the twenty-first century, the food supply is likely to be strained by demographic change (particularly population growth), and changing climate conditions.

The second Green Revolution: The role of genetically modified food

There are calls for a second Green Revolution to drive new agricultural research and development programs. Arguably, with the spread of precision agriculture and biotechnology, the second Green Revolution is already underway. Just as the first Green Revolution was composed of multiple innovations, the second is also likely to be built on multiple technologies. Genetic engineering is one technology that will fuel the second Green Revolution and improve global food security.

GM is a broad field and there are many types of GM products available or in various stages of development. Some products use GM techniques to promote more rapid growth, resistance to disease and pests, or to deliver vitamins, minerals or nutrients through a process known as bio-fortification.

There are also two ways to genetically modify an organism.

Genetically modified Bt corn contains a natural insecticide – *Bacillus thuringiensis* – which has been used as a bio-pesticide for nearly a century. (PHOTO: Keith Weller)

- The first, known as transgenic modification, involves the movement of genetic material from one variety or species of organism to another.
- The second involves changing, or editing, the existing genetic material of an organism.

Genetically modified crops and livestock

There are two groups of GM crops that are currently widely grown. The first are altered to make them resistant to herbicides, such as glyphosate. These crops allow farmers to control weeds without harming their crop.

The second type, known as Bt crops, produce a natural insecticide inside the parts of the plant that pests eat. These crops have genes from a

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common soil bacterium, *Bacillus thuringiensis*, which has been used as a natural bio-pesticide for nearly a century and continues to be widely used in organic agriculture.

Other GM crops that are currently in development – such as non-browning fruit and vegetables – could reduce food waste, which is a major contributing factor to global food insecurity.

In livestock production GM technology is used to make animals grow at a faster rate or more resistant to disease. Commercial applications of genetic engineering in the livestock sector are currently limited to salmon.

AquAdvantage salmon, a genetically modified breed of Atlantic salmon, is an early example of GM livestock. The fish has two genes from other fish species: a growth hormone gene from Chinook salmon that is under the control of a genetic "switch" from Ocean Pout. Conventionally, Atlantic salmon produce growth hormone only in summer months, but with these two genes AquAdvantage salmon produce it throughout the year.

Uninterrupted exposure to the hormone means that AquAdvantage salmon reach maturity in 18 months instead of the 36 months taken by conventional Atlantic salmon. The faster growth rate allows producers to grow and harvest more salmon in a shorter period of time.

The case for and against

Advocates of genetic modification maintain that people have manipulated plant and animal genetics since the beginning of agriculture and all biotechnology does is speed up this process.

While GM techniques enable scientists to quickly alter the genetic makeup of organisms, and do away with the laborious and time-consuming task of traditional selective breeding, they do result in organisms that probably would not have occurred naturally. But this does not necessarily mean that GM food is unsafe or environmentally harmful.

Many opponents of GM food argue that because these foods do not occur naturally they are somehow dangerous to the environment or are unhealthy. GM products undergo rigorous tests to ascertain their risk to human health and the natural environment prior to being released to the market. Of course, not every product can be declared absolutely safe, and unforeseen or unexpected dangers can arise, but these tests certainly reduce the risk of GM crops being unsafe.

Reducing the amount of food that is lost to pests and disease is the main reason for developing GM food. GM cassava, which is widely grown in some parts of Africa, for instance, is protected against cassava mosaic virus and brown-streak virus. Resistant crops are not without their problems, as eventually the pests and diseases are likely to evolve to overcome the resistance gene. This process locks genetically modified organisms (GMOs) into an ever escalating battle against harmful organisms. GM crops cannot eradicate pests and disease, but they do give farmers another tool to manage outbreaks. But an overreliance on the technology is likely to be self-defeating in the long-term.

It is also correct that there is no consensus about the safety of GM food, but, equally, there is no consensus about the danger of GM food.

The debate on scientific consensus is a moot point, designed more to distract than inform. If every innovation or technology were required to pass the consensus test, there simply would be no technological advancement.

A more pertinent argument relates to intellectual property and the right to own and propagate seed. Some biotechnology companies have developed genetic use restriction technology (GURT), colloquially called 'terminator genes'.

When activated, these genes make the seed and the crop it produces

Measuring a transgenic Atlantic salmon (top) against its wild sibling.

incapable of reproducing and results in farmers having to purchase new seed from the owner of the seed technology.

A major argument against GM food maintains that farmers will become overly dependent on a handful of biotechnology companies that could adopt extortionate practices. As many farmers rely on hybrid crops, which give a mixture of inferior varieties if re-sown, many of them were already purchasing seed every year prior to the introduction of GM crops.

Furthermore, biotechnology companies have never made GURT commercially available and have no plans to do so. While they could renege on this commitment and introduce extortionate practices, as they operate in an industry that has clear and significant effects on the public interest, they would be foolish to do so.

Biodiversity, which is an integral part of a secure global food system, could also be reduced because of GM crops. There are fears that GMOs will either interbreed or compete with natural varieties, thereby driving them to extinction. Some GMOs are less likely to enter the natural environment than other, further ensuring their containment.

GM salmon, for instance, is generally farmed in aquaculture conditions far from natural water bodies. In these cases, GMOs are unlikely to interact with non-GMOs. GURT could also resolve this problem, as any GMO that escapes into the wild would be unable to breed and compete with other organisms, but taking this course of action could re-invigorate the fears of corporate domination previously discussed.

To sum up

As GM food production has the potential to disrupt food security – a vitally important component of human survival – due diligence is not just necessary, but obligatory. But at the same time ignorance and fears of the unknown should not retard the growth of an industry that has the potential to considerably strengthen global food security.

On its own, GM food is unlikely to make the world food secure. Instead, it is part of a much larger, multifaceted and complex solution to the challenge of achieving global food security in the twenty-first century.

Any opinions or views expressed in this paper are those of the individual author, unless stated to be those of Future Directions International.

If you have any comments on this article, or would like to contribute to the work of FDI, please feel free to contact me on 08 9389 9831 or email mpiesse@futuredirections.org.au ■

SECTION 7 NEW SCIENCE & TECHNOLOGY

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Microwave – a fresh look at old technology for weed control

By Mary O'Brien

There is nothing new about microwave technology but the vast majority of us are only using it to reheat leftovers. Perhaps it is time to look with fresh eyes at its potential, particularly when dealing with resistant weeds.

Dr Graham Brodie from the University of Melbourne has spent 10 years working on microwave technology and is optimistic about its possible uses in agriculture. Previously Graham worked with the forestry industry and found benefits from microwave treatment of wood which led him to look at potential applications in farming.

This technology first emerged during the early 1970s and for several reasons it has never really taken off as a method of weed control. This period of dormancy has been due to a variety of factors – mainly the costs involved in generating the energy required and the reducing cost of herbicides over the years. Prior to conservation tillage, the plough was a much more available and affordable option for farmers. With the advent of conservation tillage, the use of herbicides has been the preferred method of weed control in broadacre farming.

With some serious resistance issues affecting our bottom line, does this technology have real potential or are we looking for a life raft in what some may consider the 'eleventh hour'?

How it works

It is no different to a standard microwave oven found in most kitchens; it heats up the plant using indirect heating and essentially cooks it. As the plants are treated, you can hear a crackling and hissing sound. The water contained in the plant cells is heated and 'creates a series of steam explosions' which ruptures the cell walls – a hard structure to break. The result is destruction of the plant cells and internal transport system, immediate and irreversible wilting followed by death.

Pop a lettuce leaf in the microwave and see what happens.

The amount of energy required to kill different weed species does vary but Graham has had good success with the following species:

- Ryegrasses – annual and perennial;
- Barnyard grass;
- Barley grass;
- Bellyache bush;
- Brome grass;
- Clover;
- Feathertop Rhodes grass;
- Fleabane;
- Hemlock;
- Mimosa pigra;
- Parthenium;
- Rubber vine;

Microwave antenna designed by Graham Brodie.
(PHOTO: Mary O'Brien)

- Wild oats; and,
- Wild radish.

For example, field trials have successfully treated fleabane 20 cm high and flowering. Larger fleabane plants can still be treated but require more energy to kill.

Benefits

When used for weed treatment, the most obvious benefit is the ability to treat herbicide resistant weeds and their seeds in-crop and in-fallow – no waiting for weeds to germinate. Secondly, applicators will not need to worry about spray drift or correct weather conditions for weed treatment as opposed to chemical sprays.

From a food safety view, there are no potential residues to contend with and no withholding periods on products. Treatment for weed seeds in the soil will act like a residual herbicide without lengthy plant back periods locking paddocks out for opportunistic cropping.

Impact on soil biota

When treating emerged weeds, the trials have shown that microwave treatment has little to no effect on the soil biota. Treatment of the seed bank significantly reduces soil bacterial numbers as more energy is used and the microwaves penetrate the top two to three cm of the soil surface. But this process does not completely sterilise the soil, it merely pasteurises it and within one month of treatment, trials have shown the populations have not only returned to normal but have been found to be much higher than before treatment. Examination is still underway to fully understand the soil benefits from microwave treatment but some surprising results have already appeared.

One of these is an increase in available nitrogen following treatment.

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Graham Brodie speaking about microwave technology at the Cotton Grower of the Year field day, Pine Ridge.
(PHOTO: Mary O'Brien)

Pot trials have shown a yield increase of 200 per cent while field trials are showing a range of 35–92 per cent increase in yield compared to control crops. Possible reasons for this include:

- The microwaves may release stored nitrogen in the soil;
- The treatment may favour re-colonisation by nitrogen producing bacteria; or,
- Production of nitrogen by bacteria recycling the dead bacteria killed during the treatment.

Factors affecting efficacy

All methods of weed control have limitations and factors that influence efficacy – microwave treatment is no different.

As with chemical applications, the size of the weed, soil moisture, and plant stress also play a role in microwave weed treatments. Larger stressed weeds are going to be more difficult to kill than smaller fresh weeds. Think about reheating leftovers in your kitchen microwave – a smaller container with high moisture content and low density is going to heat faster and use less energy than a large container with lower moisture content and higher density. It is the same with weeds.

Soil temperature can also influence microwave efficiency when treating weed seeds or soil – colder soils will require more energy to heat up than warm soils.

Costs

The first questions asked by farmers are always 'how much does it cost' and 'how fast can it go'. The answers are $50 to $60 per hectare and 5–10 km per hour when used as a knockdown. To treat weed seeds and soil the cost would increase, as significantly more power is required and the speed is reduced. Treating soil is costly and difficult regardless of the method used (eg. soil fumigation).

The ability to do one operation that acts as both a knockdown and a residual herbicide, could be time saving and be more cost efficient than doing several passes.

It is quite feasible to develop a unit suitable for broadacre situations that would operate at speeds comparable to current chemical spray applications.

It is important to not compare the cost of this technology directly to a knockdown herbicide application. While cost is always going to be a major influence, factors that should not be undervalued include the intrinsic worth in reducing herbicide pressure, the potential to manage resistant weeds and the seed bank as well as reducing the environmental impacts.

Work Health and Safety

The antenna that Graham has designed complies with international standards and when used correctly, there is no risk of exposure to the operator. But it is impossible to make anything fool proof so putting your foot under the unit while it is operating would be an obvious risk.

The design and engineering of the antenna ensures that it complies with all national and international thresholds for exposure to microwave.

Other uses

Graham has used microwave to treat hay and chaff for weed seeds with huge success. An added bonus from the treatment was a substantial increase in the digestibility of the hay for ruminants. The technology has also achieved great results treating soil pathogenic fungi in the strawberry industry. Graham is currently expanding his work into control of pests and diseases in stored grain.

Reducing the use of pesticides is beneficial for a variety of reasons, especially for slowing resistance, so the potential uses for microwave treatment may extend to a broad range of situations. These include, but are not limited to: Border quarantine, the home garden, school playgrounds, parks, sporting fields, and fire ant nests.

What's next?

Graham has built a trailer-based prototype with four antennas on it, each 11 cm wide, with the purpose of treating the inter-row space in crops. He envisages that initially a commercial unit would be about the same number of antennas and be a complete trailer based method or run on a PTO driven system. Larger scale products are certainly not out of the question but the challenge would be generating enough power.

Each antenna needs about two kW of power when used as a knockdown treatment. This amount of energy is at the lower end for a commercial unit and would increase dramatically if the aim was to treat soil and weed seeds.

Graham's project has focused on building a workable first design which he has successfully done. More long-term field trials are needed as well as additional investment but Graham believes commercialisation is only a couple of years away.

This technology can be utilised on robotic machines such as the Swarm Farm robots and could work well with weed seeking camera systems. Having the ability to use it in a Variable Rate Application scenario would potentially reduce energy costs.

Increasing populations of weed species that have developed resistance to multiple modes of action are causing issues for farmers in most regions with some returning to the use of tillage in an effort to limit overuse of herbicides. Microwave could be a good way to combat these populations.

While Graham does not declare microwave as the solution for all weed treatment, he does suggest 'it is an opportunity to do a reset; to clean up a messy patch'. Having a way to effectively treat a resistant population in a paddock or a section of a paddock without soil disturbance is definitely appealing. When asked if he thinks there is potential for the development of resistance to microwave treatment, he warns that we should never underestimate nature. ■

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The next oil boom might be from plants

By CSIRO

Research by CSIRO now makes it possible to produce oil in the leaves and stems of plants as well as the seeds. This promises to be a game changer in the global production of renewable oils.

US-based company Amfora and CSIRO recently signed an agreement that will advance development and commercialisation of the technology to produce energy-rich feed for livestock.

Innovation Leader with CSIRO Agriculture and Food, Dr Allan Green, said that this was the first of many applications of the technology, which could also be used for human food, biofuels and industrial uses.

"Previously it has only been possible to extract oil from the oil-rich seeds and fruits of some specialised plants, such as canola, soybean, sunflower, coconut and oil palm," Allan said.

"What we have been able to do is switch on this high-level oil production in vegetative tissue, such as in stems and leaves, as well."

In some plants, the research team has been able to get around 35 per cent oil content into vegetative tissue – the same amount as in many oilseed crops.

The technology will be used to produce oil in the leaves and stems of plants such as corn and sorghum.
(PHOTO: Zhanguo Xin)

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"If the technology were applied to existing oil crops it could potentially treble oil productivity and greatly expand renewable oil production worldwide," Allan said.

"We are using solar energy captured by the plant to convert the leaf's starch reserves into more energy-dense oil molecules, which significantly increases the energy value of the vegetative tissue where the oil accumulates."

Innovative solutions for a global market

CSIRO Chief Executive Larry Marshall said the work demonstrates the capacity of Australian researchers to develop innovative solutions for global industries.

"It is estimated that in 20 years' time we will need 50 per cent more plant-based oils just to meet the nutritional needs of a global population, and there is also a growing demand for renewable biofuels," Larry said.

"A transformational approach was needed to solve the increasing demand for plant oils within the limitations of our current agricultural footprint.

"CSIRO's relationship with Amfora, under which CSIRO will become a significant shareholder, is an excellent demonstration of our Strategy 2020 in action.

"We are driving profound global impact from this breakthrough innovation, benefiting Australian farmers and securing a revenue stream back to Australia to support further research that will keep Australia at the leading edge of competition."

Amfora will use the technology to develop oil content in the vegetative tissue of corn and sorghum, meaning they can market a feed for dairy farmers that does not require them to purchase additional oils, such as tallow or cotton seed, to supplement feeds.

Dairy cattle require around seven per cent fat in their diet to produce milk. If their feed already contains this fat in the form of oil then this means less agricultural land is needed to produce feed and fewer greenhouse gas emissions are produced from feed production.

The agreement with Amfora is the first major application for the high oil technology. It provides a direct path to market as the oil does not need to be extracted from the leaves before it is fed to cattle.

Future applications – such as the production of industrial oils and bio-based diesel – will require further industrial supply chain development to customise techniques for extracting the oil and converting it to suitable products.

More about the agreement

CSIRO granted Amfora a worldwide, exclusive license to its technology for use in the development of specified forage crops. CSIRO also participated in Amfora's Series A financing along with Spruce Capital Partners, a venture capital firm based in San Francisco, California and co-manager of the MLS Fund II. ■

Better paper and plastics with starch from plants

By Sandra Avant, Agricultural Research Service – USDA

AT A GLANCE…

- Starch is 100 per cent biodegradable.
- New complexes made with starch can make plastics more biodegradable.
- Paper treated with the new complexes repels water.
- Technology is biobased, nontoxic, and inexpensive.

A new starch-based film, or coating, developed by Agricultural Research Service (ARS) scientists, can make paper and other materials more water resistant and biodegradable. The film can potentially be used in food packaging, plastic bags, and other products, reducing the amount of synthetic products clogging landfills.

Starch – which is 100 per cent biodegradable – is used in some plastics and films because it is inexpensive and biodegrades rapidly. But existing starch-containing materials do not have the strength, flexibility, and ease of processing required for many other uses.

Polyvinyl alcohol (PVOH), a petroleum-based synthetic polymer, is widely used for film applications, but it has limited biodegradability.

Scientists at the USDA–ARS National Center for Agricultural Utilization Research (NCAUR) in Peoria, Illinois, recently developed starch complexes that can be blended with PVOH to improve the properties of films and make them more biodegradable.

The team included chemist George Fanta, plant physiologist Frederick Felker, chemist Gordon Selling, and research associate William Hay.

Says George, "At our lab, we look for new value-added products from starch that benefit agriculture and consumers. Products we develop can help replace totally synthetic products like plastic polyethylene bags and polystyrene foam packing materials."

Prepared from corn and soybean

The scientists prepared the complexes from high-amylose corn starch and fatty amine salts, which can be derived from soybean oil. These complexes have unique and valuable properties not found in either ingredient separately. One recent aspect of this research was published in the Journal of Applied Polymer Science in 2016.

"Our complexes can be blended with PVOH in large amounts to make films with good physical properties and increased elasticity," George says. "They are also more resistant to water penetration than films prepared from pure PVOH."

Some food packaging is also made from PVOH alone, Gordon Selling says. "We can incorporate up to 60 per cent of these starch complexes in the packaging, and performance should remain unchanged."

A new USDA ARS-developed, starch-based coating makes paper water resistant. (PHOTO: Peggy Greb)

The complexes in solution can be applied to paper to increase its water resistance. "A drop of water on untreated paper absorbs quickly," Gordon says. "But water on paper coated with these complexes beads up, remains on the surface for minutes, and often evaporates before soaking into the paper, depending on the formulation."

ARS has filed a patent application covering the new paper-related technology, which is ideal for small papermaking companies and can be readily commercialised.

"These complexes are 100 per cent biobased and nontoxic, and the process is inexpensive," George says.

For more information contact George Fanta on E: George.Fanta@ars.usda.gov
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Sorghum breeding time set to halve thanks to new research

In a major step forward for Australian farmers, new research from the US will result in a significantly quicker sorghum breeding process. The work, from the US team at DuPont Pioneer and the United Sorghum Checkoff Program, has uncovered two sorghum haploid inducer lines. The first of its kind, these patent-pending inducer lines enable the creation of doubled haploid sorghum, which is the first step to significantly accelerating the sorghum breeding process.

Sorghum research scientist with Pioneer Australia, Ivan Calvert, says the sharing of this technology between the US and Australia will mean new, improved hybrids can reach growers faster.

"It's very exciting news for DuPont Pioneer all around the world, including Australia, because with this type of technology and development we can achieve spontaneous chromosome doubling with parent development," Ivan explains.

"What it means is, in comparison with our conventional sorghum parent development, which can take up to six generations, double haploid technology can achieve this in one generation.

"This in turn rapidly speeds up hybrid development, delivering traits and yield advantages at a much quicker rate to Australian growers."

The United Sorghum Checkoff Program funded the Pioneer research in Texas, Kansas, Puerto Rico, Mexico and Iowa, leveraging the world-class, global sorghum breeding programs of Pioneer.

"With this technology, and the additional molecular breeding tools that are used by DuPont Pioneer within our sorghum program, we are able to advance parents at a rapid rate and therefore test many more parental combinations in hybrids over time. This will improve the standard of sorghum hybrids for Australian growers," Ivan says.

Ivan Culvert, sorghum research scientist.

"It's key that the new process is so much faster, it will take at least three to four years off parent development and then hybrid advancement."

With a strong track record of investing in sorghum research in Australia, this latest breakthrough means Pioneer is better placed than ever to deliver advanced sorghum hybrids into Australian paddocks. ■

SECTION 7 NEW SCIENCE & TECHNOLOGY

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Section 8

Grain Storage & Handling

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Tips for the successful storage of pulses

By GRDC Stored Grain Extension Project researchers

AT A GLANCE...

- Pulses stored above 12 per cent moisture content require aeration cooling to maintain quality;
- Meticulous hygiene and aeration cooling are the first lines of defence against pest incursion;
- Fumigation is the only option available to control pests in stored pulses, which requires a gas-tight, sealable storage; and,
- Avoiding mechanical damage to pulse seeds will maintain market quality, seed viability and be less attractive to insect pests.

Storing pulses successfully requires a balance between ideal harvest and storage conditions. Harvesting at 14 per cent moisture content captures grain quality and reduces mechanical damage to the seed but requires careful management to avoid deterioration during storage.

Quality characteristics

Pulse crops most commonly grown in Australia include broad beans, faba beans, chickpeas, field peas, lentils, lupins, vetch and mungbeans.

Many of the quality characteristics of the grain from these crops are in the appearance, size and physical integrity of the seed. Mechanical seed damage, discolouration, disease, insect damage, split or small seeds will downgrade quality and market value.

Storing pulses in silos that can be aerated or gas-tight sealed allows for quality and pest control not available to other storages.

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Buyers prefer large, consistently-sized seed free of chemical residues for easy processing and marketing to consumers.

Optimum moisture and temperature

Research has shown that harvesting pulses at higher moisture content (up to 14 per cent) reduces field mould, mechanical damage to the seed, splitting and preserves seed viability. The challenge is to maintain this quality during storage as there is an increased risk of deterioration at these moisture levels. As a result, pulses stored above 12 per cent moisture content require aeration cooling to maintain quality.

Grain Trade Australia (GTA) sets a maximum moisture limit of 14 per cent for most pulses but bulk handlers may have receival requirements as low as 12 per cent. As a general rule of thumb, the higher the moisture content, the lower the temperature required to maintain seed quality (see Table 1).

TABLE 1: Maximum recommended storage period

		Grain temperature (°C)	
		20	30
Moisture content (%)	14	3 months	N/A
	13	9 months	3 months
	12	>9 months	9 months

Source: CSIRO Stored Grains Research Laboratory

Green pods and grains increase the risk of mould developing during storage – even at lower moisture content. Aeration cooling will help prevent mould and hot spots by creating uniform conditions throughout the grain bulk.

Weather damage hinders storage

Pulses exposed to weathering before harvest deteriorate more quickly in storage. Chickpeas stored for the medium to long term (6–12 months) continue to age and lose quality (see Table 2). Growers can minimise the effects of seed darkening, declining germination and reduced seed vigour by:

- Lowering moisture content and temperature; and,
- Harvesting before weather damages the grain.

TABLE 2: Storage life of chickpeas

		Grain temperature (°C)			
		20	30	40	
Moisture content (%)	12	66.6	16.6–21.6	3.6–4.3	Longevity of seed (months)
	15	23–28	6–1	1–1.6	

Source: Pulse Australia

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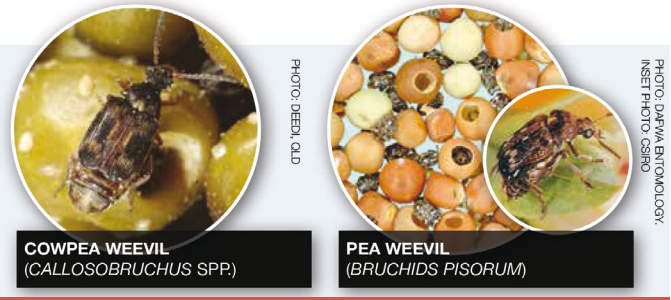

The two main storage pests of pulses are cowpea weevil and pea weevil.

Aeration cooling – a vital tool

Aeration cooling:

- Creates uniform conditions throughout the grain bulk;
- Prevents moisture migration;
- Maintains seed viability (germination and vigour);
- Reduces mould growth;
- Lengthens (and in some instances stops) insect reproduction cycles; and,
- Slows seed coat darkening and quality loss.

Aeration cooling allows for longer-term storage of low-moisture grain by creating desirable conditions for the grain and undesirable conditions for mould and pests.

Unlike aeration drying, aeration cooling can be achieved with air-flow rates of as little as two to three litres per second per tonne of grain.

High-moisture grain can also be safely held for a short time with aeration cooling before blending or drying. Run fans continuously to prevent self heating and quality damage.

Be aware that small seeds such as lentils will reduce the aeration fan capacity as there is less space for air to flow between the grains. For information on aeration cooling management, refer to the GRDC fact sheet, *Aeration cooling for pest control*.

Aeration drying

Pulses stored for longer than three months at high moisture content (above 14 per cent) will require drying or blending to maintain seed quality. Aeration drying has a lower risk of cracking and damaging pulses, which can occur with hot-air dryers.

Unlike aeration cooling, drying requires high airflow rates of at least 15–25 litres per second per tonne and careful management. For more information on aeration drying refer to the GRDC booklet, *Aerating stored grain, cooling or drying for quality control.*

Handle with care

In addition to harvesting at high moisture content, growers can manage seed quality at harvest by:

- Minimising the number of times augers shift grain;
- Ensuring augers are full of grain and operated at slow speeds;
- Checking auger flight clearance – optimum clearance between flight and tube is half the grain size to minimise grain lodging and damage;
- Operating augers as close as possible to their optimal efficiency – usually an angle of 30 degrees; and,
- Using a belt conveyor instead of an auger where possible.

Silos fit the bill

Silos are the ideal storage option for pulses, especially if they are cone based for easy out-loading with minimal seed damage. For anything more than short-term storage (three months) aeration cooling and gas-tight sealable storage suitable for fumigation are essential features for best management quality control.

Always fill and empty silos from the centre holes. This is especially important with pulses because most have a high bulk density. Loading or out-loading off-centre will put uneven weight on the structure and cause it to collapse.

Avoid storing lentils in silos with horizontally corrugated walls as the grain can run out from the bottom first and collapse the silo as the grain bulk slides down the silo walls.

Pests and control options

The most common pulse pests are the cowpea weevil (*Callosobruchus spp.*) and pea weevil (*Bruchids pisorum*). The cowpea weevil has a short life span of 10–12 days while the pea weevil only breeds one generation per year.

The only control options are phosphine, an alternative fumigant or controlled atmosphere, all of which require a gas-tight, sealable storage to control the insects at all life stages.

For more information refer to the GRDC booklet, *Fumigating with phosphine, other fumigants and controlled atmospheres*.

Chemical sprays are not registered for pulses. While there is a maximum residue limit (MRL) for dichlorvos on lentils, the product is only registered for use on cereal grains.

Weevil development ceases at temperatures below 20°C. This is a strong incentive for aeration cooling, especially if gas-tight storage is not available.

Keep it clean

The first line of defence against grain pests is before the pulses enter storage – meticulous grain hygiene. Because pest control options are limited, it's critical to remove pests from the storage site before harvest.

Cleaning silos and storages thoroughly and removing spilt and leftover grain removes the feed source and harbour for insect pests.

Clean the following areas thoroughly:

- Empty silos and grain storages;
- Augers and conveyers;
- Harvesters;
- Field and chaser bins;
- Spilt grain around grain storages; and,
- Leftover bags of grain.

The MRLs in pulses for chemicals used for structural treatments are either extremely low or nil.

Using chemicals – even as structural treatments – risks exceeding the MRL so is not recommended.

Using diatomaceous earth (DE) as a structural treatment is possible but wash and dry the storage and equipment before using for pulses. This will ensure the DE doesn't discolour the grain surface.

If unsure, check with the grain buyer before using any product that will come in contact with the stored grain. For more information see the GRDC fact sheet, *Hygiene and structural treatments for grain storages*.

For more information see: www.storedgrain.com.au

Acknowledgements: Philip Burrill, DAFF QLD; Peter Botta, PCB Consulting; Chris Newman, Stored Grain Services; Ben White, WA; and, Chris Warrick, ProAdvice.

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Finding stored grain pests early

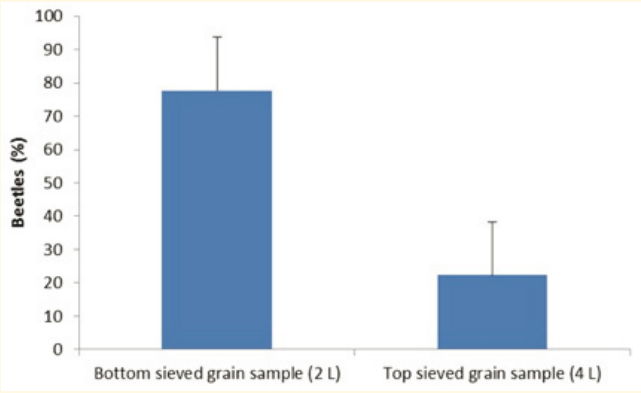
By Greg Daglish and Philip Burrill, Queensland Department of Agriculture and Fisheries

AT A GLANCE...

- A pilot study in southern Queensland demonstrated that combining the use of probe traps in the top of a silo with sieving a grain sample from the bottom was an effective insect detection method.
- Probe traps inserted into the grain surface tended to catch more beetles than traps inserted deeper.
- Probe traps inserted into the grain peak via the silo centre top hatch tended to catch more beetles than traps inserted via the roof side hatch.
- Change traps after one week initially to avoid clogging if there is a heavy infestation, and less frequently thereafter (e.g. monthly) if few or no beetles are detected.
- Further research is needed examining the relative effectiveness of sieving and trapping for detecting different species, and how serious the situation is when beetles are first detected.

Options for farmers to detect insects in stored grain were explored in a pilot study in 2016 on two farms in southern Queensland. Increasing on-farm storage comes with an increasing risk of insect infestation. There is an urgent need for appropriate sampling methods to help farmers manage this risk and minimize marketing delays. Simple, safe, cost effective and easy to interpret sampling options will enable growers to make informed decisions about pest management.

Figure 1: When grain beetles were detected in grain samples, more beetles tended to be found in the bottom rather than top sample



SECTION 8 GRAIN STORAGE & HANDLING
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For the study, farm silos containing wheat or barley were sampled for stored grain beetles using two methods (see photo):

- Sieving of grain samples taken from the top and bottom of the silo.
- Captured in probe traps inserted into the grain via the side and top hatches.

The bottom grain (2 L) sample was collected by dropping grain from the bottom of the silo. The top grain sample (4 L) was a composite of two samples scooped from the grain surface – one sample (2 L) scooped from the top hatch and a second sample (2 L) scooped from the side hatch.

Probe traps were inserted into grain via the top and side roof hatches. In each case, one trap was inserted to trap beetles 0 to 28 cm from the grain surface (shallow trap) and the second trap was inserted so that it trapped beetles 28 to 56 cm from the grain surface (deep trap).

What we found

In this pilot study, stored grain beetles were detected in both grain samples and probe traps.

In silos in which beetles were detected in sieved grain samples, the bottom and top grain samples yielded on average 78 and 20 per cent of the beetles respectively (Figure 1). This was despite the top sample having twice as much grain as the bottom sample.

In silos in which beetles were detected in the probe traps, the shallow and deep traps captured on average 82 and 18 per cent of the beetles respectively (Figure 2).

In silos in which beetles were detected in the probe traps, the traps inserted via the side and top hatches captured on average 24 and 76 per cent of the beetles respectively (Figure 3).

It is possible that the usefulness of sampling and trapping may vary between pest species – but at this early research stage, it is not possible to confirm this.

In several heavily infested silos some probe traps captured many

A simple grain sieve and probe trap were used for the early detection study.

AUSTRALIAN COTTON TRADE SHOW

July 26 & 27, 2017

The Yoogali Club
647 Mackay Avenue, Griffith

The 2017 Australian Cotton Trade Show will be held in conjunction with Cotton Australia's Cotton Collective and Industry Awards in Griffith – July 25–27.

Drawing on the very successful biennial Australian Cotton Conference model, a 'mini' conference is going on the road. Growers, consultants, researchers, processors and service providers are invited to attend the Cotton Collective with its scheduled research and policy forums running concurrently with the Trade Show's Cotton Trade Display which will accommodate the catering stations and bar.

Tuesday, July 25

- Local farm tours will be on offer
- Exhibitor bump-in for Trade Show

Wednesday, July 26

- Australian Cotton Trade Show opens in Yoogali function room and grounds – 8.00am to 5.00pm
- Cotton Collective opens in Yoogali conference room featuring sessions on key policy and research areas
- Cotton Australia Industry Awards function in the evening at the Griffith 'Exies' Conference Centre

Thursday, July 27

- Australian Cotton Trade Show – 8.00am to 5.00pm (Exhibitor bump out 5.30pm – 7.30pm)
- Cotton Collective:
  Morning sessions dedicated to new products and technologies;
  Afternoon sessions will feature a *Cotton Forum 101* taking new and potential growers through key facets of the industry

Friday, July 28

- Australian Cotton Trade Show – completion of bump out

Contact – Brian O'Connell
Mob: 0413 130 777
Email: brianoconnell@bigpond.com

thousands of *Tribolium castaneum* (rust red flour beetle) beetles resulting in traps becoming congested.

Automatic loggers were used to monitor temperature and humidity in some silos (for example, Figure 4). Temperature and humidity varied widely in the headspace reaching potentially lethal levels in the middle of the day. In contrast, temperature and humidity was much more stable in the grain bulk. Beetles are likely to avoid the grain surface during times of extreme high temperature and low humidity, potentially impacting on the usefulness of visual inspection for beetles on the grain surface.

Some early recommendations

There are many beetle species that can infest stored grain and at least five pest species were detected in this study. From a scientific perspective, knowing the identity and exact numbers of beetles in grain samples or probe traps is valuable. But from the growers' perspective, the presence of any beetles in stored grain is a problem.

This pilot study focussed on two simple methods that could be used by growers to detect pests in stored grain, and the following recommendations are based on those initial results.

- Combining sieving of grain samples and using probe traps in the top of the grain bulk is useful.
- If sieving grain is to be limited to one location, then a sample from the bottom of the silo is preferably to a sample from the top of the silo.
- Probe traps should be inserted into the grain bulk so that the top of the trap is level with the grain surface.
- If trapping is to be limited to one location, then inserting the probe trap into the grain through the centre top hatch is preferable to inserting it through the upper side hatch.
- Initially, probe traps should be inspected after one day in case there is a heavy infestation, with the risk of large numbers of beetles clogging the traps. If no or few beetles are trapped in the first instance a longer inspection interval can be used.
- Extremely high temperature and low humidity is possible during the middle of the day, so early morning may be the best time for visual inspection of the grain surface for beetles.

And some yet to be answered questions

- Are the results of this pilot study applicable more broadly?
- What does it mean if I get one beetle or many beetles in my sieved sample or my probe trap? And is the answer the same soon after harvest or later during storage?
- Do different pest species tend to be in different parts of the grain bulk, and how does this affect detection through sampling or trapping?

This pilot study was made possible through an Agri-Science Queensland Innovation Opportunity award from DAF entitled 'Sampling options for farmers to detect insects in stored grain'. We are very grateful to two grain growers and their families for allowing access to their properties and Valerie Byrne (DAF) for technical assistance.

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Philip Burrill (Ph: 0427 696 500, Email: philip.burrill@daf.qld.gov.au)

Figure 2: When grain beetles were detected in probe traps, the traps inserted near the grain surface tended to catch more beetles than traps inserted deeper

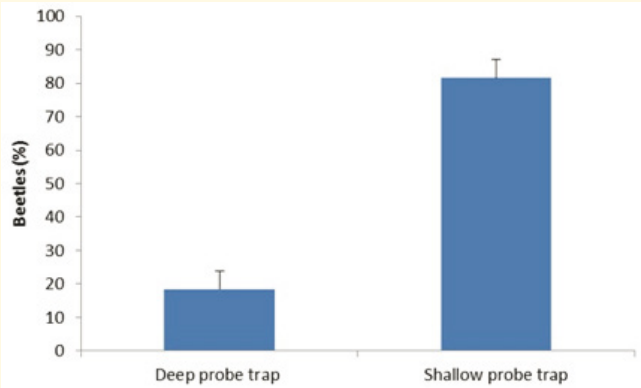


Figure 3: When grain beetles were detected in probe traps, traps inserted via the top hatch tended to catch more beetles than traps inserted via the side hatch

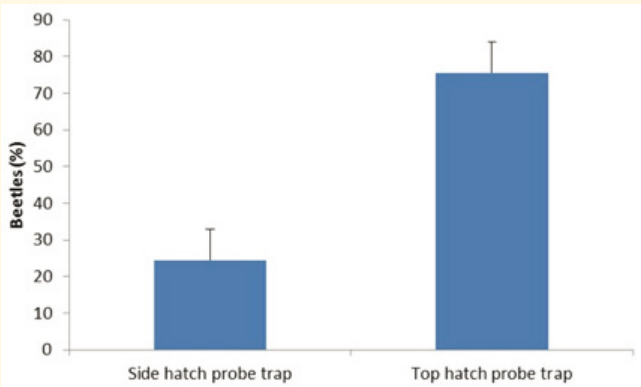
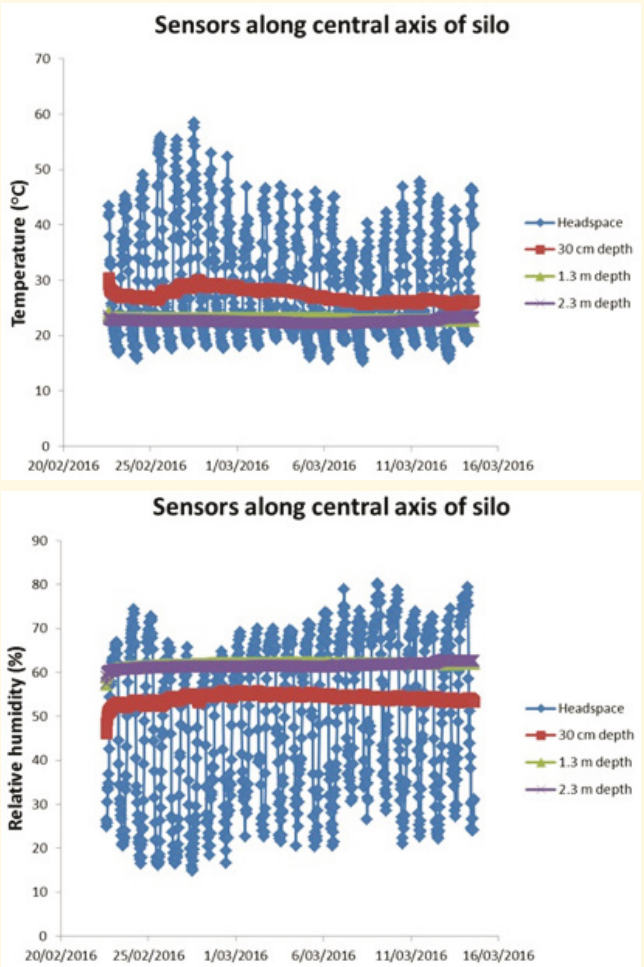


Figure 4: Temperature and relative humidity measured half-hourly in the headspace and grain bulk in an on-farm silo containing barley



Section 9

Feeding The World

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Improved varieties of legumes promoted under the MyPulses project are benefiting farmers in the central dry zone of Myanmar

The role of legumes in food security

By Dr Tun Shwe[1], Daw Khin Lay Kyu[1] and Dr Pooran Gaur[2]

The central dry zone (CDZ) of Myanmar has established itself as a key agricultural production area. The three regions of the CDZ – Sagaing, Mandalay and Magway – account for 34 per cent of the country's population – or 18 million people. It is the main region for rainfed agriculture in the country. Many of the smallholder farming systems are based on legumes – pigeonpeas, chickpeas and groundnuts – and feature rice, mungbeans (green gram), maize, millet, sesame and sunflowers grown in rotation or as intercrops.

The production share of oilseed and pulse crops for the CDZ is higher than in the Ayeyarwady River Delta: 70–90 per cent in the case of oilseed crops and about 40 per cent to more than 90 per cent for pulses, except urdbean (black gram bean). Despite the high production share, yields remain low, principally because of the lack of nutrient inputs and management, an absence of improved high yielding varieties, and limited options for pest and disease management. As a result, the CDZ is one of the most food-insecure regions in Myanmar.

"MYPULSES IS ADDRESSING THE IMMEDIATE NEEDS OF THE VULNERABLE PEOPLE OF MYANMAR THROUGH RESEARCH, DEVELOPMENT AND EXTENSION. IT HAS A STRONG FOCUS ON CAPACITY BUILDING FOR BOTH PEOPLE AND INSTITUTIONS."

Climate change poses a particular threat to the CDZ, which has suffered consecutive years of drought. Agricultural production has stagnated due to extreme water shortages and an unevenly distributed rainfall pattern, which is a constant threat to the viability of rural livelihoods. As a result, the farmers from the CDZ are poor and highly vulnerable to both present and future effects of climate change.

The ACIAR-funded MyPulses project (part of the MYFarm program) is playing an important role in achieving a sustainable increase in crop productivity and improving farmers' incomes and livelihoods in legume-based farming systems in the CDZ.

Preferred varieties

Farmer participatory varietal selection trials were used to identify farmers' preferred varieties of groundnut, pigeonpea, chickpea and mungbean. Promising breeding lines from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India, and

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Foliar spraying of nutrients on black gram rice, near Tatkon township. (PHOTO: Ian Willett)

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the Department of Agricultural Research (DAR) from Myanmar were subjected to the trial process. A total of 54 mother trials (managed by researchers) and 378 baby trials (using farmer-managed cultural practices) were conducted across the CDZ during 2014–16 under the MyPulses project.

Groundnut

Eleven groundnut mother trials and 63 baby trials were conducted during 2014–16. The best-performing line (Sinpadetha-11) out-yielded the check line by an average of 38 per cent in the mother trials and 40 per cent in the baby trials. Farmers preferred Sinpadetha-11 and YZG-98017 due to their high yield and moderate tolerance to drought.

A total of 17 tonnes of Sinpadetha-11 pure seed was distributed to 120 farmers for the 2015 monsoon season.

Pigeonpea

Ten pigeonpea mother trials and 230 baby trials were conducted in 2014–16. Overall, the lines Nyaungoo Shwedinga, Monywa Shwedinga and Yezin 9 out-yielded check varieties by 17 per cent, 15 per cent and 12 per cent, respectively. High-quality pure seed of these three lines was distributed to farmers.

Seed multiplication is continuing. Yezin 9 will be formally released in 2018.

Chickpea

A total of 19 mother trials and 78 baby trials were conducted to identify farmer-preferred chickpea lines. The desi chickpea line ICCV 00108 out-yielded Yezin 4 (the check variety used for comparisons in the trials) by an average of 23 per cent in mother trials and 10 per cent in baby trials. Line ICCV 07118 out-yielded Yezin 4 by an average 44 per cent in mother trials and 13 per cent in baby trials.

In kabuli chickpeas, line ICCV 07308 out-yielded Yezin 3 (the check variety) by an average seven per cent in mother trials and 33 per cent in baby trials. Check varieties Yezin 3 and Yezin 4 account for about 65 per cent of the current chickpea-growing area in Myanmar. All three new varieties were preferred by farmers. The lines ICCV 00108 and ICCV 07308 are due for commercial release in 2016–17.

There were eight field days conducted during 2015–16 with 550 farmers (30 per cent women) in attendance.

Mungbean

For mungbeans, 14 mother and seven baby trials were conducted. The varieties Yezin 11 and Yezin 14 out-yielded the check by an average of 14 per cent and 18 per cent, respectively. Seed of Yezin 14 is currently being increased for distribution to farmers – sufficient seed for planting 60,000 hectares. For urdbeans, 22 new lines received from the World Vegetable Center (India) in 2014 were evaluated for yield and other traits at DAR in Yezin during the 2015–16 post-monsoon season. The grain yield of these lines ranged from 1.4 to 4.2 tonnes per hectare.

Village seedbanks and distribution

Village seedbanks were established to enhance the availability of high-quality seed to farmers at a local level. During 2015–16, there were 74 pigeonpea seedbanks covering 160 hectares.

Training workshops on seed production and distribution as well as 25 pulse agronomy field days involved more than 360 DOA staff and 1400 farmers.

Achievements so far

The MyPulses project has helped to identify farmer-preferred varieties in pigeonpeas, groundnuts, chickpeas and mungbeans. The seed availability of these farmer-preferred varieties was enhanced by establishing village seedbanks. These improved lines are being rapidly adopted by farmers as they see the benefit of increased productivity and income.

The CDZ is prone to drought stresses, particularly because of changes in the climate as reflected by erratic rainfalls and fluctuations in temperature. These new varieties are not only high yielding, they also have higher levels of resistance to stress and increased resilience to climate change.

Through all these advances, the MyPulses project is contributing to improved food security and rural incomes for smallholders in the CDZ and the Ayeyarwady Delta. Farmers have also benefited by having better access to domestic and international markets. MyPulses is addressing the immediate needs of the vulnerable people of Myanmar through research, development and extension. The program has a strong focus on capacity building for both people and institutions.

The MyPulses project is showing a passage to prosperity for farmers in the CDZ through an extraordinary partnership of local communities DAR, DOA and the technical experts of ICRISAT and ACIAR.

[1]Department Of Agricultural Research.
[2]ICRISAT.

ACIAR Project: SMCN/2011/047 'Increasing productivity of legume-based farming systems in the central dry zone of Myanmar'

More information: Professor David Herridge, University of New England, david.herridge@industry.nsw.gov.au

THE MYANMAR PROGRAM

Myanmar and Australia are partnering to improve the broadscale food-producing capacity of poor, small-scale farmers in a program called MYFarm, overseen within Myanmar by program manager, Dr Ohnmar Khaing.

MYFarm is a collaboration between the Australian Department of Foreign Affairs and Trade (DFAT) and the Australian Centre for International Agricultural Research (ACIAR). The multidisciplinary approach is very new for Myanmar and is forging new linkages between research groups.

The program delivers evidence-based improvement to all aspects of the agricultural value chain. This results in food security and livelihood gains for the poorest food producers. The underlying principle of the program is improved food security and thriving rural economies – essential to the development of the broader national economy in Myanmar.

More information: Dr Ohnmar Khaing, ohnmar.khaing@aciar.gov.au

Dr Ohnmar Khaing.
(PHOTO: ACIAR)

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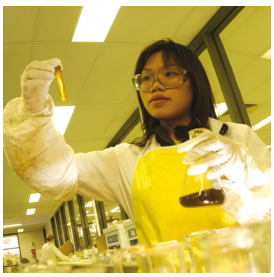

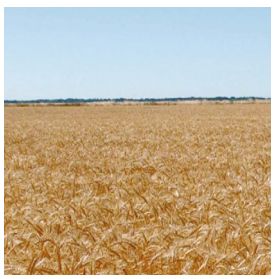

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Wheat genome decoded to enhance food security

By ARC Centre of Excellence in Plant Energy Biology, WA

The most comprehensive analysis of a wheat genome has just been published in the journal *Genome Research*. University of Western Australia researchers from the ARC Centre of Excellence in Plant Energy Biology were part of a United Kingdom-led consortium to provide the most complete map and assembly of the wheat genome so far achieved. The new sequencing of the bread wheat genome, led by the Earlham Institute, identified complete sets of genes and proteins essential to important agronomic traits.

According to The Food and Agriculture Organisation of the United Nations, global crop yields must double by 2050 to meet future food security needs. Globally, wheat is one of the most important staple crops, providing a fifth of daily calories. Extensive knowledge of the wheat genome is needed to increase wheat yield in the future.

The most well-known genome project, The Human Genome Project, was completed in 2003 and the genomes of many organisms, including some plants, have also been decoded. But despite the agricultural importance of wheat, the large size and hexaploid structure of its genome has made it historically difficult to fully sequence its chromosomes.

Globally, wheat is one of the most important staple crops. Decoding of the wheat genome will assist with increasing crop yields in the future. (PHOTO: James Campbell)

Dr Owen Duncan (pictured) says the wheat genome data will help wheat growth and development research. (PHOTO: James Campbell)

"The wheat genome contains 17 billion bases - that's five times the size of the human genome," said Professor Harvey Millar from the ARC Centre of Excellence in Plant Energy Biology.

"The success of this research was based on new technologies that solved longstanding problems in determining the structure of wheat's large hexaploid genome."

The new genome assembly predicts a large number of previously unknown wheat genes and defines where they are located along chromosomes. The UWA researchers led the protein analysis research that provided direct evidence that many of these genes coded for molecular machinery are important for wheat growth and development, protection of wheat from diseases and resistance to harsh environments.

"Evidence for over half of the predicted protein-coding genes in the new wheat genome assembly and annotation was found through our research" said Dr Owen Duncan also from the ARC Centre of Excellence in Plant Energy Biology, and a co-author of the study.

"This data helps researchers sift through the immense complexity of the wheat genome to identify which parts are playing an active role in the growth and development of wheat."

Over 1000 wheat disease resistance genes and their locations in the genome were revealed by the study. The knowledge will greatly aid marker assisted breeding of wheat disease traits. Also identified were over 100 gluten genes, the analysis of which will be vital to changing gluten content in wheat.

The collaboration combined advances in genome sequencing and assembly technology from researchers based in Norwich, England at the Earlham Institute and the John Innes Centre with leading protein mass spectrometry data from the ARC Centre of Excellence in Plant Energy Biology at the University of Western Australia. ■

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Agricultural productivity is helping feed the world

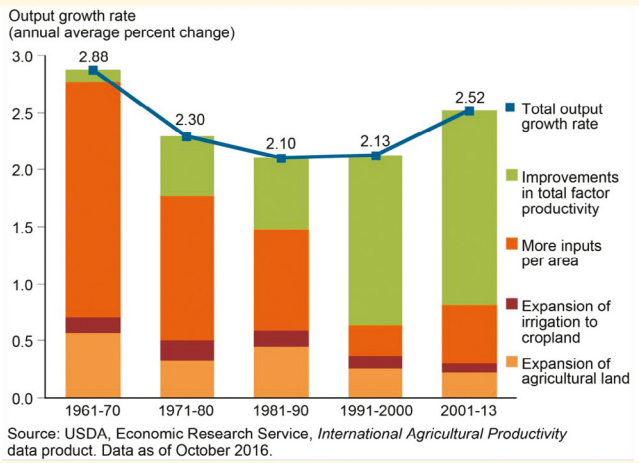
By Ross Kingwell, AEGIC Economics and Business Analysis Manager

A seemingly constant refrain from industry leaders and politicians is that we need to work smarter and be more productive. In agriculture, especially Australian agriculture, several researchers have pointed to a worrying decline in productivity, especially during the first decade of this century. But the most recent evidence from the United States Department of Agriculture (USDA) points to a recent global uplift in agricultural productivity – an uplift also enjoyed by Australian agriculture.

Ross Kingwell, AEGIC Economics and Business Analysis Manager

Figure 1 from the USDA shows that the global increase in output since the late 1980s is mostly attributable to an increase in productivity.

Figure 1: Sources of growth in global agricultural output, 1961–2013



Source: USDA, Economic Research Service, *International Agricultural Productivity* data product. Data as of October 2016.

Globally, the world is getting smarter at producing agricultural products more efficiently. Growth in output is not coming from any marked expansion in the area of farming or large new irrigation projects or large increases in the use of farm inputs (i.e. accelerated intensification). Rather the increased output mostly is coming from scientists and farmers being very clever in making agricultural inputs and farming systems much more productive, extracting more output from each unit of input.

The spectacular growth in productivity is allowing the world to more easily feed itself, without consuming ever increasing tracts of land for food production. China's agricultural production, for example, has increased more than 8-fold between 1961 and 2013, and about half of this growth is due to productivity gain.

The latest USDA analyses show that agricultural output has been growing fastest in lower- and middle-income countries, where food demand is also growing rapidly. In low income countries agricultural growth is primarily driven by greater use of farm inputs.

By contrast in high income countries like Australia – where population and food demand is growing relatively slowly – growth in output is mostly through productivity gain.

In Australia, this productivity growth has allowed some land, labour and other resources to actually be withdrawn from agriculture for other uses, while still meeting domestic food demand and creating valuable exportable surpluses.

The table below lists the agricultural productivity of various countries over different periods. Since the period 1971 to 1990 all the listed countries have increased the growth rate of their agricultural productivity.

Table 1: Annual rates of agricultural productivity growth (%)*

	1971–90	2001–13	2004–13
Brazil	2.7%	3.2%	3.0%
Argentina	0.9%	1.0%	1.1%
Canada	0.9%	1.7%	1.3%
United States	1.3%	1.8%	1.8%
China	2.2%	3.2%	3.3%
India	1.1%	2.2%	2.5%
France	1.6%	2.0%	2.3%
Germany	1.9%	2.1%	2.0%
Australia	1.1%	1.3%	2.1%
Kazakhstan	-0.8%	2.0%	1.2%
Russian Federation	-0.3%	3.0%	2.5%
Ukraine	0.3%	2.6%	2.5%

*Source: USDA (2016)

The Black Sea region countries (Russia, Ukraine and Kazakhstan) have greatly increased their agricultural productivity. As pointed out recently by the Australian Export Grains Innovation Centre (AEGIC), Ukraine and Russia now pose important competitive challenges to Australian grain exports due to the marked increases in their grain production and export prowess.

In spite of Australia commendably lifting its agricultural productivity – especially in the most recent period 2004 to 2013 – nonetheless there are other competitor nations such as those in the Black Sea region that continue to outstrip the productivity growth of Australia.

So the competitive challenges facing Australian agriculture will continue – even in a world that currently now more easily feeds itself.

More information see: www.aegic.org.au ■

Section 10

Oilseeds Update

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Looking beyond blackleg and Sclerotinia 119
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(PHOTO: Kathi Hertel, NSW DPI)

Disease threats to Australian canola: Looking beyond blackleg and Sclerotinia

By Martin Barbetti[1,2], Ming Pei You[1,2] and Roger Jones[2,3]

AT A GLANCE...

- Despite canola fungal diseases white leaf spot, downy mildew, powdery mildew and the resistance-breaking strain of Turnip mosaic virus (TuMV) being widespread and severe in some regions, their importance is grossly underestimated nationally.
- Canola varieties with resistance against white leaf spot, downy mildew and powdery mildew have been identified. These offer unique opportunities not only for their direct deployment in areas where one or more of these diseases are severe, but also for use by canola breeding programs to develop commercial varieties with effective resistance.
- The severe TuMV resistance-breaking strain is widespread in the Liverpool Plains region of NSW. It overcame all the TuMV resistance genes that currently suppress TuMV spread in canola varieties. Its spread to other canola-growing regions is likely to cause major losses nationally.
- Extension and research personnel often misdiagnose or fail to distinguish and/or identify different canola foliar diseases other than blackleg and Sclerotinia.

Australia-wide surveys were recently undertaken to determine the incidence and severity of foliar diseases of canola caused by the fungal pathogens white leaf spot, downy mildew, Alternaria and powdery mildew. Studies were also undertaken to understand the threat posed by the new resistance-breaking Turnip mosaic virus (TuMV). Australian canola varieties were screened for their relative resistances/susceptibilities to these five pathogens in field and/or glasshouse tests.

Our comprehensive surveys of canola crops around Australia revealed how extensive is the prevalence and severity of the four fungal foliar diseases. In the past, Australian canola varieties carried TuMV-resistance genes that protected them against TuMV. But with the advent of the new resistance-breaking strain, this situation has now changed completely. Infection with it is widespread in canola crops growing in the Liverpool Plains region of NSW, and all Australian canola varieties are susceptible.

TuMV causes seed yield losses of up to 70 per cent. In a survey in 2004, economic losses from downy mildew were estimated at up to $13 million annually in WA alone. For white leaf spot, yield losses in Australia are up to 30 per cent.

Powdery mildew incidence and severity increased considerably in recent years in the northern agricultural areas of WA and northern NSW causing yield losses up to 50 per cent following late season epidemics.

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What we found

White leaf spot

White leaf spot disease occurred widely throughout canola crops across southern Australia. It occurred most frequently and was most severe in WA. It was also at high incidence and particularly severe in Victoria. Up to 60 per cent of leaves were diseased, with up to 30 per cent of leaf area lost and 20 per cent of leaf area collapsed from lesions.

This demonstrated the damaging effect it has in causing extensive loss of photosynthetic area and leaf collapse.

Oscar and Stubby were among the most highly white leaf spot resistant canola varieties, while Pioneer 45Y86, Sahara, Mickey and Thunder were examples of highly susceptible varieties, as were the Indian mustard varieties Xceed X121 CL (VT X121CL), Xceed Oasis CL and Dune.

For more detailed information see:
Gunasinghe, N., You, M.P., Li, X. X., Banga, S.S. and Barbetti, M.J. (2016). New host resistances to *Pseudocercosporella capsellae* and implications for white leaf spot management in *Brassicaceae* crops. Crop Protection 86: 69-76.

Downy mildew

Downy mildew disease was extremely widespread in WA with lower levels occurring in other states. Up to 55 per cent of leaves were diseased, 15 per cent of leaf area lost and 13 per cent of leaf area collapsed. This confirmed its damaging effect in causing leaf collapse and loss of green leaf area which was particularly devastating to young canola plants.

Canola varieties CBTM Tanami, ATR Banjo, Hyola 575 CL, Wamus, Surpass 400, Hyola 432 and Hyola 76 had best downy mildew resistance.

Others with useful resistance included varieties Hyola 61, Hyola 400 RR, Hyola 444 TT, Hyola 474 CL, Hyola 500 RR, Hyola 504 RR, Hyola 577C, Hyola 559 TT, Hyola 650 TT, Pioneer 46Y78, Pioneer 45Y77, ATR-Eyre, ATR-Summit, ATR-Hyden, Trooper, AV-Jade, Jackpot TT, AV-Sapphire, Hurricane, Crusher TT, Rottnest, RT, Oscar, Atomic, and Warrior.

With the sole exception of Surpass 400 released in 1999, only since 2000 have varieties been released with very high levels of resistance.

It is particularly important that varieties within the 'highly resistant' category are selected as these offer the greatest opportunities both for direct deployment into areas highly conducive to downy mildew and for parents for breeding more highly mildew disease resistant varieties.

For more detailed information see:
Mohammed, A.E., You, M.P. and Barbetti, M.J. (2017). New resistances offer opportunity for effective management of the downy mildew (*Hyaloperonospora parasitica*) threat to canola. Crop and Pasture Science 68; (Online at: DOI: 10.1071/CP16363).

Powdery mildew

As plants approached maturity, very severe powdery mildew disease was observed on crops in the northern agricultural region of WA and the Liverpool Plains in NSW. The expression of host resistances/susceptibilities to powdery mildew was determined for Australian canola and mustard varieties. In relation to leaf infestation, the most resistant (eg. *B. juncea* Sahara CL and *B. napus* Barra ATR) had less than a third of leaf area infested, compared with the most susceptible varieties with

Typical disease symptoms for white leaf spot on canola (top LHS), Alternaria on mustard (top centre), powdery mildew on canola (top RHS), Turnip mosaic virus on canola (bottom LHS) and downy mildew on canola (bottom RHS).

more than two thirds infested (eg. canola Pioneer 45y86 and mustard Dune).

Varieties with the greatest potential in the field were those that showed low levels of infestation across all plant components (stems, leaves, petioles, pods). Of these, Trooper, Bravo TT, Summit, Tumby HT, Narendra and Hyola 650TT were in the top 10 per cent resistance category. Mustard varieties Sahara CL and Xceed X121 CL had high levels of stem infestation that would likely reduce the overall effectiveness for powdery mildew management in the field.

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For more detailed information see:
Uloth, M., You, M.P., Barbetti, M.J. (2016). Cultivar resistance offers the first opportunity for effective management of the emerging powdery mildew threat (*Erysiphe cruciferarum*) threat to oilseed brassicas in Australia. Crop and Pasture Science 67: 1179-1187.

Alternaria

Alternaria caused sporadic disease of canola crops in WA, western Victoria and northern NSW, with up to 10 per cent of leaves diseased and 5 per cent of leaf area lost to lesions. While its incidence and severity are generally low in 'drier' years, there was a higher incidence and severity in 'wetter' years, presumably a consequence of the higher rainfall.

Turnip mosaic virus

The resistance-breaking strain of TuMV overcomes all TuMV resistance genes that formerly suppressed its spread in Australian canola varieties. It appeared in the Liverpool Plains initially, but has commenced spreading nationally from there.

When 19 canola varieties were challenged with it, their resistances

From paddock to plate - Austgrains has the field covered.

AUSTGRAINS has over 40 years' experience in the domestic and export grain industry. The company specialises in:

- Supplying growers with selected grains and seeds for profitable in-paddock performance; and,
- Supplying the food/health food manufacturing industry with high quality product with full traceability and quality assurance.

By offering various contract options to their growers, Austgrains has created an avenue for farmers to become part of the supply chain. Austgrains' diverse range of products have applications in the breakfast cereal, bakery, noodle and snack food markets.

Over the last decade the company has developed an outstanding reputation as a valued supplier in these fields, and continues to support new product development and branding for its customers in domestic and export markets.

FLAXSEED – or linseed as this tap-rooted oilseed is also known as in Australia – is one of the many products Austgrains offer in its portfolio.

For many years the company has worked with growers to lift the profile of this highly valuable crop, and continues to do so with constant development in agronomics to enhance the yield and quality required to supply the growing flaxseed market.

In addition to the financial value of the crop, flaxseed assists with soil conditioning, soil-borne disease management as well as the control of root lesion nematodes with beneficial results comparable to other rotation crops such as canola.

Out of the paddock and onto the plate, flaxseed has many health benefits including the potential to reduce cardiovascular disease. Recent clinical publications have also indicated that daily consumption of flaxseed can help reduce blood pressure in hypertensive patients.

As part of their business model, Austgrains is working with individuals and organisations right along the domestic and export supply chain to lift the profile of this hugely diverse food product.

With the rapidly growing incidence of 'western lifestyle' diseases both here and internationally – such as increased cardio-vascular diseases and Type II diabetes in the more westernised Asian countries – the potential for the flaxseed health food industry is huge.

Austgrains is busily working with growers right through to consumers to identify and promote the many market opportunities for a range of flaxseed products from ingredient based solutions to the generic bulk commodity.

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were overcome, while TuMV pathotypes 1, 7 and 8 all elicited resistance responses that prevented their spread. This explains the new strain's recent widespread occurrence annually in the Liverpool Plains. But its resistance-breaking properties only applied to canola, as resistance to it was found in some non-canola brassicas, such as Indian mustard and cauliflower.

When it was sequenced, its complete genomes grouped separately from all 23 other Australian TuMV isolates sequenced previously, suggesting a recent introduction to Australia.

Spread of this resistance-breaking strain poses a significant threat to the national canola industry. Breeding canola varieties with resistance to it should constitute a critical future priority for canola breeding programs in Australia and elsewhere.

For more detailed information see:
Guerret, M. G. L., Nyalugwe, E. P., Maina, S., Barbetti, M. J., van Leur, J. A. G., and Jones, R. A. C. 2017. Biological and molecular properties of a Turnip mosaic virus (TuMV) strain that breaks TuMV resistances in Brassica napus. Plant Disease (Online at: http://dx.doi.org–10.1094/PDIS-08-16-1129-RE).

To sum up

Other than identifying blackleg and Sclerotinia diseases, extension and research personnel are missing – or misdiagnosing – foliar fungal and viral diseases, considerably underestimating the threat they pose to the national canola industry. White leaf spot and downy mildew diseases were debilitating on younger canola crops throughout much of southern Australia. Powdery mildew was a significant issue for canola crops in northern regions of NSW and WA. Alternaria disease was problematic only in wetter years in sporadic locations.

The TuMV resistance-breaking strain overcame all TuMV resistances present in the Australian canola varieties tested. As its range expands, it poses an increasing threat to the national canola industry.

Canola varieties with effective resistances were identified against white leaf spot, downy mildew and powdery mildew diseases. These disease-resistant varieties offer unique opportunities for:

- Direct deployment where any of the diseases are severe; and,
- As parents in canola breeding programs developing varieties with effective resistance.

With resistance-breaking TuMV, a comprehensive search of canola germplasm is required to identify TuMV resistance sources suitable for use in breeding canola varieties with effective resistance.

The existence of effective resistance to white leaf spot, downy mildew and powdery mildew within some existing Australian canola varieties highlights the ongoing need for assessment for reactions to each of these diseases, along with TuMV, as part of the Australian National Variety Trials program. This would not only ensure identification of new varieties with the optimal resistance, but also allow varieties identified as highly susceptible to be targeted for areas considered not conducive to disease development.

Clearly, where there is an ongoing severe foliar disease issue other than blackleg and Sclerotinia, resistant varieties identified could be deployed.

Confusion of other fungal foliar diseases, particularly with blackleg, or failure to notice them, means their threat to the canola industry remains unrecognised. Consequently, an important component of the advice about them is misleading. Before our foliar fungal disease surveys, the only information available to farmers was from occasional symptom observations on crops and NVT trials. These smaller scale observations have resulted in incorrect information.

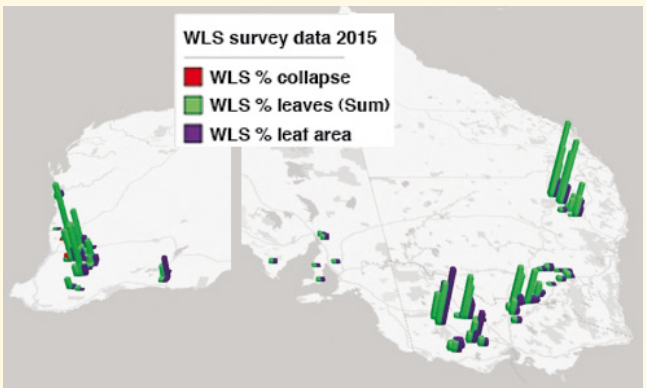
The findings from our comprehensive disease surveys will not only help remedy this situation, but also provide the first accurate information to farmers about canola fungal diseases other than blackleg and Sclerotinia. In addition, it will help the canola industry and R&D funding bodies make better-informed investment and management decisions for the future.

Finally, canola viruses other than beet western yellows are currently ignored nationally, so our findings concerning the susceptibility of all varieties tested with the resistance-breaking strain of TuMV, should serve as a warning not to neglect virus threats to the canola industry.

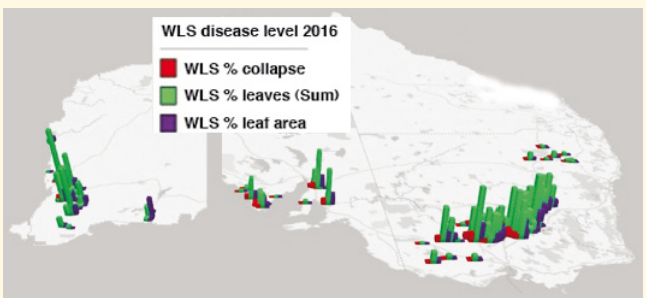
[1]UWA School of Agriculture and Environment, UWA; [2]The UWA Institute of Agriculture, UWA; and,[3]DAFWA, Perth.

The authors gratefully acknowledge the financial support of the GRDC and UWA. ■

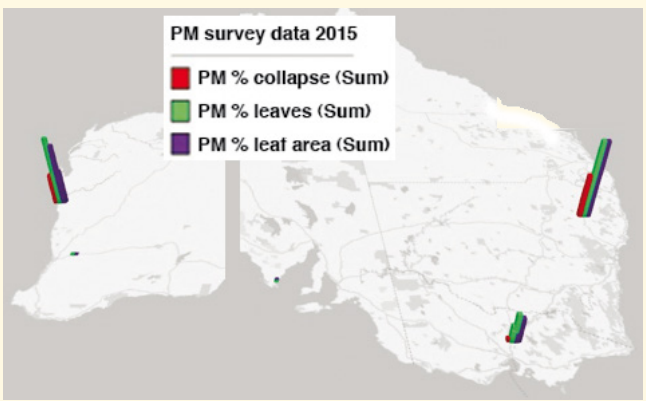
Figure 1: Shows per cent leaves diseased in the crop (green columns), the per cent of leaf area in the crop lost to lesions (purple columns), and the per cent of leaf area collapsed in the crop from disease (red columns)



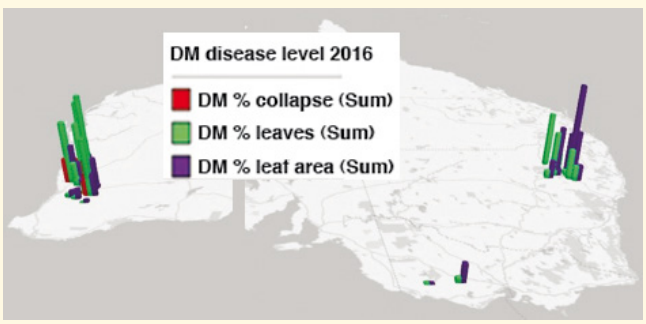
Australia-wide impact of white leaf spot disease in canola, 2015.



Australia-wide impact of white leaf spot disease in canola, 2016.



Australia-wide impact of powdery mildew disease in canola, 2015.



Australia-wide impact of powdery mildew disease in canola, 2016.

Tactical agronomy of linseed and safflower

By Kathi Hertel, NSW DPI

AT A GLANCE...

- Linseed (also called flaxseed) and safflower are winter oilseed crops best suited to be grown in rotation with cereal crops. Agronomic attributes include roles in integrated disease, weed and pest management programs.
- Limited market development of linseed and safflower restricts their current contribution to – and distribution across – our Australian farming systems.
- Linseed can play a key role with root lesion nematodes. It is resistant to both *Pratylenchus thornei* and *P neglectus.*
- Linseed is best suited to medium to high rainfall environments in Australia's northern grain regions.
- Safflower is a heat tolerant crop that is adapted to dryland and irrigated production. It requires more water than other crops. Deep well drained soils enable its deep root system to access more soil water.
- The development of safflower crop technology for the biodiesel industry presents the potential of a significant addition to crop options in northern farming systems.

Linseed and safflower are winter-spring growing oilseed crops offering key benefits to diverse summer and winter crop systems as well as components of mixed production systems.

As oilseed crops, benefits include improved productivity of subsequent crops, lifting farm income, reducing the impact of disease and weeds; and producing edible and industrial quality oil and meal. Their integration offers the opportunity to enhance overall environmental, production and economic sustainability.

Linseed and safflower are grown largely for the domestic food industry. Research to establish baseline data to enhance agronomic management is crucial for future industry and market development of the two oilseeds.

Linseed

Linseed is a winter growing oilseed crop grown for its seed and oil. Linseed contains alpha-linolenic acid, polyunsaturated oil. Alpha-linolenic acid is classed as an omega-3 fatty acid, considered to be an essential fatty acid in human health diet.

End uses have changed in recent decades as advances in technology have resulted in synthetic substitutes where linseed oil was used. Greater focus on human health and natural products has resulted in most of the Australian linseed crop grown for seed, and a lesser extent oil, in the food industry.

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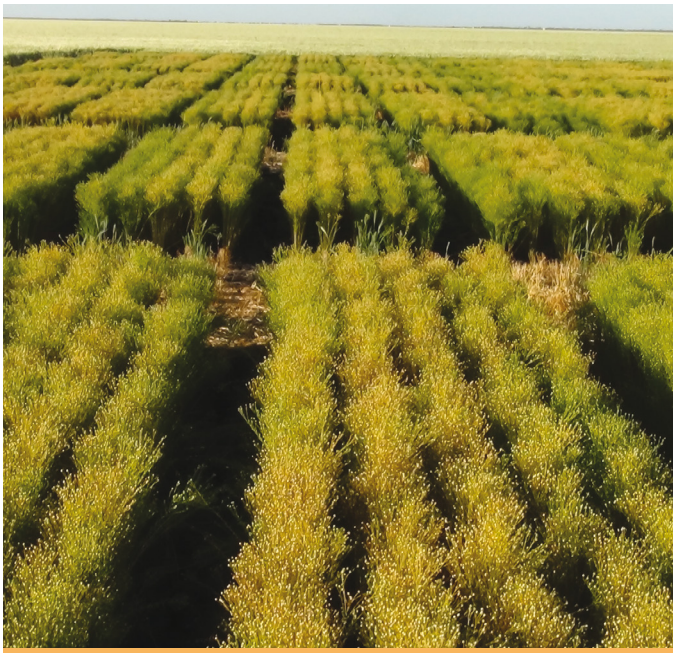

More linseed and safflower cultivars are needed to increase adaptation and marketability of these oilseeds. (PHOTO: Kathi Hertel, NSW DPI)

Linseed contains 35–40 per cent oil, with alpha-linolenic acid levels of between 45 and 60 per cent. Linoleic (omega-6) fatty acid levels, desirable for its human health attributes, are generally between 17 and 22 per cent.

Rotation fit

Linseed is a winter oilseed crop alternative.

Linseed grown after cereal crops is effective in reducing soil borne root diseases including crown rot (*Fusarium pseudograminearum*) common root rot (*Bipolaris sorokiniana*), yellow leaf spot (*Pyrenophora tritici-repentis*) and spot form of net blotch (*Pyrenophora teres f maculata*).

Linseed is resistant to both main species of root lesion nematodes – *Pratylenchus thornei* and *P neglectus.*

Linseed has a high arbuscular mycorrhizae fungi (AMF) host dependency. Significant yield losses can result if grown in low AMF situations. Linseed is best grown after AMF host crops like wheat.

As well as grass selective herbicides, a number of broadleaf herbicide options are registered, covering a wide spectrum of broadleaf weed species and including Group C and Group I herbicides.

Sowing time and varieties

Linseed is generally planted in mid-May to mid-June in the northern cropping regions of Australia. It is generally grown on row spacings varying between 18 cm (7") and 38 cm (15").

At present, there are no active breeding program in Australia since the closure of the CSIRO breeding program several decades ago.

Glenelg is an early to midseason maturing variety released in 1970. A white-flowered public variety, it is the most widely grown variety in northern NSW, accounting for more than 95 per cent of the crop area.

Croxton is a long season public variety. Blue-flowered, Croxton has been grown since 1985 in mostly southern Australia, but with small production areas in the cooler higher rainfall slopes area east of Moree.

LM14 and LM17 are two cultivars licenced to Austgrains Pty Ltd at Moree. Both blue flowering types, their maturity lies between Glenelg and Croxton.

Suitable soils

Linseed is adaptable to soils ranging from vertosols through to loams. Linseed will grow on acid soils where pH(Ca) levels are as low as 4.5, and if exchangeable aluminium levels are also low.

The crop performs best on well-structured heavier-textured soils. It is not suited to sandy soils. Linseed is classified as having a low to moderate tolerance to salinity.

Plant growth

Linseed has a very small seed. Seed placement, and particularly depth and soil contact with moist soil is critical for even crop emergence. Early plant growth is slow during cooler seasonal temperatures after planting.

After emergence, a single main stem elongates. This is usually followed by the growth of one or two pairs of basal branches that extend almost to the height of the main stem.

A seed head forms consisting of clusters of buds. Each flower bud opens, eventually forming a capsule (boll) potentially producing up to 10 seeds.

Linseed is an indeterminate crop. Flowering can continue for several weeks until seasonal conditions and /or plant resources cause flowering to cease. Seeds ripen within the capsules. Mature seeds rattle within the capsule.

Yield potential

Linseed is suited to the higher rainfall areas the northern region, with best performing crops generally grown east of the Newell Highway. Linseed is sensitive to periods of moisture or temperature stress during the flowering period.

Spring rainfall patterns have a large influence on crop yields. Reported average yields range between 1.0 and 1.5 tonnes per hectare.

Linseed is an indeterminate crop and flowering can continue for several weeks. (PHOTO: Kathi Hertel, NSW DPI)

Pests

Heliothis is the most significant pest in linseed. One, sometimes two pesticide applications are required. Heliothis can damage the crop before budding, but are most prevalent during budding – flowering.

Disease

Few diseases have been reported to be of concern in linseed. The relatively small production area and annual variations of the crop contribute to low inoculum levels and long paddock rotations between crops. Potential disease issues of linseed include:

- Fusarium wilt (*Fusarium lini*) has been reported to a major disease in southern Australia, but with few recent reports in northern NSW. Glenelg is very susceptible to fusarium wilt, the main reason why it is no longer grown in southern Australia. It has been replaced by Croxton, the only resistant variety. The reaction of LM14 and LM17 are not known.
- Pasmo (*Mycosphaerella linorum*) Pasmo is a fungal disease that may cause yield and seed quality. The last known reports of Pasmo in NSW linseed were in the 1970s and 1980s during moist conditions in spring. It has not been considered to be a major disease risk in linseed production. Neither Glenelg or Croxton are resistant to Pasmo. The status of LM14 and LM17 is unknown.

Marketing

The market for linseed is small – anecdotally between 12,000 and 20,000 tonnes per annum for the domestic human consumption market. The limited market demand and sometime plentiful supply cause large variations in price from season-to-season.

Most of the northern Australian linseed crop is grown under contract on a per hectare basis. The licenced cultivars LM14 and LM17 are grown under contract for delivery to Austgrains Pty Ltd at Moree.

Payment is based on 7.5 per cent moisture receival standards.

Safflower

Safflower comprises cultivars that are of two oil types, high in linoleic or oleic fatty acids. Safflower historically has remained a secondary crop. Linoleic cultivars were principally marketed as a component of feed mixes for birds and small animals; and oleic cultivars used in manufacturing industries producing paints, resins, pharmaceuticals and cosmetics.

Areas sown to safflower in Australia vary widely, ranging between 5000 and 45,000 hectares in the past decade. Reasons for this volatilty include few available cultivars, susceptibility to alternaria (*Alternaria carthami*) and phytophthora (*Phytophthora cryptogea*), limited agronomic research, disappointing farmer experiences and adverse seasons. A history of inconsistent prices and market opportunities because of competition from both alternative oilseed crops – and the continuing development of petroleum substitutes – have further hampered adoption.

Where safflower can fit in the rotation

Rotation benefits include:

- Late winter crop option if there is a late break or failed establishment of the winter crop.
- Potential to double crop out of sorghum.
- Heat and drought tolerant oilseed crop suited to lower rainfall areas where canola and sunflower are not adapted.
- Broadleaf crop option – break crop for cereal diseases including Crown rot (*Fusarium pseudograminearum*), Common root rot (*Bipolaris sorokiniana*), Yellow leaf spot (*Pyrenophora tritici-repentis*) and Spot form of net blotch (*Pyrenophora teres f maculata*).

Safflower has a good agronomic fit in some crop rotations.
(PHOTO: Kathi Hertel, NSW DPI)

- Resistant to both *P thornei* and *P neglectus* root lesion nematodes.
- Safflower is regarded as a good host to arbuscular mycorrhizae fungi (AMF), promoting the increase of AMF in the soil.
- Safflower is subjected to a different weed spectrum to most other crops. It offers the opportunity to control late germinating weeds and/or herbicide resistant winter weeds and to incorporate additional IWM strategies.
- Greater crop enterprise diversity to spread economic and production risk.
- Used in a soil ameliorant role to improve soil structure. For example, used strategically as a first crop in the rotation after cotton to break up subsoil to remove compacted layers, improve aeration and water infiltration; and root development to subsequent crops (anecdotal reports of rooting depths of 2.2 m).

Yield potential and marketing

In most seasons, average dryland yields are around 1.0 to 1.2 tonnes per hectare. The highest known commercial yield is reported to be 3.3 tonnes per hectare under irrigation in northern NSW.

The safflower market is currently very limited. Crops that are grown are mainly for the oilseed market where the two oil types delivered are:

Linoleic acid – a polyunsaturated (omega-6) fatty acid. The most widely grown linoleic oil cultivar is Sironaria, released by CSIRO in 1987. Linoleic genotypes contain over 75 per cent linoleic acid. Linoleic cultivars are grown for seed and oil.

Oleic acid – a monounsaturated fatty acid. Oleic varieties include S317 and S517 which are grown their oil, for use in the food industry for frying and in the manufacture of pharmaceuticals, cosmetics, soap, paint additives, adhesive and sealant compounds, plastics and lubricants.

To sum up

The suitability of safflower to the NGR environment combined with industrial crop technology creates a potential new industry – the ability to produce renewable high purity oleic acid oil suited to a range of compounds that can replace non-renewable petroleum-based industrial chemicals. But further agronomic research and development is required.

More safflower cultivars are needed to increase adaptation and marketability. The release of quicker maturing cultivars may increase the reliability and yield through improved harvest index (HI) and WUE. Disease resistance to Alternaria and Phytophthora would be important desirable features.

Better understanding of plant growth and development of safflower coupled with water use patterns are needed to develop and adapt agronomic recommendations like sowing time, crop population and row spacing to environments across the NGR and interactions with crop yield and oil quality.

As part of a rotation, safflower's long growing season and high water requirement will impact on subsequent crop choices and performance. The economics of safflower need to offer at least similar benefits and profitability to growers as alternate crop choices. The development of stable market opportunities is integral to future industry development. Wider weed and pest control options and registrations are needed.

For more information about safflower's rotational and marketing fit in Australian farming systems see: *Australian Grain*, March–April, 2016.

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 author would like to thank them for their continued support.

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Valued comments: Jim Simpson – Austgrains (Moree) and Bill Slattery – Fabi Foods Pty Ltd, Tony Cook – NSW DPI

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■

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The many benefits of linseed

By Lin Yan, Agricultural Research Service, USDA

Flax (or linseed) is an annual plant, and it is grown both for its fibre and for its seeds. The ancient Egyptians were probably the first to use flax. They used fibre from the plant to make clothes, fishnets and other products, and they used flaxseed (or linseed) as food and medicine.

Historically, flaxseed has been primarily used as a laxative, because it is high in fibre and a gummy material called mucilage. These substances expand when they come in contact with water, so they add bulk to the stool and help it move more quickly through the body.

Flaxseed is rich in nutrients. One hundred grams of ground flaxseed supply approximately 450 kilocalories, 41 grams of fat, 28 grams of fibre and 20 grams of protein. Flaxseed oil or linseed oil is rich in alpha-linolenic acid, an omega-3 fatty acid. Omega-3 fatty acids are 'good' fats that may be good for heart disease, inflammatory bowel disease, arthritis and other health problems. Each tablespoon of ground flaxseed contains about 1.8 grams of omega-3 fatty acids.

GET YOUR ESSENTIAL FATTY ACIDS FROM FLAX-FED BEEF

One day soon, beef may pack the same healthy essential acids found in fish, but it will still taste like beef. Scott Kronberg, an animal research scientist with the USDA's Agricultural Research Service, found that feeding cattle flaxseed increases the amount of omega-3 fatty acid in their tissue. In one study by researchers at North Dakota State University, omega-3 levels of cattle on a corn finishing diet represented about seven per cent of total fatty acids. That bumped up to 12 per cent for cattle fed ground flaxseed at two pounds per day (about 1 kg) of their ration, says Scott.

Getting flax past the rumen

Scott and his team have researched enriching beef with omega-3 fatty acid for about five years. "We've done a number of different trials, feeding two pounds of ground flaxseed per animal per day for two to three months, trying to see how much we've increased the omega-3 fatty acid in muscle," Scott says.

The goal is to get the flaxseed oil past the rumen microbes that turn most of the omega-3 fatty acids into saturated fatty acids by breaking the double bonds in the acid chains.

"Perhaps the biggest challenge I am trying to address is that microbes in the rumen of cattle destroy 90 to 95 per cent of the omega-3 fatty acid the animals ingest," he says.

The group has tried treating flaxseed in hopes that the omega-3 would be protected from degradation by the rumen microbes, he says. The protection treatments don't seem to actually protect the omega-3 from the rumen microbes. But he's not giving up on that approach, and is still looking for an effective treatment and will test a few more soon.

"I don't know if or when we'll see omega-3-enriched beef sold in standard supermarket beef displays," he says. "But I won't be surprised if we do in five to 10 years."

Improving cardiovascular health

Studies suggest that consumption of flaxseed may be beneficial in improving cardiovascular health.

People who eat a Mediterranean diet tend to have higher HDL ('good') cholesterol levels.

The Mediterranean diet limits the amount of red meat, butter, and cream. In laboratory studies, flaxseed and flaxseed oil have been shown to lower cholesterols in animal trials.

One of the best ways to prevent heart disease is to eat a low-fat diet, avoiding foods rich in saturated fats and trans-fats and eating those that are rich in unsaturated fats, for example, omega-3 fatty acids from flaxseed.

In addition to the important omega-3 fatty acids, flaxseed also contains a group of bioactive components called lignans. Emerging evidence suggests that lignans may help protect the body from cancer. In a human clinical study, eating a muffin each day containing 25 grams of flaxseed for 40 days showed the potential to reduce tumor growth in postmenopausal women who were newly diagnosed with breast cancer. Laboratory studies reported that flaxseed or its bioactive components lignans reduced breast tumor growth and spread in laboratory rodents.

Evidence also suggests that flaxseed may benefit men at risk of prostate cancer. In one study, a low-fat diet with 30 grams of flaxseed daily lowered prostate specific antigen levels (a marker of prostate health) in men with a precancerous prostate condition called prostatic intraepithelial neoplasia.

But more clinical studies are needed to understand how flaxseed and lignans may affect cancer in humans.

How much flaxseed for best health outcomes?

The optimum amount of intake to obtain health benefits is not known. But in the US, one to two tablespoons of ground flaxseed a day is currently suggested.

Flaxseed, when eaten whole, is more likely to pass through the body undigested, which means the body does not get all of the nutrients and bioactive components. You can buy whole flaxseed and grind it yourself. The outside shell in whole seed appears to keep the fatty acids inside well protected.

The best place to store ground flaxseed is the freezer, which will keep the ground seed from oxidising and losing its nutritional potency.

Eating flaxseed is easy. Top a salad with some ground flaxseed, sprinkle it on top of yogurt, smoothies or cereal, or stir a teaspoon into soup. It also can be a substitute for a tablespoon or two of the flour when we are making breads and biscuits.

Flaxseed oil works best in cold foods like salad dressings and should not be used for frying because it burns easily. ■

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Section 11

Industry Agencies

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National Farmers' Federation

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Pastoralists' & Graziers' Association of WA (PGA)

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Western Australian Farmers Federation (WAFarmers)

PO Box 68, GUILDFORD WA 6935
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WA Grains Group (WAGG)

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Victorian Farmers Federation (VFF)

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Chief Executive Officer: Graeme Ford

Tasmania

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Chief Executive Officer: Matt Brand
Grains Committee: Rebecca Reardon

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Minister for Agriculture and Water Resources

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Australian Pesticides and Veterinary Medicines Authority (APVMA)

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Email: enquiries@apvma.gov.au – Web: www.apvma.gov.au
Chief Executive Officer: Ms Kareena Arthy

Australian Government Department of Agriculture and Water Resources

GPO Box 858, CANBERRA ACT 2601
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Australian Plague Locust Commission

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Department of Foreign Affairs and Trade

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Ph: 02 6261 1111 – Fax: 02 6261 3111
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Secretary: Frances Adamson
Deputy Secretary, Office of Trade Negotiations: Justin Brown

Department of Agriculture and Water Resources – Levies

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Chief Financial Officer: Emily Canning

National Residue Survey

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Office of Rural Financial Counselling

GPO Box 858, CANBERRA ACT 2601
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Plant Breeder's Rights Office
(located within IP Australia)

Discovery House
47 Bowes Street, Phillip ACT 2606
PO Box 200, WODEN ACT 2606
Ph: 1300 651 010
Registrar: Fatima Beattie
Email: eservices@ipaustralia.gov.au – Web: www.ipaustralia.gov.au

Biosecurity Plant

18 Marcus Clarke Street, Canberra City
GPO Box 858, CANBERRA ACT 2601
Ph: 1800 900 090
Web: www.agriculture.gov.au
First Assistant Secretary: Marion Healy

Biosecurity Animal

18 Marcus Clarke Street, Canberra City
GPO Box 858, CANBERRA ACT 2601
Ph: 1800 900 090
Web: www.agriculture.gov.au
First Assistant Secretary: Tim Chapman

State Agriculture Departments

NSW Department of Primary industries

161 Kite Street, Orange
Locked Bag 21, ORANGE NSW 2800
Ph: 1800 808 095 – Fax: 02 6391 3336
Email: nsw.agriculture@dpi.nsw.gov.au – Web: www.dpi.nsw.gov.au
Director General: Scott Hansen

Department of Economic Development, Job, Transport and Resources Victoria

1 Spring Street, MELBOURNE 3001
GPO Box 4509, Melbourne VIC 3001
Ph: (03) 9651 9999
Email: customer.service@ecodev.vic.gov.au
Web: www.economicdevelopment.vic.gov.au/

Department of Agriculture and Fisheries (Qld)

Primary Industries Building
80 Ann Street, Brisbane
GPO Box 46, BRISBANE QLD 4001
Customer Service Centre: 13 25 23
Interstate – Ph: 07 3404 6999 – Fax: 07 3404 6900
Email: callweb@daff.qld.gov.au – Web: www.daff.qld.gov.au
Follow us on Facebook and Twitter:
Queensland Agriculture and @QldAgriculture
Queensland Food and @QueenslandFood
Director General: Beth Woods

Primary Industries and Regions SA (PIRSA)

L 14, 25 Grenfell Street, Adelaide
GPO Box 1671, ADELAIDE SA 5001
Ph: 08 8226 0995 – Email: pirsa.customerservices@sa.gov.au
Web: www.pir.sa.gov.au
Chief Executive: Scott Ashby, Phone: +61 8 8226 0168
Email: scott.ashby@sa.gov.au
Assistant Director PIRSA Strategic Communications:
Stephen Cox, Ph: 08 8429 0496, Email: stephen.cox2@sa.gov.au

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SA Research and Development Institute (SARDI)

Climate Applications: Dr Peter Hayman, Ph: 08 8303 9729
Crop Improvement: Dr Tim Sutton, Ph: 08 8303 9734
Crop Pathology: Dr Jenny Davidson, Ph: 08 8303 9389
Entomology: Greg Baker, Ph: 08 8303 9544
Farming Systems: Dr Nigel Wilhelm, Ph: 08 8303 9353
Grains Research: Dr Kathy Ophel Keller, Ph: 08 8303 9368
Food Safety and Innovation: Alison Turnbull, Ph: 08 8303 9623
New Variety Agronomy: Andrew Ware, Ph: 08 8688 3417
Pulse Development: Larn McMurray 08 8842 6265
Pastures: Dr Alan Humphries, Ph: 0427 090 959
Email: pirsa.sardi@sa.gov.au – Website: www.pir.sa.gov.au/research

Department of Agriculture and Food, Western Australia

3 Baron-Hay Court, South Perth WA 6151
Locked Bag 4, BENTLEY DELIVERY CENTRE WA 6983
Phone: +61 (0)8 9368 3333 Fax: +61 (0)8 9474 2405
Email: enquiries@agric.wa.gov.au
Web: www.agric.wa.gov.au

Tasmanian Department of Primary Industries, Parks, Water and Environment

1 Franklin Wharf, Hobart
GPO Box 44, HOBART TAS 7001
Ph: 03 6169 9021
Email: Information@dpipwe.tas.gov.au
Web: www.dpipwe.tas.gov.au

Department of Primary Industry and Resources, NT

Berrimah Farm, Makagon Road, Berrimah, Northern Territory 0828
GPO Box 3000, DARWIN NT 0801
Phone: 08 8999 5511 (Business hours) – Fax: 08 8999 2010
Email: info.dpir@nt.gov.au – Web: www.dpir.nt.gov.au

Research & Development

Research and Development Corporations

Grains Research & Development Corporation

Level 4, East Building, 4 National Circuit, BARTON, ACT 2600
PO Box 5367, KINGSTON ACT 2604
Ph: 02 6166 4500 – Fax: 02 6166 4599
Chairman: John Woods
Managing Director: Dr Steve Jefferies
Email: grdc@grdc.com.au – Web: www.grdc.com.au

Rural Industries Research & Development Corporation

Building 007, Charles Sturt University, Boorooma Street, WAGGA WAGGA NSW 2650
c/o Charles Sturt University, Locked Bag 588, WAGGA WAGGA NSW 2678
Ph: 02 6923 6900 – Fax: 02 6923 6999
Email: rirdc@rirdc.gov.au – Web: www.rirdc.gov.au
Managing Director: John Harvey

Cotton Research & Development Corporation

2 Lloyd Street, Narrabri NSW 2390
PO Box 282, NARRABRI NSW 2390
Ph: 02 6792 4088 – Fax: 02 6792 4400
Email: crdc@crdc.com.au – Web: www.crdc.com.au
Chair: Richard Haire
Executive Director: Bruce Finney

Dairy Australia

Level 5, IBM Centre, 60 City Road, Southbank, Victoria 3006
Locked Bag 104, FLINDERS LANE VIC 8009
Ph: 03 9694 3777 – Fax: 03 9694 3733
Web: www.dairyaustralia.com.au
Farm Profit and Innovation: Chris Murphy

Meat & Livestock Australia (MLA)

Level 1, 40 Mount Street, North Sydney NSW 2060
PO Box 1961, NORTH SYDNEY NSW 2059
Ph: 02 9463 9333 – Free call: 1800 023 100 – Fax: 02 9463 9393
Email: info@mla.com.au – Web: www.mla.com.au
Managing Director: Richard Norton
Email: managingdirector@mla.com.au

Australian Pork Limited

Level 2, 2 Brisbane Avenue Barton ACT 2600
PO Box 4746, KINGSTON ACT 2604
Ph: 1800 789 099 – Fax: 02 6285 2288
Email: apl@australianpork.com.au
Web: www.australianpork.com.au
Chief Executive Officer: Andrew Spencer

Sugar Research Australia

50 Meiers Road, Indooroopilly, 4068
PO Box 86, INDOOROOPILLY Q 4068
Ph: 07 3331 3333 – Fax: 07 3871 0383
Email: sra@sugarresearch.com.au – Web: www.sugarresearch.com.au

Australian Wool Innovation Limited

Level 6, 68 Harrington Street, The Rocks, Sydney NSW 2000
GPO Box 4177, SYDNEY NSW 2001
Ph: 02 8295 3100 – Fax: 02 8295 4100
Email: feedback@wool.com – Web: www.wool.com
Chief Executive Officer: Stuart McCullough

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CSIRO Enquiries

Private Bag 10, CLAYTON SOUTH, VIC 3169
Phone: 1300 363 400 Mon-Fri 9:00am–4:00pm EST
Email: enquiries@csiro.au – Web: www.csiro.au

Grain-related CSIRO

www.csiro.au/en/Research/AF
Director CSIRO Agriculture – John Manners Ph: 02 6246 4001

Related Cooperative Research Centres

Plant Biosecurity CRC

Level 2, Building 22, Innovation Centre
University Drive, University of Canberra, BRUCE ACT 2617
LPO Box 5012, BRUCE ACT 2617
Ph: 02 6201 2882 – Fax: 02 6201 5067
Web: www.pbcrc.com.au
Chief Executive Officer: Michael Robinson
Communications Manager: Tony Steeper
Email: t.steeper@pbcrc.com.au

CRC for High Integrity Australian Pork

PO Box 466, WILLASTON, SA 5118
Ph: 08 8313 7683 – Fax: 08 8313 7686
Email: roger.campbell@porkcrc.com.au – Web: www.porkcrc.com.au
Chief Executive Officer: Dr Roger Campbell

International agencies

Australian Centre for International Agricultural Research (ACIAR)

38 Thynne Street, Fern Hill Park, Bruce ACT 2617
GPO Box 1571, CANBERRA ACT 2601
Ph: 02 6217 0500 – Fax: 02 6217 0501
Email: aciar@aciar.gov.au – Web: aciar.gov.au
Chief Executive Officer: Andrew Campbell

International Center for Agricultural Research in the Dry Areas (ICARDA)

PO Box 114/5055, BEIRUT, LEBANON
Ph: +961 1 843472/813303 – Fax: +961 1 804071/01-843473
E-mail: icarda@CGIAR.org – Web: www.icarda.org
Director General: Aly Abousabaa

International Maize and Wheat Improvement Center (CIMMYT)

Apdo. Postal 6-641, 06600 Mexico, D.F., MEXICO
Ph: +52 55 5804 2004 – Fax: +52 55 5804 7558
Web: www.cimmyt.org
Director General: Martin Kropff

Associated Industry

Agrifood Awareness Australia Limited

PO Box E10, KINGSTON ACT 2604
Ph: 02 6269 5620 – Fax: 02 6273 3968

AgriFood Technology

260 Princes Highway, Werribee
PO Box 728, WERRIBEE VIC 3030
Ph: 1800 801 312 – Fax: 03 9742 4228
Email: lab.vic@agrifood.com.au – Web: agrifood-srp.com.au

Australian Fertiliser Services Association (AFSA)

Company Secretary: Neil Henry
PO Box 10, GLENTHOMPSON. 3293.
Mob: 0418 562 570 – Email: henfert@bigpond.com
Executive Officer: Krysteen McElroy
Ph: 0408 655 108
Email: bkmcelroy22@outlook.com – Web: www.afsa.net.au

Australian Herbicide Resistance Initiative

School of Agriculture and Environment
The University of Western Australia
35 Stirling Highway, CRAWLEY WA 6009
Ph: 08 6488 7870 – Web: www.ahri.uwa.edu.au
Director: Professor Stephen Powles
Ph: 08 6488 7833 – Fax: 08 6488 7834
Email: stephen.powles@uwa.edu.au
Centre Manager: Ms Lisa Mayer
Email: lisa.mayer@uwa.edu.au

Australian Lot Feeders' Association

Level 5, 131 Clarence Street, Sydney
GPO Box 149, SYDNEY NSW 2001
Ph: 02 9290 3700 – Fax: 02 9290 2808
Email: info@feedlots.com.au – Web: www.feedlots.com.au
President: Tess Herbert
Chief Executive Officer: Christian Mulders

Australian Oilseeds Federation Inc

PO Box H236, AUSTRALIA SQUARE NSW 1215
Ph: 02 8007 7553 – Fax: 02 8007 7549
President: Jon Slee
Treasurer: Charles Aldersey
Web: www.australianoilseeds.com

Australian Research Council

Level 2, 11 Lancaster Place, Canberra Airport ACT 2609
GPO Box 2702, CANBERRA ACT 2601
Ph: 02 6287 6600 – Fax: 02 6287 6601
Email: info@arc.gov.au – Web: www.arc.gov.au
Acting Chief Executive Officer: Leanne Harvey

Australian Seed Federation Limited

Unit 1, 20 Napier Close, Deakin ACT 2600
PO Box 3572, MANUKA ACT 2603
Ph: 02 6282 6822 – Fax: 02 6282 6922
Email: enquiry@asf.asn.au – Web: www.asf.asn.au
President: Steve Brill
Chief Executive Officer: Bill Fuller

Barley Australia

PO Box 422, VERMONT VIC 3133
Ph: 0408 178 872
Email: info@barleyaustralia.com.au
Web: www.barleyaustralia.com.au
Executive Chairman: Andrew Gee
Email: andrew.gee@barleyaustralia.com.au

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Bean Growers' Australia Limited

82–86 River Road, Kingaroy QLD 4610
PO Box 328, KINGAROY QLD 4610
Ph: 07 4162 1100 – Fax: 07 4162 4706
Chief Executive Officer & Export Manager: Lloyd Neilsen
Email: lneilsen@beangrowers.com.au
Email: info@beangrowers.com.au
Web: www.beangrowers.com.au

Centre for Legumes in Mediterranean Agriculture (CLIMA)

The University of Western Australia,
35 Stirling Highway, CRAWLEY, WA 6009
Mailbox M080
Ph: 08 6488 2505 – Fax: 08 6488 1140
Email: reception-clima@uwa.edu.au – Web: www.clima.uwa.edu.au
Director: Prof. William Erskine

CropLife Australia

Level 1 Maddocks House
40 Macquarie Street, BARTON ACT 2600
Locked Bag 4396, Kingston ACT 260
Ph: 02 6273 2733
Web: www.croplife.org.au
President: Paul Luxton, Syngenta Australia Pty Ltd
Chief Executive Officer: Matthew Cossey

Farmsafe Australia

Head office: 14-16 Brisbane Avenue Barton ACT 2600
Locked Bag 9, KINGSTON, ACT 2604
PH: 02 6269 5622 – Fax: 02 6273 2331
Email: info@farmsafe.org.au – Web: www.farmsafe.org.au
Secretary: Sarah McKinnon
Chairman: Charles Armstrong
State Farmsafe contacts:
Queensland: 07 4774 0522
New South Wales: 02 9478 1000
Victoria: 1300 882 833
Western Australia 08 9359 4118

Fertilizer Australia

Level 1 Maddock House
40 Macquarie St BARTON ACT 2604
Locked Bag 4396 KINGSTON ACT 2604
Ph: 02 6273 2422
Email: info@fertilizer.org.au – Web: www.fertilizer.org.au
Chairman: Charlie Perkins

Grains & Legumes Nutrition Council

Level 1, 40 Mount Street, NORTH SYDNEY NSW 2060
Ph: 1300 472 467 (Australia only) or 02 9394 8661
Email: contactus@glnc.org.au – Web: www.glnc.org.au
Managing Director: Michelle Broom

Grains Research Foundation Ltd (GRFL)

PO Box 299, SOUTHTOWN QLD 4350
Mob: 0447 763 852
Email: admin@grf.org.au – Web: www.grf.org.au/
Chairman: Damien Scanlan

Nuffield Australia

PO Box 1021, NORTH SYDNEY NSW 2059
Ph: 0431 438 684
Email: enquiries@nuffield.com.au – Web: www.nuffield.com.au
Chief Executive Officer: Jodie Dean
Chairman: Andrew Fowler

Peanut Company of Australia

133 Haly Street, Kingaroy QLD 4610
PO Box 26, KINGAROY QLD 4610
Ph: 07 4162 6311 – Fax: 07 4162 4402
Email: peanuts@pca.com.au – Web: www.pca.com.au
Chief Executive Officer: John Howard

Plant Health Australia

Level 1, 1 Phipps Close, DEAKIN ACT 2600
Ph: 02 6215 7700 – Fax: 02 6260 4321
Email: info@phau.com.au – Web: www.planthealthaustralia.com.au
Chairman: Darral Ashton
Executive Director and CEO: Greg Fraser
Toll Free Exotic Plant Pest Hotline 1800 084 881

Pulse Australia Ltd

Level 10, Farrer House 24–28 Collins Street, MELBOURNE Vic 3000
PO Box H236, AUSTRALIA SQUARE NSW 1215
Chief Executive Officer: Nick Goddard
Ph: 02 8007 7553
Email: nick@pulseaus.com.au – Web: www.pulseaus.com.au
Industry Development Managers:
Northern region (Qld & northern NSW)
Paul McIntosh, Mob: 0429 566 198 Email: paul@pulseaus.com.au
Southern region (central & southern NSW)
Phil Bowden, Mob: 0427 201 946 Email: phil@pulseaus.com.au

Ricegrowers' Association of Australia

NIP 37, Yanco Avenue, Leeton
PO Box 706, LEETON NSW 2705
Ph: 02 6953 0433 – Fax: 02 6953 3823
Email: rga@rga.org.au – Web: www.rga.org.au
President: Jeremy Morton
Executive Director: Graeme Kruger

Ricegrowers' Limited – trading as SunRice

NIP 37, Yanco Avenue, Leeton
Locked Bag 2, LEETON NSW 2705
Ph: 02 6953 0411 – Fax: 02 8916 8350
Email: mdelgigante@sunrice.com.au – Web: www.sunrice.com.au

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Chairman: Laurie Arthur
Chief Executive Officer: Rob Gordon

Sustainability and Biosecurity Policy

18 Marcus Clarke Street, Canberra City
GPO Box 858, CANBERRA ACT 2601
Ph: 1800 900 090
Web: www.agriculture.gov.au
First Assistant Secretary: Phillip Glyde

Tractor and Machinery Association of Australia

Suite 617, 434 St Kilda Road, MELBOURNE VIC 3004
Ph: 03 9867 4289
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 26, 175 Liverpool Street, Sydney NSW 2000
GPO Box A268, SYDNEY SOUTH NSW 1235
Ph: 02 9325 9100 – Fax: 02 9325 9180
Email: enquiries@graincorp.com.au – Web: www.graincorp.com.au
Chairman: Don Taylor
CEO: Mark Plamquist

Viterra

Level 1, 186 Greenhill Road, Parkside SA 5063
GPO Box 1169, ADELAIDE SA 5001
Ph: 08 8304 5000 – Fax: 08 8231 1249 – Freecall: 1800 018 205
Email: viterra.aus@viterra.com – Web. www.viterra.com.au

Australian Grain Exporters Association (AGEA)

Australian Grain Exporters Association (AGEA)
PO Box 6156, Highton Vic 3216
Executive Officer: Ian Desborough
Ph: 0418 853 881
Email: agea@agea.com.au – Web: www.agea.com.au
President: Lyndon Asser

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Sales Team: Brian 0427 722 925 Graeme 0427 700 779 Ron 0427 293 653 Stewart 0457 922 001

CBH Group
GPO Box L886, PERTH WA 6842
Toll Free Grower Service Centre 1800 107 759 (SA, NSW, VIC, QLD)
1800 199 083 (WA)
Web: www.cbh.com.au

Australian Securities Exchange (ASX) Limited
20 Bridge Street, Sydney
PO Box H224, AUSTRALIA SQUARE NSW 1215
Ph: 02 9227 0197 – Fax: 02 9227 0667
Email: grainfutures@asx.com.au
Web: www.asx.com.au/grainfutures
Enquiries: Kristen Hopkins, Manager, Commodities Sales

Namoi Cotton Commodities Pty Ltd
1B Kitchener Street, TOOWOOMBA QLD 4350
Ph: 07 4631 6100 – Fax: 07 4631 6184
Grain Marketing and Logistics: John Haigh
Ph: 07 4631 6118 – Mob: 0428 146 318 – Fax: 07 4631 6184
Email: jhaigh@namoicotton.com.au
Web: www.namoicotton.com.au

Grain standards/rules/contracts

Grain Trade Australia Ltd
PO Box R1829, Royal Exchange, NSW 1225
Level 7, 12–14 O'Connell Street, SYDNEY NSW 2000
Ph: 02 9235 2155 – Fax: 02 9235 0194
Email: admin@graintrade.org.au – Web: www.graintrade.org.au
Chief Executive Officer: Pat O'Shannassy

Grower Groups

AgVance Farming Pty Ltd
172A George Street, QUIRINDI NSW 2343
Ph: 02 6746 2336
Email: office@agvance.com.au – Web: www.agvance.com.au
Contact: Jackie Crossing

Birchip Cropping Group Inc. (BCG)
PO Box 85, BIRCHIP Vic 3483
Ph: 03 5492 27873
Email: info@bcg.org.au – Web: www.bcg.org.au
Chief Executive Officer: Chris Sounness

Conservation Agriculture & No-till Farming Association (CANFA)
PO Box 2014, DUBBO NSW 2830
Chair: Gavin Tom
Ph: 0428 621 075 – Email: gaveltom@hotmail.com
Secretary: Anne Williams
Ph: 02 6825 6212 – Mob: 0428 177 225
Email: magomadine2@bigpond.com
Treasurer: John Shepherd
Ph: 02 6882 4723 – Mob: 0414 661 445
Email: john@canfa.com.au – Web: www.canfa.com.au

Corrigin Farm Improvement Group Inc. (CFIG)
PO Box 2, CORRIGIN WA 6375
Group Coordinator: Veronika Crouch
Mob: 0476 046 100
Email: cfig@cfig.asn.au – Web: www.cfig.asn.au

Central West Farming Systems
1 Fifield Road/PO Box 171, CONDOBOLIN NSW 2877
Chief Executive Officer: Di Parsons
Ph: 02 6895 1007 – Mob: 0408 655 205 – Fax: 02 6895 2688
Email: diana.parsons@dpi.nsw.gov.au

Conservation Farmers Inc (CFI)
266 Margaret Street, Toowoomba
PO Box 1666, TOOWOOMBA QLD 4350
Ph: 07 4620 0146 – Fax: 07 4641 7460
Email: office@cfi.org.au – Web: www.cfi.org.au
Executive Officer: Bernard O'Brien

Eyre Peninsula Agricultural Research Foundation (EPARF)
SARDI, Minnipa Agricultural Centre
Box 31, MINNIPA SA 5654
Project Manager: Naomi Scholz
Ph: 08 8680 6200 – Fax: 08 8680 5020
Email: naomi.scholz@sa.gov.au

Facey Group
40 Wogolin Rd, Wickepin
PO Box 129, WICKEPIN WA 6370
Ph: 08 9888 1223
Email: admin@faceygroup.org.au – Web: www.faceygroup.org.au
Executive Officer: Sarah Hyde

FarmLink Research Limited
361 Trungley Hall Road, Temora
PO Box 521, TEMORA NSW 2666
Ph: 02 6980 1333 – Fax: 02 6978 1290
Chief Executive Officer: Cindy Cassidy
Email: farmlink@farmlink.com.au – Web: www.farmlink.com.au

Grain Growers Limited
Level 19, 1 Market Street, SYDNEY NSW 2000
PO Box Q1355, Queen Victoria Building NSW 1230
Freecall 1800 620 519 – Ph: 02 9286 2000 – Fax: 02 9286 2099
Email: enquiry@graingrowers.com.au
Web: www.graingrowers.com.au
General Manager – Policy & Innovation: David McKeon
General Manager – Industry Development: Michael Southan

Grain Orana Alliance Inc (GOA)
PO Box 2880, DUBBO NSW 2830
Ph: 0400 066 201
Email: admin@grainorana.com.au – Web: www.grainorana.com.au
Chief Executive Officer: Maurie Street

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Grower Group Alliance

PO Box 1081, BENTLEY DC, WA, 6983
Project Leader: Sarah Houston
Ph: 08 6180 5759 – Mobile: 0408 602 269
Email: shouston@gga.org.au – Web: www.gga.org.au
Executive Officer: Annabelle Bushell
Ph: 08 6180 5759 – Mob: 0427 992 945
Email: abushell@gga.org.au

Hart Field Site Group Inc.

PO Box 939, CLARE SA 5453
Ph: 0427 423 154
Email: admin@hartfieldsite.org.au – Web: www.hartfieldsite.org.au
Chairman: Damien Sommerville
Mobile: 0417 850 587
Email: chairperson@hartfieldsite.org.au
Research & Extension Manager: Sarah Noack
Mobile: 0420 218 420
Email: trials@hartfieldsite.org.au
Secretary: Sandy Kimber
Mobile: 0427 423 154
Email: admin@hartfieldsite.org.au

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Kondinin Group

Head Office: 613–619 Wellington Street, Perth WA 6000
PO Box 78, LEEDERVILLE WA 6902
Free Ph: 1800 677 761 – Fax: 08 6263 9177
Web: www.farmingahead.com.au

Liebe Group

PO Box 340, DALWALLINU WA 6609
Ph: 08 9661 0570 – Fax: 08 9661 0575
Executive Officer: Bec McGregor
Email: eo@liebegroup.org.au – Web: www.liebegroup.org.au

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www.the-gate.com.au the gate

Mallee Sustainable Farming Inc

Work Days: Mon-Thurs
1/2103 Fifteenth St, Irymple VIC 3498
PO Box 843, IRYMPLE 3498
Ph: 03 5024 5835
Web: www.msfp.org.au
Executive Manager: Win Scott
Email: win.scott @msfp.org.au

MacKillop Farm Management Group (MFMG)

Limestone Coast, South Australia
PO Box 534, KEITH SA 5267
Executive Officer: Charlie Crozier
Ph: 0427 775 822
Email: ccrozier@mackillopgroup.com.au
Web: www.mackillopgroup.com.au

Mingenew Irwin Group

PO Box 6, MINGENEW WA 6522
Ph: 08 9928 1645 – Fax: 08 9928 1540
Email: admin@mig.org.au
Chief Executive Officer: Jenny Thomas
Mob: 0427 281 007 – Email: ceo@mig.org.au
Web: www.mig.org.au

Northern Grower Alliance

Level 1, 292 Ruthven St, TOOWOOMBA Qld 4350
PO Box 78, Harlaxton Qld 4350
Ph: +61 7 4639 5344 – Email: admin@nga.org.au
Chief Executive Officer: Richard Daniel
Mobile: 0428 657 782 – Email: richard.daniel@nga.org.au
Web: www.nga.org.au

Partners in Grain

Web: www.partnersingrain.org.au

Riverine Plains Inc

PO Box 214, MULWALA NSW 2647
Ph: 03 5744 1713
Executive Officer: Fiona Hart
Email: info@riverineplains.com.au – Web: www.riverineplains.com.au

SANTFA (South Australian No-Till Farmers Association Inc)

PO Box 930, BERRI SA 5343
Admin contact: admin@santfa.com.au Fax: 08 8125 6502
Web: www.santfa.com.au
President: Sam Venning
Mob: 0427 200 879 – Email: president@santfa.com.au

South East Premium Wheat Growers Association (SEPWA)

PO Box 365, ESPERANCE WA 6450
Executive Officer: Niki Curtis
Ph: 08 9083 1125 – Fax: 08 9083 1100 – Mob: 0447 908 311
Email: eo@sepwa.org.au – Web: www.sepwa.org.au

Southern Farming Systems Ltd

23 High Street, INVERLEIGH, VIC 3321
Ph: 03 5265 1666 – Fax: 03 5265 1678
Email: office@sfs.org.au – Web: www.sfs.org.au
Chief Executive Officer: Jon Midwood
Email: jmidwood@sfs.org.au

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Gyral 60 YEARS

SPAA Society of Precision Agriculture Australia Inc

PO Box 3490, MILDURA VIC 3502
Ph: 0437 422 000 – Fax: 1300 422 279
Executive Officer: Nicole Dimos
Email: info@spaa.com.au – Web: www.spaa.com.au

Victorian No-Till Farmers Association (VNTFA)

17 Darlot Street, Horsham
PO Box 1397, HORSHAM VIC 3402
Ph: 03 5382 0422
Email: info@vicnotill.com.au – Web: www.vicnotill.com.au
Executive Officer: Kerry Grigg
Ph: 0429 820 429 – Email: Kerryvicnotill.com.au

Walgett Special One Grain (WSOG)

58 Fox Street, WALGETT NSW 2832
PO Box 496, Walgett NSW 2832
Ph: 1300 28 12 28 – Fax: 02 6828 1249
Email: admin@specialonegrain.com.au
Web: www.specialonegrain.com.au

WANTFA

Leeuwin Centre, CSIRO, 65 Brockway Rd, Floreat WA 6014
Private Bag 5, WEMBLEY WA 6014
Ph: 08 9383 7630
Email: admin@wantfa.com.au – Web: www.wantfa.com.au
Executive Director: David Minkey – Mob: 0417 999 304
Email: david.minkey@wantfa.com.au

Yorke Peninsula Alkaline Soils Group

61–63 Main Street, MINLATON SA 5575
Ph: 08 8853 2241 – Fax: 08 8853 2269
Project and Funding Coordinator: Kristin McEvoy
Mob: 0400 283 015
Email: projects@alkalinesoils.com.au
Web: www.alkalinesoils.com.au

Government Grants

For special circumstances assistance administered by DAFF go to:

Web: www.agriculture.gov.au/ag-farm-food/drought

GrantsLINK (for assistance with federal grants for community projects) see:

Web: www.business.gov.au/assistance – Ph: 13 28 46

Section 12

Suppliers' Directory

AGRICULTURAL CHEMICALS

4Farmers – www.4farmers.com.au
Achieve – Crop Care: www.cropcare.com.au
Axial – Syngenta: www.syngenta.com
Barrack 720 Fungicide – Crop Care: www.cropcare.com.au
Barrack Betterstick – Crop Care: www.cropcare.com.au
Boxer – Syngenta: www.syngenta.com
Cognito – Syngenta: www.syngenta.com
Deluge – Victorian Chemicals: www.vicchem.com
Dow AgroSciences: www.dowagro.com
Envoy – Victorian Chemicals: www.vicchem.com
FMC: www.fmccrop.com.au
Hammer – Crop Care: www.cropcare.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
Steward EC – DuPont: www.dupont.com
Valor – Sumitomo: www.sumitomo-chem.com.au
Velocity – Bayer CropScience: www.bayercropscience.com.au

AG MACHINERY PARTS & TUNING

Advantage Tuning: www.advantagetuning.com.au
Agri Tune: www.agritune.com.au
Alloy & Stainless Products: www.asproducts.com.au
Big Tyre: www.bigtyre.com.au
ITC National: www.itcnational.com.au
Neil's Parts: www.neils.com.au
Next Instruments: www.nextinstruments.net

CONTAINER RECYCLING

drumMuster: www.drummuster.com.au

EDUCATION

C-Qual: www.c-qual.com
CSIRO: www.csiro.au
Kondinin Group: www.farmingahead.com.au

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www.polytex.net.au
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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
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
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
Chemtura: www.chemtura.com.au
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
Microbials: www.microbials.com.au
Nutrilab: 07 4671 5155
Omnia Nutriology: www.omnia.net.nz
Phosyn Analytical: www.yaraphosyn.com
Superior Fertilisers: www.superiorfertilisers.com.au
Ultimate Agri Products: www.ultimateagri.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
Accelerate – AgFarm: www.agfarmaccelerate.com.au
NAB Agribusiness: www.nab.com.au
Achmea: www.achmea.com.au

GRAIN STORAGE & HANDLING
Agridry: www.agridry.com.au
Agrishelter: www.agrishelter.com.au/
Allied Grain Systems: www.alliedgrainsystems.com.au
AllShelter: www.allshelter.com.au
Assorted Bag Closers: 03 9399 9171
Aurora: www.auroraagencies.co.nz
Convey-All: www.convey-all.com
CSW Chaser Bins: www.cswag.com.au
CustomVac: www.customvac.com.au
Cyclone Silos (One Steel): www.onesteelcyclone.com.au
Ellis & Son: Freecall 1800 808 769
Geronimo: www.geronimo.com.au
Grainline Augers: www.grainline.com.au
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Kotzur: www.kotzur.com.au
LeverLink: www.leverlink.com.au
Perry Engineering: www.perryengineering.com
Polytex: www.polytex.net.au
SCT Logistics: www.sctlogistics.com.au
Silo Ventilation Systems: www.silovent.com
Tapex: www.tapex.com.au
Widespan Sheds: www.sheds.com.au
WRL Engineering: www.wrltoolboxes.com.au

HARVESTERS & COMBINES
Case IH Agriculture: www.caseih.com
Chesterfield: www.chesterfieldaustralia.com.au
Claas: www.landpower.com.au
John Deere: www.johndeere.com.au/combines
Neil's Parts: www.neils.com.au
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
Kleenheat Gas: 1300 135 111
Lowes Petroleum: www.lowespetrol.com.au

MACHINERY MANUFACTURERS & DISTRIBUTORS
Case IH Agriculture: www.caseih.com
Claas: www.landpower.com.au
Flexicoil: www.flexicoil.com.au
John Deere: www.johndeere.com.au
Neil's Parts: www.neils.com.au
New Holland Agriculture: www.newholland.com

REAL ESTATE
CBRE: www.cbre.com.au/services/agribusiness
Colliers International: colliers.com.au/agribusiness

SEED SUPPLIERS & PLANT BREEDERS
Australian Grain Technologies: www.ausgraintech.com
Canola Breeders: www.canolabreeders.com.au
Nufarm: www.nufarm.com.au
Nuseed: www.nuseed.com
Nuseed Roundup Ready Canola – Nufarm: www.nufarm.com.au
Pioneer: www.pioneer.com
Roundup Ready Canola – Monsanto: www.monsanto.com.au
Seednet: www.seednet.com.au

SEED TREATMENT
CRT Seed Treatment: www.cropcare.com.au
Dividend – Syngenta: www.syngenta.com.au
Emerge – Syngenta: www.syngenta.com.au
Nodulaid – Becker Underwood: www.beckerunderwood.com.au
Nodulator – Becker Underwood: www.beckerunderwood.com.au
Seedboost – Omnia Nutriology: www.omnia.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
Hardi: www.hardi.com.au
Integrated Transfer Solutions: www.its-aust.net
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
Tobin No-Till Seeding Technology: www.tobinnotill.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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