Farm Practices Survey Report 2021

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

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Title: ***GRDC Farm Practices Survey Report 2021***

This report outlines the adoption of key management practices used in Australian grain growing regions. Specific practices include:

1. Land Use;
2. Crops grown;
3. Precision Agriculture;
4. Fallow and Stubble management;
5. Crop sequencing;
6. Soil Management;
7. Fertiliser Management;
8. Weed, Pest and Disease Management.

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Foreword

Change and innovation are a constant in the Australian grains industry, both to meet the challenge of seasonal conditions as well as commodity market fluctuations.

In this evolving environment, Australian grain growers continue to demonstrate ingenuity and agility in navigating challenging seasons and circumstances.

The adoption of sustainable practices in tillage, fertiliser application, crop residue management, integrated pest, disease and weed management, crop rotations, precision agriculture and others has had a direct impact on the resilience and success of grain businesses. These practices drive productivity, profitability, sustainability and environmental improvements on grain farms.

The Grains Research and Development Corporation (GRDC) invests around $180 million of grain grower levies and government funds each year in research, development and extension (RD&E).

For this fifth GRDC Farm Practice Survey report, GRDC and Down to Earth Research conducted a national survey of growers to obtain up-to-date information on the farming practices on grain and mixed farms across Australia.

The report provides quantitative data to monitor and evaluate key on-farm management practices, including the adoption levels of various farming systems, by grain growers across Australia. It helps GRDC identify positive outcomes and opportunities, modify existing projects and assists to direct future investments.

GRDC continues to collaborate with growers, advisers and research partners to improve adoption of research and development. We do this to ensure investment in grains RD&E creates enduring profitability for Australian grain growers.

Peter Carberry
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2. Executive summary

Background and methodology

This is the fifth GRDC Farm Practices Survey. Since 2008, GRDC has undertaken the Farm Practices Survey to help the organisation and wider industry gain a better understanding of trends relating to farm management practices. The data collected informs GRDC's monitoring and evaluation of its investments and assists identifying gaps in the adoption of R&D outcomes and sustainable farm practices.

In 2021, GRDC commissioned Down to Earth Research to conduct the survey. 1200 Computer Assisted Telephone Interviews (CATI) were conducted during September and October 2021, with randomly selected grain growers. The sample was stratified by agro-ecological zone (AEZ) and data weighted to ensure results were representative of the true population and geographical spread of grain growers. The survey response rate was 56%, providing a high level of confidence in the data.

On typical measurements involving the entire sample, the standard error at the 95% confidence level is approximately ±2.5%.

The total area of farmland represented by those surveyed was approximately 4.7 million hectares (ha) and 2.56 million ha of grain crops.

Farm size

Average respondent farm size in 2021 was 3846 hectares (ha). ABARES data from the AgSurf website[1] for 2020 suggests that average *wheat and other grain* farms are 2801 ha and *mixed grain/livestock* farms are 2893 ha. However, it is notable these results appear to be based on a much smaller sample size (n = 194) than the Farm Practice Survey (n = 1200).

There remains a general trend to increasing farm size in agro-ecological zones in Western Australia (WA), the Eyre Peninsula, and Mid North of South Australia (SA), the SA/Victorian Mallee.

Area of crop per farm

Since the survey commenced in 2008, the largest crop areas (total hectares of crop) per farm have been in WA, northwestern NSW/southwestern Qld and the Mallee region of SA and Victoria. There has been an increase in the proportion of farmland cropped compared to previous survey results, with this most marked in much of WA, SA and Victoria, likely due to increasing farm sizes.

Proportion of crop per farm

On a national basis, the average proportion cropped (% of the farm that is cropped) has remained at approximately 60% (58% in 2021), with greater proportions of crop noted in WA, the Mallee, much of SA and the NSW/VIC slopes.

Crops on grain farms

Wheat remains the dominant crop planted. When compared to 2016, it has increased as a proportion of the cropped area nationally, to 46% (was 39% in 2016, 44% in 2014 and 58% in 2011).

The AEZs with highest proportions of wheat tended to be those with lower rainfall, such as eastern and northern WA, northern and western NSW and southern Qld, the Mallee, and SA mid north / Eyre Peninsula. In some of these AEZs, wheat is over 60% of the cropped area. The resurgence in wheat area is likely due to a good seasonal start and prospects of good prices.

Other crops, as a proportion of the cropped area, tend to show a slight increase in barley and decrease in other winter cereals.

Compared to 2016, there has been a significant increase in the proportion of area planted to oilseeds. Pulses remain stable, but significantly greater than in 2014 and 2011. Seasonal conditions and forecast prices for the various grain types are likely to have influenced these changes.

Almost 60% of farms planted a new winter cereal variety in the past 2 years (higher in WA, NSW/VIC slopes and SA mid north, lower EP), two thirds planted a new oilseed variety (again higher in WA and parts of NSW and Victoria) and 42% planted new pulse and summer crops varieties. Reasons for planting new varieties were dominated by varietal yield gains followed by disease resistance.

Most (70%) wheat varieties were of mid-season maturity within a normal curve of other maturity times.

[1] http://apps.agriculture.gov.au/agsurf/agsurf.asp

Precision agriculture

The use of controlled traffic farming has continued to increase and is now being used on 34% of the cropped area nationally, higher in much of NSW and Qld and northern and southern WA.

Variable rate technology for fertiliser application is reported by growers as being used on 11% (up significantly from 7% in 2016) of the cropped area nationally, notably in the Mallee and eastern and northern WA.

Yield mapping has increased significantly from 35% in 2016 to 44% of the cropped area.

Fallow and stubble management

In northern NSW and Qld up to 100% of growers use a fallow period. Nationally, more than three quarters of growers use some fallow in their crop program. Most of this is short fallow (30%), with only 6% of land nationally being long fallowed.

57% of cropped area had stubble retained intact through to planting in 2021, statistically significantly greater than in 2016 (49%). The balance of stubble was either retained, but not standing (13% nationally), burnt late (11%) or incorporated into soil (14% nationally).

Crop sequencing

This section of the survey focused on the use of break crops and the purpose(s) for them.

28% of the cropped area was planted with a break crop to help with weed control in 2021, significantly up from 17% in 2016. Higher proportions were noted in NSW /VIC slopes, Victorian high rainfall, and southern WA.

In a significant increase from 2016, 21% of the cropped area was planted with a break crop for disease management, most likely to assist with managing cereal foliar diseases. 19% was planted with a break crop for nutritional reasons.

Soil management

Lime use

38% of farms applied lime in 2021, a significant 5 point increase from 2016. More farms in WA, Victorian high rainfall and NSW/Vic Slopes used lime and almost none in the Mallee or northern NSW/southern Qld. Where lime was applied, this was to an increased proportion of the cropped area, nationally at 25% in 2021, up from 19% in 2016. This was mostly found in WA (central and southern) and Victorian high rainfall.

Where lime was applied it was at an average of 2 tonnes per hectare, consistent with the 2016 figure, of 1.9t/ha.

Soil testing

a) For nutrient management

Nationally, 26 per cent of the winter cereal area was pre-plant soil tested in 2021. Higher percentages of the crop area were soil tested in WA (northern and southern), the high rainfall area of Victoria, NE NSW/SE Qld and central Qld. Compared to winter cereals, a higher proportion of the oilseed area was soil tested (nationally 34%), notably higher in northern and southern WA, NSW/Vic slopes, and Victorian high rainfall. This likely represents the higher general nutrient requirements for oilseeds, such that growers are using soil tests to assist with planning their fertiliser program.

Where soil testing for nutrient measurement was done, 75% was to 10cm depth, but deeper measurements were taken by 65% of those soil testing.

b) For moisture assessment

24% of farms nationally, and 18% of the cropped area was soil tested to assess soil moisture pre-planting. This was higher in northern NSW/southern Qld. Soil testing depth was equally split across all depths down to 1 metre, although the deeper testing was used more in the northern cropping areas. Push probes were the most common method used to assess soil moisture, with soil core, moisture sensor and calculation based on rainfall used between 15% and 22% (of those testing soil moisture). The relative popularity of these methods varied across AEZs, with

Fertiliser planning and use

On par with 2016, 65% of the cropped area had the fertiliser program informed by soil test results. This was higher in WA, northern NSW/southern Qld, and central Qld.

Similar to past surveys, about two thirds of cropped area had the fertiliser program informed by estimates based on the removal rates by the previous and this year's expected crops. This was higher in WA (except southern WA) and parts of SA.

The use of leaf / petiole testing remained low at only 5% of the cropped area, though was higher in northern (11%) and southern (18%) WA.

Over 60% of the national crop had an in-season (top dressing) fertiliser application, notably in much of WA, the Victorian high rainfall area and NSW/VIC slopes. This would reflect the generally good season being experienced with growers wishing to ensure good yields in both cereals and oilseed crops. Over 50% of the nitrogen applied to wheat in 2021 was applied post-planting, again more in WA and the higher yielding areas of Victoria and NSW.

When calculating the amount of nitrogen to apply, 59% of growers used a yield target, 52% calculations of the removal by previous crop and 34% pre-plant soil tests. It is likely that a combination of these was used by growers to determine nitrogen application rates.

On average, 84kg per hectare of N was applied to winter cereals, 120kg/ha to oilseeds and 85 kg/ha to summer crops in 2021. These application rates were greater in the higher rainfall AEZs and lower in others and represent the higher than average yields expected for both winter cereals and oilseeds in these AEZs.

Weed, pest and disease management

Almost one third of the crop was planted in a fashion to assist with weed competition, for example, with higher seeding rate or narrower row spacing. This was a significant increase on 2016 levels (24%) and was higher in WA (apart from eastern WA).

The *double knock* (using two different mode of action herbicides in separate applications) technique continues to grow as a method for herbicide weed control on fallow areas and is now used on 58% (50% in 2016) of farms nationally. It is used most widely in WA and NSW/VIC slopes. The double knock technique is used on 34% of the fallow area, again higher in WA, NSW/VIC slopes and on a lower percentage of fallow in SA and parts of NSW/Qld.

The main reasons for using the double knock technique are to stop seed set and reduce seed bank (93%), to delay the onset of herbicide resistance (86%) and to improve control of difficult weeds (72%). A combination of these are likely working together to influence the use of double knock. The relative importance of these reasons will vary depending on the weeds encountered (e.g. difficult weeds is a reason for 100% of central Qld to use a double knock), while both delaying herbicide resistance and preventing seed set dominates reasons for double knock use in WA, SA and parts of NSW and Victoria.

Among those using double knock, prior to sowing, 80% of the chemical weed control passes are a single knockdown application (lower in WA, higher in SA, NSW/VIC), with 20% a double knock (higher in WA).

A variety of harvest weed management techniques were used, with crop topping and narrow windrow burning being the most common, although 48% of farms used no harvest weed management system. Considerable variation is evident across AEZs.

Ryegrass was the main weed concern in 2021, with herbicide resistance also important. It is likely these two are linked. Foliar diseases were the main disease concerns.

Three quarters of farms applied fungicides to their winter cereals, this was higher in WA, parts of SA and NSW/VIC slopes. 61% of pulse crops had foliar fungicides applied and 56% of oilseeds (national averages).

On average, winter cereals had 1.2 foliar fungicide applications, 0.6 as seed treatment and 0.3 in-furrow. Pulses and legumes had more foliar fungicide applications (1.7), and oilseeds had fewer foliar application (0.9 average), but more seed treatment (0.6 application per crop). This likely reflects how oilseeds seeds are used, with many growers buying treated seed each year.

54% of farms spent money on mouse control in 2021, more common in the northern and southern regions than in the west, but where mice were an issue, the amount spent per farm was also high in WA. A national average of almost $16,000 per farm was spent on mouse control in 2021.

3. Introduction

This is the fifth GRDC Farm Practices Survey Report.

GRDC commissioned Down to Earth Research to survey 1200 grain producers about their farming operations and practices. The survey focused on their farming activities for the 2021 winter cropping year, but some questions relate to the 2020-21 summer cropping season and where possible, data was tracked against the earlier surveys of 2011, 2014 and 2016.

Consistent with past survey waves, data is presented by national and agro-ecological zone (AEZ) results. This year regional and farm size segment (hectares planted) results are provided in the appendix.

4. Survey methodology

Who was surveyed and margin of error

Grain producers were randomly selected from GRDC's Customer Relationship Management system (CRM). The survey was conducted during September and October 2021 with 1,200 grain producers agreeing to be interviewed. The response rate was 56%, providing a high level of confidence in results.

While a margin of error (based on sampling error) of ±5% is acceptable based on industry standards, the Farm Practice Survey's robust, random and representative sample (probabilty sample) means that on typical measurements involving the entire sample and based on the total population of grain growers (approximately 20,000), a margin for error of ±2.5% (at the 95% confidence interval) is achieved. Where the total number of responses is less than 1200, for example, data by AEZ, the margin of error is greater.

The sample was stratified, with quotas set in each AEZ, reflecting the population of growers in each and allowing sound statistical conclusions to be drawn. In some cases, AEZs were combined to enable more robust data analysis (see map below).

The sample in each location was weighted at the computer stage to represent the true geographic distribution of grain growers. Consequently, national results are not disproportionately influenced by responses from zones with smaller concentrations of grain growers.

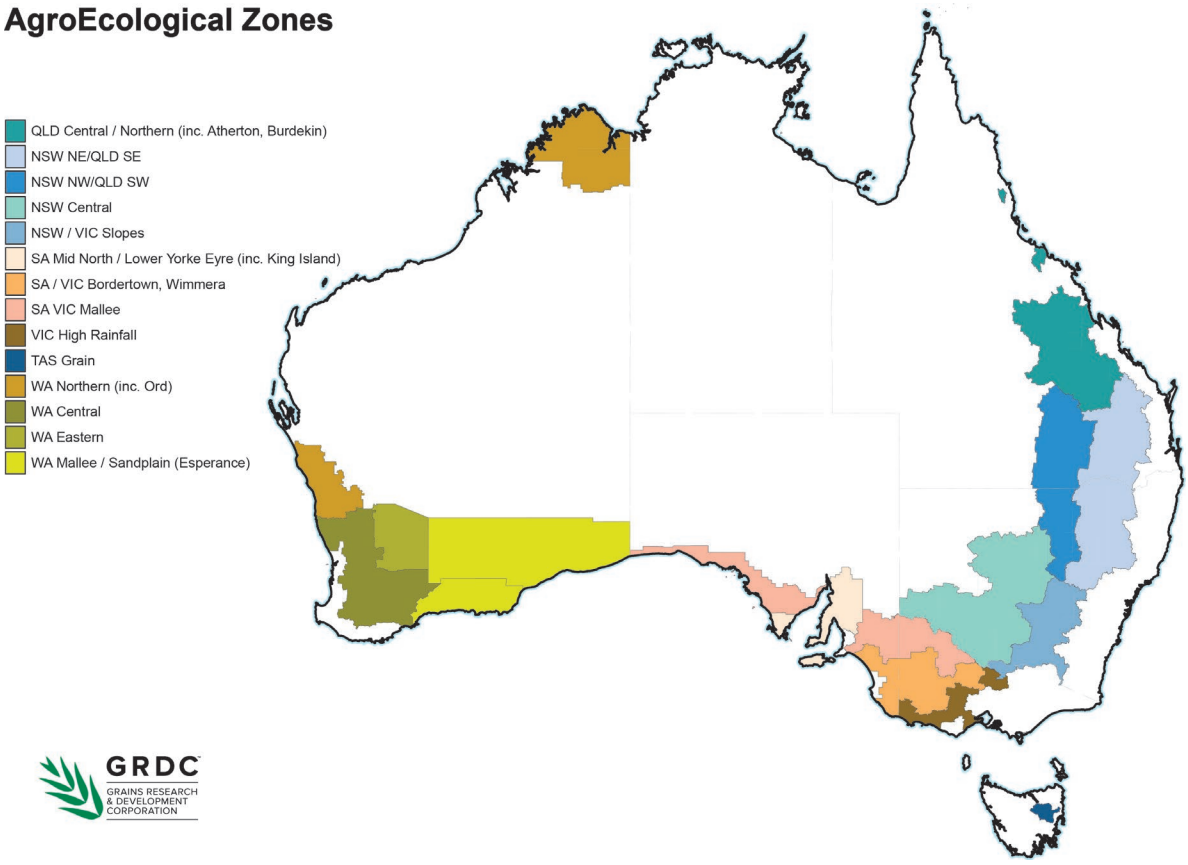
The sample size and margins of error in each agro-ecological zone and region are presented in Table 1.

The amount of crop area represented by the survey respondents represented approximately 2.56 million hectares, or approximately 13% of the estimated total crop in Australia.

Table 1 Sample size and margin of error for each of the agro-ecological zones

Agro-ecological zone	Interview sample size	Margin of error
NSW Central	90	±8.8%
NSW North-East / QLD South-East	165	±7.0%
NSW North-West / QLD South-West	55	±11.8%
NSW / VIC Slopes	180	±6.7%
QLD Central / Northern (inc. Atherton, Burdekin)	30	±15.8%
SA Mid North / Lower Yorke Eyre (inc. King Island)	125	±8.1%
SA / VIC Bordertown, Wimmera	145	±7.2%
SA / VIC Mallee	125	±7.8%
TAS	5	*
VIC High Rainfall	45	±13.0%
WA Central	145	±7.2%
WA Eastern	30	±15.6%
WA Mallee / Sandplain (Esperance)	30	±15.8%
WA Northern (inc. Ord)	30	±15.8%
National	**1,200**	**±2.5%**
Northern region	491	±3.9%
Southern region	474	±4.1%
Western region	235	±5.6%

*caution small sample size



Combined AEZs used in this survey

The survey questions

The final questionnaire consisted of 47 questions, designed to provide data on the following farm characteristics and sustainable farm practices:

- Basic statistics for the farm - farm type, areas of farm, crop, pasture, areas of the various crops;
- Crops grown, varietal choices;
- Fallow and stubble management practices;
- Weed, pest and disease issues and management practices;
- Crop sequencing and use of break crops;
- Soil management, the use of lime and soil testing;
- Precision agriculture techniques;
- Fertiliser management;

The survey was conducted through late September and early October 2021 using Computer Assisted Telephone Interviewing (CATI). A team of specialised interviewers, with empathy for rural Australia and farmers' availability, conducted the interviews.

The data analysis process

During and following the interviewing process the data was checked for validity with error flags prompting follow-up enquiries with survey respondents.

Data has been allocated to agro-ecological zones, enabling comparison with the 2016 survey.

Data was analysed using specialized statistical software.

How is the data presented

As the methodology and many of the questions used in this and the previous surveys were the same (sample size, agro-ecological zone quotas and screening criteria), the results from surveys can be compared in agro-ecological zones.

Where questions are comparable between all surveys, the data from these are presented in this report as:

- tables comparing 2011, 2014, 2016 and 2021 winter crop year data
- figures / graphs comparing the 2021 data in each agro-ecological zone, some with comparisons with earlier survey data
- maps showing the 2021 data

Definitions and report notes

*	Caution small sample	Caution sample size smaller than n=30, data is indicative only
**	Significant variation between 2021 and 2016 data	Significant variation between 2021 and 2016 data (at the 95% confidence level) according to statistical analysis

In this report, statistically significant differences at the 95% confidence level will be highlighted using the terminology *significant* or *considerable.* Where results may appear to be significant but are not, terminology such as *slight* is used.

Actual data will be referred to as ‘2021’, ‘2016’, ‘2014’, or '2011' to denote the data being from the winter crop years of 2021, 2016 and 2014 or 2011.

5. Grain farm statistics

Questions asked:

- Q3. Can you tell me your total farm area?
- Q4a. How many (hectares/acres) of winter crop have you sown in 2021? Please include any double cropped area
- Q4b. How many (hectares/acres) of spring or summer crop did you plant in the 2020-21 season
- Q5. Has any crop area been double cropped during 2021?
- Q6. How many (hectares/acres) have been double cropped?
- Q7. How many (hectares/acres) of your land is under pasture or under a permanent vegetation plan in 2021?
- Q8. Do you have a vegetation plan to ...
  Assist with crop production?
  Provide additional income?
  Conserve an area of native vegetation for biodiversity or amenity benefit?

Total area of farmland surveyed

In 2021 the total farm area of the growers surveyed was just on 4.7 million hectares. See Table 3.

Table 2 Sample size and total farmland represented in the survey data by agro-ecological zone in 2011, 2014, 2016 and 2021 (Q3)

Agro-ecological zone	Sample size				Total farm area (ha surveyed)			
	2011	2014	2016	2021	2011	2014	2016	2021
NSW Central	95	100	95	90	588,559	446,303	358,438	365,604
NSW North-East / QLD South-East	86	127	227	165	250,633	364,221	732,192	640,605
NSW North-West / QLD South-West	94	53	53	55	443,651	293,073	507,651	345,222
NSW / VIC Slopes	160	167	160	180	375,633	390,612	320,612	476,579
QLD Central/Northern	35	32	35	30	177,243	117,820	139,400	111,187
SA Mid North / Lower Eyre Peninsula	118	122	118	125	257,819	194,033	210,617	419,330
SA / VIC Bordertown, Wimmera	106	113	106	145	188,513	178,006	202,310	296,433
SA / VIC Mallee	160	167	160	125	627,427	521,416	517,044	523,317
TAS*	7	7	7	5	15,185	16,488	12,420	27,010
VIC High Rainfall	65	71	65	45	111,685	73,899	68,940	70,342
WA Central	185	191	184	145	663,131	660,269	685,589	626,297
WA Eastern	62	47	31	30	382,235	335,648	241,788	281,644
WA Mallee/Sandplain (Esperance)	57	44	30	30	279,801	191,872	150,506	233,843
WA Northern (Ord)	82	42	30	30	464,709	215,367	205,058	284,418
Totals	1,312	1,283	1301	1,200	4,826,224	3,999,028	4,352,566	4,701,832

* caution, small sample size

Farm size

The data reported are for total farm size, regardless of land use, including areas of crop, pasture, native vegetation and utility areas.

There are considerable differences in the size of grain farms across the various agro-ecological zones, with larger farms present in much of WA, Central Qld, NSW Central and NW NSW/SW Qld (Table 4, Figure 1, Figure 2 and Figure 3). Smaller farm sizes are found in the high rainfall parts of Victoria, much of SA and Victoria, the NSW/Vic slopes and NE NSW/SE Qld. Variation in Tasmanian data is due to the small sample size in this survey for Tasmania.

In 2011, the average size of grain farms surveyed was 3,768, in 2014 it was 3,810ha, in 2016 it was 3,475ha and in 2021 it is 3,846ha.

Notably, average farm size is significantly greater than in the most recent results available from ABS (2801 ha and *mixed grain/livestock* farms 2893 ha). Variation may be due in part, to a significantly greater number of businesess surveyed than for the ABS statistics.

There appears to be a general trend for farm sizes to increase, most evident in WA and parts of northern NSW / Southern Qld and parts of SA. Farm sizes appear more stable in central Qld, the Mallee, the rest of NSW, Victoria and SA.

Table 3 Average farm size (ha) within agro-ecological zones in 2011, 2014, 2016 and 2021 (Q3)

Agro-ecological zone	Average area per farm (ha)				Significant difference between years
	2011 (ha)	2014 (ha)	2016 (ha)	2021 (ha)	2016 to 2021
NSW Central	6,195	4,463	3,773	4,107	
NSW NE / QLD SE	2,914	2,868	3,226	3,931	
NSW NW / QLD SW	4,720	5,530	9,578	6,211	**
NSW / VIC Slopes	2,348	2,339	2,004	2,642	
QLD Central/Northern	5,064	3,682	3,983	3,706	
SA Mid North / Lower EP	2,185	1,590	1,785	3,355	**
SA / VIC Bordertown, Wimmera	1,778	1,575	1,909	2,044	
SA / VIC Mallee	3,921	3,122	3,232	4,191	**
TAS*	2,169	2,355	1,774	5,402	
VIC High Rainfall	1,718	1,041	1,061	1,563	**
WA Central	3,584	3,457	3,726	4,319	
WA Eastern	6,165	7,141	7,800	9,388	
WA Mallee/Sandplain (Esperance)	4,909	4,361	5,190	7,795	**
WA Northern	5,667	5,128	6,835	7,976	
National Averages	3,810	3,475	3,991	3,846	**

* caution, small sample size

Figure 1 Farm size trends (ha) within agro-ecological zones

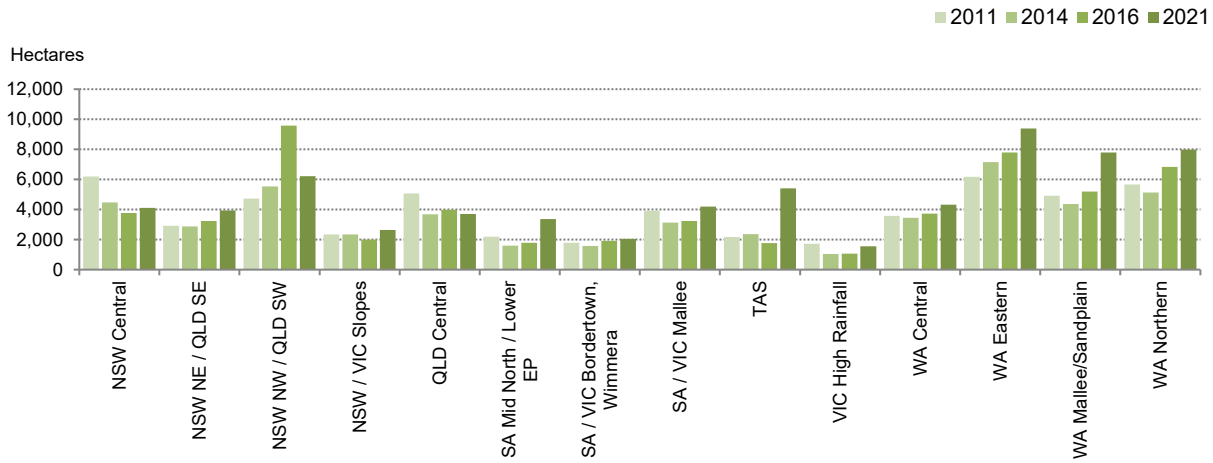


Figure 2 Grain Farm size trends (ha) nationally

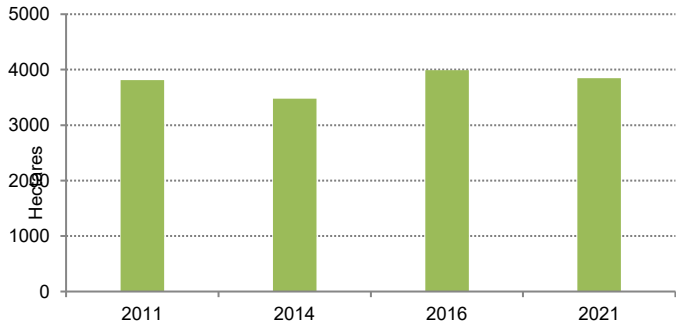
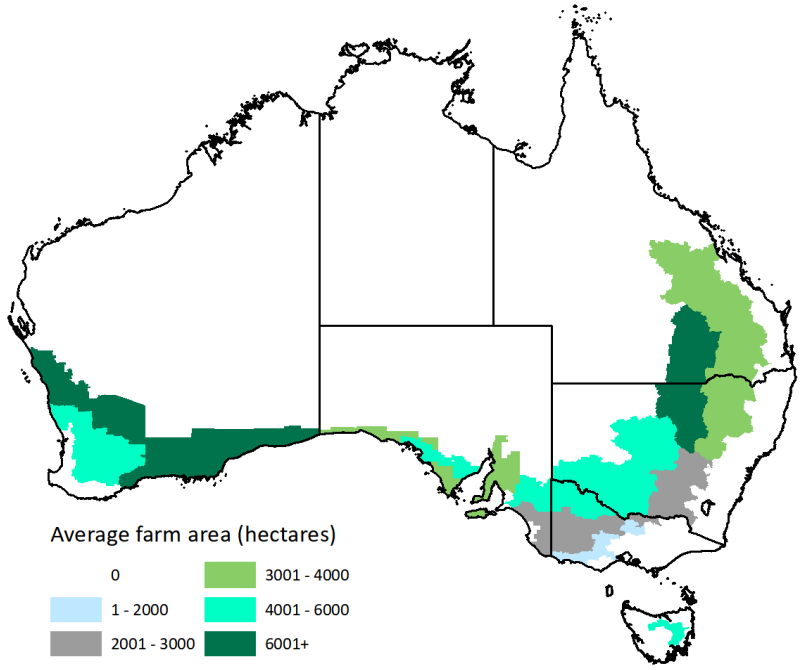


Figure 3 Average farm area (ha), 2021.



Cropped area

Table 5 shows total respondent crop area. The area of crop in the survey in 2021 is similar to that of 2016 and greater than earlier surveys.

The total area of crop grown in Australian in 2021 was not estimated at the time of preparing this report, however in 2019-20 there were approximately 20 million hectares (ha) of combined cereals, pulses and oilseeds (data from ABS). On that basis, the crop area included in the 2021 survey represents almost 13% of the total area of crop in Australia.

Table 4 Total crop area (ha) in 2011, 2014, 2016 and 2021 GRDC surveys (Q4)

Agro-ecological zone	2011 (ha)	2014 (ha)	2016 (ha)	2021 (ha)
NSW Central	171,572	143,906	162,269	155,598
NSW NE / QLD SE	88,814	149,601	371,922	284,638
NSW NW / QLD SW	161,461	78,953	209,660	111,730
NSW / VIC Slopes	180,828	163,380	180,625	251,128
QLD Central/Northern	44,020	40,450	56,783	48,723
SA Mid North / Lower EP	156,052	116,713	162,099	224,182
SA / VIC Bordertown, Wimmera	92,102	103,420	143,379	188,811
SA / VIC Mallee	287,024	297,100	379,186	341,207
TAS*	1,767	2,452	6,018	3,184
VIC High Rainfall	67,777	36,904	38,983	34,165
WA Central	380,849	413,516	425,909	407,049
WA Eastern	233,744	203,839	151,761	179,197
WA Mallee/Sandplain (Esperance)	178,059	128,440	120,444	143,016
WA Northern	311,067	138,981	127,801	187,706
Total in survey	2,355,135	2,017,654	2,536,838	2,560,332

* caution, small sample size

Cropped area per farm

The average area of crop per farm found in the survey is shown in Table 6, Figure 4, Figure 5 and Figure 6. There is a general trend to increased area of crop per farm, more pronounced in some AEZ's than others.

The largest crop areas per farm are in Western Australia, western New South Wales, and the Mallee region of South Australia and Victoria. Additionally, there has been an increase in area of crop per farm in WA (notably in central and northern WA), the SA Mid North and Eyre Peninsula. Although the data shows a decrease in cropped area per farm in Northwest NSW / Southwest Qld, this is against a strong rise in 2016 (likely due to very large farms included in the sample), the overall trend is an increase in cropped area per farm.

The areas with the greatest amount of crop per farm are generally the areas of lower annual rainfall. One means to spread risk is by increasing cropped area and increasing efficiencies of machinery, labour and inputs.

In agro-ecological zones where mixed grain and livestock farming are common, crop areas have generally not increased as much (e.g. NSW/Vic slopes, SA/Vic Bordertown, Wimmera, Vic High rainfall). This may reflect the generally good prices and returns from livestock enterprises in the recent years.

Table 5 Average area (ha) of crop per farm (Q4)

Agro-ecological zone	Average area per farm (ha)				Significant difference between years
	2011 (ha)	2014 (ha)	2016 (ha)	2021 (ha)	2016 to 2021
NSW Central	1,806	1,439	1,708	1,746	
NSW NE / QLD SE	1,036	1,178	1,638	1,647	
NSW NW / QLD SW	1,718	1,490	3,956	2,010	**
NSW / VIC Slopes	1,130	978	1,129	1,389	
QLD Central/Northern	1,258	1,264	1,622	1,548	
SA Mid North / Lower EP	1,322	957	1,374	1,793	**
SA / VIC Bordertown, Wimmera	869	915	1,353	1,298	
SA / VIC Mallee	1,794	1,779	2,370	2,737	
TAS*	252	350	860	627	
VIC High Rainfall	1,043	520	600	759	
WA Central	2,059	2,165	2,315	2,807	**
WA Eastern	3,770	4,337	4,896	5,973	
WA Mallee/Sandplain (Esperance)	3,124	2,919	4,015	4,767	
WA Northern	3,231	3,309	4,260	6,257	**
National Averages	1,744	1,686	2,292	2,088	

* caution, small sample size

Figure 4 Average area of crop (ha) per farm trend by agro-ecological zone

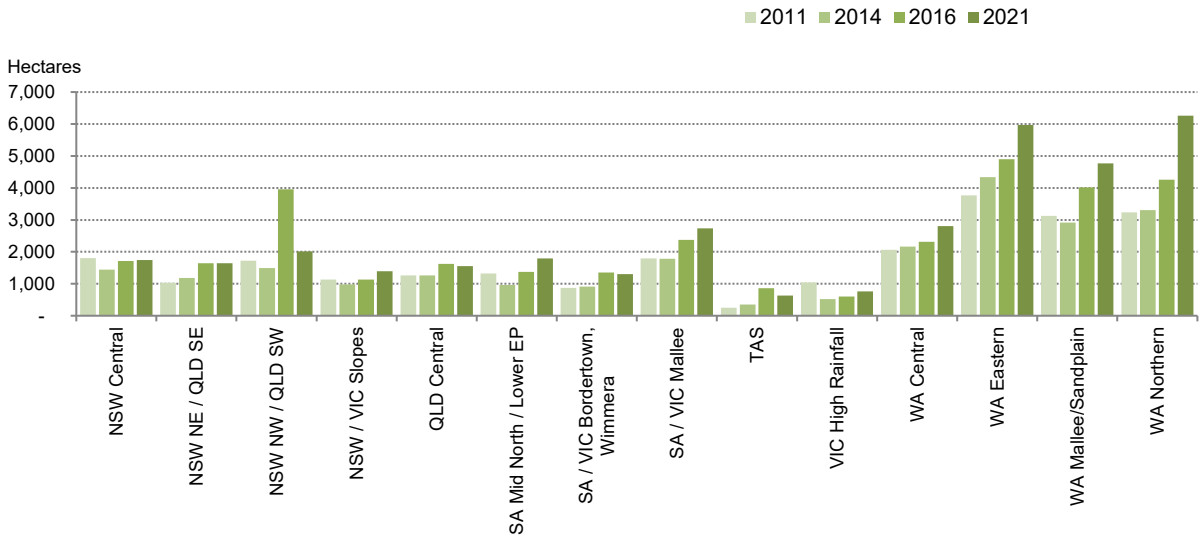


Figure 5 Average area of crop (ha) per farm trend – national averages

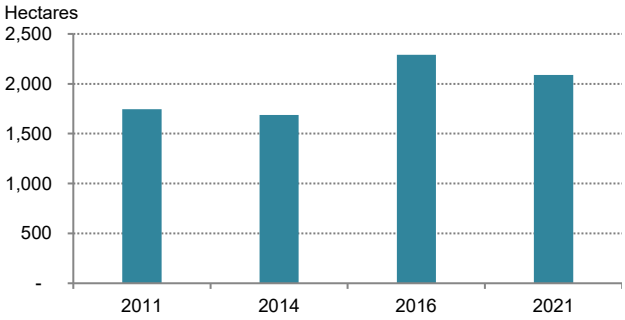
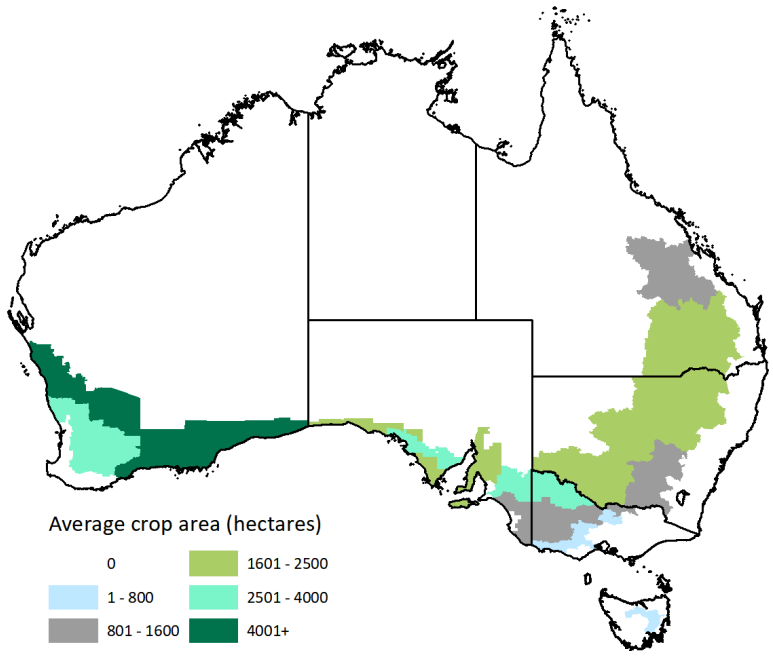


Figure 6 Average Crop area (ha per farm)



Use of farmland

In this survey, the focus is on grain production. However, there is also information about other vegetation on the farm and vegetation plans.

Land use on grain and mixed farms generally consists of areas of crop, pasture and native or remnant vegetation. Together, these components usually add to the approximate farm area. Not all grain farms have all of these land uses represented. Some farms are essentially grain only, others also grow non-grain crops (such as cotton) and others still have little or no native vegetation present. Areas of 'fallow' may be described as either a pasture (if grazing of the fallow occurs) or crop area not yet planted. Some farmers identify areas of native or remnant vegetation as 'available' for some grazing and often also listing these areas as 'pasture'.

Proportion of crop per farm

In general, there has been little movement in the proportion of cropped areas on farms in the last 10 or so years.

The proportion (%) of farmland used for grain production on the farms in the past 4 surveys are shown in Table 7, Figure 7, Figure 8 and Figure 9 (below).

Since 2011, the proportion of farm area used for grain cropping has remained around 60% as a national average (except 2014). There are differences between the various agro-ecological zones e.g. those in South Australia and the NSW/Vic slopes. It is likely that where livestock are present that cropping areas will be reduced in favour of pasture area (see next section). This is more likely in the higher rainfall areas and parts of NSW and Qld. The data for Tasmania should be treated with caution since the sample size is very small (5 respondents) and likely to be heavily influenced by one or two of the properties in the sample.

Table 6 Percentage of farm area cropped (Q4/Q3)

Agro-ecological zone	Average % of farm area				Significant difference between years
	2011	2014	2016	2021	2016 to 2021
NSW Central	52	48	52	49	
NSW NE / QLD SE	55	50	52	47	
NSW NW / QLD SW	50	37	47	46	
NSW / VIC Slopes	62	56	58	56	
QLD Central/Northern	52	54	54	43	
SA Mid North / Lower EP	63	69	79	67	**
SA / VIC Bordertown, Wimmera	73	58	69	62	
SA / VIC Mallee	72	66	73	67	
TAS*	39	22	43	18	
VIC High Rainfall	67	49	57	49	
WA Central	62	57	60	62	
WA Eastern	65	61	64	66	
WA Mallee/Sandplain (Esperance)	67	66	69	69	
WA Northern	72	66	69	62	
National Averages	61	54	60	58	

* caution, small sample size

Figure 7 Percentage of farm area cropped (trend)

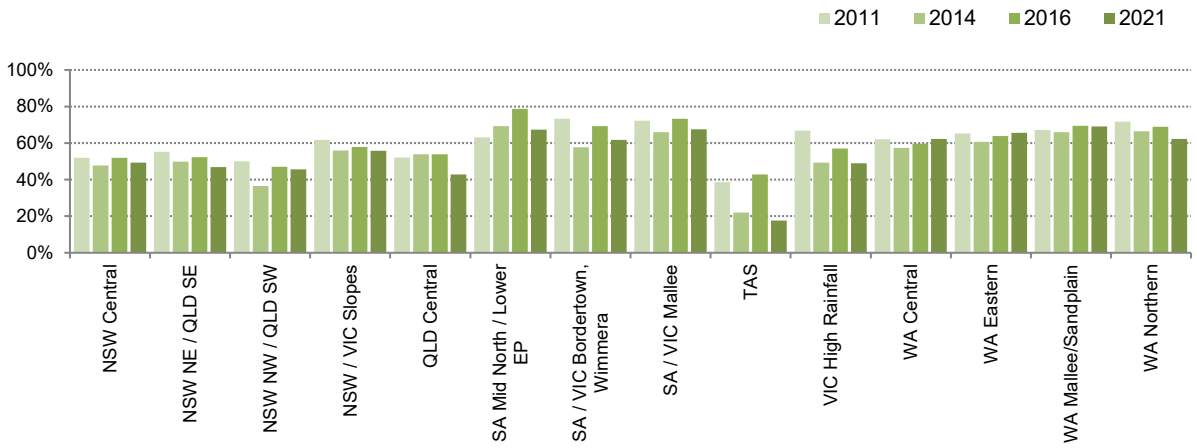


Figure 8 Average % of farm area cropped (national average)

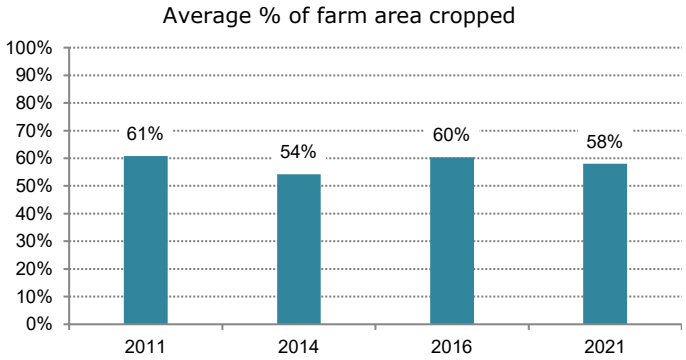
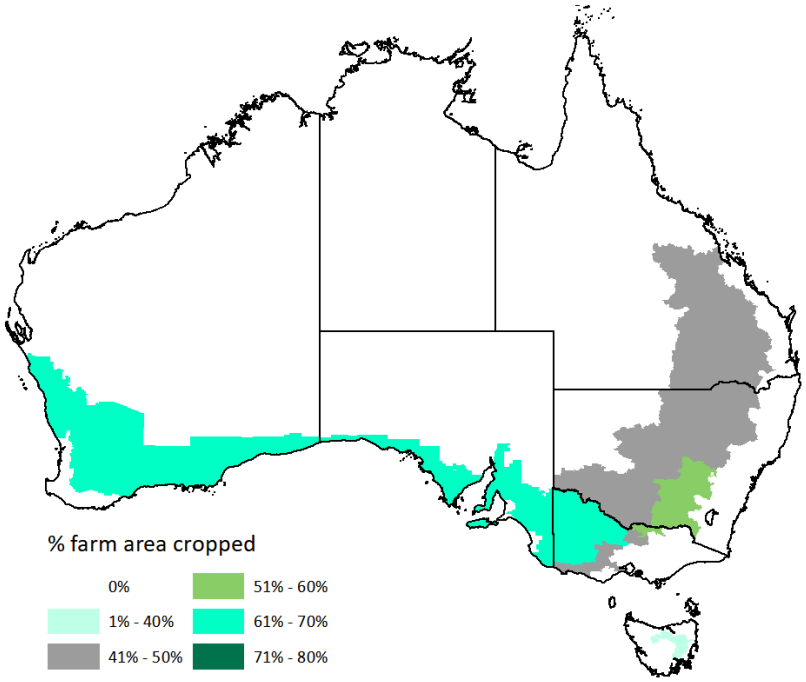


Figure 9 Proportion of farm area cropped (% of farm area) in 2021



Proportion of pasture per farm

Pasture is a feature of most grain producing areas, although many grain-only farms do exist (25% of respondents nationally).

Data on pastures is often complicated by the definition of a 'pasture'. Pastures can be:

- perennial
- annual
- 'improved' (i.e. planted and managed as a pasture),
- 'unimproved' (i.e. volunteer plants or native species that simply emerge on land otherwise not managed)
- combinations of the above.

Data is presented as the proportion of the farm that is identified as pasture, or with a vegetation plan expressed as a percentage of the farm. The data is shown in Table 8, Figure 10 and Figure 11.

Caution is required comparing 2021 data with prior survey waves due to variation in questionnaire wording.

The data parallels those for proportion of crop, whereby between 25% and around 40% of farms have pasture or a permanent vegetation plan. Where the proportion of crop is higher, pasture tends to be lower, for example in much of WA. This is not uniform however, with central NSW and northern NSW/Sthn Qld showing combined percentages of approximately 75% being crop and pasture. It is possible that other enterprises, e.g. cotton may also be present in some of these areas.

Table 7 Percentage of farm area maintained as pasture or permanent vegetation (Q7)

Agro-ecological zone	Average % of farm area				Significant difference between years
	2011	2014	2016	2021	2016 to 2021
NSW Central	37	31	33	29	Significance testing not conducted due to change in question wording
NSW NE / QLD SE	38	27	31	28	
NSW NW / QLD SW	41	49	38	38	
NSW / VIC Slopes	34	36	38	34	
QLD Central/Northern	40	42	44	40	
SA Mid North / Lower EP	23	27	24	19	
SA / VIC Bordertown, Wimmera	34	34	38	28	
SA / VIC Mallee	23	25	29	20	
TAS*	52	48	50	37	
VIC High Rainfall	30	42	41	43	
WA Central	32	33	36	29	
WA Eastern	30	29	27	30	
WA Mallee/Sandplain (Esperance)	29	26	31	23	
WA Northern	20	19	18	25	
National Averages	33	33	34	28	

* caution, small sample size

Figure 10 Percentage of farm area maintained as pasture or vegetation

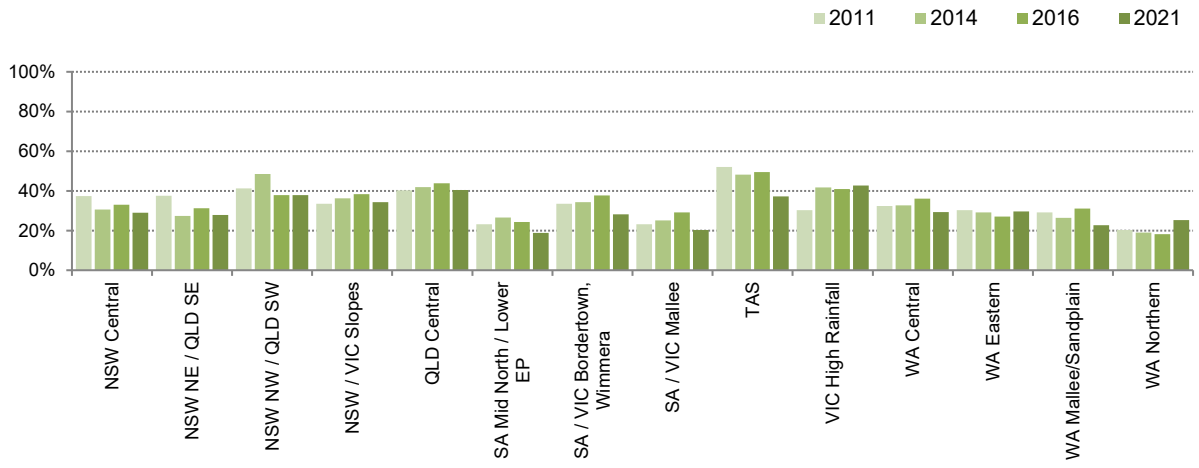
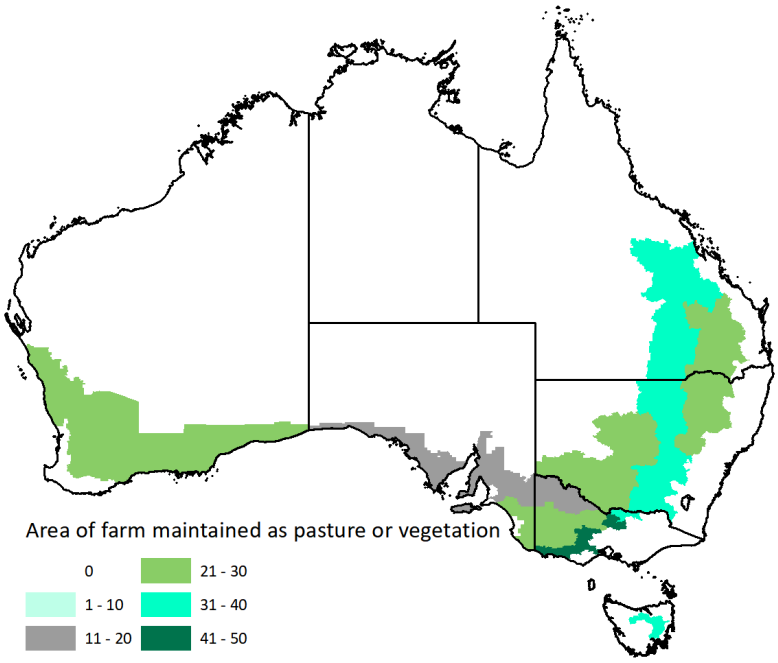


Figure 11 Proportion of pasture or vegetation (% of farm area) within agro-ecological zones in 2021



Farmland with a vegetation plan

Respondents were asked if they had a vegetation plan for their farm, and for what purpose. Vegetation plan refers to a plan for establishing or managing areas of vegetation (remnant native or newly established) with a longer term view for enhancing the amount and quality of vegetation on farms.

The percentage of farms with vegetation plans is shown in Table 9 and Figure 12. While caution is required comparing 2021 with prior results, it is notable that in all AEZs the percentage of farms with a vegetation plan has increased.

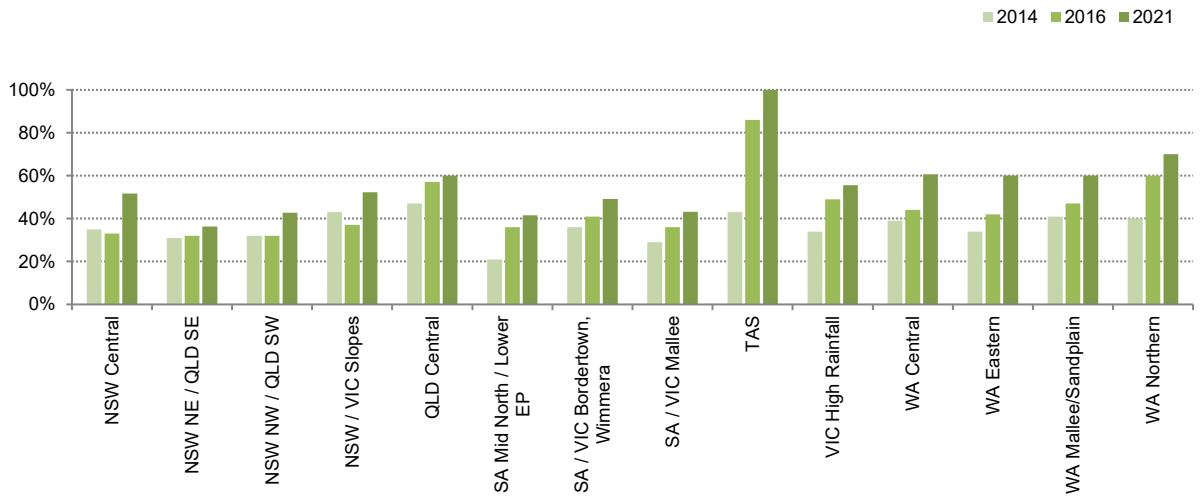
Generally, between 30% and 70% of farms in the survey have a vegetation plan, however, these figures have generally increased when compared to previous surveys, potentially due to the changed question structure.

Table 8 Percentage of farms with a vegetation plan (Q8)

Agro-ecological zone	% farms with plan			Significant difference between years
	2014	2016	2021	2016 to 2021
NSW Central	35	33	52	Significance testing not conducted due to change in question wording
NSW NE / QLD SE	31	32	36	
NSW NW / QLD SW	32	32	43	
NSW / VIC Slopes	43	37	52	
QLD Central/Northern	47	57	60	
SA Mid North / Lower EP	21	36	42	
SA / VIC Bordertown, Wimmera	36	41	49	
SA / VIC Mallee	29	36	43	
TAS*	43	86	100	
VIC High Rainfall	34	49	56	
WA Central	39	44	61	
WA Eastern	34	42	60	
WA Mallee/Sandplain (Esperance)	41	47	60	
WA Northern	40	60	70	
National Averages	35	39	50	

* caution, small sample size

Figure 12 Percentage of farms with a vegetation plan



Purpose of vegetation plan

When asked about the purpose of their vegetation plan, respondents were offered options of: to assist with crop production, as an additional income source, or to conserve an area of native or remnant vegetation for biodiversity or amenity purposes. Multiple reasons were able to be selected.

Vegetation plan to assist with crop production

On average, 21% of farms reported that it had some use in assisting crop production (Table 10). This is a reduction as compared with the 2014 survey, but consistent with the 2016 survey.

Table 9 Percentage of farms with a vegetation plan to assist with crop production (base: have plan) (Q8)

Agro-ecological zone	% farms with plan			Significant difference between years
	2014	2016	2021	2016 to 2021
NSW Central	36	32	17	Significance testing not conducted due to change in question wording
NSW NE / QLD SE	38	32	34	
NSW NW / QLD SW*	53	18	42	
NSW / VIC Slopes	46	32	19	
QLD Central/Northern*	27	30	11	
SA Mid North / Lower EP	42	7	17	
SA / VIC Bordertown, Wimmera	20	9	22	
SA / VIC Mallee	24	14	18	
TAS*	67	33	0	
VIC High Rainfall	46	6	20	
WA Central	29	20	24	
WA Eastern*	38	15	22	
WA Mallee/Sandplain (Esperance)*	33	14	6	
WA Northern*	18	0	14	
National Averages	37	19	21	

* caution, small sample size

However, the changes in percentages of farms with vegetation plans where the purpose is to assist with crop production is not consistent across AEZ's, making any overall conclusions difficult without further investigation.

Vegetation plan to provide additional income

Nationally, an average of 15% of growers with a vegetation plan did so to provide an additional income source. The response varied from 6% in the WA sandplain AEZ to 28% in central and northern Qld. The actual income from the plan was not determined and could have been direct (such as from firewood, carbon credit, etc.) or indirect (protection from unfavorable weather for livestock, windbreaks or similar). Again further investigation would help identify the reasons for these data. See Table 11

.

Table 10 Percentage of farms with a vegetation plan to provide additional income (base: have plan) (Q8)

Agro-ecological zone	% farms with plan			Significant difference between years
	2014	2016	2021	2016 to 2021
NSW Central	19	10	15	Significance testing not conducted due to change in question wording
NSW NE / QLD SE	26	26	25	
NSW NW / QLD SW*	29	12	26	
NSW / VIC Slopes	35	22	12	
QLD Central/Northern*	13	15	28	
SA Mid North / Lower EP	15	7	15	
SA / VIC Bordertown, Wimmera	20	9	10	
SA / VIC Mallee	10	7	13	
TAS*	67	33	20	
VIC High Rainfall	33	9	16	
WA Central	17	14	14	
WA Eastern*	25	15	17	
WA Mallee/Sandplain (Esperance)*	17	21	6	
WA Northern*	24	0	19	
National Averages	25	14	15	

* caution, small sample size

Vegetation plan to conserve native vegetation for biodiversity or amenity value

Table 12 shows the proportion of growers with a vegetation plan to assist with conserving vegetation for biodiversity or amenity value. The proportions are high, reaching over 90% in WA, the Mallee, Victorian High R much of SA and NW/Vic Slopes, and over 80% in most other AEZ's.

This indicates that the dominant reason growers have a vegetation plan is to conserve an area for biodiversity or amenity.

Table 11 Percentage of farms with a vegetation plan to conserve an area of native vegetation for biodiversity or amenity benefit (base: have plan) (Q8)

Agro-ecological zone	% farms with plan			Significant difference between years
	2014	2016	2021	2016 to 2021
NSW Central	97	65	87	Significance testing not conducted due to change in question wording
NSW NE / QLD SE	77	77	75	
NSW NW / QLD SW*	88	82	71	
NSW / VIC Slopes	72	81	93	
QLD Central/Northern*	73	85	83	
SA Mid North / Lower EP	88	83	88	
SA / VIC Bordertown, Wimmera	100	88	93	
SA / VIC Mallee	88	77	94	
TAS*	100	100	100	
VIC High Rainfall	83	84	92	
WA Central	92	81	93	
WA Eastern*	88	54	94	
WA Mallee/Sandplain (Esperance)*	83	71	94	
WA Northern*	94	94	95	
National Averages	87	80	90	

* caution, small sample size

6. Crops on grain farms

Questions asked:

- Q9a. What winter crops have you sown in 2021?
- Q9b. What spring or summer crops did you plant in the 2020-21 season
- Q10. How many (hectares/acres) of these crops have you sown in 2021?
- Q11. Over the past 2 years have you planted a new variety of winter cereal, pulse, oilseed)?
- Q12. And what were the main reasons for planting a new variety
- Q13. n 2021, what varieties of wheat did you sow?

The data for crop areas on farms are reported against the main crop types described below.

Respondents were asked about their decisions regarding variety (cultivar) of their crop, whether they have chosen to grow a new variety and the reasons for this.

Wheat

The proportion of wheat sown by survey respondents in 2021 is presented in Table 13, Figure 13, Figure 14 and Figure 15.

The highest proportion of wheat is grown in AEZs characterized by moderate or low rainfall. These include eastern and northern WA, central NSW, north-west NSW/south-west Qld, the SA/Victorian Mallee and SA's Mid North and Eyre Peninsula, where 40 per cent or more of the crop area is sown to wheat.

A general decrease in wheat as a proportion of total crop area from 2011 to 2016 appears to have been reversed in most AEZs in 2021.

The change is likely due to seasonal and economic factors. 2020 was a good season in most of Australia's grain growing areas, and 2021 started with generally good rainfall. Forecasts of good prices compared to other grain types may have also encouraged growers to hold or increase their wheat areas.

Nationally, the proportion of cropped are sown to wheat is now 46 per cent, a significant increase over the 2016 level.

Table 12 Percentage of crop area planted to wheat (Q10)

Agro-ecological zone	Average % of crop area				Significant difference between years
	2011	2014	2016	2021	2016 to 2021
NSW Central	72	51	47	56	
NSW NE / QLD SE	55	38	30	45	
NSW NW / QLD SW	70	58	46	64	
NSW / VIC Slopes	61	45	40	45	
QLD Central/Northern	42	38	30	26	
SA Mid North / Lower EP	54	44	41	44	
SA / VIC Bordertown, Wimmera	46	29	24	32	
SA / VIC Mallee	65	51	40	44	
TAS*	47	11	13	31	
VIC High Rainfall	47	24	27	41	
WA Central	55	39	34	37	
WA Eastern	85	73	67	69	
WA Mallee/Sandplain (Esperance)	43	39	42	44	
WA Northern	73	71	60	59	
National Averages	58	44	39	46	**

*Caution, small sample

Figure 13 Percentage of crop area planted to wheat

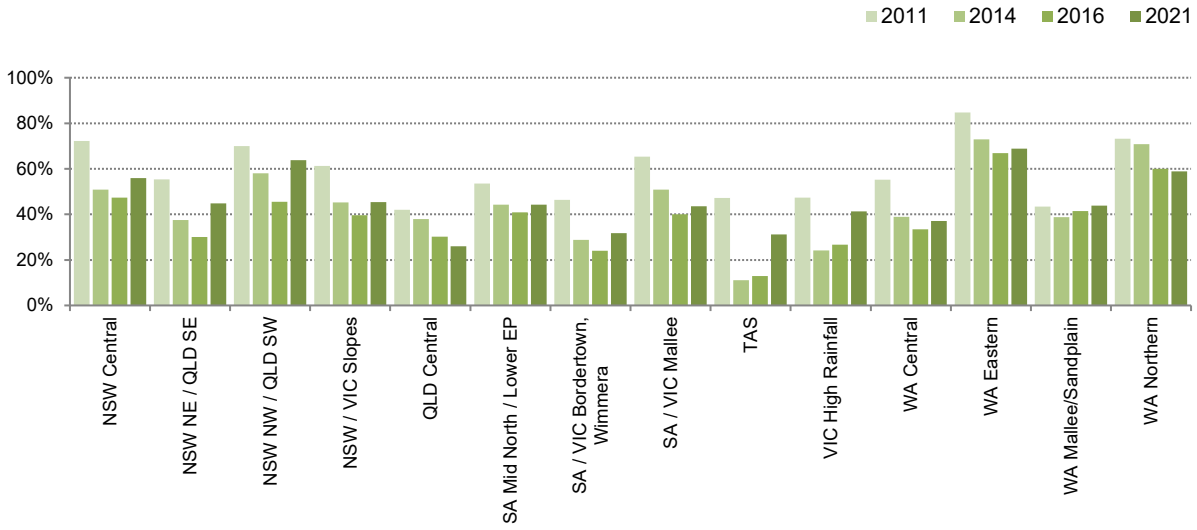


Figure 14 Average % of crop area planted to wheat national averages

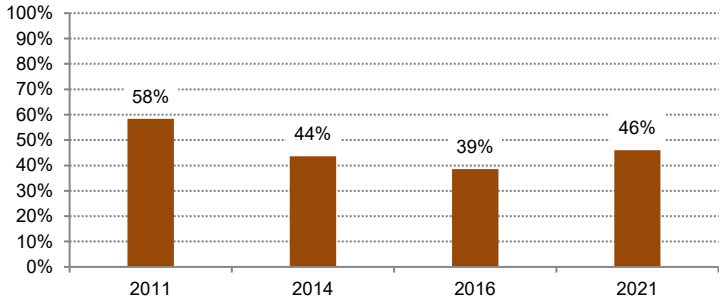
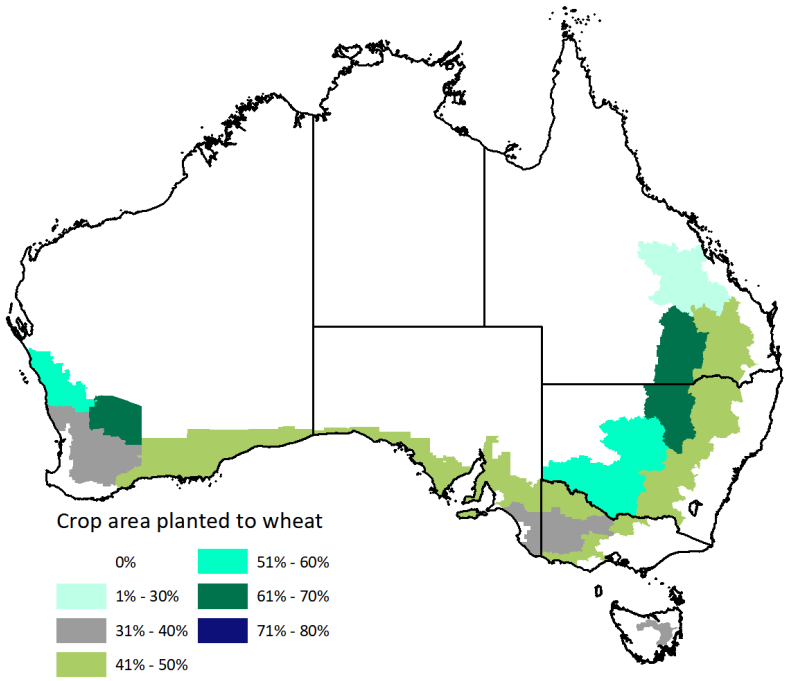


Figure 15 % of cropped area planted with wheat in 2021



Barley

The AEZs with the highest proportions of barley as a percentage of the total cropped area are usually found in the more southern AEZs of SA, Victoria and the WA Mallee/Sandplain. However, in 2021, higher proportions of barley (20% or more) in the crop mix are seen in NE/NSW/SE Qld and central WA (see Table 14, Figure 16 and Figure 17).

Overall, there has been an increase in barley as a proportion of total crop area in 2021, continuing a trend seen in earlier surveys. The potential reasons for these changes are possibly in rotational consideraions, and seasonal conditions in the year, especially at the time planting decisions were made.

Table 13 Percentage of crop area planted to barley (Q10)

Agro-ecological zone	Average % of crop area				Significant difference between years
	2011	2014	2016	2021	2016 to 2021
NSW Central	10	18	17	16	No significant variation to 2016
NSW NE / QLD SE	10	14	17	22	
NSW NW / QLD SW	7	11	11	6	
NSW / VIC Slopes	9	12	12	17	
QLD Central/Northern	1	4	1	3	
SA Mid North / Lower EP	22	27	26	19	
SA / VIC Bordertown, Wimmera	18	24	27	20	
SA / VIC Mallee	17	24	30	29	
TAS*	39	16	7	35	
VIC High Rainfall	15	21	20	11	
WA Central	19	21	23	25	
WA Eastern	8	14	14	10	
WA Mallee/Sandplain (Esperance)	26	28	33	19	
WA Northern	3	4	4	10	
National Averages	15	17	17	19	

*Caution, small sample

Figure 16 Percentage of crop area planted to barley

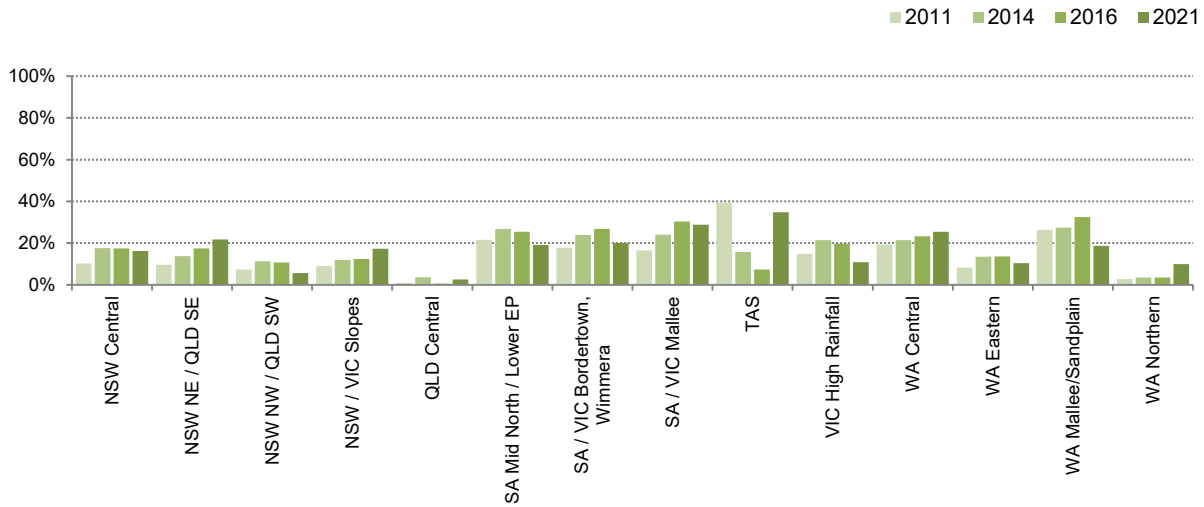
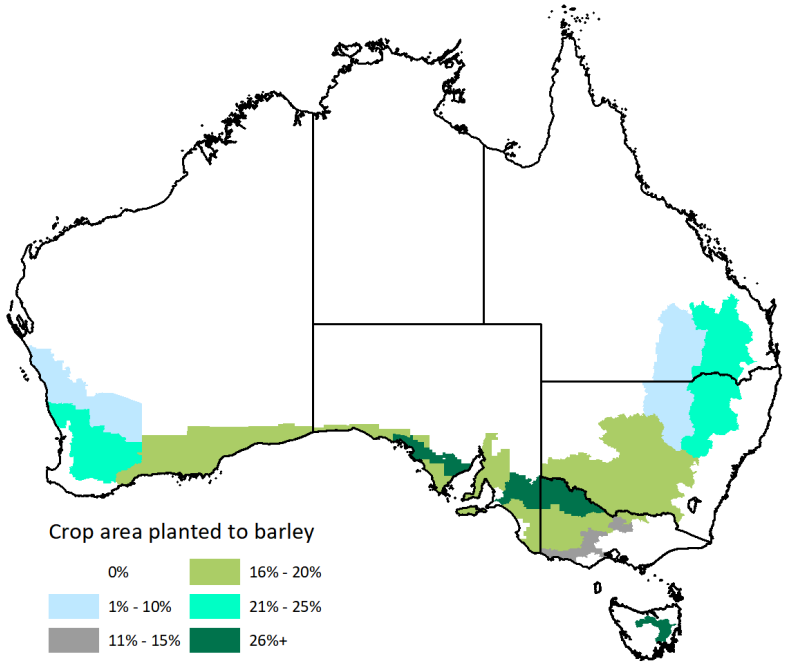


Figure 17 Percentage of barley (% of cropped area) in 2021



Other winter cereals

Other winter cereals include oats, triticale and cereal rye. These crops are mainly used for grazing, for producing grain to be retained on-farm or sold for feeding livestock. For this reason, it is common to find a high proportion of these crops in AEZs where mixed grain/livestock farming is a widely practiced farming system. The proportions of each individual crop (oats, cereal rye and triticale) were not recorded.

There was a decrease in other winter cereal crops in 2021 compared with the two previous surveys (Table 15 and Figure 18). This decrease may have been to allow for an increase in area to canola (see later data), particularly where canola is popular.

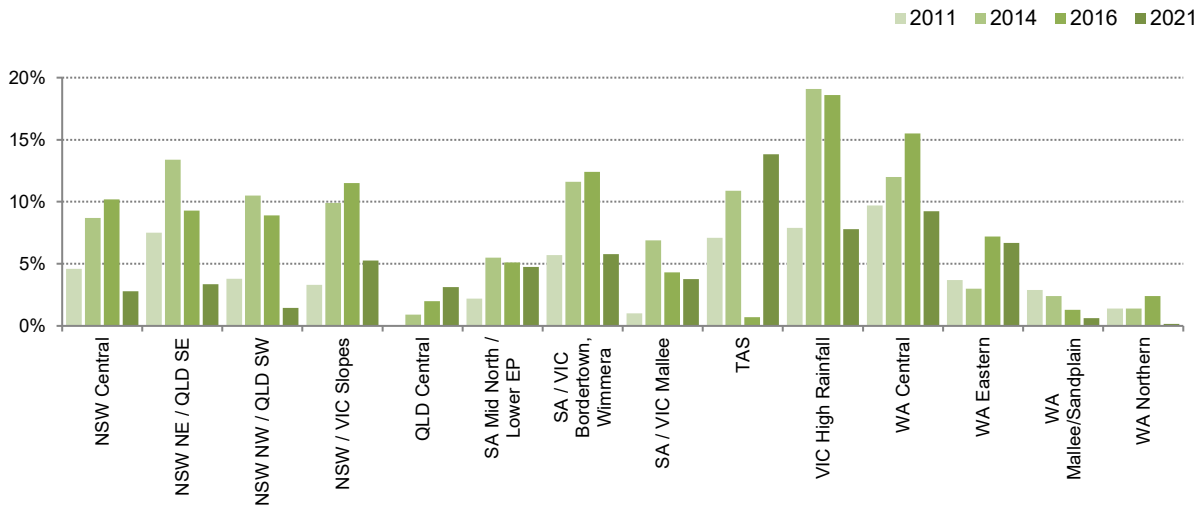
It is likely that oats are the 'other winter cereal' found in the NSW/Vic slopes the areas of SA and Victoria and in central and eastern WA. In WA oats are also used for producing export hay. Both triticale and cereal rye are considered to be very minor crops in the farm mix, though triticale is well adapted to acid soils and is used by some dairy producers.

Table 14 Percentage of crop area planted to other winter cereals (Q10)

Agro-ecological zone	Average % of crop area				Significant difference between years
	2011	2014	2016	2021	2016 to 2021
NSW Central	5	9	10	3	
NSW NE / QLD SE	8	13	9	3	
NSW NW / QLD SW	4	11	9	1	
NSW / VIC Slopes	3	10	12	5	**
QLD Central/Northern	0	1	2	3	
SA Mid North / Lower EP	2	6	5	5	
SA / VIC Bordertown, Wimmera	6	12	12	6	
SA / VIC Mallee	1	7	4	4	
TAS*	7	11	1	14	
VIC High Rainfall	8	19	19	8	
WA Central	10	12	16	9	
WA Eastern	4	3	7	7	
WA Mallee/Sandplain (Esperance)	3	2	1	1	
WA Northern	1	1	2	0	
National Averages	4	8	8	5	**

*Caution, small sample

Figure 18 Percentage of crop area planted to other winter cereals



Summer cereals

Summer cereals (principally grain sorghum and maize) form a significant component of crop sequences in the northern AEZs, especially QLD Central/Northern and north-east NSW/south-east Qld.

In 2016, details of summer cereals were not included in the survey. Nationally, the areas of summer cereals are generally minor and fluctuate markedly with seasonal conditions. The data reported here (Table 16, Figure 19) show these features.

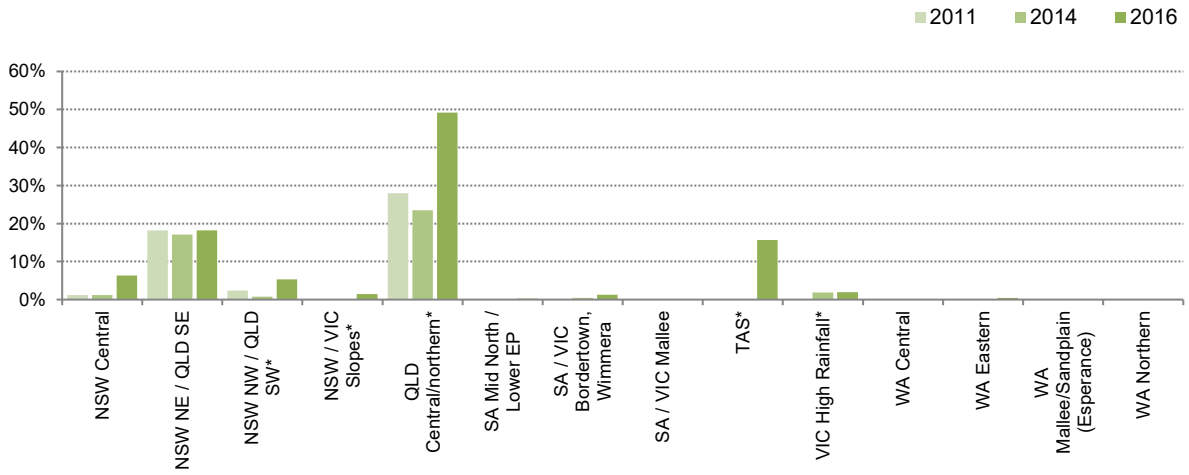
It is notable that the proportion of summer cereals in central Qld has markedly increased in 2021, however caution is required due to the small sample size in this AEZ.

Table 15 Percentage of crop area planted to summer cereals (Q10)

Agro-ecological zone	Average % of crop area			Significant difference between years
	2011	2014	2021	2014 to 2021
NSW Central	1	1	6	No significant variation to 2014, largely due to small sample sizes
NSW NE / QLD SE	18	17	18	
NSW NW / QLD SW*	2	1	5	
NSW / VIC Slopes*	0	0	1	
QLD Central/Northern*	28	24	49	
SA Mid North / Lower EP	0	0	0	
SA / VIC Bordertown, Wimmera	0	0	1	
SA / VIC Mallee	0	0	0	
TAS*	0	0	16	
VIC High Rainfall*	0	2	2	
WA Central	0	0	0	
WA Eastern	0	0	0	
WA Mallee/Sandplain (Esperance)	0	0	0	
WA Northern	0	0	0	
National Averages	4	3	4	

*Caution, small sample

Figure 19 Percentage of crop area planted to summer cereals (trend)



Oilseeds

Oilseeds (predominantly canola) have tended to be more popular in southern NSW, the Bordertown/Wimmera areas (Victoria/SA), and the northern, central and southern cropping areas of WA (see Table 17, Figure 20 and Figure 21). However, canola is also now being grown in central NSW and NW NSW/SW Qld.

There was an increase in the proportion of the cropped area across all AEZs (apart from the SA/VIC Mallee) in 2021), most dramatic in northern and southern WA, and parts of NSW and SA/Victoria. Canola now represents over 25% of the cropped area in NSW/Vic slopes, Victorian High Rainfall and WA Mallee/Sandplain (Esperance), and has also increased substantially in WA Northern.

The increase in the proportion of oilseeds in cropping areas in 2021 is likely for two reasons. Firstly, the expected strong financial returns from these crops forecasted early in 2021 when planting decisions were being made or modified. Secondly, a positive assessment of seasonal conditions in many AEZs approaching the ideal sowing times for canola. This is possibly the case in VIC High Rainfall AEZ where the lower proportion of oilseeds in 2016 is likely to be due to seasonal conditions in that year. As noted earlier, the generally increased canola area may have been at the expense of other winter cereals, such as oats and potentially some pulses in some AEZs.

Table 16 Percentage of crop area planted to winter oilseeds (Q10)

Agro-ecological zone	Average % of crop area				Significant difference between years
	2011	2014	2016	2021	2016 to 2021
NSW Central	7	9	9	13	
NSW NE / QLD SE	2	2	3	4	
NSW NW / QLD SW	4	4	4	9	
NSW / VIC Slopes	23	22	23	26	
QLD Central/Northern	0	0	0	0	
SA Mid North / Lower EP	8	7	6	10	
SA / VIC Bordertown, Wimmera	18	16	9	16	
SA / VIC Mallee	9	8	3	3	
TAS*	3	1	4	14	
VIC High Rainfall	22	22	15	28	
WA Central	10	18	15	19	
WA Eastern	2	6	6	8	
WA Mallee/Sandplain (Esperance)	20	26	19	32	
WA Northern	8	13	13	22	
National Averages	10	11	9	14	**

*Caution, small sample

Figure 20 Percentage of crop area planted to winter oilseeds (trend)

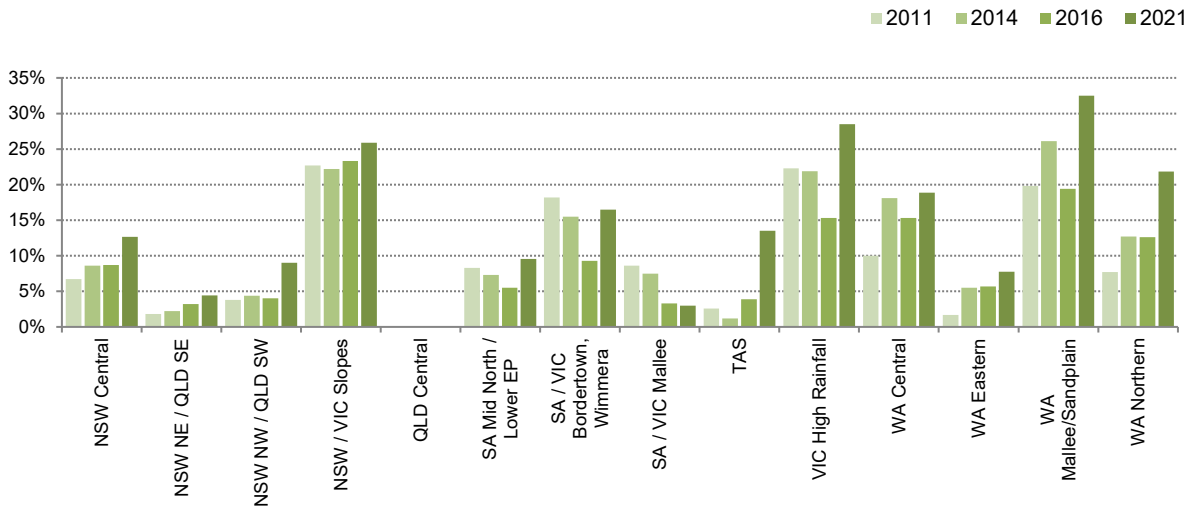
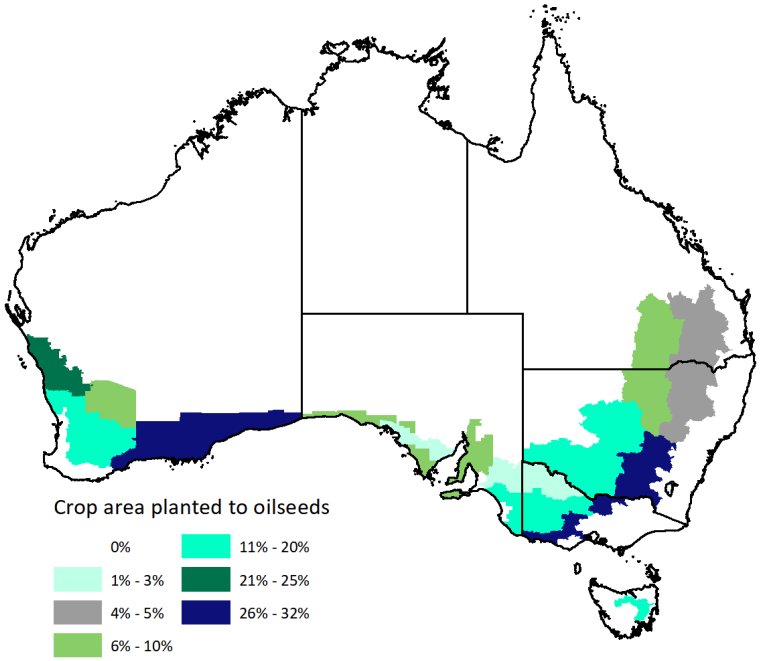


Figure 21 Percentage of crop area planted to oilseeds in 2021



Pulses

Pulses have historically made up a relatively minor proportion (frequently under 10 per cent) of the total crop area for most AEZs during the period to 2014. However, the proportion of pulses in the crop mix on grain farms since 2014 shows pulses to make up between 20% and 30% of the crop area in many AEZs. The proportion of pulses was generally higher in 2016 than 2021, though remain at over 20% of the crop area in much of SA, Victoria and central Qld, while still at over 10% in northern NSW and southern Qld.

The reasons for the changes in pulse areas observed in the survey data are likely a combination of:

- Strong prices for pulses, suited to some AEZs, for example chickpeas in northern areas of NSW and southern Qld, and lentils in Victoria and SA.
- The strong prices on offer for canola, meaning growers in WA may have included canola instead of lupins;
- Traditionally strong in mungbean and chickpea plantings in Central Qld;

Table 17 Percentage of crop area planted to pulses (Q10)

Agro-ecological zone	Average % of crop area				Significant difference between years
	2011	2014	2016	2021	2016 to 2021
NSW Central	1	5	8	9	
NSW NE / QLD SE	3	7	27	16	**
NSW NW / QLD SW	11	9	28	16	
NSW / VIC Slopes	2	5	5	5	
QLD Central/Northern	8	10	30	24	
SA Mid North / Lower EP	13	15	20	22	
SA / VIC Bordertown, Wimmera	10	14	19	24	
SA / VIC Mallee	9	10	15	22	
TAS*	4	3	2	0	
VIC High Rainfall	4	4	6	10	
WA Central	6	4	7	9	
WA Eastern	2	3	4	6	
WA Mallee/Sandplain (Esperance)	8	2	5	5	
WA Northern	15	10	18	9	
National Averages	7	7	14	14	

*Caution, small sample

Figure 22 Percentage of crop area planted to pulses (trend)

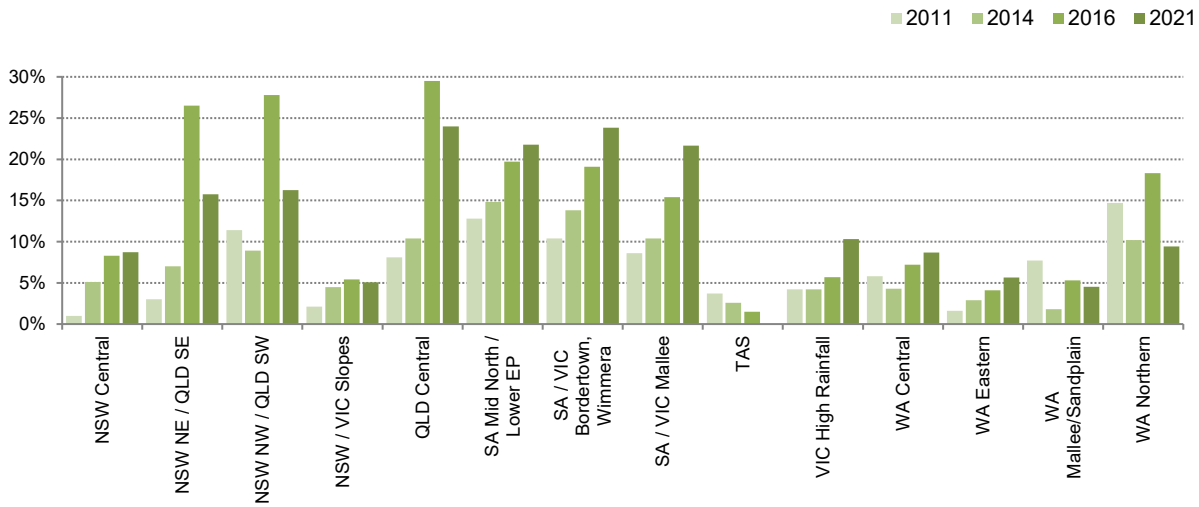
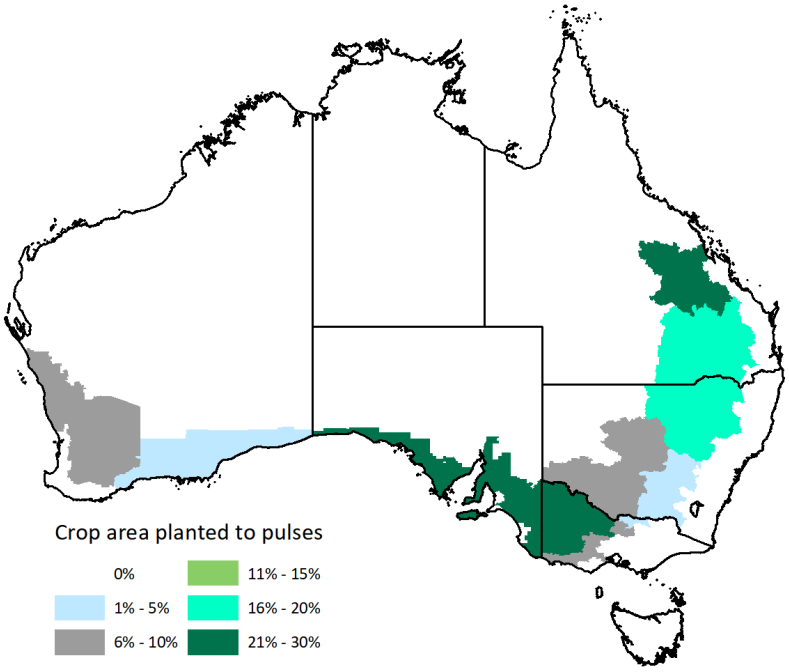


Figure 23 Percentage of crop area planted to pulses in 2021



National trends

When the survey data is considered on a national basis, some trends can be noted (Table 19 and Figure 24, Figure 25 and Figure 26).

The changes in national cropped area trends show:

- A national decrease in the proportion of wheat in each survey year until 2021, when a significant increase is observed
- The proportion of barley has increased since 2011, now reaching almost 20% nationally
- Other cereals have declined as a proportion of the crop area since 2014/2016
- Oilseeds have grown strongly since 2016, likely taking the place of some other winter cereals and pulses in some AEZs
- Pulses have remained stable since 2016 at almost 15% of the cropped area, but vary considerably among AEZs
- Summer cereals remain minor apart from parts of the northern region.

Table 18 Average national percentage of cropped area planted with the major crops in 2011 to 2021 (Q10)

Crop type	2011	2014	2016	2021	Significance between years 2016 to 2021
Wheat	60	44	39	46	**
Barley	14	17	17	19	
Other cereals	5	8	8	5	
Oilseeds	11	11	9	14	
Pulses	7	7	14	14	
Summer cereals	2	3	n/a	2	

Figure 24 Average national percentage of cropped area planted with the major crops

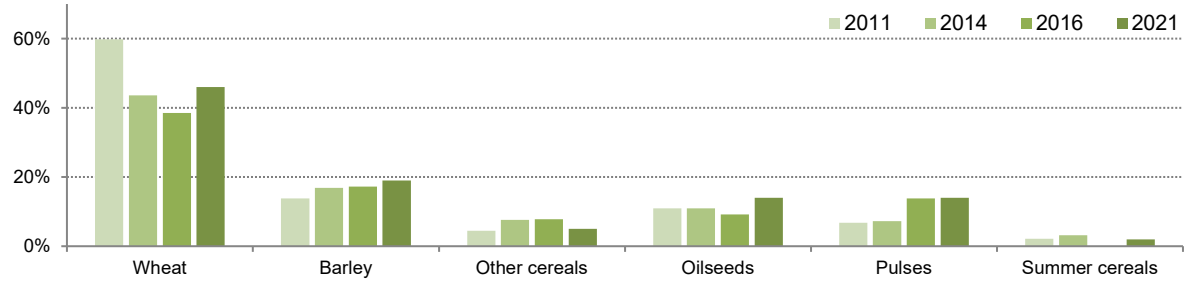


Figure 25 Average national percentage of cropped area planted with the major crops - changes since 2011

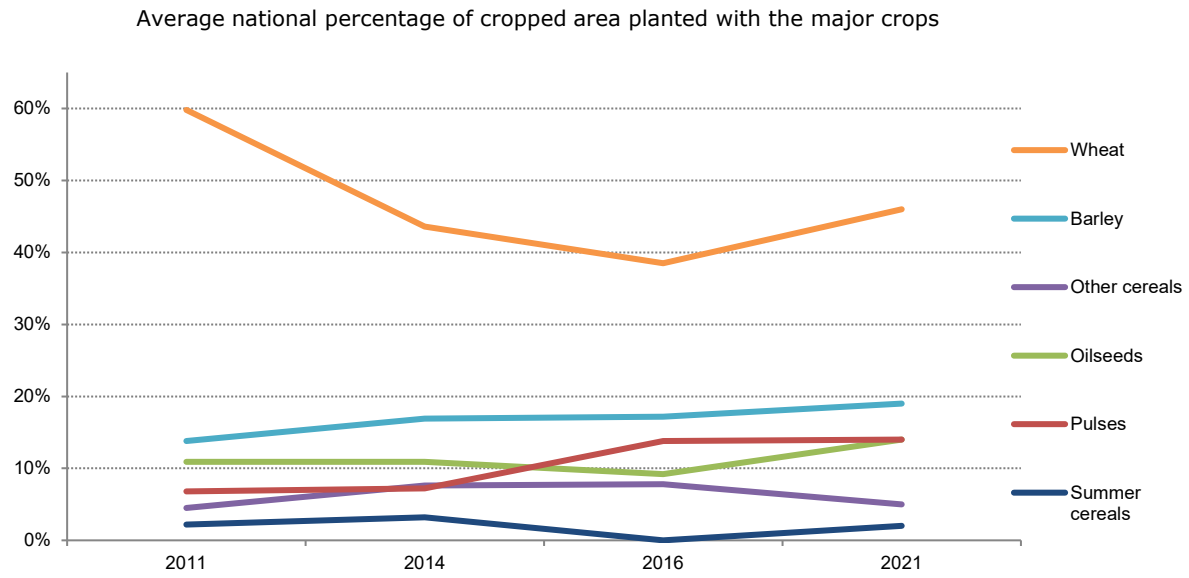
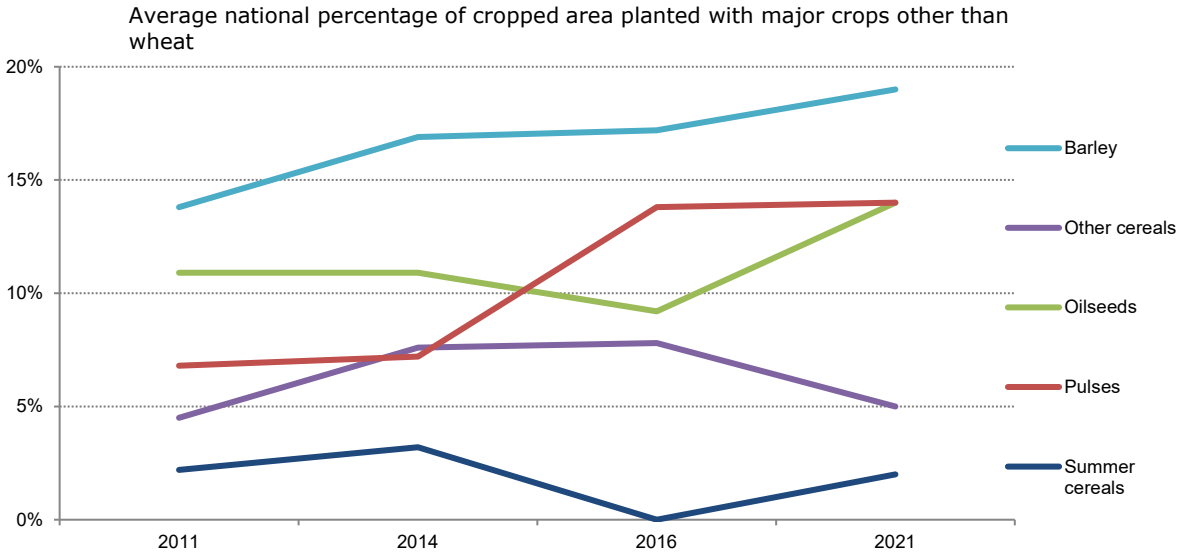


Figure 26 Average national percentage of cropped area planted with major crops (other than wheat) - changes since 2011



Crop variety (cultivar) change and rationale (new in 2021)

Frequency of varietal change

Respondents were asked if they had chosen a new variety for each crop type sown in the last 2 years and their reasons for doing so. The data is shown in Table 24, Figure 27 and Figure 28.

The data suggest that growers tend to change to a new variety fairly regularly. New varieties of winter cereals are chosen by 59% of growers every 2 years or so, higher in WA Northern and WA Eastern, NSW Central, NSW/Vic slopes and SA Mid North / Lower Eyre Peninsular. In most cases growers would be evaluating one or more new varieties each year or so on smaller areas and be increasing seed from these before adopting across the broader winter cereal area. It is also likely that most would be using more than one variety, and one or two of these would be changing on a gradual basis over some years.

Pulse varieties tend to be changed a little less frequently than wheat, though 50% or more of pulse growers change their varieties over each 2 year period in central / northern Qld, parts of SA and southern WA. This may correlate with the relative proportion of pulses grown in these AEZs.

In the case of oilseeds (notably canola) it is evident that growers choose new varieties quite frequently, with a national average of two thirds doing so in each 2 year period. This is higher in the strong canola growing areas, notably all of WA and the NSW /Vic slopes. The use of hybrid canola varieties will have a strong influence, where growers will not be saving seed with this making it easier to change to newer varieties. It is also enhanced by quite active canola breeding programs and pressure from diseases such as Blackleg.

More detail on the reasons growers change varieties is presented in the next section.

Table 19 Percent of farms planting a new variety in the past 2 years for each crop type (base: planted crop type in 2021) (Q11)

Agro-ecological zone	Winter cereals	Pulses/legumes	Oilseeds	Summer crops
NSW Central	60	47	46	12
NSW North-East / QLD South-East	56	35	57	49
NSW North-West / QLD South-West	47	27	72	32
NSW / VIC Slopes	66	41	76	30
QLD Central/Northern*	59	57	0	47
SA Mid North / Lower Eyre Peninsula	65	51	66	100
SA / VIC Bordertown, Wimmera	52	39	63	0
SA / VIC Mallee	54	56	64	0
TAS*	0	0	33	0
VIC High Rainfall*	42	30	60	0
WA Central	63	30	71	67
WA Eastern*	73	31	75	0
WA Mallee/Sandplain (Esperance)*	62	58	69	0
WA Northern*	86	45	81	0
National Averages	59	42	67	42

*Caution, small sample

Figure 27 % planting a new variety in past 2 years (base: planted crop type in 2021)

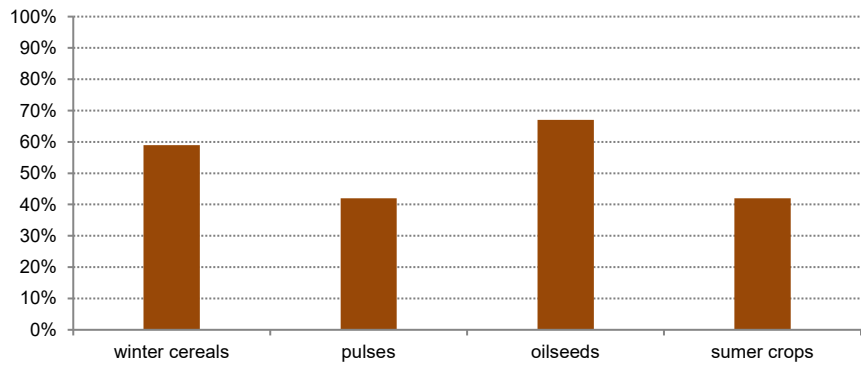
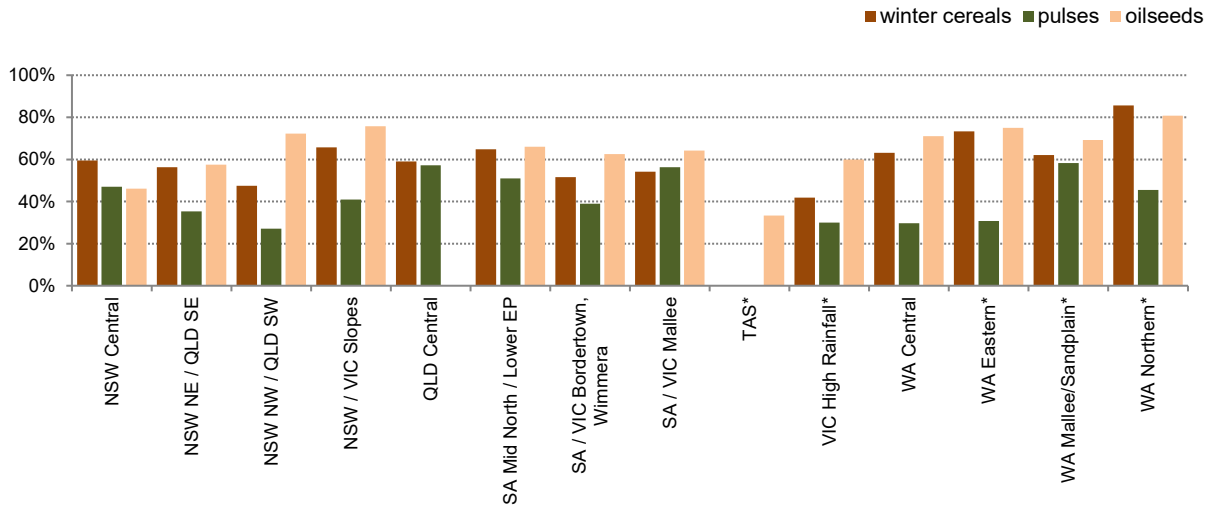


Figure 28 Percentage of farms planting a new variety x crop type (base: planted crop type in 2021)



Reasons for changing to different varieties (new in 2021)

Respondents were asked their main reasons for planting a new variety as an open question. The answers were placed into five main categories. The categories were not the same for each crop. Data is presented for each main crop category – i.e. winter cereals, pulses, oilseed and summer crops.

Winter cereals .

The main reasons for changing variety with winter cereals are yield gain and disease resistance. This is most notable in SA/VIC Bordertown & Wimmera, SA/VIC Mallee, VIC High Rainfall, WA Northern and QLD Central/Northern. It is lower in much of northern NSW and QLD. This is likely to be influenced by changing foliar (mainly stripe rust) pathotypes and the effectiveness of newer varieties to resist infection, coupled with higher yield potential. Agronomist and peer recommendation is also likely to include these factors in their advice.

Table 20 Reason for planting new winter cereal variety - % of farms (base: planted new variety) (Q12)

Agro-ecological zone	Yield gains	Disease resistance	Agronomist/ peer recommend	Keep up to date	Weed/ chemical control
NSW Central	47	40	15	6	2
NSW North-East / QLD South-East	46	26	14	9	4
NSW North-West / QLD South-West	40	32	15	15	0
NSW / VIC Slopes	58	43	9	7	4
QLD Central/Northern	62	0	8	15	0
SA Mid North / Lower Eyre Peninsula	52	41	11	9	9
SA / VIC Bordertown, Wimmera	71	44	12	14	7
SA / VIC Mallee	62	40	10	15	5
TAS*	0	0	0	0	0
VIC High Rainfall	67	50	11	0	0
WA Central	57	31	9	8	8
WA Eastern	55	27	9	9	0
WA Mallee/Sandplain (Esperance)	56	28	11	6	6
WA Northern	67	21	13	4	0
National Averages	56	36	11	9	5

*Caution, small sample

Pulses (Table 22).

The main reasons for changing pulse variety are yield gain and disease resistance, using pulses as a break crop was the third most common reason. Weed control options and harvestability were also mentioned.

It is likely that the main reason(s) for choosing new varieties for pulses will vary depending on the pulse crop, however, yield gain is likely a factor in all crops. Yield gain was mentioned more as a reason for choosing new pulse varieties in NSW North-West / QLD South-West, SA Mid North / Lower Eyre Peninsula, VIC High Rainfall, and less frequently in WA Central, and WA Mallee/Sandplain.

Disease resistance is a factor for most pulses, with the importance varying between pulse crop types. Chickpeas, lentils and faba beans are some where disease resistance is important. Where the climatic conditions are more conducive to pulse diseases (e.g. higher rainfall) this will also be a factor.

Disease resistance is a more important factor in Northern NSW and Southern QLD, SA Mid North / Lower Eyre Peninsula, SA VIC Bordertown, Wimmera and VIC High Rainfall. It was lower in WA, NSW Central and QLD Central/Northern.

Almost all pulse crops provide a disease break for cereal diseases, especially foliar diseases. Choosing a new pulse crop variety was noted to be for the break crop effect in WA Eastern and WA Northern, and NSW Central.

Harvestability is a likely factor for field pea and chickpea varietal choice.

Table 21 Reason for planting new pulses/legume variety - % of farms (base: planted new variety) (Q12)					
Agro-ecological zone	**Yield gains**	**Disease resistance**	**Break crop**	**Weed/chemical control**	**Harvestability**
NSW Central	50	13	31	19	6
NSW North-East / QLD South-East	48	52	6	4	4
NSW North-West / QLD South-West	68	61	0	0	18
NSW / VIC Slopes	48	35	17	4	0
QLD Central/Northern*	50	25	0	0	17
SA Mid North / Lower Eyre Peninsula	62	47	4	11	6
SA / VIC Bordertown, Wimmera	52	50	9	19	12
SA / VIC Mallee	52	26	10	4	10
TAS*	0	0	0	0	0
VIC High Rainfall*	83	67	0	0	17
WA Central	40	23	10	13	7
WA Eastern*	50	25	50	13	13
WA Mallee/Sandplain (Esperance)*	29	29	14	0	0
WA Northern*	50	0	20	0	0
National Averages	53	37	11	9	8

*Caution, small sample

Oilseeds (Table 23).

The main reasons for changing oilseed variety are yield gain and disease resistance. Yield gain is mentioned by more growers in WA Central, WA Mallee/Sandplain, WA NorthernSA/VIC Mallee and NSW North-East / QLD South-East. Disease resistance is more a factor in NSW / VIC Slopes, SA / VIC Bordertown, Wimmera, VIC High Rainfall. It is likely that a combination of factors influence the choosing of a new oilseed variety, as perhaps is evident in NSW Central, and NSW / VIC Slopes and SA Bordertown, Wimmera, SA Mid North Lower Eyre Peninsula, whereas yield is more dominant in others, such as NSW North-West / QLD South-West, the SA/VIC Mallee and WA Eastern ad WA Northern.

Hybrid varieties are not kept for grower seed and so new varieties tend to be procured each year contributing to the frequency of changing varieties and the reasons for doing so.

Table 22 Reason for planting new oilseed variety - % of farms (base: planted new variety) (Q12)					
Agro-ecological zone	**Yield gains**	**Disease resistance**	**Weed/ chemical control**	**Agronomist/ peer recommend**	**Keep up to date**
NSW Central*	56	28	6	11	6
NSW North-East / QLD South-East*	63	30	0	22	0
NSW North-West / QLD South-West	46	8	0	15	0
NSW / VIC Slopes	58	35	10	12	5
QLD Central/Northern	0	0	0	0	0
SA Mid North / Lower Eyre Peninsula	46	31	18	8	18
SA / VIC Bordertown, Wimmera	49	37	9	14	5
SA / VIC Mallee	67	5	17	11	5
TAS*	0	0	0	0	0
VIC High Rainfall*	48	43	14	19	0
WA Central	61	20	11	7	14
WA Eastern*	58	8	17	0	0
WA Mallee/Sandplain (Esperance)*	83	28	11	0	11
WA Northern*	62	5	19	5	5
National Averages	56	27	11	10	7

*Caution, small sample

Summer crops (Table 24).

The main reasons for changing summer crop variety appears to be yield gain and actual variety availability.

Table 23 Reason for planting new summer crop variety - % of farms (base: planted new variety)* (Q12)

Agro-ecological zone	Yield gains	Availability	Disease resistance	Agronomist/peer recommendation
NSW Central	0	0	0	0
NSW North-East / QLD South-East	59	14	10	9
NSW North-West / QLD South-West	50	0	0	0
NSW / VIC Slopes	33	33	0	0
QLD Central/Northern	78	11	0	0
SA Mid North / Lower Eyre Peninsula	0	0	0	0
SA / VIC Bordertown, Wimmera	0	0	0	0
SA / VIC Mallee	0	0	0	0
TAS*	0	0	0	0
VIC High Rainfall	0	0	0	0
WA Central	0	50	0	0
WA Eastern	0	0	0	0
WA Mallee/Sandplain (Esperance)	0	0	0	0
WA Northern	0	0	0	0
National Averages	55	15	7	6

*Caution, small sample

Wheat variety (cultivar) use and maturity

Growers were also asked what wheat varieties they had planted in 2021. The data has been grouped into maturity period (early, early-to-mid, mid, mid-to-late, and late). The data as shown in Table 25 and Figure 29

Growers tend to use several wheat varieties to manage seasonal break timing, machinery availability and scale and property size amongst other considerations. It is common to have varieties that cover for more than one maturity timing.

The national averaged data suggest a 'normal' curve of varieties are used. Mid maturing varieties are 70% of those grown in 2021. Early-to-mid and early-to-late are both around 35%. Early and late are about 12% of the varieties used. This suggests that growers spread their sowing window by using varieties suited to various maturities and hence sowing date.

Of note is the higher use of mid-late maturity varieties in NSW North-West / QLD South-West, possibly influenced by seasonal conditions whereby later sowing can be a feature.

Table 24 Wheat variety grown in 2021 by maturity time category - % of farms (Q13)

Agro-ecological zone	Early	Early to mid	Mid	Mid to late	Late
NSW Central	24	46	67	34	9
NSW North-East / QLD South-East	10	21	48	51	24
NSW North-West / QLD South-West	23	40	32	79	17
NSW / VIC Slopes	17	31	71	38	32
QLD Central/Northern	54	38	38	31	8
SA Mid North / Lower Eyre Peninsula	5	39	88	27	2
SA / VIC Bordertown, Wimmera	5	25	78	25	10
SA / VIC Mallee	19	37	79	21	1
TAS*	0	0	0	0	100
VIC High Rainfall	0	7	48	44	44
WA Central	5	50	76	40	1
WA Eastern	11	71	93	79	0
WA Mallee/Sandplain (Esperance)	4	46	86	0	0
WA Northern	7	79	82	11	0
National Averages	12	36	70	35	13

*Caution, small sample

Figure 29 national results - wheat variety sown in 2021 maturity times

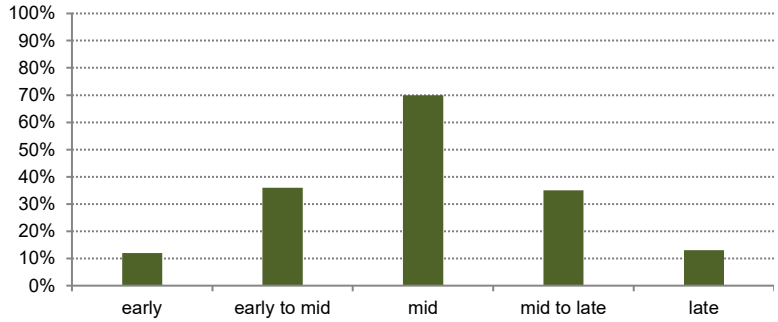
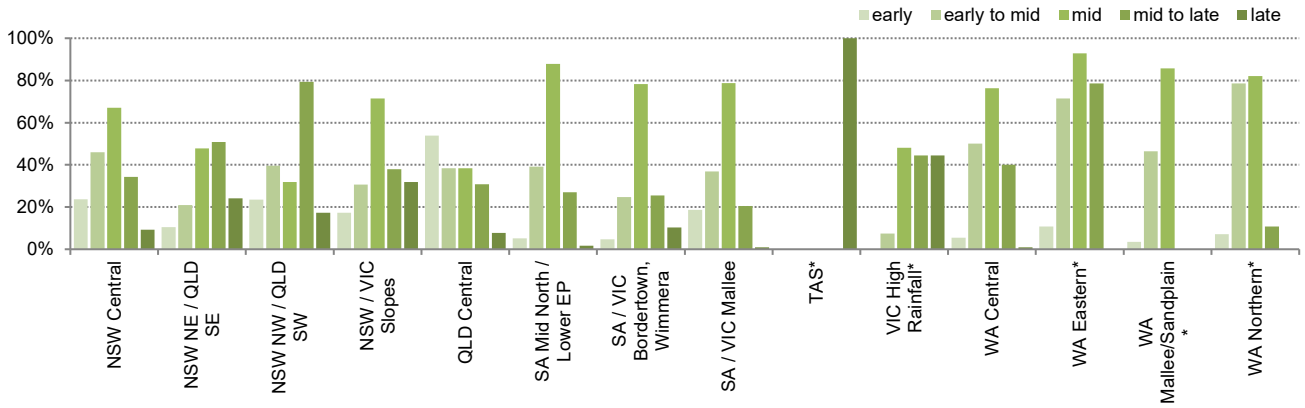


Figure 30 wheat variety sown in 2021 maturity times x AEZ



7. Precision Agriculture

Questions asked:

- Q45. On what proportion of the crop, if any, was controlled traffic used?
- Q46. What proportion of the crop, if any, is yield mapped?
- Q47. What proportion of the crop, if any, was variable rate technology for fertiliser application used?

This section discusses the use of various precision agriculture practices, including controlled traffic, autosteer (GPS machine guidance), yield mapping and variable rate fertiliser application .

Controlled traffic

Controlled traffic (CT) is where the drive and other wheels on implements and tractors, headers etc., follow the same path with each pass over the paddock. This means that wheels travel on defined paths, leaving the soil area elsewhere un-trafficked.

The adoption of CT has continued to increase in all AEZs in the 2021 survey. It appears that CT is now used on over one-third of the cropped area, nationally. However, in some AEZs it is now used on over 50% of the cropped area, for example in northern NSW and southern Qld, and central Qld, with over 40% in northern and southern WA. See Table 26, Figure 31 and Figure 32.

CT is understood to have benefits for soil compaction and trafficability in heavier clay soils (for example, in much of northern NSW, and southern and central Qld). This may explain the relatively high adoption of CT in these zones. It also is useful in weed management where coupled with chaff lining and other gathering and managing of weed seeds is done.

Table 25 Percentage of cropped area where controlled traffic was used (Q45)

Agro-ecological zone	Average % of crop area				Significant difference between years
	2011	2014	2016	2021	2016 to 2021
NSW Central	17	13	21	31	
NSW NE / QLD SE	34	44	52	64	**
NSW NW / QLD SW	46	42	49	50	
NSW / VIC Slopes	18	18	29	33	
QLD Central/Northern	49	64	61	72	
SA Mid North / Lower EP	11	9	12	23	**
SA / VIC Bordertown, Wimmera	13	15	27	34	
SA / VIC Mallee	4	4	6	14	**
TAS*	40	25	54	27	
VIC High Rainfall	26	19	26	40	
WA Central	5	5	9	21	**
WA Eastern	2	6	13	27	
WA Mallee/Sandplain (Esperance)	17	17	30	40	
WA Northern	15	19	23	42	
National Averages	21	21	29	34	**

* Caution small sample size

Figure 31 Percentage of cropped area where controlled traffic was used (trend).

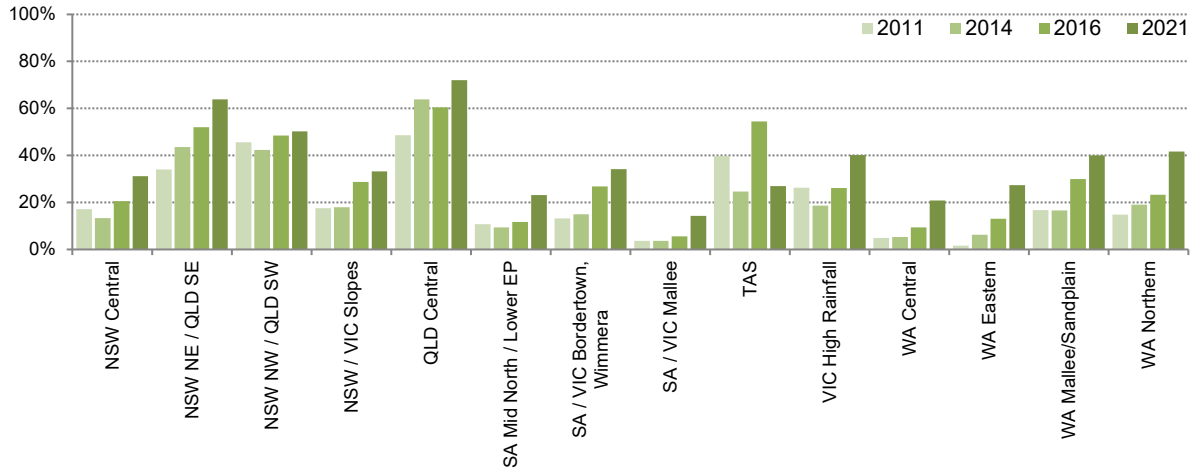
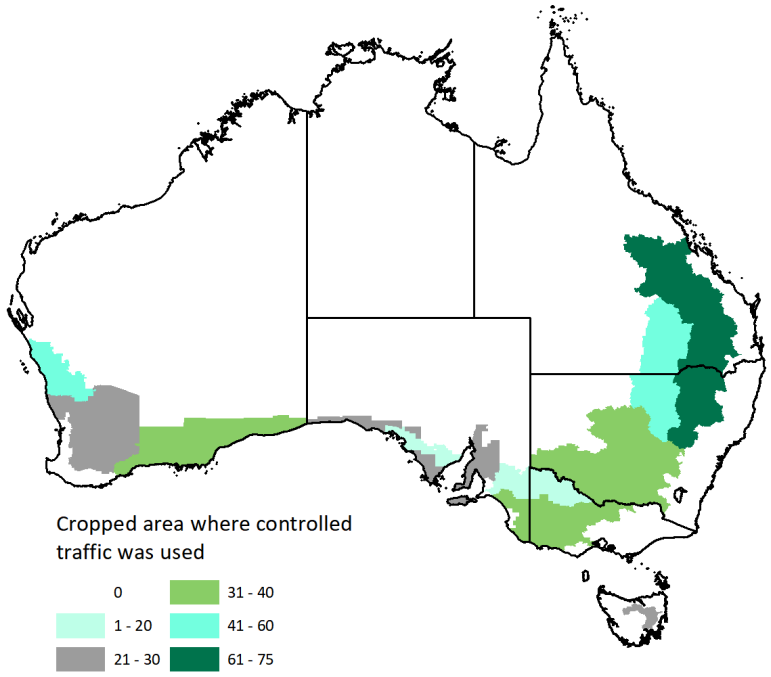


Figure 32 Percentage of crop area using controlled traffic by agro-ecological zone in 2021.



Variable rate technology

Variable rate technology (VRT) involves varying fertiliser application rates on a paddock. The various rates are informed by previous crop results, soil test data or remote sensed information. Data for 2021 is shown in Table 27, Figure 33 and Figure 34.

The survey results show that adoption of variable rate fertiliser use is growing in general although this is not uniform across AEZs. Significant increases are recorded in central Qld, northern NSW/Southern Qld, Vic High Rainfall and northern WA.

Nationally the average area per farm applying fertiliser using VRT fertiliser is 11%, significantly up from 2016.

Table 26 Percentage of cropped area where variable rate fertiliser technology was used (Q47)

Agro-ecological zone	% crop where variable rate fertiliser used			Significant difference between years
	2014	2016	2021	2016 to 2021
NSW Central	13	8	5	
NSW NE / QLD SE	7	4	10	**
NSW NW / QLD SW	1	0	3	
NSW / VIC Slopes	7	8	7	
QLD Central/Northern	3	0	14	**
SA Mid North / Lower EP	10	8	13	
SA / VIC Bordertown, Wimmera	7	4	9	
SA / VIC Mallee	22	21	23	
TAS*	0	0	4	
VIC High Rainfall	4	1	15	**
WA Central	9	7	8	
WA Eastern	5	24	16	
WA Mallee/Sandplain (Esperance)	17	7	9	
WA Northern	21	14	38	**
National Averages	9	7	11	**

*Caution, small sample

Figure 33 Percentage of cropped area where variable rate fertiliser technology was used. 2021

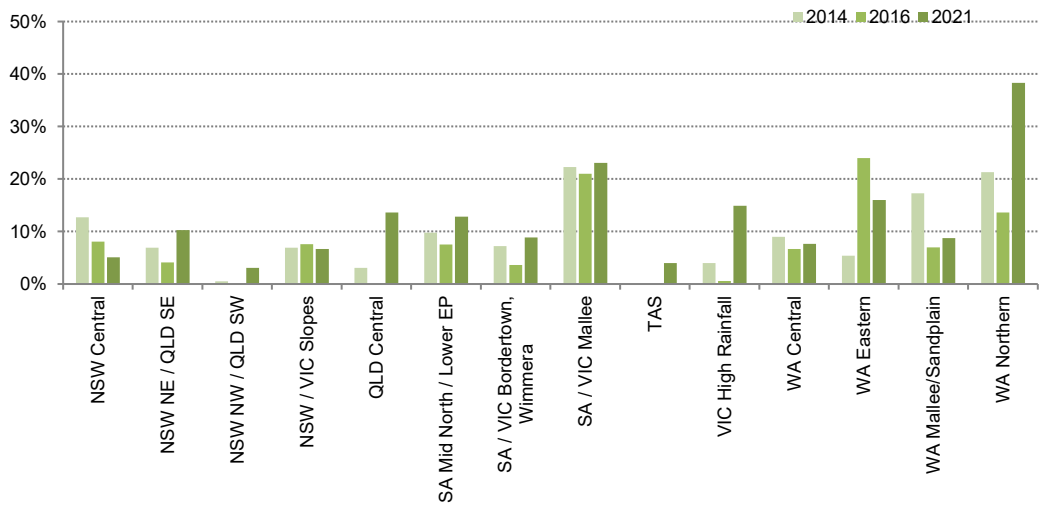
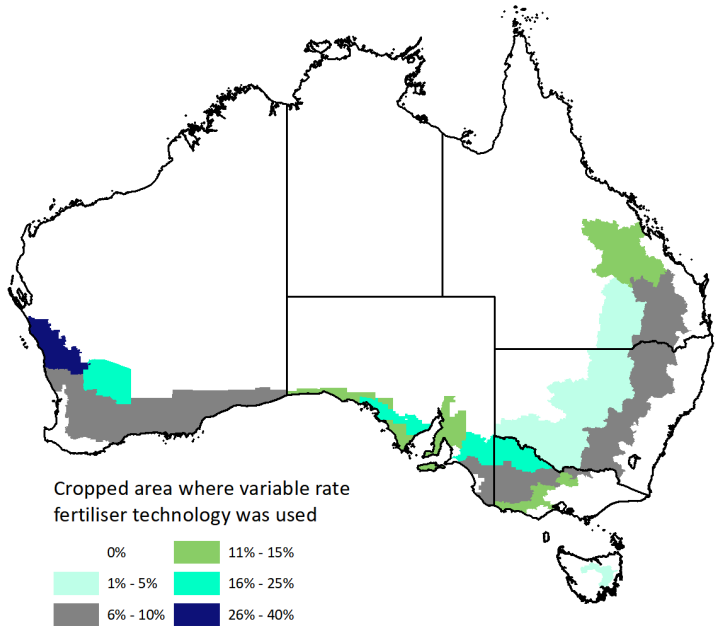


Figure 34 Percentage of cropped area where variable rate fertiliser technology was used in 2021



Yield mapping

Yield mapping is where a map of crop yield is created by the harvesting machinery as it harvests a paddock of grain. It can be used for general crop performance monitoring, for making decisions about inputs, or to choose the type of crop for various paddocks. It can guide growers and advisers on areas for further investigation. For example, zoned soil tests, for investigating the presence of diseases or impediments in soil, or other factors across a paddock. Yield mapping is also an important input for use when partnered with variable rate seed or fertiliser technology. It can help determine where the variable rates of these are best applied.

There has been a continued increase in the proportion of the cropped area where yield mapping is used (Table 32, Figure 35 and Figure 36). This reflects the reality that almost all new harvesters bought by growers have this technology in-built as standard, and that where contract harvesters are used, many provide yield mapping as a service.

The highest adoption rates of this technology are in WA, though is growing in all AEZs, notably in VIC High Rainfall. However, is it is notable that the proportion of crop area where yield mapping is used in NSW NW/QLD SW is significantly lower than the national average.

Table 27 Percentage of cropped area where yield mapping was used (Q46)

Agro-ecological zone	Average % of crop area				Sig difference between years
	2011	2014	2016	2021	2016 to 2021
NSW Central	13	27	27	38	
NSW NE / QLD SE	11	26	33	41	
NSW NW / QLD SW	17	21	21	27	
NSW / VIC Slopes	22	24	32	43	**
QLD Central/Northern	17	35	33	38	
SA Mid North / Lower EP	32	34	44	52	
SA / VIC Bordertown, Wimmera	17	23	31	43	
SA / VIC Mallee	21	28	37	36	
TAS*	11	0	34	20	
VIC High Rainfall	20	18	19	47	**
WA Central	21	29	35	53	**
WA Eastern	22	38	42	48	
WA Mallee/Sandplain (Esperance)	40	47	49	68	
WA Northern	41	57	53	62	
National Averages	22	29	35	44	**

* Caution small sample

Figure 35 Percentage of cropped area where yield mapping was used (trend)

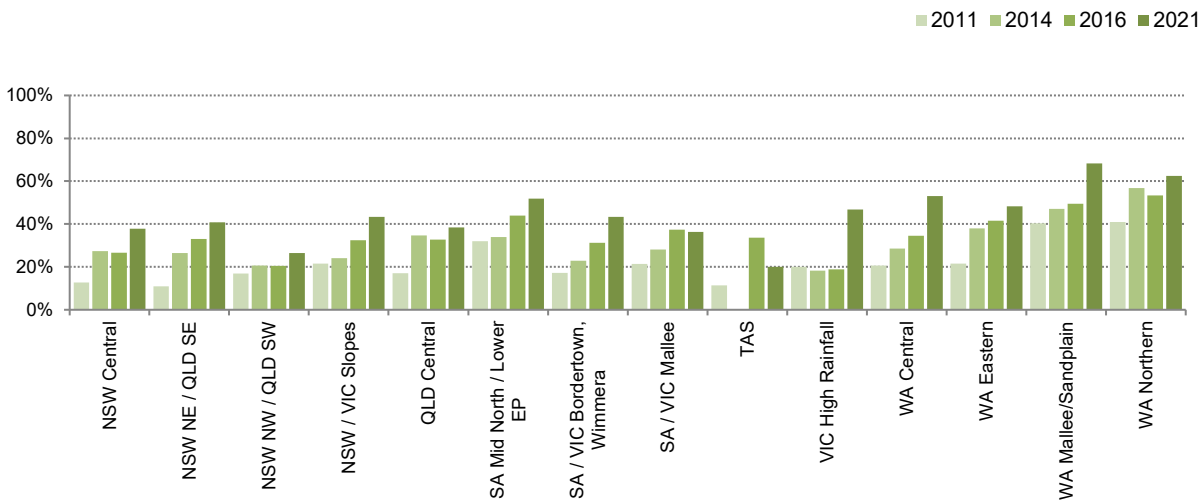
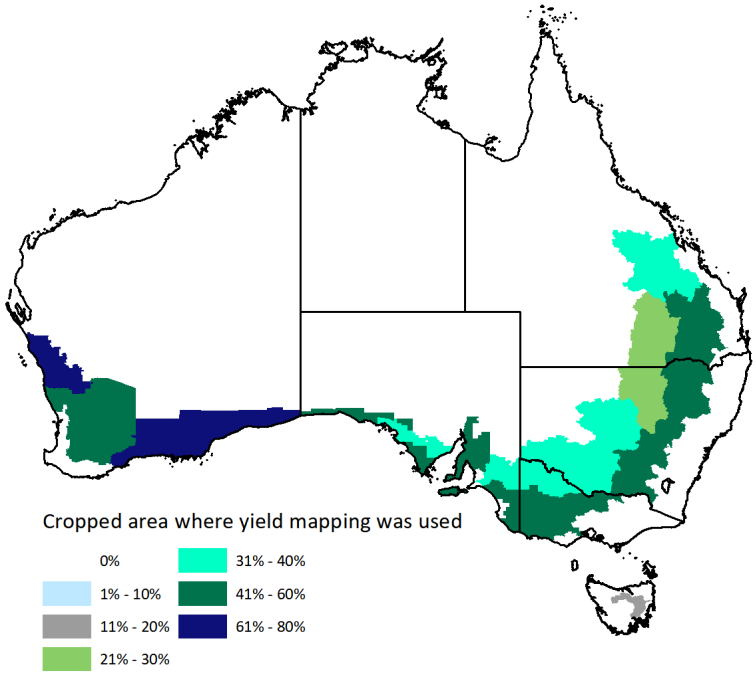


Figure 36 Percentage of cropped area where yield mapping was used in 2021



8. Fallow and Stubble Management in 2021.

Fallow:

Questions asked:

- Q14. Over the past 12 months, how many (hectares/acres) have been
- Long fallowed
- Short fallowed
- Q15. This year, 2021, how did you manage your fallow stubble?
- Q16. And what proportion of your total cropping area in 2021 did you plant where stubble from the previous crop was:
    - *Left intact,*
    - *treated,*
    - *windrow burnt,*
    - *burnt early or late,*
    - *incorporated into soil using tillage or a disc.*

The term *fallow* was defined as either the time between crops in the same paddock or the period between a pasture phase and beginning a cropping phase in a paddock.

A short fallow can be as short as weeks for a summer crop following a winter crop harvest, or some months in GRDC southern and western regions from a November/December harvest to a April/May/June planting.

Proportion of grain farms where a fallow was a feature of the 2021 crop.

The data (Table 29, Figure 37 and Figure 38) indicates that fallow periods are used significantly more in the northern than southern and western regions. Although question alteration in 2021 means caution is required comparing data longitudinally, there appears to be an increase in the use of fallows since 2016. This suggests many growers are using some form of fallow either between crops or between a non-crop period and crop. It is likely that much of the increase in fallow is short fallow where weed control is the priority for moisture conservation and disease management. The importance of these factors may vary between AEZs due to soil type and climate.

Table 28 Percentage of farms using a fallow period (Q14)

Agro-ecological zone	% farms using fallow			Significant difference between years
	2014	2016	2021	2016 to 2021
NSW Central	73	72	90	No significant variation to 2016
NSW NE / QLD SE	76	88	97	
NSW NW / QLD SW	77	94	100	
NSW / VIC Slopes	77	70	84	
QLD Central/Northern	72	71	100	
SA Mid North / Lower EP	30	34	65	
SA / VIC Bordertown, Wimmera	47	53	69	
SA / VIC Mallee	53	61	78	
TAS*	71	86	75	
VIC High Rainfall	45	42	58	
WA Central	26	36	63	
WA Eastern	64	65	80	
WA Mallee/Sandplain (Esperance)	32	50	69	
WA Northern	55	70	77	
National Averages	57	64	78	

*Caution small sample

Figure 37 Percentage of farms using a fallow period over past 12 months in 2021.

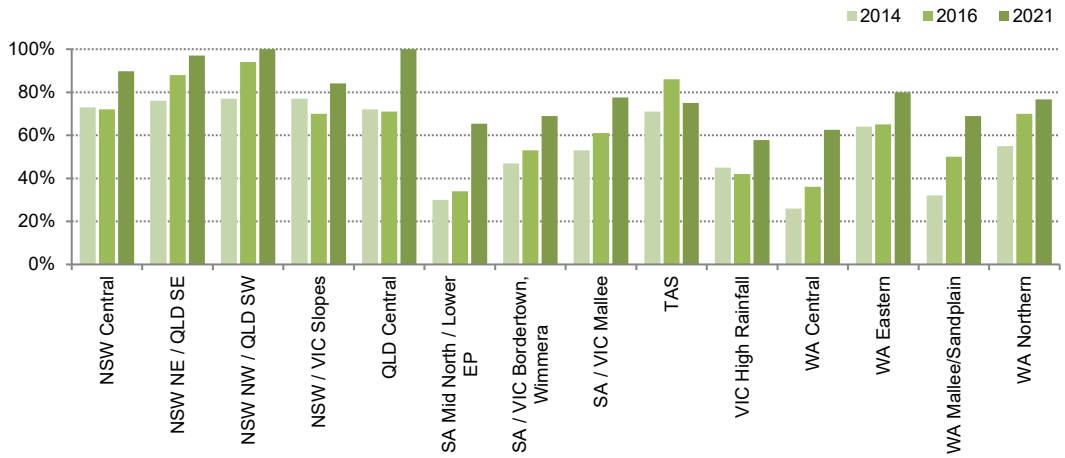
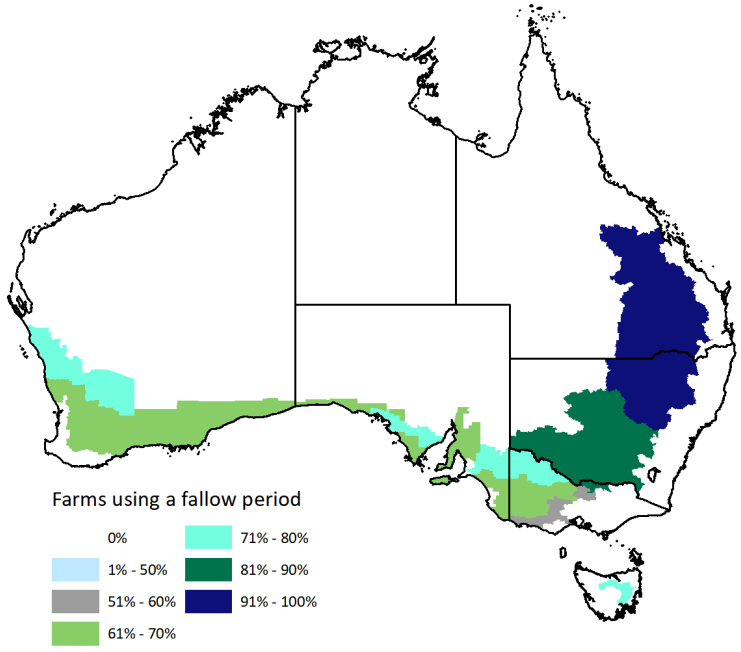


Figure 38 Percentage of respondents reporting a fallow period being used in the last 12 months, in 2021.



Length of Fallow

Long Fallow (new in 2021)

The proportion of cropped area long fallowed is generally low, mostly less than 20% of the cropped area in each AEZ. The areas using a higher proportion tend to be in northern eastern AEZs and eastern WA.

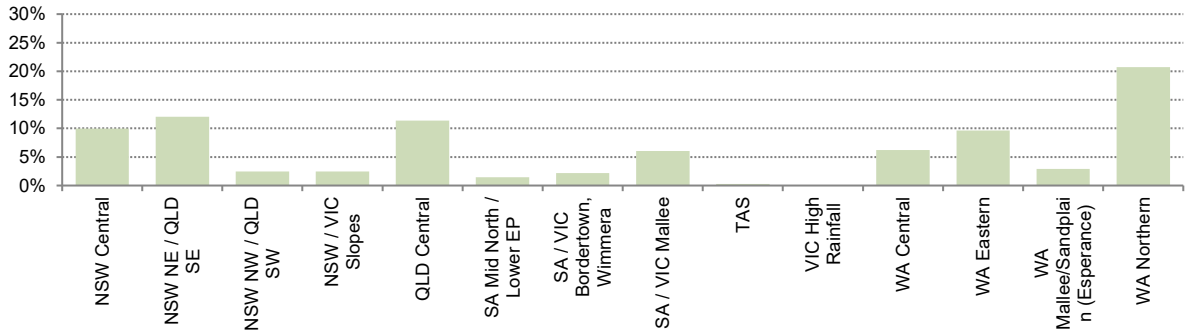
Data are present in Table 30 and Figure 39.

Table 29 Percentage of land long fallowed over the past 12 months (Q14)

Agro-ecological zone	2021
NSW Central	10
NSW NE / QLD SE	12
NSW NW / QLD SW	2
NSW / VIC Slopes	2
QLD Central/Northern	11
SA Mid North / Lower EP	1
SA / VIC Bordertown, Wimmera	2
SA / VIC Mallee	6
TAS*	0
VIC High Rainfall	0
WA Central	6
WA Eastern	10
WA Mallee/Sandplain (Esperance)	3
WA Northern	21
National Averages	6

*Caution, small sample

Figure 39 Percentage of land long fallowed over the past 12 months



Short Fallow

Most AEZs appear to be using a proportion of short fallow, generally around 30% of the cropped area. It is likely that this represents the period between crops being managed for moisture or weeds and diseases.

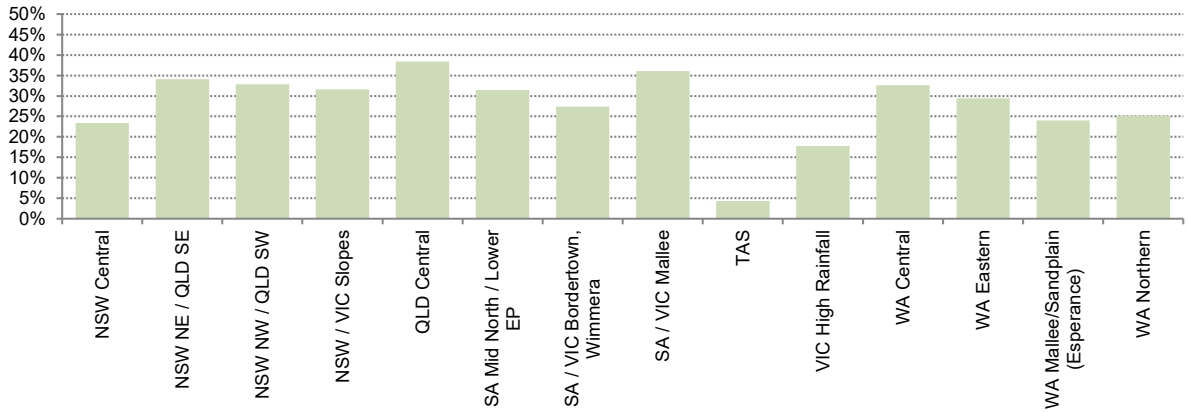
Data are in Table 36 and Figure 40.

Table 30 Percentage of land short fallowed over the past 12 months (Q14)

Agro-ecological zone	2021
NSW Central	23
NSW NE / QLD SE	34
NSW NW / QLD SW	33
NSW / VIC Slopes	32
QLD Central/Northern	38
SA Mid North / Lower EP	31
SA / VIC Bordertown, Wimmera	27
SA / VIC Mallee	36
TAS*	4
VIC High Rainfall	18
WA Central	33
WA Eastern	29
WA Mallee/Sandplain (Esperance)	24
WA Northern	25
National Averages	30

*Caution, small sample

Figure 40 Percentage of land short fallowed over the past 12 months



Stubble (crop residue) management

Questions asked:

Q15. In 2021, how did you manage your fallow stubble?

1. Planted crops into stubble from the previous crop left intact;
2. Planted crop into stubble from the previous crop retained, but treated in a way to help with managing the stubble at planting, for example baling the stubble, harrowing, chaining or using some other treatment that means the stubble is no longer the same as it was after harvesting the previous crop;
3. Planted crops into stubble that was harvested to produce windrows that were then burnt;
4. Planted crops into stubble was burnt within a few weeks prior to planting;
5. Planted crops into stubble burnt some months prior to planting;
6. Planted crop into stubble incorporated into the soil using a tillage or disc machine or similar.

Q16. Roughly what proportion of your total cropping area in 2021 did you plant where:

1. Stubble from the previous crop was left intact;
2. Stubble from the previous crop was retained, but treated;
3. Stubble harvested to produce windrows, then burnt later;
4. Stubble was burnt within a few weeks of planting;
5. Stubble was burnt months prior to planting;
6. Stubble was incorporated into the soil using a tillage or disc machine;

Stubble retained through to planting

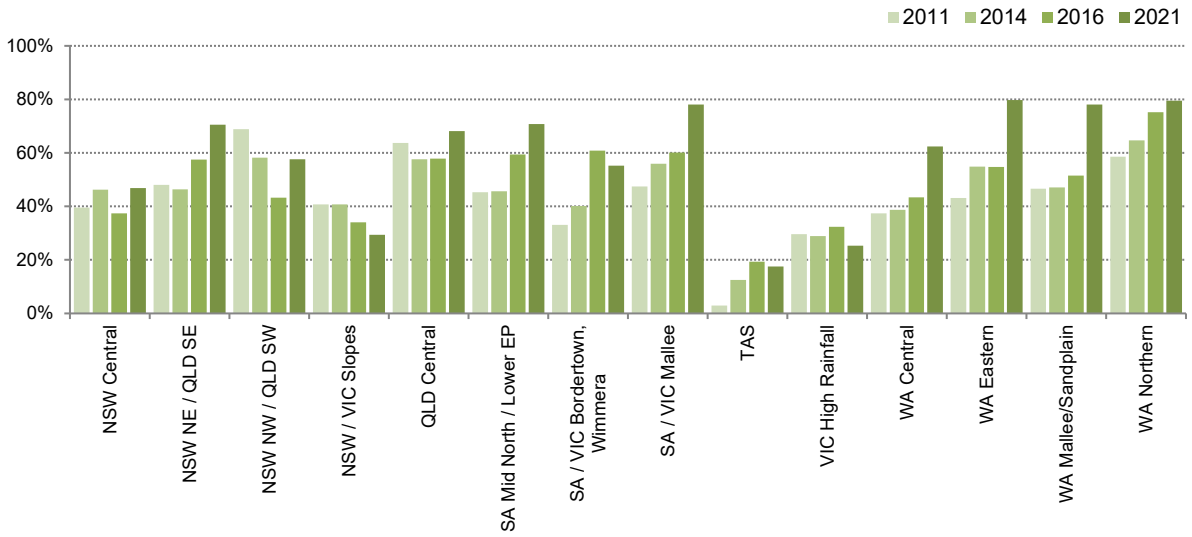
Stubble retained intact is defined as stubble that has not been grazed, slashed or otherwise managed to remove or reduce it.

The data from the 2021 survey (see Table 32 and Figure 41) shows that on average, almost 60% of the cropped area in Australia has stubble retained, intact, through to planting the following crop. This is significantly higher than 2016, and is higher in some AEZs, such as WA Northern, WA Eastern and WA Mallee/Sandplain, the SA/VIC Mallee, SA Mid North /Lower Eyre Peninsula and NSW North-East / QLD South-East, with over 70% of the cropped area. AEZs with lower levels of retention of intact stubble include NSW/VIC Slopes, and VIC High Rainfall. It is possible that where stubble levels are very high, more likely in higher rainfall areas, treatments to remove or reduce stubble loads are carried out to assist with planting the following crop.

Table 31 Percentage of cropped area where stubble was retained intact through to planting (Q16)					
Agro-ecological zone	**Average % of crop area**				**Significant difference between years**
	2011	**2014**	**2016**	**2021**	**2016 to 2021**
NSW Central	40	46	37	47	
NSW NE / QLD SE	48	46	58	71	**
NSW NW / QLD SW	69	58	43	58	
NSW / VIC Slopes	41	41	34	29	
QLD Central/Northern	64	58	58	68	
SA Mid North / Lower EP	45	46	59	71	
SA / VIC Bordertown, Wimmera	33	40	61	55	
SA / VIC Mallee	47	56	60	78	**
TAS*	3	13	19	18	
VIC High Rainfall	30	29	32	25	
WA Central	37	39	43	62	**
WA Eastern	43	55	55	80	**
WA Mallee/Sandplain (Esperance)	47	47	52	78	**
WA Northern	59	65	75	80	
National Averages	43	46	49	57	**

*Caution, small sample

Figure 41 percentage of cropped area where stubble was retained intact through to planting (trend)



Stubble retained (not standing) through to planting

Stubble retained (not standing) can include stubble grazed, slashed or otherwise managed such that it remains present on the soil surface. Where livestock are used on stubbles they are likely to knock stubble down, such that what was *standing* becomes *not standing* due to this grazing.

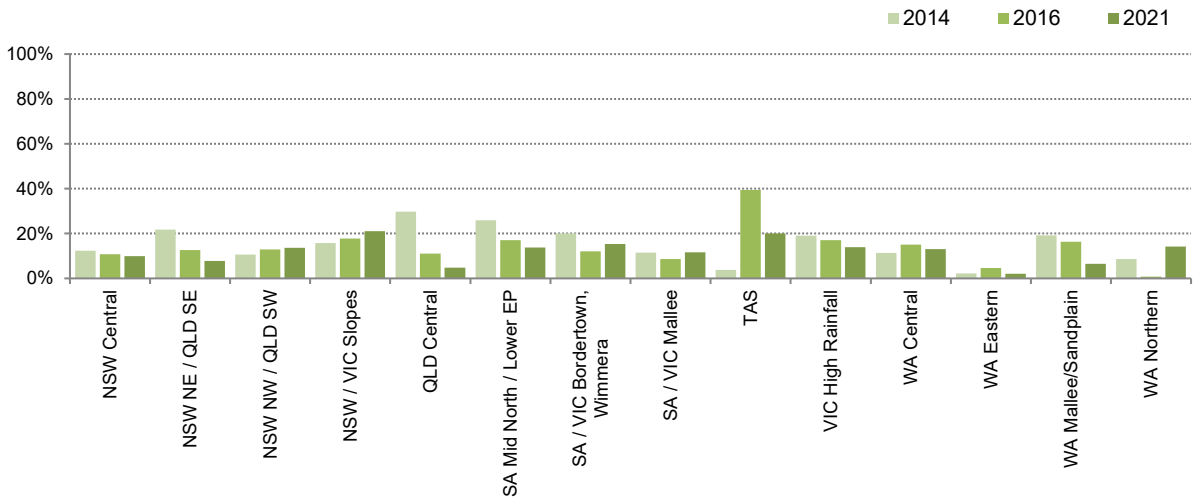
The proportion of stubble retained (not standing) has remained at similar levels to previous surveys, on average, less than 15% (see Table 33 and Figure 42).

Table 32 Percentage of cropped area where stubble was retained (not standing) through to planting (Q16)

Agro-ecological zone	Average % of crop area				Significant difference between years
	2011	2014	2016	2021	2016 to 2021
NSW Central	37	12	11	10	No significant variation to 2016
NSW NE / QLD SE	42	22	13	8	
NSW NW / QLD SW	22	11	13	14	
NSW / VIC Slopes	29	16	18	21	
QLD Central/Northern	29	30	11	5	
SA Mid North / Lower EP	38	26	17	14	
SA / VIC Bordertown, Wimmera	42	20	12	15	
SA / VIC Mallee	40	12	9	12	
TAS*	42	4	40	20	
VIC High Rainfall	34	19	17	14	
WA Central	54	11	15	13	
WA Eastern	53	2	5	2	
WA Mallee/Sandplain (Esperance)	51	19	16	6	
WA Northern	32	9	1	14	
National Averages	39	15	14	13	

*Caution, small sample

Figure 42 percentage of cropped area where stubble was retained (not standing) through to planting



Stubble harvested to windrows that are then burnt

Narrow windrow burning (NWB) is a relatively new weed management practice. It is where crops are cut relatively short at harvest (e.g. 15cm above ground) and the straw and chaff or chaff only is placed in narrow windrows (e.g. less than one metre wide). The objective is to capture weed seeds by ensuring that they enter the harvester and then to deposit the weed seeds in the windrows, which are burnt in the lead up to sowing of the following crops, thereby destroying the seeds. The aim is to burn only the windrow rather than the whole paddock. As such NWB is primarily a weed-management technique rather than a technique for stubble management. However, by the nature of the harvest height and removal of some crop residue by burning, growers also find that stubble flow in sowing machinery is greatly improved and so this practice has both weed-control and stubble-management benefits.

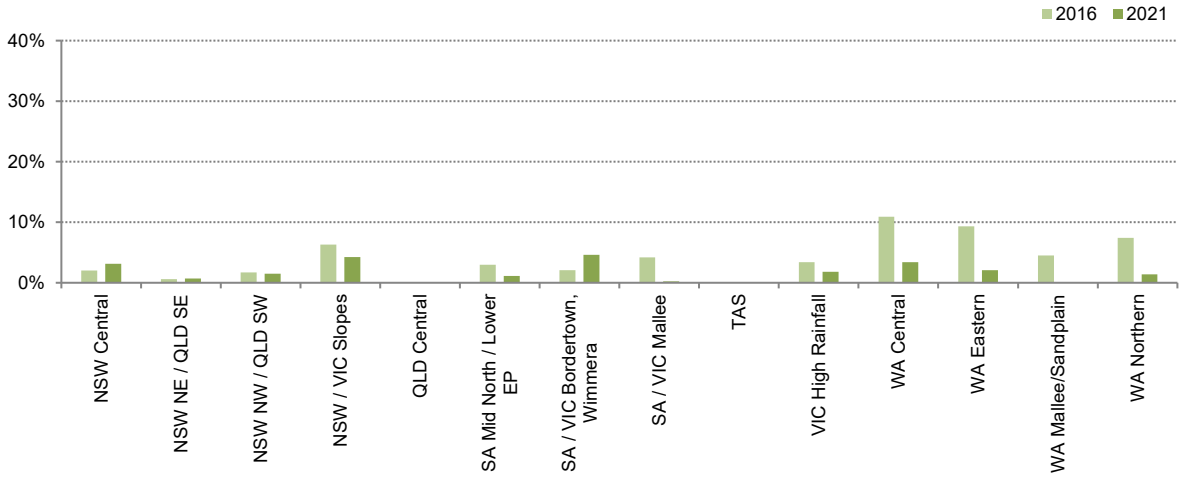
Data for this practice is presented in Table 34 and Figure 43. The data suggest that 'stubble harvested to produce windrows then burnt later' is not a widely used practice, with only 2% of the cropped area reporting this activity, a decline on 2016 data.

Table 33 Percentage of cropped area where stubble was harvested to windrows that were then burnt (Q16)

Agro-ecological zone	Average % of crop area		Significant difference between years
	2016	2021	
NSW Central	2	3	
NSW NE / QLD SE	1	1	
NSW NW / QLD SW	2	1	
NSW / VIC Slopes	6	4	
QLD Central/Northern	0	0	
SA Mid North / Lower EP	3	1	
SA / VIC Bordertown, Wimmera	2	5	
SA / VIC Mallee	4	0	
TAS*	0	0	
VIC High Rainfall	3	2	
WA Central	11	3	*
WA Eastern	9	2	
WA Mallee/Sandplain (Esperance)	5	0	
WA Northern	7	1	
National Averages	4	2	*

*Caution, small sample

Figure 43 percentage of cropped area where stubble was windrowed then burnt (trend)



Stubble burnt early 'hot burn' – months prior to planting

A hot burn occurs when stubble is burnt relatively soon (early) after harvest. For example, in summer or early autumn following harvest of the recent winter crop. Dry and hot conditions, common at this time, lead to hot burns, where all above ground crop residue is burnt.

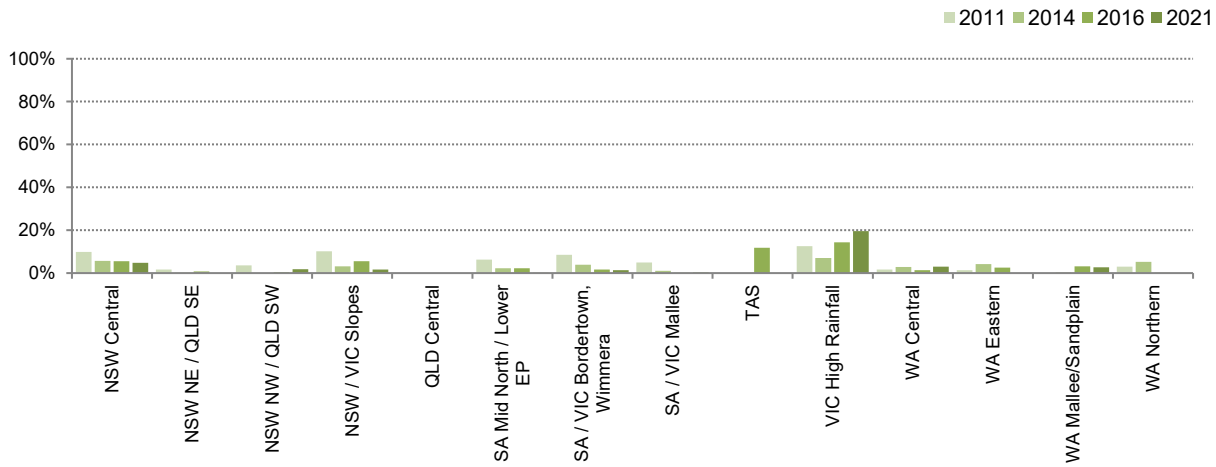
The proportion of stubble burnt soon after the previous harvest is generally quite low and has further decreased, now at 2% average nationally. Only the VIC High Rainfall shows a significantly higher proportion using this technique. See Table 35 and Figure 44.

Table 34 Percentage of cropped area where stubble was burnt early – months prior to planting (hot burn) (Q16)

Agro-ecological zone	Average % of crop area				Significant difference between years
	2011	2014	2016	2021	2016 to 2021
NSW Central	10	6	6	5	No significant variation to 2016
NSW NE / QLD SE	2	0	1	0	
NSW NW / QLD SW	4	0	1	2	
NSW / VIC Slopes	10	3	6	2	
QLD Central/Northern	0	0	0	0	
SA Mid North / Lower EP	6	2	2	0	
SA / VIC Bordertown, Wimmera	9	4	2	1	
SA / VIC Mallee	5	1	0	0	
TAS*	0	0	12	0	
VIC High Rainfall	13	7	14	20	
WA Central	2	3	1	3	
WA Eastern	1	4	3	0	
WA Mallee/Sandplain (Esperance)	0	0	3	3	
WA Northern	3	5	0	0	
National Averages	5	3	4	2	

*Caution, small sample

Figure 44 Percentage of cropped area where stubble was burnt early (hot burn) (trend)



Stubble burnt late 'cool burn' – within weeks of planting

A *cool burn* is defined as burning the previous crop stubble a few weeks before, just before or at the point of planting. This type of burning often incompletely burns the stubble due to cool and/or wet conditions, leaving a proportion of the crop residue remaining on or attached to the soil. The result is that sufficient residue is removed to allow most planting machinery to get through the remaining stubble.

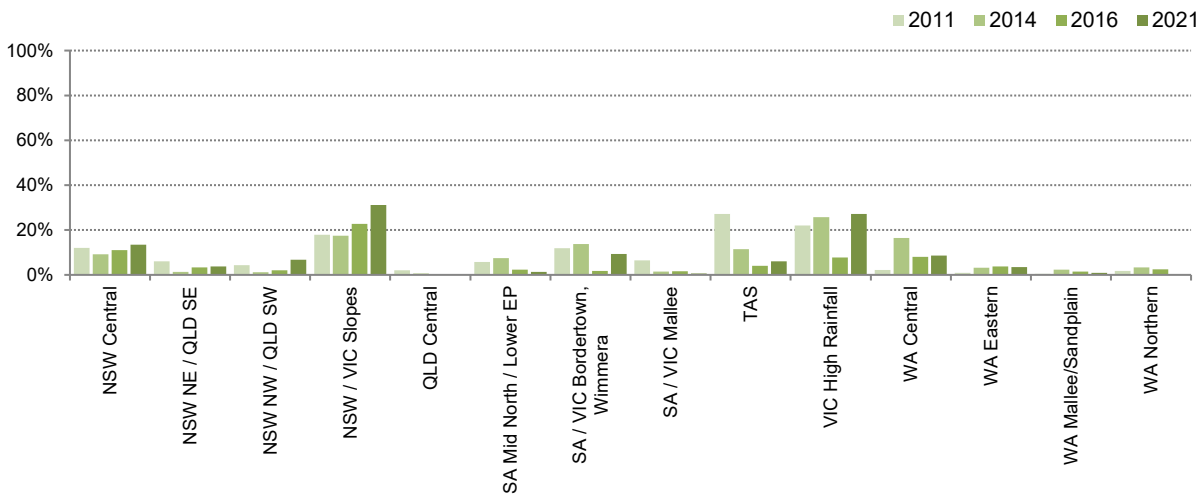
Use of late burning in 2021 is at levels above that of 2016 and previous surveys now at 11% nationally of the crop area (Table 36 and Figure 45). The main AEZs where increased areas of late burning occurred were NSW / VIC slopes and Victorian high rainfall. Growers also conducted a cool burn in central NSW, northwestern NSW/southwestern Qld and parts of SA /Vic Bordertown Wimmera.

Table 35 Percentage of cropped area where stubble was burnt late (Q16)

Agro-ecological zone	Average % of crop area				Significant difference between years
	2011	2014	2016	2021	2016 to 2021
NSW Central	12	9	11	14	
NSW NE / QLD SE	6	1	3	4	
NSW NW / QLD SW	4	1	2	7	
NSW / VIC Slopes	18	18	23	31	
QLD Central/Northern	2	1	0	0	
SA Mid North / Lower EP	6	7	2	1	
SA / VIC Bordertown, Wimmera	12	14	2	9	**
SA / VIC Mallee	7	2	2	1	
TAS*	27	12	4	6	
VIC High Rainfall	22	26	8	27	**
WA Central	2	17	8	9	
WA Eastern	1	3	4	4	
WA Mallee/Sandplain (Esperance)	1	2	2	1	
WA Northern	2	3	3	0	
National Averages	9	8	5	11	**

*Caution, small sample

Figure 45 percentage of cropped area where stubble was burnt late



Proportion of crop where stubble was incorporated into the soil using mechanical tillage.

Some growers manage stubble by incorporating it into the soil using a tillage, commonly using an offset disc, one-way disc plough, a *speed tiller* or a tyned implement, such as a scarifier. Disc machines also tend to cut stubble into shorter lengths as well as mixing it into the soil, whereas tyned machines tend to leave a greater proportion of stubble on the soil surface, while mixing some into the soil.

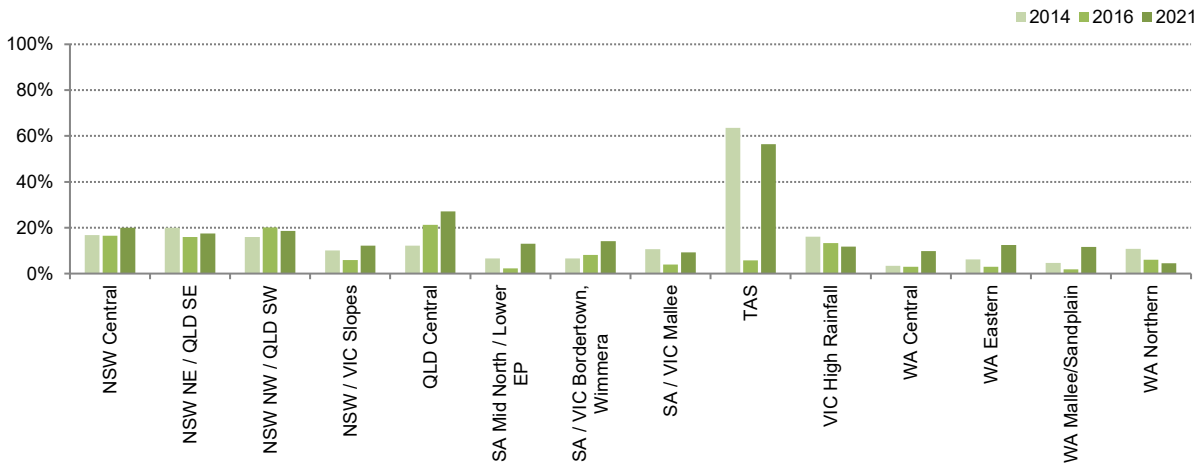
The data shows an increase in the use of this technique, bringing it back to levels similar to 2014, at 14% of the cropped area (Table 37 and Figure 46). Increases were likely due to seasonal conditions, control of some weeds, stubble loads and double cropping, where this practice can assist.

Table 36 Percentage of cropped area where stubble was incorporated into soil using tillage machine (Q16)

Agro-ecological zone	Average % of crop area			Significant difference between years
	2014	2016	2021	2016 to 2021
NSW Central	17	17	20	
NSW NE / QLD SE	20	16	18	
NSW NW / QLD SW	16	20	19	
NSW / VIC Slopes	10	6	12	
QLD Central/Northern	12	21	27	
SA Mid North / Lower EP	7	2	13	**
SA / VIC Bordertown, Wimmera	7	8	14	
SA / VIC Mallee	11	4	9	
TAS*	64	6	56	
VIC High Rainfall	16	13	12	
WA Central	3	3	10	**
WA Eastern	6	3	13	
WA Mallee/Sandplain (Esperance)	5	2	12	
WA Northern	11	6	4	
National Averages	15	9	14	**

*Caution, small sample

Figure 46 Percentage of cropped area where stubble was incorporated into soil using tillage machine in 2021 (trend)

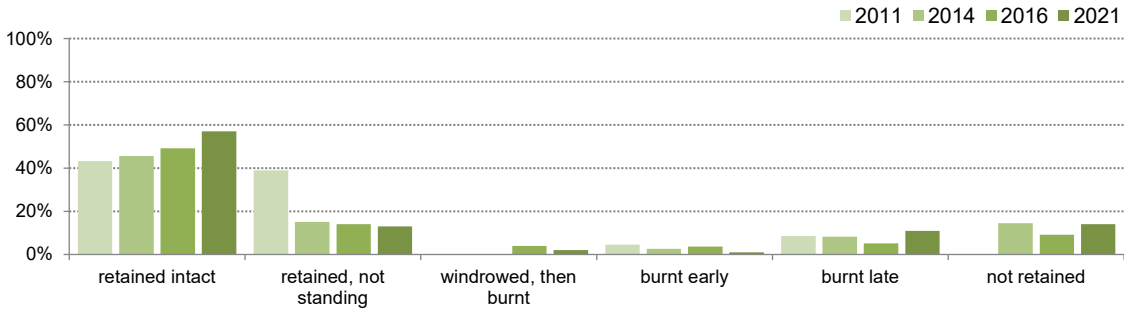


National summary of stubble management practices.

Figure 47 shows national averages for the various stubble management practices as a proportion of the cropped area.

It shows that retaining stubble intact is the dominant practice and continues to increase, while the other practices remain at relatively low levels with some minor changes occurring. Early burning is almost no longer practiced as is windrow burning.

Figure 47 National stubble management practices (trend)



9. Crop Sequencing in 2021

Questions asked:

- Q26. What proportion, if any, of cropping area was planted with a break crop specifically for weed control reasons? That is, the crop was chosen to allow targeted control measures to be used against key weeds.
- Q27. What proportion, if any, of cropping area was planted with a break crop specifically for disease control reasons? That is, the crop was chosen to allow targeted control measures to be used against key diseases
- Q28. What proportion, if any, of cropping area was planted with a break crop specifically for the nutritional benefits from the crop or the management of the crop? For example, nitrogen input from a pulse crop or the use of a green or brown manure technique

Break crop specifically for weed control

One of the reasons for using break crops in a crop rotation or sequence is to assist with control of weeds. Weeds that are difficult or expensive to control in some crops can be more easily controlled or managed in others.

The data (Table 38, Figure 48 and Figure 49) show that nationally a growing proportion of the break crops planted were for weed control (28% cropped area). There has been an increase in the area planted with break crops for weed management.

The highest AEZs were NSW Vic Slopes, Tasmania, southern WA, VIC high rainfall and the SA Bordertown Vic Wimmera. It is possibly a feature of some of the higher rainfall, or more intensely cropped areas.

Table 37 Percentage of cropped area planted with a break crop specifically for weed control (Q26)

Agro-ecological zone	% of crop area			Significant difference between years
	2014	2016	2021	2016 to 2021
NSW Central	13	17	19	
NSW NE / QLD SE	16	22	23	
NSW NW / QLD SW	19	16	24	
NSW / VIC Slopes	23	24	35	**
QLD Central/Northern	16	14	16	
SA Mid North / Lower EP	18	18	29	**
SA / VIC Bordertown, Wimmera	20	22	31	
SA / VIC Mallee	20	21	24	
TAS*	6	3	41	
VIC High Rainfall	25	18	36	**
WA Central	18	18	28	**
WA Eastern	15	9	16	
WA Mallee/Sandplain (Esperance)	23	14	32	
WA Northern	18	22	29	
National Averages	18	17	28	**

*Caution, small sample

Figure 48 Percentage of cropped area planted with a break crop specifically for weed control

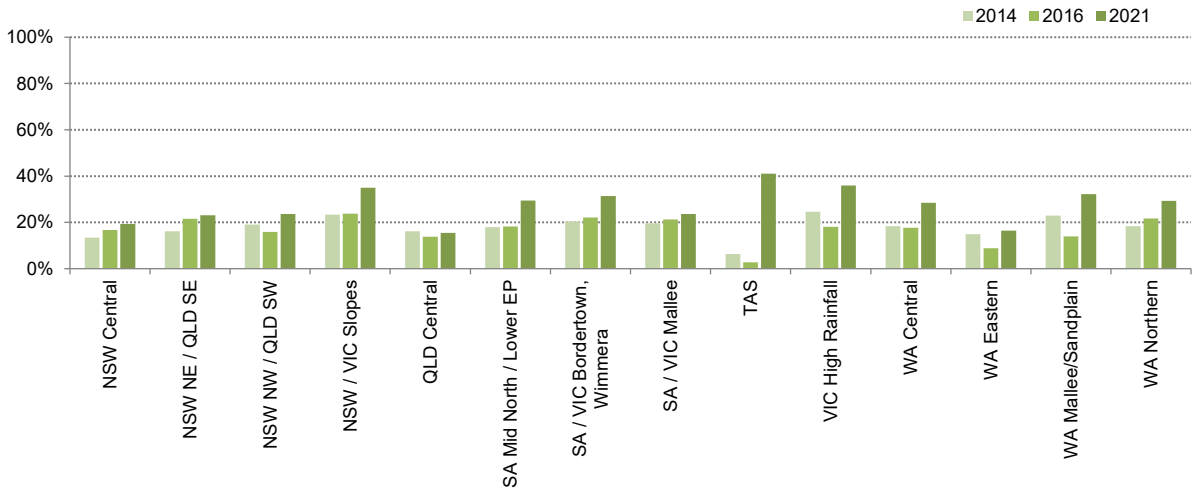
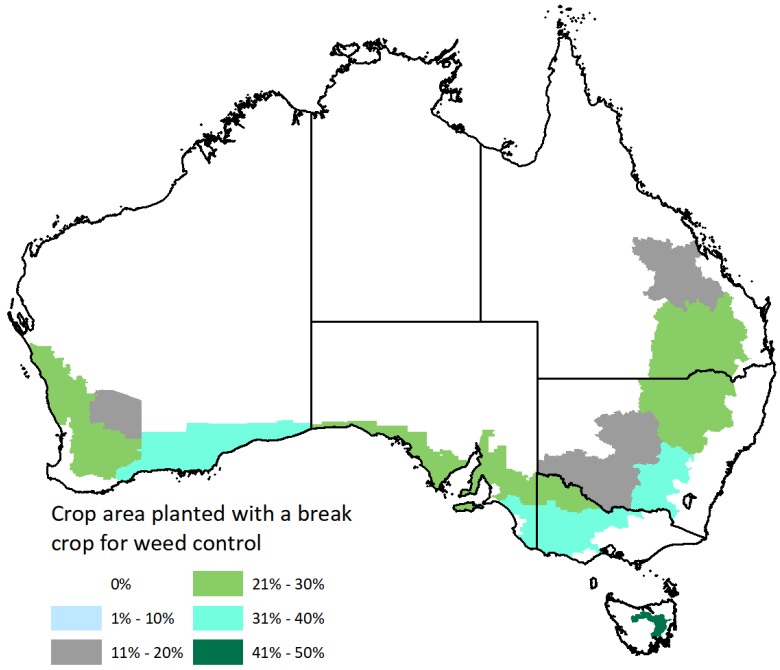


Figure 49. Percentage of crop area planted with a break crop for weed control.



Break crop specifically for disease control

Another reason growers choose a break crop can be for the opportunities they provide to control diseases, or 'break' the disease cycle for other crops. The impact on disease comes from choosing an alternative crop that does not host the disease pathogen, so either decreasing or not increasing pathogen levels. Typical examples are the use of broadleaf crops (pulses or oilseeds) that do not host cereal foliar or root and crown pathogens.

Data for the 2021 survey are shown in Table 39, Figure 50 and Figure 51 shows that the proportion of crop sown with disease management as a reason has grown and is now over 20% of the cropped area in 2021. The highest use of this practice is in the AEZs in NSW and southern Qld, the NSW/Victorian Slopes, Victorian high rainfall and southern WA. The general growth in the use of break crops for disease management suggests that this practice is effective and with recent prices for some break crops, profitable.

Table 38 Percentage of cropped area planted with a break crop specifically for disease control (Q27)

Agro-ecological zone	Average % of crop area			Significant difference between years
	2014	2016	2021	2016 to 2021
NSW Central	12	15	18	
NSW NE / QLD SE	17	22	24	
NSW NW / QLD SW	19	25	23	
NSW / VIC Slopes	21	26	26	
QLD Central/Northern	13	8	2	
SA Mid North / Lower EP	11	17	20	
SA / VIC Bordertown, Wimmera	17	20	22	
SA / VIC Mallee	16	15	16	
TAS*	14	2	20	
VIC High Rainfall	22	12	24	
WA Central	15	14	17	
WA Eastern	6	5	8	
WA Mallee/Sandplain (Esperance)	24	15	26	
WA Northern	10	12	21	
National Averages	15	15	21	**

*Caution, small sample

Figure 50 Percentage of cropped area planted in 2021 with a break crop specifically for disease management

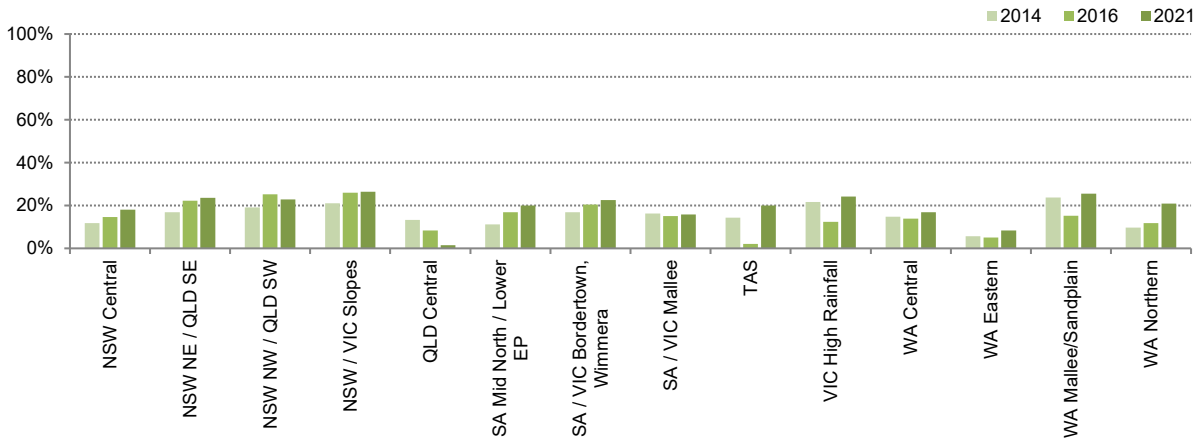
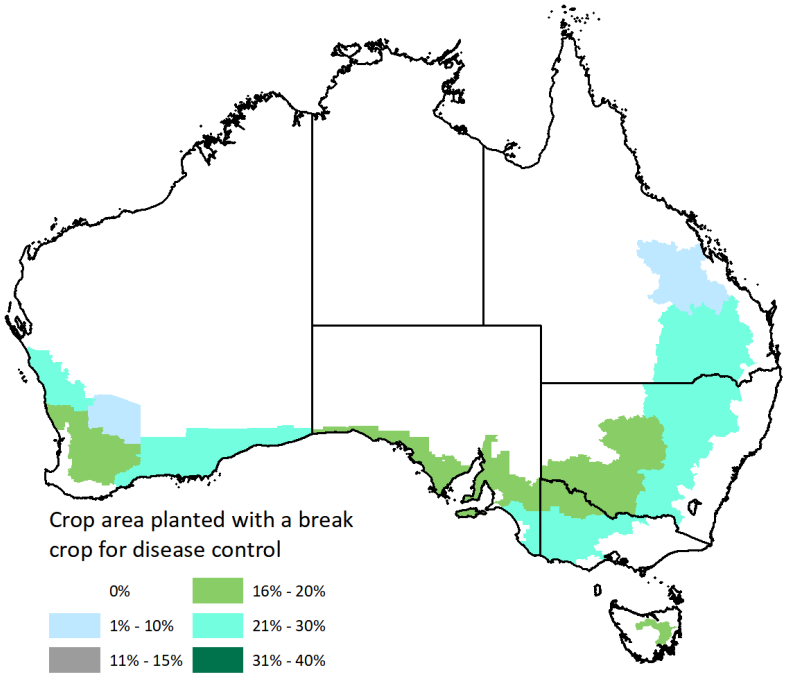


Figure 51 Percentage of cropped area planted in 2021 with a break crop specifically for disease management



Break crop planted for nutrition

The data (Table 40, Figure 53 and Figure 53) shows almost 20% of break crops were id sown for nutritional benefits, an increase consistent with previous survey data. The most prevalent use of this practice occurred in the AEZs SA and in much of Victoria, QLD Central/Northern and northern WA. Declines were noted in northern NSW / Southern Qld.

It is likely that the most prevalent break crops that bring nutritional benefit are the various pulse crops, chickpeas and lentils in southern AEZs and lupins in WA and parts of NSW. Where these crops are also profitable, for example with chickpeas and lentils, their use would be more attractive.

Table 39 Percentage of cropped area planted with a break crop specifically for nutritional benefits (Q28)

Agro-ecological zone	Average % of crop area			Significant difference between years
	2014	2016	2021	2016 to 2021
NSW Central	11	12	13	
NSW NE / QLD SE	10	23	13	**
NSW NW / QLD SW	15	25	22	
NSW / VIC Slopes	11	12	15	
QLD Central/Northern	14	19	23	
SA Mid North / Lower EP	17	18	23	
SA / VIC Bordertown, Wimmera	15	16	25	
SA / VIC Mallee	16	20	26	
TAS*	7	11	18	
VIC High Rainfall	15	6	19	**
WA Central	11	11	14	
WA Eastern	9	11	10	
WA Mallee/Sandplain (Esperance)	4	10	12	
WA Northern	11	16	23	
National Averages	12	15	19	**

*Caution, small sample

Figure 52 Percentage of cropped area planted in 2021 with a break crop specifically for nutritional benefits

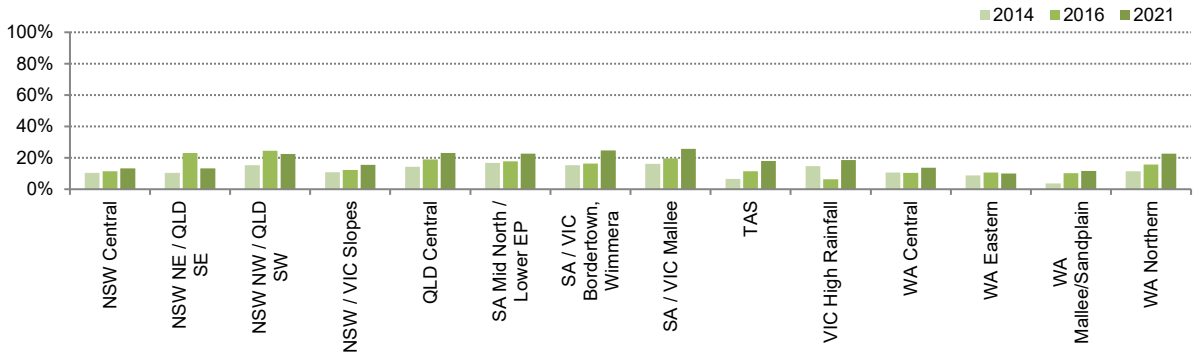
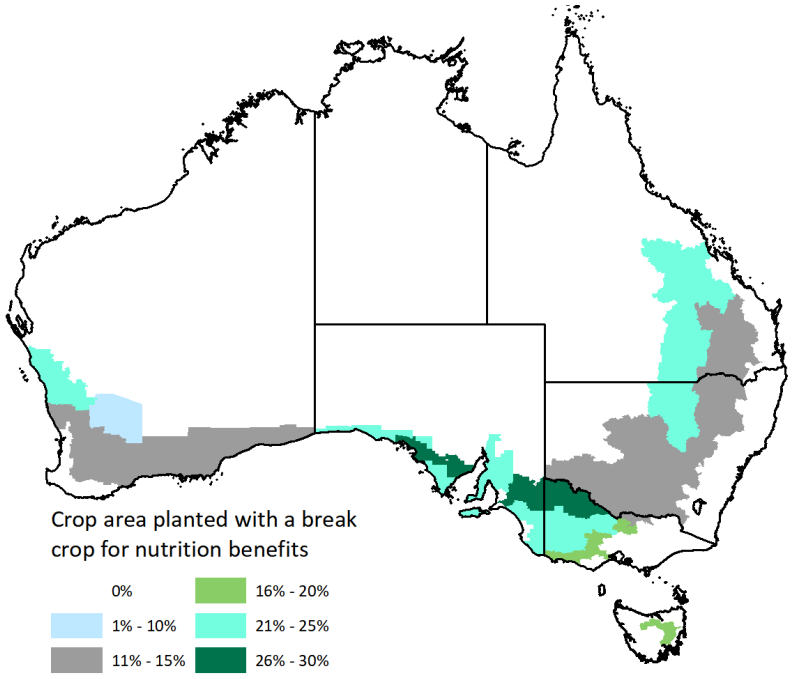


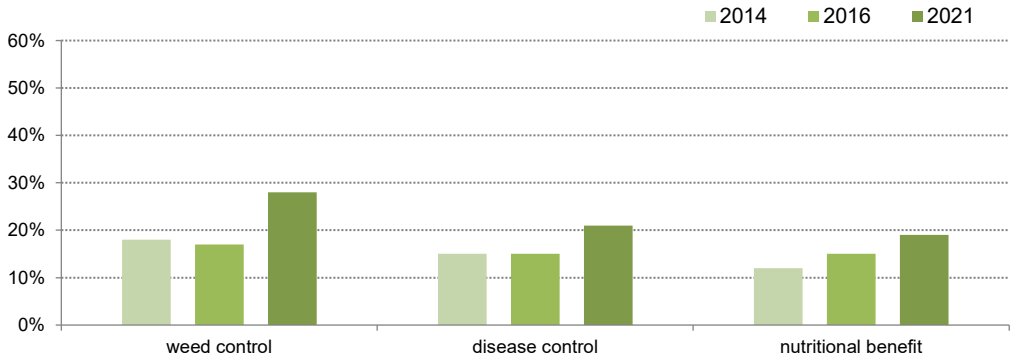
Figure 53 Percentage of cropped area planted in 2021 with a break crop specifically for nutritional benefits



Summary data on break crop use for weed, disease or nutritional reasons

Figure 54 shows summary data about the use of break crops and the reasons as recorded in the 2021 survey. It shows that the use of break crops for all reasons (weed, disease or nutrition) has grown, with weed control being the highest. It is likely that in many cases a break crop provides more than a single benefit, offering opportunities for alternative means of weed control, providing a disease break and, in the case of pulses, increasing soil nitrogen levels.

Figure 54 Average proportion of cropped area planted with a break crop for weed/disease/nutrition benefits (national trend)



10. Soil Management

Questions used in 2021 were:

- Q30. What proportion of cropped area was lime applied to?
- Q29. How many tonnes of lime, if any, did you apply in the last year?
- Q31. What proportion of your winter cereal crop was pre-plant soil tested for nutrient levels this year?
- Q32. What proportion of your oilseed crop was pre-plant soil tested for nutrient levels this year?
- Q33. What proportion of your most recent sorghum crop was pre-plant soil tested for nutrient levels this year?
- Q34. What proportion of your soil nutrient tests were to a depth of: 10cm or less, 11 to 30cm, 31 to 60cm, 61cm to 1m, > 1m, or Do not soil test.
- Q35. What proportion of your cropped area was pre-plant tested for soil moisture levels this year?
- Q36. What proportion of your soil moisture tests are taken to a depth of? 10cm or less, 11 to 30cm, 31 to 60cm, 61cm to 1m, > 1m, or Do not soil test.
- Q37. How was soil moisture measured or assessed this year? *Using a: Push probe, Soil core, Moisture sensor or Calculation based on fallow rainfall (e.g. using fallow efficiency, model)*

Lime application

Applying lime is a practice to manage soil acidity, whether soil is naturally acidic in nature or where soil pH has declined, for example from the use of nitrogenous fertilisers. Investment in lime applications often increase following a profitable year making the data somewhat variable. The proportion of farms where lime was applied is shown below (Table 41, Figure 55 and Figure 56)

The use of lime is generally higher in WA, Victorian high rainfall and NSW/Vic slopes AEZs. Increased proportion of farms using lime was noted in SA and Victorian high rainfall AEZ.

Table 40 Percentage of farms applying lime (Q29)

Agro-ecological zone	% farms		Significant difference between years
	2016	2021	
NSW Central	34	19	**
NSW NE / QLD SE	6	9	
NSW NW / QLD SW	8	5	
NSW / VIC Slopes	62	64	
QLD Central/Northern	0	7	
SA Mid North / Lower EP	15	31	**
SA / VIC Bordertown, Wimmera	23	40	**
SA / VIC Mallee	3	1	
TAS*	71	80	
VIC High Rainfall	52	80	**
WA Central	76	70	
WA Eastern	68	63	
WA Mallee/Sandplain (Esperance)	43	47	
WA Northern	73	70	
National Averages	33	38	**

* Caution small sample

Figure 55 Percentage of farms where lime was applied in 2021

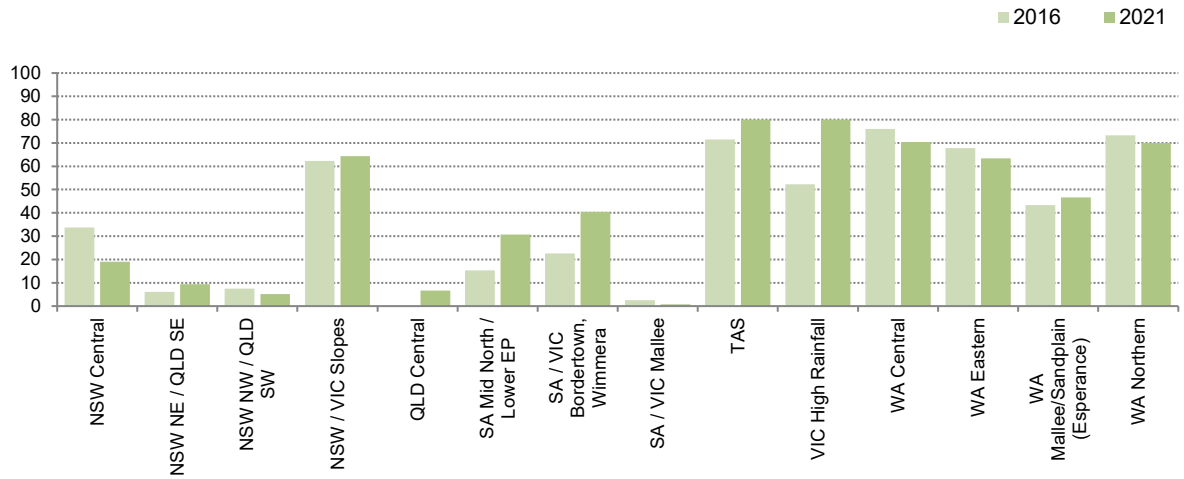
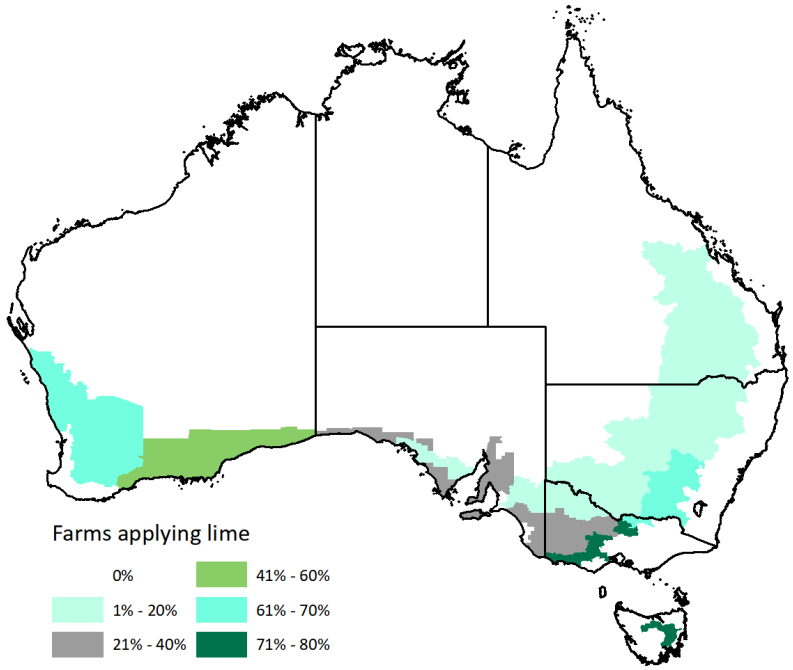


Figure 56 Percentage of farms applying lime in 2021



Proportion of crops where lime was applied before sowing

The data (Table 42, Figure 57 and Figure 58) shows that among those applying lime, it was applied to 25% of the crop area on a national basis. This is an increase on the 2016 level and continues an upward trend.

In those AEZs where the application of lime is a common practice, such as the NSW/Victorian Slopes and much of WA, survey results show that, on average, growers apply lime to 20% to over 30% of their cropped area in 2021.

Growers in WA, central and south-east NSW, NSW/Vic slopes and Victoria high rainfall show the highest proportion of cropped area being limed and, in many cases, have increased this proportion. In the alkaline soils of northern NSW and Qld lime is generally not needed for addressing low soil pH. The variation in central Qld data is due to extremely small sample sizes.

Table 41 Percentage of crop area where lime was applied (base: apply lime) (Q30)					
Agro-ecological zone	**Average % of crop area**				**Significant difference between years**
	2011	**2014**	**2016**	**2021**	**2016 to 2021**
NSW Central*	0	18	22	20	
NSW NE / QLD SE*	2	26	27	14	
NSW NW / QLD SW*	1	10	6	16	
NSW / VIC Slopes	11	20	22	26	
QLD Central/Northern*	0	0	0	60	
SA Mid North / Lower EP	2	16	12	15	
SA / VIC Bordertown, Wimmera	8	29	26	24	
SA / VIC Mallee*	0	12	7	2	
TAS*	50	37	34	13	
VIC High Rainfall	21	26	28	37	
WA Central	12	30	28	28	
WA Eastern*	4	15	13	16	
WA Mallee/Sandplain (Esperance)*	10	31	17	36	
WA Northern*	14	34	24	24	
National Averages	5	10	19	25	**

* Caution small sample

Figure 57 Percentage of crop area where lime was applied in 2011, 2014, 2016 and 2021 (base: apply lime).

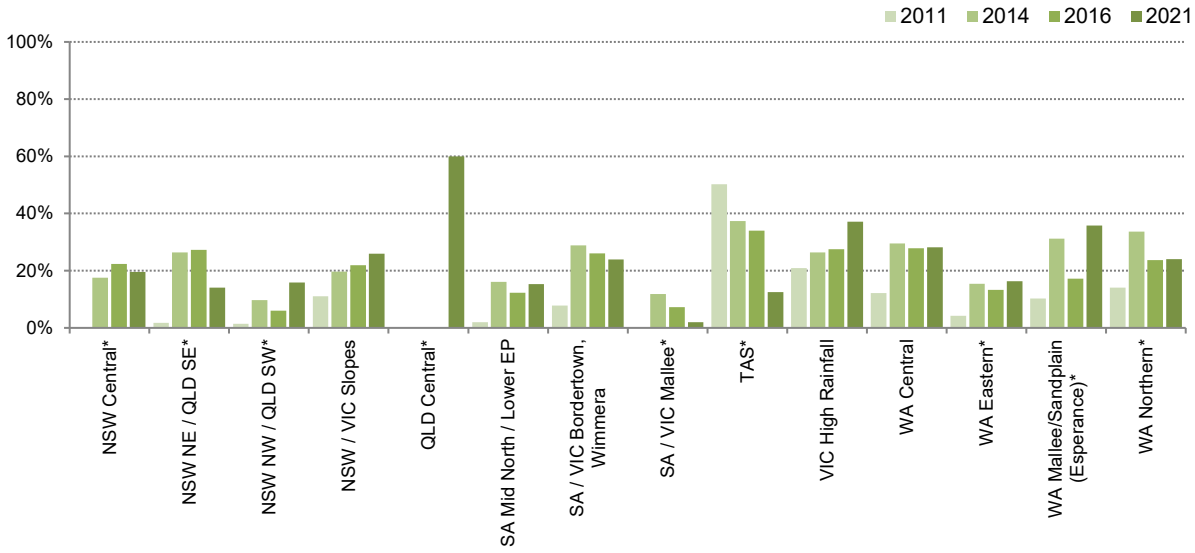
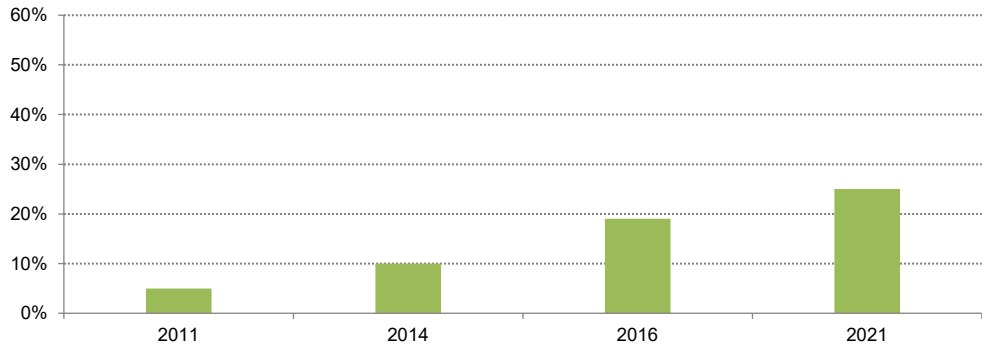


Figure 58 % of crop lime applied (national trend; base: apply lime)



Amount of lime applied

The data (Table 43, Figure 59 and Figure 60) shows a general increase in the amount of lime applied over the period since 2011, with 2.0t/ha the national average, although this hasn't changed significantly since 2016.

Some of the data from small sample sizes should be treated with caution, especially QLD Central/Northern and the SA/VIC Mallee. However, it does appear that in several AEZs the application rate has increased, notably many in NSW and southern Qld, Victoria High Rainfall and central and northern WA.

Table 42 Average use rate of lime (t/ha) on area where applied (Q29/Q30)

Agro-ecological zone	Average use rate (t/ha)				Significant difference between years
	2011	2014	2016	2021	2016 to 2021
NSW Central*	1.6	0.8	1.7	2.0	No significant variation to 2016
NSW NE / QLD SE*	1.8	1.2	1.8	2.6	
NSW NW / QLD SW*	1.6	1.0	2.0	1.9	
NSW / VIC Slopes	1.5	0.8	1.8	1.9	
QLD Central/Northern*	0.0	0.0		3.7	
SA Mid North / Lower EP	1.6	0.5	2.1	2.5	
SA / VIC Bordertown, Wimmera	1.0	3.9	1.8	2.2	
SA / VIC Mallee*	0.5	0.8	1.4	4.2	
TAS*	2.6	0.3	4.0	2.1	
VIC High Rainfall	1.4	1.5	2.0	2.3	
WA Central	1.1	1.3	1.6	1.7	
WA Eastern*	1.2	0.8	1.5	1.5	
WA Mallee/Sandplain (Esperance)*	1.2	0.8	1.7	1.6	
WA Northern*	1.5	0.8	1.9	2.4	
National Averages	1.3	1.0	1.9	2.0	

* Caution small sample

Figure 59 Average application rate of lime on the area where lime was applied

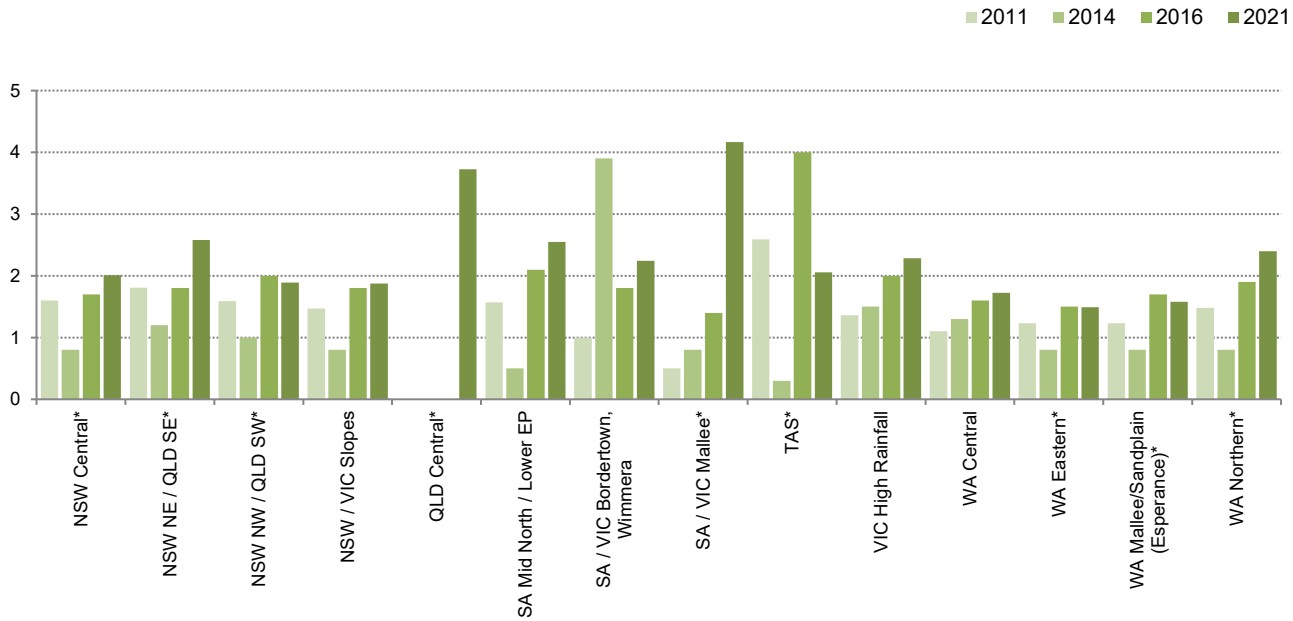
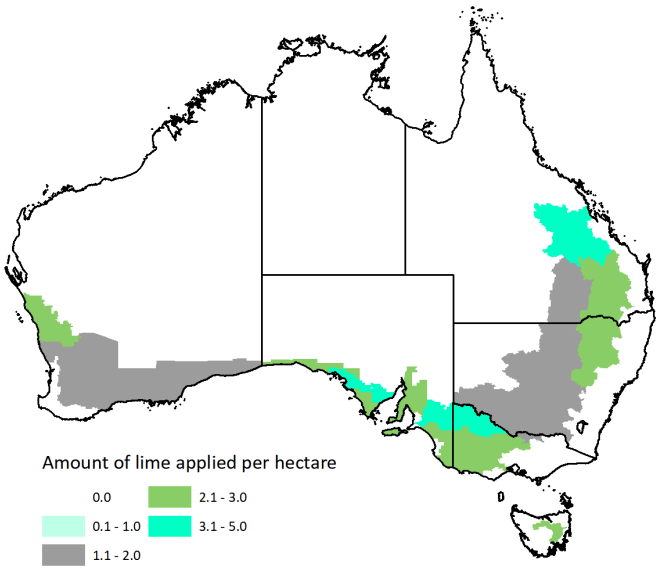


Figure 60 Average application rate of lime on the area where lime was applied



Soil testing for nutrition management

Growers were asked about the proportion of their cropped area that was pre-plant soil tested for nutrition management (relevant to winter cereals, oilseeds and sorghum).

Percentage of winter cereal cropped area pre-plant soil tested.

Data are presented in Table 44, Figure 61 and Figure 62. Figure 7 shows that the proportion of winter cereal crop soil tested varied from, and is generally higher in parts of WA, northern NSW and Qld and lower in some of SA.

The reasons for variation in the proportion of cereal areas soil tested, may relate to previous crop performance, whereby a high yielding previous crop may see grower soil testing to help determine nutrient status and the need for replacement. It is also possible that growers are moving to more strategic use of soil testing, seeking to use them more for higher fertiliser requiring crops such as oilseeds. Data for Oilseed soil testing is shown in the next section.

Table 43 Percentage of winter cereal crop area soil tested pre-planting (Q31)

Agro-ecological zone	Average % of crop area
	2021
NSW Central	19
NSW NE / QLD SE	38
NSW NW / QLD SW	26
NSW / VIC Slopes	29
QLD Central/Northern	37
SA Mid North / Lower EP	13
SA / VIC Bordertown, Wimmera	22
SA / VIC Mallee	20
TAS*	38
VIC High Rainfall	34
WA Central	26
WA Eastern	19
WA Mallee/Sandplain (Esperance)	46
WA Northern	40
National Averages	26

* Caution small sample Longitudinal comparison not possible due to question alteration in 2021

Figure 61 Percentage of winter cereals crop area soil tested for nutrition management

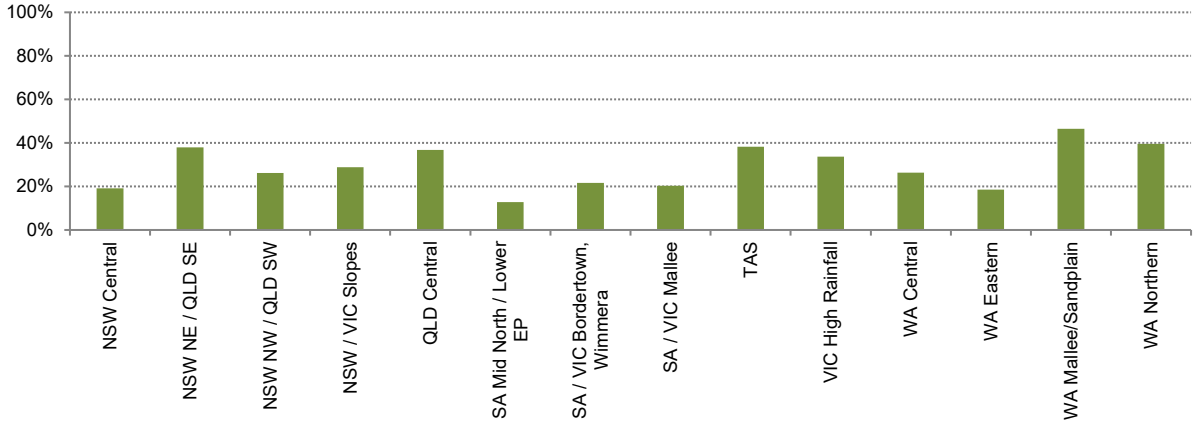
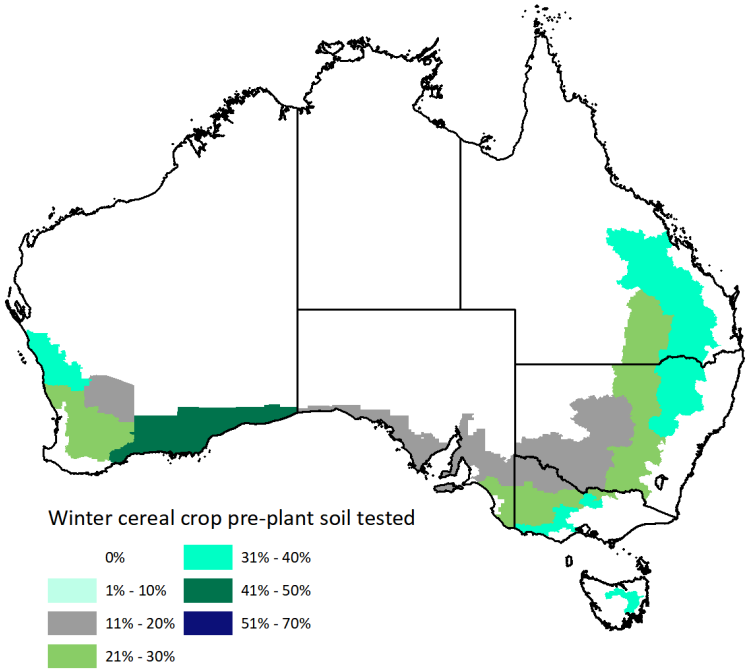


Figure 62 Percentage of winter cereal crop area soil tested for nutrition management in 2021



Percentage of oilseed cropped area pre-plant soil tested

Nationally 34% of the oilseed crop area was pre-plant soil tested in 2021. Higher proportions of the oilseed area were soil tested in northern and southern WA, Victorian high rainfall, SA/Victoria Bordertown/Wimmera, and much of NSW, especially northern NSW/southern Qld.

It is possible more as more canola is being grown in many of these AEZs, having higher nutrient requirements that testing these areas to assist with planning the fertiliser strategy.

Table 44 Percentage of oilseed crop area soil tested in 2021 (Q32)

Agro-ecological zone	2021
NSW Central	23
NSW NE / QLD SE*	67
NSW NW / QLD SW*	36
NSW / VIC Slopes	36
QLD Central/Northern*	0
SA Mid North / Lower EP	26
SA / VIC Bordertown, Wimmera	33
SA / VIC Mallee*	24
TAS*	26
VIC High Rainfall	48
WA Central*	28
WA Eastern*	28
WA Mallee/Sandplain*	44
WA Northern*	46
National Average	34

* Caution small sample Longitudinal comparison not possible due to question alteration in 2021

Figure 63. Percentage of oilseed crop area soil tested in 2021

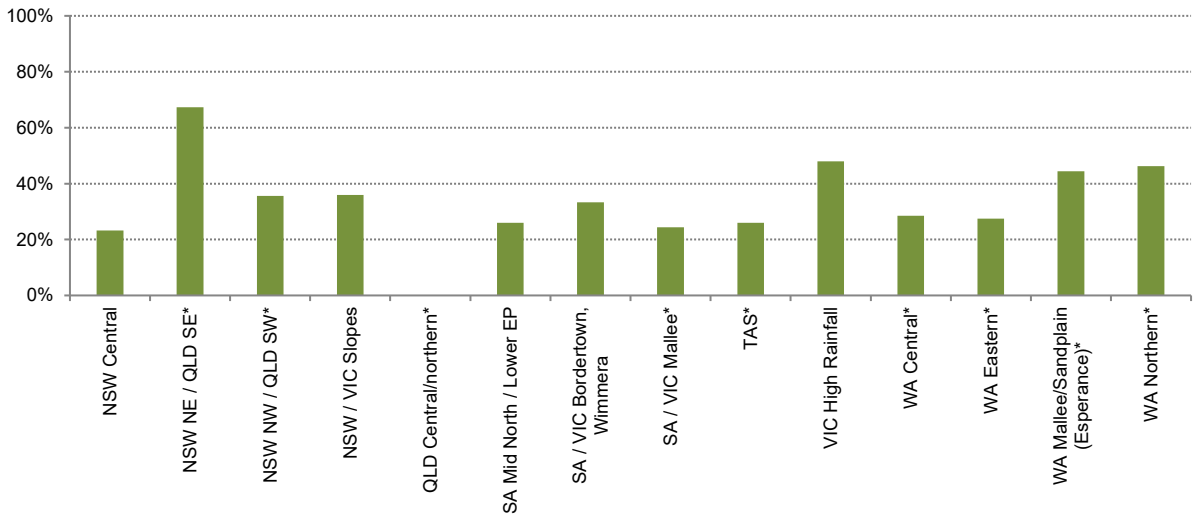
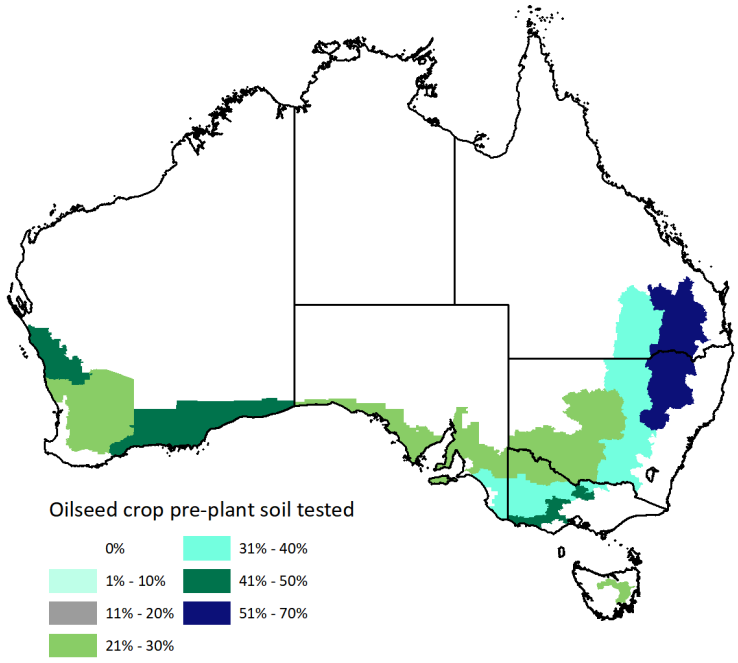


Figure 64. Percentage of winter oilseed crop area soil tested in 2021.



Percentage of sorghum crop area pre-plant soil tested

Data for the proportion of the sorghum crop that was pre-plant soil tested in 2021 and 2014 are presented below in Table 50 and Figure 65.

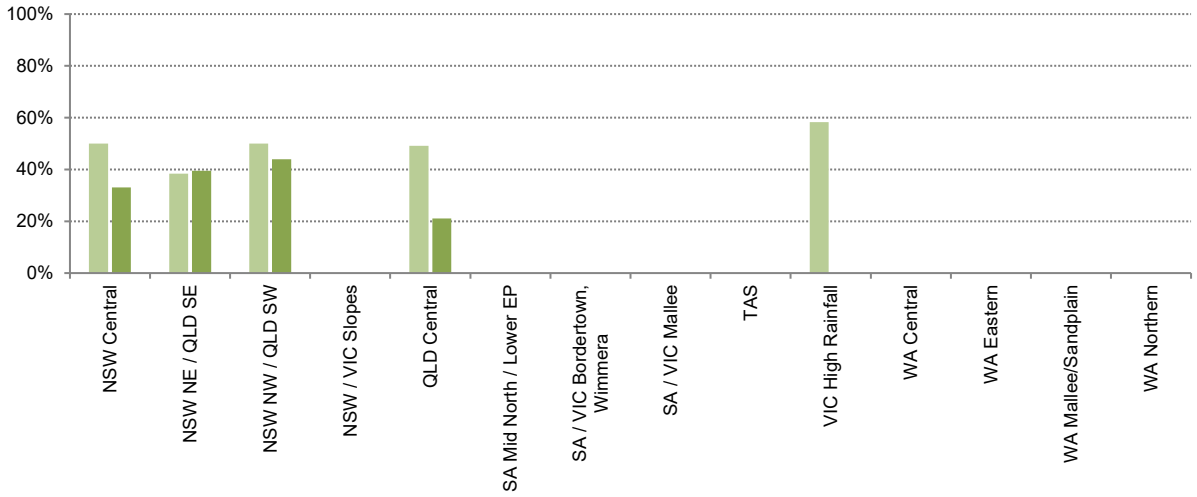
Sorghum is generally only generally grown in the northern region, and parts of the higher rainfall areas of the south. In 2021 reliable data was only collected in NSW North-East / QLD South-East, where 40% of the sorghum crop area is soil tested in advance of sowing.

Table 45 Percentage of most recent sorghum crop area soil tested before planting in 2014 and 2021 (Q33)

Agro-ecological zone	2014	2021
NSW Central*	50	33
NSW NE / QLD SE	38	40
NSW NW / QLD SW*	50	44
NSW / VIC Slopes		
QLD Central/Northern*	49	21
SA Mid North / Lower EP		
SA / VIC Bordertown, Wimmera		
SA / VIC Mallee		
TAS		
VIC High Rainfall*	58	0
WA Central		
WA Eastern		
WA Mallee/Sandplain		
WA Northern		
National Averages	49	33

* Caution small sample

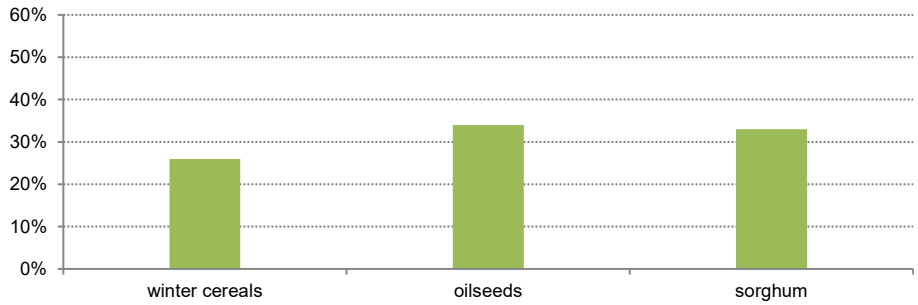
Figure 65 Percentage of sorghum crop area soil tested before sowing in 2014 and 2021



Percentage of winter cereals, oilseeds and sorghum crop area pre-plant soil tested

Figure 66 shows the data for the three crop types discussed above. National averages indicate that oilseed crop (most likely canola) are pre-plant soil tested more than winter cereals. The data for sorghum is based on small samples and may be anomalous.

Figure 66 Average proportion of cropped area pre-plant soil tested x crop type



Depth of soil testing (new in 2021)

Soil testing can be done by sampling to various depths. Generally, a test to 10cm depth is standard practice, although more growers are testing to deeper layers. The following data presents results for testing to various depths, down to 1 metre. The total can be more than 100% since many tests are to multiple depths.

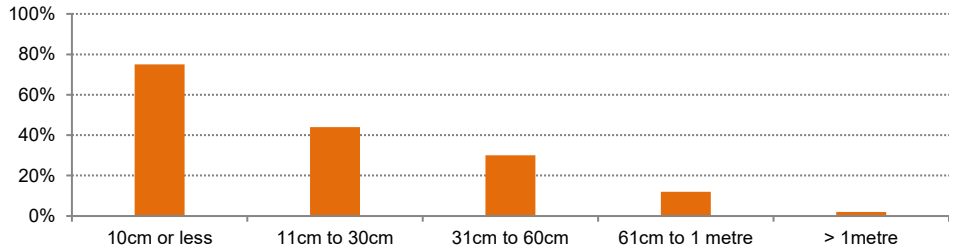
The data in Table 47 (and Figure 67) summarises the proportion of soil tests for nutrition management conducted at the various depths. It shows that testing to 10cm is the most common with decreasing amounts testing to the deeper layers. In total, 75% of those soil testing test at less than 10cm, but 65% conduct tests to deeper levels. Very high amounts of 0-10cm testing is noted in AEZs of NSW/VIC slopes, Victorian high rainfall and all areas in WA apart from WA eastern.

Table 46 Percentage of soil nutrient tests conducted at depth (base: conduct soil tests) (Q34)

Agro-ecological zone	zero to 10cm	11cm to 30cm	31cm to 60cm	61cm to 1 metre	> 1metre
NSW Central	75	43	37	5	0
NSW North-East / QLD South-East	54	54	50	39	5
NSW North-West / QLD South-West*	56	51	53	26	4
NSW / VIC Slopes	80	31	21	6	1
QLD Central/Northern*	59	80	66	38	0
SA Mid North / Lower Eyre Peninsula	76	47	39	12	0
SA / VIC Bordertown, Wimmera	79	41	30	6	1
SA / VIC Mallee	67	46	44	11	2
TAS*	93	33	0	0	0
VIC High Rainfall*	90	23	8	4	0
WA Central	85	47	12	5	2
WA Eastern*	83	54	5	5	0
WA Mallee/Sandplain (Esperance)*	88	29	9	4	0
WA Northern*	73	80	23	8	0
National averages	75	44	30	12	2

* Caution small sample Longitudinal comparison unavailable due to question alteration in 2021

Figure 67 % of soil tests at each depth (national averages)



Soil testing for soil moisture measurement / estimation

Assessing soil moisture at planting was more highly practiced in NSW and southern Qld than elsewhere in previous surveys. This trend remains, although the practice is now more common across AEZs

Farms pre-plant testing for soil moisture

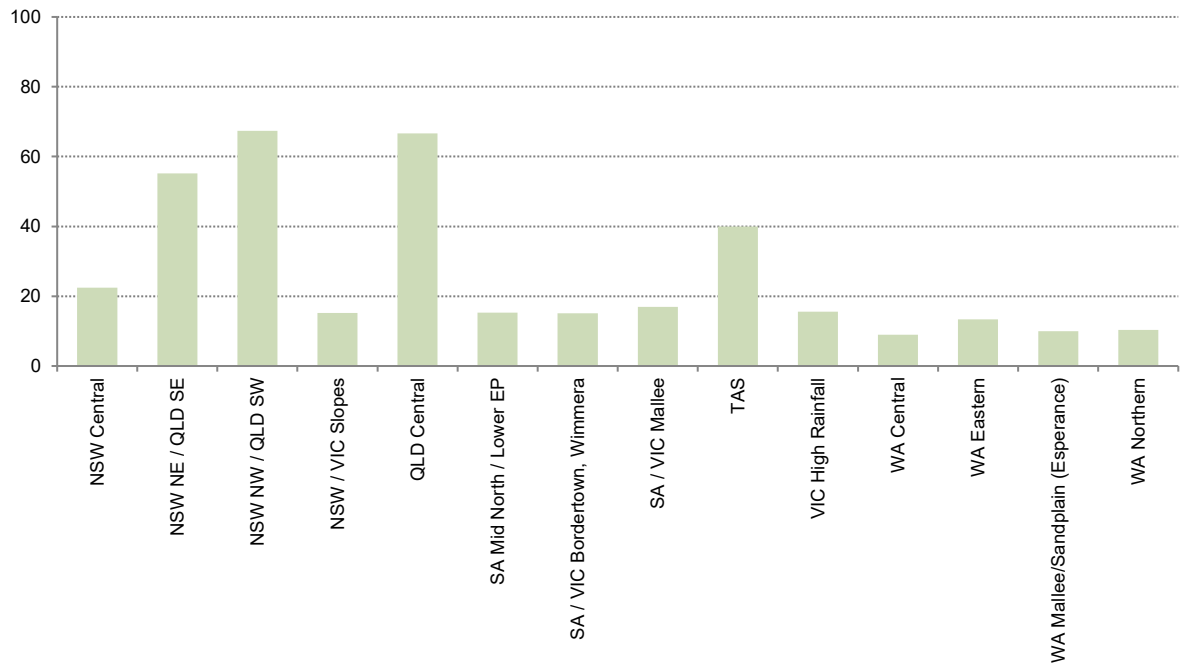
Table 48 and Figure 68 show that pre-plant soil testing for moisture is more widely done in northern NSW, and southern and central Qld. This corresponds with areas of deeper clay soils where considerable amounts of moisture are able to be stored. Testing to see how 'full' the soil profile is in these AEZs is a common practice to assess the risk of planting a crop.

Table 47 Percentage of farms pre-plant testing for soil moisture (Q35)

Agro-ecological zone	2021
NSW Central	22
NSW NE / QLD SE	55
NSW NW / QLD SW	67
NSW / VIC Slopes	15
QLD Central/Northern	67
SA Mid North / Lower EP	15
SA / VIC Bordertown, Wimmera	15
SA / VIC Mallee	17
TAS*	40
VIC High Rainfall	16
WA Central	9
WA Eastern	13
WA Mallee/Sandplain (Esperance)	10
WA Northern	10
National Averages	24

* Caution small sample Longitudinal comparison unavailable due to question alteration in 2021

Figure 68 Percentage of farms surveyed carrying out pre-plant testing in 2021



Proportion of the crop area pre-plant testing for soil moisture

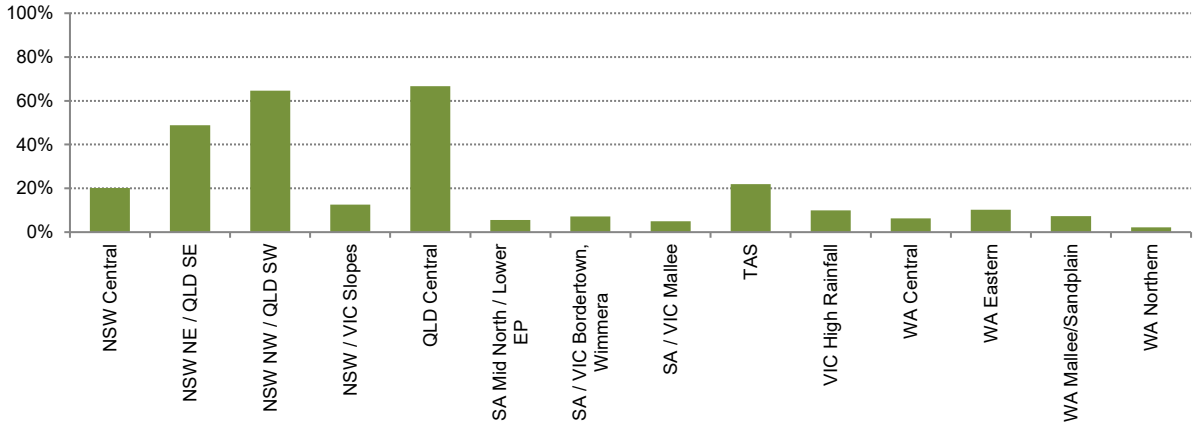
Nationally, 18% of cropped area was pre-plant tested for soil moisture, but varies significantly from 67% in QLD Central/Northern to 2% in Northern WA. Data is shown in Table 53 and Figure 69 and suggests that AEZs in northern NSW and southern Qld have the largest proportion of cropped area tested for soil moisture pre-planting.

Table 48 Percentage of crop area pre-plant tested for soil moisture (base: all respondents) (Q35)

Agro-ecological zone	2021
NSW Central	20
NSW NE / QLD SE	49
NSW NW / QLD SW	65
NSW / VIC Slopes	13
QLD Central/Northern	67
SA Mid North / Lower EP	5
SA / VIC Bordertown, Wimmera	7
SA / VIC Mallee	5
TAS*	22
VIC High Rainfall	10
WA Central	6
WA Eastern	10
WA Mallee/Sandplain (Esperance)	7
WA Northern	2
National Averages	18

* Caution small sample Longitudinal comparison unavailable due to question alteration in 2021

Figure 69 Percentage of crop area where soil moisture assessed pre-planting (base: all respondents)



Proportion of soil moisture tests based on sampling at different depths (new in 2021)

Growers were asked about the depths of soil sampling they carried out to assess soil moisture. The options for the depths were the same as for sampling for soil nutrient status. The data are shown in Table 50 and Figure 70 below.

It is likely that many soil tests are done to 60cm, and the data suggest that this is done for around half of the soil moisture testing, though higher in some AEZs, such as parts of SA and southern WA.

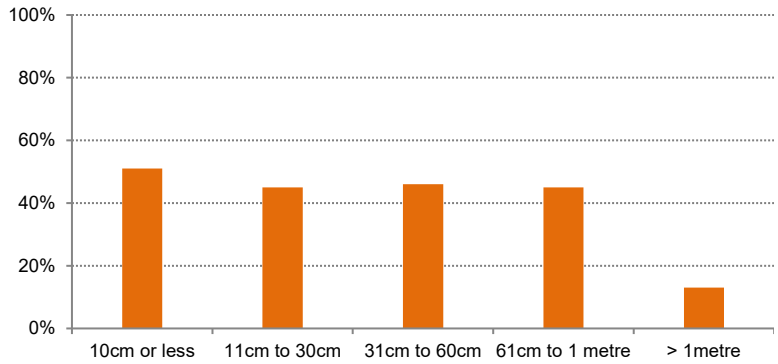
As discussed in the next section some of the soil moisture testing is done using a push probe or soil corer. Most of these are able to indicate or provide soil moisture data to around 1 metre and it is possible that many growers are using these to estimate soil moisture and are suggesting they can test down to depths of 60cm or greater. This may have influenced the data presented here.

Table 49 Percentage of soil moisture tests conducted at depth (base: test soil moisture) (Q36)

Agro-ecological zone	10cm or less	11cm to 30cm	31cm to 60cm	61cm to 1 metre	> 1metre
NSW Central*	59	47	36	28	5
NSW North-East / QLD South-East	41	39	44	66	14
NSW North-West / QLD South-West	27	24	31	48	20
NSW / VIC Slopes*	46	48	34	43	11
QLD Central/Northern*	56	56	56	66	15
SA Mid North / Lower Eyre Peninsula*	56	54	59	53	26
SA / VIC Bordertown, Wimmera*	56	50	70	24	9
SA / VIC Mallee*	60	54	59	31	5
TAS*	100	100	50	0	0
VIC High Rainfall*	86	43	43	29	14
WA Central	85	46	38	15	0
WA Eastern*	25	50	25	0	25
WA Mallee/Sandplain (Esperance)*	100	67	67	0	0
WA Northern*	75	75	50	50	25
National averages	51	45	46	45	13

* Caution small sample

Figure 70 % of soil moisture tests for each depth of soil sample in 2021



Method for measuring soil moisture (new in 2021)

Table 51 shows the data for methods of measuring or estimating soil moisture as reported in 2021 (among those pre-plant testing for soil moisture). As suggested above, the majority of soil moisture measurements or estimations are done using a push probe. In some AEZs, 100% of soil moisture testing uses a push probe, for example in northern NSW and southern Qld with very high levels also in central Qld, NSW/VIC slopes.

However, other methods are also notable. Taking a soil core is practiced in 25%-35% of SA and many WA AEZs, even higher in southern WA. .

Some growers are also using moisture sensors. These can be sensors placed in the soil down to 1 metre and electronically report soil moisture percentage.

Table 50 Percent using soil moisture assessment tool in 2021 (base: test soil moisture) (Q37)

Agro-ecological zone	Push probe	Soil core	Moisture sensor	Calculation based on rainfall	Other
NSW Central*	80	10	10	20	5
NSW North-East / QLD South-East	93	13	12	13	2
NSW North-West / QLD South-West	100	2	3	10	3
NSW / VIC Slopes*	77	17	17	23	3
QLD Central/Northern*	90	10	10	10	10
SA Mid North / Lower Eyre Peninsula*	25	25	50	20	5
SA / VIC Bordertown, Wimmera*	32	36	32	18	9
SA / VIC Mallee*	26	30	44	4	9
TAS*	50	0	50	0	50
VIC High Rainfall*	29	0	71	14	0
WA Central	8	8	23	31	31
WA Eastern*	0	0	25	25	50
WA Mallee/Sandplain (Esperance)*	33	33	67	33	33
WA Northern*	25	25	25	0	50
National Average	67	15	22	15	8

* Caution small sample

11. Fertiliser Management

Questions asked:

Q39. What proportion of your crop, if any, has been treated with fertiliser at rates based on soil test results?

Q40. What proportion of your crop, if any, has been treated by fertiliser at rates based on your estimates or calculations of nutrient removal rates by the crop?

Q41. What proportion of your crop, if any, has had a leaf or petiole test?

Q42. What proportion of your crop, if any, has had an in-season application or top dressing of fertiliser such as urea, liquid N, UAN, etc?

Q43. In your 2021 wheat crop, what proportion of nitrogen fertiliser was applied post-planting?

Q44. What was the average amount of nitrogen per hectare applied for the 2020-21 growing season to

- Winter cereals
- Oilseeds
- Sorghum/summer crops

Q38. Which of the following do you use to calculate Nitrogen fertiliser application rates:

- *Setting a target yield and consequent nitrogen demand for your crop*
- *Adjusted for nutrient removal by previous crop based on yield*
- *Adjusted for nutrient removal by previous crop based on protein map*
- *Pre-plant soil tests*
- *In-season leaf or petiole test*
- *In-season NVDI scan*
- *Decision support tools*
- *Other (specify)*
- *None*

Basis for fertiliser use rates

The basis for determining the fertiliser program for a considerable proportion of the crop is informed by soil testing, in conjunction with other factors, such as calculation of nutrient removal from the previous crop(s) or expected usage by the planned crop.

Fertiliser program based on soil test results

How much of the cropped area had the fertiliser program informed by soil testing is shown in Table 52, Figure 71 and Figure 72.

The national average has remained relatively consistent for some years, at around 65% of the cropped area.

Compared to past survey waves, there has been no significant variation in most AEZs. It is notable however, that while results must be viewed with caution due to small sample sizes, there has been increases in in NW NSW/SW Qld and central Qld.

Conversely, results suggest significant reductions in SA / VIC/ Bordertown / Wimmera, NSW Central and Central WA.

Table 51 Percentage of crop area where the fertiliser program was informed by soil testing (base: soil test) (Q39)

Agro-ecological zone	Average % of crop area				Significant difference between years
	2011	2014	2016	2021	2016 to 2021
NSW Central	39	54	70	53	**
NSW NE / QLD SE	52	70	73	76	
NSW NW / QLD SW*	37	51	38	75	
NSW / VIC Slopes	61	61	65	62	
QLD Central/Northern*	38	72	55	87	
SA Mid North / Lower EP	49	56	51	55	
SA / VIC Bordertown, Wimmera	44	60	70	55	**
SA / VIC Mallee	40	54	53	56	
TAS*	78	89	82	80	
VIC High Rainfall*	54	64	57	67	
WA Central	71	82	83	73	**
WA Eastern*	52	77	80	81	
WA Mallee/Sandplain (Esperance)*	76	80	57	76	
WA Northern*	73	81	76	80	
National Averages	55	68	65	65	

*Caution small sample

Figure 71 Percentage of crop area where the fertiliser program was informed by soil testing (trend)

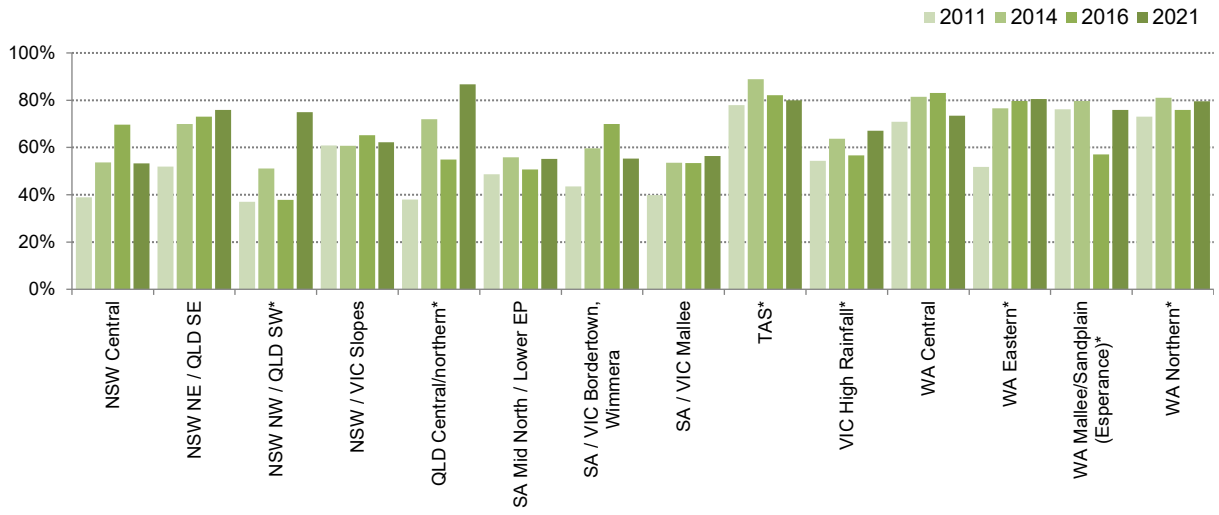
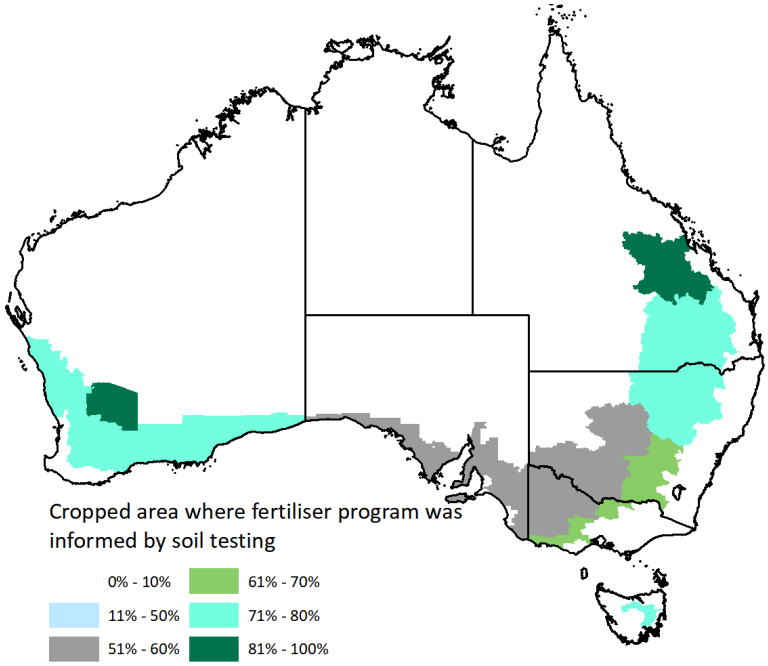


Figure 72 Percentage of crop area where the fertiliser program was informed by soil testing (trend)



Fertiliser program based on estimates of nutrient removal by the crop

Growers were asked over what proportion of their cropped area was the fertiliser program informed by estimates of nutrient removal by the crop (generally the crop in 2020, with estimates of crop needs in 2021).

Table 53 and Figure 73 show that a relatively high proportion (about two thirds nationally) of the crop has fertiliser usage informed by estimates of nutrient removal from the current and previous crops. This was higher in some AEZs, for example, SA mid north/lower EP and northern eastern and central WA, and NSW Central.

Table 52 Percentage of crop area treated with fertiliser at rates based on estimates of nutrient removal rates by the crop (Q40)

Agro-ecological zone	Average % of crop area			Significant difference between years
	2014	2016	2021	2016 to 2021
NSW Central	77	81	70	
NSW NE / QLD SE	64	57	65	
NSW NW / QLD SW	61	56	46	
NSW / VIC Slopes	76	71	65	
QLD Central/Northern	40	52	60	
SA Mid North / Lower EP	80	83	75	
SA / VIC Bordertown, Wimmera	77	65	64	
SA / VIC Mallee	77	76	57	**
TAS*	77	66	82	
VIC High Rainfall	71	71	69	
WA Central	73	61	71	
WA Eastern	67	68	71	
WA Mallee/Sandplain (Esperance)	79	57	57	
WA Northern	87	81	81	
National Averages	72	67	66	

*Caution small sample

Figure 73 Percentage of crop area where the fertiliser program was informed by estimates of nutrient removal

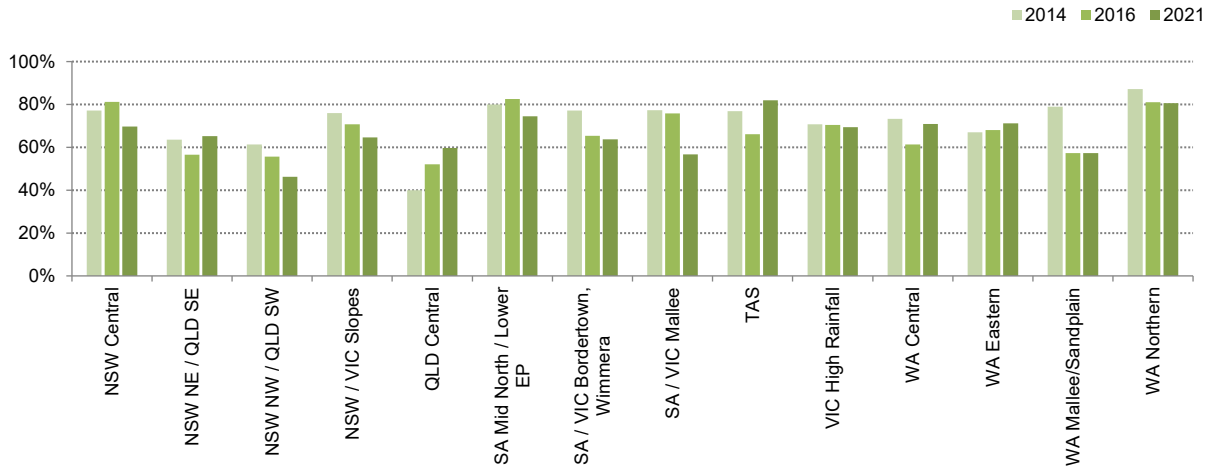
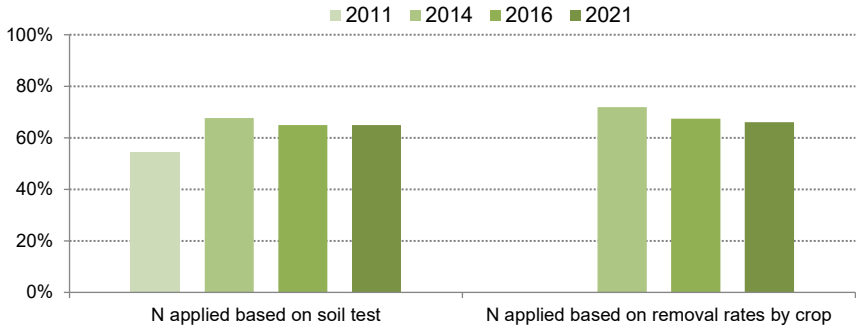


Figure 74 Average proportion of cropped area treated with N based on method (trend)



Crop area being leaf or petiole tested

According to the 2021 data, leaf / petiole testing is used on only 5% of the cropped area, slightly lower than previous surveys (Table 54, Figure 75 and Figure 76).

The use of leaf and petiole tests is higher in southern and northern WA than elsewhere.

Table 53 Percentage of crop area having a leaf or petiole test in 2021 (Q41)

Agro-ecological zone	Average % of crop area			Significant difference between years
	2014	2016	2021	2016 to 2021
NSW Central	7	7	7	
NSW NE / QLD SE	2	6	4	
NSW NW / QLD SW	5	1	6	
NSW / VIC Slopes	3	2	3	
QLD Central/Northern	8	4	2	
SA Mid North / Lower EP	5	6	4	
SA / VIC Bordertown, Wimmera	4	5	5	
SA / VIC Mallee	3	4	3	
TAS*	25	17	20	
VIC High Rainfall	8	6	3	
WA Central	12	12	8	
WA Eastern	4	2	4	
WA Mallee/Sandplain (Esperance)	20	25	18	
WA Northern	13	16	11	
National Averages	9	8	5	**

*Caution small sample

Figure 75. Percentage of crop area having a leaf or petiole test in 2021

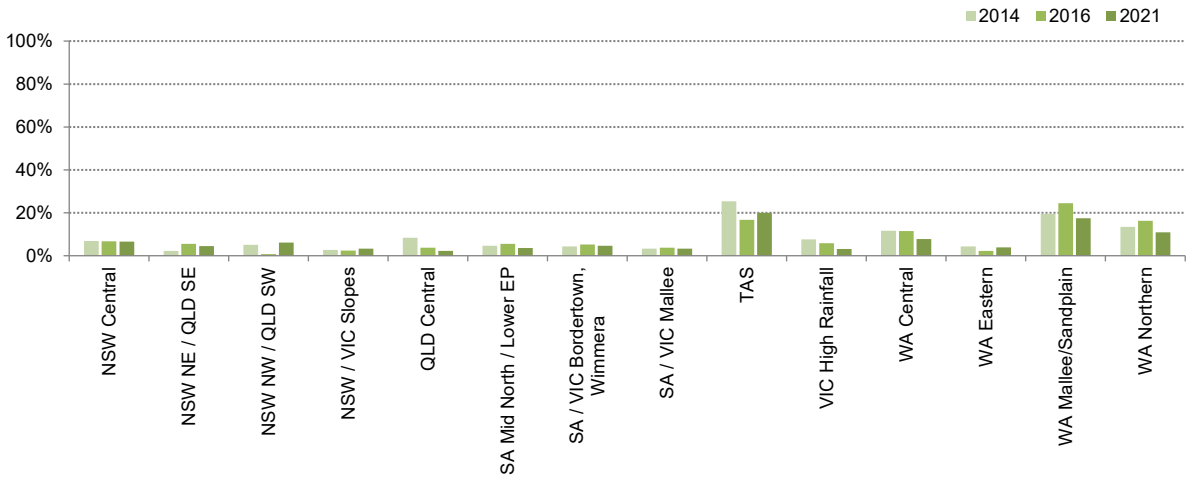
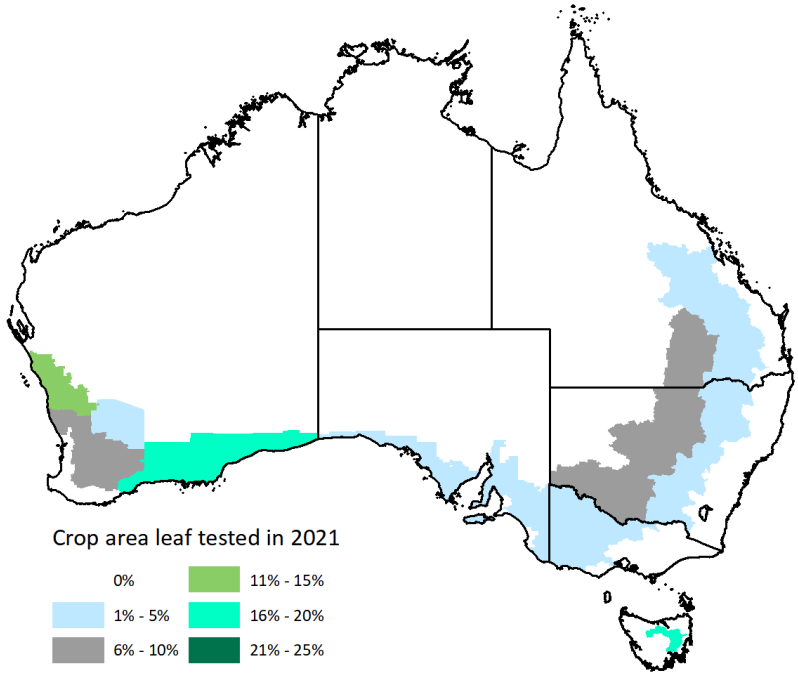


Figure 76. Percentage of crop area having a leaf or petiole test in 2021



Crop area receiving an in-season application (top-dressing) of fertiliser

As with previous surveys, growers were asked how much of their crop program in 2021 received an in-season, or top-dressing, application of fertiliser. Table 55 and Figure 77 show that nationally, 61% of the cropped area received an in-season (top dressing) application of fertiliser. This was lower in NSW North-East / QLD South-East and NSW North-West / QLD South-West, and higher in the NSW/VIC Slopes, VIC High Rainfall, parts of SA and much of WA.

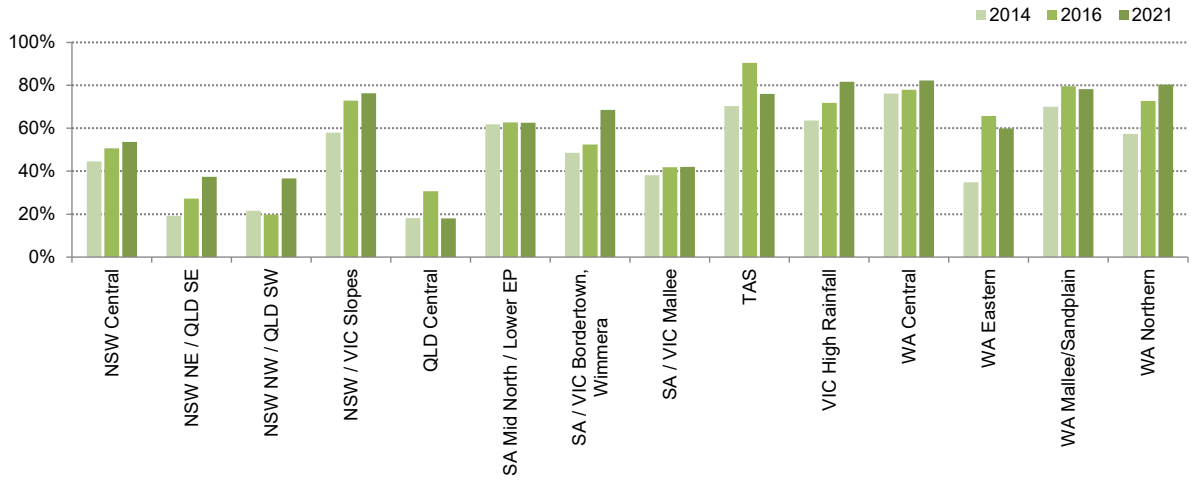
In season fertiliser decisions are generally influenced by current and forecast seasonal conditions (principally rainfall / soil moisture levels), and commodity price forecasts. These factors were likely to have been a strong driver of top-dressing decisions.

Table 54 Percentage of crop area having an in-season application or top dressing of fertiliser in 2021 (Q42)

Agro-ecological zone	Average % of crop area			Significant difference between years
	2014	2016	2021	2016 to 2021
NSW Central	45	51	54	
NSW NE / QLD SE	19	27	37	**
NSW NW / QLD SW	22	20	37	
NSW / VIC Slopes	58	73	76	
QLD Central/Northern	18	31	18	
SA Mid North / Lower EP	62	63	63	
SA / VIC Bordertown, Wimmera	49	53	69	**
SA / VIC Mallee	38	42	42	
TAS*	70	90	76	
VIC High Rainfall	64	72	82	
WA Central	76	78	82	
WA Eastern	35	66	60	
WA Mallee/Sandplain (Esperance)	70	80	78	
WA Northern	57	73	80	
National Averages	49	58	61	

*Caution small sample

Figure 77. Percentage of crop area having an in-season or top dressed application of fertiliser in 2021.



Nitrogen applied to wheat post planting in 2021 (new in 2021).

In 2021 growers were asked how much of the nitrogen they applied to their wheat crop was applied post planting. The data are presented in Table 56 and Figure 78. On average just over half of the nitrogen applied to the wheat crop was made post-plant in 2021. The proportion was higher in the higher producing AEZs, for example NSW/VIC slopes, Victoria high rainfall SA (excluding the Mallee) and WA (excluding the eastern wheatbelt).

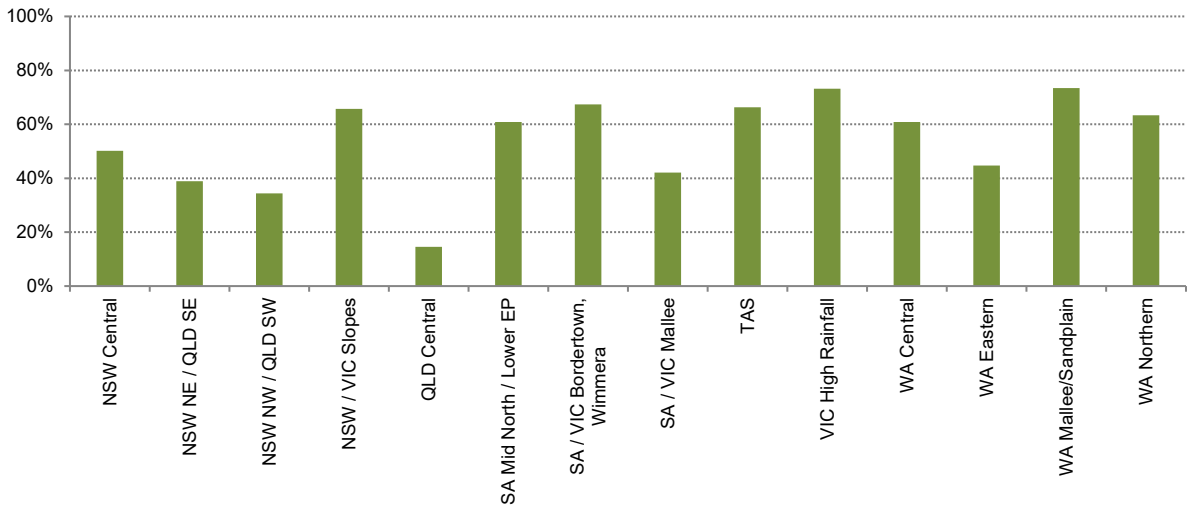
Generally good seasons experienced in many AEZs, coupled with forecast pricing for wheat in 2021 would have encouraged additional nitrogenous fertiliser post planting fertiliser, especially in those areas where the expected impact would be positive for yield.

Table 55 Percentage of N applied to wheat crop post planting (Q43)

Agro-ecological zone	2021
NSW Central	50
NSW NE / QLD SE	39
NSW NW / QLD SW	34
NSW / VIC Slopes	66
QLD Central/Northern	15
SA Mid North / Lower EP	61
SA / VIC Bordertown, Wimmera	67
SA / VIC Mallee	42
TAS*	66
VIC High Rainfall	73
WA Central	61
WA Eastern	45
WA Mallee/Sandplain (Esperance)	73
WA Northern	63
National Averages	55

*Caution, small sample

Figure 78 Percentage of nitrogen applied to the wheat crop post planting in 2021



Methods used to calculate amount of nitrogenous fertiliser to apply (new in 2021).

Growers were asked how they determine the amount of nitrogen fertiliser to apply to their crops. Several methods were listed. The data are shown in Table 57 and Figure 79.

Setting a target yield and consequent nitrogen demand is the dominant method growers use. However taking into account (i.e. including in the calculations) the amounts removed by previous crops based on yield maps and referring to pre-plant soil test are also part of the decision making process for many growers.

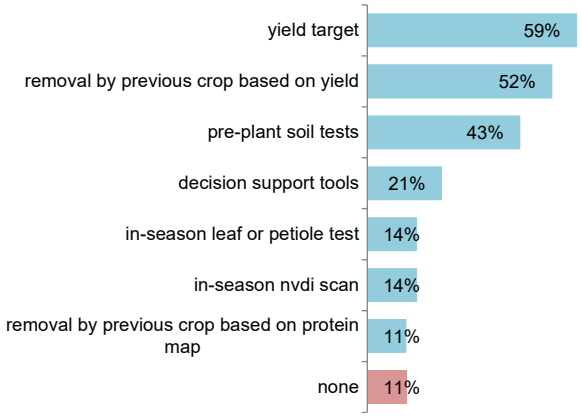
There are some differences in the relative weight given to these factors across AEZs, with some increase in use of yield target evident in higher yielding AEZs.

Table 56 Methods to calculate N application rates - % of farms (prompted) (Q38)

Agro-ecological zone	Yield target	Removal by previous crop based on yield	Removal by previous crop based on protein map	Pre-plant soil tests	In-season leaf or petiole test	In-season NVDI scan	Decision support tools	Other	None
NSW Central	53	52	7	33	15	18	18	0	16
NSW North-East / QLD South-East	63	61	20	54	12	14	16	1	8
NSW North-West / QLD South-West	34	42	10	46	11	11	15	0	33
NSW / VIC Slopes	61	59	11	41	12	15	22	2	10
QLD Central/Northern	47	43	27	67	7	3	23	0	17
SA Mid North / Lower Eyre Peninsula	64	56	10	33	12	16	26	0	8
SA / VIC Bordertown, Wimmera	59	51	8	40	10	12	22	0	7
SA / VIC Mallee	54	41	10	31	9	10	21	1	15
TAS*	60	60	0	60	60	0	0	0	0
VIC High Rainfall	62	40	16	40	11	18	20	0	9
WA Central	69	55	7	50	23	14	26	1	10
WA Eastern	57	40	10	57	13	7	27	0	13
WA Mallee/Sandplain (Esperance)	47	40	3	43	23	17	27	0	10
WA Northern	77	47	20	60	23	23	27	0	10
National averages	59	52	11	43	14	14	21	1	11

*Caution, small sample

Figure 79 Calculation method for determining N application rates in 2021 (prompted)



Average amount of N applied in 2021 (new in 2021).

Growers were asked the average amount of nitrogen applied per hectare for winter cereals, oilseed and sorghum/summer crops. The data are in Table 58 and Figure 80.

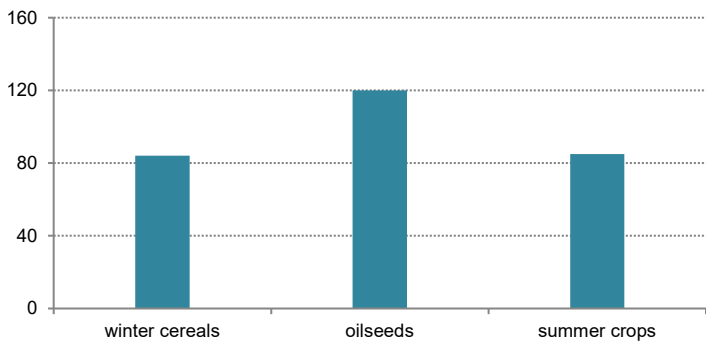
These data reveal that oilseeds receive the highest amounts of N at an average of 120kg/ha, with winter cereals and sorghum/summer crops roughly equal at about 85kg/ha.

Table 57 N applied (kg/hectare) (Q44)

Agro-ecological zone	Winter cereals		Oilseeds		Summer crops*	
	Average	Median	Average	Median	Average	Median
NSW Central	83	56	112	100	334	300
NSW North-East / QLD South-East	72	60	102	100	67	46
NSW North-West / QLD South-West	48	40	106	100	20	0
NSW / VIC Slopes	105	92	134	106	220	150
QLD Central/Northern	42	25	0	0	16	12
SA Mid North / Lower Eyre Peninsula	98	80	136	120	0	0
SA / VIC Bordertown, Wimmera	94	80	125	105	194	200
SA / VIC Mallee	46	40	68	50	No summer crops	
TAS*	218	210	167	200	No summer crops	
VIC High Rainfall	153	150	179	175	0	0
WA Central	77	70	98	91	20	10
WA Eastern	49	41	77	70	0	0
WA Mallee/Sandplain (Esperance)	80	70	120	100	No summer crops	
WA Northern	75	78	93	90	No summer crops	
National averages	84	69	120	100	85	40

*Caution, small sample

Figure 80 Average N application rate (kg/ha) in 2021



12. Weed Pest and Disease Management in 2021

Questions asked:

Q17. What proportion of area planted (%), if any, did you plant in a way that assists with weed competition, for example using higher seeding rate or narrower row spacing?

Q18. What proportion of fallow, if any, did you use the double knock technique?

Q19. What are the main reasons for using double knock techniques on your farm? *Read out*

- *Achieve very high levels of weed control to stop seed set and drive down weed seed banks*
- *To delay the onset of herbicide resistance*
- *To provide improved levels of control of difficult-to-control weeds such as feathertop Rhodes and windmill grass, fleabane and sowthistle*
- *To overcome physical or biological incompatibility of certain herbicide mixtures*

Q20. Prior to sowing, what proportion of chemical weed control passes are:

- *One pre-plant knockdown herbicide*
- *Double knockdown, so 2 pre-plant knockdown herbicides or glyphosate followed by paraquat/diquat 1-5 days apart*

Q21. Which of the following harvest weed control systems do you currently use? *Read out*

- *Chaff carts*
- *Bale direct*
- *Seed impact mills or destructors*
- *Narrow windrow burning*
- *Spraying under windrows*
- *Crop topping*
- *Chaff lining*
- *Chaff tramlining or chaff decks*
- *No harvest weed control system used*
- *Other (specify)*

Q22. What would you say is currently your main concern related specifically to: Weeds/Diseases:

Q23. In the 2020-21 cropping season, have you applied fungicide to:

- *Winter cereals*
- *Pulses/legumes*
- *Oilseeds*
- *Sorghum/summer crops*

Q24. How many fungicide applications have you applied:

- *In-furrow/into soil*
- *As seed treatment*
- *Foliar application*

Q25. In the 2020-21 cropping season, approximately how much money have you spent on mouse control measures, including baiting, grain screening and cleaning?

Crop area planted to assist with weed control

Growers were asked what proportion of their crop was planted in a manner to assist with weed control. This question was also asked in 2016. The data are shown in Table 59 and Figure 81.

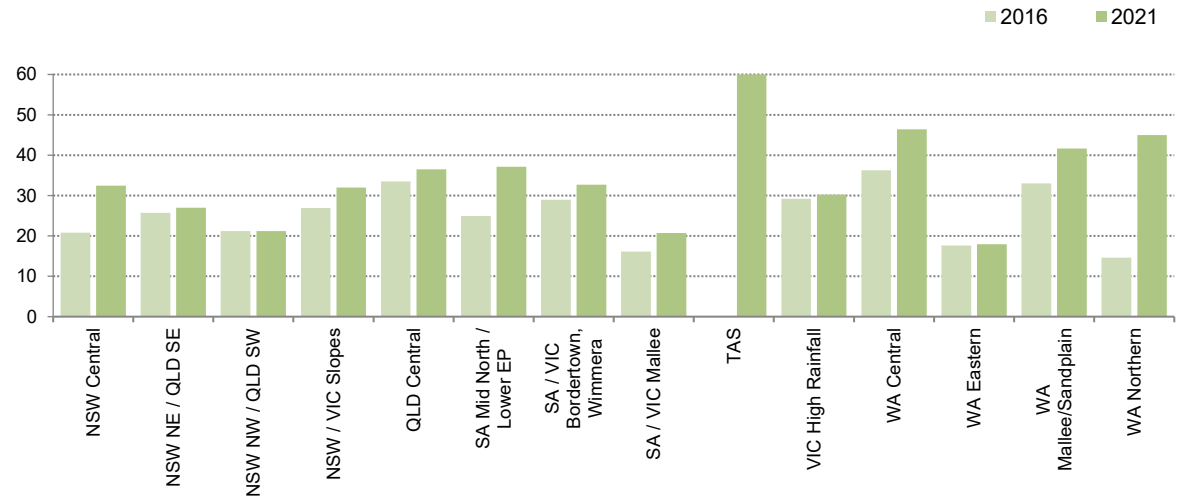
The data indicates that the use of tactics such as increased seeding rates and narrower row spacing for helping with seed management has grown significantly on a national basis since 2016, now being done on almost two thirds of the cropped area. It is higher in almost every AEZ, notably in WA and parts of SA. This suggests that growers are employing a range of tactics to help manage weeds, and are including increased competition from the crop as one of these.

Table 58 Percentage of crop area planted to assist with weed competition e.g. Higher seeding rate or narrower row spacings (Q17)

Agro-ecological zone	Average % of crop area		Significant difference between years
	2016	2021	
NSW Central	21	32	
NSW NE / QLD SE	26	27	
NSW NW / QLD SW	21	21	
NSW / VIC Slopes	27	32	
QLD Central/Northern	34	37	
SA Mid North / Lower EP	25	37	**
SA / VIC Bordertown, Wimmera	29	33	
SA / VIC Mallee	16	21	
TAS*	0	60	
VIC High Rainfall	29	30	
WA Central	36	46	
WA Eastern	18	18	
WA Mallee/Sandplain (Esperance)	33	42	
WA Northern	15	45	**
National Averages	24	32	**

*Caution, small sample

Figure 81 Percentage (%) of the crop area planted to assist with weed control in 2016 and 2021



Use of the double knock weed management technique

The *double knock* weed management technique is where two applications of two different herbicide modes of actions are applied to a paddock, several days or up to 2 weeks apart. Typically the approach is used on fallows where generally a first application of glyphosate is made, with a subsequent of paraquat as the second 'knock'.

Farms using the double knock on fallow

Data for the proportion of farms using the double knock technique on fallows are presented in Table 60 and Figure 82. These data show that an increasing proportion of farms are using this technique, now almost 60%.

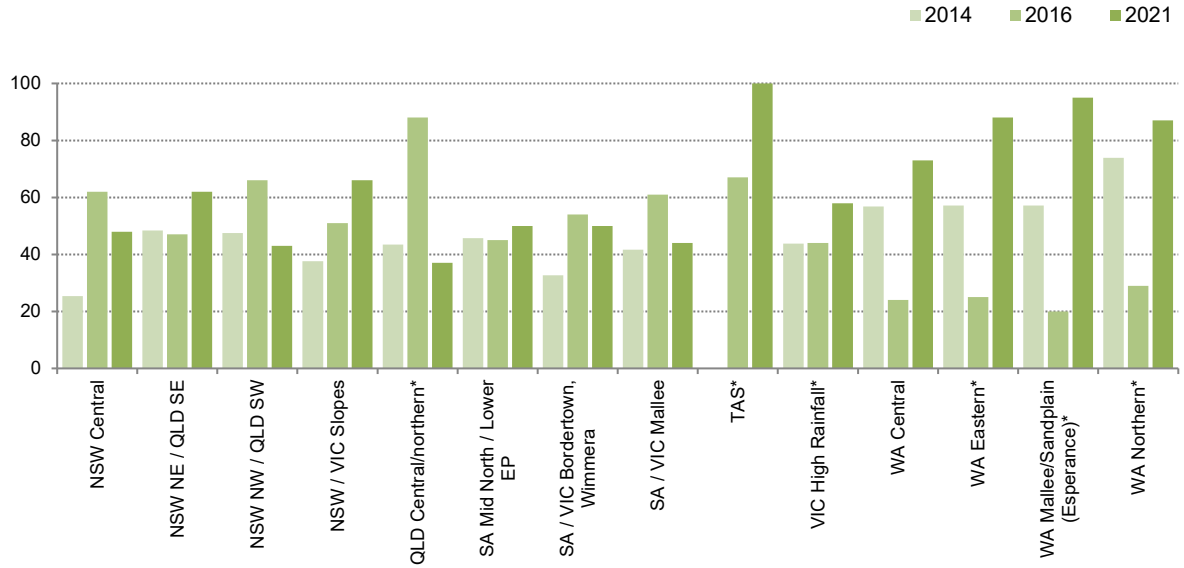
It is used by more farms in WA than elsewhere, suggesting the presence of herbicide resistant weeds may be one reason for this in those AEZs. The proportion of farms using this technique in other regions is more variable and a general trend is less able to be identified.

Table 59 Percentage of farms using double-knock technique on fallow area (base: use fallow period) (Q18)

Agro-ecological zone	Average % of crop area			Significant difference between years
	2014	2016	2021	2016 to 2021
NSW Central	25	62	48	
NSW NE / QLD SE	48	47	62	**
NSW NW / QLD SW	48	66	43	**
NSW / VIC Slopes	38	51	66	**
QLD Central/Northern*	43	88	37	
SA Mid North / Lower EP	46	45	50	
SA / VIC Bordertown, Wimmera	33	54	50	
SA / VIC Mallee	42	61	44	**
TAS*	0	67	100	
VIC High Rainfall*	44	44	58	
WA Central	57	24	73	**
WA Eastern*	57	25	88	
WA Mallee/Sandplain (Esperance)*	57	20	95	
WA Northern*	74	29	87	
National Averages	43	50	58	**

*Caution, small sample

Figure 82 Percentage (%) of farms using double knock on fallow



Fallow area where the double knock technique was used

The data for the amount of the fallowed area where the double knock technique was used is presented in Table 61 and Figure 83.

The data suggest that the double knock technique is used nationally on around one third of the fallow area, though this is higher in WA, notably in northern and southern WA and also NE NSW / SE Qld.

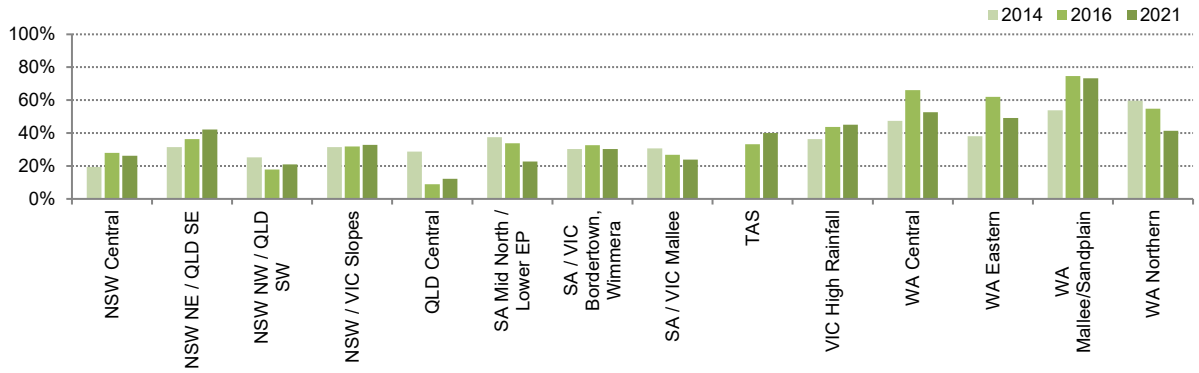
There is no clear observable trend in the use of the double knock technique as some AEZs show an increase while others retain status quo or show a decrease. It is likely that seasonal condition through the fallow period may be responsible for the degree to which double knock is employed.

Table 60 Percentage of fallow area where the double-knock herbicide technique has been used (Q18)

Agro-ecological zone	Average % of fallow area			Significant difference between years
	2014	2016	2021	2016 to 2021
NSW Central	19	28	26	
NSW NE / QLD SE	32	36	42	**
NSW NW / QLD SW	25	18	21	
NSW / VIC Slopes	31	32	33	
QLD Central/Northern*	29	9	12	
SA Mid North / Lower EP	38	34	23	
SA / VIC Bordertown, Wimmera	30	33	30	
SA / VIC Mallee	31	27	24	
TAS*	0	33	40	
VIC High Rainfall*	36	44	45	
WA Central	47	66	53	**
WA Eastern*	38	62	49	
WA Mallee/Sandplain (Esperance)*	54	75	73	
WA Northern*	60	55	41	
National Averages	34	39	34	**

*Caution, small sample. Calculation is area double knock / area fallow. Base = fallowed area in 2021

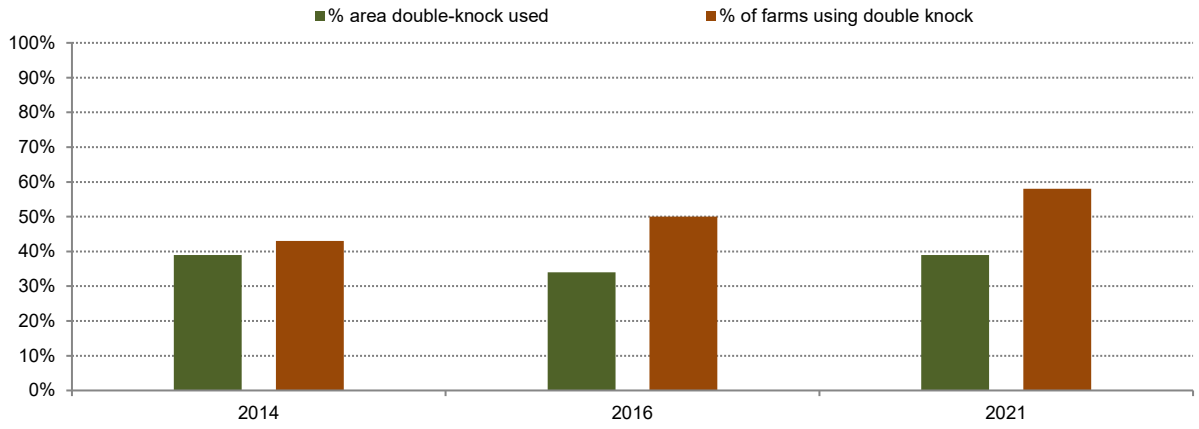
Figure 83 Percentage of fallow area where the double-knock herbicide technique has been used



Double knock usage – summary

The above data is presented in summary form at a national levels in Figure 83 below. These data show growth nationally in proportion of farms using double knock, and an increase on 2016 levels (back to the levels of 2014) of the area where it is used.

Figure 84 Double knock technique usage - % of area and % of farms



Reasons for using the double knock technique on fallow

Growers were asked their main reasons for using the double knock technique. The data in Table 62 suggests that the main reason is for seed set control and thus to reduce the weed seed bank.

Delaying the onset of herbicide resistance was a close second and is likely to be linked. There are several AEZs where the control of some difficult weeds is also a significant reason, for example in northern NSW/Southern Qld, NSW VIC slopes, parts of SA and the VIC Mallee. Weeds where this applies are likely to include feather-top rhodes grass, flax-leaf fleabane, hairy panic, annual ryegrass and sowthistle. These are also found to develop herbicide resistance more commonly and to set large amounts of seed. It is therefore reasonable to assume that double knock is used for a combination of reasons, as shown in the responses.

Table 61 Main reasons double knock technique is used (prompted; base: use double-knock on fallow) (Q19)

Agro-ecological zone	Stop seed set and reduce weed seed bank	Delay onset of herbicide resistance	Improve control of difficult weeds	Overcome incompatibility of herbicide mixtures
NSW Central	89	74	76	32
NSW North-East / QLD South-East	93	85	96	43
NSW North-West / QLD South-West*	91	84	96	47
NSW / VIC Slopes	89	84	69	28
QLD Central/Northern*	91	82	100	27
SA Mid North / Lower Eyre Peninsula	93	83	61	34
SA / VIC Bordertown, Wimmera	98	92	60	22
SA / VIC Mallee	98	88	79	37
TAS*	100	100	75	75
VIC High Rainfall*	80	80	33	13
WA Central	94	95	53	26
WA Eastern*	100	90	67	38
WA Mallee/Sandplain (Esperance)*	95	80	80	35
WA Northern*	90	85	55	30
National Averages	93	86	72	33

*Caution, small sample Base: use double knock on fallow

Number of herbicide passes pre-sowing (new in 2021)

Growers were asked the proportion of herbicide weed control passes that were single pass or double knock pre sowing in 2021. Table 63 and Figure 85 suggest that about 80% of weed control passes prior to sowing are single knockdown herbicide application and 20% a double knock. The proportion using a double application is somewhat higher in WA and lower in SA and parts of northern NSW/southern Qld.

Table 62 Percent of chemical weed control passes prior to sowing (base: use doubleknock) (Q20)

Agro-ecological zone	% weed control passes	
	One pre-plant knockdown	Double knockdown (herbicides)
NSW Central	81	19
NSW North-East / QLD South-East	79	21
NSW North-West / QLD South-West*	90	10
NSW / VIC Slopes	74	25
QLD Central/Northern*	90	10
SA Mid North / Lower Eyre Peninsula	87	13
SA / VIC Bordertown, Wimmera	88	12
SA / VIC Mallee	89	11
TAS*	64	36
VIC High Rainfall*	77	23
WA Central	69	31
WA Eastern*	65	35
WA Mallee/Sandplain (Esperance)*	48	52
WA Northern*	78	23
National Averages	80	20

Figure 85 Proportion (%) of pre-sowing herbicide passes being single or double knock

Harvest weed seed management systems (new in 2021)

Growers were asked what (if any) harvest weed seed management system they used. Table 64, Figure 86 and Figure 87, shows that crop topping is the most popular technique used, being used on almost 30% of farms nationally. However several other techniques are also used, and the preference for each varies considerably across AEZs. Nationally 52% of farms use one , or more than one, harvest weed management technique. This is lower in northern NSW and Qld and higher in SA and WA.

Table 63 Harvest weed control systems used - % of farms (prompted) (Q21)

Agro-ecological zone	Crop topping	Narrow windrow burning	Spraying under windrows	Seed impact mill	Chaff lining	Chaff carts	Chaff tramlining/ decks	Bale direct	No system used
NSW Central	17	9	2	2	0	2	0	8	66
NSW North-East / QLD South-East	4	3	1	1	0	2	2	2	80
NSW North-West / QLD South-West	7	17	5	2	6	2	5	2	72
NSW / VIC Slopes	23	24	12	2	1	1	2	6	45
QLD Central/Northern	3	0	7	0	0	3	3	0	77
SA Mid North / Lower Eyre Peninsula	54	13	16	6	9	6	3	1	25
SA / VIC Bordertown, Wimmera	39	17	12	9	7	3	3	6	41
SA / VIC Mallee	28	8	2	5	10	3	3	2	53
TAS*	0	20	0	0	0	20	0	0	60
VIC High Rainfall	40	18	0	2	4	2	2	7	44
WA Central	44	21	9	17	9	12	8	4	28
WA Eastern	30	33	0	0	13	0	13	0	37
WA Mallee/Sandplain (Esperance)	40	10	7	17	7	7	17	0	30
WA Northern	10	27	0	13	13	7	7	0	37
National averages	28	15	7	6	5	4	4	4	48

*Caution, small sample

Figure 86 harvest weed control system used (% of farms)

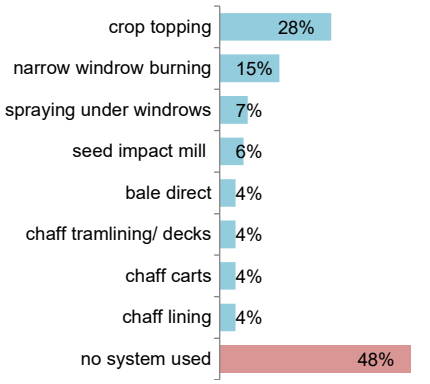
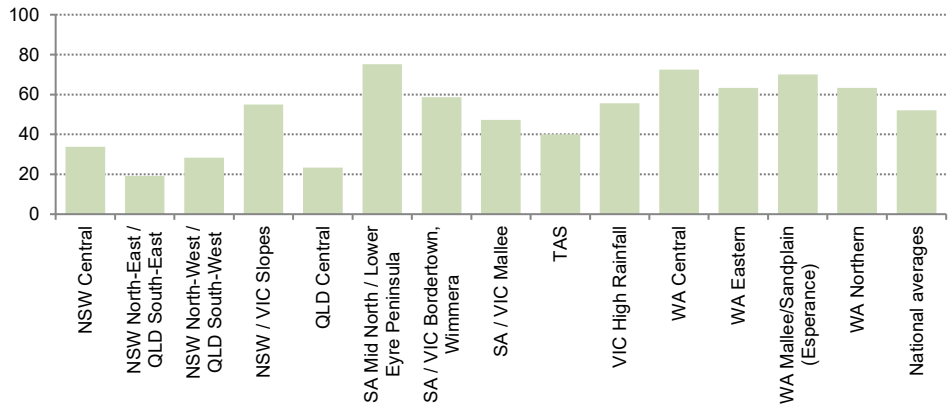


Figure 87 harvest weed control system used (% of farms using any technique)



Main weed concerns (new in 2021)

Growers were asked their main concerns with weeds (Table 65 and Figure 88). Ryegrass and herbicide resistance were the main concerns mentioned. Interestingly, ryegrass was prominent enough to be an issue in its own right. Ryegrass is notably a concern in the NSW/VIC slopes, parts of SA and southern and northern WA, though is mentioned in almost all AEZs.

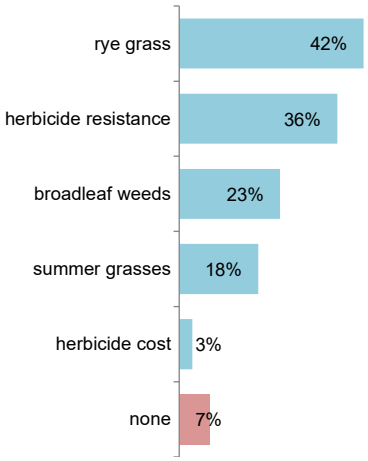
Herbicide resistance is also a common concern, and is likely linked to the concern about ryegrass, although is also important in northern AEZs. The issues listed below are the top 5.

Table 64 Main weed concerns (% of farms) (Q22)

Agro-ecological zone	Rye grass	Herbicide resistance	Broadleaf weeds	Summer grasses	Herbicide cost
NSW Central	40	31	18	12	7
NSW North-East / QLD South-East	16	41	25	31	4
NSW North-West / QLD South-West	22	39	34	30	3
NSW / VIC Slopes	51	43	23	16	1
QLD Central/Northern	3	27	10	40	7
SA Mid North / Lower Eyre Peninsula	58	37	19	15	2
SA / VIC Bordertown, Wimmera	52	32	19	12	1
SA / VIC Mallee	42	28	23	26	5
TAS*	60	60	20	0	0
VIC High Rainfall	44	38	24	9	0
WA Central	39	37	28	12	1
WA Eastern	27	43	27	17	10
WA Mallee/Sandplain (Esperance)	53	17	27	23	0
WA Northern	47	40	33	3	3
National averages	42	36	23	18	3

*Caution, small sample

Figure 88 Main weed concerns in 2021 (% of farms)



Main disease concerns (new in 2021)

Table 66 and Figure 89 suggest that growers are mainly concerned with foliar diseases of cereals, followed by diseases of canola, then other various diseases. Interestingly root and crown diseases of cereals (e.g. crown rot and rhizoctonia) were relatively minor, being similar to a suite of diseases mainly infecting pulses.

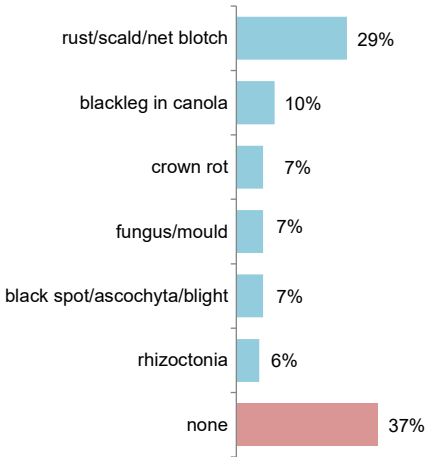
The main concerns growers have are the easy to see foliar diseases of cereals and the known threats in canola. This may also help explain the earlier noted use of seed dressings, in-furrow and foliar treatments used in cereals and oilseeds.

Table 65 Main disease concerns (% of farms) (Q22)

Agro-ecological zone	Stem/Stripe /Leaf Rust/scald/ net blotch in cereals	Black leg / Sclerotinia in canola	Crown rot	Fungal diseases / mould - Black Rot/ Foliar/ Septoria (Leaf Spot)/Smut / Scald/Vert	Blackspot /Ascochyta / Bacterial Blight / Phytophthora in pulses	Rhizoctonia	No problems experienced
NSW Central	46	10	6	4	7	6	35
NSW North-East / QLD South-East	26	1	27	4	8	4	30
NSW North-West / QLD South-West	16	4	18	2	15	0	49
NSW / VIC Slopes	48	16	2	4	2	3	28
QLD Central/Northern	7	0	0	3	3	0	83
SA Mid North / Lower Eyre Peninsula	25	12	3	20	16	6	33
SA / VIC Bordertown, Wimmera	31	15	2	10	10	5	37
SA / VIC Mallee	25	0	6	3	2	11	49
TAS*	20	0	0	0	0	0	60
VIC High Rainfall	33	18	2	16	9	0	29
WA Central	20	12	1	4	1	8	40
WA Eastern	17	3	7	3	0	7	47
WA Mallee/Sandplain (Esperance)	27	20	13	3	10	23	27
WA Northern	10	30	7	10	7	17	40
National averages	29	10	7	7	7	6	37

*Caution, small sample

Figure 89 Main disease concerns in 2021 (% of farms mentioning)



Fungicide application to main crop types (new in 2021)

Table 67 and Figure 90 show percentage of farms using fungicides in their crops. These show that most farms applied fungicides to cereals, followed by pulses/legumes, then oilseeds. Data for how the fungicides were applied (i,e. in-furrow, as seed dressing, or foliar) are presented in the next section.

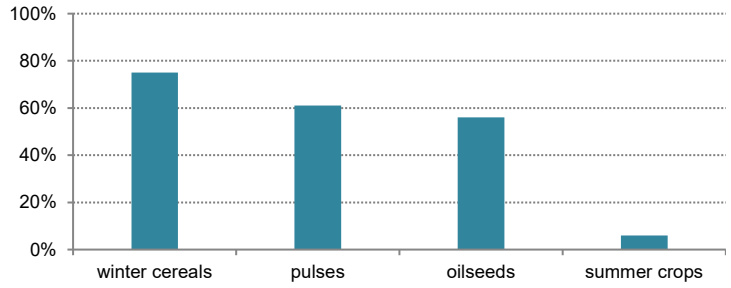
A higher proportion of farms in WA, SA and the higher yielding areas of Victoria and NSW appear to be applying fungicide to cereals. SA growers seem to apply more to pulses, as do growers in some of Victoria and northern NSW/southern Qld. This could be explained by the relative popularity of pulses, for example chickpeas and lentils, and peas/beans in these AEZs, which tend to require more protection from foliar diseases. The data for oilseed crops is more consistent, with around 40% to 60% (72% in NSW/VIC Slopes) of farms treating oilseeds with fungicides.

Table 66 Percent of farms applying fungicide to crop type (Q23)

Agro-ecological zone	Winter cereals	Pulses/legumes	Oilseeds	Summer crops
NSW Central	71	35	44	0
NSW North-East / QLD South-East	63	74	53	7
NSW North-West / QLD South-West	54	77	61	0
NSW / VIC Slopes	81	48	72	20
QLD Central/Northern	5	29	0	0
SA Mid North / Lower Eyre Peninsula	89	92	59	0
SA / VIC Bordertown, Wimmera	84	81	47	0
SA / VIC Mallee	65	47	25	0
TAS*	100	0	100	0
VIC High Rainfall	91	85	54	0
WA Central	81	29	56	0
WA Eastern	63	23	38	0
WA Mallee/Sandplain (Esperance)	90	33	54	0
WA Northern	75	45	58	0
National Averages	75	61	56	6

*Caution, small sample

Figure 90 % farms applying fungicide to crop type



Number of applications and method of applying fungicide to winter cereals

Growers were asked how many and the method of applying fungicides to their winter cereals in 2021. The data is recorded as the number of applications by the application method used. Table 68, Figure 91 and Figure 92 show that most fungicide applied to winter cereals in 2021 was as a foliar treatment (spray), averaging 1.2 applications to these crops. Fungicide seed treatment averaged 0.6 applications to winter cereals and in-furrow (i.e. mainly fertiliser applied fungicide) averaged lower at 0.3 applications.

Higher yielding AEZs (NSW/VIC, much of SA and southern WA) showed higher numbers of foliar application in 2021, probably reflecting the high yields expected in those AEZs, and likely increased foliar disease pressure. The data for number of applications made as seed treatments or in-furrow are relatively consistent across AEZs, and at generally low levels.

Again, the higher rainfall and potentially higher yielding AEZs show higher number of applications when all treatments are totaled (Figure 91)

Table 67 Average number of fungicide applications to winter cereals (base: apply fungicide) (Q24)			
Agro-ecological zone	**In-furrow**	**As seed treatment**	**Foliar application**
NSW Central	0.3	0.5	1.2
NSW North-East / QLD South-East	0.1	0.7	1.2
NSW North-West / QLD South-West	0.3	0.5	1.0
NSW / VIC Slopes	0.4	0.7	1.2
QLD Central/Northern	1.0	1.0	0.0
SA Mid North / Lower Eyre Peninsula	0.2	0.4	1.3
SA / VIC Bordertown, Wimmera	0.2	0.6	1.3
SA / VIC Mallee	0.2	0.5	1.0
TAS*	0.0	0.8	1.5
VIC High Rainfall	0.3	0.6	1.7
WA Central	0.6	0.6	1.1
WA Eastern	0.3	0.5	1.0
WA Mallee/Sandplain (Esperance)	0.4	0.7	1.3
WA Northern	0.4	0.5	1.1
National Averages	0.3	0.6	1.2

*Caution, small sample

Figure 91 Number of fungicide application and type of application to winter cereals in 2021

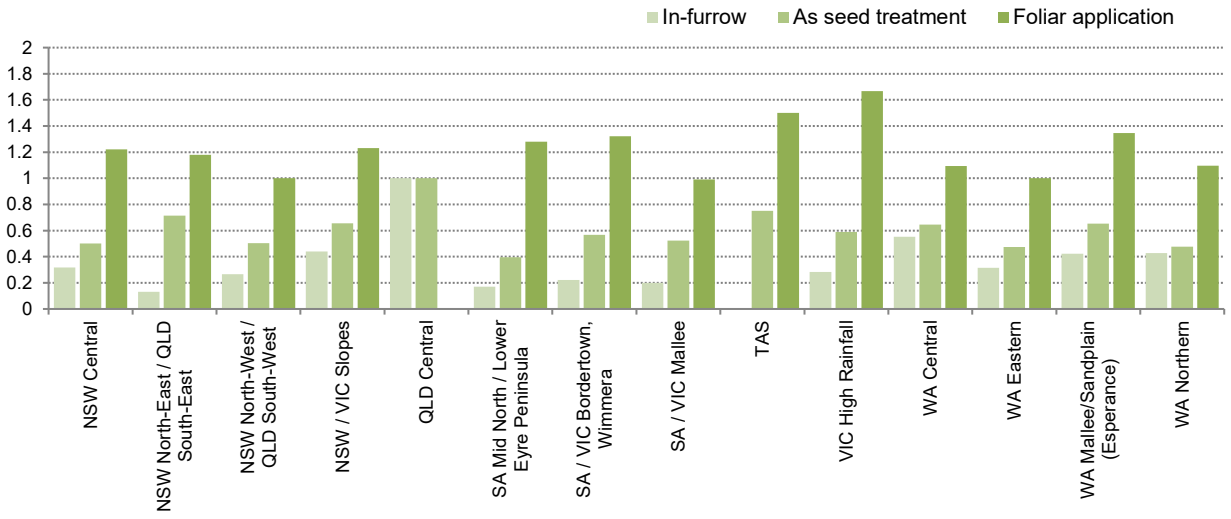
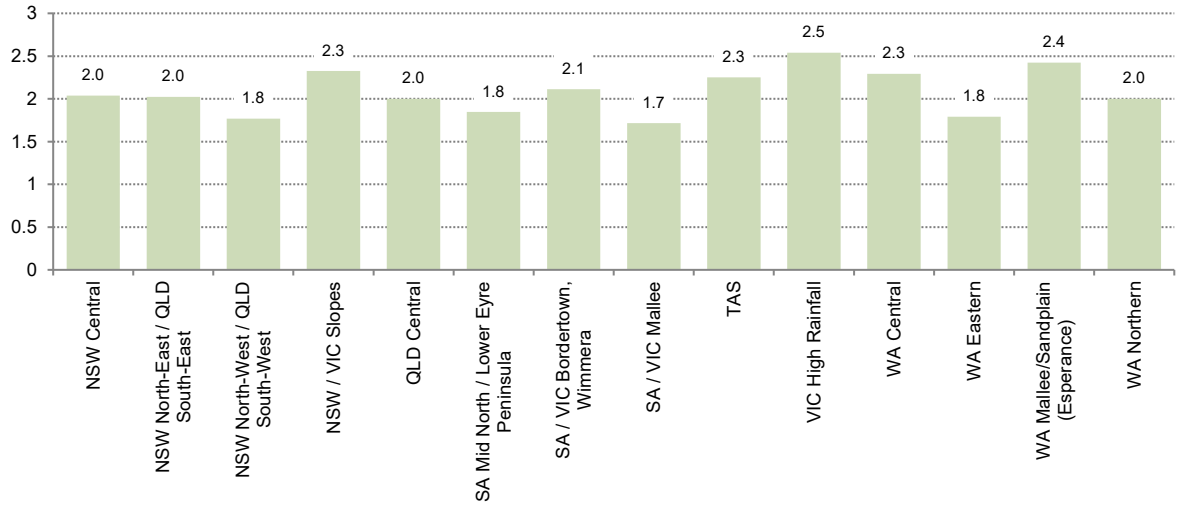


Figure 92 Number of fungicide application to winter cereals – all methods



Number of applications and method of applying fungicide to pulses/legumes

Table 69 and Figure 93 suggest that the vast majority of fungicides applied to pulses/legumes in 2021 was foliar, with an average 1.7 applications to these crops. Higher numbers of foliar applications were noted in NE NSW/SE Qld, some of SA, VIC high rainfall and southern WA. This is likely to due to these being somewhat higher yielding areas and the likely growing of chickpeas, peas//beans/lentils in these AEZs.

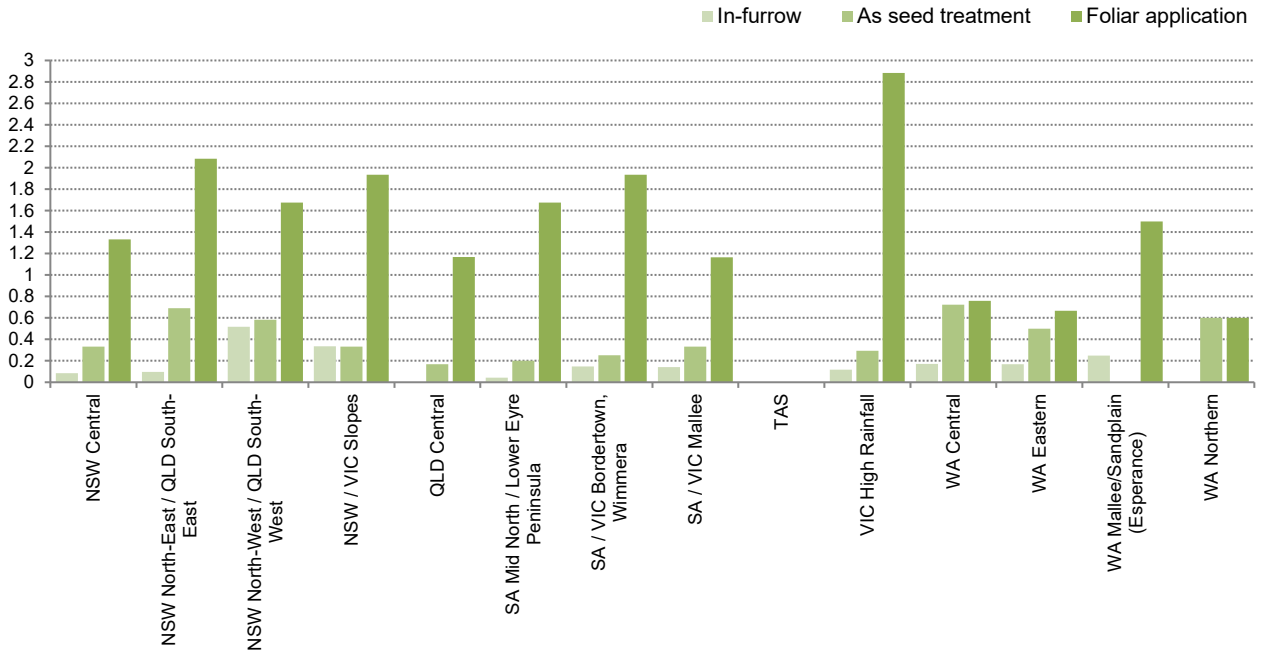
Some seed treatment was used, notably in WA, potentially on lupins.

Table 68 Average number of fungicide applications to pulses/legumes (base: apply fungicide) (Q24)

Agro-ecological zone	In-furrow	As seed treatment	Foliar application
NSW Central*	0.1	0.3	1.3
NSW North-East / QLD South-East	0.1	0.7	2.1
NSW North-West / QLD South-West*	0.5	0.6	1.7
NSW / VIC Slopes*	0.3	0.3	1.9
QLD Central/Northern*	0.0	0.2	1.2
SA Mid North / Lower Eyre Peninsula	0.0	0.2	1.7
SA / VIC Bordertown, Wimmera	0.1	0.3	1.9
SA / VIC Mallee	0.1	0.3	1.2
TAS*			
VIC High Rainfall*	0.1	0.3	2.9
WA Central*	0.2	0.7	0.8
WA Eastern*	0.2	0.5	0.7
WA Mallee/Sandplain (Esperance)*	0.3	0.0	1.5
WA Northern*	0.0	0.6	0.6
National Averages	0.1	0.4	1.7

*Caution, small sample

Figure 93 Number of fungicide application to pulses



Number of applications by method of applying fungicide to oilseeds

Table 74, Figure 94 and Figure 95 show that most oilseed crops receive around 1 application of a foliar fungicide. In-furrow fungicide is lower at an average of 0.3 with seed applied at 0.6 percrop. The data are relatively similar across most AEZs, although was lower in the Mallee.

Growers often purchase new seed for canola each year, especially if using hybrid (including GM) seed. This seed is almost always provided as treated with a fungicide, making up the majority of seed applied fungicide noted.

The data suggests that most canola receives a foliar fungicide application likely for protection from blackleg or sclerotinia and is more likely to be treated in potentially high yielding years where strong prices are present, such as 2021.

Table 69 Average number of fungicide applications to oilseeds (base: apply fungicide) (Q24)

Agro-ecological zone	In-furrow	As seed treatment	Foliar application
NSW Central*	0.1	0.5	1.0
NSW North-East / QLD South-East*	0.2	0.5	1.1
NSW North-West / QLD South-West*	0.1	0.3	1.0
NSW / VIC Slopes	0.5	0.6	1.1
QLD Central/Northern*			
SA Mid North / Lower Eyre Peninsula*	0.2	0.6	0.9
SA / VIC Bordertown, Wimmera	0.3	0.7	0.8
SA / VIC Mallee*	0.1	0.9	0.3
TAS*	0.0	0.3	1.0
VIC High Rainfall*	0.3	0.3	0.8
WA Central	0.5	0.6	0.7
WA Eastern*	0.7	0.5	0.8
WA Mallee/Sandplain (Esperance)*	0.4	0.5	0.9
WA Northern*	0.1	0.5	0.9
National Averages	0.3	0.6	0.9

*Caution, small sample

Figure 94 Number of fungicide applications by method to oilseeds

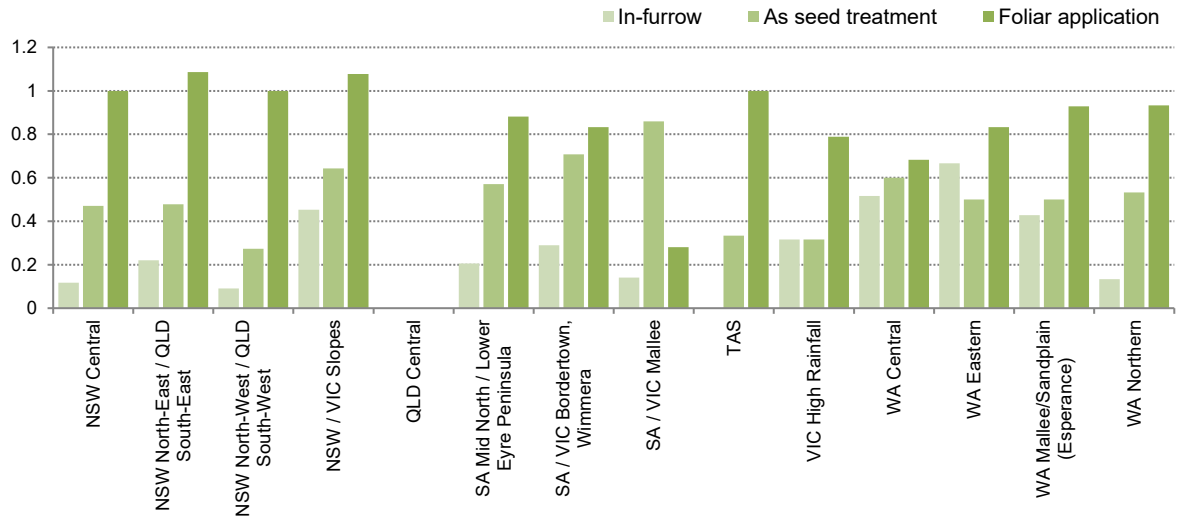
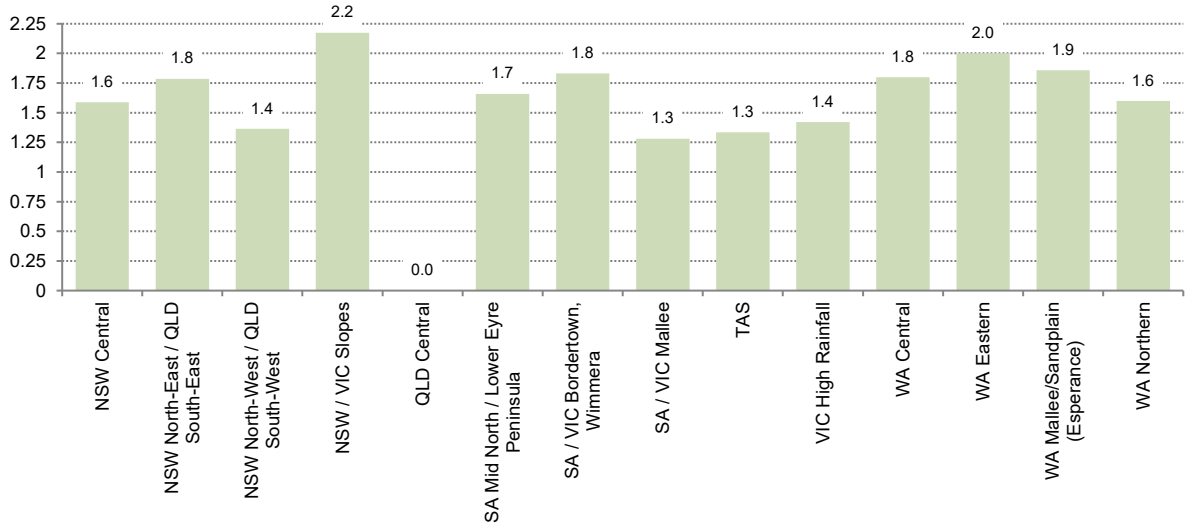


Figure 95 Number of fungicide applications in total to oilseeds



Number of applications and method of applying fungicide to summer crops

The data suggests that summer crops are treated with foliar fungicide when needed, around once per crop (Table 75). However, the data for the number and method of applying fungicides to summer crops is scant and little interpretation can be made.

Table 70 Average number of fungicide applications to summer crops* (base: apply fungicide) (Q24)

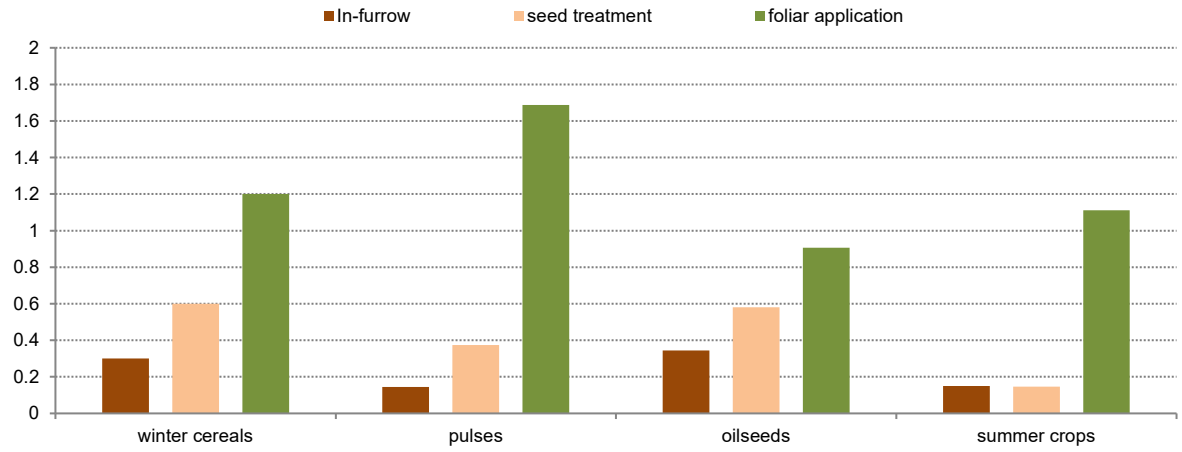
Agro-ecological zone	In-furrow*	As seed treatment*	Foliar application*
NSW Central			
NSW North-East / QLD South-East	0	0.2	1.2
NSW North-West / QLD South-West			
NSW / VIC Slopes	0.5	0.0	1.0
QLD Central/Northern			
SA Mid North / Lower Eyre Peninsula			
SA / VIC Bordertown, Wimmera			
SA / VIC Mallee			
TAS*			
VIC High Rainfall			
WA Central			
WA Eastern			
WA Mallee/Sandplain (Esperance)			
WA Northern			
National Averages	0.2	0.1	1.1

*Caution, small sample

Fungicide applications and method

The data shown in Figure 96, shows that on average foliar fungicide applications are preferred on all crop types, though dominate in winter cereals and pulses. Seed treatment is at similar levels for winter cereals and oilseeds at 0.6 average applications per crop.

Figure 96 Average number of fungicide applications, by method, to the main crop types in 2021



Mouse Management (new in 2021)

Percentage of farms who spent money on mouse control

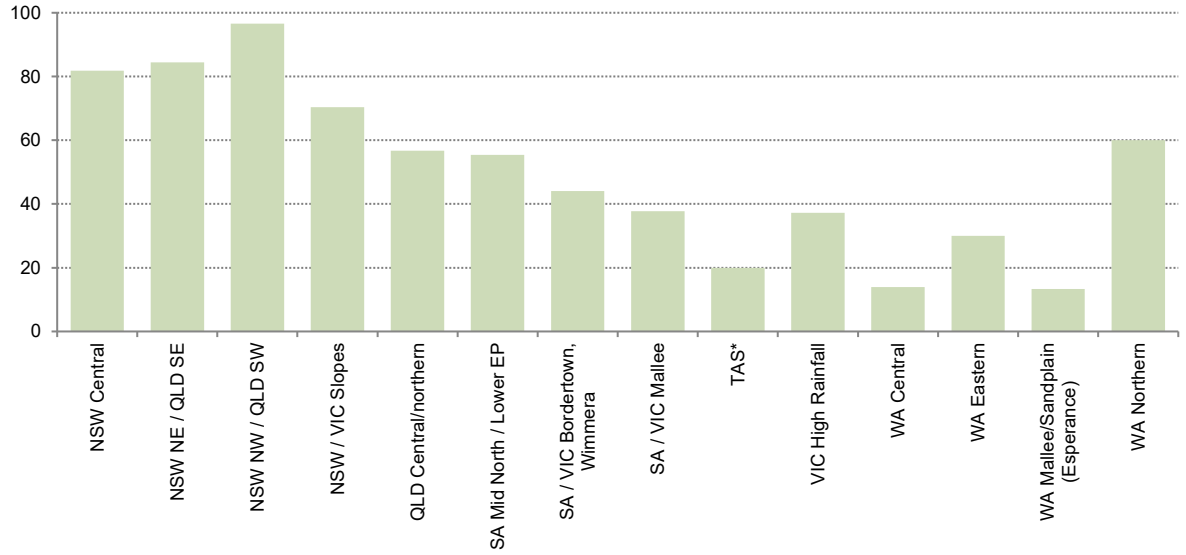
Table 76 and Figure 97 shows that in the eastern states, NSW, Qld, a very high percentage of farms needed to invest in mouse management in 2021. However in SA and WA many farms also needed to invest for mouse control, up to 60% in northern WA and around 45-55% in parts of SA and 70% in the NSW/VIC slopes AEZ. This reflects the extent of the mouse plague in 2021.

Table 71 % of farms spending money on mouse control measures in 2020-21 (Q25)

Agro-ecological zone	2021
NSW Central	82
NSW NE / QLD SE	84
NSW NW / QLD SW	97
NSW / VIC Slopes	70
QLD Central/Northern	57
SA Mid North / Lower EP	55
SA / VIC Bordertown, Wimmera	44
SA / VIC Mallee	38
TAS*	20
VIC High Rainfall	37
WA Central	14
WA Eastern	30
WA Mallee/Sandplain (Esperance)	13
WA Northern	60
National Averages	54

*Caution, small sample

Figure 97 Percentage of farms who spent money on mouse control in 2021



Average amount ($) spent on mouse control in 2021 (base: those farms that spent money)

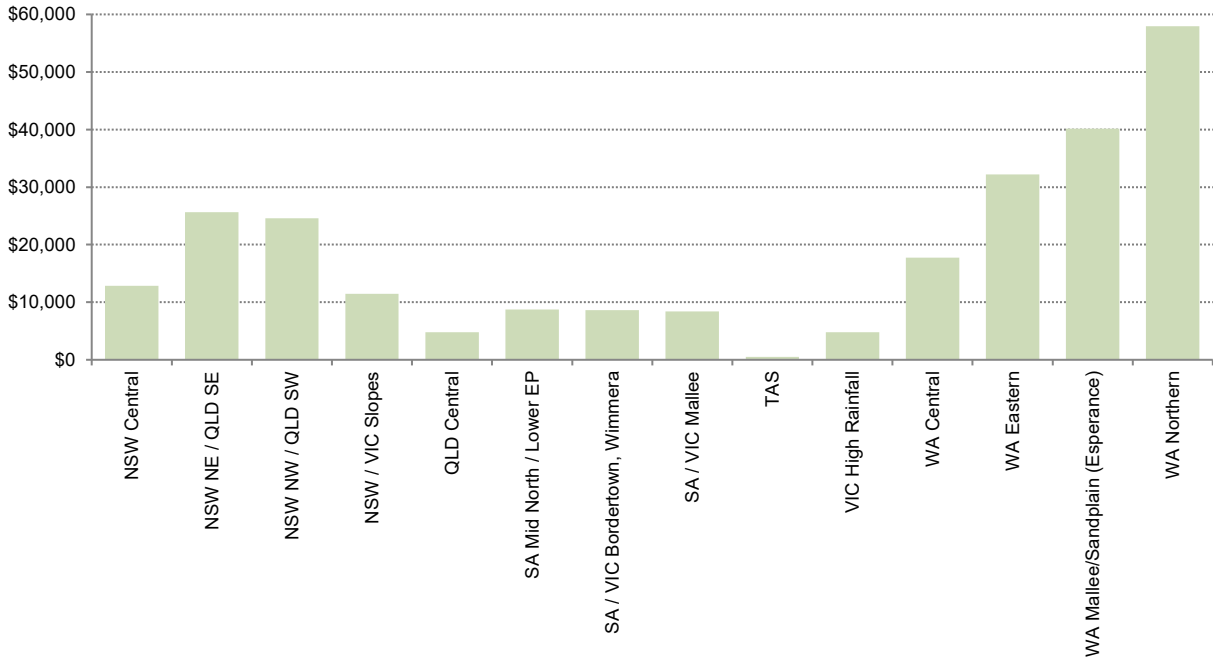
This section requires caution interpreting results due to small sample sizes in Western region AEZs. While the percentage of farms investing in mouse control was significantly more widespread in the northern and southern AEZs than in the west, data suggests that where mouse control was carried out, the greatest amounts spent were in the west, and northern NSW. This likely reflects the larger farm sizes in much of WA, but also that the mouse problem was not restricted to the eastern states.

Table 72 Mouse control measures in 2020-21 (base: spent money on mouse control) (Q25)

Agro-ecological zone	Average $ amount spent	Median $ amount spent	Maximum $ amount spent	Maximum $ amount spent	$ spent per hectare of cropped area
NSW Central	12,858	9,500	100,000	150	9
NSW NE / QLD SE	25,650	10,000	240,000	50	36
NSW NW / QLD SW	24,577	8,000	150,000	800	11
NSW / VIC Slopes	11,477	5,000	110,000	200	7
QLD Central/Northern*	4,786	3,000	15,000	54	7
SA Mid North / Lower EP	8,719	5,000	40,000	100	3
SA / VIC Bordertown, Wimmera	8,641	3,000	70,000	50	3
SA / VIC Mallee	8,414	5,500	35,000	10	1
TAS*	500	500	500	500	1
VIC High Rainfall*	4,813	3,500	25,000	200	2
WA Central*	17,740	9,000	100,000	100	1
WA Eastern*	32,228	15,000	180,000	50	1
WA Mallee/Sandplain (Esperance)*	40,125	30,000	100,000	500	1
WA Northern*	57,944	37,500	200,000	5,000	4
National	15,925	6,000	240,000	10	8

*Caution, small sample

Figure 98 Amount ($) spent per farm on mouse management in 2021 (base: farms that invested in mouse control)



13. Appendix 1: Region and farm size (hectares planted) results

Farm characteristics

Table 73

	total	region			area planted (hectares)				
		northern	southern	western	<1,500	1,500-3,000	3,001-5,000	5,001-8,000	8,001+
Q1 farming enterprise type									
Grain only (non-mixed)	25%	25%	25%	26%	19%	28%	35%	40%	49%
Grain/cattle	27%	44%	16%	14%	34%	18%	16%	21%	19%
Grain/sheep	65%	56%	70%	71%	67%	65%	59%	56%	51%
Q3 farm area									
Average farm area	3,846	3,889	2,946	5,868	1,622	4,396	6,212	10,817	18,681
Q4 area of crops sown									
Average crop area	2,088	1,652	1,713	3,902	607	2,233	3,884	6,114	13,515
Average proportion of farm area cropped	58%	49%	63%	64%	48%	68%	71%	71%	79%
Q7 pasture/permanent vegetation									
Average proportion of farm area maintained as pasture or permanent vegetation	28%	33%	24%	28%	36%	20%	19%	15%	13%
Q8 % farms with a vegetation plan (total: base: all)	50%	47%	47%	62%	50%	49%	53%	46%	49%
Vegetation plan to conserve an area of native vegetation for biodiversity or amenity benefit (base: have plan)	90%	84%	92%	94%	89%	89%	93%	91%	96%
Vegetation plan assist with crop production (base: have plan)	21%	24%	19%	20%	22%	20%	25%	6%	26%
Vegetation plan to provide additional income (base: have plan)	15%	19%	13%	14%	14%	19%	12%	13%	19%

Crop mix

Table 74

	total	region			area planted (hectares)				
		northern	southern	western	<1,500	1,500-3,000	3,001-5,000	5,001-8,000	8,001+
Q9/10 area planted to each crop type									
Average % crop area planted to **wheat**	46%	50%	41%	49%	43%	46%	44%	49%	50%
Average % crop area planted to **barley**	19%	17%	23%	18%	20%	20%	21%	18%	19%
Average % crop area planted to **pulses**	14%	12%	21%	8%	11%	15%	16%	14%	12%
Average % crop area planted to **oilseeds**	14%	13%	10%	19%	15%	14%	12%	15%	15%
Average % crop area planted to **other winter cereals**	3%	2%	3%	5%	6%	3%	4%	1%	3%
Average % crop area planted to **summer crops**	4%	11%	1%	0%	9%	3%	4%	2%	1%

Crop varieties

Table 75

	total	region			area planted (hectares)				
		northern	southern	western	<1,500	1,500-3,000	3,001-5,000	5,001-8,000	8,001+
Q11 new variety planted in past 2 years (base: plant crop type)									
Planted new winter cereal variety	59%	60%	54%	67%	51%	66%	73%	74%	63%
Planted new pulse variety	42%	40%	46%	34%	36%	43%	42%	60%	60%
Planted new oilseed variety	67%	69%	63%	73%	62%	67%	84%	73%	70%
Planted new summer crop variety	42%	45%	12%	29%	36%	55%	42%	49%	42%
Q12 wheat variety planted									
Early maturing variety	12%	19%	8%	6%	11%	14%	13%	11%	16%
Early to mid maturing variety	36%	33%	30%	57%	27%	38%	51%	62%	48%
Mid maturing variety	70%	57%	78%	81%	60%	81%	81%	87%	70%
Mid to late maturing variety	35%	46%	26%	36%	31%	39%	42%	42%	36%
Late maturing variety	13%	24%	9%	1%	17%	9%	11%	3%	18%

Precision agriculture

Table 76

	total	region			area planted (hectares)				
		northern	southern	western	<1,500	1,500-3,000	3,001-5,000	5,001-8,000	8,001+
Q45 average % crop area where controlled traffic was used	44%	39%	44%	56%	26%	62%	70%	75%	84%
Q46 average % crop area where yield mapping was used	44%	39%	44%	56%	26%	62%	70%	75%	84%
Q45 average % crop area where variable rate fertiliser application was used	11%	7%	14%	13%	5%	13%	17%	35%	44%

Fallow and stubble management

Table 77

	total	region			area planted (hectares)				
		northern	southern	western	<1,500	1,500-3,000	3,001-5,000	5,001-8,000	8,001+
Q15/16 stubble management									
% crop area where stubble was retained intact through to planting	57%	51%	59%	69%	46%	69%	77%	73%	73%
% crop area where stubble retained but treated	13%	13%	14%	11%	16%	9%	8%	10%	9%
% crop area where stubble was windrowed then burnt	2%	2%	2%	3%	3%	2%	2%	0%	5%
% crop area where stubble was burnt within a few weeks of planting (cool)	11%	15%	8%	6%	14%	7%	5%	5%	4%
% crop area where stubble was burnt months prior to planting (hot burn)	2%	2%	3%	2%	3%	2%	1%	1%	0%
% crop area where stubble was incorporated into the soil	14%	16%	14%	10%	18%	11%	8%	10%	8%
Q14 fallow period									
% farms using a fallow period	78%	93%	69%	67%	77%	80%	78%	83%	83%
% of land long fallowed over past year	6%	7%	3%	9%	5%	4%	8%	2%	14%
% of land short fallowed over past year	30%	31%	30%	29%	22%	30%	32%	35%	38%

Crop sequencing

Table 78

	total	region			area planted (hectares)				
		northern	southern	western	<1,500	1,500-3,000	3,001-5,000	5,001-8,000	8,001+
Q26 average % crop area planted with break crop for weed control	28%	26%	29%	27%	25%	29%	33%	36%	36%
Q27 average % crop area planted with break crop for disease control	21%	23%	20%	17%	19%	23%	23%	24%	25%
Q28 average % crop area planted with break crop for nutrition benefits	19%	16%	23%	14%	17%	19%	23%	20%	21%

Soil management – lime application

Table 79

	total	region			area planted (hectares)				
		northern	southern	western	<1,500	1,500-3,000	3,001-5,000	5,001-8,000	8,001+
Q29/30 tonnes of lime applied/area lime applied									
% farms applying lime	38%	27%	35%	66%	34%	40%	41%	47%	45%
% crop area where lime was applied	25%	23%	25%	27%	31%	20%	15%	19%	20%
Average use rate of lime (t/ha)	2.0	2.0	2.3	1.8	2.1	2.0	2.0	1.7	1.8

Soil management – pre-plant soil testing

Table 80

	total	region			area planted (hectares)				
		northern	southern	western	<1,500	1,500-3,000	3,001-5,000	5,001-8,000	8,001+
Q31 average % winter cereal crop area pre-plant soil tested (base: soil test)	26%	30%	21%	30%	23%	27%	30%	28%	39%
Q32 average % oilseed crop area pre-plant soil tested (base: soil test)	34%	37%	32%	33%	34%	37%	31%	28%	39%
Q33 average % sorghum crop area pre-plant soil tested (base: soil test)	32%	36%	0%	0%	30%	39%	56%	11%	18%
Q34 soil testing depths (base: soil test)									
10cm or less	75%	67%	77%	83%	77%	71%	73%	83%	74%
11cm to 30cm	44%	44%	41%	50%	39%	45%	50%	56%	57%
31cm to 60cm	30%	38%	31%	13%	24%	35%	34%	38%	38%
61cm to 1 metre	12%	20%	8%	6%	10%	15%	15%	8%	13%
> 1metre	2%	3%	1%	1%	1%	3%	0%	4%	3%
Total: at least one test deeper than 10cm	65%	70%	62%	62%	57%	70%	75%	73%	75%

Soil management – pre-plant soil moisture monitoring

Table 81

	total	region			area planted (hectares)				
		northern	southern	western	<1,500	1,500-3,000	3,001-5,000	5,001-8,000	8,001+
Q35 pre-plant test for soil moisture									
% farms pre-plant testing for soil moisture	24%	39%	16%	10%	21%	25%	32%	25%	32%
% cropped area pre-plant tested for soil moisture (base: all respondents)	18%	35%	6%	6%	16%	17%	24%	14%	26%
Q36 soil moisture testing depths (base: test soil moisture)									
10cm or less	51%	42%	64%	75%	48%	46%	55%	87%	49%
11cm to 30cm	45%	39%	56%	54%	41%	46%	47%	70%	46%
31cm to 60cm	46%	40%	59%	42%	42%	42%	52%	63%	68%
61cm to 1 metre	45%	55%	32%	17%	46%	46%	41%	51%	48%
> 1metre	13%	14%	12%	8%	10%	17%	16%	12%	18%
Q37 soil moisture assessment tool (base: test soil moisture)									
Push probe	67%	90%	30%	13%	73%	62%	61%	40%	78%
Soil core	15%	11%	25%	13%	12%	14%	22%	28%	26%
Moisture sensor	22%	11%	44%	29%	15%	27%	21%	48%	35%
Calculation based on rainfall	15%	15%	13%	25%	13%	15%	20%	16%	19%

Fertiliser management

Table 82

	total	region			area planted (hectares)				
		northern	southern	western	<1,500	1,500-3,000	3,001-5,000	5,001-8,000	8,001+
Q38 method to calculate N rates									
Yield target	59%	56%	59%	66%	53%	69%	63%	71%	70%
Removal by previous crop based on yield	52%	56%	49%	50%	47%	60%	58%	53%	63%
Removal by previous crop based on protein map	11%	14%	10%	9%	12%	10%	8%	15%	20%
Pre-plant soil tests	43%	46%	36%	51%	37%	47%	53%	53%	56%
In-season leaf or petiole test	14%	12%	12%	22%	13%	14%	17%	17%	21%
In-season NVDI scan	14%	14%	13%	15%	9%	18%	16%	23%	38%
Decision support tools	21%	19%	22%	26%	18%	24%	26%	29%	30%
None	11%	13%	10%	10%	14%	8%	4%	14%	2%
Q39 % crop area where N applied based on soil test results (base: soil test)	65%	68%	58%	76%	60%	67%	68%	79%	81%
Q40 % crop area where N applied based nutrient removal by crop	66%	64%	65%	70%	63%	69%	66%	67%	83%
Q41 % crop leaf/petiole tested	5%	5%	4%	9%	5%	5%	6%	10%	6%
Q42 % crop with in-season/top dressing of N	61%	52%	62%	79%	59%	63%	65%	64%	63%
Q43 % N applied post planting	55%	48%	59%	61%	54%	58%	58%	53%	48%
Q44 average N application rate (kg/ha) for each crop type									
Winter cereals	84	77	95	73	86	87	74	74	70
Oilseeds	120	116	136	98	124	127	104	100	113
Sorghum/summer crops	85	76	222	10	106	58	45	50	16

Weed, pest & disease management

Table 83

	total	region			area planted (hectares)				
		northern	southern	western	<1,500	1,500-3,000	3,001-5,000	5,001-8,000	8,001+
Q22 main weed related concern									
Rye Grass	42%	32%	51%	40%	41%	44%	40%	46%	41%
Herbicide resistance	36%	38%	35%	35%	35%	36%	41%	41%	37%
Broadleaf weeds	23%	24%	21%	28%	23%	26%	19%	24%	27%
Summer grasses	18%	23%	16%	13%	16%	19%	21%	27%	19%
Cost of herbicides	3%	3%	2%	3%	2%	4%	4%	0%	2%
No concerns	7%	7%	5%	8%	8%	4%	5%	4%	2%
Q22 main disease related concern									
Stem/Stripe/Leaf Rust/scald/net blotch in cereals	29%	35%	29%	19%	29%	32%	25%	37%	17%
Black leg/Sclerotinia in canola	10%	8%	10%	14%	7%	13%	11%	19%	12%
Crown rot	7%	13%	3%	4%	6%	8%	8%	6%	17%
Fungal diseases/mould - Black Rot/ Foliar/ Sceptoria (Leaf Spot)/Smut/Scald/Vert	7%	3%	11%	5%	7%	8%	6%	3%	5%
Blackspot /Ascochyta/Bacterial Blight/Phytophthora in pulses	7%	7%	9%	3%	4%	11%	10%	13%	12%
Rhizoctonia	6%	3%	6%	11%	4%	8%	6%	12%	10%
No concerns	37%	35%	38%	39%	41%	30%	39%	28%	30%
Q25 mouse control									
% farms spending money on mouse control	54%	80%	45%	22%	51%	54%	59%	66%	73%
Average **$** amount spent (base: incurred mouse control costs)	15,925	18,157	8,041	36,242	8,308	14,815	23,523	30,930	68,616
Q21 harvest weed control systems									
Crop topping	28%	13%	38%	37%	21%	40%	33%	35%	37%
Narrow windrow burning	15%	14%	13%	22%	13%	17%	21%	13%	22%
Spraying under windrows	7%	5%	10%	6%	6%	11%	6%	11%	5%
Seed impact mill	6%	2%	6%	14%	1%	12%	10%	9%	12%
Chaff lining	5%	1%	7%	10%	2%	8%	9%	19%	3%
Chaff carts	4%	2%	4%	9%	3%	5%	4%	10%	0%
Chaff tramlining/ decks	4%	2%	3%	9%	2%	4%	8%	9%	9%
Bale direct	4%	4%	4%	3%	5%	1%	3%	3%	3%
No system used	48%	65%	41%	30%	59%	35%	37%	29%	32%

Weed, pest & disease management – double-knock technique

Table 84

	total	region			area planted (hectares)				
		northern	southern	western	<1,500	1,500-3,000	3,001-5,000	5,001-8,000	8,001+
Q18 use of double knock technique									
% farms using double knock technique on fallow	58%	58%	50%	80%	50%	62%	75%	68%	88%
% fallow where double knock was used	34%	33%	27%	53%	31%	35%	44%	36%	46%
Q20 % pre sowing chemical passes that were double knock (base: use double knock)	20%	21%	14%	33%	17%	22%	23%	29%	30%
Q19 reasons for using double knock									
Stop seed set and reduce weed seed bank	93%	92%	93%	94%	93%	90%	93%	97%	96%
Delay onset of herbicide resistance	86%	83%	87%	91%	83%	85%	91%	93%	90%
Improve control of difficult weeds	72%	83%	64%	60%	71%	74%	73%	65%	77%
Overcome incompatibility of herbicide mixtures	33%	36%	30%	30%	31%	36%	31%	40%	35%

Weed, pest & disease management – fungicide usage

Table 85

	total	region			area planted (hectares)				
		northern	southern	western	<1,500	1,500-3,000	3,001-5,000	5,001-8,000	8,001+
Q23 fungicide application to crop type (base: grow crop type)									
% applying fungicide to winter cereals	75%	67%	81%	79%	69%	84%	83%	81%	76%
% applying fungicide to pulses/legume	61%	58%	75%	30%	62%	66%	51%	61%	53%
% applying fungicide to oilseeds	56%	61%	54%	54%	54%	61%	55%	57%	54%
% applying fungicide to summer crops	6%	4%	22%	0%	8%	4%	0%	0%	0%
Q24 number of fungicide applications to winter cereals (base: apply fungicide)									
In furrow	0.3	0.3	0.2	0.5	0.2	0.4	0.3	0.4	0.4
As seed treatment	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.5	0.7
Foliar application	1.2	1.2	1.3	1.1	1.2	1.2	1.2	1.2	1.2
Q24 number of fungicide applications to pulses/legumes (base: apply fungicide)									
In furrow	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.2
As seed treatment	0.4	0.6	0.2	0.6	0.4	0.3	0.3	0.4	0.7
Foliar application	1.7	1.8	1.8	0.8	1.8	1.7	1.5	1.5	1.4
Q24 number of fungicide applications to oilseeds (base: apply fungicide)									
In furrow	0.3	0.3	0.3	0.5	0.3	0.4	0.5	0.3	0.3
As seed treatment	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.8
Foliar application	0.9	1.1	0.9	0.8	1.0	0.9	0.8	0.8	0.9
Q24 number of fungicide applications to summer crops* (base: apply fungicide)									
In furrow	0.2	0.0	0.5		0.2	0.0			
As seed treatment	0.1	0.2	0.0		0.2	0.0			
Foliar application	1.1	1.2	1.0		1.0	2.0			

**caution small sample sizes*

14. Appendix 2: Questionnaire

Farm demographics

Q1. On the land you manage, do you ... *multiple response possible*
- Grow grain crops ---------- 1
- Run cattle ---------- 2
- Run sheep ---------- 3

If Q1 is not code 1, thank and end.

Q2. Most of the survey questions ask about area. Do you prefer to use hectares or acres?
- Hectares ---------- 1
- Acres ---------- 2

Q3. Can you tell me your total farm area?

Q4. **A)** How many (hectares/acres) of winter crop have you sown in 2021? Please include any double cropped area

B) How many (hectares/acres) of spring or summer crop did you plant in the 2020-21 season

Q5. Has any crop area been double cropped during 2021?

Yes	1	continue
No	2	go to Q7

Q6. How many (hectares/acres) have been double cropped?

Q7. How many (hectares/acres) of your land is under pasture or under a permanent vegetation plan in 2021?

Q8. Do you have a vegetation plan to ... *Multiple response possible*
- Assist with crop production ---------- 1
- Provide additional income ---------- 2
- Conserve an area of native vegetation for biodiversity or amenity benefit ---------- 3

Q9. **A)** What winter crops have you sown in 2021? (*do not read, record in grid)*

Winter crops:
- Bread wheat ---------- 1
- Durum wheat ---------- 2
- Feed barley (respondent may not know the grade of barley they will achieve, but this may be planned for) ---------- 3
- Malt barley (respondent may not know the grade of barley they will achieve, but this may be planned for) ---------- 4
- Oats ---------- 5
- Triticale (pronounced tri – ti – carly) ---------- 6
- Cereal rye ---------- 7
- Canola ---------- 8
- Mustard ---------- 9
- Linola ---------- 10
- Chickpeas ---------- 11
- Field peas ---------- 12
- Lentils ---------- 13
- Lupins ---------- 14
- Faba beans ---------- 15
- Vetch ---------- 16
- Other winter crops ---------- 19
- Crop intended to be or already '**green** manured' (ploughed into soil prior to maturity for weed or disease management) ---------- 17
- Crop intended to be or already '**brown** manured' (sprayed out prior to maturity for weed or disease management) ---------- 18

If Q4B = >0, ask:
B) What spring or summer crops did you plant in the 2020-21 season

Summer crops:
Sunflower ---------- 20
Sorghum ---------- 21
Corn or Maize ---------- 22
Soybeans ---------- 23
Mungbeans ---------- 24
Cotton ---------- 25
Rice ---------- 26
Other summer crops ---------- 27
Crop intended to be or already '**green** manured' (ploughed into soil prior to maturity for weed or disease management) ---------- 17
Crop intended to be or already '**brown** manured' (sprayed out prior to maturity for weed or disease management) ---------- 18

For each crop planted in 2021 (Q9A), ask:
Q10. **A)** How many (hectares/acres) of (from Q9A) have you sown in 2021? *Please include any area that you may have double cropped*

For each crop planted in 2021 (Q9B), ask:
B) How many (hectares/acres) of (from Q9B) did you plant in the 2020-21 season (*do not read, record in grid)*

Q11. Over the past 2 years have you planted a new variety of (ask each from Q9 – winter cereal, pulse, oilseed)? *Record in grid below*

Q12. And what were the main reasons for planting a new variety of (from Q9)? *Do not read- record in grid below*
Yield gains ---------- 1
Disease resistance ---------- 2
Longer duration (early season) crop ---------- 3
Shorter duration (late season) crop ---------- 4
Graze and grain ---------- 5
Milling quality ---------- 6
Harvestability ---------- 7
Plant height ---------- 8
Flowering times(*interviewer note: answers for frost and heat resistance included here*) ---------- 9
Drought resistance/low moisture
Recommended by other farmer/agronomist/other ---------- 10
Other (specify) ---------- 11

		Q12 planted new variety			Q13 Reason for planting new variety
		Yes	**No**	**Unsure**	
A	If Q9 = code 1 to 7 ask: **Winter cereals**	1	2	2	
B	If Q9 = code 11 to 16 or 23 or 24 ask: **Pulses/legumes**	1	2	3	
C	If Q9 = code 8 to 10 or 20 ask: **Oilseeds**	1	2	3	
D	If Q9 = code 21, 22 ask: **Sorghum/summer crops**	1	2	3	

If Q9 = code 1 or 2, ask:
Q13. In 2021, what varieties of wheat did you sow?

Fallow and Stubble management
I have some questions about fallow and stubble management. By **fallow**, I mean either the time between crops in the same paddock or the period between a pasture phase and beginning a cropping phase in a paddock. In this survey, the definition of 'short fallow' is the period between annual crops, usually about 6 months, whereas a long fallow is 12 months or longer.

Q14. Over the past 12 months, how many (hectares/acres) have been … *read out? (MR)*
A. Long fallowed _____
B. Short fallowed _____

Q15. This year, 2021, how did you manage your fallow stubble? *read out…*

Planted crops into stubble from the previous crop left intact ---------- 1

Planted crop into stubble from the previous crop retained, but treated in a way to help with managing the stubble at planting, for example baling the stubble, harrowing, chaining or using some other treatment that means the stubble is no longer the same as it was after harvesting the previous crop 2

Planted crops into stubble that was harvested to produce windrows that were then burnt ---------- 3

Planted crops into stubble was burnt within a few weeks prior to planting ---------- 4

Planted crops into stubble burnt some months prior to planting ---------- 5

Planted crop into stubble incorporated into the soil using a tillage or disc machine or similar ---------- 6

For each method mentioned in Q15, ask Q16.
Q16. And roughly what proportion of your total cropping area in 2021 did you plant where …

Weed, pest and disease management

I would like to ask you some questions about weed management

Q17. This year, 2021, what proportion of area planted (%), if any, did you plant in a way that assists with weed competition, for example using higher seeding rate or narrower row spacing?

Ask Q18 only of people using fallow in past 12 months (Q14a + Q14b = > 0), ask:

Q18. In 2021, what proportion of fallow, if any, did you use the double knock technique

Ask Q19 only of people using double knock (Q18 = not zero)

Q19. What are the main reasons for using double knock techniques on your farm? *Read out…*

		Yes	No	Unsure
A	Achieve very high levels of weed control to stop seed set and drive down weed seed banks	1	2	3
B	To delay the onset of herbicide resistance	1	2	3
C	To provide improved levels of control of difficult-to-control weeds such as feathertop Rhodes and windmill grass, fleabane and sowthistle	1	2	3
D	To overcome physical or biological incompatibility of certain herbicide mixtures	1	2	3
E	*Do not read* - Other (specify)	1	2	3
F		1	2	3

Ask Q19 only of people using double knock (Q18 = not zero)

Q20. Prior to sowing, what proportion of chemical weed control passes are …*read out*

A – One pre-plant knockdown herbicide

B – Double knockdown, so 2 pre-plant knockdown herbicides or glyphosate followed by paraquat/diquat 1-5 days apart

Ask all

Q21. Which of the following harvest weed control systems do you currently use? *Read out*

		Yes	No	Unsure
A	Chaff carts	1	2	3
B	Bale direct	1	2	3
C	Seed impact mills or destructors	1	2	3
D	Narrow windrow burning	1	2	3
F	Spraying under windrows	1	2	3
F	Crop topping	1	2	3
G	Chaff lining	1	2	3
H	Chaff tramlining or chaff decks	1	2	3
I	No harvest weed control system used	1	2	3
J	*Do not read O*ther (specify)	1	2	3

Ask all:

Q22. What would you say is currently your main concern related specifically to … *Read out categories highlighted in bold – a/ weeds, b/ diseases?*

A. Weeds:

Rye Grass ---------- 1
Herbicide resistance ---------- 2
Weather related / drought / variability ---------- 3
Wild Radish- ---------- 4
Fleabane ---------- 5
Summer grass weeds ---------- 6
Broadleaf weeds ---------- 7
Other (specify) ---------- 8
No problems experienced ---------- 13

b. Diseases:

Stem Rust / Stripe Rust / Leaf Rust / scald / net blotch in cereals ---------- 26
Crown rot ---------- 27
Rhizoctonia ---------- 28
Black Leg / Sclerotinia in canola ---------- 29
Blackspot / Ascochyta Blight / Bacterial Blight / Phytophthora / in pulses ---------- 30
Yellow leaf spot ---------- 67
Other (specify) ---------- 31
No problems experienced ---------- 35

Q23. In the 2020-21 cropping season, have you applied fungicide to…

		Yes	No	Not sure
A	If Q9 = code 1 to 7 ask: **Winter cereals**	1	2	3
B	If Q9 = code 11 to 16 or 23 or 24 ask: **Pulses/legumes**	1	2	3
C	If Q9 = code 8 to 10 or 20 ask: **Oilseeds**	1	2	3
D	If Q9 = code 21, 22 ask: **Sorghum/summer crops**	1	2	3

For each mentioned at Q23, ask

Q24. How many fungicide applications have you applied to … *read out each crop type grown and method …*

		In-furrow *or into soil*	As seed treatment	foliar app lication	Don't know
A	**Winter cereals**				
B	**Pulses/legumes**				
C	**Oilseeds**				
D	**Sorghum/summer crops**				

Q25. In the 2020-21 cropping season, approximately how much money have you spent on mice control measures, including baiting, grain screening and cleaning?

Crop sequencing
The following questions relate to crop sequencing.

Q26. What proportion, if any, of cropping area was planted with a break crop specifically for weed control reasons? So the crop was chosen to allow targeted control measures to be used against key weeds.

Q27. What proportion, if any, of cropping area was planted with a break crop specifically for disease control reasons? So the crop was chosen to allow targeted control measures to be used against key diseases

Q28. What proportion, if any, of cropping area was planted with a break crop specifically for the nutritional benefits from the crop or the management of the crop? For example, nitrogen input from a pulse crop or the use of a green or brown manure technique

Soil management
The following questions relate to soil management.

Q29. How many **tonnes** of lime, if any, did you apply in the last year?

If Q29>0 ask:
Q30. What proportion of cropped area was the lime applied to?

If grow cereal crop (Q9 = 1, 2, 3, 4, 5, 6, or 7), ask Q31, others go to Q32
Q31. What proportion of your **winter cereal** crop was pre-plant soil tested for nutrient levels this year?

If grow oilseed crop (Q9 = 8, 9, 10 or 20 equal not 0, ask Q32, others go to Q33
Q32. What proportion of your **oilseed** crop was pre-plant soil tested for nutrient levels this year?

If grow sorghum (Q9 = 21, ask Q33, others go to Q34
Q33. What proportion of your most recent **sorghum** crop was pre-plant soil tested for nutrient levels this year?

If Q31, Q32 or Q33 = >0 ask:
Q34. What proportion of your soil nutrient tests were to a depth of:

1. 10cm or less
2. 11 to 30cm
3. 31 to 60cm
4. 61cm to 1m
5. > 1m
6. Do not soil test

If not code 6, then code 1 to 5 must add to 100%

Ask all:
Q35. What proportion of your cropped area was pre-plant tested for soil moisture levels this year?

If Q35 does not equal 0, ask: (others to Q38)
Q36. What proportion of your soil moisture tests are taken to a depth of?

1. 10cm or less
2. 11 to 30cm
3. 31 to 60cm
4. 61cm to 1m
5. > 1m
6. Do not soil test

If Q35 does not equal 0, ask: (others to Q38)
Q37. How was soil moisture measured or assessed this year? Using a … *Read out*

		Yes	No	Unsure
A	Push probe	1	2	3
B	Soil core	1	2	3
C	Moisture sensor	1	2	3
D	Calculation based on fallow rainfall (e.g. using fallow efficiency, model)	1	2	3
F	*Do not read O*ther (specify)	1	2	3

Fertilizer management

Ask all

Q38. Which of the following do you use to calculate Nitrogen fertiliser application rates: *read out…(MR)*

Setting a target yield and consequent nitrogen demand for your crop	1
Adjusted for nutrient removal by previous crop based on yield	2
Adjusted for nutrient removal by previous crop based on protein map	3
Pre-plant soil tests	4
In-season leaf or petiole test	5
In-season NVDI scan	6
Decision support tools	7
Other (specify)	8
None	9

If Q31, Q32 or Q33 = >0 ask Q39, others go to Q40

Q39. What proportion of your crop, if any, has been treated with fertiliser at rates based on soil test results? _____

Ask all:

Q40. What proportion of your crop, if any, has been treated by fertiliser at rates based on your estimates or calculations of nutrient removal rates by the crop? _____

Q41. What proportion of your crop, if any, has had a leaf or petiole test? _____

Q42. What proportion of your crop, if any, has had an in-season application or top dressing of fertiliser such as urea, liquid N, UAN, etc? _____

If Q9 = code 1 or 2, ask:

Q43. In your 2021 wheat crop, what proportion of nitrogen fertiliser was applied post-planting? _____

Q44. What was the average amount of nitrogen per hectare applied for the 2020-21 growing season to…. *Read out crop types from table below*? (Interviewer note: 2020-21 is last season) (if required, estimated amount will do) (normal range xx/ha –xx/ha) *DP: allow hectares and acres – convert acres to hectares*.

		Average rate (kg)/ha
A	If Q9 = code 1 to 7 ask: **Winter cereals**	
B	If Q9 = code 8 to 10 or 20 ask: **Oilseeds**	
C	If Q9 = code 21, 22 ask: **Sorghum/summer crops**	

Precision agriculture techniques

The next questions relate to precision agriculture techniques.

If none, write 0.

Q45. On what proportion of the crop, if any, was controlled traffic used? (*interviewer note: for clarification: permanent wheel paths or traffic lanes, with most equipment using the same track widths used*)

Q46. What proportion of the crop, if any, is yield mapped?

Q47. What proportion of the crop, if any, was variable rate technology for fertiliser application used?