

# FARM PRACTICES SURVEY

REPORT 2015



**GRDC**<sup>TM</sup>

GRAINS RESEARCH &  
DEVELOPMENT CORPORATION



Title: **GRDC Farm Practices Survey Report 2015**

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

1. land use (crop/pasture/native vegetation);
2. crop mix
3. tillage regime;
4. stubble management;
5. crop rotation/sequencing with pastures, oilseeds and pulses;
6. precision agriculture techniques;
7. fallow management
8. soil management, nutrient budgeting and soil testing;
9. soil moisture management;
10. miscellaneous practices (herbicide resistance management, grain storage, quality assurance)

Authors: **Alan Umbers, Pamela and Daniel Watson**

Alan Umbers  
Grains Research & Development Corporation  
PO Box 5367  
KINGSTON ACT 2604  
P: 02 6166 4500  
E: alan.umbers@grdc.com.au

Pamela Watson and Dan Watson  
Down to Earth Research Pty Ltd  
10 Caladenia Circuit  
FRANKSTON SOUTH  
VICTORIA 3199  
P: 03 9708 8008  
E: pam@dter.com.au

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Ashley Ramm says one of the benefits of narrow windrow burning is that it is an inexpensive method of weed control, despite the windrows requiring a 'bit of work' to burn.



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# FOREWORD

Over recent years, Australian grain growers have demonstrated their resourcefulness and success in managing what has been a run of challenging seasons. Farming practices are constantly changing to match the challenge.

The adoption of sustainable practices in tillage, fertiliser application, crop residue management, integrated pest, disease and weed management, rotations, precision agriculture and others has contributed to the resilience and success of grain businesses.

The GRDC invests about \$190 million of grain levies and government funds each year into research, development and extension (RD&E). Of this, around \$40 million is invested in farm management practice RD&E to provide grain growers with better tools and information to enhance farm productivity and sustainability.

This is the third GRDC Farm Practices Survey report. The GRDC and Down to Earth Research conducted a national survey of growers to capture information about the farming practices currently in use on grain and mixed farms across Australia.

The report provides quantitative data to monitor and evaluate the adoption levels of farming systems and key on-farm management practices by grain growers across Australia. These practices are important to drive productivity, profitability, sustainability and environmental improvements on grain farms. It helps the GRDC identify successes and gaps, and assists the GRDC with directing future investments and modifying existing projects.

The GRDC will continue to work with growers, advisers and research partners to improve adoption and make our industry more sustainable and profitable.



*Stuart Kearns,  
executive manager, regional grower services,  
Grains Research and Development Corporation*

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# EXECUTIVE SUMMARY

## Measurement of farming practices

The GRDC commissioned Down to Earth Research Pty Ltd to contact a national subset of grain producers and gather data about their farming operations and practices. The survey was based on the farming operations for the 2014 (winter) cropping year and, where possible, was tracked against the 2008 baseline assessment conducted by Solutions Marketing and Research Pty Ltd and the 2011 survey conducted by Kaliber Research Pty Ltd.

## Summary of main trends

### Farm size

Farm size as recorded by respondents in 2014 showed a decrease in average farm size compared with previous survey data, averaging 3475 hectares per farm. These changes may be within the margins of error, although there are suggestions that in parts of South Australia and Victoria farm size has decreased since previous surveys.

### Area of crop per farm

The largest crop farms are in Western Australia, as in previous surveys. There does appear to have been a decrease in cropped area on farms in many agro-ecological zones (AEZs).

### Proportion of crop per farm

There has been a general decrease in the average total area of farms that has been allocated to cropping in the past three years. This was most marked in north-west New South Wales/south-west Queensland, NSW/Victorian Slopes, the NSW/Victorian Mallee, Victorian High Rainfall and SA/Victorian–Bordertown Wimmera zones.

### Farmland with a vegetation plan

Generally, between 30% and 40% of farms in the survey have a vegetation plan, varying from 21% to almost 50% in Queensland Central.

### Crop mix on grain farms in 2014

While wheat remains the dominant crop planted, a general decrease in the proportion of the crop that is wheat was reported. An increase in the proportion of barley and other cereals crops was reported in 2014, although barley remained below the levels reported in 2008.

The proportion of crop area sown to oilseeds and pulses showed a slight increase in 2014, continuing a trend since 2008.

### Tillage in 2014.

The data suggests a decrease in the use of zero-tillage, with an increase in no-tillage. However, there also appears to be an inverse relationship between these. When taken together these two tillage regimes have increased as a proportion of how the crop is sown.

There appears to have been an increase in the use of multiple tillage techniques in 2014 compared with previous surveys.

### Precision agriculture in 2014

The use of controlled traffic has remained stable, at 21% of the cropped area. Autosteer has continued to grow in popularity, used on more than 80% of the cropped area nationally.

Variable-rate technology is used more for fertiliser application than seeding, and remains a minor practice applied across 10% or less of the national cropping area.

Yield mapping has continued to grow in popularity, now approaching 30% of the national cropping area.

### Fallow management in 2014

The majority of farms used a fallow period in their cropping program in 2014, with this being highest in the northern region than elsewhere. Herbicides are the dominant management tool used in fallows, although some cultivation is used on more than 30% of the fallow area. Livestock are grazed on approximately half of fallow areas.

### Stubble management

The proportion of crop sown where stubble was retained right through to sowing is relatively stable at 60% of the cropping area, although there appears to be possible practice differences in how the stubble was managed. Stubble burning has remained a minor practice.

Almost 25% of the cropped area had stubble incorporated.

Several additional questions were included in the 2014 survey. While there were differences between the various AEZs, approximately 30% (nationally) of the cropped area was sown and harvested with stubble retention in mind and with the inter-crop/fallow period managed similarly. Almost 50% of the crop area was sown using practices conducive to stubble retention, and 25% of the crop area was managed where stubble was removed or otherwise managed to avoid any negative impacts from stubble.

Additional data was gathered about the management of weeds, pests, diseases and nutrition with stubble retention in mind.

### Paddock history

The proportion of cereals sown following a break crop or pasture has decreased slightly since the previous surveys. Again, differences between AEZs are apparent. Nationally, almost 13% of the crop is sown following a long fallow.

Reasons for the use of break crops were weed management (18% of crop area), disease management (15%) and nutrition (12%).

### Lime use

The data suggests that the proportion of the cropped area where lime was applied in 2014 was significantly lower than previously. Some doubt exists about the data since relatively high proportions were reported in areas where soils are alkaline or neutral rather than acid. The national average use rate appears to have fallen slightly.

### Soil testing (nutrition)

The proportion of the cropped area soil tested in 2014 appears to be quite a degree lower than in previous surveys. Soil testing tends to be used more where cereal and oilseed crops are sown.

### Fertiliser program development

Overall there was a decrease in soil testing. Where soil testing was carried out it was to better understand the existing soil nutrient status of a paddock and to assist the grower in developing an appropriate fertiliser program going forward.

### In-season fertiliser use

In-season fertiliser applications (top-dressing) continue to be applied on almost 50% of the cropped area, although these are not necessarily based on in-season soil testing, or leaf/petiole testing.

### Soil moisture management

The proportion of the crop where soil moisture was assessed at sowing has continued to grow, now approaching 60% of the cropped area nationally. In-season moisture measurements have also increased, now more than 34% of the cropped area nationally.

### Miscellaneous questions in 2014

Soil testing for nematodes remains low, at less than 5% of the cropped area nationally in any five-year period.

Up to one-third of farms in some AEZs report being affected by herbicide-resistant weeds, nationally averaging 16%.

The double-knock weed-management technique (using herbicides) is used on almost 20% of the fallow area, with tillage used as the second knock on 8% of the fallow area.

Group A herbicides continue to be applied on about 30% of the cropped area, with a small increase in Group B herbicides being applied..

Nationally, 16% of farms are using some form of Quality Assurance or Environmental Assurance program. This is highest in Western Australia, with between 20% and 43% of farms using a program of this type.



# INTRODUCTION

This is the third GRDC Farm Practices Survey report.

The GRDC commissioned Down to Earth Research Pty Ltd to survey a national subset of grain producers and gather data about their farming operations and practices. The survey was based on their farming activities for the 2014 (winter) cropping year and, where possible, was tracked against the 2008 baseline assessment and 2011 farming practices survey.

# SURVEY METHODOLOGY

## Who was surveyed

Down to Earth Research Pty Ltd contacted grain producers who were randomly selected from the GRDC Customer Relationship Management (CRM) database. The response rate was 26%. The response rate was low as the survey was conducted at the beginning and carried on through the winter crop harvest period over late 2014 and early 2015. 1283 grain producers agreed to be interviewed. This gave an overall margin of error of  $\pm 2.7\%$ .

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

This sample size represents approximately 5.3% of the estimated number of grain producers in Australia (based on an estimate of 24,183 growers/farms in Australia).

However, the amount of crop area represented by the survey respondents equated to approximately 2.018 million hectares, or around 9% of the estimated total crop in Australia (Table 4).

Respondents were chosen randomly.

**TABLE 1** Estimate of the number of farms, sample size and margin of error for each of the agro-ecological zones.

Agro-ecological zone	Estimate of number of farms*	Interview sample size	Margin of error
NSW Central	2353	100	$\pm 9.8\%$
NSW North-East / Queensland South-East	2969	127	$\pm 8.5\%$
NSW North-West / Queensland South-West	896	53	$\pm 13.2\%$
NSW / Victorian Slopes	4015	167	$\pm 7.5\%$
Queensland Central	426	32	$\pm 16.6\%$
SA Mid North / Lower Eyre Peninsula	2598	122	$\pm 8.7\%$
SA / VIC Bordertown, Wimmera	3046	113	$\pm 9.1\%$
SA / Victorian Mallee	2532	167	$\pm 7.4\%$
Tasmania	9	7	$\pm 36.0\%$
Victorian High Rainfall	744	71	$\pm 11.4\%$
WA Central	3020	191	$\pm 6.9\%$
WA Eastern	608	47	$\pm 13.6\%$
WA Mallee/Sandplain	354	44	$\pm 14.2\%$
WA Northern	596	42	$\pm 14.7\%$
<b>Totals</b>	<b>24,183</b>	<b>1283</b>	<b><math>\pm 2.7\%</math></b>

\*Note: The total number of grain or mixed grain farms are estimated by the Australian Bureau of Statistics, and provided by Neil Clark & Associates for 2012 for each agro-ecological zone.

## The survey questions

The final questionnaire consisted of 23 individual questions, many of which had sub-component questions. The survey questions were designed to provide data on the following sustainable farm practices:

- basic statistics for the farm – farm type, areas of farm, crop and pasture, areas of the various crops;
- fallow management;
- reduced or no-tillage. The use of minimum, zero or no-tillage systems for crop and pasture establishment;
- stubble management. There have been several additional questions included in the 2014 survey in response to the commencement of a stubble management initiative by the GRDC;
- crop sequencing with pastures, oilseeds and pulses;
- soil management. The use of lime and the use of soil testing;
- controlled traffic/precision agriculture. Includes the use of remote sensing;
- soil moisture management
- nutrient budgeting and soil testing in crop and pasture;
- miscellaneous questions. Grain storage, use of Group A and B herbicides, use of any stewardship programs.

Quantitative answers were sought wherever possible.

The survey was carried out from October 2014 into January 2015. There was a break in interviewing during the busiest period of harvest.

Interviewing was conducted using Computer Aided Telephone Interviews (CATI). A team of specialised interviewers, with empathy for rural Australia made telephone contact with growers.

## The data analysis process

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

Data has been allocated to agro-ecological zones, enabling comparison with the earlier surveys (2008 and 2011 crop years).

Data was analysed by the statistical software package R.

## How is the data presented

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

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

- tables comparing 2008, 2011 and 2014 winter crop year data;
- figures comparing the 2014 data in each agro-ecological zone; and
- maps showing the 2014 data.

When the data is shown in tables, where means are significantly different between survey years and within agro-ecological zones the statistical analysis of the data is denoted as:

- \*\* = means are significantly different at the 5% level;
- \*\*\* = means are significantly different at the 1% level.

Where data is presented for only the 2014 survey year, statistical comparisons have been made between agro-ecological zone means for these data. Agro-ecological zone (AEZ) means are identified in these tables with lower case letters in brackets (for example: NSW Central (a)). Statistically significant differences ( $P < 0.05$ ) between an AEZ and others are indicated by the letters in the final (right-hand) column. In these tables, the mean for an AEZ where a letter is displayed in the final column signifies a significant difference between this mean and those for the AEZ of the letter(s) indicated.

Actual data will be referred to as '2008', '2011' or '2014' to denote the data being from the winter crop years of 2008, 2011 and 2014.

# 2014 survey results

## GRAIN FARM STATISTICS



PHOTO: PAUL JONES

A number of questions were asked about the farm:

- What is the total area of your farm, including all leased land and any unused land?
- In 2014, how many hectares of crop/pasture/native vegetation did you have?
- Do you have a vegetation plan for your farm? What purpose is this land used for?

### Number of grain farms and total area of farmland

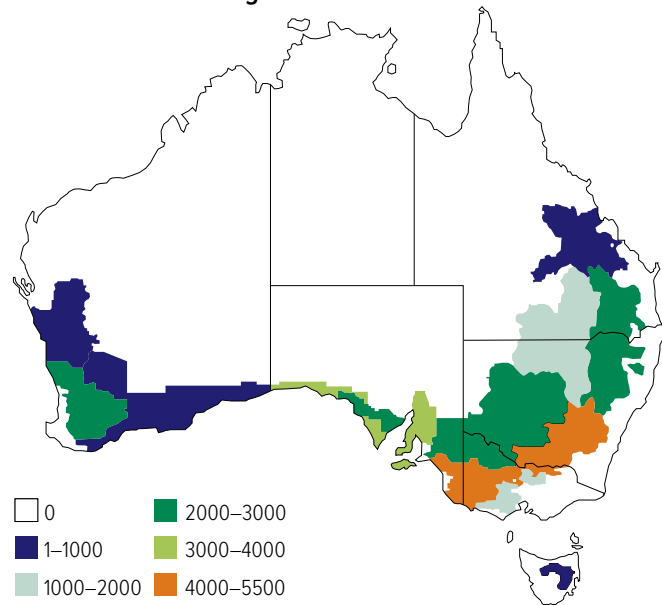
In both 2008 and 2011 approximately 1300 farms were accessed representing 4.3% of the estimated number of grain producing farms in Australia (Table 2). In 2014 1283 farms responded and participated in the survey. The number of grain farms in Australia is difficult to estimate. Data from the Australian Bureau of Statistics (ABS), as manipulated and provided by Neil Clark & Associates, suggests that between grain-only and mixed grain-livestock farms in Australia

**TABLE 2** Sample size and total farmland represented in the survey data by agro-ecological zone in 2008, 2011, 2014.

Agro-ecological zone	Sample size			Total farm area (ha) surveyed		
	2008	2011	2014	2008	2011	2014
NSW Central	75	95	100	361,822	588,559	446,303
NSW NE / Queensland SE	158	86	127	424,831	250,633	364,221
NSW NW / Queensland SW	60	94	53	270,496	443,651	293,073
NSW / Victorian Slopes	124	160	167	319,586	375,633	390,612
Queensland Central	23	35	32	137,003	177,243	117,820
SA Mid North / Lower EP	97	118	122	231,131	257,819	194,033
SA / VIC Bordertown Wimmera	126	106	113	242,981	188,513	178,006
SA / Victorian Mallee	180	160	167	613,059	627,427	521,416
Tasmania	4	7	7	12,435	15,185	16,488
Victorain High Rainfall	37	65	71	86,636	111,685	73,899
WA Central	200	185	191	728,108	663,131	660,269
WA Eastern	62	62	47	347,584	382,235	335,648
WA Mallee / Sandplain	68	57	44	325,016	279,801	191,872
WA Northern	86	82	42	492,904	464,709	215,367
<b>Total</b>	<b>1300</b>	<b>1312</b>	<b>1283</b>	<b>4,593,592</b>	<b>4,826,224</b>	<b>3,999,028</b>



**FIGURE 1** Number of grain farms in 2010.



SOURCE: NEIL CLARKE & ASSOCIATES

there were 24,183 grain farms in Australia in 2012. This data suggests that the number of farms surveyed in 2014 was approximately 5.3% of grain farms.

In the previous two surveys, the amount of farm area represented was over 4.5 million hectares, while in the 2014 survey the farm area was just on 4.0 million hectares. This possibly reflects the decreased numbers of respondents as compared with the previous surveys, although it is also noted that the average farm area per respondent is reduced (see notes in the following section).

### Farm size

There are considerable differences in farm area of grain farms across the various agro-ecological zones (AEZs), with larger farms present in much of Western Australia, Queensland Central, New South Wales Central and north-west NSW/south-west Queensland (Table 3, Figure 2 and Figure 3). Smaller farm sizes are found in Victorian High Rainfall zones, much of South Australia and Victoria, NSW/Victorian Slopes and north-east NSW/south-east Queensland.

In 2008 the average farm area of grain farms surveyed was 3768ha, in 2011 it was 3810ha, and in 2014 it was 3475ha.

**TABLE 3** Average farm size (ha) within agro-ecological zones in 2008, 2011 and 2014.

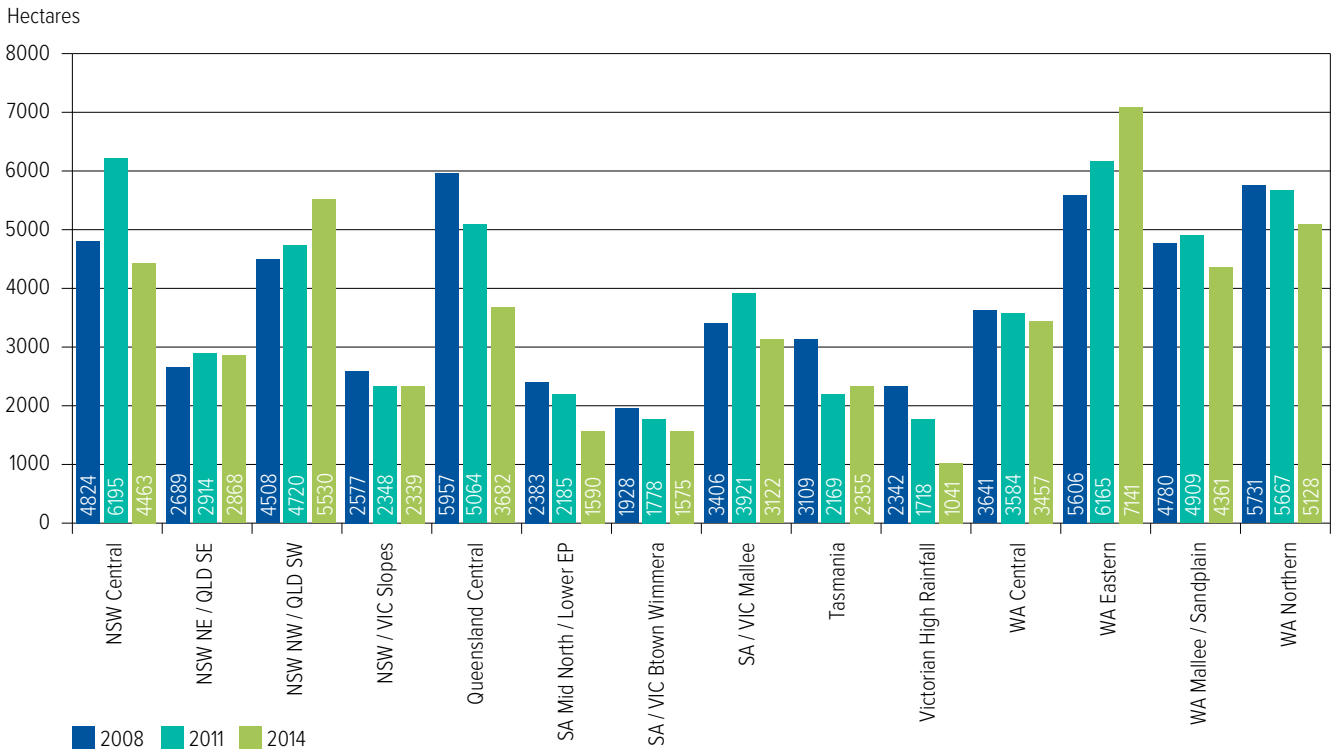
Agro-ecological zone	Average area per farm (ha)			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	4824	6195	4463		
NSW NE / Queensland SE	2689	2914	2868		
NSW NW / Queensland	4508	4720	5530		
NSW / Victorian Slopes	2577	2348	2339		
Queensland Central	5957	5064	3682		
SA Mid North / Lower EP	2383	2185	1590	**	**
SA / VIC Bordertown Wimmera	1928	1778	1575		**
SA / Victorian Mallee	3406	3921	3122		
Tasmania	3109	2169	2355		
Victorian High Rainfall	2342	1718	1041	***	
WA Central	3641	3584	3457		
WA Eastern	5606	6165	7141		**
WA Mallee / Sandplain	4780	4909	4361		
WA Northern	5731	5667	5128		
National averages	3768	3810	3475		

### Area of crop in the survey

Table 4 shows the area of crop represented by the respondents in the surveys. The area of crop covered by the survey in 2014 is lower than in the previous surveys, possibly due to the reduced number of respondents in 2014, and, as mentioned, the lower farm area on average per respondent.

The total area of crop grown in Australian in 2015-16 was 23.94 million ha and in 2014-15 the total crop area was approximately 23.72 million ha of combined cereals, pulses and oilseeds (data from ABARES Australian Commodities, Table 14, p25). The crop area as included in the 2014 survey amounts to approximately 8.6% of the total cropped area based on these figures (Table 5).

**FIGURE 2** Farm size (ha) trends within agro-ecological zones.



**Area of crop per farm**

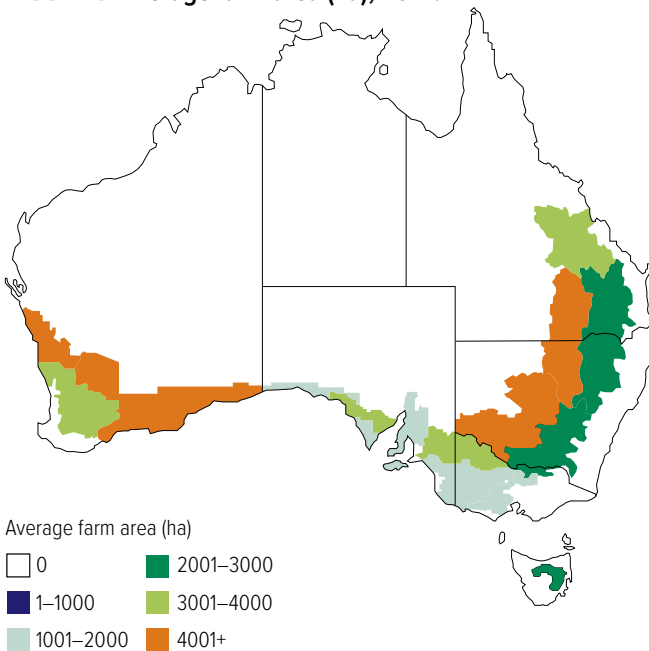
The average area of crop per farm identified in the survey is shown in Table 6, Figure 4 and Figure 5.

The largest crop areas per farm are in Western Australia, western New South Wales, the Mallee region of South Australia and Victoria, and northern NSW/southern Queensland (Table 6).

There is a significant variation between years in some agro-ecological zones.

There appears to have been a decrease in area of crop per farm in several agro-ecological zones, notably NSW Central, NSW/Victorian Slopes, Queensland Central, much of South Australia and the Victorian High Rainfall zone, although a trend is evident in most AEZs.

**FIGURE 3** Average farm area (ha), 2014.



**TABLE 4** Total crop area (ha) in 2008, 2011 and 2014 surveys

Agro-ecological zone	2008 (ha)	2011 (ha)	2014 (ha)
NSW Central	129,205	171,572	143,906
NSW NE / Queensland SE	189,031	88,814	149,601
NSW NW / Queensland SW	112,443	161,461	78,953
NSW / Victorian Slopes	237,149	180,828	163,380
Queensland Central	51,793	44,020	40,450
SA Mid North / Lower EP	152,396	156,052	116,713
SA / VIC Bordertown Wimmera	174,060	92,102	103,420
SA / Victorian Mallee	399,534	287,024	297,100
Tasmania	4453	1767	2452
Victorian High Rainfall	59,308	67,777	36,904
WA Central	502,201	380,849	413,516
WA Eastern	265,492	233,744	203,839
WA Mallee / Sandplain	222,949	178,059	128,440
WA Northern	313,473	311,067	138,981
<b>Total in survey</b>	<b>2,813,487</b>	<b>2,355,135</b>	<b>2,017,654</b>

**TABLE 5** Total crop area (ha) in 2013, surveyed in 2014 and 2014 surveyed as a percentage of 2013 crop area by agro-ecological zone.

Agro-ecological zone	2013 (ha)	2014 (ha in survey)	2014 (% crop of 2013 area)
NSW Central	1,722,365	143,906	8.4%
NSW NE / Queensland SE	2,377,342	149,601	6.3%
NSW NW / Queensland SW	1,416,840	78,953	5.6%
NSW / Victorian Slopes	2,189,911	163,380	7.5%
Queensland Central	393,990	40,450	10.3%
SA Mid North / Lower EP	1,686,999	116,713	6.9%
SA / VIC Bordertown Wimmera	1,908,145	103,420	5.4%
SA / Victorian Mallee	2,989,919	297,100	9.9%
Tasmania	8687	2452	28.3%
Victorian High Rainfall	325,194	36,904	11.3%
WA Central	4,436,959	413,516	9.3%
WA Eastern	1,275,121	203,839	16.0%
WA Mallee / Sandplain	960,591	128,440	10.4%
WA Northern	1,330,506	138,981	13.4%
Total in survey	23,022,570	2,017,654	8.6%

**TABLE 6** Average area (ha) of crop per farm.

Agro-ecological zone	Average area per farm (ha)			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	2115	1806	1439		**
NSW NE / Queensland SE	1954	1036	1178		
NSW NW / Queensland SW	1977	1718	1490		
NSW / Victorian Slopes	1480	1130	978		***
Queensland Central	2242	1258	1264		**
SA Mid North / Lower EP	1263	1322	957	***	***
SA / VIC Bordertown Wimmera	1168	869	915		**
SA / Victorian Mallee	2096	1794	1779		
Tasmania	1068	252	350		
Victorian High Rainfall	1282	1043	520	***	
WA Central	2247	2059	2165		
WA Eastern	3537	3770	4337		
WA Mallee / Sandplain	2995	3124	2919		
WA Northern	3489	3231	3309		
National averages	2065	1744	1686		

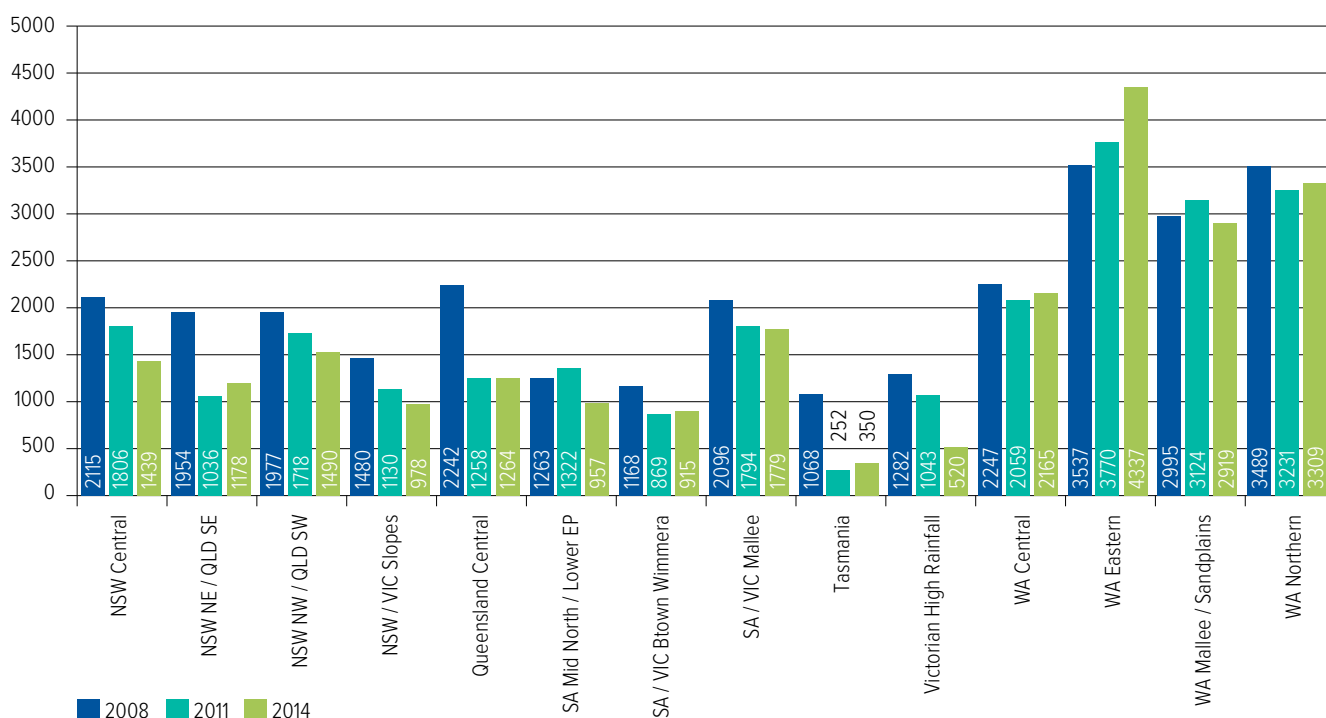
Reasons for these changes are not easily explained, although may lie in the nature of mixed farming (grain and livestock), which tends to be a feature of these AEZs, with the relative profitability of grain and sheep/cattle being an influencing factor. Crop areas per farm in WA appear more stable over the period from 2008 to 2014.

## Use of farmland

Land use on grain and mixed farms generally consists of areas of crop, pasture and native or remnant vegetation. Together, these components should add to the approximate farm area. Not all grain farms have all of these land uses represented, due to their management or for other reasons. Some grain farms are essentially 'grain only', some have little or no native

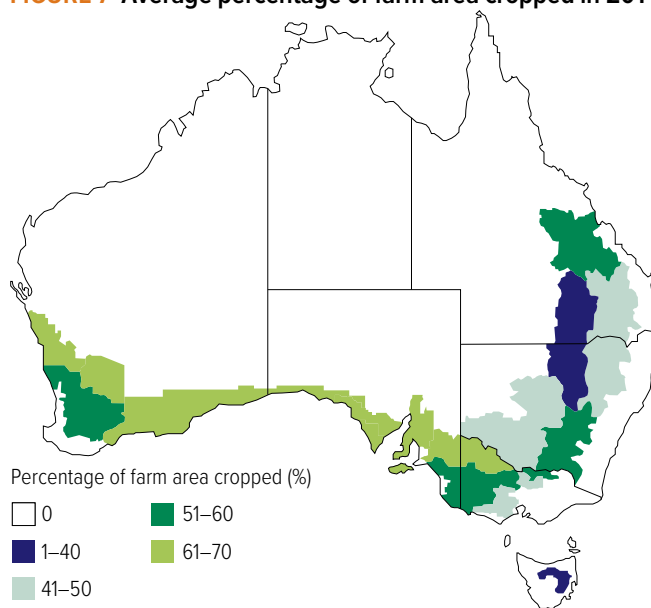
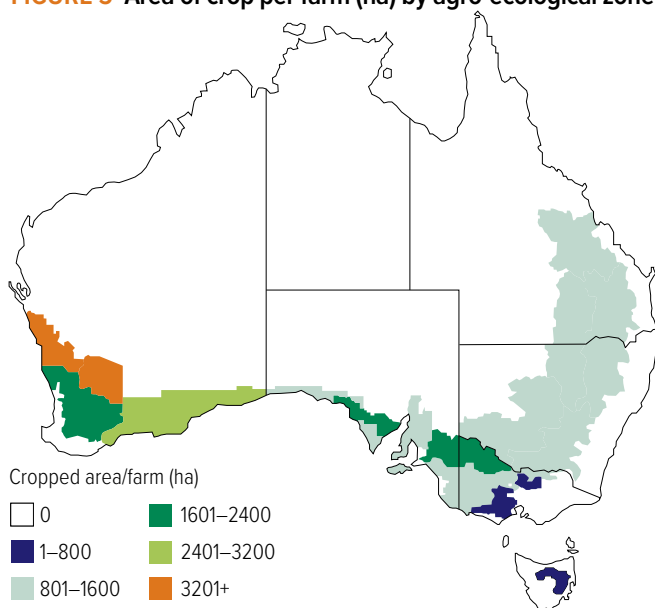
**FIGURE 4** Average area of crop per farm (ha) by agro-ecological zone.

Hectares





**FIGURE 5** Area of crop per farm (ha) by agro-ecological zone. **FIGURE 7** Average percentage of farm area cropped in 2014.



**TABLE 7** Average percentage of farm area cropped.

Agro-ecological zone	Average % of farm area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	49.8	51.9	47.8		
NSW NE / Queensland SE	61.5	55.2	49.8		***
NSW NW / Queensland SW	44.7	50.1	36.6	***	
NSW / Victorian Slopes	61.4	61.7	55.9	**	**
Queensland Central	52.2	52.2	53.9		
SA Mid North / Lower EP	70.0	63.1	69.3		
SA / VIC Bordertown Wimmera	63.3	73.3	57.8		
SA / Victorian Mallee	65.5	72.2	65.9	***	
Tasmania	45.0	38.6	22.0		
Victorian High Rainfall	63.2	66.9	49.4		**
WA Central	61.3	62.1	57.4	**	
WA Eastern	63.9	65.2	60.7		
WA Mallee / Sandplain	61.4	67.1	65.9		
WA Northern	66.8	71.8	66.4		
National averages	59.3	60.8	54.2		

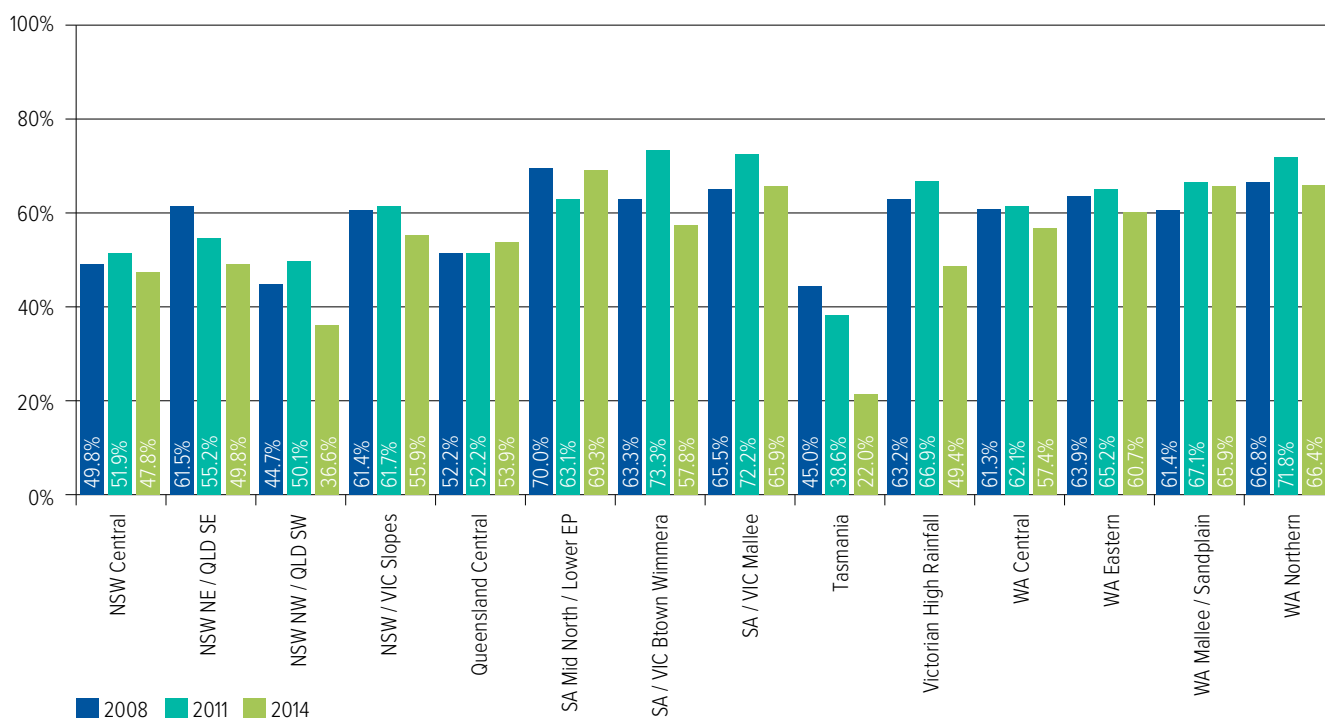
vegetation present, and in some cases areas of 'fallow' may be described as either a pasture (if grazing of the fallow occurs) or crop area not yet planted. Some growers identify areas of native or remnant vegetation as 'available' for some grazing and often nominate these areas as also for 'pasture'.

### Proportion of crop per farm

The proportions (%) of farmland used for grain production on farms in the three surveys are shown in Table 7, Figure 6 and Figure 7.

There has been a general decrease in the average total area of farms that have been allocated to cropping in the past three years. This was most evident in north-west New South Wales/south-west Queensland, NSW/Victorian Slopes, the NSW/Victorian Mallee, Victorian High Rainfall and South Australian/Victorian Bordertown Wimmera.

**FIGURE 6** Average percentage of farm area cropped.



### Proportion of pasture per farm

The presence of some pasture is a feature of most grain producing areas, although many grain-only farms do exist.

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 dedicated pasture);
- 'unimproved' (i.e. volunteer plants or native species that simply emerge on land otherwise not managed); and
- several combinations of the above.

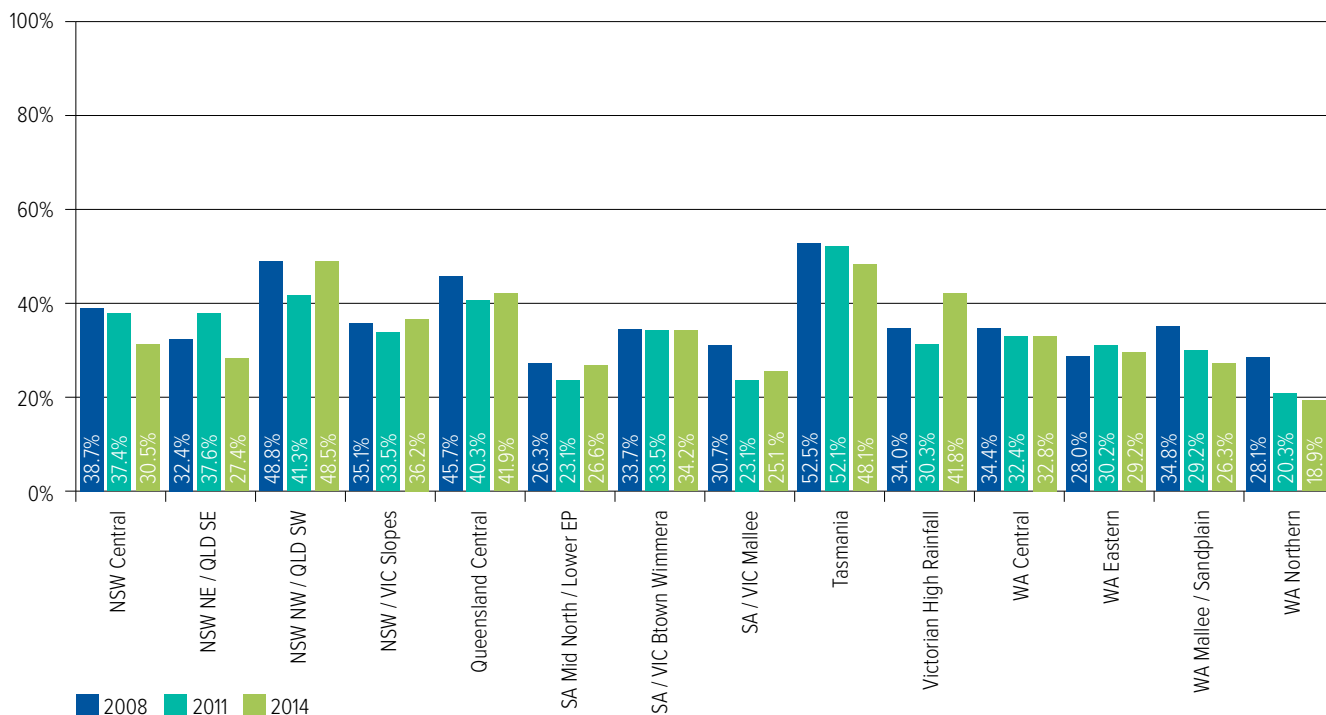
Further, in some areas there is uncertainty about the difference between 'native vegetation' and unimproved, extensive 'pastures'. Livestock on some farms can graze some areas of native vegetation and therefore these areas can be reported as 'unimproved pasture', or 'remnant/native vegetation' or sometimes both.

For these reasons data about pastures often fluctuates between surveys and it can be difficult to make interpretations about changes suggested by survey results. However, as a general rule where area of crop is high, pasture is expected to be low and vice versa.

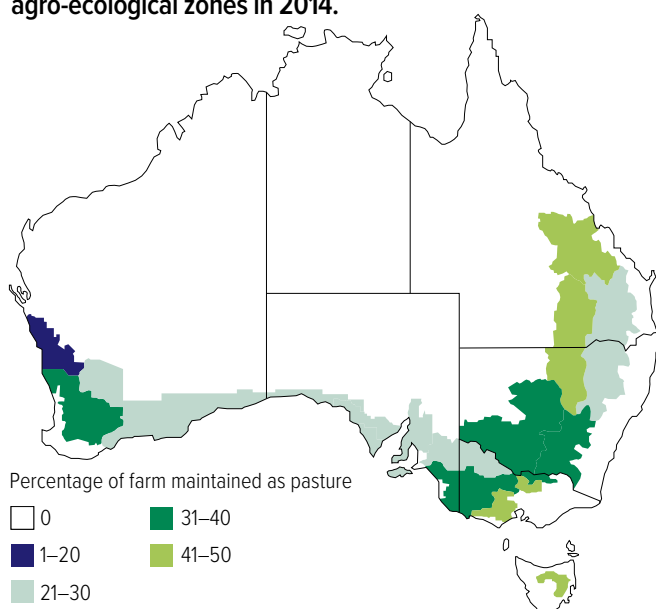
**TABLE 8** Average percentage of farm area maintained as pasture.

Agro-ecological zone	Average % of farm area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	38.7	37.4	30.5		
NSW NE / Queensland SE	32.4	37.6	27.4	***	
NSW NW / Queensland SW	48.8	41.3	48.5		
NSW / Victorian Slopes	35.1	33.5	36.2		
Queensland Central	45.7	40.3	41.9		
SA Mid North / Lower EP	26.3	23.1	26.6		
SA / VIC Bordertown Wimmera	33.7	33.5	34.2		
SA / Victorian Mallee	30.7	23.1	25.1		**
Tasmania	52.5	52.1	48.1		
Victorian High Rainfall	34.0	30.3	41.8	**	
WA Central	34.4	32.4	32.8		
WA Eastern	28.0	30.2	29.2		
WA Mallee / Sandplain	34.8	29.2	26.3		
WA Northern	28.1	20.3	18.9		**
National averages	35.9	33.2	33.4		

**FIGURE 8** Average proportion (%) of land under pasture on grain farms, 2008–2014.



**FIGURE 9** Proportion of pasture (% of farm area) within agro-ecological zones in 2014.

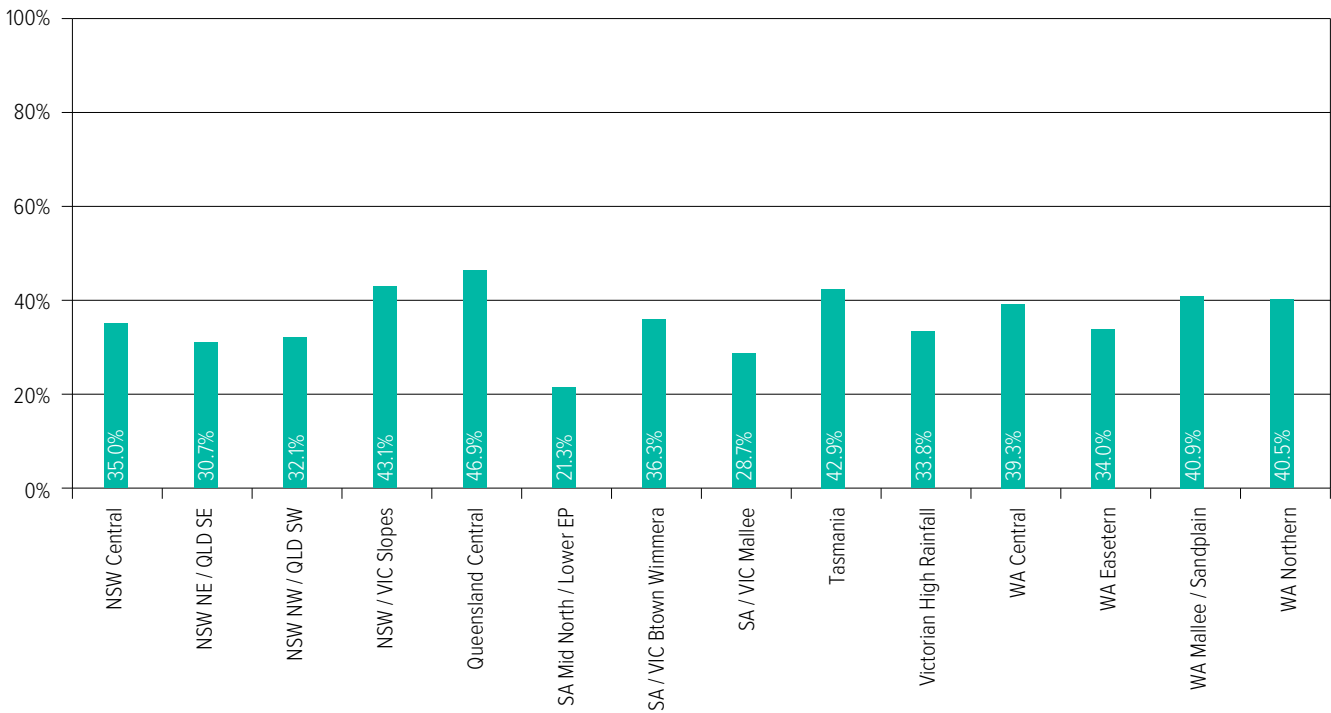


**TABLE 9** Percentage of farms with a vegetation plan.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	35	
NSW NE / Queensland SE (b)	31	
NSW NW / Queensland SW (c)	32	
NSW / Victorian Slopes (d)	43	f
Queensland Central (e)	47	
SA Mid North / Lower EP (f)	21	
SA / VIC Bordertown Wimmera (g)	36	
SA / Victorian Mallee (h)	29	
Tasmania (i)	43	
Victorian High Rainfall (j)	34	
WA Central (k)	39	f
WA Eastern (l)	34	
WA Mallee / Sandplain (m)	41	
WA Northern (n)	40	
National average	35	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

**FIGURE 10** Percentage of grain / mixed farms with a vegetation plan in 2014.



Data here is presented by the proportion of the farm that is said by survey respondents to be pasture, expressed as a percentage of the farm. The data is shown in summary form in Table 8, Figure 8 and Figure 9.

There appears to have been some minor changes to the amount and proportion of the farmed area that is denoted pasture since the last survey, although in most cases these are not significant.

Changes in the proportion of pastures on farms in the survey have been generally minor, although one increase in pasture was noted on those farms where grazing is frequently the dominant enterprise (e.g. Victorian High Rainfall), and also in southern and northern WA. Reasons for any changes are not able to be identified.

**TABLE 10** Percentage of farms with a vegetation plan to assist with crop production.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	36	
NSW NE / Queensland SE (b)	38	
NSW NW / Queensland SW (c)	53	
NSW / Victorian Slopes (d)	46	
Queensland Central (e)	27	
SA Mid North / Lower EP (f)	42	
SA / VIC Bordertown Wimmera (g)	20	
SA / Victorian Mallee (h)	24	
Tasmania (i)	67	
Victorian High Rainfall (j)	46	
WA Central (k)	29	
WA Eastern (l)	38	
WA Mallee / Sandplain (m)	33	
WA Northern (n)	18	
National average	37	

**TABLE 11** Percentage of farms with a vegetation plan to provide additional income.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	19	
NSW NE / Queensland SE (b)	26	
NSW NW / Queensland SW (c)	29	
NSW / Victorian Slopes (d)	35	
Queensland Central (e)	13	
SA Mid North / Lower EP (f)	15	
SA / VIC Bordertown Wimmera (g)	20	
SA / Victorian Mallee (h)	10	
Tasmania (i)	67	
Victorian High Rainfall (j)	33	
WA Central (k)	17	
WA Eastern (l)	25	
WA Mallee / Sandplain (m)	17	
WA Northern (n)	24	
National average	25	

## Proportion of the farmland that is described as native vegetation

In previous surveys (2008 and 2011) respondents were asked to estimate the proportion of their holding that could be described as native or remnant vegetation. This proved to be an area of potential confusion, with many growers unsure of how to identify the various types of non-crop or non-pasture areas on their land. As mentioned above, many growers with areas of native or remnant vegetation allow livestock to graze some of these areas, and so were unsure if this should be described as 'pasture' or 'native vegetation'.

Additionally in some areas, for example Queensland, regrowth of what was native vegetation can also be difficult to describe.

For these reasons and also that describing areas of native vegetation does not actually assist with measuring a grain-centric farming practice, this has been omitted from the survey in 2014. It is also observed that areas of native and remnant vegetation on farms change little over time, generally being left alone or otherwise preserved.

Readers seeking information about the proportions of native and remnant vegetation on grain farms should consult the previous Farming Practice Survey reports:

[www.grdc.com.au/Resources/Publications/2012/11/GRDC-Farm-Practices-Survey-2012](http://www.grdc.com.au/Resources/Publications/2012/11/GRDC-Farm-Practices-Survey-2012)

[www.grdc.com.au/Resources/Publications/2008/02/GRDC-Farm-Practices-Survey-2008](http://www.grdc.com.au/Resources/Publications/2008/02/GRDC-Farm-Practices-Survey-2008).

However, it was felt that seeking information about whether farms have vegetation plans, and for what purpose these may be used, was closer to a practice or activity of interest. It was also felt that such a practice had value in an environmental sense, and hence held some general interest, and so questions about whether farms have vegetation plans and what they were used for were included.

## Farmland with a vegetation plan

Respondents were asked if they had a vegetation plan for their farm. '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 10.

Generally, between 30% and 40% of farms in the survey have a vegetation plan, varying from 21% to almost 50% in central Queensland.



**TABLE 12** Percentage of farms with a vegetation plan to conserve an area of native vegetation for biodiversity or amenity benefit.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	97	d
NSW NE / Queensland SE (b)	77	
NSW NW / Queensland SW (c)	88	
NSW / Victorian Slopes (d)	72	
Queensland Central (e)	73	
SA Mid North / Lower EP (f)	88	
SA / VIC Bordertown Wimmera (g)	100	bde
SA / Victorian Mallee (h)	88	
Tasmania (i)	100	
Victorian High Rainfall (j)	83	
WA Central (k)	92	d
WA Eastern (l)	88	
WA Mallee / Sandplain (m)	83	
WA Northern (n)	94	
National average	87	

## Purpose of vegetation plan

When asked about the purpose of their vegetation plan, those with a vegetation plan were offered options that included: 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

When asked about the purpose of the vegetation plan, on average 37% of farms reported that it had some use in aiding crop production (Table 10).

This suggests that growers felt that having a vegetation plan can be an effective (positive influence) on their crop production system, although the exact nature of this was not able to be determined in the phone interview. This also suggests that to determine motives for practices such as this, grower focus groups or workshops may be of greater value than phone surveys seeking mainly quantitative data.

### Vegetation plan to provide additional income

Nationally, an average of 25% of growers with a vegetation plan listed the purpose of their plan as generating an additional income source. The response varied from only 10% in the SA/Victorian Mallee, to 67% in Tasmania. The actual income from the plan was not determined, and could have been direct (such as from firewood, carbon credit, etc.) or indirect (such as the provision of protection from unfavorable weather for livestock, windbreaks or similar).

The data are presented in Table 11.

### Vegetation plan to conserve native vegetation for biodiversity or amenity value

Table 12 shows the proportion of respondents that described their vegetation plan as assisting with conserving vegetation for biodiversity or amenity value. The proportions are quite high, reaching 100% in SA/Vic Bordertown Wimmera and Tasmania.

This suggests that growers who do have vegetation plans recognise that there is some merit in the conservation of the vegetation or the establishment of vegetation, and that the inherent value of such vegetation is for biodiversity or amenity value in the main.

# CROP MIX ON GRAIN FARMS IN 2014

PHOTO: NICOLE BAXTER

Respondents to the survey of 2014 were asked: What area of (various crops) did you plant/sow in 2014.

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

## Wheat

The proportion of wheat as reported by survey respondents in 2014 is presented in Table 13, Figure 11 and Figure 12.

The highest proportion of wheat is grown in eastern and northern Western Australia, central NSW, the Mallee areas, and north-western NSW/south-western Queensland.

A general decrease in the proportion of wheat was reported by survey respondents in 2014 compared with the previous survey (2011), which showed a general increase in the proportion of wheat sown as compared with 2008. The decrease appeared to be quite significant in almost all agro-ecological zones (AEZs), apart from southern and northern WA. The large decrease in proportion of wheat planted in Tasmania is likely the result of a very small sample size for that area.

The change is possibly driven by seasonal conditions and/or grower's perceptions of potential relative prices (i.e. expected returns from wheat as compared with other crop choices) likely to be obtained.

## Barley

The highest percentages of barley were grown in SA and Victoria and the WA Mallee/Sandplain, exceeding 20% of the cropped area in these AEZs in most years (Table 14, Figure 13 and Figure 14).

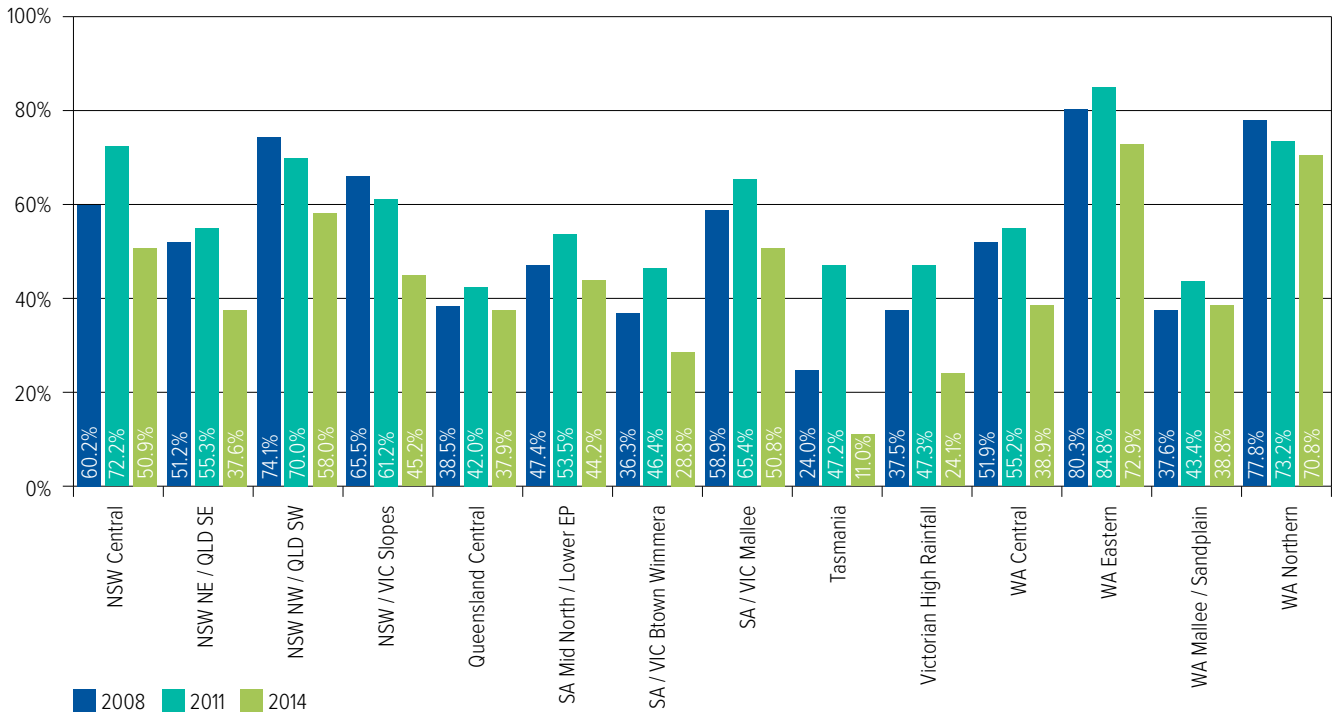
Overall there has been an increase in the proportion of barley sown by grain producers in 2014 as compared to 2011, although this remains below the levels reported in 2008. Changes in the proportion of barley are open to interpretation although may be potentially driven by:

- seasonal conditions in the year, especially at time of planting when decisions are made;
- the relative price prospects for barley (both malt and feed); and
- price of feed grains (influenced by the supply of feed wheat from the 2010 wet harvest, especially in the eastern states).

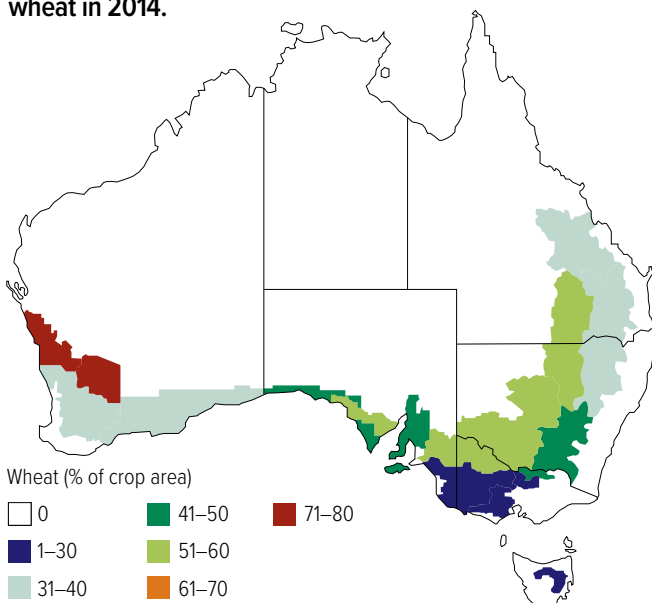
**TABLE 13 Average percentage of crop area planted to wheat in 2008, 2011 and 2014.**

Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	60.2	72.2	50.9	***	
NSW NE / Queensland SE	51.2	55.3	37.6	***	***
NSW NW / Queensland SW	74.1	70.0	58.0	***	***
NSW / Victorian Slopes	65.5	61.2	45.2	***	***
Queensland Central	38.5	42.0	37.9		
SA Mid North / Lower EP	47.4	53.5	44.2	***	
SA / VIC Bordertown Wimmera	36.3	46.4	28.8	***	***
SA / Victorian Mallee	58.9	65.4	50.8	***	***
Tasmania	24.0	47.2	11.0	**	
Victorian High Rainfall	37.5	47.3	24.1	***	***
WA Central	51.9	55.2	38.9	***	
WA Eastern	80.3	84.8	72.9	***	
WA Mallee / Sandplain	37.6	43.4	38.8		
WA Northern	77.8	73.2	70.8		
National averages	52.9	58.4	43.6		

**FIGURE 11** Average percentage of crop area planted to wheat in 2008, 2011 and 2014.



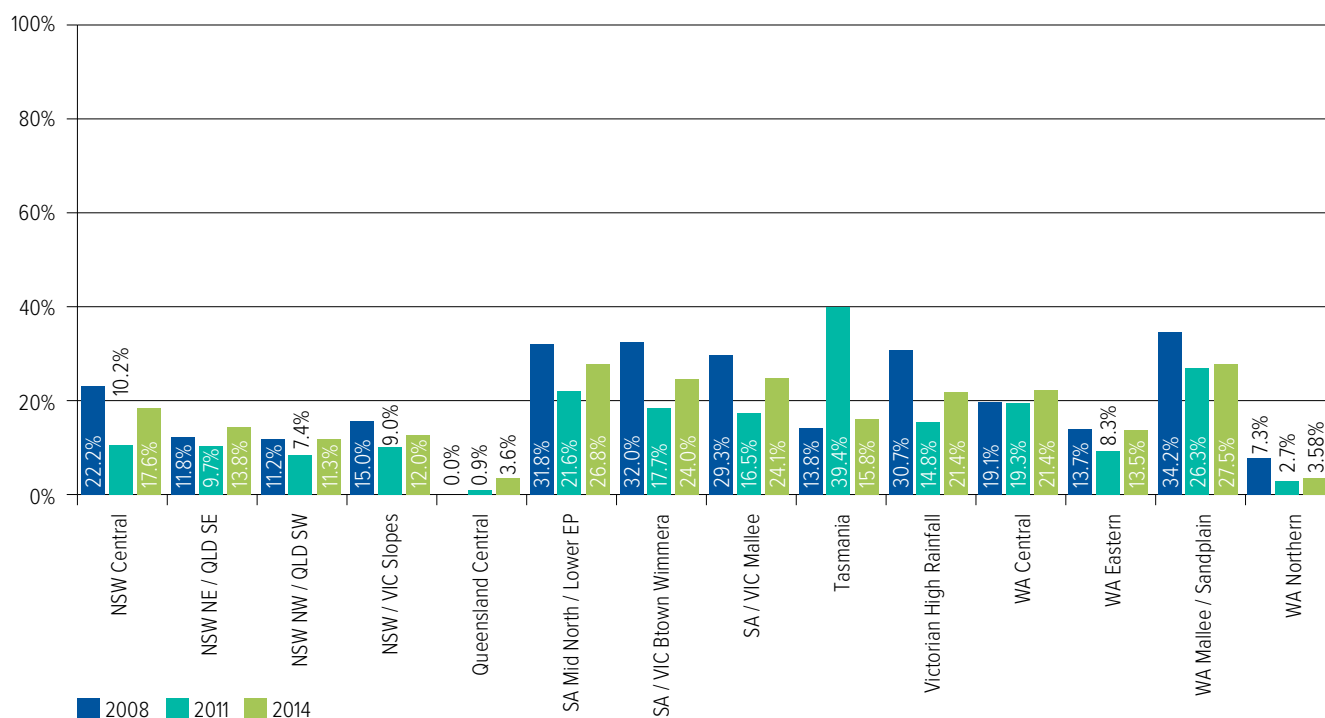
**FIGURE 12** Percentage of crop area planted to wheat in 2014.



**TABLE 14** Average percentage of crop area planted to barley in 2008, 2011 and 2014.

Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	22.2	10.2	17.6	**	
NSW NE / Queensland SE	11.8	9.7	13.8		
NSW NW / Queensland SW	11.2	7.4	11.3		
NSW / Victorian Slopes	15.0	9.0	12.0		
Queensland Central	0.0	0.9	3.6		
SA Mid North / Lower EP	31.8	21.6	26.8	**	
SA / VIC Bordertown Wimmera	32.0	17.7	24.0	**	***
SA / Victorian Mallee	29.3	16.5	24.1	***	**
Tasmania	13.8	39.4	15.8		
Victorian High Rainfall	30.7	14.8	21.4		
WA Central	19.1	19.3	21.4		
WA Eastern	13.7	8.3	13.5	**	
WA Mallee / Sandplain	34.2	26.3	27.5		
WA Northern	7.3	2.7	3.5		
National averages	19.4	14.5	16.9		

**FIGURE 13** Average percentage of crop area planted to barley in 2008, 2011 and 2014.

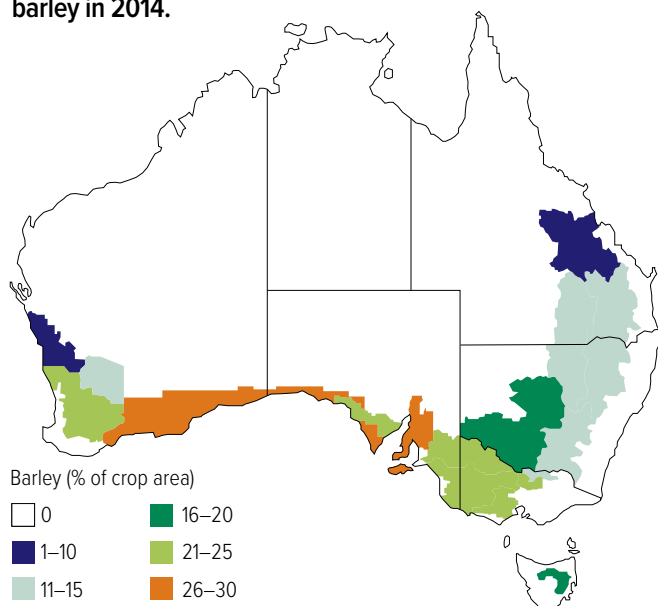


### Other winter cereals

The 'other winter cereal' category includes oats, triticale and cereal rye, mainly used either for grazing as a crop or for providing grain intended for feeding livestock. For this reason it is not unusual to find these crops grown where there is mixed grain/livestock farming. The actual proportions of each component crop in 2014 (i.e. oats, cereal rye, triticale) was not recorded.

The proportion of other winter cereals in the cropping program is relatively minor compared with wheat and barley. However, an increase in the use of these cereal crops is evident in 2014, as compared with the previous survey data. Significant increases in the proportion of these crops were reported in most AEZs, aside from most of WA (Table 15, Figure 15).

**FIGURE 14** Percentage of cropped area planted to barley in 2014.

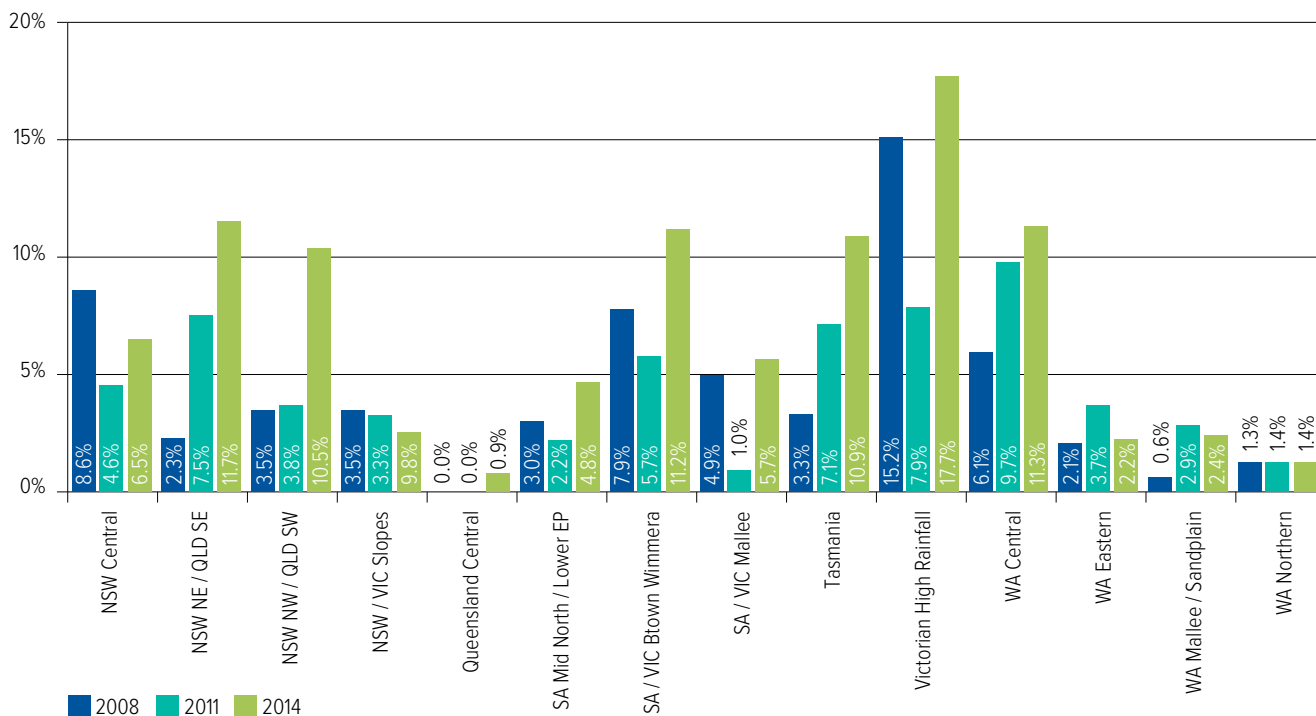


**TABLE 15** Average percentage of crop area planted to other winter cereals in 2008, 2011 and 2014.

Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	8.6	4.6	8.7		
NSW NE / Queensland SE	2.3	7.5	13.4		***
NSW NW / Queensland SW	3.5	3.8	10.5	***	***
NSW / Victorian Slopes	3.5	3.3	9.9	***	***
Queensland Central	0.0	0.0	0.9		
SA Mid North / Lower EP	3.0	2.2	5.5	**	
SA / VIC Bordertown Wimmera	7.9	5.7	11.6	**	
SA / Victorian Mallee	4.9	1.0	6.9	***	
Tasmania	3.3	7.1	10.9		
Victorian High Rainfall	15.2	7.9	19.1	**	
WA Central	6.1	9.7	12.0		***
WA Eastern	2.1	3.7	3.0		
WA Mallee / Sandplain	0.6	2.9	2.4		
WA Northern	1.3	1.4	1.4		
National averages	4.4	4.3	8.3		



**FIGURE 15** Average percentage of crop area planted to other winter cereals in 2008, 2011 and 2014.



### Summer cereals

Summer cereals (principally grain sorghum and maize) comprise a significant component of the crop mix in the northern AEZs dominated by Central Queensland and north-east NSW / south-east Queensland.

There appears to have been a reduction in the proportion of these summer crops grown in the 2013-14 season compared with the previous two survey years. The decrease

would likely be attributed to seasonal conditions, and soil moisture levels at sowing time for these crops (Table 16, Figure 16).

### Oilseeds

Oilseeds (predominantly canola) tend to be more commonly grown in southern NSW, the higher rainfall areas and

**TABLE 16** Average percentage of crop area planted to summer cereals in 2008, 2011 and 2014.

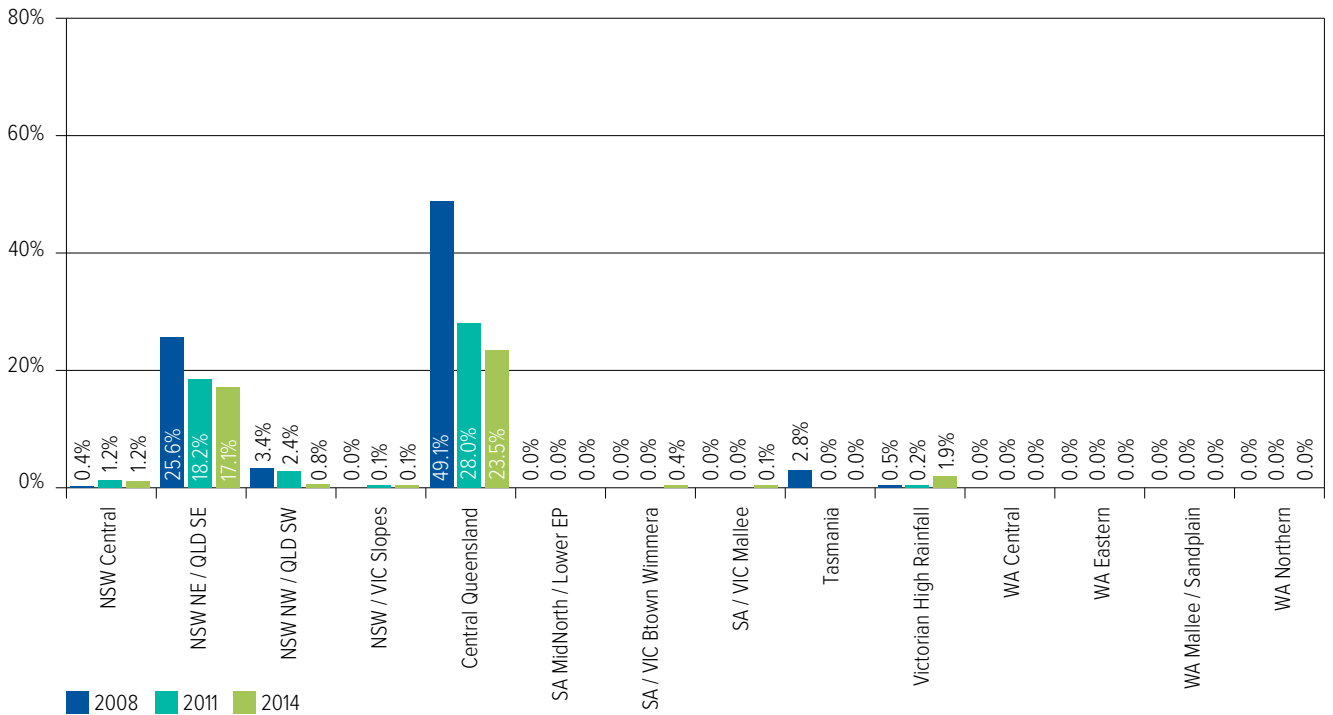
Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	0.4	1.2	1.2		
NSW NE / Queensland SE	25.6	18.2	17.1		**
NSW NW / Queensland SW	3.4	2.4	0.8		
NSW / Victorian Slopes	0.0	0.1	0.1		
Queensland Central	49.1	28.0	23.5		***
SA Mid North / Lower EP	0.0	0.0	0.0		
SA / VIC Bordertown Wimmera	0.0	0.0	0.4		
SA / Victorian Mallee	0.0	0.0	0.1		
Tasmania	2.8	0.0	0.0		
Victorian High Rainfall	0.5	0.2	1.9		
WA Central	0.0	0.0	0.0		
WA Eastern	0.0	0.0	0.0		
WA Mallee / Sandplain	0.0	0.0	0.0		
WA Northern	0.0	0.0	0.0		
National averages	5.8	3.6	3.2		

**TABLE 17** Average percentage of crop area planted to winter oilseeds in 2008, 2011 and 2014.

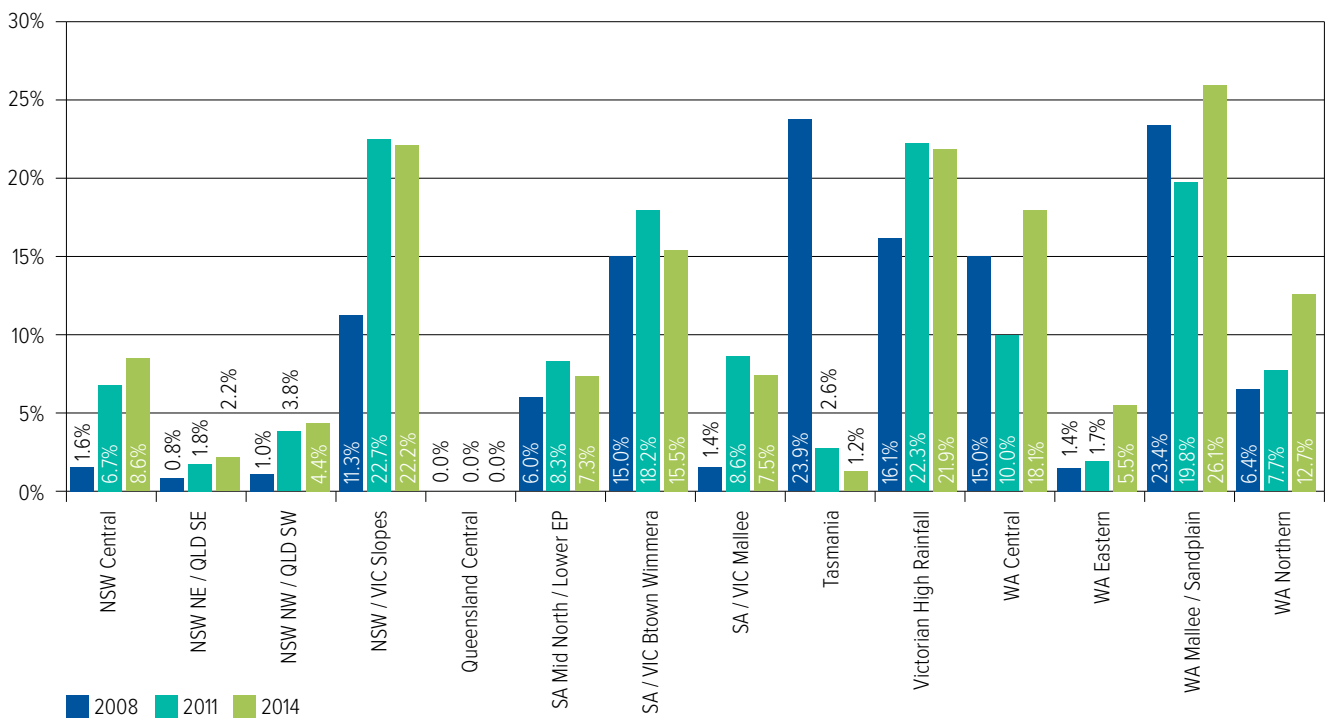
Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	1.6	6.7	8.6		***
NSW NE / Queensland SE	0.8	1.8	2.2		
NSW NW / Queensland SW	1.0	3.8	4.4		**
NSW / Victorian Slopes	11.3	22.7	22.2		***
Queensland Central	0.0	0.0	0.0		
SA Mid North / Lower EP	6.0	8.3	7.3		
SA / VIC Bordertown Wimmera	15.0	18.2	15.5		
SA / Victorian Mallee	1.4	8.6	7.5		***
Tasmania	23.9	2.6	1.2		
Victorian High Rainfall	16.1	22.3	21.9		
WA Central	15.0	10.0	18.1	***	
WA Eastern	1.4	1.7	5.5	**	***
WA Mallee / Sandplain	23.4	19.8	26.1		
WA Northern	6.4	7.7	12.7	**	**
National averages	8.8	9.6	10.9		



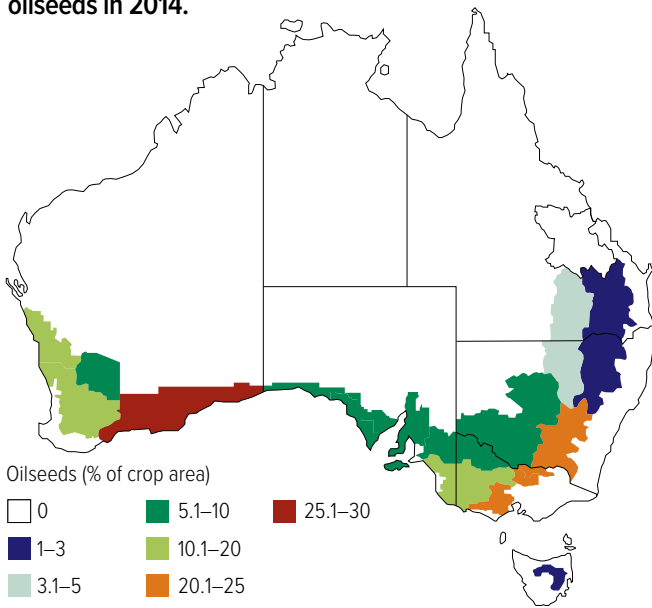
**FIGURE 16** Average percentage of crop area planted to summer cereals in 2008, 2011 and 2014.



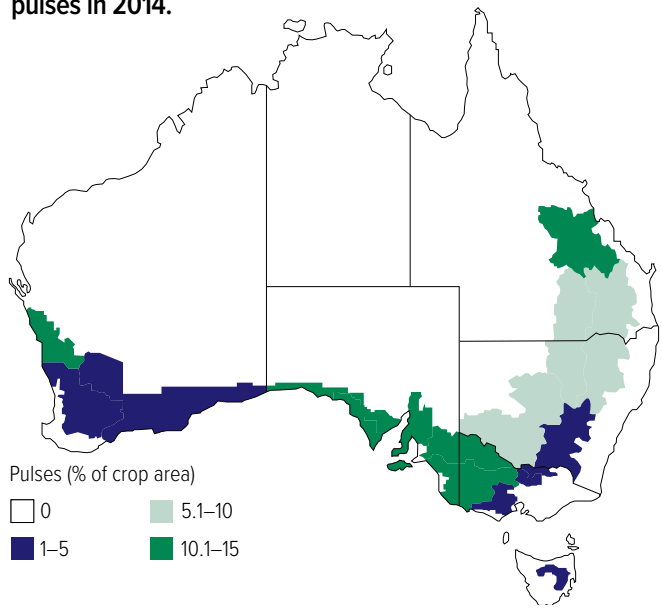
**FIGURE 17** Average percentage of crop area planted to oilseeds in 2008, 2011 and 2014.



**FIGURE 18** Percentage of crop area planted to oilseeds in 2014.



**FIGURE 20** Percentage of crop area planted to pulses in 2014.



Bordertown / Wimmera areas of Victoria and SA, and the central and southern cropping areas of Western Australia (Table 17, Figure 17, Figure 18).

There was an increase in the proportion of oilseeds (mainly canola) recorded in 2014 compared with the 2008 and 2011 surveys. This increase was mostly in NSW / Victorian slopes, SA / Victorian Mallee, WA Eastern and Northern and to a lesser extent WA Mallee and the sandplains.

The change (increase) in the proportion of oilseeds in the crop mix in these AEZs is difficult to attribute, although will possibly be related to the perception of financial returns from the use of these crops, along with an assessment of seasonal conditions approaching the ideal sowing times for canola.

### Pulses

Pulses make up a relatively minor proportion of the cropped area for most agro-ecological zones, with the exception of:

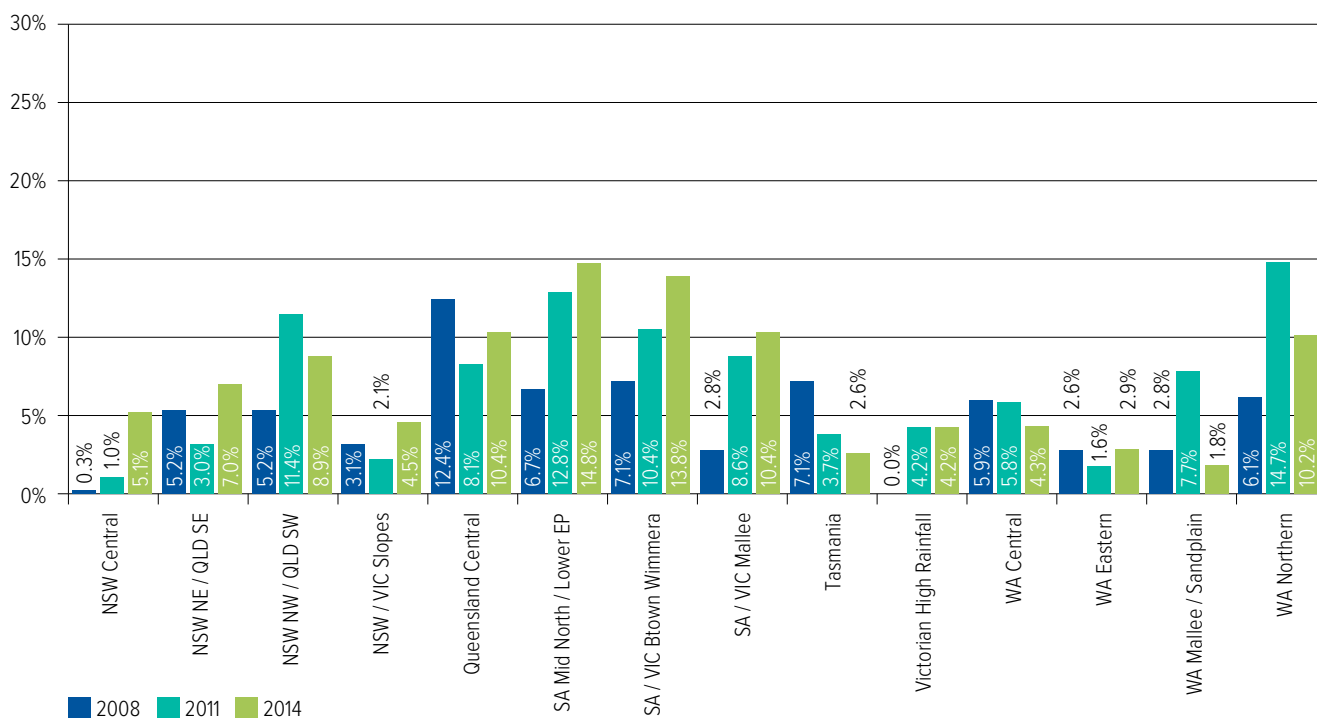
- north-west New South Wales / south-west Queensland (likely to be chickpeas);
- Queensland central (likely to be mungbeans and chickpeas);
- Mid North / lower Eyre Peninsula of South Australia (lentils, chickpeas, field peas, faba beans and vetch);
- Wimmera region of South Australia / Victoria (lentils, faba beans, chickpeas and vetch); and
- northern Western Australia (narrow-leaf lupins).

The proportion of pulses in the crop mix in 2014

**TABLE 18** Average percentage of crop area planted to pulses in 2008, 2011 and 2014.

Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	0.3	1.0	5.1	***	***
NSW NE / Queensland SE	5.2	3.0	7.0	***	
NSW NW / Queensland SW	5.2	11.4	8.9		
NSW / Victorian Slopes	3.1	2.1	4.5	***	
Queensland Central	12.4	8.1	10.4		
SA Mid North / Lower EP	6.7	12.8	14.8		***
SA / VIC Bordertown Wimmera	7.1	10.4	13.8		***
SA / Victorian Mallee	2.8	8.6	10.4	***	***
Tasmania	7.1	3.7	2.6		
Victorian High Rainfall	0.0	4.2	4.2		***
WA Central	5.9	5.8	4.3		
WA Eastern	2.6	1.6	2.9		
WA Mallee / Sandplain	2.8	7.7	1.8	***	
WA Northern	6.1	14.7	10.2		**
National averages	4.8	6.8	7.2		

**FIGURE 19** Average percentage of crop area planted to pulses in 2008, 2011 and 2014.



increased in the AEZs of NSW Central, north-eastern NSW/ south-east Queensland, NSW/Victorian Slopes and much of South Australia and Victoria. There appeared to be a decrease in WA. Overall a slight increase in the use of pulses was evident, although they remain less than 10% of the cropped area nationally. See Table 18, Figure 19 and Figure 20.

Reasons for these changes vary between different agro-ecological zones, but are likely to be due to seasonal conditions coupled with grower perceptions of risk and price prospects.

### Total crop mix

Table 19, Table 20 and Table 21, and Figure 21 and Figure 22 show in summary the proportion of the major crops as a percentage of the cropped farm area as recorded in the surveys of 2008, 2011 and 2014. These tables and figures represent the data shown in the earlier sections of this chapter.

As mentioned in the section describing wheat, the data for Tasmania is likely unreliable due to small sample size.

### National trends

When the data is considered on a national basis, some trends can be noted (Table 22).

The changes in national cropped area trends show:

- a national decrease in the proportion of wheat in each survey year;
- the proportion of barley decreased between 2008 and 2011, then has increased as a proportion of the cropped area in 2014;
- other cereals have also increased slightly, notably since 2011;
- oilseeds are stable as a proportion of the cropped area, having grown between 2008 and 2011;
- pulses have shown an increase in each survey since 2008; and
- summer cereals remain minor apart from areas of the northern region, although have decreased as a proportion of the cropped area since 2008.

**TABLE 19 Average percentage of cropped area planted to major crops in 2008.**

Agro-ecological zone	% wheat	% barley	% other cereals	% summer cereals	% oilseeds	% pulses
NSW Central	60.2	22.2	8.6	0.4	1.6	0.3
NSW NE / Queensland SE	51.2	11.8	2.3	25.6	0.8	5.2
NSW NW / Queensland SW	74.1	11.2	3.5	3.4	1.0	5.2
NSW / Victorian Slopes	65.5	15.0	3.5	0.0	11.3	3.1
Queensland Central	38.5	0.0	0.0	49.1	0.0	12.4
SA Mid North / Lower EP	47.4	31.8	3.0	0.0	6.0	6.7
SA / VIC Bordertown Wimmera	36.3	32.0	7.9	0.0	15.0	7.1
SA / Victorian Mallee	58.9	29.3	4.9	0.0	1.4	2.8
Tasmania	24.0	13.8	3.3	2.8	23.9	7.1
Victorian High Rainfall	37.5	30.7	15.2	0.5	16.1	0.0
WA Central	51.9	19.1	6.1	0.0	15.0	5.9
WA Eastern	80.3	13.7	2.1	0.0	1.4	2.6
WA Mallee / Sandplain	37.6	34.2	0.6	0.0	23.4	2.8
WA Northern	77.8	7.3	1.3	0.0	6.4	6.1

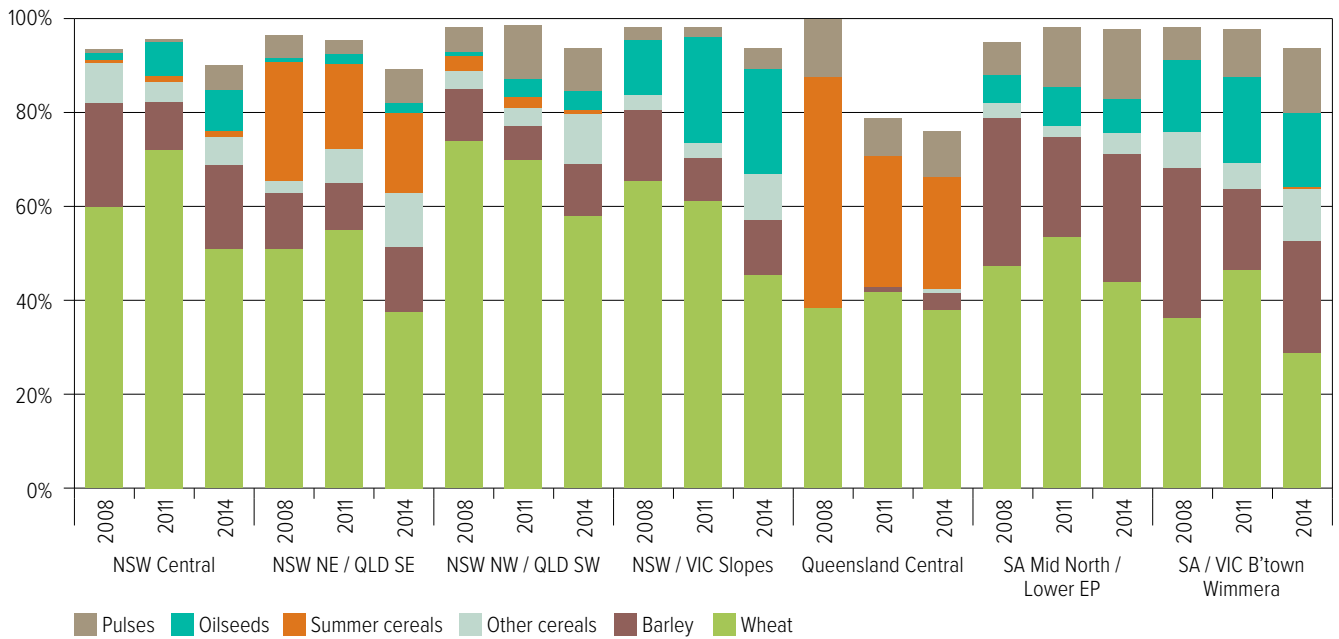
**TABLE 20 Average percentage of cropped area planted to major crops in 2011.**

Agro-ecological zone	% wheat	% barley	% other cereals	% summer cereals	% oilseeds	% pulses
NSW Central	72.2	10.2	4.6	1.2	6.7	1.0
NSW NE / Queensland SE	55.3	9.7	7.5	18.2	1.8	3.0
NSW NW / Queensland SW	70.0	7.4	3.8	2.4	3.8	11.4
NSW / Victorian Slopes	61.2	9.0	3.3	0.1	22.7	2.1
Queensland Central	42.0	0.9	0.0	28.0	0.0	8.1
SA Mid North / Lower EP	53.5	21.6	2.2	0.0	8.3	12.8
SA / VIC Bordertown Wimmera	46.4	17.4	5.7	0.0	18.2	10.4
SA / Victorian Mallee	65.4	16.5	1.0	0.0	8.6	8.6
Tasmania	47.2	39.4	7.1	0.0	2.6	3.7
Victorian High Rainfall	47.3	14.8	7.9	0.2	22.3	4.2
WA Central	55.2	19.3	9.7	0.0	10.0	5.8
WA Eastern	84.8	8.3	3.7	0.0	1.7	1.6
WA Mallee / Sandplain	43.4	26.3	2.9	0.0	19.8	7.7
WA Northern	73.2	2.7	1.4	0.0	7.7	14.7

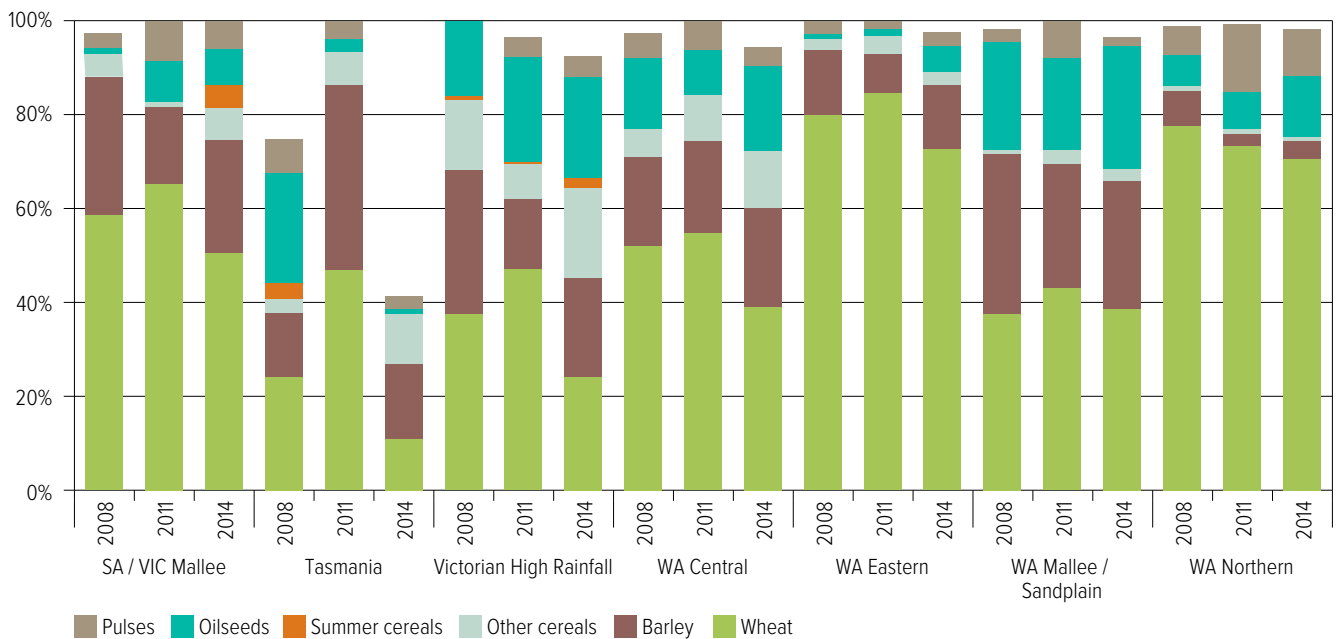
**TABLE 21 Average percentage of cropped area planted to major crops in 2014.**

Agro-ecological zone	% wheat	% barley	% other cereals	% summer cereals	% oilseeds	% pulses
NSW Central	50.9	17.6	6.5	1.2	8.6	5.1
NSW NE / Queensland SE	37.6	13.8	11.7	17.1	2.2	7.0
NSW NW / Queensland SW	58.0	11.3	10.5	0.8	4.4	8.9
NSW / Victorian Slopes	45.2	12.0	9.8	0.1	22.2	4.5
Queensland Central	37.9	3.6	0.9	23.5	0.0	10.4
SA Mid North / Lower EP	44.2	26.8	4.8	0.0	7.3	14.8
SA / VIC Bordertown Wimmera	28.8	24.0	11.2	0.4	15.5	13.8
SA / Victorian Mallee	50.8	24.1	5.7	0.1	7.5	10.4
Tasmania	11.0	15.8	10.9	0.0	1.2	2.6
Victorian High Rainfall	24.1	21.4	17.7	1.9	21.9	4.2
WA Central	38.9	21.4	11.3	0.0	18.1	4.3
WA Eastern	72.9	13.5	2.2	0.0	5.5	2.9
WA Mallee / Sandplain	38.8	27.5	2.4	0.0	26.1	1.8
WA Northern	70.8	3.5	1.4	0.0	12.7	10.2

**FIGURE 21** Average percentage of crop area planted to major crops in 2008, 2011 and 2014 by agro-ecological zone.

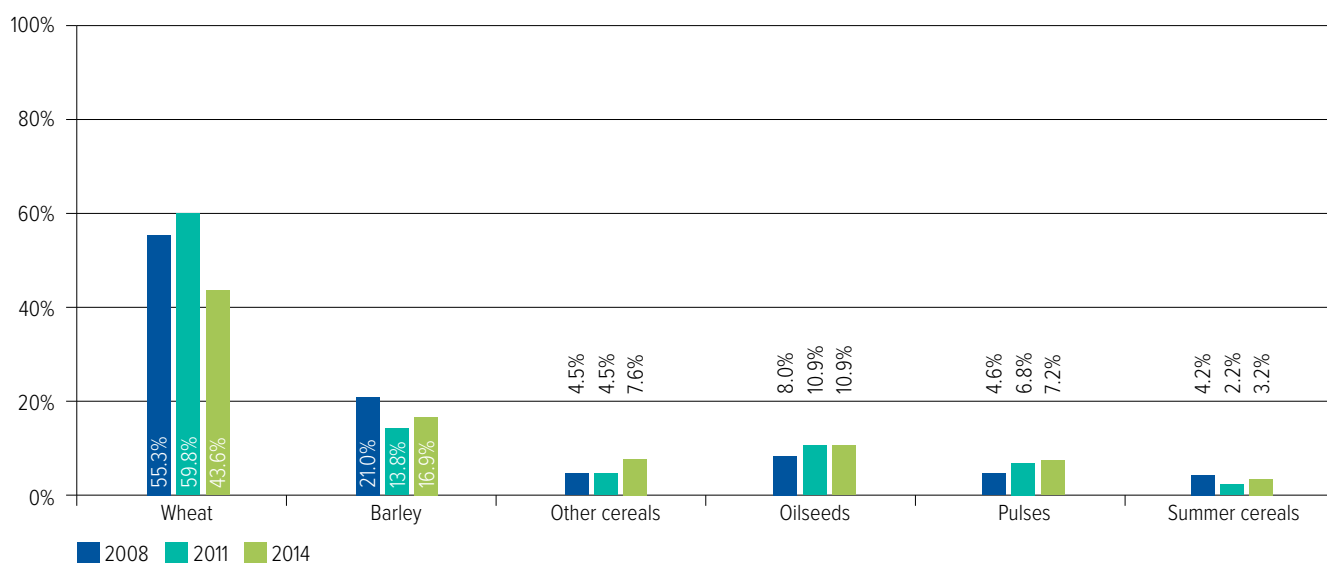


**FIGURE 22** Average percentage of crop area planted to major crops in 2008, 2011 and 2014 by agro-ecological zone.





**FIGURE 23** Average national percentage of crop area planted to major crops in 2008, 2011 and 2014.



**TABLE 22** Average national percentage of cropped area planted to major crops in 2008, 2011 and 2014.

Crop type	2008	2011	2014	Significant difference between years	
				2011 to 2014	2008 to 2014
Wheat	55.3	59.8	43.6	***	***
Barley	21.0	13.8	16.9	***	***
Other cereals	4.5	4.5	7.6	***	***
Oilseeds	8.0	10.9	10.9	***	
Pulses	4.6	6.8	7.2	***	
Summer cereals	4.2	2.2	3.2		

# TILLAGE IN 2014



PHOTO: GRDC

The following questions were asked about the use of tillage systems for crop and pasture establishment:

- In the sowing of your crops in 2014, what area of your crop (converted to percentage in this report) was sown using:
  - zero-tillage – < 10% soil disturbance, e.g. disc planters;
  - no-tillage – between 10% and 30% soil disturbance, e.g. knife or spear points;
  - direct drill – one pass at sowing, with full cut planting;
  - minimum tillage – one cultivation prior to planting operation
  - multiple tillage – more than one cultivation before sowing.

## Zero-tillage

Zero-tillage is where no cultivation of the soil occurs and less than 10% of the soil is disturbed in the planting operation.

Typically, machinery used would be a disc-based implement, where vertical or near-vertical discs (several combinations are available, often with leading coulter discs followed by pairs of discs forming a narrow 'v' shape), effectively 'slice' through the soil, placing seed and fertiliser at the desired depth and leaving very little soil actually disturbed. Presswheels are often also used.

The data from the 2011 survey suggested that the proportion of the crop reported by survey participants as planted using zero-tillage had decreased compared to what was reported as being used in 2008. See Table 23, Figure 24 and Figure 25. The data from the 2014 survey suggests that this decrease in the use of zero tillage has continued, significantly so in most AEZs.

The data from the 2011 survey also suggests that the proportion of no-tillage had increased significantly in many agro-ecological zones. This trend has continued to be

reported in the survey of 2014. See the section below (about no-tillage) for this data.

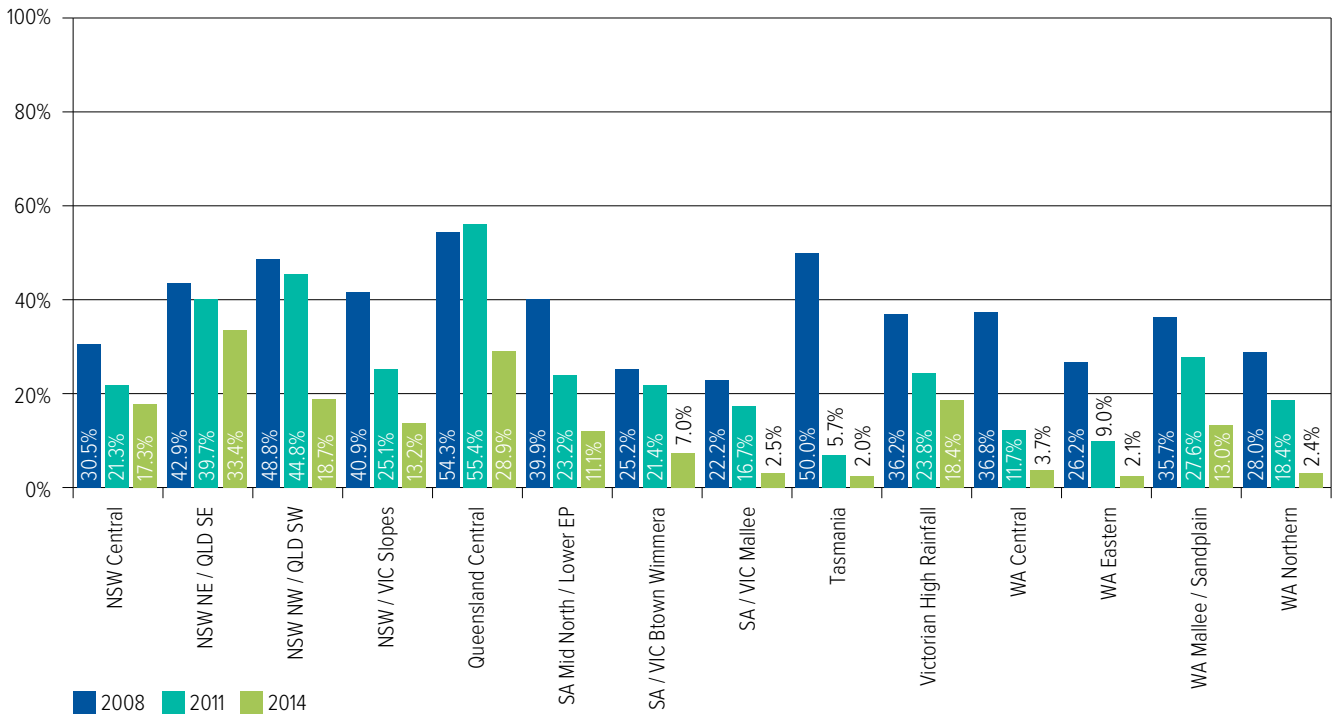
These trends, as reported by growers, may be an artifact of the survey questions, or as the terms 'no-tillage' and 'zero-tillage' were understood. In the agro-ecological zones where zero-tillage has declined, no-tillage generally is reported as having increased. This may be due to some confusion about the terms used as these have become

**TABLE 23** Average percentage of crop area planted using zero-tillage\* in 2008, 2011 and 2014.

Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	30.5	21.3	17.3		**
NSW NE / Queensland SE	42.9	39.7	33.4		
NSW NW / Queensland SW	48.8	44.8	18.7	***	***
NSW / Victorian Slopes	40.9	25.1	13.2	***	***
Queensland Central	54.3	55.4	28.9	**	
SA Mid North / Lower EP	39.9	23.2	11.1	**	***
SA / VIC Bordertown Wimmera	25.2	21.4	7.0	***	***
SA / Victorian Mallee	22.2	16.7	2.5	***	***
Tasmania	50.0	5.7	2.0		**
Victorian High Rainfall	36.2	23.8	18.4		
WA Central	36.8	11.7	3.7	***	***
WA Eastern	26.2	9.0	2.1		***
WA Mallee / Sandplain	35.7	27.6	13.0		***
WA Northern	28.0	18.4	2.4	***	***
<b>National averages</b>	<b>37.0</b>	<b>24.6</b>	<b>12.4</b>		<b>***</b>

\*Less than 10% soil disturbance

**FIGURE 24** Average percentage of crop area planted using zero-tillage in 2008, 2011 and 2014.



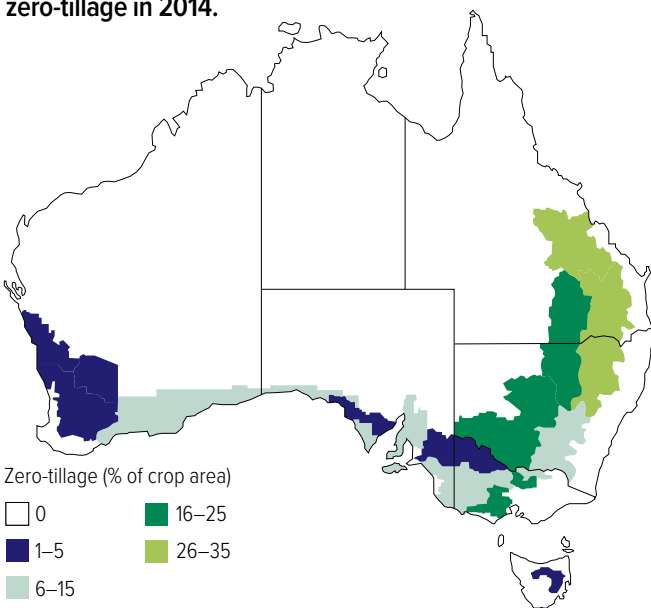
known between 2008 and 2014 among growers. It is possible that growers who reported using zero-tillage for the 2008 and 2011 surveys may have actually been using knife points and reported this as ‘zero-tillage’, when such a planting system is now defined as ‘no-tillage’.

This appears to require further investigation since the use of disc machinery among grain growers anecdotally has

increased in recent years, and the expectation would be for this practice to have increased or been maintained since 2008 and 2011.

Once a grower invests in a disc (zero-tillage) machine, it would be expected to be used for some years with few of these growers reverting back to using no-tillage planters in the short term.

**FIGURE 25** Average percentage of crop area planted using zero-tillage in 2014.

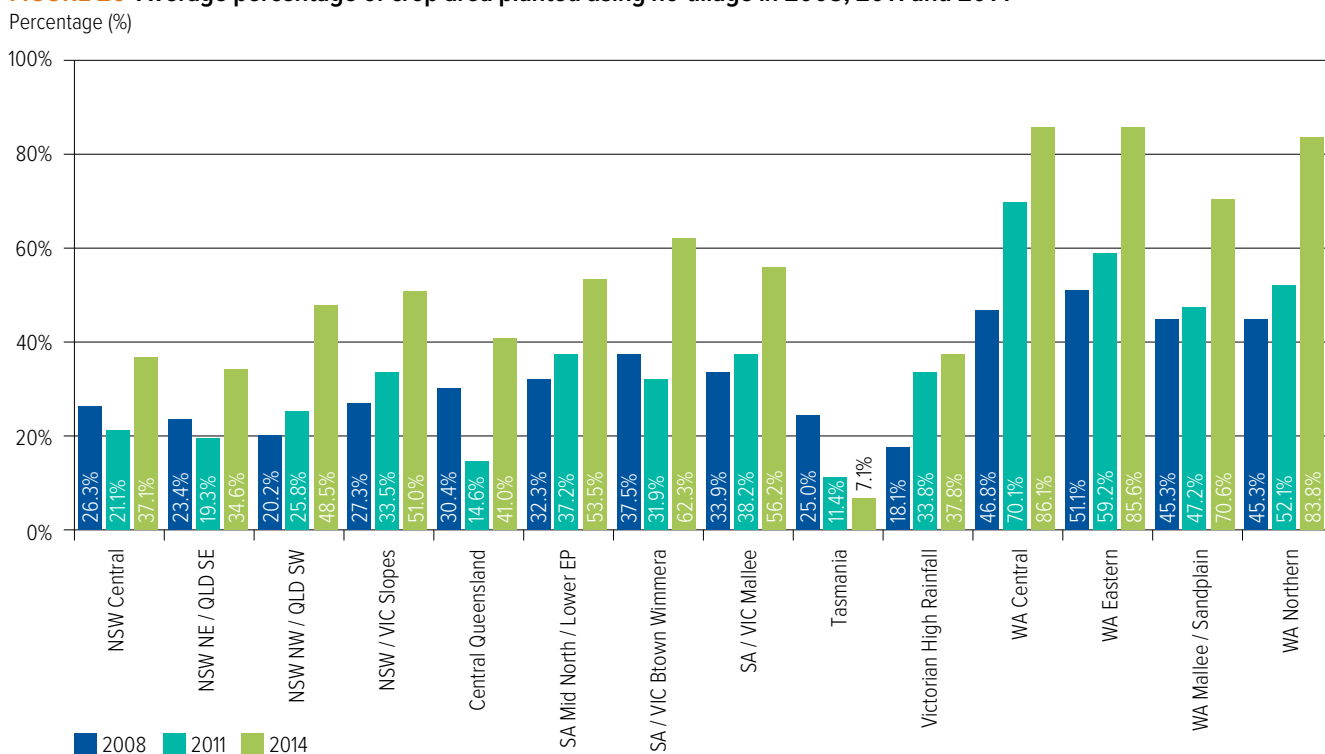


**TABLE 24** Average percentage of crop area planted using no-tillage\* in 2008, 2011 and 2014.

Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	26.3	21.1	37.1	***	
NSW NE / Queensland SE	23.4	19.3	34.6	***	**
NSW NW / Queensland SW	20.2	25.8	48.5	***	***
NSW / Victorian Slopes	27.3	33.5	51.0	***	***
Queensland Central	30.4	14.6	41.0	**	
SA Mid North / Lower EP	32.3	37.2	53.5	***	***
SA / VIC Bordertown Wimmera	37.5	31.9	62.3	***	***
SA / Victorian Mallee	33.9	38.2	56.2	***	***
Tasmania	25.0	11.4	7.1		
Victorian High Rainfall	18.1	33.8	37.8		**
WA Central	46.8	70.1	86.1	***	***
WA Eastern	51.1	59.2	85.6	***	***
WA Mallee / Sandplain	45.3	47.2	70.6	**	***
WA Northern	45.3	52.1	83.8	***	***
National averages	33.1	35.4	53.9	***	***

\*Between 10 and 30% soil disturbance

**FIGURE 26 Average percentage of crop area planted using no-tillage in 2008, 2011 and 2014**

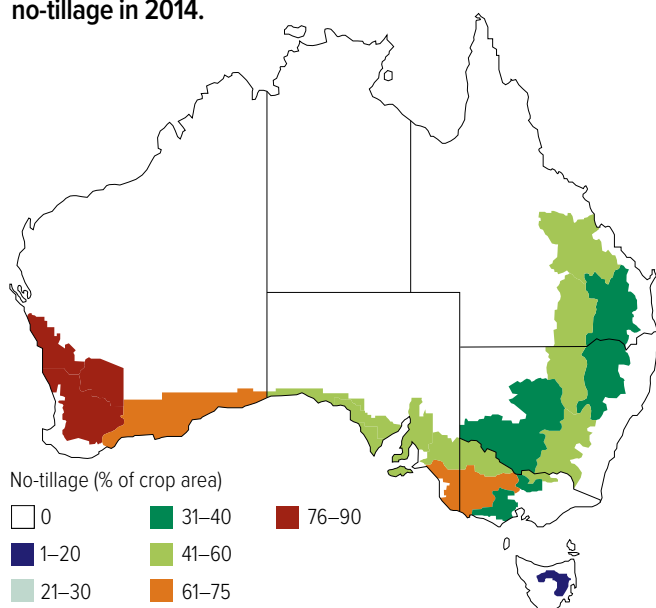


## No-tillage

No-tillage is defined as where machinery disturbs more than 10% but less than 30% of the soil surface across the planting width. Typically such machinery consists of very narrow, or ‘knife’ soil-engaging tools, where a relatively narrow area of soil is moved aside allowing seed and

fertiliser to be placed in the ‘trench’. Loosened soil then falls, or is pushed, back in to cover the seed and presswheels are commonly used to firm the soil over the seed. Row spacing is often set to allow for ease of crop residue flow.

**FIGURE 27 Average percentage of crop sown using no-tillage in 2014.**



The data as reported by growers for the 2014 season shows a general increase, often quite large, in the use of no-tillage techniques as compared to previous survey data (see Table 24, Figure 26 and Figure 27).

In Western Australia the use of knife-type planting systems remains high, with no-till techniques being used on approximately three-quarters, and often more than 80%, of the cropped area in WA.

As mentioned in the section above concerning zero-tillage, the data for many agro-ecological zones shows a decrease in zero-till and increase in no-till between the survey years, with these changes in several cases showing similar absolute levels of change. It is possible that the reasons mentioned earlier concerning definitions may explain these movements in the data, with the actual levels of adoption different in the field. These suggestions cannot be verified by the data, although perhaps warrant some further qualitative investigations.

## Zero and no-tillage combined

One way of determining the level of adoption of conservation farming techniques in a general sense is to consider the combination of both zero-tillage and no-tillage, and the changes in adoption levels of these combined practices. The data for the combination of these practices is presented in an amalgamated form below (see Table 25 and Figure 28). This allows some consideration to be made between the levels of adoption of the combined zero +

**TABLE 25** Average percentage of crop area planted using zero-tillage or no-tillage in 2008, 2011 and 2014.

Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	56.8	42.4	54.5		
NSW NE / Queensland SE	66.3	59.0	68.0		
NSW NW / Queensland SW	69.0	70.6	67.2		
NSW / Victorian Slopes	68.2	58.7	64.2		
Queensland Central	84.8	70.0	69.9		
SA Mid North / Lower EP	72.3	60.4	64.6		
SA / VIC Bordertown Wimmera	62.7	53.3	69.3	***	
SA / Victorian Mallee	56.0	54.9	58.4		
Tasmania	75.0	17.1	9.1		**
Victorian High Rainfall	54.3	57.5	56.2		
WA Central	83.6	81.8	89.8	**	
WA Eastern	77.3	68.2	87.7	***	
WA Mallee / Sandplain	81.0	74.8	83.6		
WA Northern	73.3	70.5	86.2	**	**
National averages	70.0	59.9	66.3		

**TABLE 26** Average percentage of crop area planted using direct drill in 2008, 2011 and 2014.

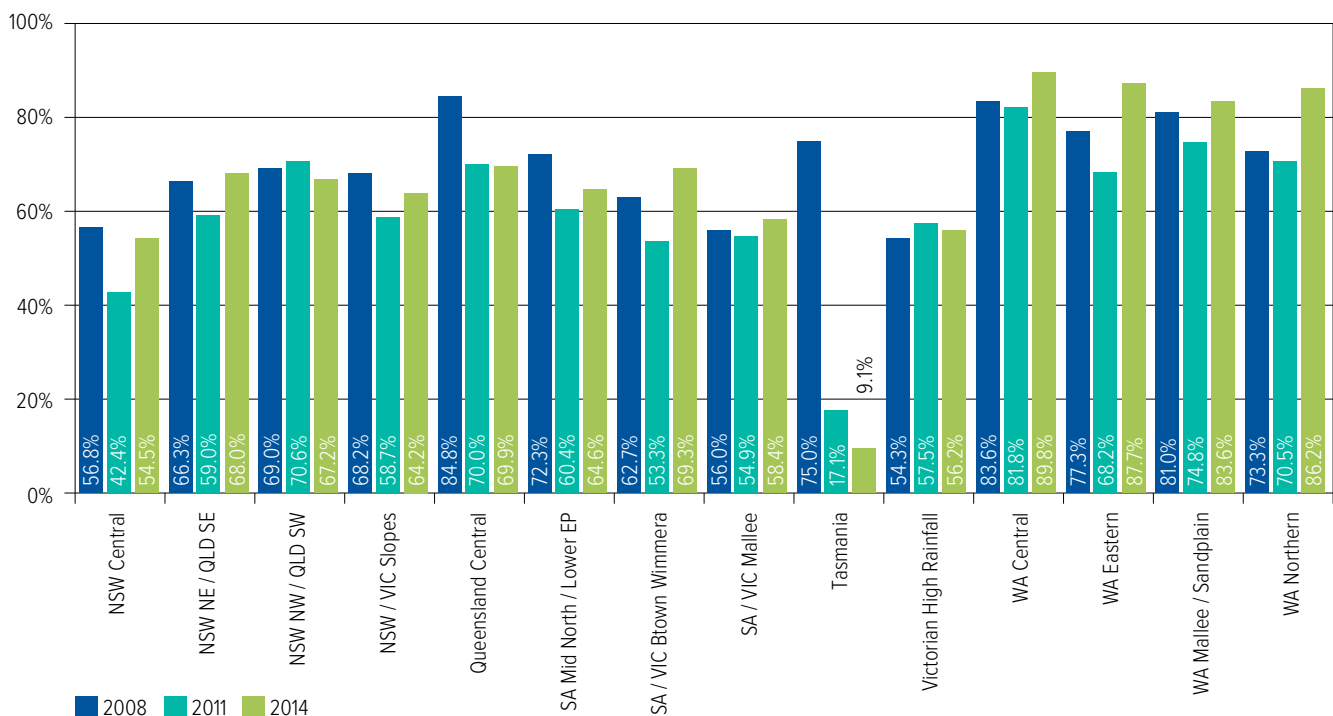
Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	18.2	23.3	23.3		
NSW NE / Queensland SE	19.0	24.5	9.9	***	**
NSW NW / Queensland SW	18.2	13.7	21.0		
NSW / Victorian Slopes	25.2	31.5	20.7	**	
Queensland Central	6.5	9.1	9.4		
SA Mid North / Lower EP	17.9	29.7	26.1		
SA / VIC Bordertown Wimmera	25.7	31.8	14.5	***	**
SA / Victorian Mallee	23.3	22.9	19.1		
Tasmania	20.0	54.3	5.9	***	
Victorian High Rainfall	44.7	33.5	26.3		
WA Central	13.7	14.8	7.1	**	**
WA Eastern	14.7	24.7	2.6	***	**
WA Mallee / Sandplain	15.4	18.2	13.1		
WA Northern	18.1	22.0	5.1	***	**
National averages	20.0	25.3	14.6	***	

no-tillage (i.e. any practice that disturbs less than 30% of soil when planting) and how these may have changed in the absence of any effect of the way the two practices are understood to be defined by growers.

The adoption of zero-tillage or no-till combined remains quite high, with two-thirds of the cropped area using these

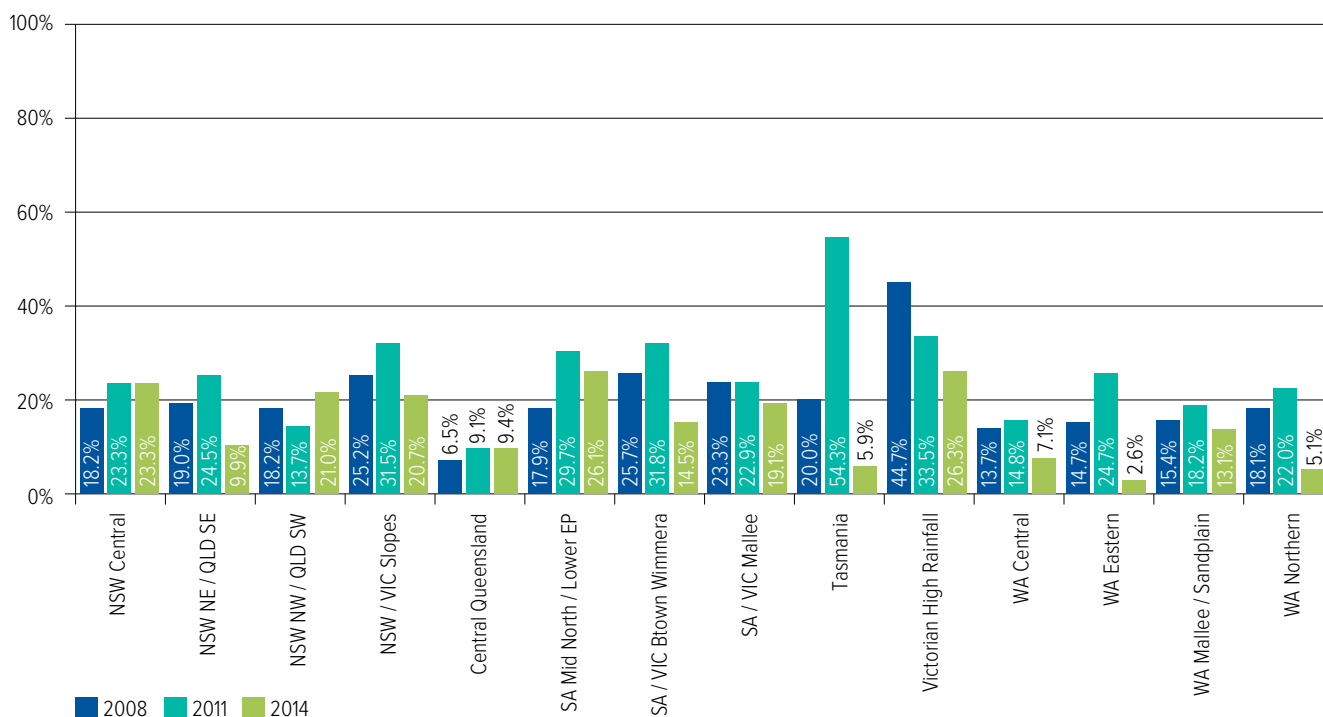
techniques nationally, and 80% or higher using these techniques in four AEZs. Taken together there appears to have been a decrease in their use between 2008 and 2011, however an increase is evident in 2014. Although this did not bring the levels back to their 2008 values nationally, it did in eastern and southern AEZs and all of WA.

**FIGURE 28** Average percentage of cropped area planted using zero-tillage or no-tillage (less than 30% soil disturbance) in 2008, 2011 and 2014





**FIGURE 29** Average percentage of crop area planted using direct drill in 2008, 2011 and 2014.



### Direct-drill

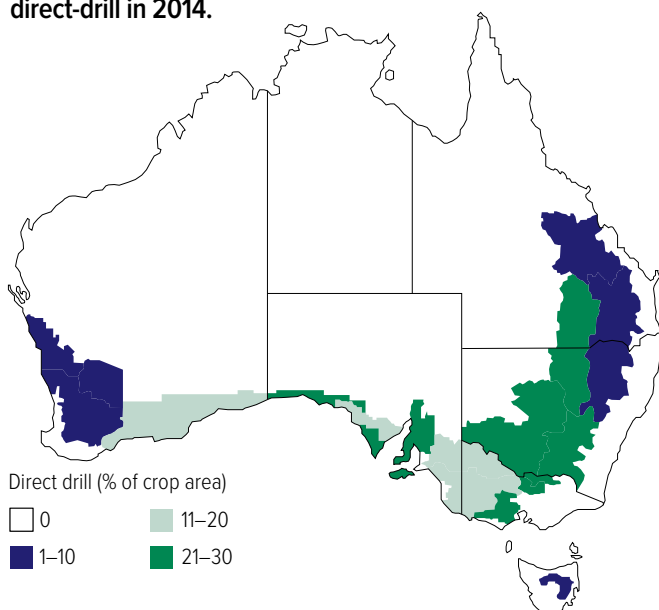
In a direct-drilling system, there are no cultivations prior to planting. However, the crop is planted in a single pass with full soil disturbance across the full width of the machine. While, as with zero and no-tillage, this is a 'one-pass' planting operation, frequently more 'conventional' or modified conventional machines are used.

When direct drilling, soil-engaging points are wide

enough to loosen the soil across the whole planting width, providing a 'full cut' of the soil surface. Covering devices may consist of a range of options, from press wheels to more conventional harrows.

The proportion of direct-drill in 2011 was higher in many AEZs than in 2008. However, the reported areas using direct-drilling in 2014 have decreased since 2011,

**FIGURE 30** Proportion of crop area planted using direct-drill in 2014.

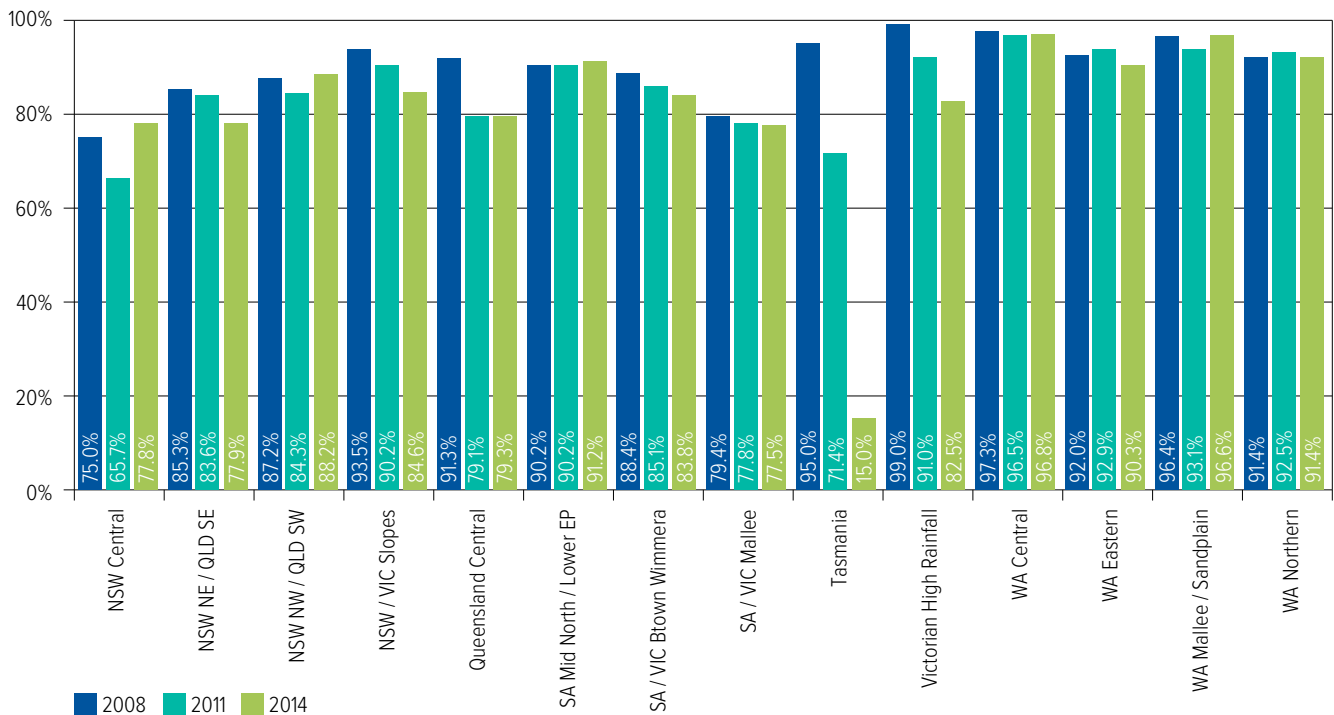


**TABLE 27** Average percentage of crop area planted using a single pass in 2008, 2011 and 2014.

Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	75.0	65.7	77.8	**	
NSW NE / Queensland SE	85.3	83.6	77.9		
NSW NW / Queensland SW	87.2	84.3	88.2		
NSW / Victorian Slopes	93.5	90.2	84.6		***
Queensland Central	91.3	79.1	79.3		
SA Mid North / Lower EP	90.2	90.2	91.2		
SA / VIC Bordertown Wimmera	88.4	85.1	83.8		
SA / Victorian Mallee	79.4	77.8	77.5		
Tasmania	95.0	71.4	15.0	***	***
Victorian High Rainfall	99.0	91.0	82.5		***
WA Central	97.3	96.5	96.8		
WA Eastern	92.0	92.9	90.3		
WA Mallee / Sandplain	96.4	93.1	96.6		
WA Northern	91.4	92.5	91.4		
National averages	90.1	85.2	80.9		



**FIGURE 31** Average percentage of crop area planted using zero-tillage, no-tillage or direct drill in 2008, 2011 and 2014.



significantly so in several AEZs, although this was not the case in NSW Central and SA Mid North/Lower Eyre Peninsula (Table 26). It is possible that seasonal, weed management or other reasons account for these differences. Follow-up qualitative surveying work would be required to identify these differences.

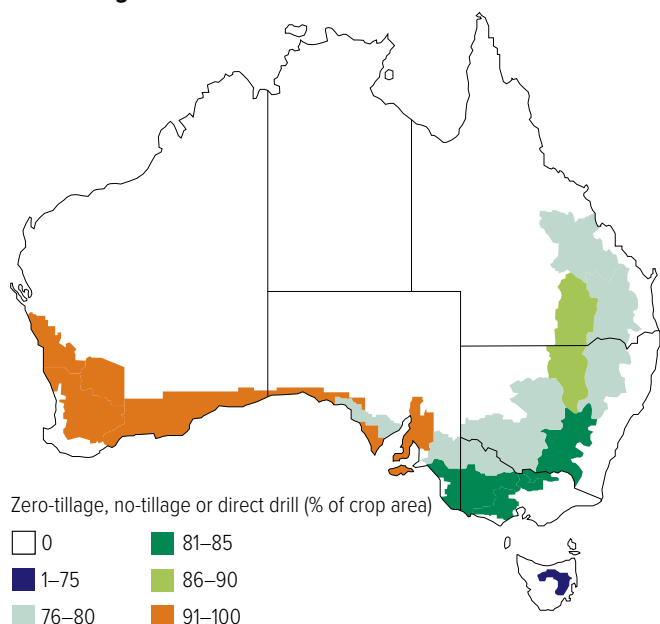
### Zero-tillage, no-tillage and direct-drill combined

Given the potential for some confusion about conservation tillage system terminology among grain producers, and the impacts of this on how they may have reported the usage of different tillage practices, the data for the combination of these three practices is also presented in amalgamated form (see Table 27, Figure 31 and Figure 32). This allows some

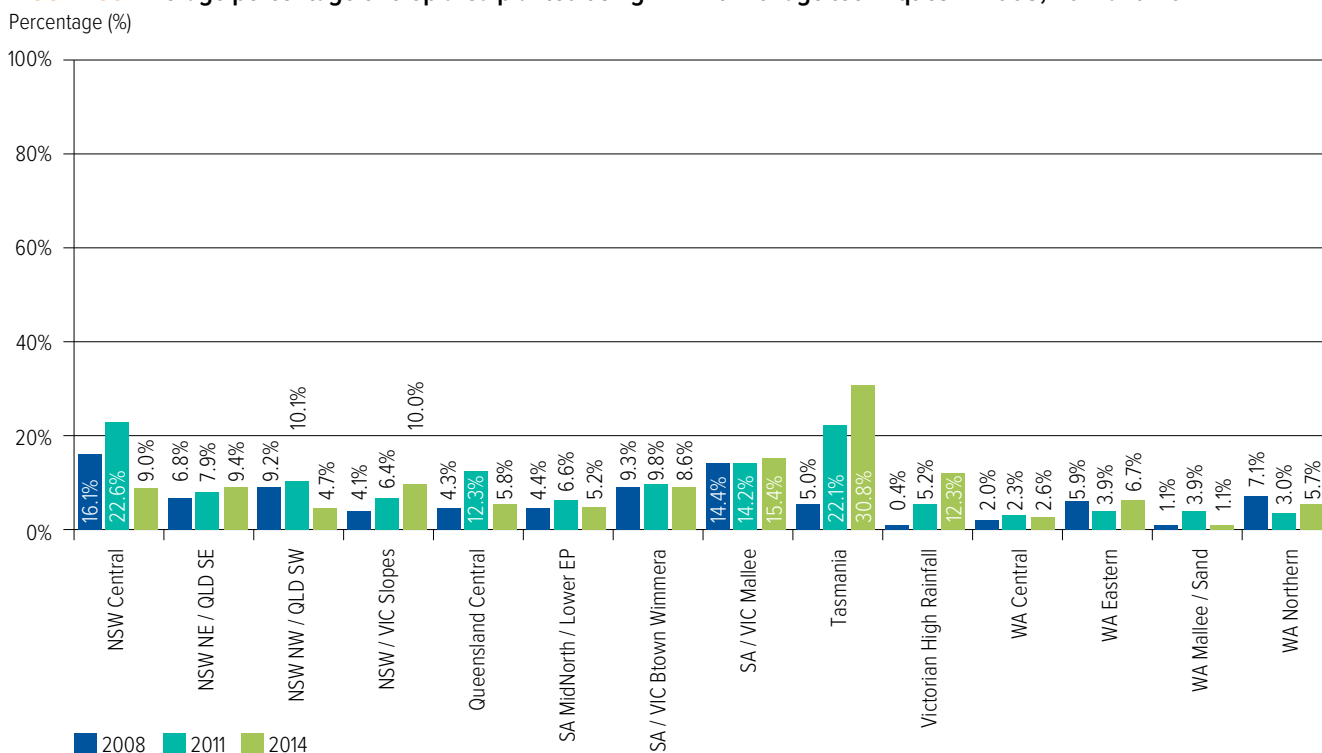
**TABLE 28** Average percentage of crop area planted using minimum tillage techniques in 2008, 2011 and 2014.

Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	16.1	22.6	9.0	***	
NSW NE / Queensland SE	6.8	7.9	9.4		
NSW NW / Queensland SW	9.2	10.1	4.7		
NSW / Victorian Slopes	4.1	6.4	10.0		***
Queensland Central	4.3	12.3	5.8		
SA Mid North / Lower EP	4.4	6.6	5.2		
SA / VIC Bordertown Wimmera	9.3	9.8	8.6		
SA / Victorian Mallee	14.4	14.2	15.4		
Tasmania	5.0	22.1	30.8		
Victorian High Rainfall	0.4	5.2	12.3		***
WA Central	2.0	2.3	2.6		
WA Eastern	5.9	3.9	6.7		
WA Mallee / Sandplain	1.1	3.9	1.1		
WA Northern	7.1	3.0	5.7		
National averages	6.4	9.3	9.1		

**FIGURE 32** Proportion of crop area planted using zero-till or no-tillage or direct drill in 2014.



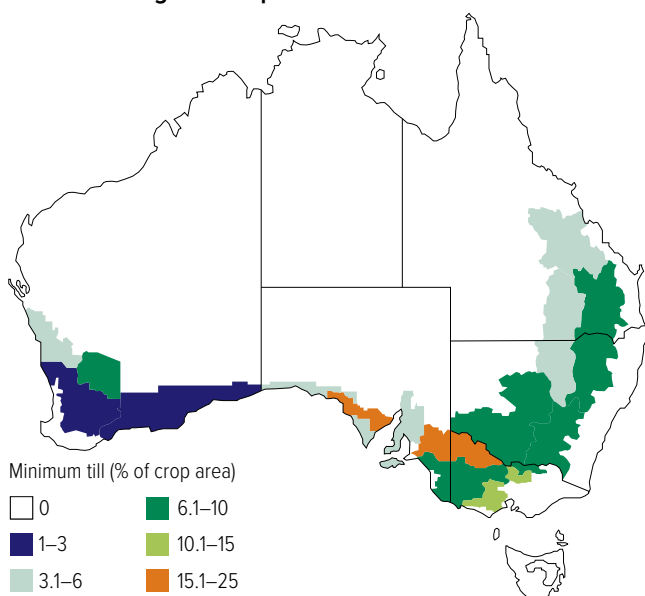
**FIGURE 33 Average percentage of crop area planted using minimum tillage techniques in 2008, 2011 and 2014**



consideration to be made between the levels of adoption of the combined zero/no tillage/direct-drilling (i.e. any practice where only one pass through the soil occurs at planting) and how these one-pass practices may have changed in relation to the use of minimum, reduced and multiple tillage practices that are described below.

The three one-pass practices (zero-tillage/no-tillage and direct-drill) represent the majority of cropped area in most agro-ecological zones, with typically 80% or more of the crop area planted using these techniques. However, there seems to be some decline in their use in a general sense since the last two surveys.

**FIGURE 34 Proportion of crop area planted using minimum tillage techniques in 2014.**



### Minimum-tillage

Minimum-tillage involves generally only one cultivation, with full soil disturbance, prior to the planting operation, i.e. less than the usual more numerous cultivations of a 'multiple tillage' system.

Such cultivations are often used for weed control or to place previous crop residues into the soil so that planting operations, often with conventional machinery, are not impeded by such residue.

As shown in Table 28, Figure 33 and Figure 34, minimum-tillage techniques are seen to be slightly higher in some AEZs, for example, Central New South Wales, NSW/Victorian Slopes, SA/Victorian Mallee, and have increased NSW/Victorian Slopes and Victorian High Rainfall zones.

### Multiple-tillage (conventional cultivation)

This system often includes a long, cultivation-based fallow where tillage is the dominant method of soil preparation prior to planting.

This category, previously known as 'conventional cultivation', is used to ensure fine and loose, weed and crop-residue-free soil at planting.

The use of a multiple-tillage-based system had been reported as being at very low levels in both 2008 and 2011 surveys. However, in 2014 (see Table 29, Figure 35 and

**FIGURE 35** Average percentage of crop area planted using multiple tillage in 2008, 2011 and 2014.

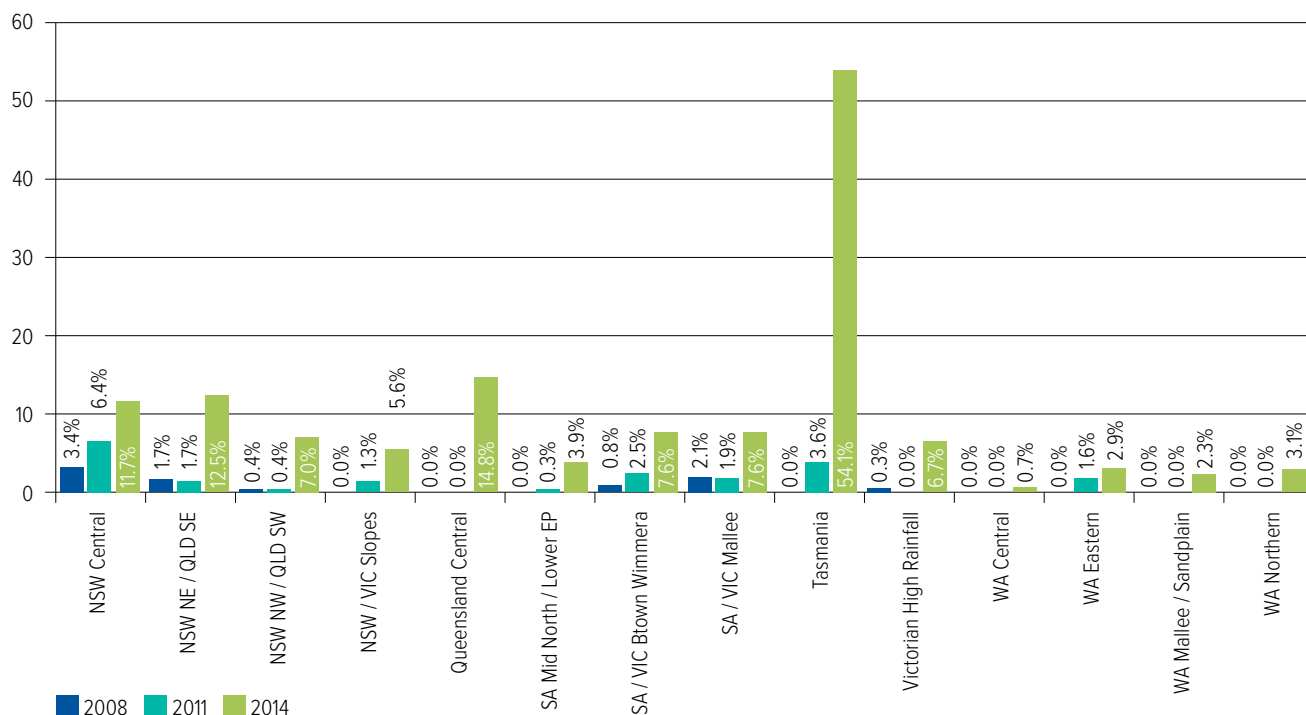
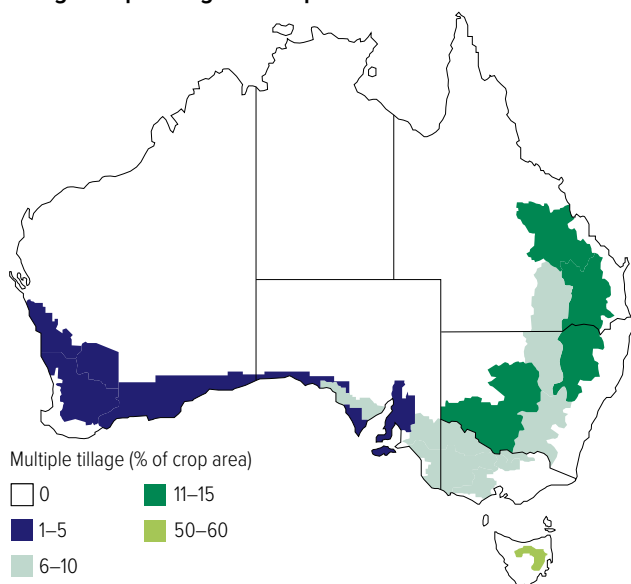


Figure 36) there appeared to be an increase in the use of cultivation prior to sowing in all AEZs apart from WA, where there was also a slight (although non-significant) increase.

Reasons for these increases will be speculative, although likely include seasonal conditions, weed or disease management.

**FIGURE 36** Proportion (%) percentage of crop area planted using multiple tillage techniques in 2014.



**TABLE 29** Average percentage of crop area planted using multiple tillage techniques in 2008, 2011 and 2014.

Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	3.4	6.4	11.7		**
NSW NE / Queensland SE	1.7	1.7	12.5	***	***
NSW NW / Queensland SW	0.4	0.4	7.0	**	**
NSW / Victorian Slopes	0.0	1.3	5.6	***	***
Queensland Central	0.0	0.0	14.8	**	**
SA Mid North / Lower EP	0.0	0.3	3.9	**	**
SA / VIC Bordertown Wimmera	0.8	2.5	7.6	**	**
SA / Victorian Mallee	2.1	1.9	7.6	***	***
Tasmania	0.0	3.6	54.1	**	**
Victorian High Rainfall	0.3	0.0	6.7	**	**
WA Central	0.0	0.0	0.7		
WA Eastern	0.0	1.6	2.9		
WA Mallee / Sandplain	0.0	0.0	2.3		
WA Northern	0.0	0.0	3.1		
National averages	0.6	1.4	10.0		

# PRECISION AGRICULTURE IN 2014



PHOTO: EVAN COLLIS

The use of various precision agriculture practices, including controlled traffic, autosteering, yield mapping and variable-rate fertiliser application were included in the 2014 survey.

Questions were:

- What area of your crops are the following techniques used:
  - autosteering or GPS guidance,
  - controlled traffic,
  - remote sensing using EM38 or NDVI,
  - yield mapping,
  - variable-rate technology for seeding,
  - variable rate for fertiliser application.

## Controlled traffic

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

It appears that, in general, CT is widely used on larger farms with larger crop areas in the northern region AEZs, with some use in the northern and southern areas of Western Australia.

Controlled traffic is known to have benefits for soil compaction, which can be a problem in heavier clay soils, for example, in much of northern NSW and southern and Queensland Central. This could explain the relatively high adoption in these zones.

As shown in Table 30, Figure 37 and Figure 38, the national average use of controlled traffic remains largely unchanged since the last survey of 2011.

## Autosteering

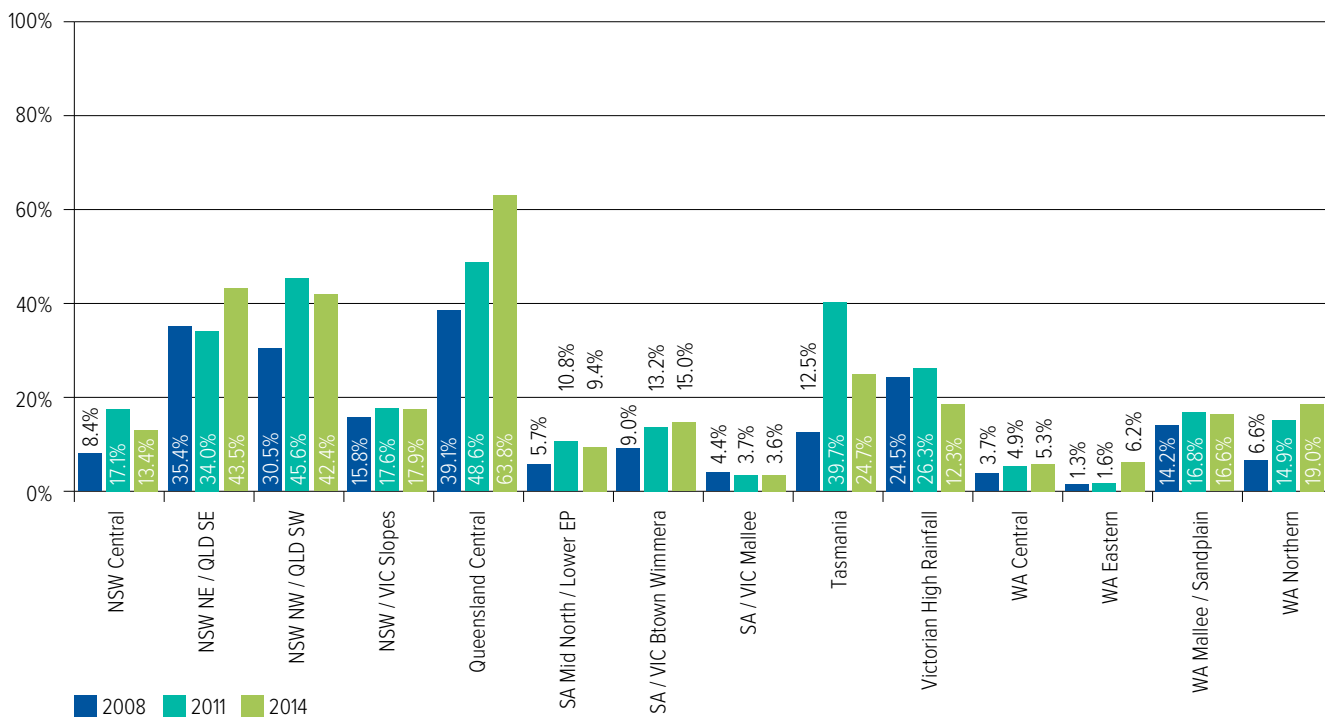
Autosteering uses GPS-based guidance to assist with guiding the tractor, header and sprayer across the cropped or pasture area. Autosteering is a more sophisticated level of GPS guidance where the technology steers the machine for the driver, who only has to manually make turns where necessary.

Autosteering guides machinery to within 2 centimetres (or less) of the desired location and can be a form of CT,

**TABLE 30** Average percentage of crop area where controlled traffic was used in 2008, 2011 and 2014.

Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	8.4	17.1	13.4		
NSW NE / Queensland SE	35.4	34.0	43.5		
NSW NW / Queensland SW	30.5	45.6	42.4		
NSW / Victorian Slopes	15.8	17.6	17.9		
Queensland Central	39.1	48.6	63.8		
SA Mid North / Lower EP	5.7	10.8	9.4		
SA / VIC Bordertown Wimmera	9.0	13.2	15.0		
SA / Victorian Mallee	4.4	3.7	3.6		
Tasmania	12.5	39.7	24.7		
Victorian High Rainfall	24.5	26.3	18.7		
WA Central	3.7	4.9	5.3		
WA Eastern	1.3	1.6	6.2		
WA Mallee / Sandplain	14.2	16.8	16.6		
WA Northern	6.6	14.9	19.0		
<b>National averages</b>	<b>15.1</b>	<b>21.1</b>	<b>21.4</b>		

**FIGURE 37** Average percentage of crop area where controlled traffic was being used in 2008, 2011 and 2014.



although this is not always the case. Autosteering can be used with any implement to provide accurate steering and to avoid overlapping or missing areas.

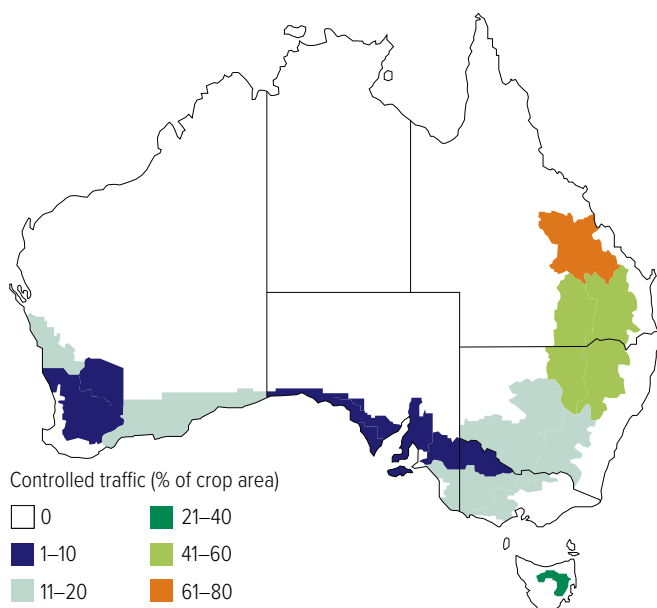
There has been a significant uptake in the adoption of autosteering in recent years, with usage as reported in the 2014 survey now at quite high levels (over 90% of the crop area in many AEZs). See Table 31, Figure 39 and Figure 40.

Anecdotally, it is suggested that grain farms are by and

large embracing this technology, and where it is used it is employed on virtually all of the cropping area.

The general continued uptake of autosteering as compared to controlled traffic suggests that grain growers are going straight for the benefits of controlled traffic that are also offered through autosteering, without implementing CT as a first step.

**FIGURE 38** Average percentage of crop area using controlled traffic in 2014.

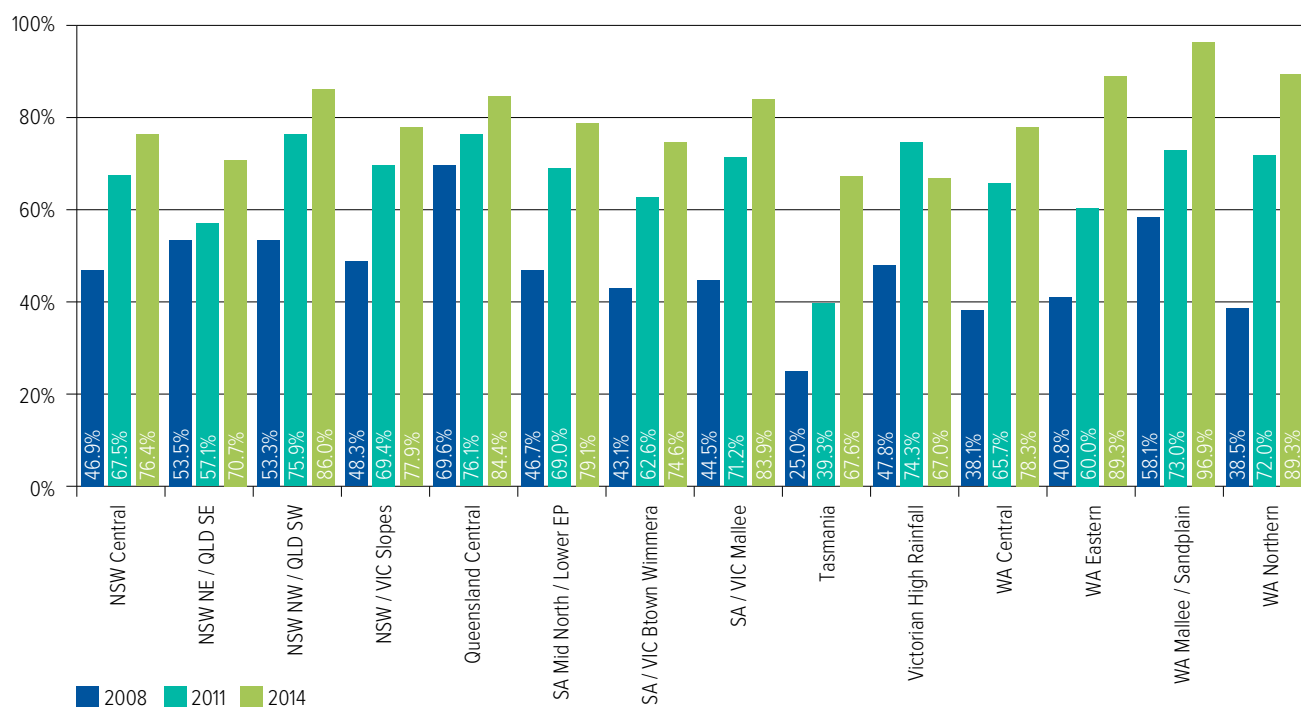


**TABLE 31** Average percentage of crop area where autosteering was used in 2008, 2011 and 2014.

Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	46.9	67.5	76.4		***
NSW NE / Queensland SE	53.5	57.1	70.7	**	***
NSW NW / Queensland SW	53.3	75.9	86.0		***
NSW / Victorian Slopes	48.3	69.4	77.9		***
Queensland Central	69.6	76.1	84.4		
SA Mid North / Lower EP	46.7	69.0	79.1		***
SA / VIC Bordertown Wimmera	43.1	62.6	74.6		***
SA / Victorian Mallee	44.5	71.2	83.9	**	***
Tasmania	25.0	39.3	67.6		
Victorian High Rainfall	47.8	74.3	67.0		
WA Central	38.1	65.7	78.3	***	***
WA Eastern	40.8	60.0	89.3	***	***
WA Mallee / Sandplain	58.1	73.0	96.9	***	***
WA Northern	38.5	72.0	89.3	**	***
National averages	46.7	66.7	80.1		



**FIGURE 39** Average percentage of cropped area where autosteer was used as reported in surveys in 2008, 2011 and 2014.

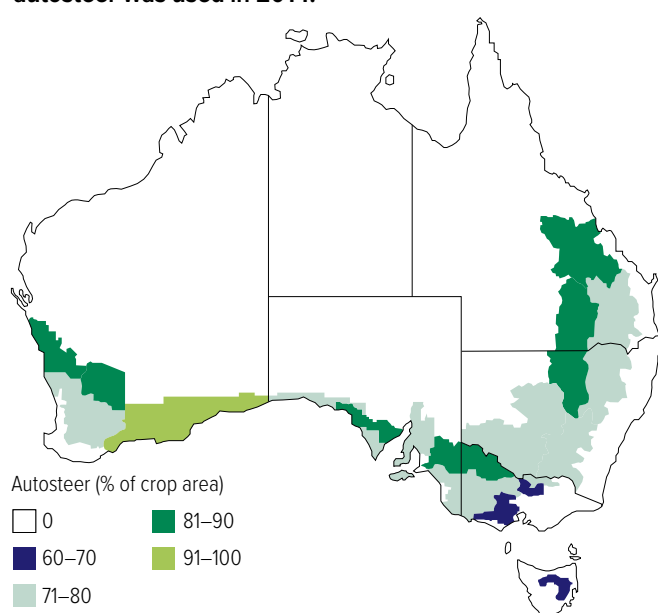


### Variable-rate technology (VRT).

One aspect of precision agriculture is to use data about crop performance, soil tests and paddock history, along with other remote sensing data, to determine the characteristics of various areas within a paddock. One application of this integrated approach is to use this data to apply variable rates

of seed and fertiliser (or other inputs) to different parts of the paddock using satellite-guided positioning. This technology is relatively sophisticated and complex and requires expert technical input. The technology is often linked to yield maps, or other data about paddock performance or characteristics

**FIGURE 40** Average percentage of crop area where autosteer was used in 2014.



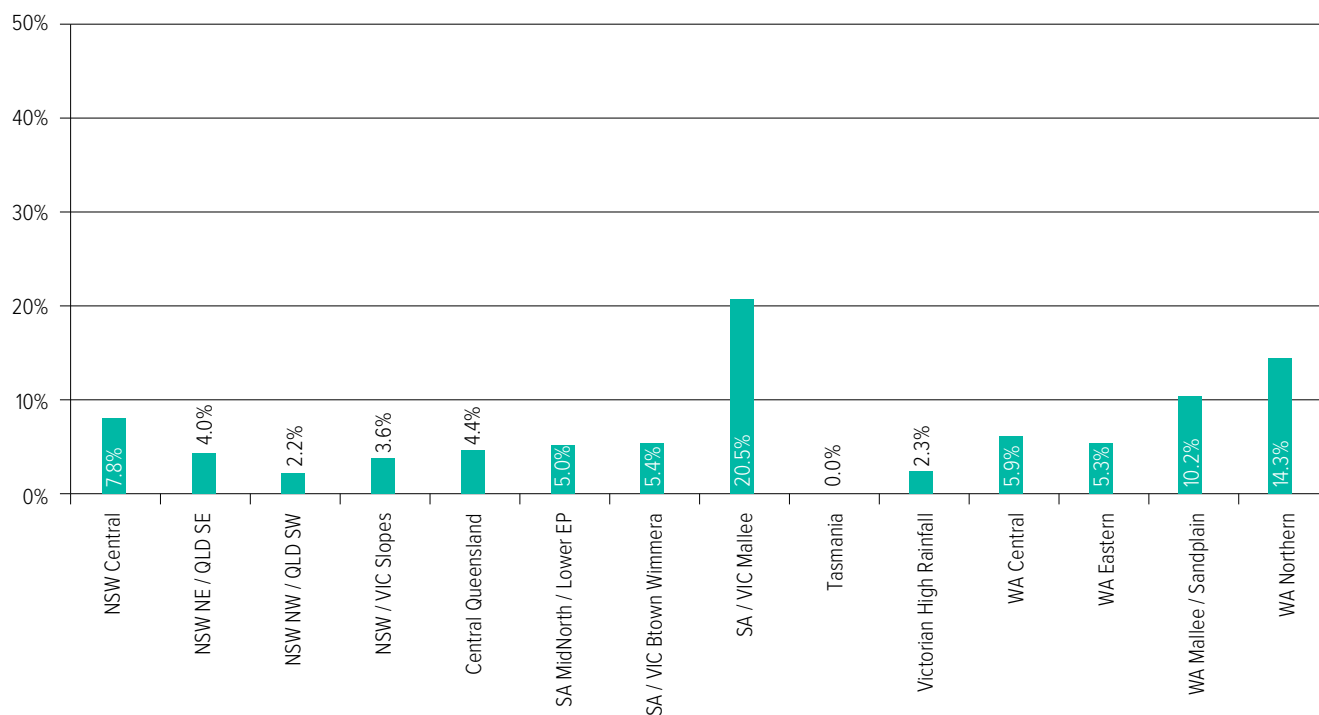
**TABLE 32** Average percentage of cropped area where variable-rate seeding technology was used in 2014.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	7.8	
NSW NE / Queensland SE (b)	4.0	
NSW NW / Queensland SW (c)	2.2	
NSW / Victorian Slopes (d)	3.6	
Queensland Central (e)	4.4	
SA Mid North / Lower EP (f)	5.0	
SA / VIC Bordertown Wimmera (g)	5.4	
SA / Victorian Mallee (h)	20.5	bcdefghklm
Tasmania (i)	0.0	
Victorian High Rainfall (j)	2.3	
WA Central (k)	5.9	
WA Eastern (l)	5.3	
WA Mallee / Sandplain (m)	10.2	
WA Northern (n)	14.3	cj
<b>Average in survey</b>	<b>6.5</b>	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.



**FIGURE 41** Average percentage of crop area where variable-rate seeding technology was used in 2014.

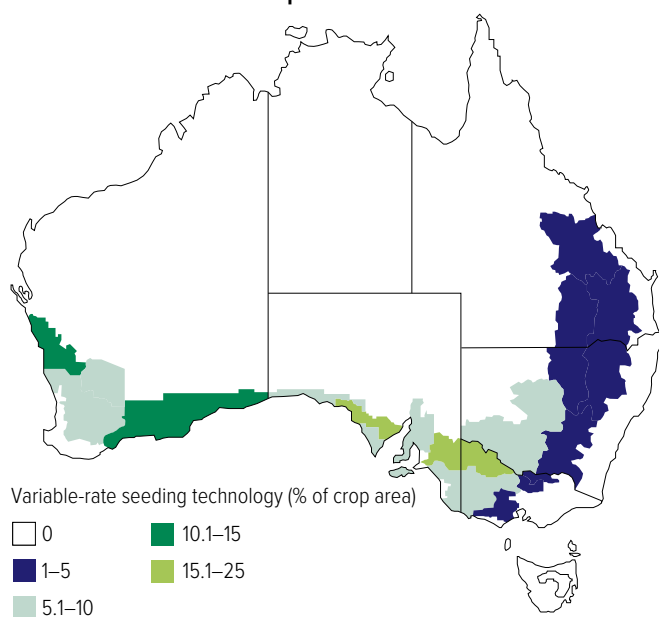


where these vary across the area.

In the survey of 2014 growers were asked about their use of variable-rate technology for both seed and fertiliser applications. This data is shown in Table 32, Table 33, Figure 41, Figure 42, Figure 43 and Figure 44.

The uptake of this technology is lower than for other forms of precision agriculture technologies studied in the 2014 survey, although is reported by growers in the SA/Vic Mallee to be used on 20% of the grain production area, and over 10% of the cropped area in the north and south of the WA crop.

**FIGURE 42** Average percentage of crop area where variable rate seed techniques were used in 2014.

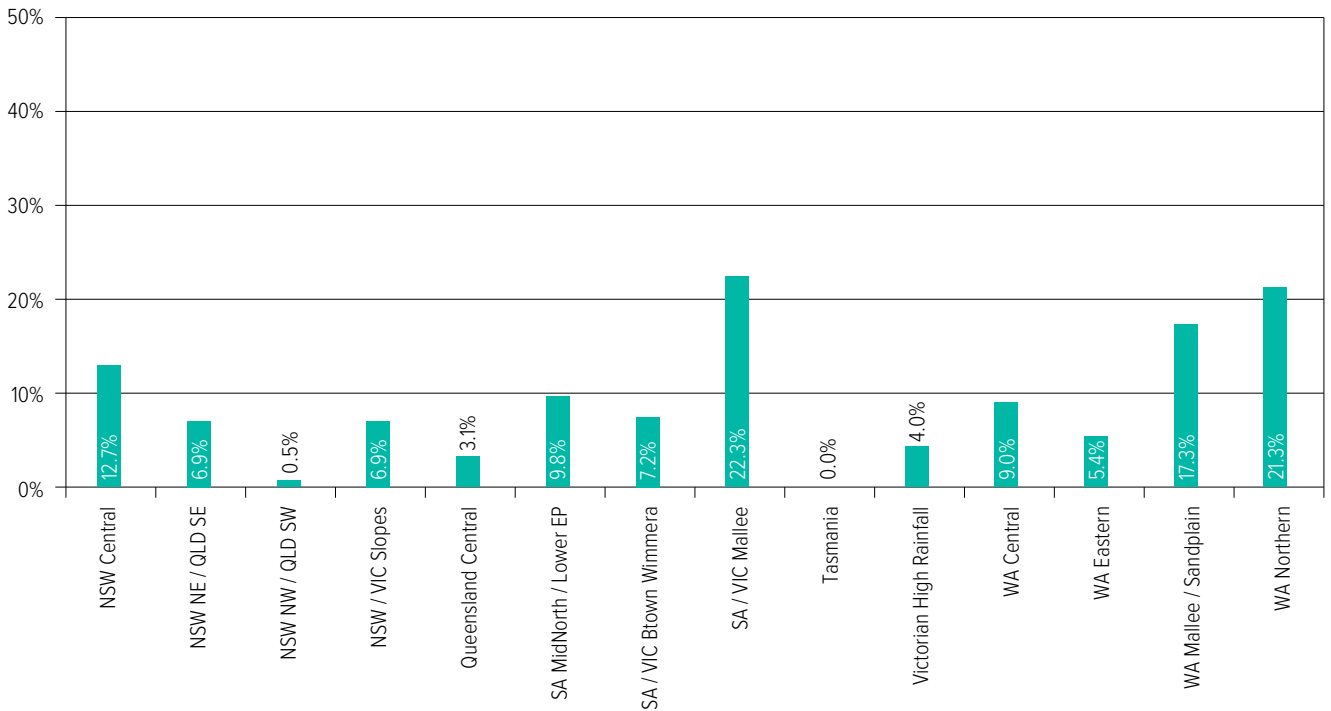


**TABLE 33** Average percentage of cropped area where variable rate fertiliser technology was used in 2014.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	12.7	cej
NSW NE / Queensland SE (b)	6.9	c
NSW NW / Queensland SW (c)	0.5	
NSW / Victorian Slopes (d)	6.9	c
Queensland Central (e)	3.1	
SA Mid North / Lower EP (f)	9.8	c
SA / VIC Bordertown Wimmera (g)	7.2	c
SA / Victorian Mallee (h)	22.3	abcdefgijkl
Tasmania (i)	0.0	
Victorian High Rainfall (j)	4.0	
WA Central (k)	9.0	c
WA Eastern (l)	5.4	
WA Mallee / Sandplain (m)	17.3	cej
WA Northern (n)	21.3	bcdejl
Average in survey	9.0	

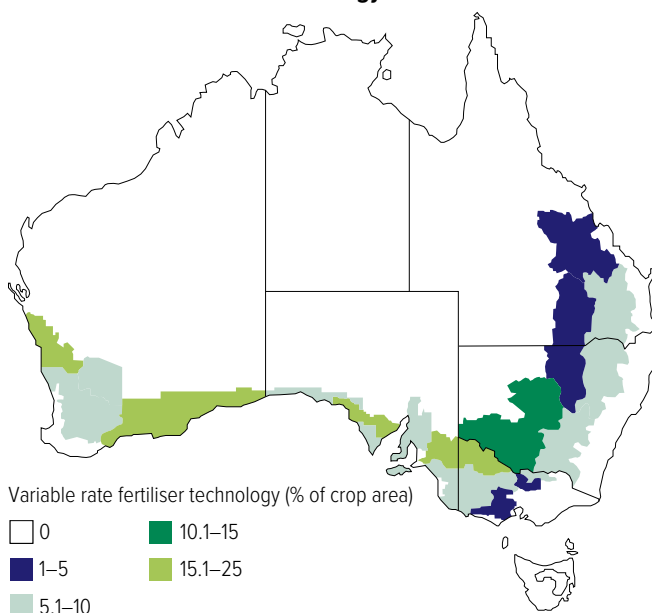
Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

**FIGURE 43** Average percentage of crop area where variable-rate fertiliser technology was used in 2014.



The result in the Mallee may be due to the development of applying different fertiliser regimes to Mallee dunes and swale areas in a paddock.

**FIGURE 44** Average percentage of crop area where variable-rate fertiliser technology was used in 2014.



### Variable-rate seed technology

Variable rate seed technology is where the seed rate (i.e. amount of seed per hectare) is varied across the paddock, in response to guidance from previous measurements, or remote-sensing or historic crop data. This practice is relatively recent and is used on less than 10% of the cropped area with the exceptions of the SA/ Victorian Mallee and two AEZs in WA (see Table 32, Figure 41 and Figure 42).

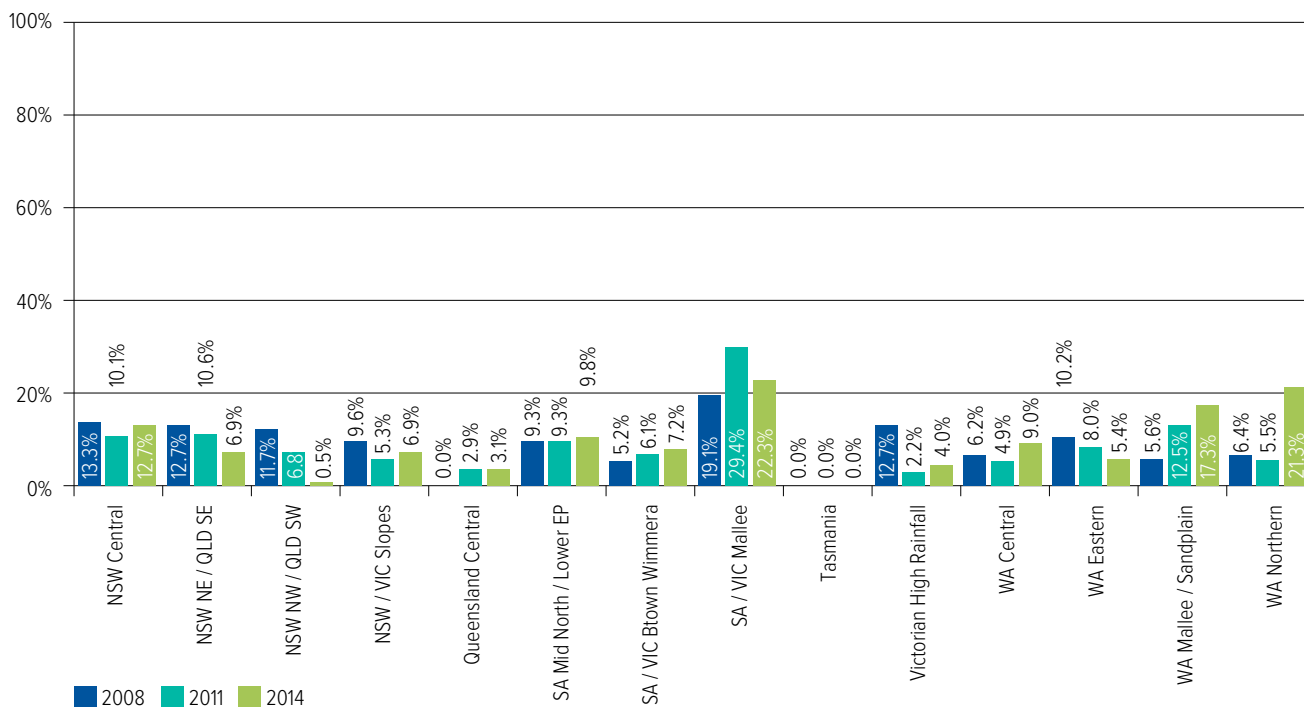
As mentioned above, one feature of some Mallee soils is the presence of dune and swale areas. Growers have traditionally chosen to sow different crop types on these areas (for example, alternating wheat with barley), or varying fertiliser application rates on these as well. It is possible that some growers have reported this practice as a form of variable rate use, potentially inflating this data in AEZs where Mallee soils are prevalent.

### Variable-rate fertiliser technology

Similarly to variable-rate seed technology, variable-rate fertiliser technology involves varying the fertiliser application rates on different parts of a paddock, guided by previous crop results, soil test data or remote sensing information, or manipulations and calculations of these. Data for 2014 is shown in Table 33, Figure 43 and Figure 44.

The data shows that adoption of variable-rate fertiliser use is slightly higher than variable-rate seeding use, is again higher in the Mallee, and also in NSW Central and Western Australia.

**FIGURE 45** Average percentage of crop area where variable-rate technology was used in 2008, 2011 and 2014.



### Comparison of variable-rate technology use in 2014 with previous surveys

In the previous two surveys respondents were asked about their use of VRT in a general sense, although, as noted, in 2014 they were asked about the use of this technology at either seeding or in applying fertiliser.

From the data on variable-rate seed application described above, it is apparent that using variable-rate seed application is lower than its use for fertiliser application. It is likely that where VRT is used for seed application it would also be used for fertiliser, although not

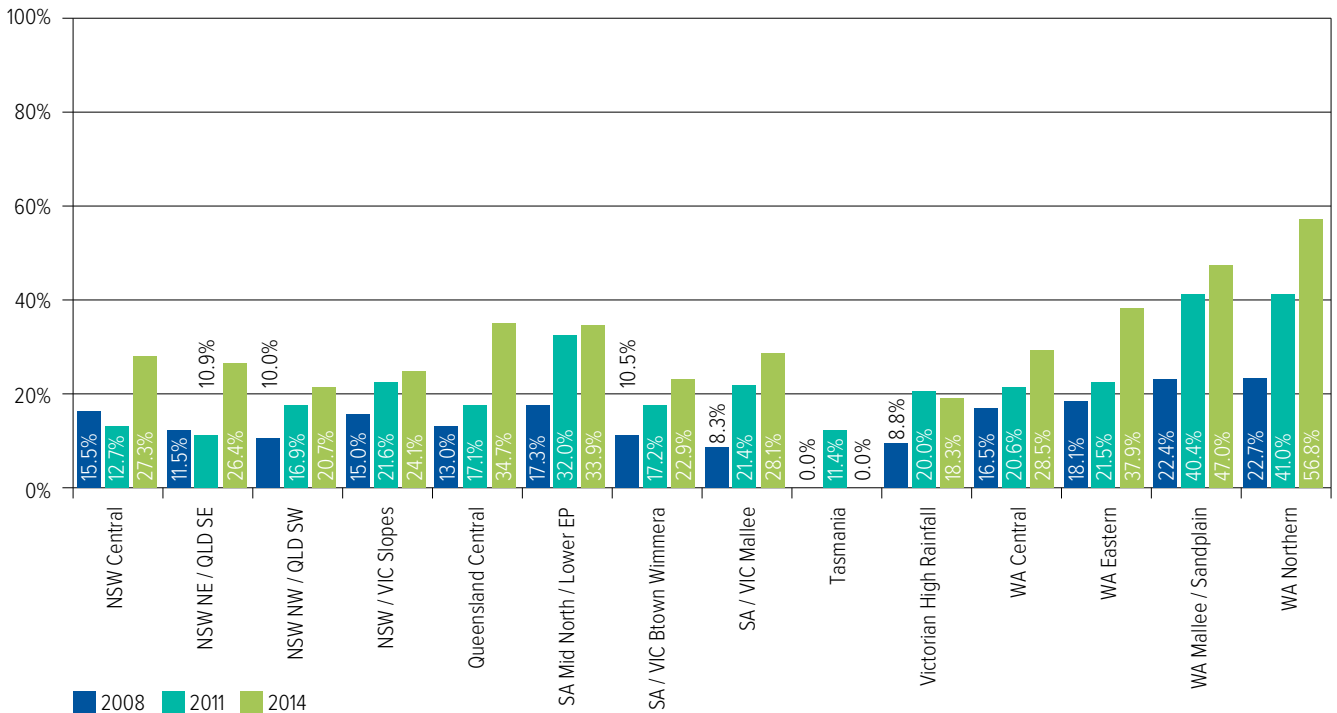
**TABLE 34** Average percentage of crop area where variable-rate technology was used in 2008, 2011 and 2014.

Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	13.3	10.1	12.7		
NSW NE / Queensland SE	12.7	10.6	6.9		
NSW NW / Queensland SW	11.7	6.8	0.5	**	***
NSW / Victorian Slopes	9.6	5.3	6.9		
Queensland Central	0	2.9	3.1		
SA Mid North / Lower EP	9.3	9.3	9.8		
SA / VIC Bordertown Wimmera	5.2	6.1	7.2		
SA / Victorian Mallee	19.1	29.4	22.3		
Tasmania	0	0	0		
Victorian High Rainfall	12.7	2.2	4.0		
WA Central	6.2	4.9	9.0		
WA Eastern	10.2	8	5.4		
WA Mallee / Sandplain	5.6	12.5	17.3		
WA Northern	6.4	5.5	21.3	**	**
National averages	8.7	8.1	9.0		

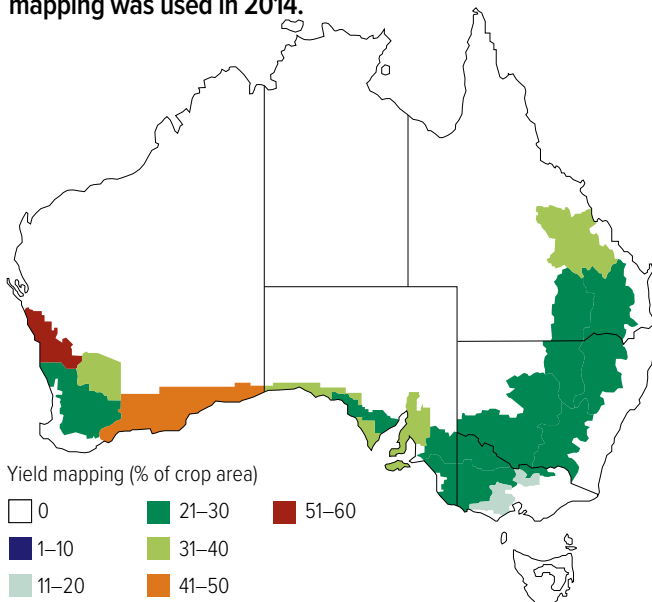
**TABLE 35** Average percentage of crop area where yield mapping was used in 2008, 2011 and 2014.

Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	15.5	12.7	27.3	***	
NSW NE / Queensland SE	11.5	10.9	26.4	***	***
NSW NW / Queensland SW	10.0	16.9	20.7		
NSW / Victorian Slopes	15.0	21.6	24.1		**
Queensland Central	13.0	17.1	34.7		
SA Mid North / Lower EP	17.3	32.0	33.9		***
SA / VIC Bordertown Wimmera	10.5	17.2	22.9		**
SA / Victorian Mallee	8.3	21.4	28.1		***
Tasmania	0.0	11.4	0.0		
Victorian High Rainfall	8.8	20.0	18.3		
WA Central	16.5	20.6	28.5		***
WA Eastern	18.1	21.5	37.9		**
WA Mallee / Sandplain	22.4	40.4	47.0		***
WA Northern	22.7	41.0	56.8		***
National averages	13.5	21.8	29.0		***

**FIGURE 46** Average percentage of cropped area where yield mapping was used in 2008, 2011 and 2014.



**FIGURE 47** Average percentage of crop area where yield mapping was used in 2014.



necessarily vice versa. Varying fertiliser application rates is generally more widely used, and based on more analysis and experience, and so the data for variable-rate fertiliser application is likely to indicate the general or combined level of VRT in 2014.

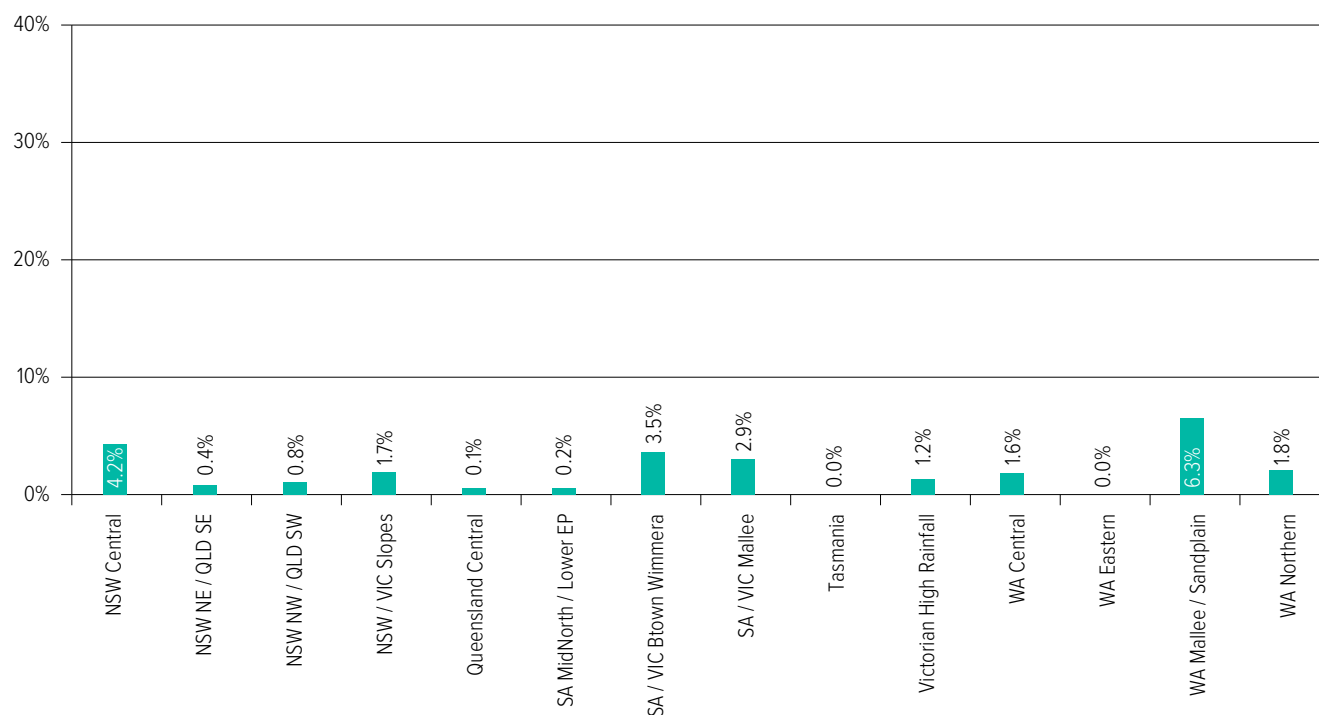
The data in Table 34 and Figure 45 compares the use of VRT (in general) as found in 2008 and 2011 and for VRT use (for fertiliser) in 2014. It shows a slight general increase in the use of these practices, although a decrease in several AEZs, for example in northern NSW and southern Queensland.

### Yield mapping

Yield mapping can be used for general monitoring of crop performance, for making decisions about inputs, or even in choosing the type of crop for various paddocks. It can give guidance as to further investigations that should be undertaken, e.g. zoned soil tests, and for use in identifying soil impediments or the presence of diseases or other factors across a paddock.

There has been an increase in the proportion of the cropped area where yield mapping is used in 2014 compared with the previous surveys (Table 35, Figure 46 and Figure 47). This is possibly due to most new harvesters bought by growers having this technology built in, and that where contract harvesters are used, many of these also possessing yield-mapping capability.

**FIGURE 48** Average percentage of crop area where remote sensing using EM38 or NDVI was used in 2014.



**TABLE 36** Average percentage of cropped area where remote sensing using EM38 or NDVI was used in 2014.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	4.2	bcefl
NSW NE / Queensland SE (b)	0.4	
NSW NW / Queensland SW (c)	0.8	
NSW / Victorian Slopes (d)	1.7	
Queensland Central (e)	0.1	
SA Mid North / Lower EP (f)	0.2	
SA / VIC Bordertown Wimmera (g)	3.5	efl
SA / Victorian Mallee (h)	2.9	efl
Tasmania (i)	0.0	
Victorian High Rainfall (j)	1.2	
WA Central (k)	1.6	efl
WA Eastern (l)	0.0	
WA Mallee / Sandplain (m)	6.3	bcefl
WA Northern (n)	1.8	
National average	1.8	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

### Use of other remote-sensing technologies.

Some grain growers use technologies to provide knowledge about their soil or other resources to assist with their management. Two candidate technologies are remote sensing using electromagnetic sensing (known as EM38), and Normalised Difference Vegetation Index (NDVI).

EM38 soil mapping is a relatively quick means of measuring levels and depths of clay and lighter-textured soil, and can assist with identifying soil areas with different moisture-holding content, salt levels and soil texture (clay). EM38 mapping is generally carried out using portable measuring equipment, for example, towed behind quad bikes or other vehicles.

One other source of data being used by some growers is Normalised Difference Vegetation Index (NDVI), which is satellite data that can be used to show crop biomass levels, which correlate with potential crop yield. This data can assist with defining areas in terms of yield potential.

Survey respondents in 2014 were asked about their use of these technologies. The data shows (Table 36, Figure 48) that the adoption of these technologies as reported by survey respondents is relatively low, averaging less than 2% of the cropped area nationally. Higher use of these technologies was noted in parts of South Australia and Victoria, central NSW and southern WA.



# FALLOW MANAGEMENT IN 2014



PHOTO: BRAD COLLIS

Questions included in 2014 were:

- How much area of your farm has been fallowed in the last 12 months?
- What area of the fallow has been managed?
  - without any tillage;
  - only with herbicides;
  - grazed by livestock; and
  - cultivated.

A period of fallow was described as: “the period between a pasture phase and the beginning a cropping phase in a paddock. The length of fallow can be short (a few weeks or months between pasture and crops), or it can be long (several months between pasture and crops).”

Fallows vary in length. A short fallow can be very short (as short as weeks for a summer crop following a winter crop harvest in the more northern regions) to some months (between 3 and 7 months in the southern and western cropping areas from a November/December harvest to sowing in April/May/June.

Long fallows can last up to 18 months.

Fallow periods have traditionally been seen as useful for storing soil moisture, weed control, mineralisation of nitrogen and providing a disease break. The length of the fallow period and how it is managed can influence available soil moisture and ultimate water use efficiency of the future crop. Not all grain growers would identify as using a fallow period, although in most cases the period between crops could be considered as a ‘fallow’.

In some grain-growing areas soil types and seasonal conditions are such that the generally recognised benefits from a fallow are less apparent. The key factor that would lead to this period being identified as a ‘fallow period’ would be whether the grower actively manages the area in the period between crops (or in the period leading up to the sowing of the crop). Controlling plant growth (weeds/volunteer

crop plants that emerge) is the key consideration in fallow management, and is the reason that fallows can assist with holding soil moisture, providing weed and disease control and conserving/allowing nitrogen mineralisation.

In 2014, respondents were asked if they managed a fallow period over the past 12 months, prior to sowing their crops in 2014, with the definition (if needed) following the dot points on left.

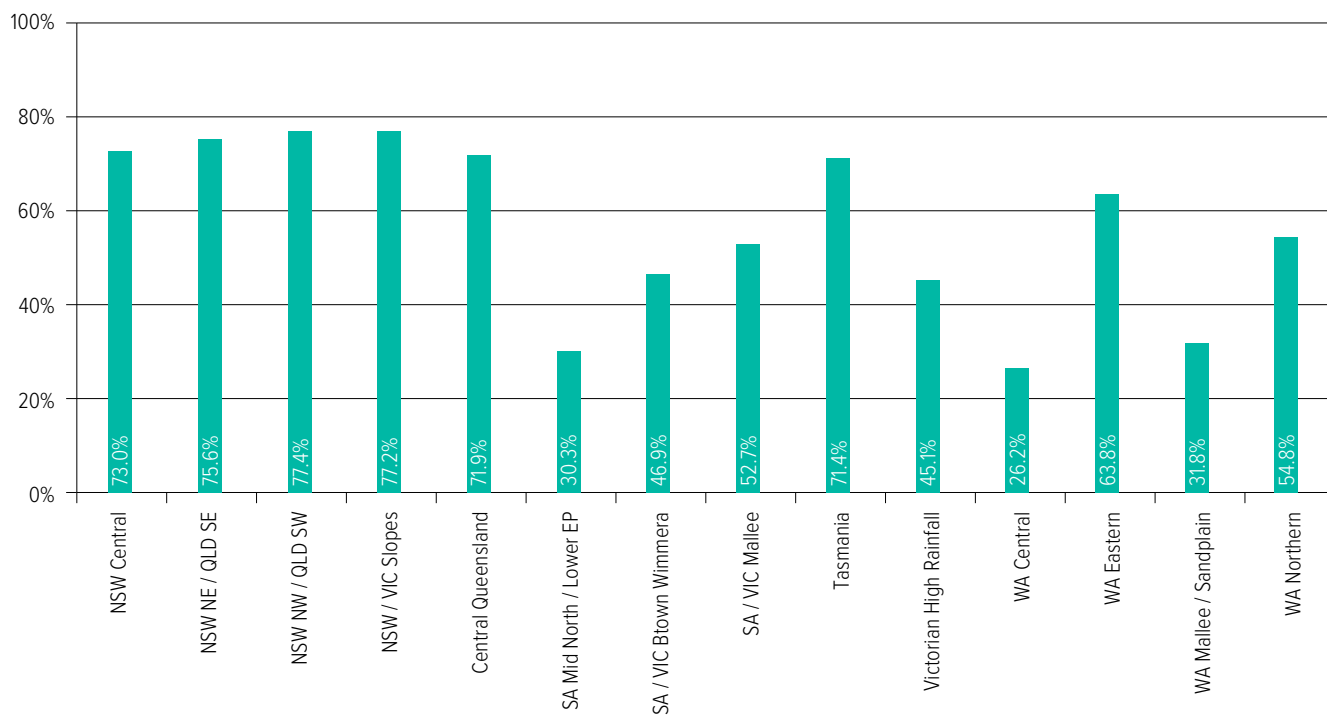
**TABLE 37** Average percentage of farms using a fallow period over the past 12 months in 2014.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	73	fghjkmn
NSW NE / Queensland SE (b)	76	fghjkmn
NSW NW / Queensland SW (c)	77	fghjkmn
NSW / Victorian Slopes (d)	77	fghjkmn
Queensland Central (e)	72	fgjkm
SA Mid North / Lower EP (f)	30	
SA / VIC Bordertown Wimmera (g)	47	fk
SA / Victorian Mallee (h)	53	fk
Tasmania (i)	71	fk
Victorian High Rainfall (j)	45	k
WA Central (k)	26	
WA Eastern (l)	64	fk
WA Mallee / Sandplain (m)	32	
WA Northern (n)	55	fk
<b>National average</b>	<b>57</b>	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.



**FIGURE 49** Average percentage of farms using a fallow period over the past 12 months in 2014.

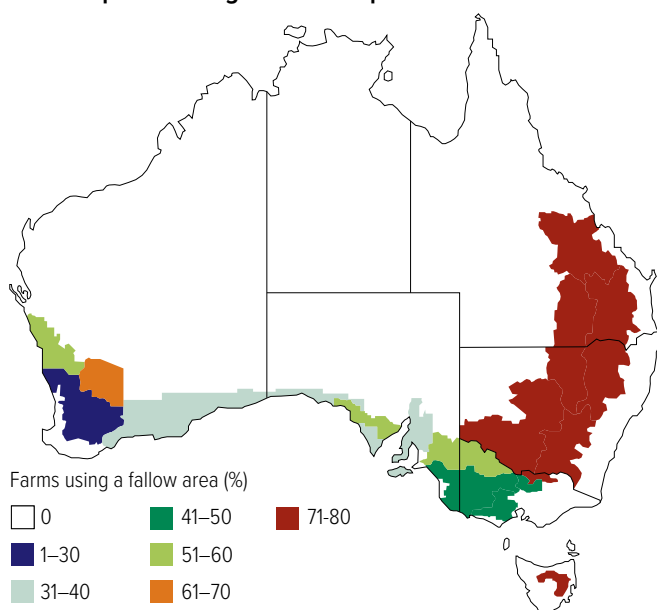


### Proportion of grain farms where a fallow was a feature of the 2014 crop

The data shown in Table 37, Figure 49 and Figure 50 indicates that a fallow period was utilised more in the AEZs of NSW and Queensland than elsewhere. Fallows are much less identified in southern and central WA, although fallows are more present in eastern and northern WA, suggesting some soil types in these AEZs with an ability to hold more moisture as different

from the more sandy textured soils in central and southern WA grain areas. In the northern AEZs the combination of clay textured soils with moisture holding capacities, the presence of summer and winter crop options, and a farming system that includes a significant emphasis on soil moisture management has meant that fallows are a common feature.

**FIGURE 50** Average percentage of respondents reporting a fallow period being used in the past 12 months in 2014.

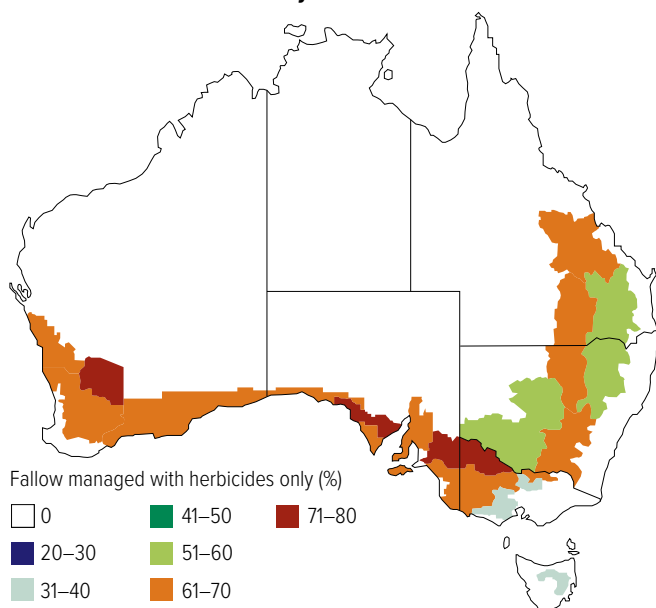


**TABLE 38** Average percentage of farms using a fallow period over the past 12 months in 2014.

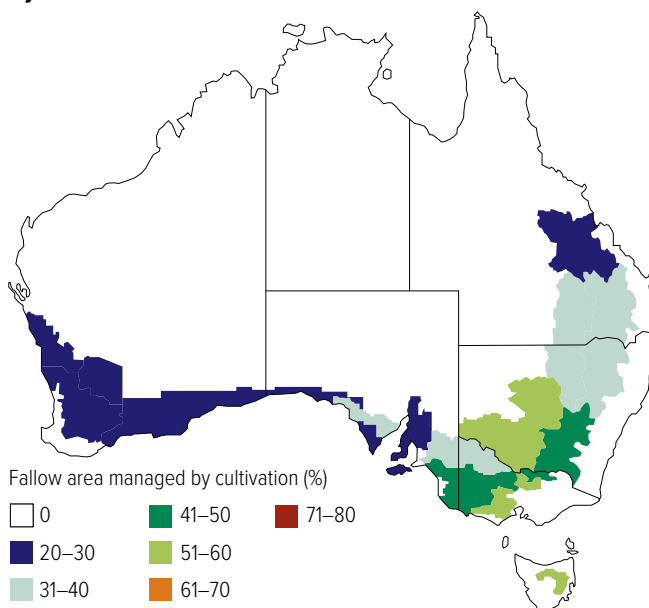
Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	51.4	
NSW NE / Queensland SE (b)	58.2	
NSW NW / Queensland SW (c)	62.5	
NSW / Victorian Slopes (d)	62.6	j
Queensland Central (e)	69.3	j
SA Mid North / Lower EP (f)	62.9	
SA / VIC Bordertown Wimmera (g)	66.0	j
SA / Victorian Mallee (h)	74.4	aj
Tasmania (i)	40.0	
Victorian High Rainfall (j)	31.2	
WA Central (k)	62.3	j
WA Eastern (l)	73.2	j
WA Mallee / Sandplain (m)	61.0	
WA Northern (n)	67.2	
National average	60.2	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

**FIGURE 51** Percentage of area using fallow weed control with herbicides only in 2014.



**FIGURE 52** Average percentage of fallow area managed by cultivation in 2014.



### Fallow management technique

One of the main activities in managing the fallow period is controlling plant growth (weeds and volunteer crop plants) to try to maintain the area free of plant growth. There are several options and combinations available to growers, including the use of herbicides, cultivation or grazing.

### Fallow managed by herbicide only

Data for 2014 (Table 38, Figure 51) suggests that herbicides are responsible for the majority (although not all) of weed management on fallow areas. Higher herbicide usage in fallow was reported in the AEZs of the SA and Victorian Mallee and WA Eastern, although the national average is just over 60% of the fallow area. The lower percentage of fallow maintained with herbicide was reported for the Victorian High Rainfall and NSW Central AEZs.

**TABLE 39** Average percentage of fallow area managed by cultivation (base: used fallow period) in 2014.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	56.2	cefhkln
NSW NE / Queensland SE (b)	38.1	k
NSW NW / Queensland SW (c)	32.6	
NSW / Victorian Slopes (d)	44.2	k
Queensland Central (e)	26.5	
SA Mid North / Lower EP (f)	25.0	k
SA / VIC Bordertown Wimmera (g)	42.6	
SA / Victorian Mallee (h)	31.6	
Tasmania (i)	60.0	
Victorian High Rainfall (j)	56.5	fk
WA Central (k)	18.2	
WA Eastern (l)	27.1	
WA Mallee / Sandplain (m)	22.6	
WA Northern (n)	25.5	
National average	36.2	

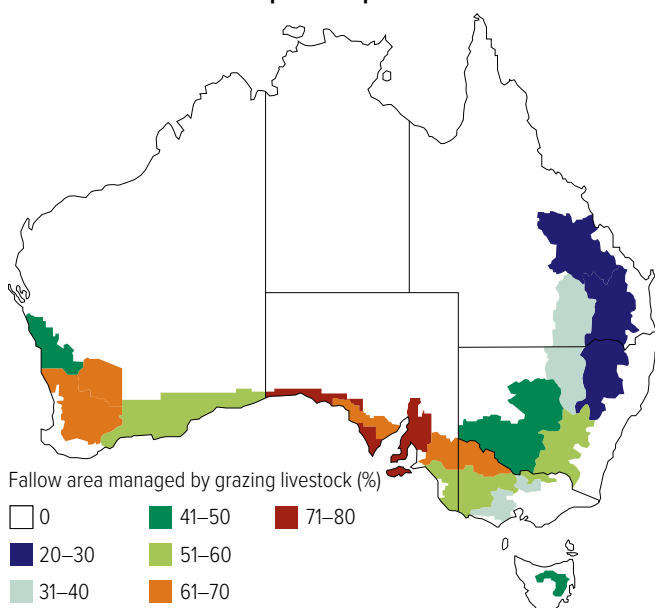
Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

**TABLE 40** Average percentage of fallow area managed by grazing with livestock (base: used fallow period) in 2014.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	40.7	b
NSW NE / Queensland SE (b)	22.5	
NSW NW / Queensland SW (c)	31.3	
NSW / Victorian Slopes (d)	56.8	bce
Queensland Central (e)	22.6	
SA Mid North / Lower EP (f)	78.2	abcdegjn
SA / VIC Bordertown Wimmera (g)	51.5	be
SA / Victorian Mallee (h)	60.0	abce
Tasmania (i)	50.0	
Victorian High Rainfall (j)	39.2	
WA Central (k)	65.1	abce
WA Eastern (l)	64.9	bce
WA Mallee / Sandplain (m)	59.2	
WA Northern (n)	45.2	
National average	49.1	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

**FIGURE 53** Proportion of crop area in 2011 where grazing occurred in the inter-crop/fallow period.



#### Fallow managed by cultivation

The data from respondents (based on those who reported using a fallow period) suggests that there remains a reasonable area of fallow where cultivation only is used, generally for weed control, nationally averaging 36.2% of the fallow area (Table 39, Figure 52). When considered with the data above for herbicide-managed fallows it is evident that where less of the fallow is managed by herbicides, more of the fallow being cultivated.

In many agro-ecological zones where some cultivation was evident in 2014, the management of herbicide-resistant weeds may be a factor in choosing this practice.

#### Livestock grazing of the fallow

The data from survey respondents in 2014 shows that a significant proportion of the fallow and inter-crop/fallow period has some grazing through the inter-crop/fallow period or summer/short fallow period (Table 40). This may be a relatively standard practice as possibly suggested by the level of this practice remaining around 50% of the fallow area in 2014.

Grazing is sometimes seen as a cheap alternative to the use of herbicides for the control of weeds in stubbles or fallow periods, although grazing for effective weed control can be variable and livestock can have negative impact on soil structure.

The data from 2014 suggests the grazing of livestock on fallows remains widespread in the southern and western agro-ecological zones.



# STUBBLE MANAGEMENT



PHOTO: BRAD COLLIS

There were several questions included in the 2014 survey in the interests of assisting with gathering baseline data for use in the GRDC stubble management initiative series of projects. The following questions about stubble management and the area of the crop managed in 2014 were asked:

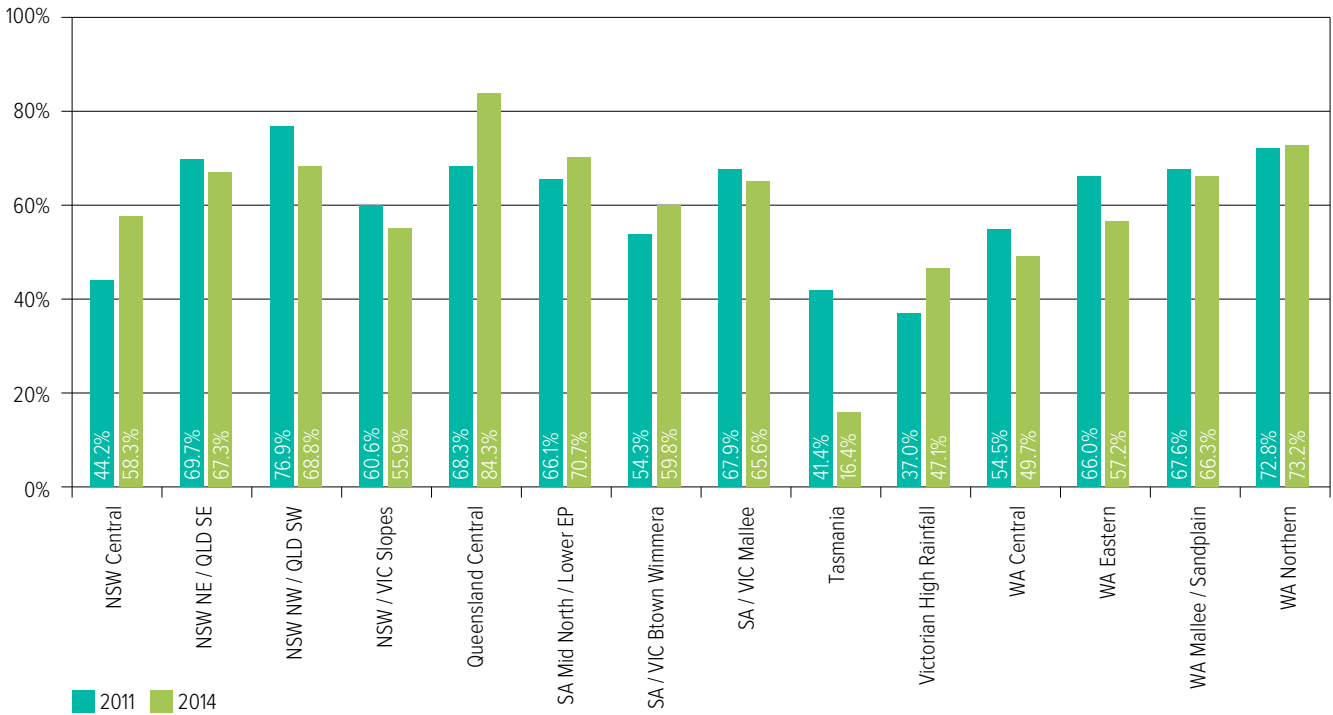
- planted with the stubble left intact (undisturbed);
- planted with the stubble from the previous crop retained, but treated to help with managing the stubble at planting (slashed, baled, raked, harrowed, chained, otherwise);
- where stubble burnt late (within a few weeks of sowing – a ‘cool’ burn);
- where stubble burnt early (some months prior to sowing – a ‘hot’ burn);
- where stubble incorporated into the soil using tillage or disc;
- where the crop was planted so that the stubble left after harvest was more suitable for sowing into (i.e. row spacing, direction of travel, crop type);
- where the crop was harvested to enhance how the stubble could be managed (height of cutter bar, use of a second cutter bar, adjustments or use of modified harvesting machinery);
- where management through the period between the last crop and sowing this one was such that the stubble was more suitable for sowing into;
- where the crop was established using set-ups or machinery specifically designed to suit stubble retention;
- where the area was managed for weeds through the period up to sowing that impacted on stubble retention;
- where the area was managed for pests through the period up to sowing that impacted on stubble retention;
- where the area was managed for diseases through the period up to sowing that impacted on stubble retention;

- where the nutrient decisions were made with stubble management in mind (i.e. fertiliser use);
- where the area was managed so that stubble present up to planting was removed, modified, reduced, incorporated to avoid perceived negative impacts of having the stubble present in its original form; and
- area of stubble where impact on soil health is measured or monitored.

**TABLE 41 Average percentage of cropped area where stubble was retained through to planting.**

Agro-ecological zone	Average % of crop area		Significant difference between years
	2011	2014	
NSW Central	44.2	58.3	**
NSW NE / Queensland SE	69.7	67.3	
NSW NW / Queensland SW	76.9	68.8	
NSW / Victorian Slopes	60.6	55.9	
Queensland Central	68.3	84.3	
SA Mid North / Lower EP	66.1	70.7	
SA / VIC Bordertown Wimmera	54.3	59.8	
SA / Victorian Mallee	67.9	65.6	
Tasmania	41.4	16.4	
Victorian High Rainfall	37.0	47.1	
WA Central	54.5	49.7	
WA Eastern	66.0	57.2	
WA Mallee / Sandplain	67.6	66.3	
WA Northern	72.8	73.2	
National averages	60.5	60.0	

**FIGURE 54** Average percentage of cropped area where stubble was retained through to planting in 2011 and 2014.



### Stubble retained through to planting

The data for 2014 (Table 41, Figure 54 and Figure 55) suggests that, where possible, growers choose to retain stubble cover on paddocks which are intended for a following crop right through until planting. The overall proportion of the cropped area where stubble has been retained intact through to sowing has remained steady when compared with the 2011 survey, at approximately 60% of the cropped area.

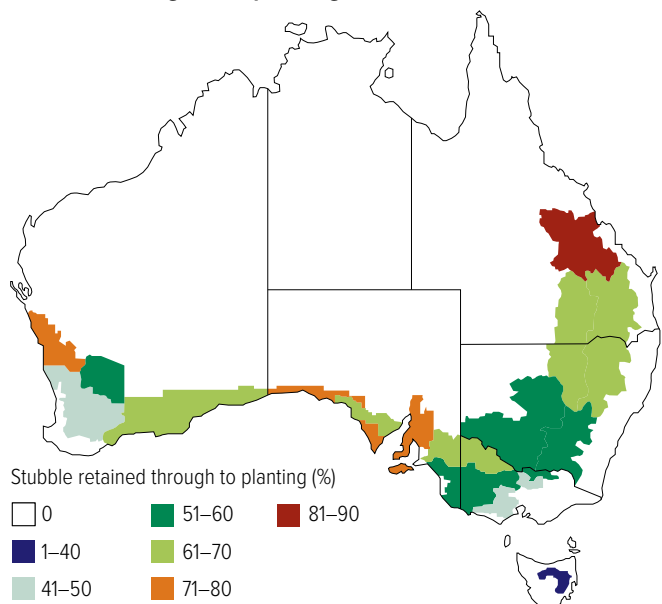
The proportion of the cropped area where stubble is retained through until sowing in 2014 had grown somewhat in central NSW and Queensland Central.

### Stubble retained intact (standing) through to planting

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

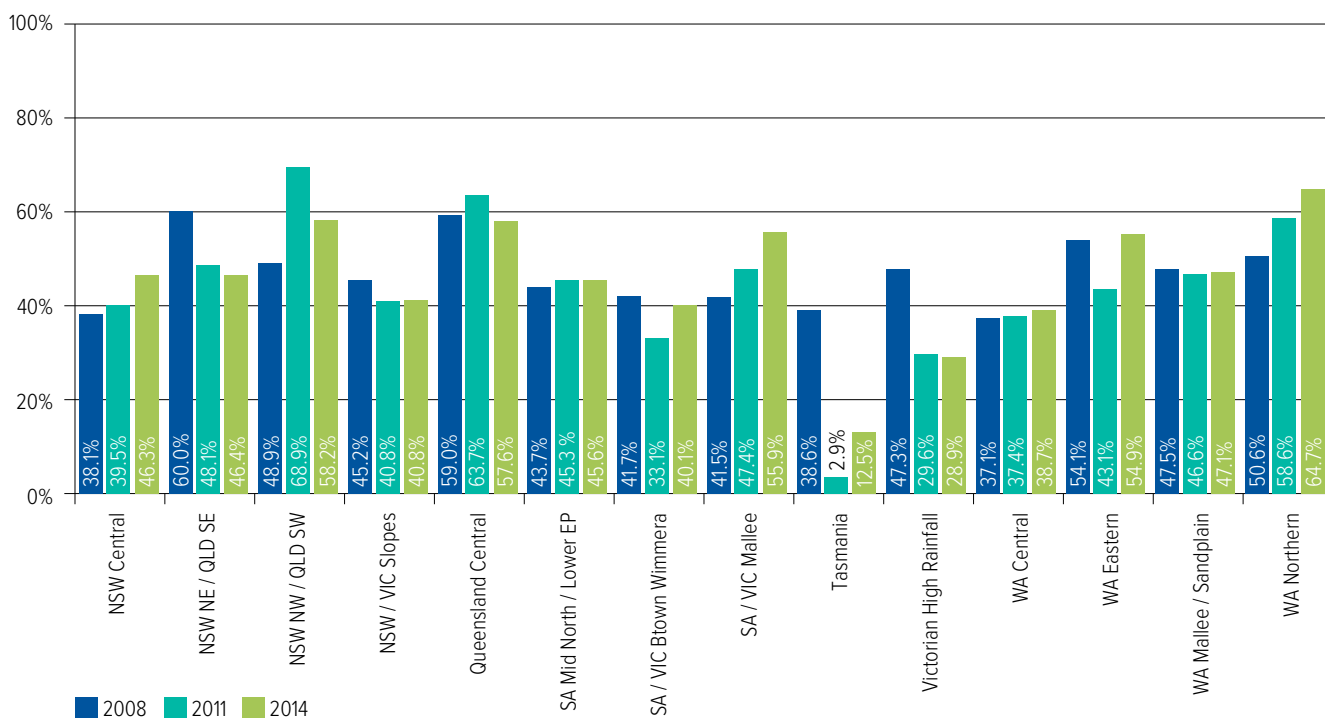
The proportion of the cropped area where stubble has been retained intact through to sowing has remained relatively stable across the three surveys, at approximately 45% of the cropped area nationally. The proportion of the cropped area where this practice has been carried out has shown a slight increase in the South Australian/Victorian Mallee, although a fall in this proportion was noted in north-east NSW/south-east Queensland and Victoria. See Table 42 and Figure 56.

**FIGURE 55** Percentage of crop area where stubble was retained through until planting in 2014.





**FIGURE 56** Average percentage of cropped area where stubble was retained intact through to planting in 2008, 2011 and 2014



**Stubble retained (not necessarily standing)**

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

The proportion of stubble retained (not standing) as reported in 2014 appears to have decreased markedly compared with the previous surveys (see Table 43, Figure 57 and Figure 58).

When the proportions of retained stubble standing and

**TABLE 42** Average percentage of cropped area where stubble was retained intact through to planting in 2008, 2011 and 2014.

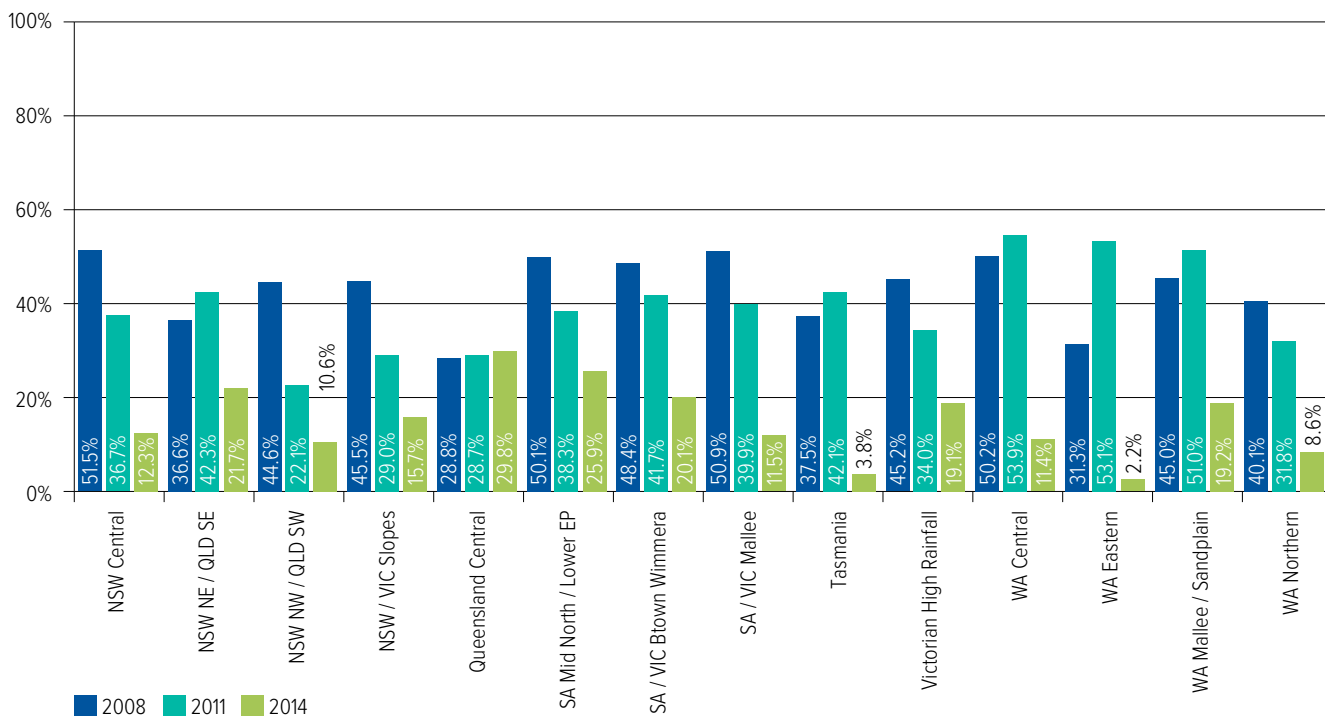
Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	38.1	39.5	46.3		
NSW NE / Queensland SE	60.0	48.1	46.4		**
NSW NW / Queensland SW	48.9	68.9	58.2		
NSW / Victorian Slopes	45.2	40.8	40.8		
Queensland Central	59.0	63.7	57.6		
SA Mid North / Lower EP	43.7	45.3	45.6		
SA / VIC Bordertown Wimmera	41.7	33.1	40.1		
SA / Victorian Mallee	41.5	47.4	55.9		***
Tasmania	38.6	2.9	12.5		
Victorian High Rainfall	47.3	29.6	28.9		**
WA Central	37.1	37.4	38.7		
WA Eastern	54.1	43.1	54.9		
WA Mallee / Sandplain	47.5	46.6	47.1		
WA Northern	50.6	58.6	64.7		
National averages	46.7	43.2	45.6		

**TABLE 43** Average percentage of cropped area where stubble was retained (not standing) through to planting in 2008, 2011 and 2014.

Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	51.5	36.7	12.3	***	***
NSW NE / Queensland SE	36.6	42.3	21.7	***	***
NSW NW / Queensland SW	44.6	22.1	10.6	**	***
NSW / Victorian Slopes	45.5	29.0	15.7	***	***
Queensland Central	28.8	28.7	29.8		
SA Mid North / Lower EP	50.1	38.3	25.9	**	***
SA / VIC Bordertown Wimmera	48.4	41.7	20.1	***	***
SA / Victorian Mallee	50.9	39.9	11.5	***	***
Tasmania	37.5	42.1	3.8	**	
Victorian High Rainfall	45.2	34.0	19.1	**	***
WA Central	50.2	53.9	11.4	***	***
WA Eastern	31.3	53.1	2.2	***	***
WA Mallee / Sandplain	45.0	51.0	19.2	***	***
WA Northern	40.1	31.8	8.6	***	***
National averages	43.3	38.9	15.1	***	***



**FIGURE 57** Average percentage of crop area where stubble was retained (not standing) through to planting in 2008, 2011 and 2014.



not-standing are added, it comes to approximately 60% of the cropped area in 2014. The decrease in the proportion of cropped area where stubble is retained (not standing) requires some further investigation.

### Stubble burnt

Areas where stubble is burnt represent a small portion of the crop area. Burning can be carried out anytime following harvest of the previous crop, although often stubble is left in situ to reduce soil erosion, and to assist in capturing rainfall and holding soil moisture.

The stubble load from the previous crop and height of stubble, coupled with a consideration of the stubble-handling ability of the planting machinery generally determines whether stubble is burnt.

#### Stubble burnt early (i.e. ‘hot’ burn)

A ‘hot’ burn occurs when stubble is burnt relatively soon after harvest, for example, in summer after harvesting the winter crop.

The proportion of stubble burnt soon after the previous harvest is generally quite low – less than 5% of the cropped area in many agro-ecological zones – and has decreased further since the survey of 2011 (see Table 44, Figure 59 and Figure 60).

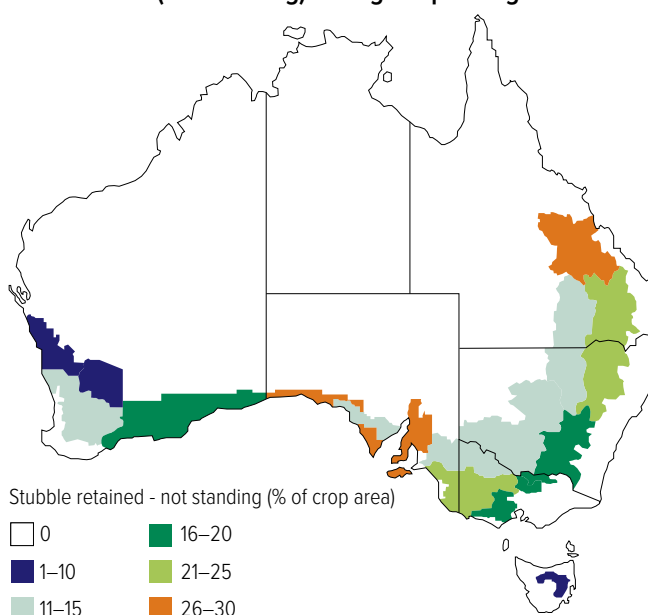
#### Stubble burnt late prior to planting (i.e. ‘cool’ burn).

A ‘cool’ burn is defined as burning late in the season (late summer or early autumn), often just before or at the point of sowing. Such burns are often incomplete, leaving a proportion of the stubble remaining on or attached to the soil, although removing enough stubble to allow most

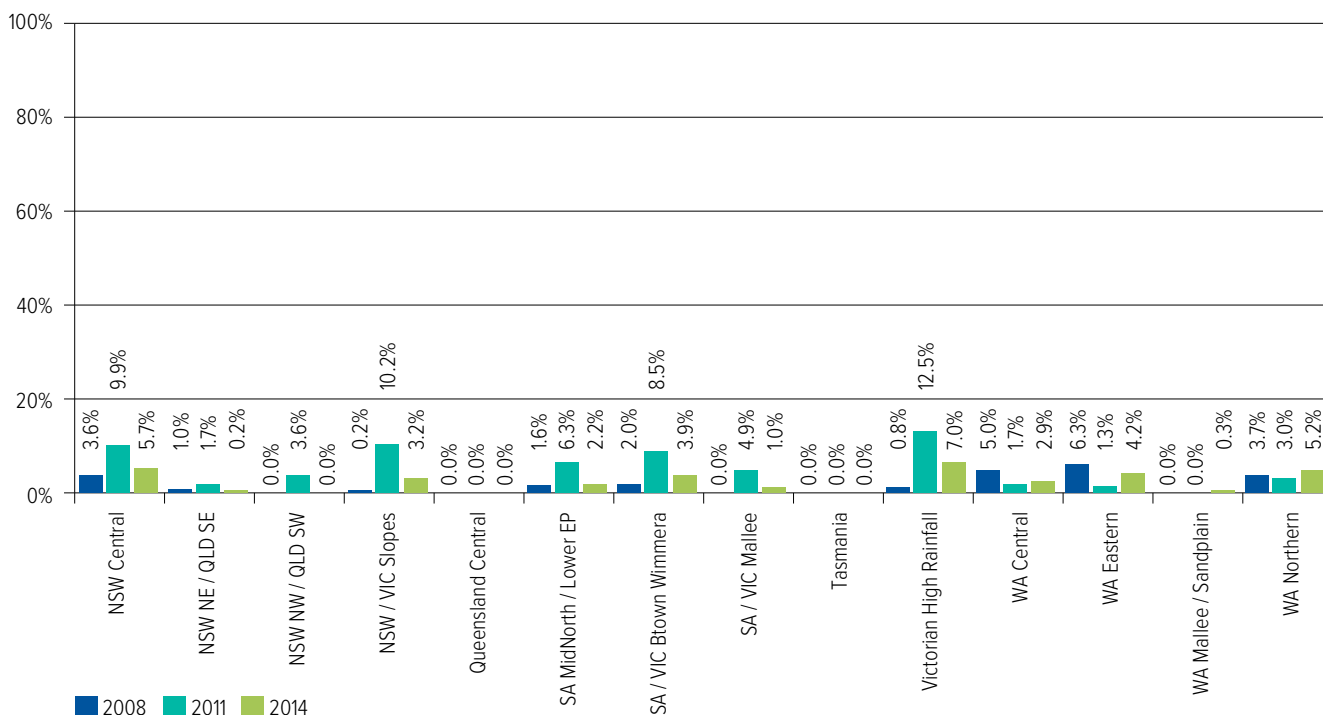
planting machinery, including conventional, to get through.

It is evident that the amount of late burning remains generally as it was in the previous surveys (Table 45, Figure 61 and Figure 62).

**FIGURE 58** Average percentage of crop area where stubble was retained (not standing) through to planting in 2014.



**FIGURE 59** Average percentage of cropped area where stubble was burnt early ('hot' burn) in 2008, 2011 and 2014.



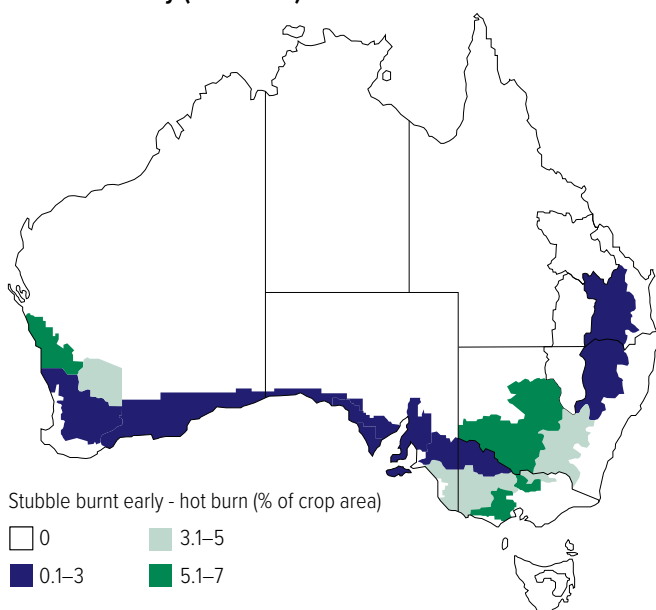
### Stubble incorporated by cultivation

Some growers manage stubble by incorporating it into the soil using a tillage machine (offset disc plough, or a tined implement, such as chisel plough). Disc machines also tend to cut stubble into shorter lengths as well as mixing it into the soil, whereas tined machines tend to leave a greater proportion of stubble on the soil surface, while mixing some into the soil.

### Additional stubble management questions

The GRDC has commenced funding a national stubble management initiative, with a series of projects examining various stubble management techniques. In order to assist with monitoring of this investment, a series of questions were included in the 2014 survey that asked about survey respondents' crop management practices and how many of

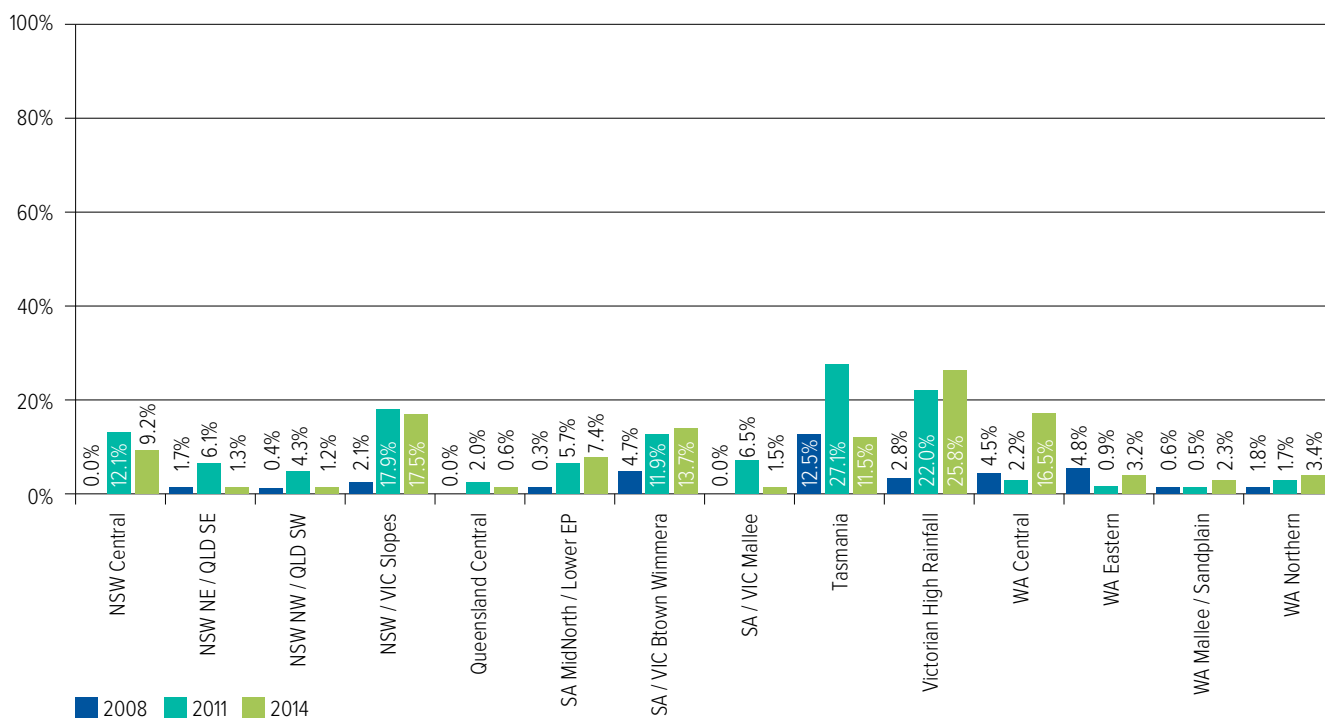
**FIGURE 60** Percentage of crop area where stubble was burnt early ('hot' burn) in 2014.



**TABLE 44** Average percentage of cropped area where stubble was burnt early ('hot' burn) in 2008, 2011 and 2014.

Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	3.6	9.9	5.7		
NSW NE / Queensland SE	1.0	1.7	0.2		
NSW NW / Queensland SW	0.0	3.6	0.0	**	
NSW / Victorian Slopes	0.2	10.2	3.2	***	***
Queensland Central	0.0	0.0	0.0		
SA Mid North / Lower EP	1.6	6.3	2.2		
SA / VIC Bordertown Wimmera	2.0	8.5	3.9		
SA / Victorian Mallee	0.0	4.9	1.0	**	**
Tasmania	0.0	0.0	0.0		
Victorian High Rainfall	0.8	12.5	7.0		**
WA Central	5.0	1.7	2.9		
WA Eastern	6.3	1.3	4.2		
WA Mallee / Sandplain	0.0	0.0	0.3		
WA Northern	3.7	3.0	5.2		
National averages	1.7	4.5	2.6		

**FIGURE 61** Average percentage of cropped area where stubble was burnt late ('cool' burn) in 2008, 2011 and 2014.



these were used with stubble management in mind.

These questions are described and the related data are presented in the following sections.

### Crop planted to enhance the management of the stubble resulting from that crop (retained stubble)

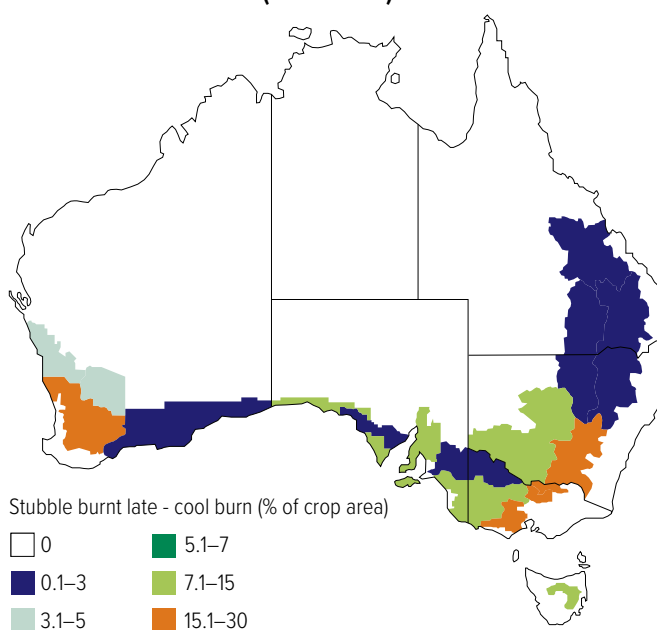
This question asked growers about the planting of their crop,

focusing on whether they managed their planting techniques, machine set-up or machine choice in order to ensure that the stubble resulting from this crop was more suitable for retaining, or had desirable characteristics in a stubble retention system. This might mean growers chose a row spacing, direction of travel, varietal or crop choice with a view to retaining stubble after harvest that was more suitable for retaining and managing.

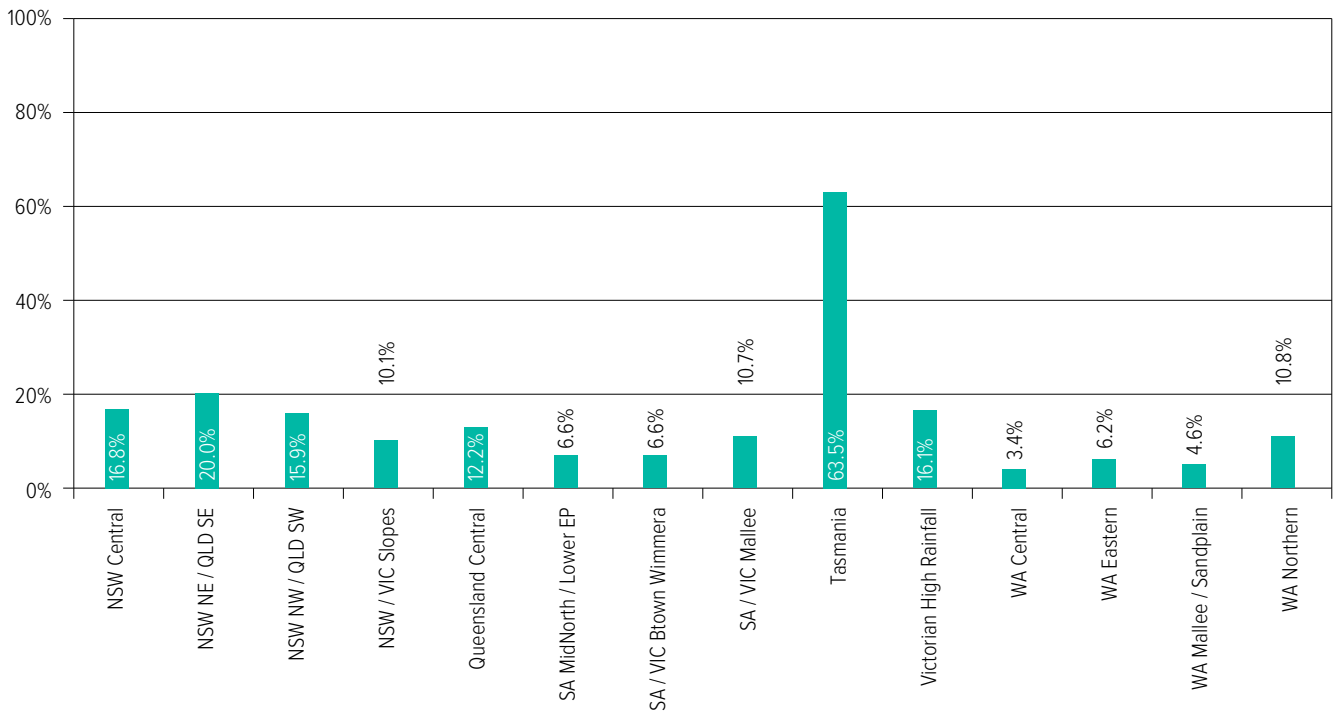
**TABLE 45** Average percentage of cropped area where stubble was burnt late ('cool' burn) in 2008, 2011 and 2014.

Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	0.0	12.1	9.2		***
NSW NE / Queensland SE	1.7	6.1	1.3	**	
NSW NW / Queensland SW	0.4	4.3	1.2	**	
NSW / Victorian Slopes	2.1	17.9	17.5		***
Queensland Central	0.0	2.0	0.6		
SA Mid North / Lower EP	0.3	5.7	7.4		***
SA / VIC Bordertown Wimmera	4.7	11.9	13.7		***
SA / Victorian Mallee	0.0	6.5	1.5	***	***
Tasmania	12.5	27.1	11.5		
Victorian High Rainfall	2.8	22.0	25.8		***
WA Central	4.5	2.2	16.5	***	***
WA Eastern	4.8	0.9	3.2		
WA Mallee / Sandplain	0.6	0.5	2.3		
WA Northern	1.8	1.7	3.4		
National averages	2.6	8.6	8.2		

**FIGURE 62** Average percentage of cropped area where stubble was burnt late ('cool' burn) in 2014.



**FIGURE 63** Average percentage of cropped area where stubble was incorporated into soil using tillage machine in 2014.



The data for 2014 (Table 47, Figure 64), suggests that nationally an average of 30% of the crop is planted such that the stubble remaining following harvest is more suitable for a stubble retention system, with the proportion being slightly higher in the northern region.

**Crop harvested to enhance the management of the stubble resulting from that crop (retained stubble)**

This question asked growers about the harvesting of their crop, focusing on whether they made adjustments in the set-up of their harvesting machine or techniques used to ensure that the stubble left after harvest was more

**TABLE 46** Average percentage of crop area where stubble was incorporated into soil using a tillage machine in 2014.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	16.8	fgklm
NSW NE / Queensland SE (b)	20.0	dfghklm
NSW NW / Queensland SW (c)	15.9	k
NSW / Victorian Slopes (d)	10.1	k
Queensland Central (e)	12.2	
SA Mid North / Lower EP (f)	6.6	
SA / VIC Bordertown Wimmera (g)	6.6	
SA / Victorian Mallee (h)	10.7	k
Tasmania (i)	63.5	abcdefghijklmnop
Victorian High Rainfall (j)	16.1	k
WA Central (k)	3.4	
WA Eastern (l)	6.2	
WA Mallee / Sandplain (m)	4.6	
WA Northern (n)	10.8	
National average	14.5	

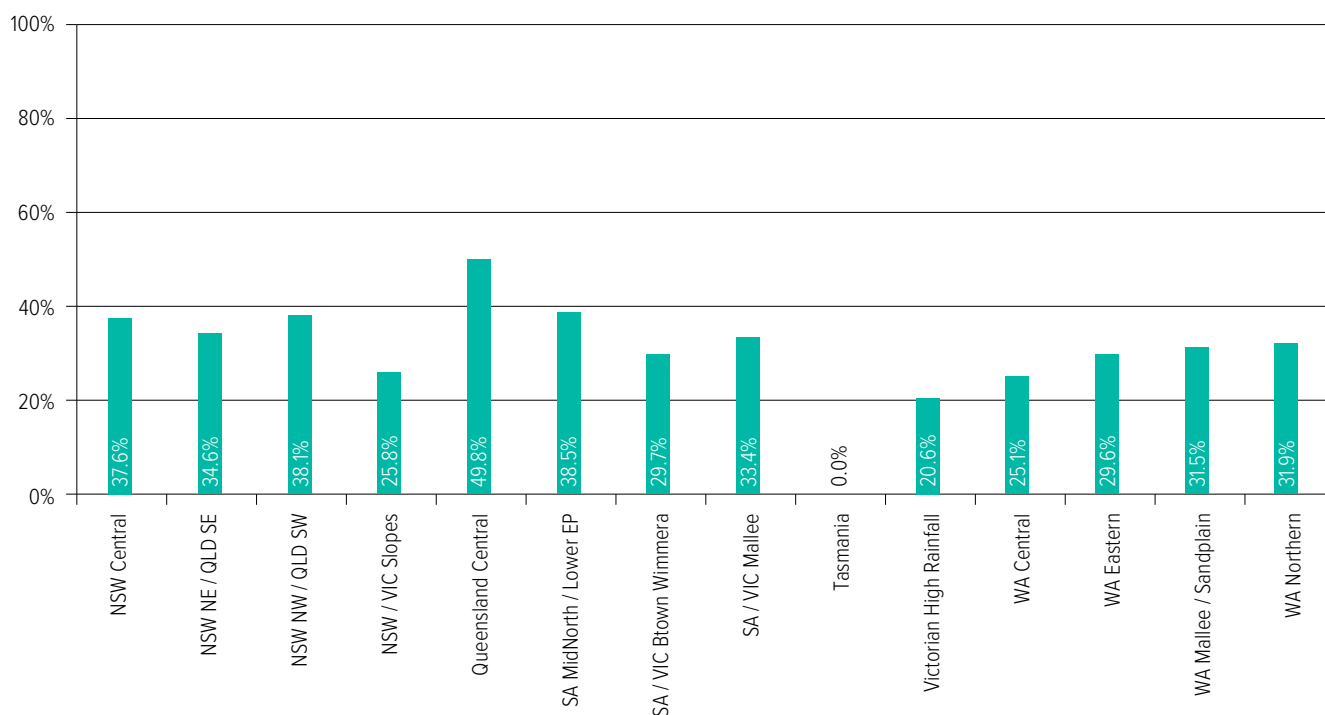
Note: Statistically significant differences (P<0.05) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

**TABLE 47** Average percentage of crop area planted to enhance management of retained stubble.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	37.6	
NSW NE / Queensland SE (b)	34.6	
NSW NW / Queensland SW (c)	38.1	
NSW / Victorian Slopes (d)	25.8	
Queensland Central (e)	49.8	
SA Mid North / Lower EP (f)	38.5	
SA / VIC Bordertown Wimmera (g)	29.7	
SA / Victorian Mallee (h)	33.4	
Tasmania (i)	0.0	
Victorian High Rainfall (j)	20.6	
WA Central (k)	25.1	
WA Eastern (l)	29.6	
WA Mallee / Sandplain (m)	31.5	
WA Northern (n)	31.9	
National average	30.4	

Note: Statistically significant differences (P<0.05) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

**FIGURE 64** Average percentage of crop area planted to enhance management of retained stubble in 2014.



suitable for retaining, or had desirable characteristics in a stubble retention system. This might mean growers made adjustments to their cutter bar height, may have used additional cutter bars, windrow management or used other settings with the aim of obtaining stubble after harvest more suitable for retaining and managing.

The data for 2014 (Table 48, Figure 65) suggests that nationally an average of just over 30% of the crop is harvested and that the stubble remaining is more suitable for a stubble retention system, with the proportion being higher in much of WA and parts of SA, and lower in parts of NSW.

**TABLE 48** Average percentage of crop area harvested in way to produce desirable stubble characteristics.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	29.7	
NSW NE / Queensland SE (b)	30.6	
NSW NW / Queensland SW (c)	15.8	
NSW / Victorian Slopes (d)	21.1	
Queensland Central (e)	35.5	
SA Mid North / Lower EP (f)	42.0	cdj
SA / VIC Bordertown Wimmera (g)	28.0	
SA / Victorian Mallee (h)	38.0	cdj
Tasmania (i)	8.5	
Victorian High Rainfall (j)	20.4	
WA Central (k)	40.2	cdj
WA Eastern (l)	34.9	
WA Mallee / Sandplain (m)	36.2	
WA Northern (n)	56.0	abcdgj
National average	31.2	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

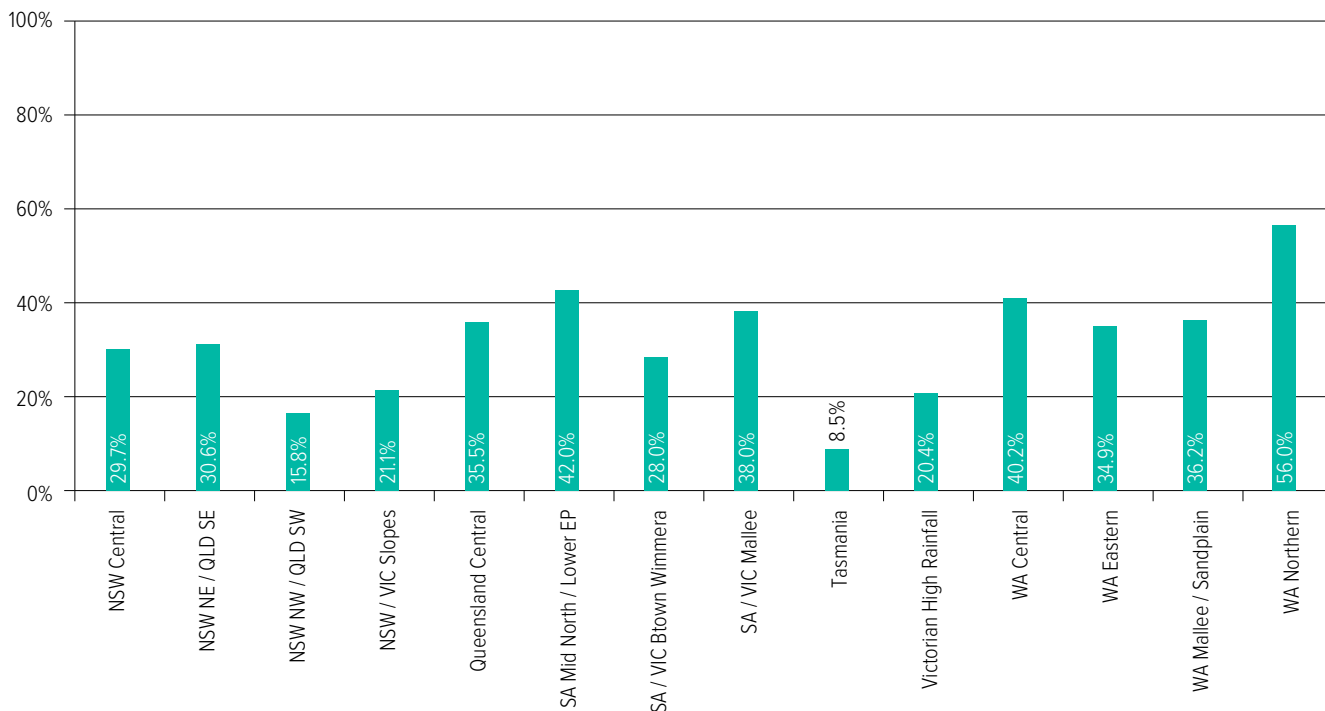
**TABLE 49** Average percentage of crop area managed between crops so stubble easier to plant into.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	28.3	
NSW NE / Queensland SE (b)	33.9	
NSW NW / Queensland SW (c)	28.6	
NSW / Victorian Slopes (d)	27.0	
Queensland Central (e)	32.2	
SA Mid North / Lower EP (f)	37.4	j
SA / VIC Bordertown Wimmera (g)	36.4	j
SA / Victorian Mallee (h)	39.8	j
Tasmania (i)	44.9	
Victorian High Rainfall (j)	17.2	
WA Central (k)	30.4	
WA Eastern (l)	31.5	
WA Mallee / Sandplain (m)	32.7	
WA Northern (n)	45.8	j
National average	33.7	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.



**FIGURE 65** Average percentage of crop area harvested in way to produce desirable stubble characteristics in 2014.



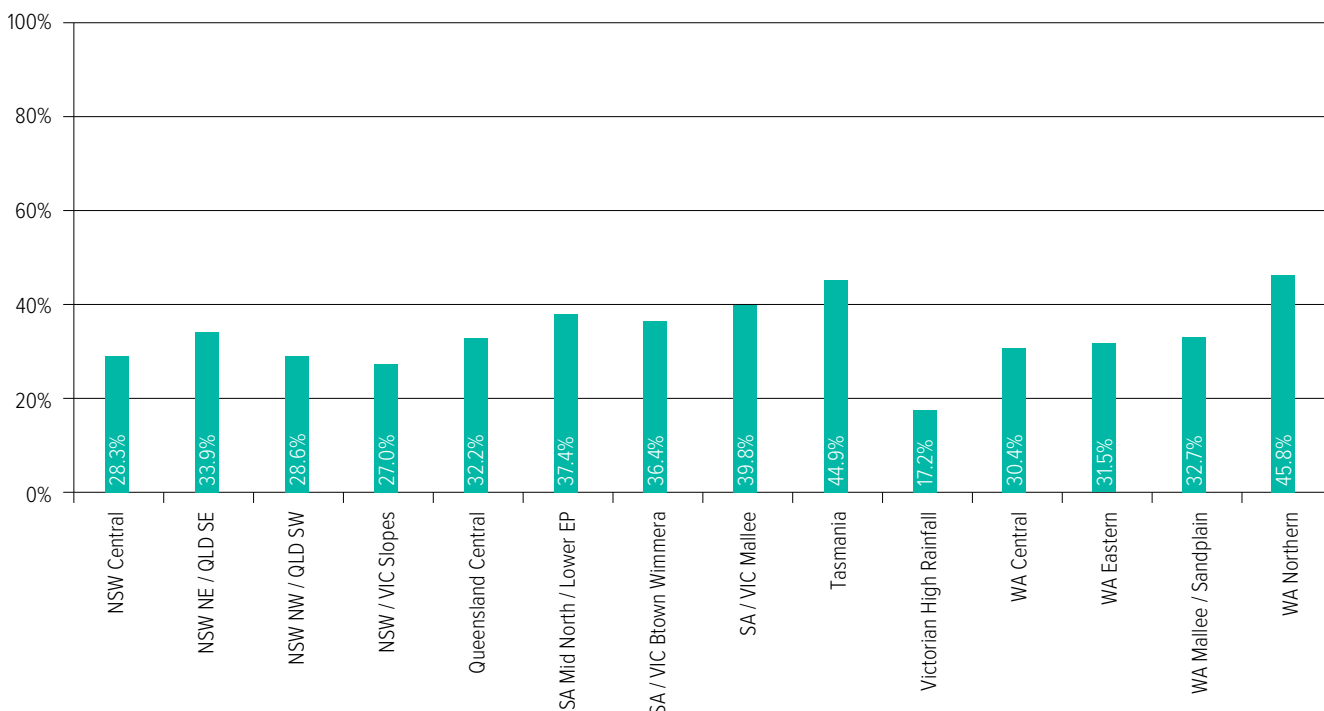
Crop area managed between crops to assist making stubble easier to plant into

The question asked in the survey was: what area of your crop has been managed such that the period between the previous crop and this one was managed to maintain stubble such that it was more suitable for planting into?

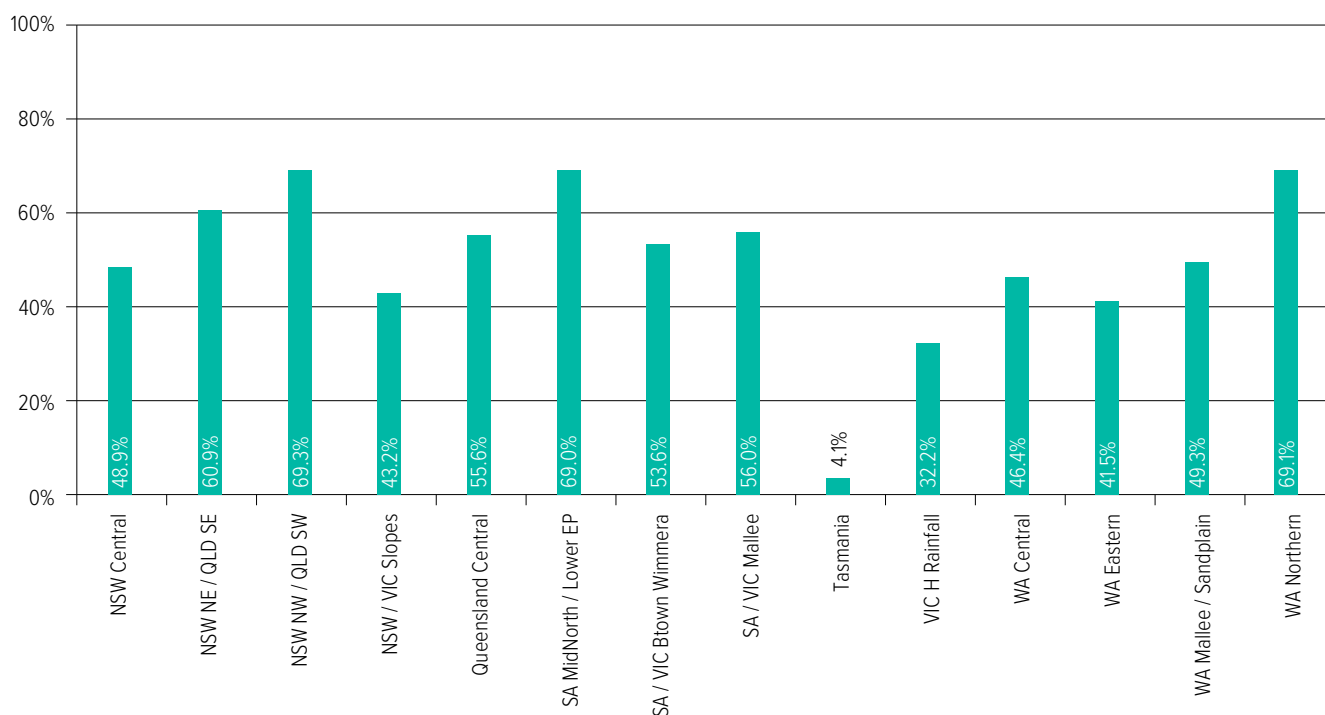
Again, just over 30% of the crop area is said to be managed in the period between crops such that the stubble is easier to manage. Most AEZs were of a similar level, with only the Victorian High Rainfall zone being lower in the use of this technique.

**FIGURE 66** Average percentage of crop area managed between crops in 2014 so stubble was easier to plant into.

Percentage (%)



**FIGURE 67** Average percentage of crop area established in 2014 using techniques to suit stubble retention.



### Crop area where crop was established using techniques or machinery to suit stubble retention

The question in this case in the 2014 survey was: what area of your crop has been established using techniques or machinery set-up designed specifically to suit stubble retention? This differs from the earlier question that asked

about the amount of crop that was planted so that the stubble resulting from this crop was better suited for stubble retention. The earlier question asked about the techniques used at planting so the stubble resulting from this crop would be more suited for a stubble retention system. This question asks about the use of machinery for the planting of the current crop into the stubble present at this (current) planting. One is about sowing the crop with the management of that crop's stubble in mind, while this question is about the actual sowing of this year's crop into the stubble present at the sowing time.

In the survey of 2014, respondents reported that nationally about 50% of the crop was sown using machinery designed specifically for or set up specifically to suit stubble retention. This proportion is higher in the northern region and parts of the southern and western regions, and lower in NSW/Vic slopes and the higher rainfall AEZs. This suggests that growers have chosen machinery to assist with sowing into stubble, possibly more so than they have been able to use other techniques in the planting of the preceding crop, or the harvesting process to assist with retaining stubble. Data is presented in Table 50 and Figure 67.

**TABLE 50** Average percentage of crop area established using techniques to suit stubble retention in 2014.

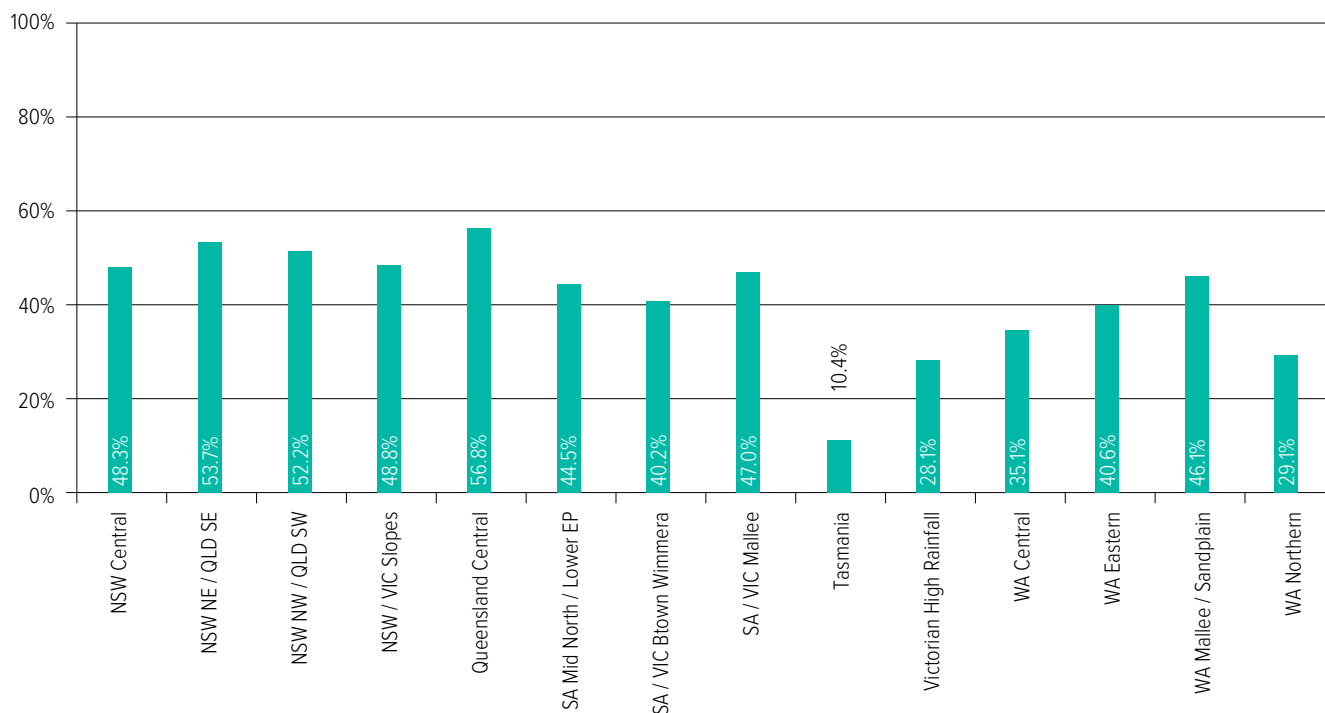
Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	48.9	i
NSW NE / Queensland SE (b)	60.9	dijk
NSW NW / Queensland SW (c)	69.3	adljk
NSW / Victorian Slopes (d)	43.2	
Queensland Central (e)	55.6	j
SA Mid North / Lower EP (f)	69.0	adghijkl
SA / VIC Bordertown Wimmera (g)	53.6	ij
SA / Victorian Mallee (h)	56.0	dij
Tasmania (i)	4.1	
Victorian High Rainfall (j)	32.2	
WA Central (k)	46.4	
WA Eastern (l)	41.5	
WA Mallee / Sandplain (m)	49.3	
WA Northern (n)	69.1	adljk
National average	49.9	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

### Average percentage of crop where weed management decisions leading up to and in-crop impact on stubble retention

The question asked here was: what proportion of your crop area was managed such that the weed management through the period leading up to planting, and in the crop, was in a way to impact on stubble retention? The data (Table 51, Figure 68) shows that approximately 40% of the crop area had weed management carried out in a way to assist with stubble retention.

**FIGURE 68** Average percentage of crop area managed for weeds in 2014 that ultimately impacted on stubble retention.



Average percentage of the crop area where pest management decisions were made with the impact on stubble retention in mind.

Similarly to the question about weed management (above) the question in this case was about management of pests in the inter-crop/fallow and in-crop period in 2014, where this was carried out with stubble retention in mind.

The data is presented in Table 52 and Figure 69 and suggests that less than 20% of the cropped area has pests managed with stubble retention in mind, with this slightly higher in the higher rainfall areas and in parts of the southern AEZs and lower in the northern and western AEZs.

Average percentage of cropped area where disease management decisions were made with the impact of stubble retention in mind.

Again, growers were asked in 2014 about how much of their cropped area had disease management carried out that impacted on stubble retention.

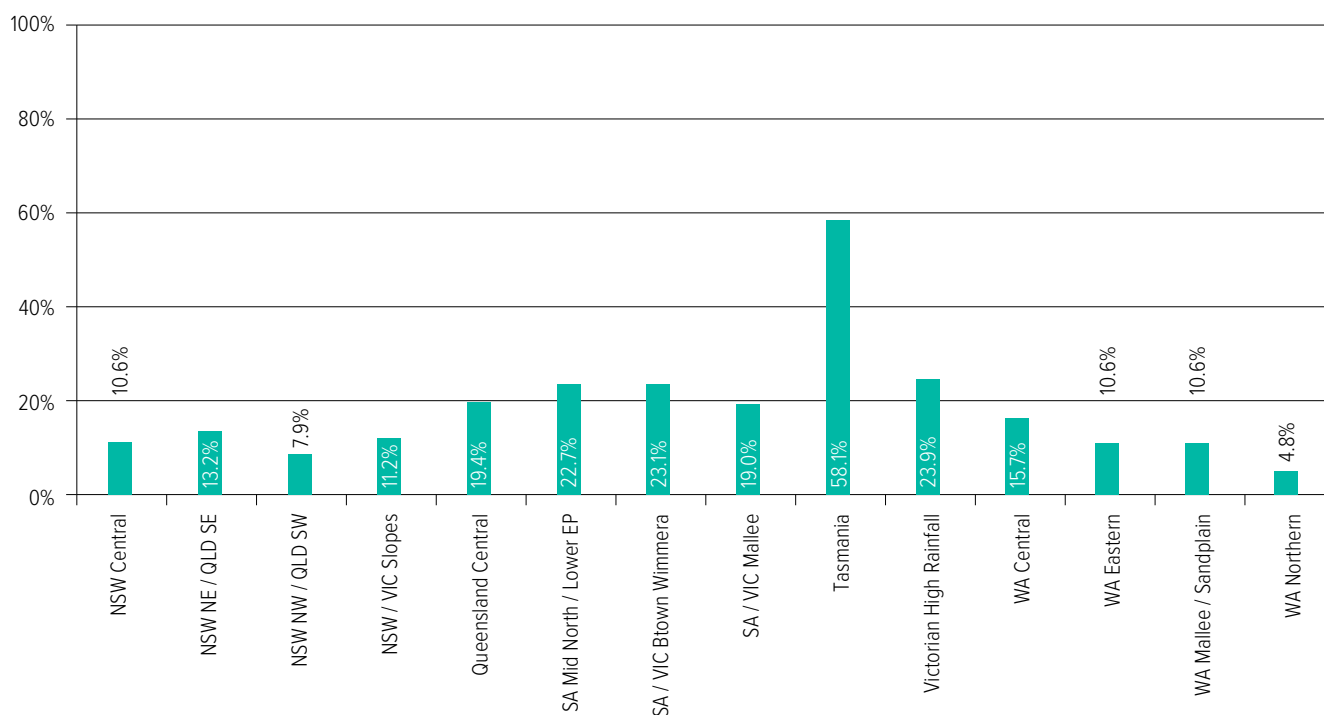
Also similarly to other data (for example for pest management) just under 20% of the cropped area was reported to have disease management where stubble retention impact was a consideration (Table 53 and Figure 70), although differences exist between AEZs.

**TABLE 51** Average percentage of crop area managed for weeds that impacted stubble retention.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	48.3	/
NSW NE / Queensland SE (b)	53.7	jk
NSW NW / Queensland SW (c)	52.2	
NSW / Victorian Slopes (d)	48.8	jk
Queensland Central (e)	56.8	
SA Mid North / Lower EP (f)	44.5	
SA / VIC Bordertown Wimmera (g)	40.2	
SA / Victorian Mallee (h)	47.0	
Tasmania (i)	10.4	
Victorian High Rainfall (j)	28.1	
WA Central (k)	35.1	
WA Eastern (l)	40.6	
WA Mallee / Sandplain (m)	46.1	
WA Northern (n)	29.1	
National average	41.5	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

**FIGURE 69** Average percentage of crop area managed for pests in 2014 that ultimately impacted on stubble retention.



**TABLE 52** Average percentage of crop area managed for pests that impacted stubble retention in 2014.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	10.6	
NSW NE / Queensland SE (b)	13.2	
NSW NW / Queensland SW (c)	7.9	
NSW / Victorian Slopes (d)	11.2	
Queensland Central (e)	19.4	
SA Mid North / Lower EP (f)	22.7	acd
SA / VIC Bordertown Wimmera (g)	23.1	acd
SA / Victorian Mallee (h)	19.0	n
Tasmania (i)	58.1	abcdhklmn
Victorian High Rainfall (j)	23.9	cd
WA Central (k)	15.7	n
WA Eastern (l)	10.6	
WA Mallee / Sandplain (m)	10.6	
WA Northern (n)	4.8	
National average	17.9	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

Average percentage of the crop was managed where nutrition (i.e. fertiliser application) management decisions were made with stubble retention in mind

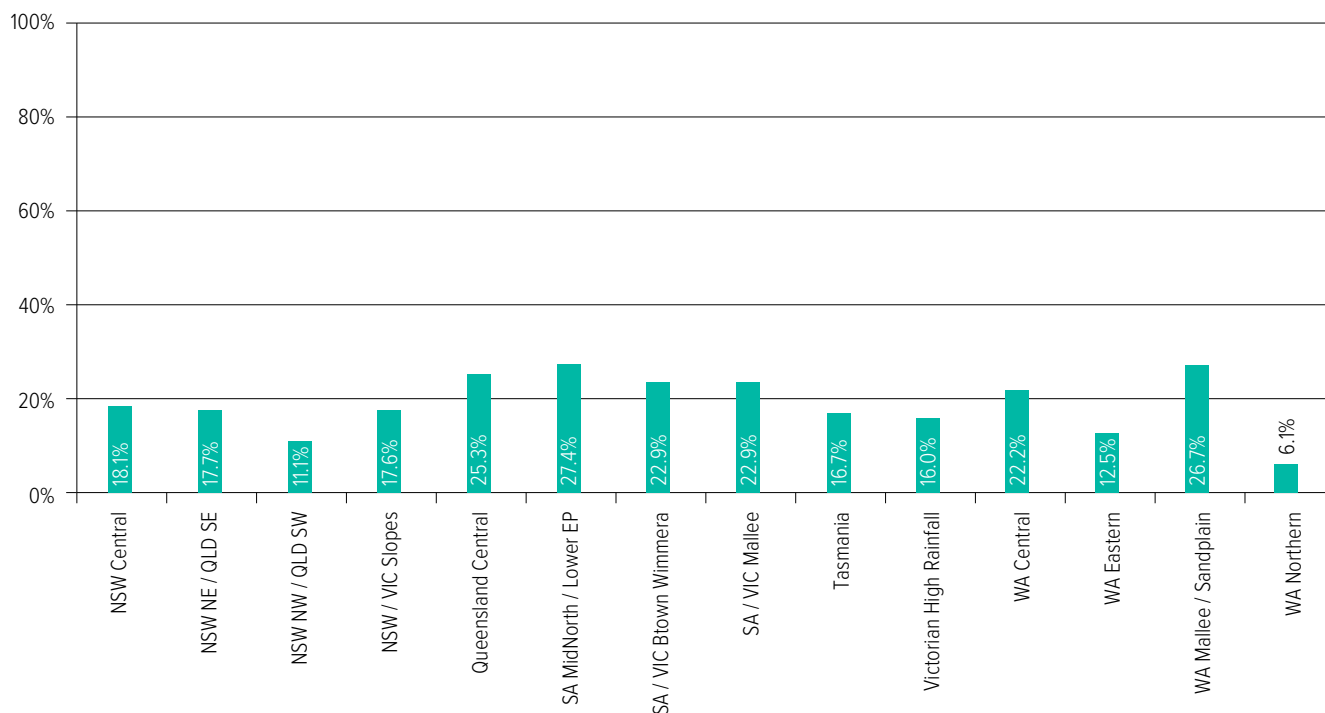
Growers were also asked about their nutrition programs and how much of their crop had nutrition decisions (fertiliser use) made with stubble retention in mind. The data (see Table 54 and Figure 71) suggests that about 40% of the cropped area has had fertiliser decisions made where the impacts on stubble retention was a factor. This appeared to be higher in the southern region AEZs, although variation was evident across all AEZs.

Average percentage of the crop managed such that stubble was managed (removed, modified, reduced, incorporated) to avoid negative impacts of leaving it in its original form

Survey respondents were asked about how much of their cropped area was managed where the stubble present up to sowing was either removed, modified, reduced, incorporated or similar to avoid negative impacts of having stubble present in its original form. This question is somewhat similar to some in previous surveys where growers were asked about some of the individual practices, for example, stubble incorporation or raking.

The data, shown in Table 55 and Figure 72, indicates that about 25% of the cropped area had some form of stubble modification or removal carried out.

**FIGURE 70** Average percentage of crop area managed for diseases in 2014 that ultimately impacted on stubble retention.



**TABLE 53** Average percentage of crop area managed for diseases that impacted stubble retention in 2014.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	18.1	
NSW NE / Queensland SE (b)	17.7	
NSW NW / Queensland SW (c)	11.1	
NSW / Victorian Slopes (d)	17.6	
Queensland Central (e)	25.3	
SA Mid North / Lower EP (f)	27.4	n
SA / VIC Bordertown Wimmera (g)	22.9	n
SA / Victorian Mallee (h)	22.9	n
Tasmania (i)	16.7	
Victorian High Rainfall (j)	16.0	
WA Central (k)	22.2	n
WA Eastern (l)	12.5	
WA Mallee / Sandplain (m)	26.7	
WA Northern (n)	6.1	
National average	18.8	

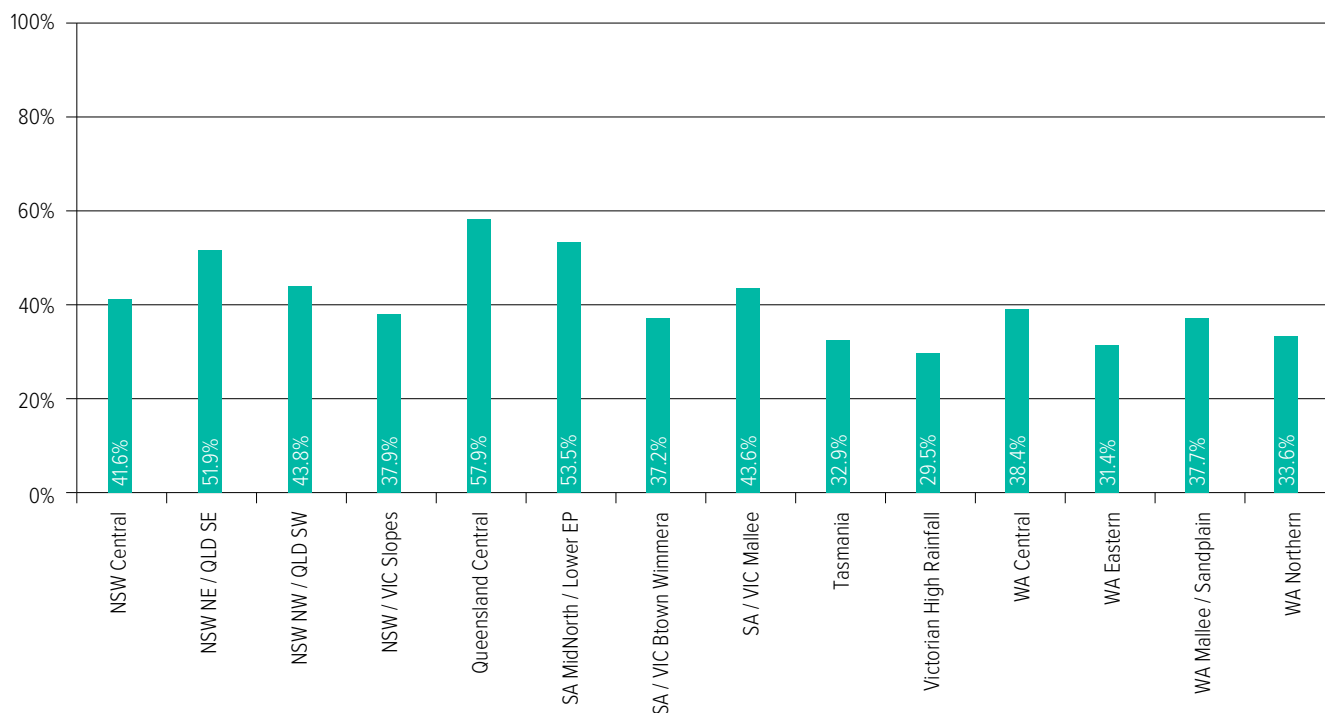
Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

Average percentage of stubble managed such that any impacts on soil health are measured or monitored

The final question about stubble retention in 2014 was about the area of stubble where the impact on soil health was measured or monitored. The data as shown in Table 56 and Figure 73 suggests that over 25% of the stubble area is such that an impact on soil health is measured or monitored. This implies that some growers consider that stubble retention is a contributory factor to soil health, and applies to over 30% of the cropped area in several AEZs.



**FIGURE 71** Average percentage of crop area managed in 2014 where nutrition decisions made with consideration of impact on stubble retention.

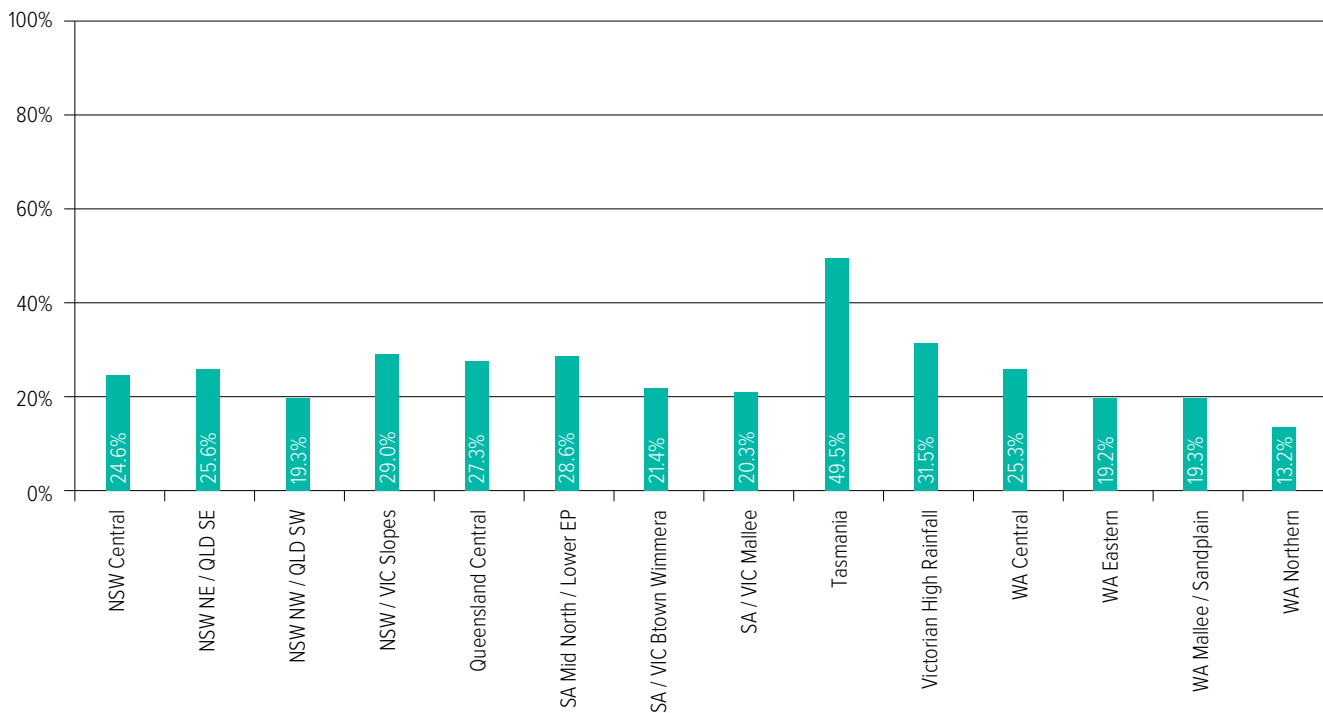


**TABLE 54** Average percentage of crop area managed where nutrition decisions made with consideration of impact on stubble retention in 2014.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	41.6	
NSW NE / Queensland SE (b)	51.9	
NSW NW / Queensland SW (c)	43.8	
NSW / Victorian Slopes (d)	37.9	
Queensland Central (e)	57.9	
SA Mid North / Lower EP (f)	53.5	j
SA / VIC Bordertown Wimmera (g)	37.2	
SA / Victorian Mallee (h)	43.6	
Tasmania (i)	32.9	
Victorian High Rainfall (j)	29.5	
WA Central (k)	38.4	
WA Eastern (l)	31.4	
WA Mallee / Sandplain (m)	37.7	
WA Northern (n)	33.6	
National average	40.8	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

**FIGURE 72** Average percentage of crop area managed in 2014 so stubble was removed, modified, reduced to avoid any perceived negative impacts of having stubble present.



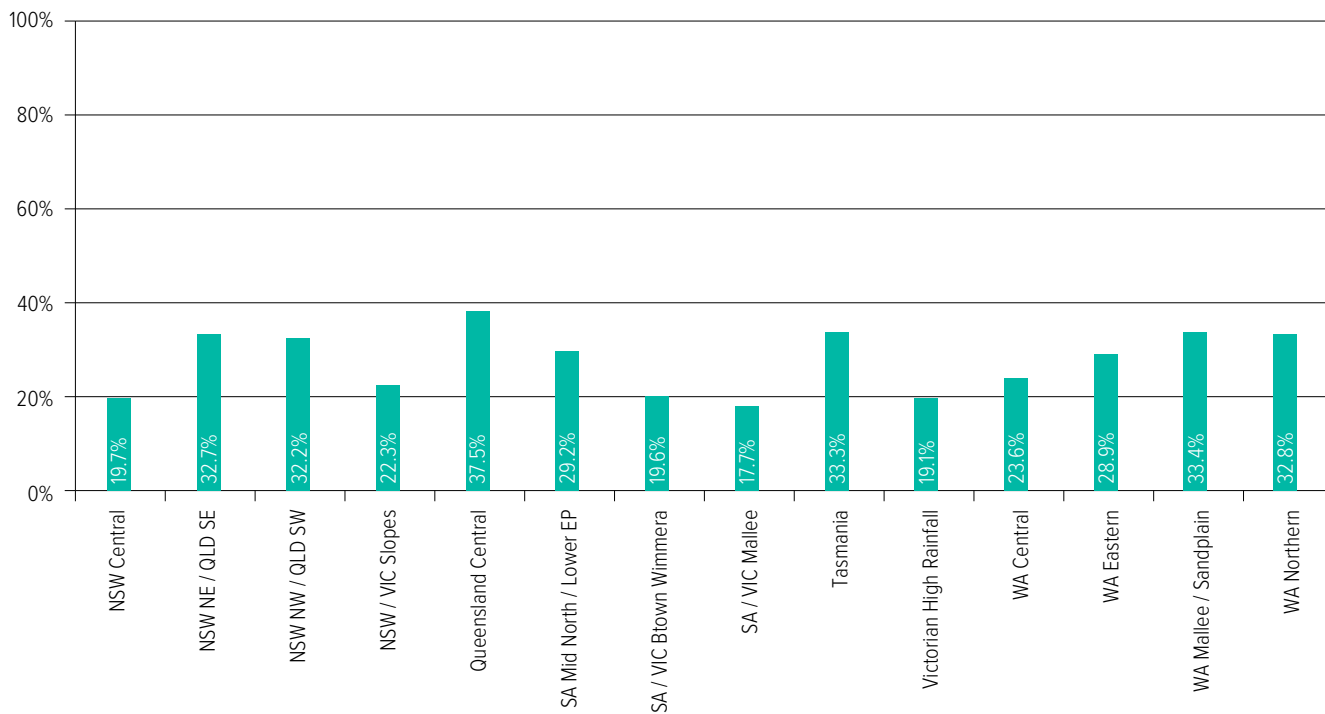
**TABLE 55** Average percentage of crop area managed so that stubble was removed, modified or reduced to avoid perceived negative impacts of having stubble present in 2014.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	24.6	
NSW NE / Queensland SE (b)	25.6	
NSW NW / Queensland SW (c)	19.3	
NSW / Victorian Slopes (d)	29.0	
Queensland Central (e)	27.3	
SA Mid North / Lower EP (f)	28.6	
SA / VIC Bordertown Wimmera (g)	21.4	
SA / Victorian Mallee (h)	20.3	
Tasmania (i)	49.5	
Victorian High Rainfall (j)	31.5	
WA Central (k)	25.3	
WA Eastern (l)	19.2	
WA Mallee / Sandplain (m)	19.3	
WA Northern (n)	13.2	
National average	25.3	

**TABLE 56** Average percentage of crop area where stubble impact on soil health was measured or monitored in 2014.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	19.7	
NSW NE / Queensland SE (b)	32.7	
NSW NW / Queensland SW (c)	32.2	
NSW / Victorian Slopes (d)	22.3	
Queensland Central (e)	37.5	
SA Mid North / Lower EP (f)	29.2	
SA / VIC Bordertown Wimmera (g)	19.6	
SA / Victorian Mallee (h)	17.7	
Tasmania (i)	33.3	
Victorian High Rainfall (j)	19.1	
WA Central (k)	23.6	
WA Eastern (l)	28.9	
WA Mallee / Sandplain (m)	33.4	
WA Northern (n)	32.8	
National average	27.3	

**FIGURE 73** Average percentage of crop area where impact of stubble on soil health was measured/monitored in 2014.





# PADDOCK HISTORY

PHOTO: STEPHEN DAVIES

Respondents were asked:

- What proportion of your cereal crop in 2014 was planted following:
  - a long fallow;
  - a pulse crop;
  - a canola crop;
  - a legume-dominant pasture phase; and
  - the same crop (i.e. wheat-wheat).
- What proportion of the 2014 crop was planted with a break crop specifically for the purposes of weed, disease or nutrient benefits?

## Previous crop type where a cereal planted in 2014 (or other survey year)

Respondents were asked about what the previous crop was in the areas where they had sown cereal crops in the survey year (see the question list above). The data is presented below.

### Summary

a) Previous crop as reported in survey of 2011.

The data as shown in Table 57 records the previous crop type as reported by survey respondents where a cereal crop was planted in 2011.

b) Previous crop as reported in survey of 2014.

The same questions were asked in the 2014 survey, with the data reported in Table 58.

The data is described for the individual previous crop types in the sections below, however from the two tables mentioned a consideration of the proportion of cereals sown following 'break crops' (i.e. canola, pulses or a legume-dominant pasture) suggests that this has decreased somewhat between 2011 and 2014, with the proportion of cereals following all of the break crops declining in proportion nationally.

## Previous canola crop

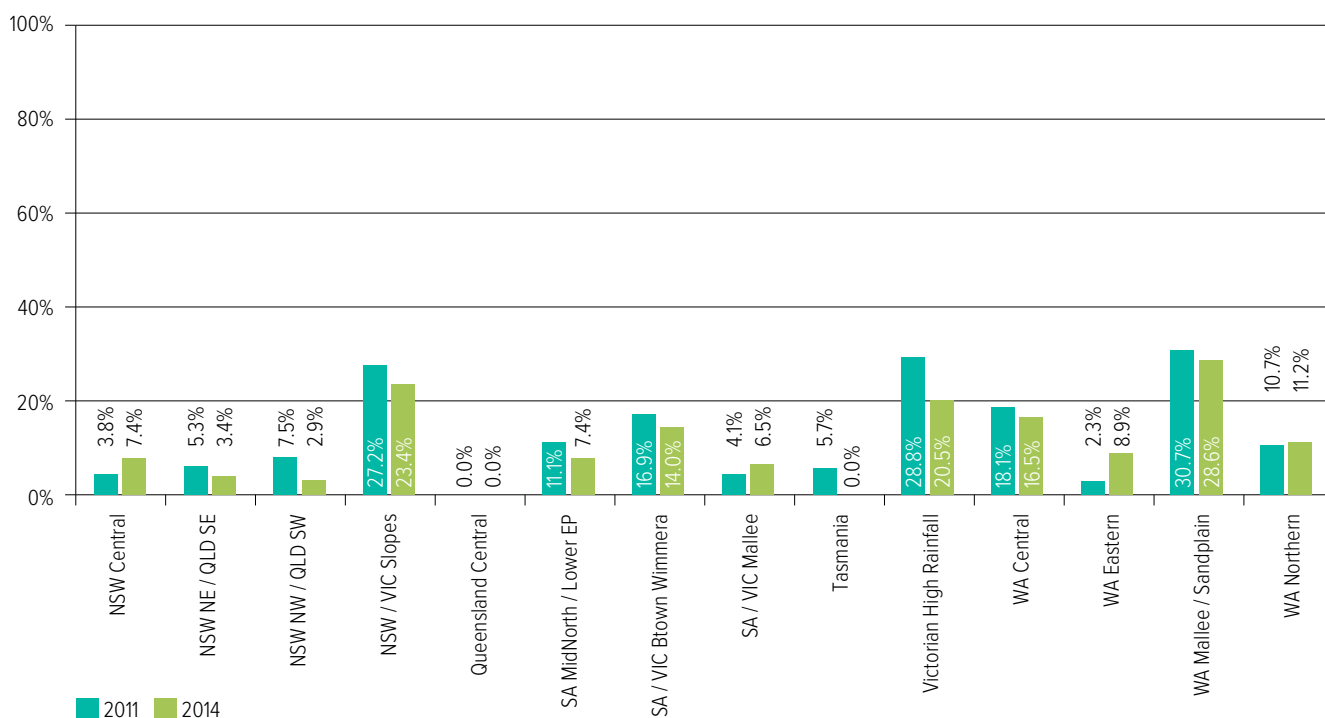
Cereal crops were more likely to have been planted in 2014 following a canola crop in 2013 in the agro-ecological zones of:

- NSW/Victorian Slopes;
- Victorian High Rainfall;
- Central Western Australia;
- Western Australian Mallee/Sandplain.

**TABLE 57** Average percentage of cereal crop area planted in 2011 following canola, pulses or legume-based pasture.

Agro-ecological zone	Following canola crop	Following pulse crop	Following legume pasture
NSW Central	3.8	3.5	9.8
NSW NE / Queensland SE	5.3	15.7	4.1
NSW NW / Queensland SW	7.5	27.2	5.0
NSW / Victorian Slopes	27.2	7.5	6.3
Queensland Central	0.0	27.6	0.0
SA Mid North / Lower EP	11.1	26.8	12.5
SA / VIC Bordertown Wimmera	16.9	18.0	10.6
SA / Victorian Mallee	4.1	12.4	16.4
Tasmania	5.7	6.4	5.7
Victorian High Rainfall	28.8	5.1	6.0
WA Central	18.1	11.2	22.2
WA Eastern	2.3	4.0	15.5
WA Mallee / Sandplain	30.7	9.5	23.1
WA Northern	10.7	18.0	4.2
National averages	12.3	13.8	10.1

**FIGURE 74** Average percentage of cereal crop area planted following canola in previous years for 2011 and 2014.



An increase in the proportion of cereal crop sown following canola was reported in NSW Central and eastern WA, although declined in many other AEZs. See Table 59, Figure 74 and Figure 75.

**TABLE 58** Average percentage of cereal crop area planted in 2014 following canola, pulses or legume-based pasture.

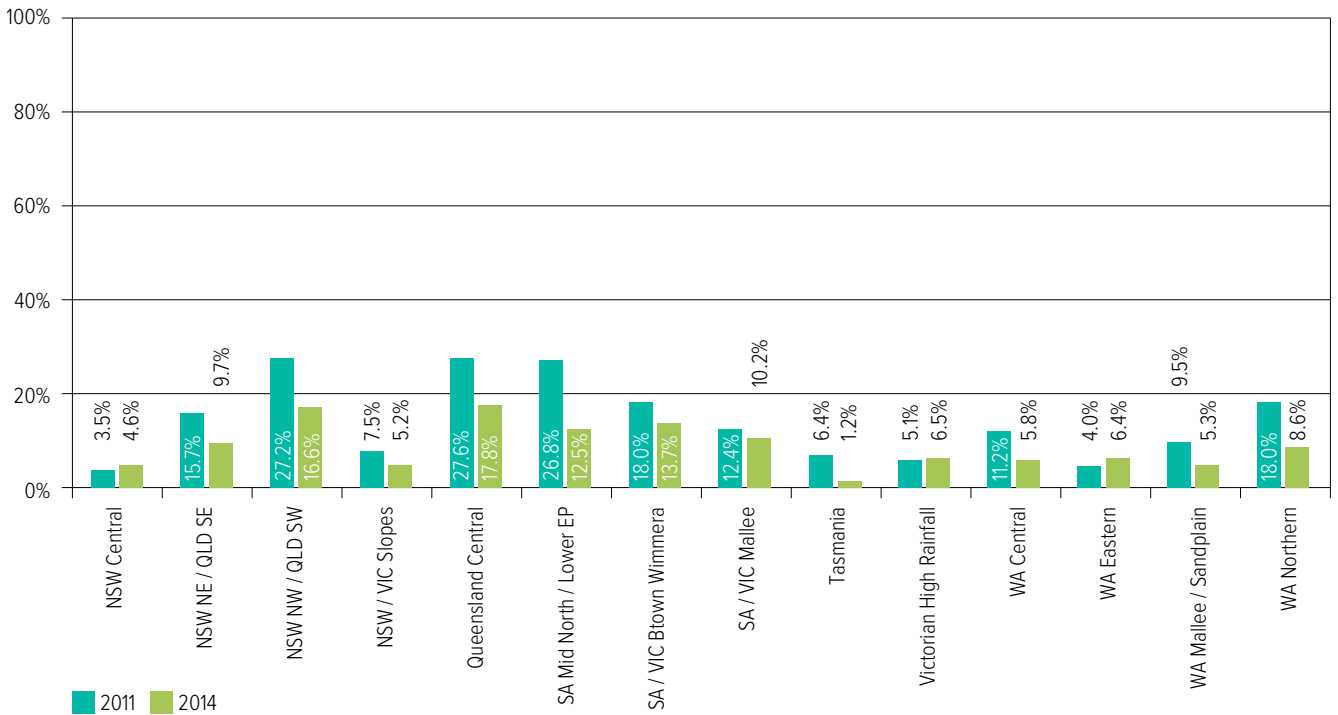
Agro-ecological zone	Following canola crop	Following pulse crop	Following legume pasture	Net: following canola / pulse / legume
NSW Central	7.4	4.6	5.3	17.3
NSW NE / Queensland SE	3.4	9.7	5.5	18.5
NSW NW / Queensland SW	2.9	16.6	5.2	24.6
NSW / Victorian Slopes	23.4	5.2	7.2	35.8
Queensland Central	0.0	17.8	5.5	23.3
SA Mid North / Lower EP	7.4	12.5	11.9	31.8
SA / VIC Bordertown Wimmera	14.0	13.7	10.7	36.8
SA / Victorian Mallee	6.5	10.2	15.2	30.5
Tasmania	0.0	1.2	1.3	2.6
Victorian High Rainfall	20.5	6.5	6.7	33.3
WA Central	16.5	5.8	23.3	45.3
WA Eastern	8.9	6.4	9.4	24.0
WA Mallee / Sandplain	28.6	5.3	17.8	49.4
WA Northern	11.2	8.6	2.9	22.7
National averages	10.8	8.9	9.1	28.3

**TABLE 59** Average percentage of cereal crop area planted following canola in previous years for 2011 and 2014.

Agro-ecological zone	Average % of crop area		Significant difference between years
	2011	2014	
NSW Central	3.8	7.4	**
NSW NE / Queensland SE	5.3	3.4	
NSW NW / Queensland SW	7.5	2.9	**
NSW / Victorian Slopes	27.2	23.4	
Queensland Central	0.0	0.0	
SA Mid North / Lower EP	11.1	7.4	**
SA / VIC Bordertown Wimmera	16.9	14.0	
SA / Victorian Mallee	4.1	6.5	
Tasmania	5.7	0.0	
Victorian High Rainfall	28.8	20.5	**
WA Central	18.1	16.5	
WA Eastern	2.3	8.9	**
WA Mallee / Sandplain	30.7	28.6	
WA Northern	10.7	11.2	
National averages	12.3	10.8	



**FIGURE 76** Average percentage of cereal crop area planted following a pulse crop in previous years for 2011 and 2014.



**Previous pulse crop**

Survey respondents were asked what proportion of their cereal crops sown were following a pulse crop. Cereal crops planted in 2014 were more likely to have followed a pulse crop in the agro-ecological zones of:

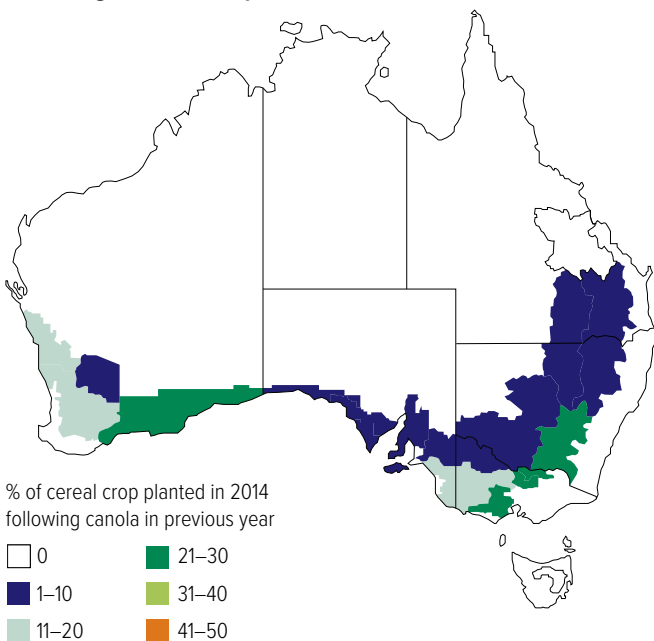
- North-west NSW / south-west Queensland;
- Queensland Central; and
- South Australian Mid North / Lower Eyre Peninsula.

Pulse crops were less likely have been used in rotation in:

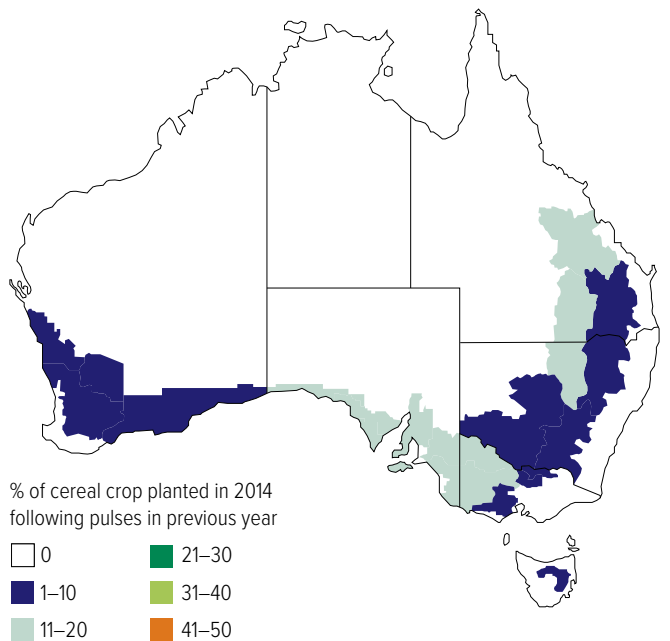
- Central NSW;
- NSW / Victorian Slopes;
- Victorian High Rainfall; and
- Eastern Western Australia.

Data is shown in Table 60, Figure 76 and Figure 77.

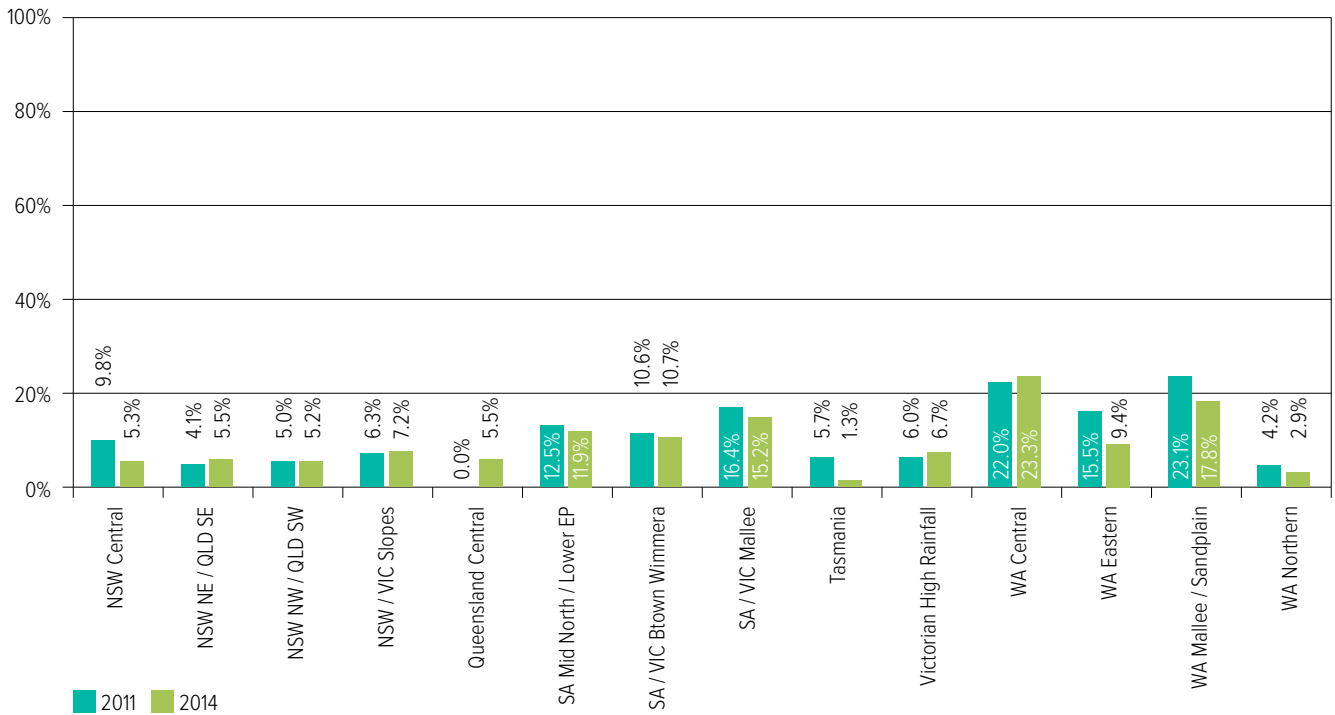
**FIGURE 75** Average percentage of cereal crop sown in 2014 following a canola crop in 2013.



**FIGURE 77** Average percentage of cereal crop sown in 2014 following a pulse crop in 2013.



**FIGURE 78** Average percentage of cereal crop area planted in 2011 and 2014 following a legume-dominant pasture in previous year.



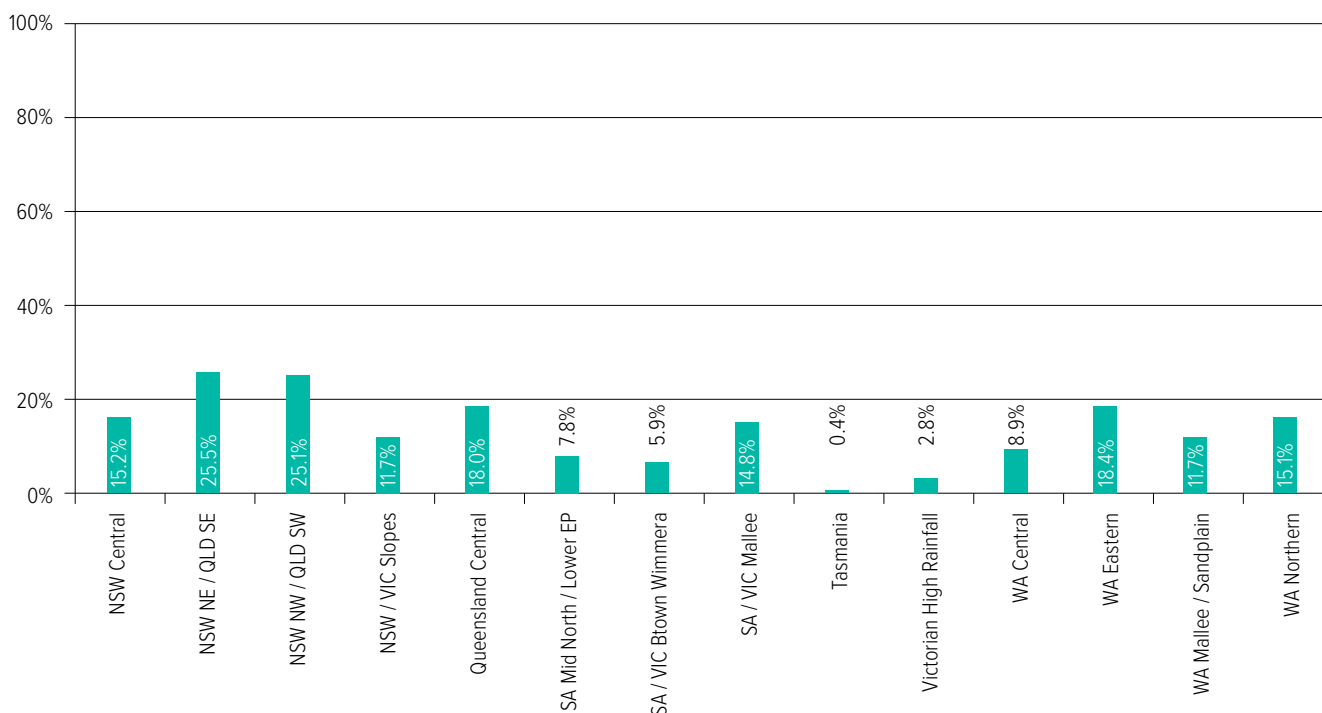
**TABLE 60** Average percentage of cereal crop area planted following a pulse crop in previous years for 2011 and 2014.

Agro-ecological zone	Average % of crop area		Significant difference between years
	2011	2014	
NSW Central	3.5	4.6	
NSW NE / Queensland SE	15.7	9.7	**
NSW NW / Queensland SW	27.2	16.6	**
NSW / Victorian Slopes	7.5	5.2	
Queensland Central	27.6	17.8	
SA Mid North / Lower EP	26.8	12.5	***
SA / VIC Bordertown Wimmera	18.0	13.7	
SA / Victorian Mallee	12.4	10.2	
Tasmania	6.4	1.2	
Victorian High Rainfall	5.1	6.5	
WA Central	11.2	5.8	***
WA Eastern	4.0	6.4	
WA Mallee / Sandplain	9.5	5.3	
WA Northern	18.0	8.6	***
National averages	13.8	8.9	

**TABLE 61** Average percentage of cereal crop area planted following a legume-dominant pasture in previous year in 2011 and 2014.

Agro-ecological zone	Average % of crop area		Significant difference between years
	2011	2014	
NSW Central	9.8	5.3	
NSW NE / Queensland SE	4.1	5.5	
NSW NW / Queensland SW	5.0	5.2	
NSW / Victorian Slopes	6.3	7.2	
Queensland Central	0.0	5.5	
SA Mid North / Lower EP	12.5	11.9	
SA / VIC Bordertown Wimmera	10.6	10.7	
SA / Victorian Mallee	16.4	15.2	
Tasmania	5.7	1.3	
Victorian High Rainfall	6.0	6.7	
WA Central	22.0	23.3	
WA Eastern	15.5	9.4	
WA Mallee / Sandplain	23.1	17.8	
WA Northern	4.2	2.9	
National averages	10.1	9.1	

**FIGURE 80** Average percentage of cereal crop area planted in 2014 onto long fallow.



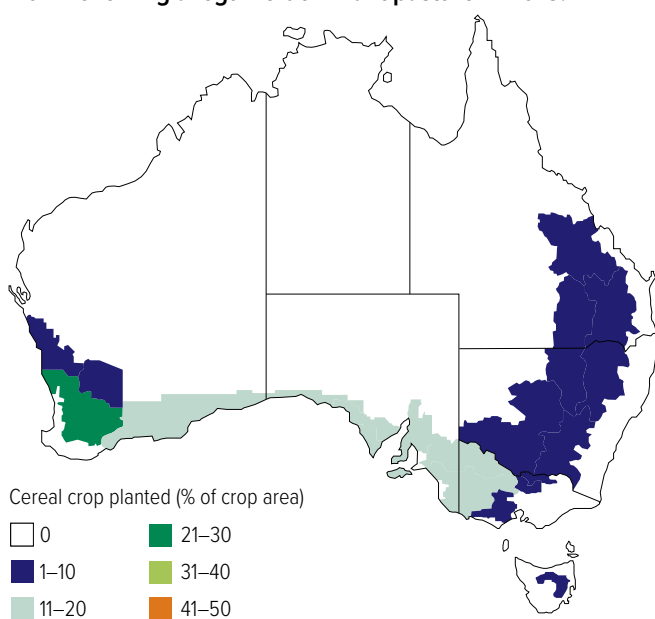
#### Previous legume-dominant pasture

Legume pastures were more likely to be grown in the agro-ecological zones with higher levels of mixed cropping/livestock enterprises. They are used for many purposes, including as a disease break crop in a crop rotation or sequence, for nitrogen fixation, weed management (also as a benefit for following cereal crops) and as feed for

livestock. Agro-ecological zones where growers reported cereal crops being sown following legume-dominant pastures include:

- South Australian / Victorian Mallee;
- central Western Australia;
- eastern Western Australia; and

**FIGURE 79** Percentage of cereal crop planted in 2014 following a legume-dominant pasture in 2013.

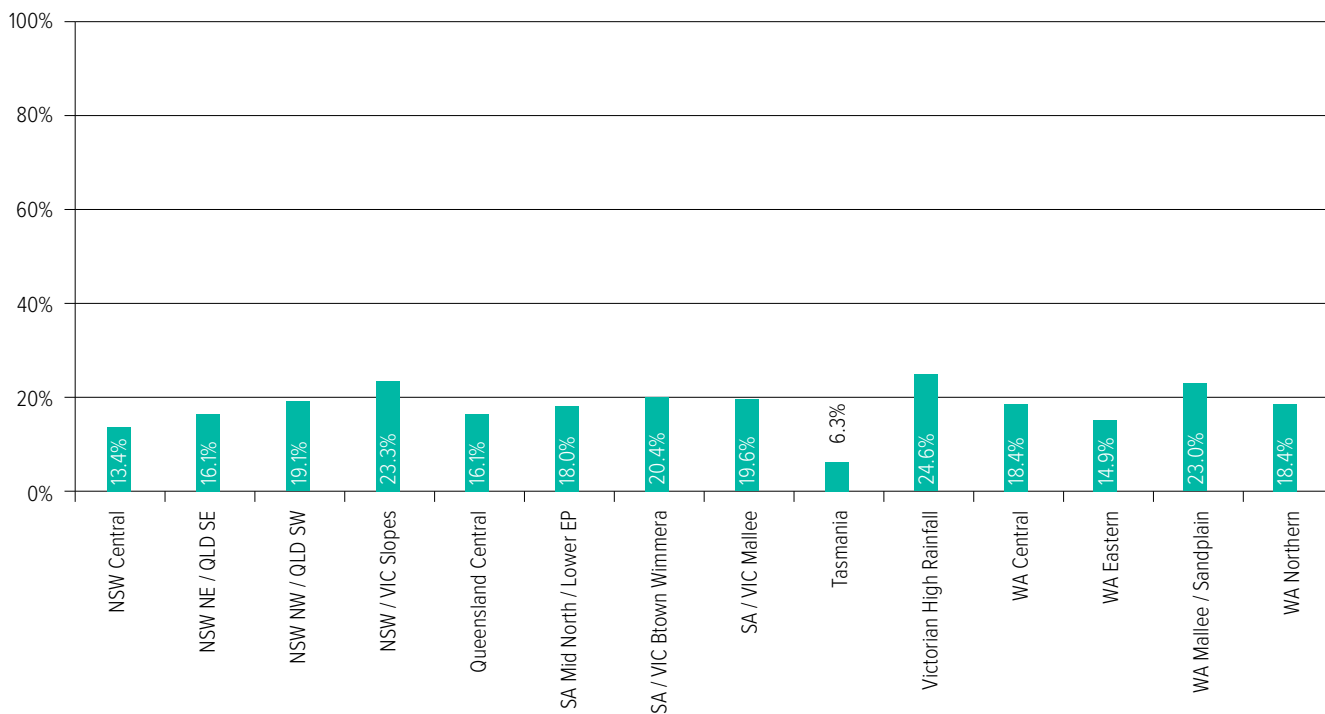


**TABLE 62** Average percentage of cereal crop area planted in 2014 onto long fallow.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	15.2	fgj
NSW NE / Queensland SE (b)	25.5	adfgjkm
NSW NW / Queensland SW (c)	25.1	dfgjk
NSW / Victorian Slopes (d)	11.7	gj
Queensland Central (e)	18.0	
SA Mid North / Lower EP (f)	7.8	j
SA / VIC Bordertown Wimmera (g)	5.9	
SA / Victorian Mallee (h)	14.8	fgj
Tasmania (i)	0.4	
Victorian High Rainfall (j)	2.8	
WA Central (k)	8.9	j
WA Eastern (l)	18.4	gj
WA Mallee / Sandplain (m)	11.7	j
WA Northern (n)	15.1	j
National average	12.9	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

**FIGURE 82** Average percentage of cropped area planted in 2014 with a break crop specifically for weed control.

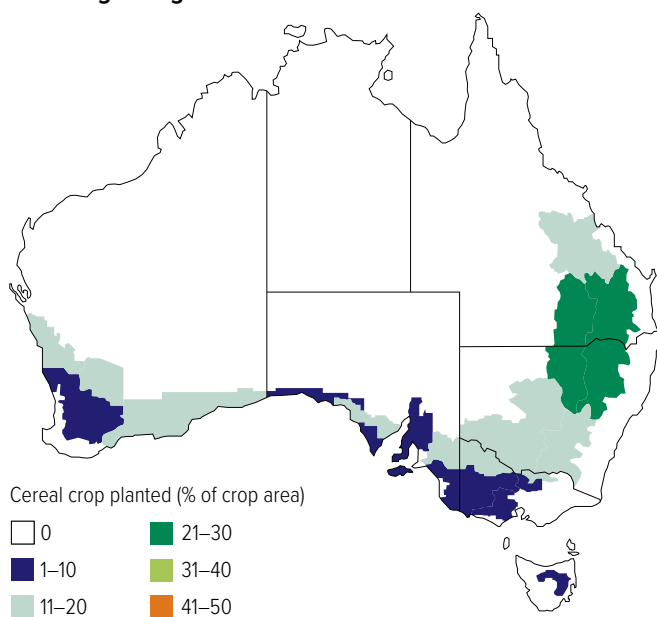


- Western Australian Mallee / Sandplain.
- Conversely, pasture legumes were less likely to be used in the crop rotation on the grain-intensive properties of:
- NSW / Queensland;
- Queensland Central;
- NSW / Victorian Slopes; and

- Northern Western Australia.

The national average area of cereals sown following a legume-dominant pasture shows some decline, from approximately 10% in 2011 to 9% in 2014 (Table 61, Figure 78 and Figure 79).

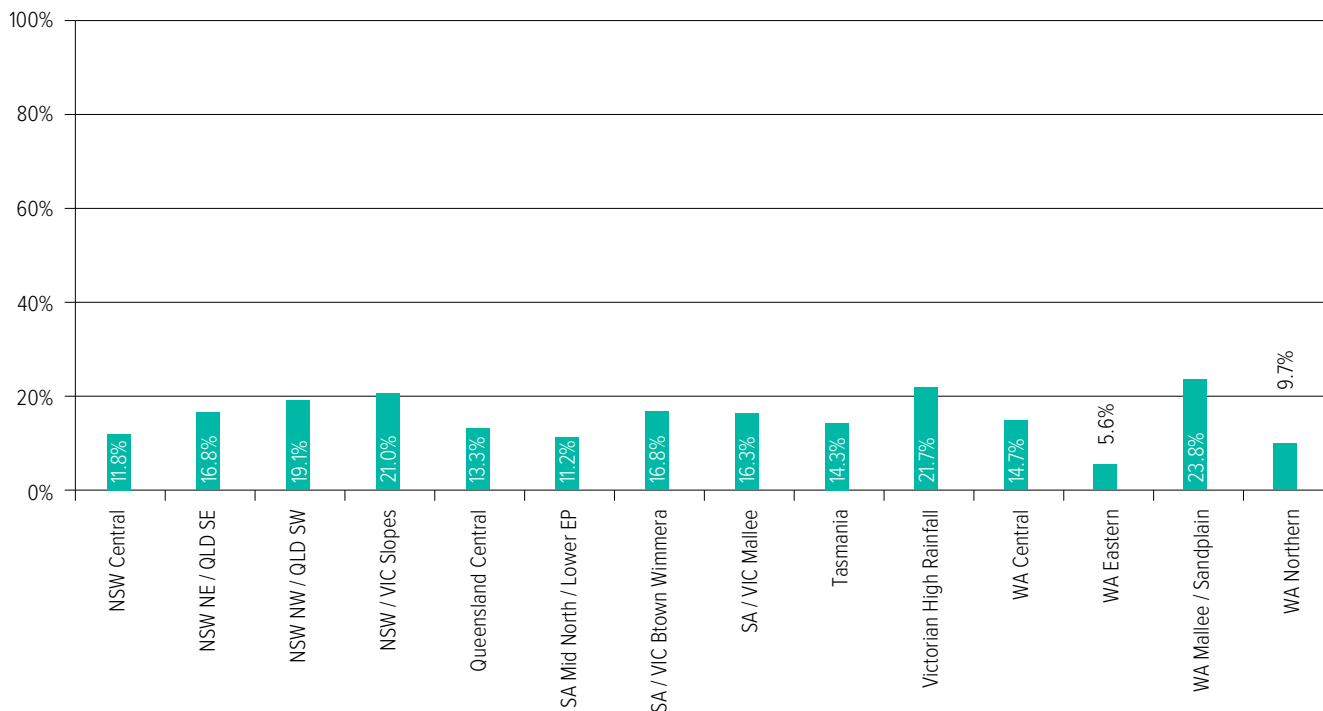
**FIGURE 81** Percentage of cereal planted in 2014 following a long fallow.



**TABLE 63** Average percentage of cropped area planted in 2014 with a break crop specifically for weed control.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	13.4	
NSW NE / Queensland SE (b)	16.1	
NSW NW / Queensland SW (c)	19.1	
NSW / Victorian Slopes (d)	23.3	
Queensland Central (e)	16.1	
SA Mid North / Lower EP (f)	18.0	
SA / VIC Bordertown Wimmera (g)	20.4	
SA / Victorian Mallee (h)	19.6	
Tasmania (i)	6.3	
Victorian High Rainfall (j)	24.6	
WA Central (k)	18.4	
WA Eastern (l)	14.9	
WA Mallee / Sandplain (m)	23.0	
WA Northern (n)	18.4	
National average	18.0	

**FIGURE 84** Average percentage of cropped area planted in 2014 with a break crop specifically for disease management.



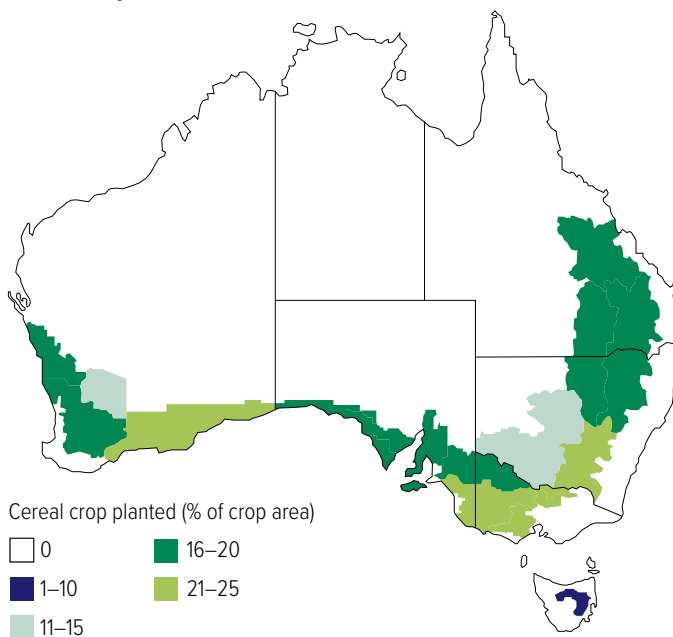
### Planted following a long fallow

Grain producers were asked to estimate how much of their 2014 crop was planted following a period described as a long fallow. A long fallow in the southern and western cropping regions would generally be where the area had been kept free of plant growth from the previous season

until sowing. This can mean the commencement of a fallow period in the late winter of one year, with sowing occurring in the late autumn of the next, with the fallow period lasting up to 9 months.

In the northern region the situation is complicated by the

**FIGURE 83** Percentage of crop area planted with a break crop for weed control.

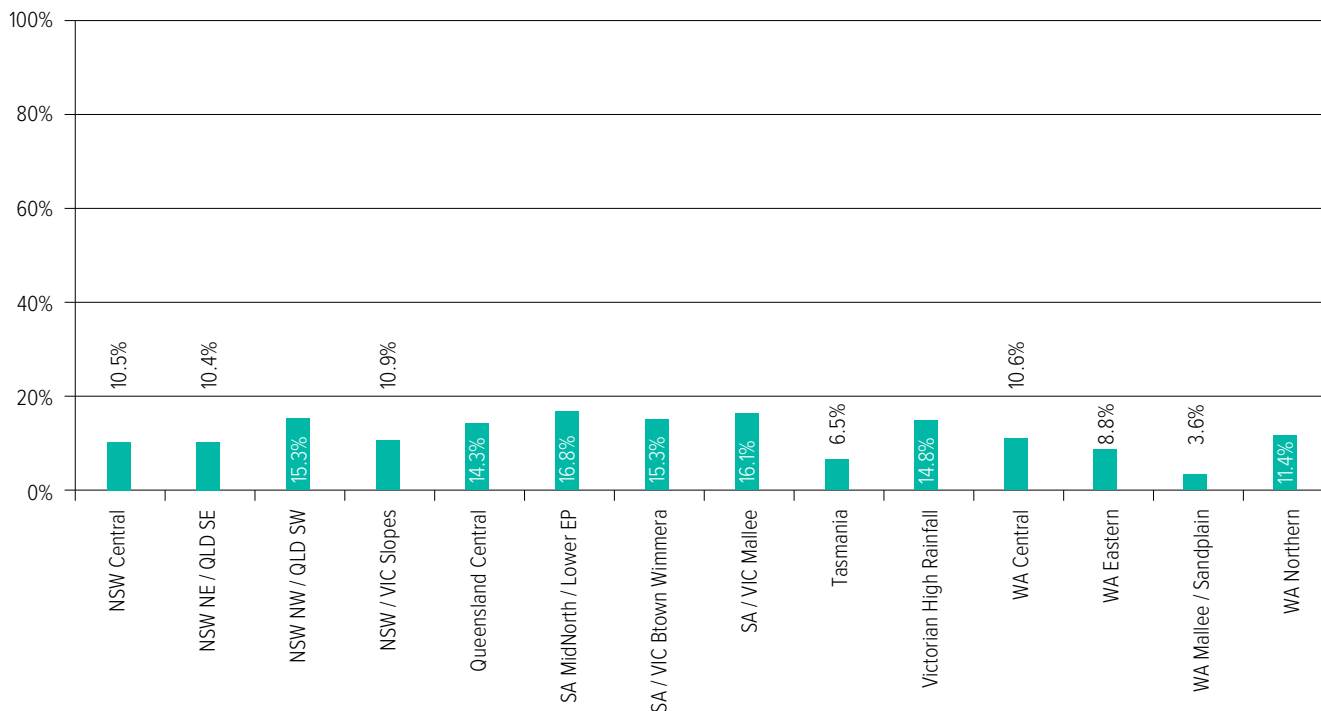


**TABLE 64** Average percentage of cropped area planted in 2014 with a break crop specifically for disease control.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	11.8	
NSW NE / Queensland SE (b)	16.8	l
NSW NW / Queensland SW (c)	19.1	l
NSW / Victorian Slopes (d)	21.0	afln
Queensland Central (e)	13.3	
SA Mid North / Lower EP (f)	11.2	
SA / VIC Bordertown Wimmera (g)	16.8	l
SA / Victorian Mallee (h)	16.3	l
Tasmania (i)	14.3	
Victorian High Rainfall (j)	21.7	ln
WA Central (k)	14.7	l
WA Eastern (l)	5.6	
WA Mallee / Sandplain (m)	23.8	ln
WA Northern (n)	9.7	
National average	15.4	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

**FIGURE 86** Average percentage of cropped area planted in 2014 with a break crop specifically for nutritional benefits.

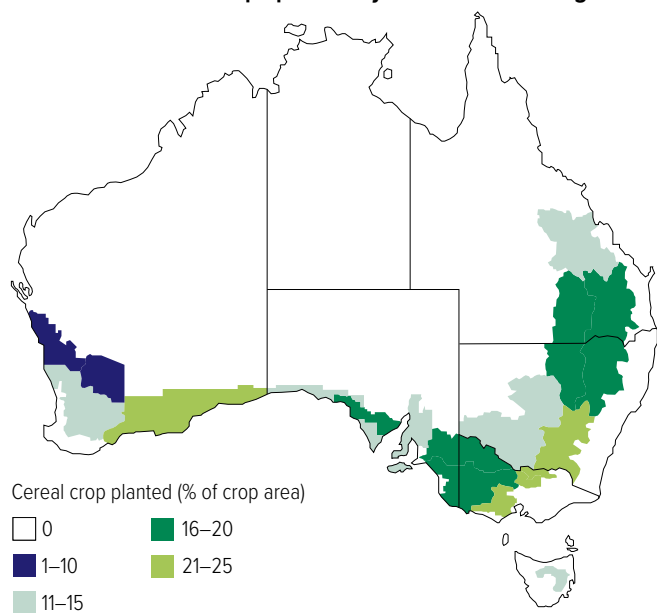


opportunity to sow either summer or winter crops. In these areas a fallow may be as long as it takes to secure a soil profile with adequate moisture to give confidence that a successful crop (either winter or summer) can be grown. In these areas a fallow may be short (a month or so) between

(say) a winter crop harvest in October, and sowing of a summer crop in November–December, or quite long where (say) 12 or more months may pass before rain received is such that the profile is filled.

In general, long fallows have mixed purposes: no plant

**FIGURE 85** Average percentage of cropped area planted in 2014 with a break crop specifically for disease management.



**TABLE 65** Average percentage of cropped area planted in 2014 with a break crop specifically for nutritional benefits.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	10.5	m
NSW NE / Queensland SE (b)	10.4	m
NSW NW / Queensland SW (c)	15.3	m
NSW / Victorian Slopes (d)	10.9	m
Queensland Central (e)	14.3	
SA Mid North / Lower EP (f)	16.8	m
SA / VIC Bordertown Wimmera (g)	15.3	m
SA / Victorian Mallee (h)	16.1	m
Tasmania (i)	6.5	
Victorian High Rainfall (j)	14.8	m
WA Central (k)	10.6	m
WA Eastern (l)	8.8	
WA Mallee / Sandplain (m)	3.6	
WA Northern (n)	11.4	
<b>National average</b>	<b>11.8</b>	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.



growth assists with maximising soil moisture, minimises weed seed-set, reduces the potential of hosting of diseases and allows nitrogen mineralisation. Moisture accumulation is often considered the dominant purpose of a long fallow.

The data presented in Table 62, Figure 80 and Figure 81, shows approximately 13% of the cereal crop is sown into a long fallow on a national basis. This proportion is higher in the northern AEZs, possibly reflecting the mixed winter and summer crop systems that are a feature, where fallows frequently occur in the interests of filling the soil profile with moisture as a precursor for sowing of any crop. In other AEZs where long fallow is a feature, this tends to be where soils have some clay content, and soil moisture is able to be stored over a fallow (NSW central, the Mallee areas, and eastern WA).

### Percentage of crop planted to assist with weed control

One of the reasons some growers identify for sowing break crops in a crop rotation or sequence is to assist with control of some weeds.

In the 2014 survey respondents were asked what proportion of their crop was a break crop where weed management was the purpose for sowing this crop. The data (as shown in Table 63, Figure 82 and Figure 83) suggests that approaching 20% of the crop area is sown with weed control being the main objective. This objective is higher in the AEZs of the NSW/Victorian Slopes and the WA Mallee/Sandplain, although the differences between AEZs are not great.

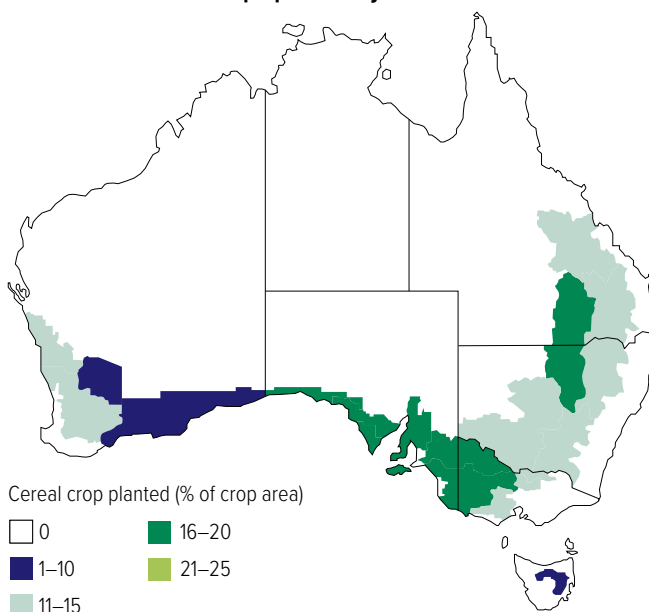
### Percentage of crop planted to assist with disease control

Growers were asked in the 2014 survey what proportion of their crop area was a crop sown with disease management as being the key objective. The data (Table 64, Figure 84 and Figure 85) suggests that the proportion of crop sown with disease management as the main aim varies and averages more than 15%, with higher proportions in the AEZs of the WA Mallee/Sandplain, Victorian High Rainfall and NSW/Victorian slopes, and lower in eastern and northern WA.

### Percentage of crop planted (break crop) sown for nutritional reasons

The proportion of crop sown in 2014 for nutritional reasons, as reported in the 2014 survey (Table 65, Figure 86 and Figure 87), shows that less than 12% of crops were said to be sown for this reason. This was lowest in eastern and southern WA and highest in Victorian High Rainfall and Queensland Central AEZs.

**FIGURE 87** Average percentage of cropped area planted in 2014 with a break crop specifically for nutritional benefits.



# SOIL MANAGEMENT

PHOTO: EVAN COLLIS

Questions asked in the 2014 survey were:

- What was the area and use rate of lime was applied?
- What percentage of your crops (broken by crop type) were soil tested in 2014?
- What area of your crop was soil tested to 10cm depth?
- What area of crop had a comprehensive, deep soil test in 2014?
- What area of crop was treated with fertiliser at rates based on soil test results?
- What area of crop was treated with fertiliser at rates based on estimates or calculations of nutrient removal by the crop?
- What area of crop had a leaf or petiole test?
- What area of crop had an in-season application or top-dressing of fertiliser?

## Crops sown in 2014 where lime was applied in the period leading to sowing

Respondents were asked about what proportion of their crop area had lime applied. The data is presented in Table 66 and Figure 88, and shows that, based on what survey respondents reported, the percentage of crop area where lime was applied in 2014 has strongly increased since the previous surveys, being less than 10% of the crop area in 2011, and now over 20% in 2014.

**TABLE 66** Average percentage of crop area where lime was applied.

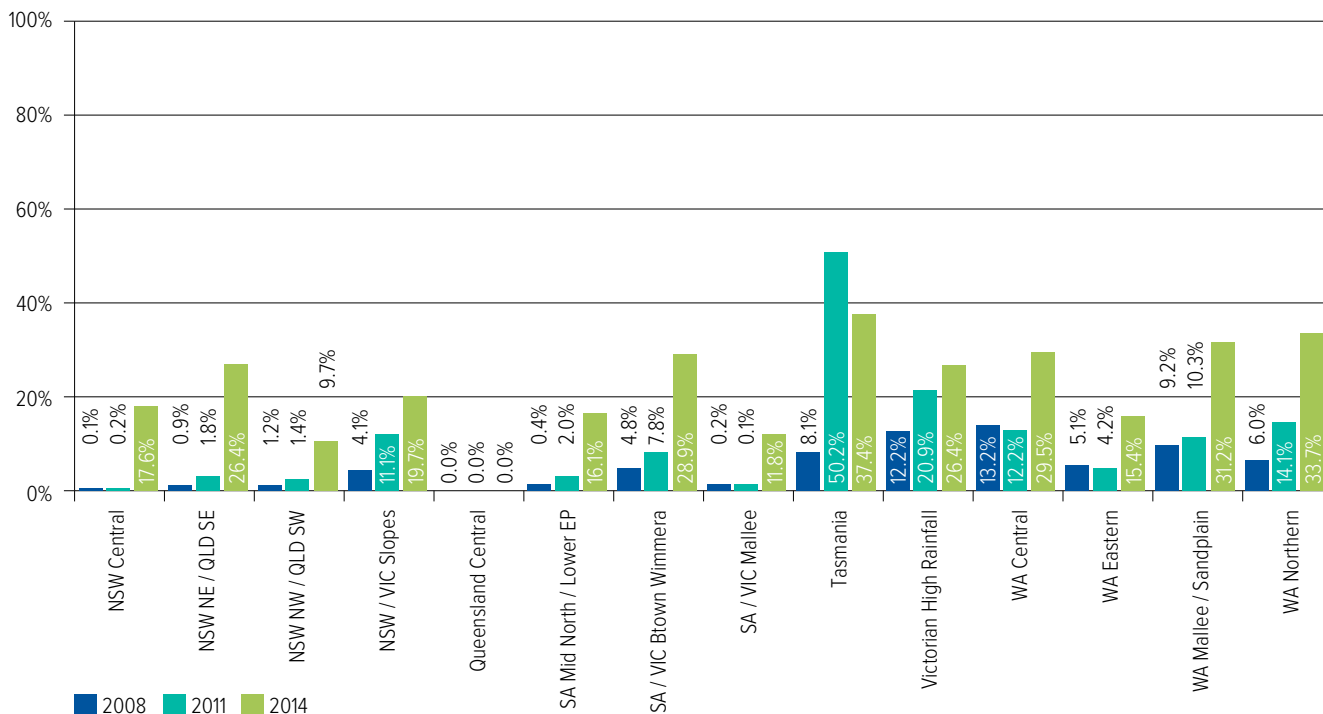
Agro-ecological zone	Average % of crop area		
	2008	2011	2014
NSW Central	0.1	0.2	17.6
NSW NE / Queensland SE	0.9	1.8	26.4
NSW NW / Queensland SW	1.2	1.4	9.7
NSW / Victorian Slopes	4.1	11.1	19.7
Queensland Central	0.0	0.0	0.0
SA Mid North / Lower EP	0.4	2.0	16.1
SA / VIC Bordertown Wimmera	4.8	7.8	28.9
SA / Victorian Mallee	0.2	0.1	11.8
Tasmania	8.1	50.2	37.4
Victorian High Rainfall	12.2	20.9	26.4
WA Central	13.2	12.2	29.5
WA Eastern	5.1	4.2	15.4
WA Mallee / Sandplain	9.2	10.3	31.2
WA Northern	6.0	14.1	33.7
National averages	4.7	9.7	21.7

Note: data not tested for statistical significance.

**TABLE 67** Average use rate of lime (t/ha) on area where applied.

Agro-ecological zone	Average use rate (t/ha)		
	2008	2011	2014
NSW Central	2.00	1.60	0.8
NSW NE / Queensland SE	1.13	1.81	1.2
NSW NW / Queensland SW	1.22	1.59	1.0
NSW / Victorian Slopes	1.51	1.47	0.8
Queensland Central	0.0	0.0	0.0
SA Mid North / Lower EP	1.57	1.57	0.5
SA / VIC Bordertown Wimmera	1.75	1.00	3.9
SA / Victorian Mallee	1.66	0.50	0.8
Tasmania	3.96	2.59	0.3
Victorian High Rainfall	1.90	1.36	1.5
WA Central	1.07	1.10	1.3
WA Eastern	1.12	1.23	0.8
WA Mallee / Sandplain	1.36	1.23	0.8
WA Northern	1.18	1.48	0.8
National averages	1.53	1.32	1.0

**FIGURE 88** Average percentage of crop area where lime was applied in 2008, 2011 and 2014.

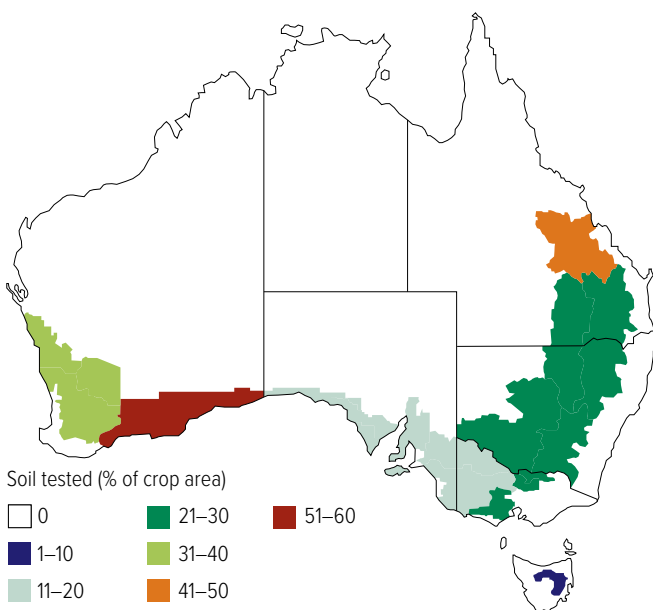


It is highly unlikely that lime was applied to over 26% of the cropped area in north-eastern NSW/ south-eastern Queensland, where traditionally soils are not acid in nature, and previous data suggests well below 5% of the cropped area has been treated in the past. Similar comments apply to NSW Central and most of SA and the Victorian Mallee, where soils tend to be alkaline rather than acid.

In those AEZs where applying lime is a more common practice, as reflected in previous surveys (for example, the NSW/Victorian slopes, central, northern and southern WA) there is some evidence that the proportion of the cropped area where lime has been applied has increased.

These trends may require some further investigation.

**FIGURE 90** Average percentage of cropped area soil tested in 2014.

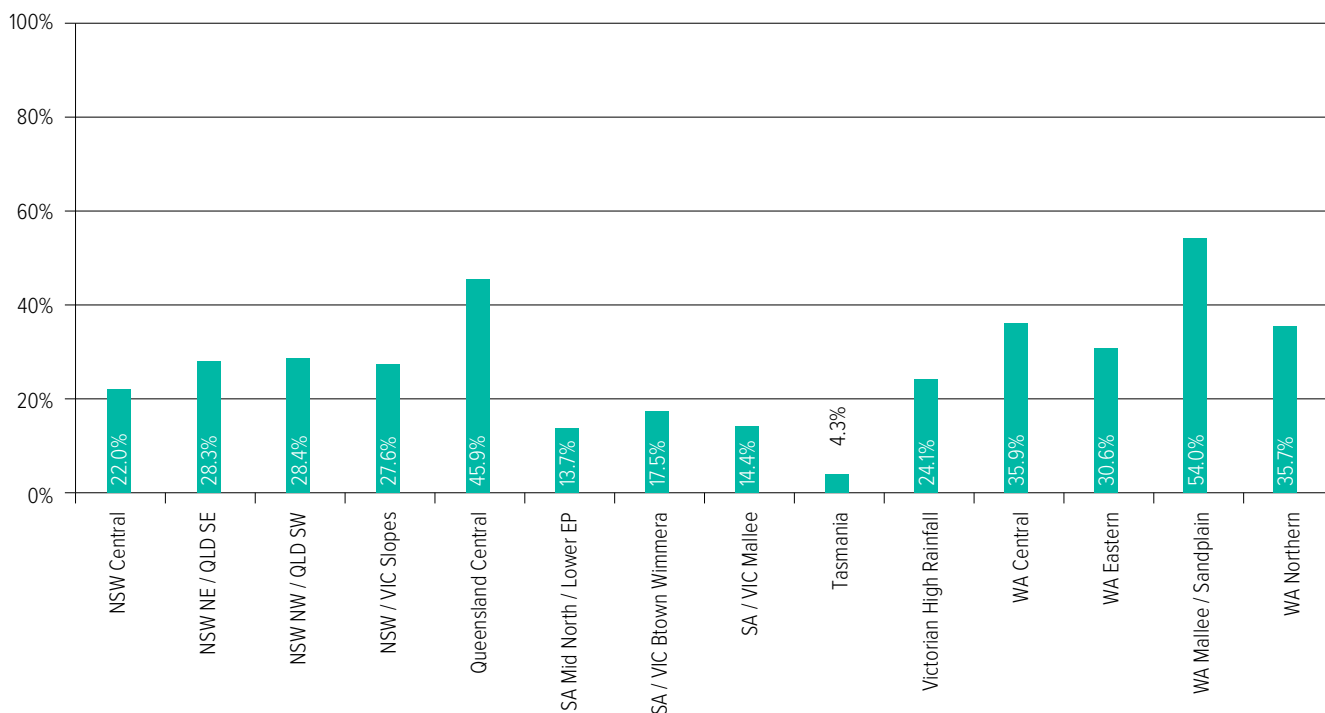


**TABLE 68** Average percentage of crop area soil tested in 2008, 2011 and 2014.

Agro-ecological zone	2008	2011	2014
NSW Central	53.6	35.5	22.0
NSW NE / Queensland SE	51.9	37.2	28.3
NSW NW / Queensland SW	41.7	33.8	28.4
NSW / Victorian Slopes	56.2	50.4	27.6
Queensland Central	33.3	38.6	45.9
SA Mid North / Lower EP	30.8	29.7	13.7
SA / VIC Bordertown Wimmera	38.7	35.1	17.5
SA / Victorian Mallee	39.4	25.5	14.4
Tasmania	75.0	71.4	4.3
Victorian High Rainfall	56.2	40.3	24.1
WA Central	64.8	58.2	35.9
WA Eastern	47.7	46.2	30.6
WA Mallee / Sandplain	54.4	64.1	54.0
WA Northern	55.4	56.5	35.7
National averages	49.9	44.5	27.3

Note: Data not tested for statistical significance

**FIGURE 89** Average percentage of crop area soil tested in 2014.



### Amount of lime applied

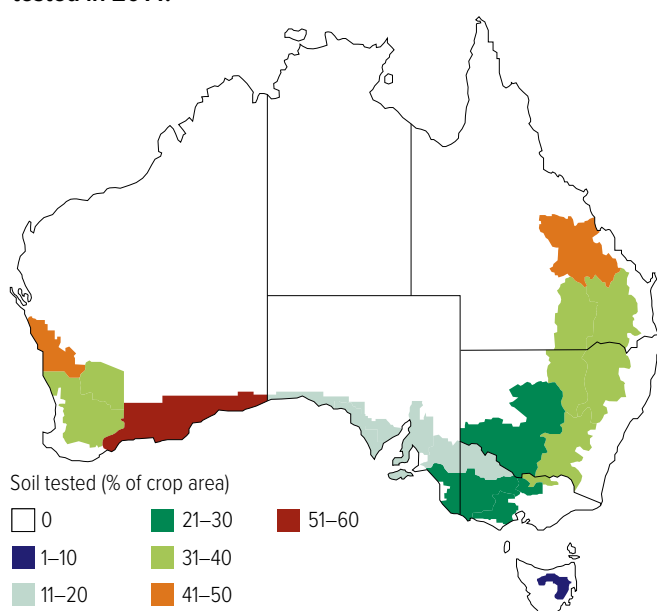
Respondents were asked what use rate of lime was applied to the area treated in 2014 (as reported above).

The data as presented in Table 67 appears to show very marked differences from the data reported for the previous two surveys. Reasons for this may be in the method for determining the use rate. In the previous

two surveys respondents were asked the area that lime was applied to and the total amount of lime applied. The use rate was then calculated from these answers. In 2014 respondents were simply asked what their average application rate of lime was.

Secondly, it is noted that the area reported as having

**FIGURE 92** Percentage of winter cereal crop area soil tested in 2014.

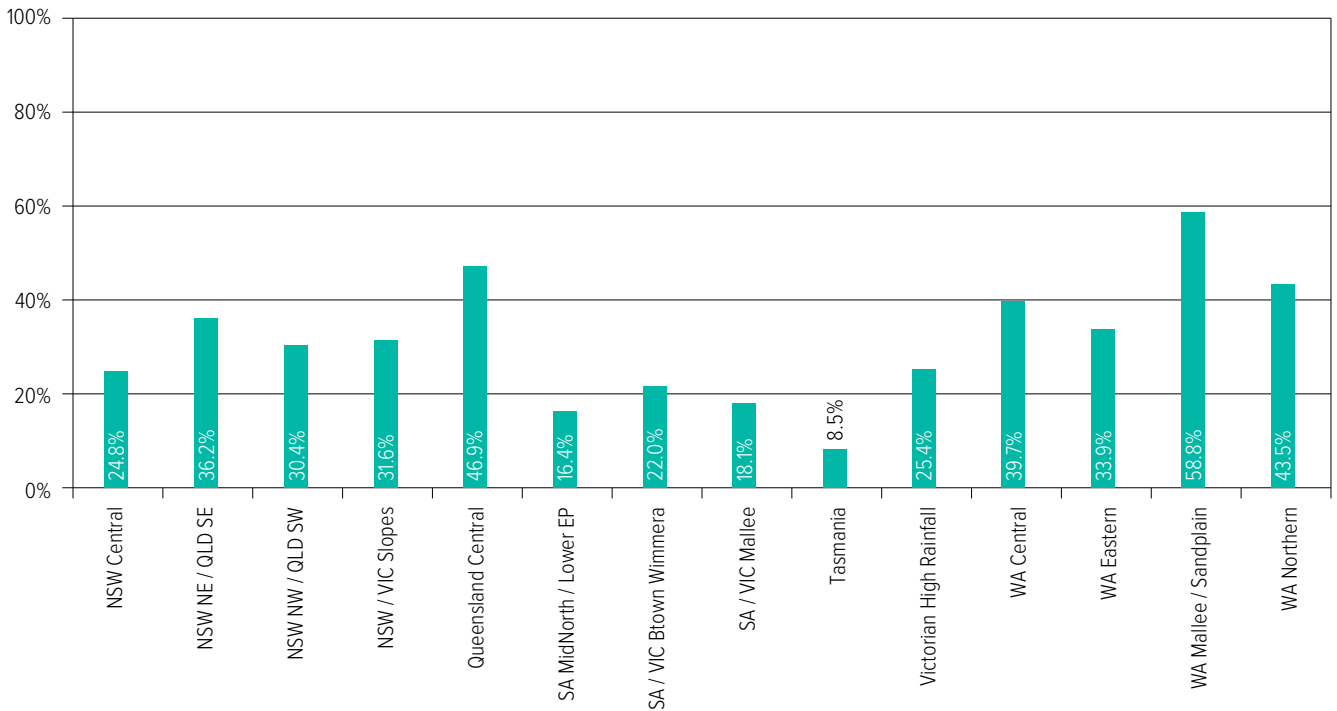


**TABLE 69** Average percentage of winter cereal crop area soil tested in 2014.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	24.8	
NSW NE / Queensland SE (b)	36.2	fgh
NSW NW / Queensland SW (c)	30.4	fgh
NSW / Victorian Slopes (d)	31.6	fgh
Queensland Central (e)	46.9	fgh
SA Mid North / Lower EP (f)	16.4	
SA / VIC Bordertown, Wimmera (g)	22.0	
SA / Victorian Mallee (h)	18.1	
Tasmania (i)	8.5	
Victorian High Rainfall (j)	25.4	
WA Central (k)	39.7	afg hj
WA Eastern (l)	33.9	fh
WA Mallee/Sandplain (m)	58.8	abcdfghijkl
WA Northern (n)	43.5	afg hj
National average	31.1	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

**FIGURE 91** Average percentage of winter cereal crop area soil tested in 2014.

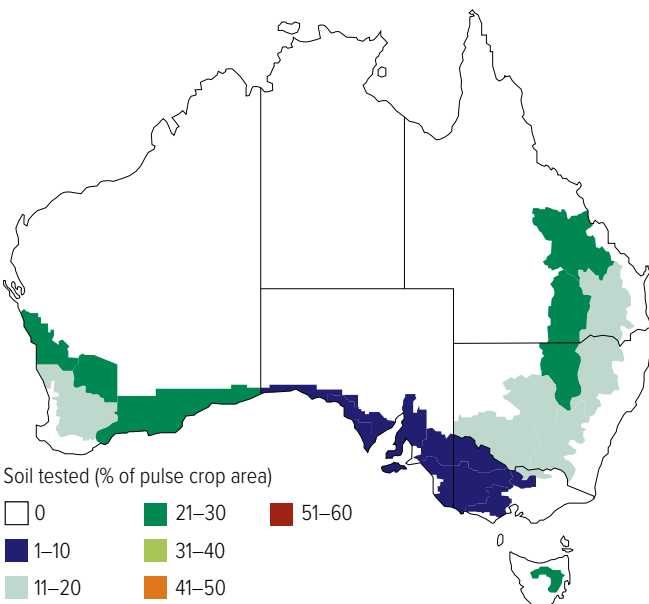


lime applied has increased compared with previous survey data (see above). The data suggests more than a doubling of the proportion of the crop area where lime was applied compared with the last survey. It is possible that growers have increased the proportion of their crop where lime was applied, although have applied a similar total amount of lime to this increased area, resulting in a lowered application rate of lime per hectare.

It is also possible that some growers reported their application rate in tonnes per acre, rather than per hectare.

Nonetheless, a general observation is that the application rates on a per hectare basis in 2014 appear considerably lower than in the previous surveys, although there are some exceptions.

**FIGURE 94** Percentage of pulse crop area soil tested in 2014.

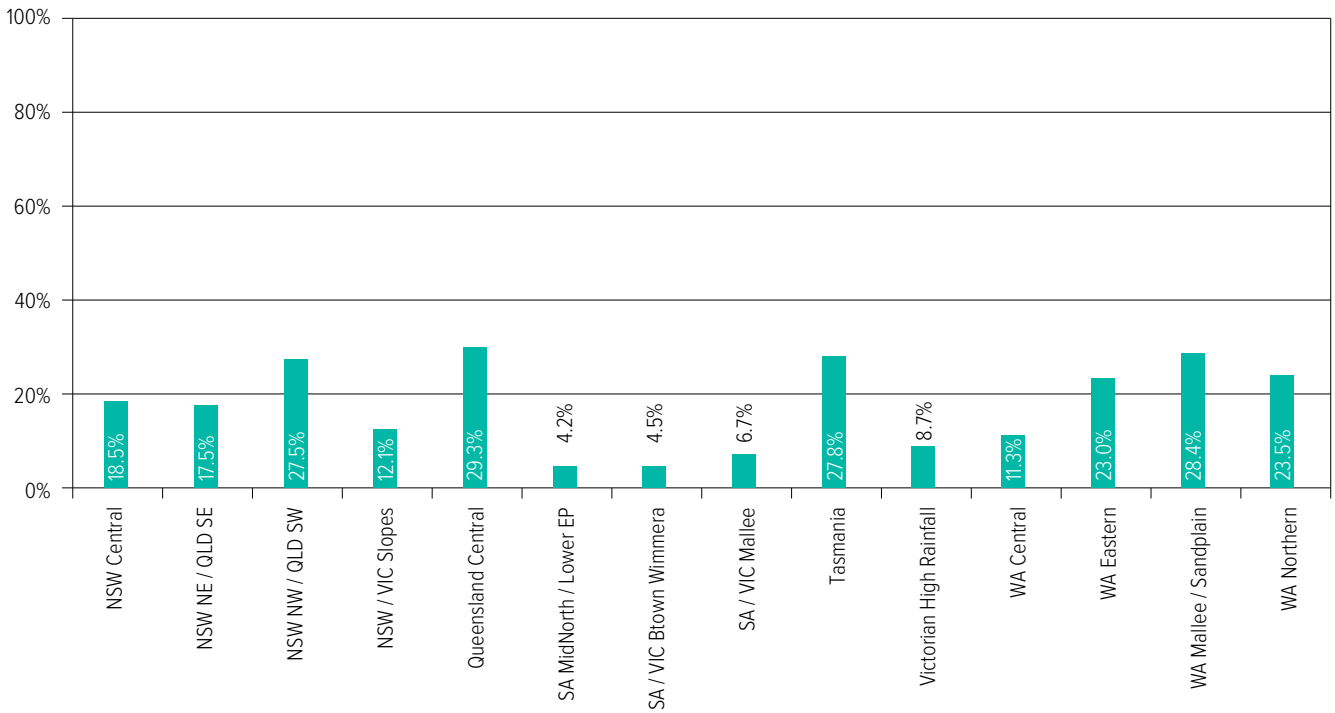


**TABLE 70** Average percentage of pulse crop area soil tested in 2014.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	18.5	
NSW NE / Queensland SE (b)	17.5	
NSW NW / Queensland SW (c)	27.5	
NSW / Victorian Slopes (d)	12.1	
Queensland Central (e)	29.3	
SA Mid North / Lower EP (f)	4.2	
SA / VIC Bordertown, Wimmera (g)	4.5	
SA / Victorian Mallee (h)	6.7	
Tasmania (i)	27.8	
Victorian High Rainfall (j)	8.7	
WA Central (k)	11.3	
WA Eastern (l)	23.0	
WA Mallee/Sandplain (m)	28.4	
WA Northern (n)	23.5	
National average	17.4	



**FIGURE 93** Average percentage of pulse crop area soil tested in 2014.



### Soil testing for nutrition management

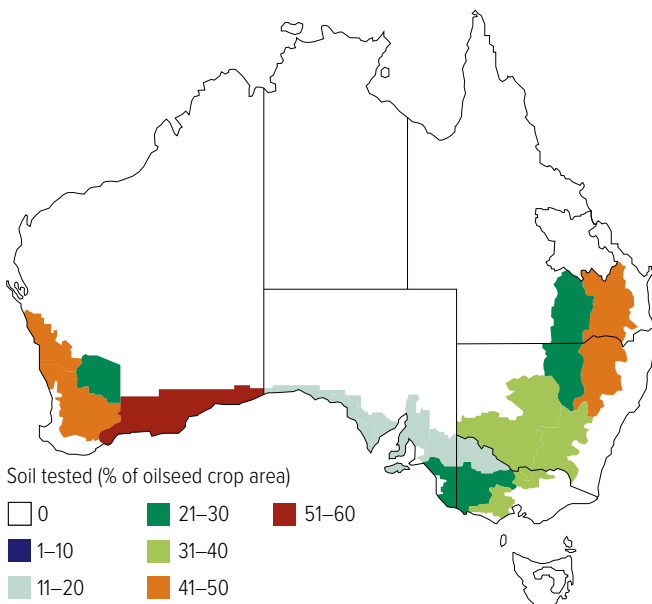
#### Average percentage of cropped area soil tested

The data presented below shows the percentage of the cropped area survey respondents reported as having been soil tested in 2014.

The data shows that nationally on average 25% to 30% of the cropped area was soil tested in 2014. The previous

surveys (where the depth of the soil test was not specified) suggested that 45% to 50% of the cropped area was soil tested. On this basis it could be interpreted that soil testing has declined as a practice, although the proportion of the crop where soil testing was carried out remained relatively high in several AEZs, for example much of Western Australia and Central Queensland. See Table 68, Figure 89 and Figure 90.

**FIGURE 96** Percentage of winter oilseed crop area soil tested in 2014.

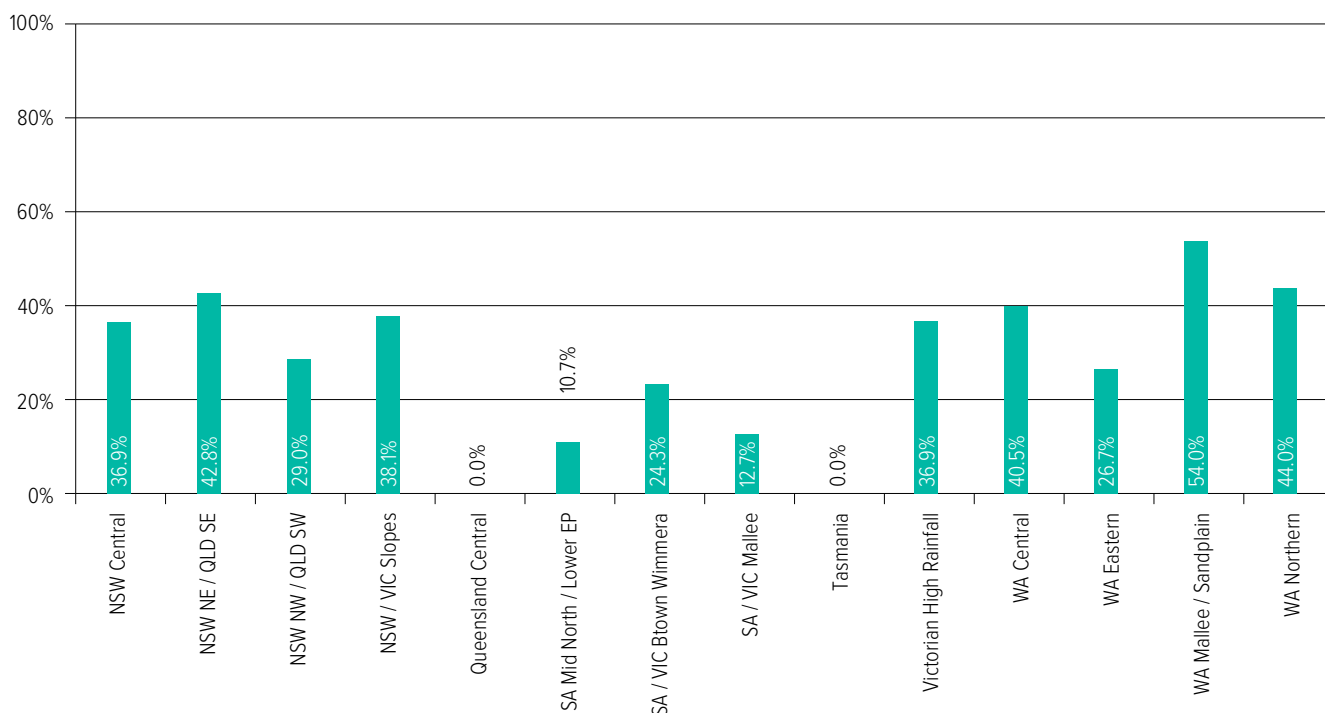


**TABLE 71** Average percentage of oilseed crop area soil tested in 2014.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	36.9	fh
NSW NE / Queensland SE (b)	42.8	
NSW NW / Queensland SW (c)	29.0	
NSW / Victorian Slopes (d)	38.1	fh
Queensland Central (e)	0.0	fh
SA Mid North / Lower EP (f)	10.7	
SA / VIC Bordertown, Wimmera (g)	24.3	
SA / Victorian Mallee (h)	12.7	
Tasmania (i)	0.0	
Victorian High Rainfall (j)	36.9	fh
WA Central (k)	40.5	fgh
WA Eastern (l)	26.7	
WA Mallee/Sandplain (m)	54.0	fgh
WA Northern (n)	44.0	fh
National average	30.5	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

**FIGURE 95** Average percentage of oilseed crop area soil tested in 2014.



The data suggests further investigation would be valuable.

Further discussion of these observations is presented below following the data for the individual crops and the amount of soil testing done for them.

Growers who responded in 2014 were asked about how much of their various cropped areas (i.e. area of cereals, pulses, oilseeds, etc) were soil tested in advance of sowing in 2014.

#### Average percentage of winter cereal crop area soil tested

The data for the proportion of the winter cereal crop that was soil tested in 2014 is presented below (Table 69, Figure 91 and Figure 92).

This data suggests that about 25% to 35% of the area sown to winter cereals nationally was soil tested. Higher proportions were evident in parts of Queensland, and WA, with lower proportions tested in SA and Victoria.

#### Average percentage of pulse crop area soil tested

The data for the proportion of pulse crop area soil tested in 2014 is presented in Table 70, Figure 93 and Figure 94.

This data suggests that the proportion of the pulse crop where soil was tested is variable, from below 10% in much of SA and Victoria to over 20% of the pulse crop area in parts of WA and north-west NSW/south-west Queensland.

#### Average percentage of oilseed crop area soil tested

The data for the proportion of the oilseed crop that was soil tested in 2014 is presented below in Table 71, Figure 95 and Figure 96.

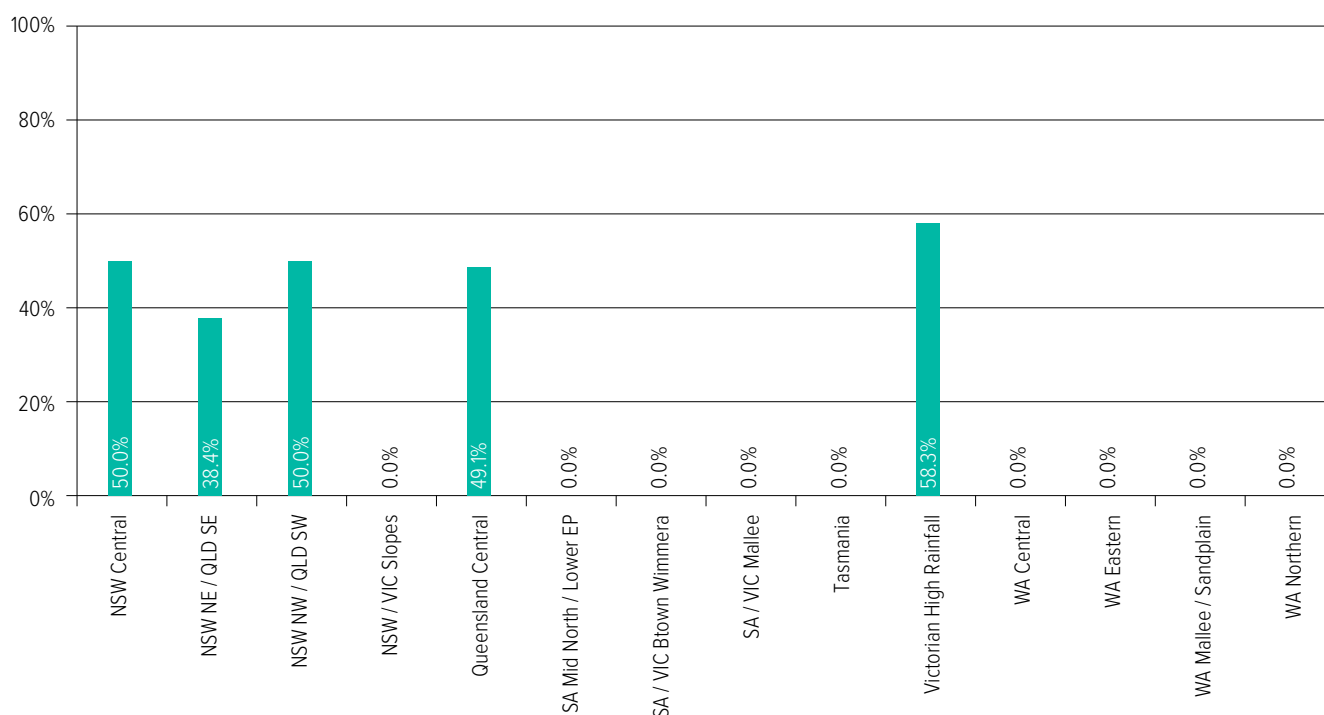
This data suggests that nationally 30% of the oilseed crop

**TABLE 72** Average percentage of most recent sorghum crop area soil tested before planting in 2014.

Agro-ecological zone	2014
NSW Central (a)	50.0
NSW NE / Queensland SE (b)	38.4
NSW NW / Queensland SW (c)	50.0
NSW / Victorian Slopes (d)	
Queensland Central (e)	49.1
SA Mid North / Lower EP (f)	
SA / VIC Bordertown, Wimmera (g)	
SA / Victorian Mallee (h)	
Tasmania (i)	
Victorian High Rainfall (j)	58.3*
WA Central (k)	
WA Eastern (l)	
WA Mallee/Sandplain (m)	
WA Northern (n)	
National average	

\*Based on 3 mixed farms

**FIGURE 97** Average percentage of sorghum crop area soil tested before sowing in 2014.



area was soil tested, with this varying from below 15% of the oilseed area in parts of SA (Mid North, Lower EP), Victorian Mallee, and more than 40% in north-east NSW /south-east Queensland and much of WA.

It is possible that much of this area is being sown with

canola, and given that canola tends to require higher inputs of nutrients than some other crops, testing of these areas to assist with planning the fertiliser strategy would be understandable.

**TABLE 73** Average percentage of cropped area soil tested only to a depth of 10cm in 2014.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	33.6	befh
NSW NE / Queensland SE (b)	9.8	
NSW NW / Queensland SW (c)	27.4	
NSW / Victorian Slopes (d)	32.9	befh
Queensland Central (e)	11.3	
SA Mid North / Lower EP (f)	17.6	
SA / VIC Bordertown, Wimmera (g)	34.5	befh
SA / Victorian Mallee (h)	17.5	
Tasmania (i)	77.8	bdefhjn
Victorian High Rainfall (j)	32.0	bfh
WA Central (k)	44.4	bdefhn
WA Eastern (l)	39.7	befh
WA Mallee/Sandplain (m)	57.2	abcdefgjhjn
WA Northern (n)	24.5	
National average	32.9	

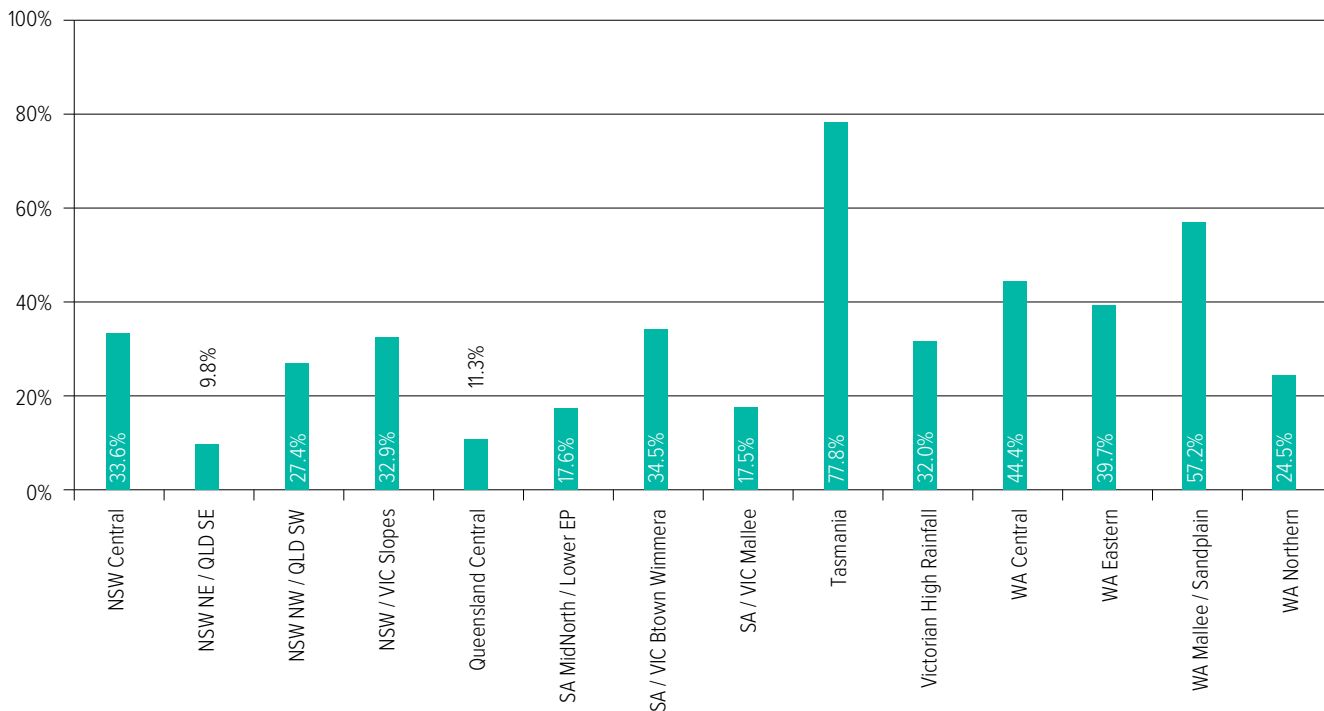
Note: Statistically significant differences (P<0.05) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

**TABLE 74** Average percentage of cropped area having deep soil test in the past 5 years.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	11.6	
NSW NE / Queensland SE (b)	31.6	acdfghjklm
NSW NW / Queensland SW (c)	16.8	g
NSW / Victorian Slopes (d)	12.8	fg
Queensland Central (e)	43.4	acdfghjklm
SA Mid North / Lower EP (f)	6.4	
SA / VIC Bordertown, Wimmera (g)	5.4	
SA / Victorian Mallee (h)	12.1	g
Tasmania (i)	8.5	
Victorian High Rainfall (j)	7.0	
WA Central (k)	9.7	
WA Eastern (l)	9.3	
WA Mallee/Sandplain (m)	13.5	
WA Northern (n)	32.4	adefghjklm
National average	15.8	

Note: Statistically significant differences (P<0.05) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

**FIGURE 98** Average percentage of crop area soil tested to 10cm depth in 2014.



**Average percentage of sorghum crop area soil tested**

The data for the proportion of the sorghum crop that was soil tested in 2014 is presented in Table 72 and Figure 97).

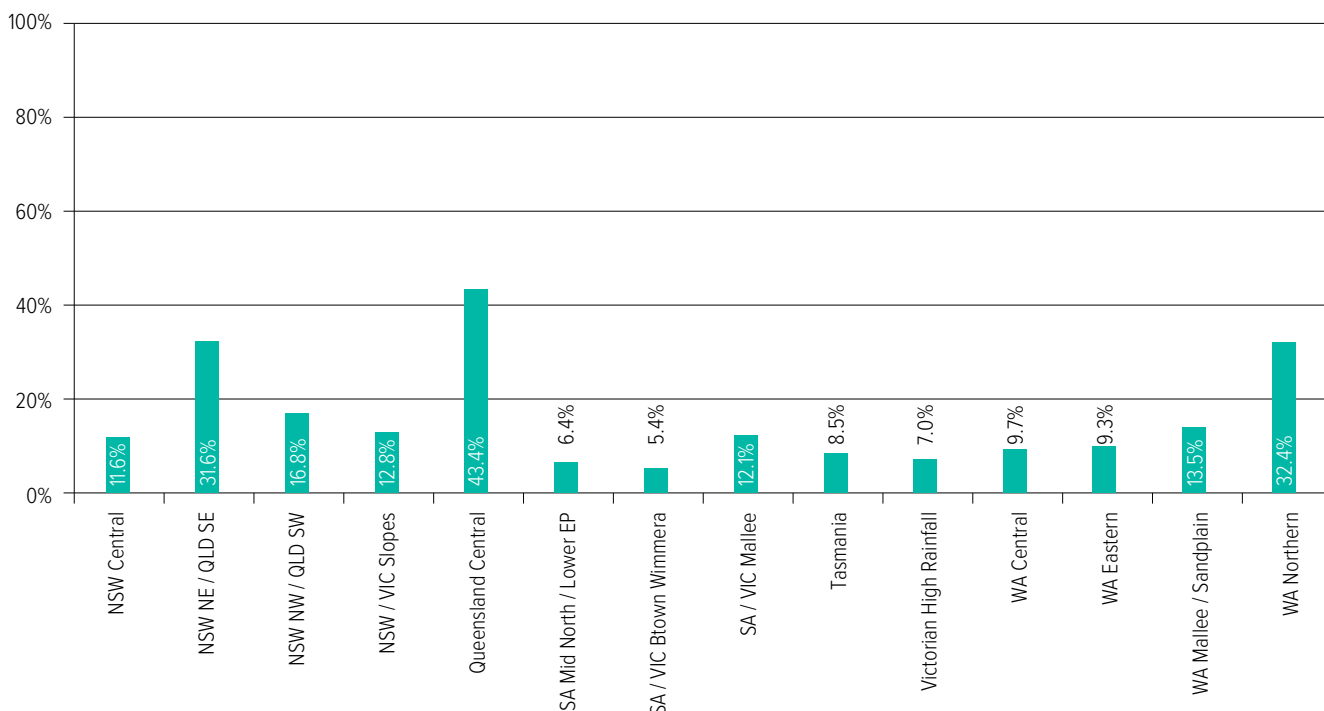
Sorghum is primarily only grown in the northern region, and parts of the higher rainfall areas of the south. Where it is grown it appears that around half of the area is soil tested in advance of sowing.

**Average percentage of cropped area soil tested only to 10cm deep in 2014**

Survey respondents in 2014 reported that on average about one-third of their cropped area was soil tested to 10cm.

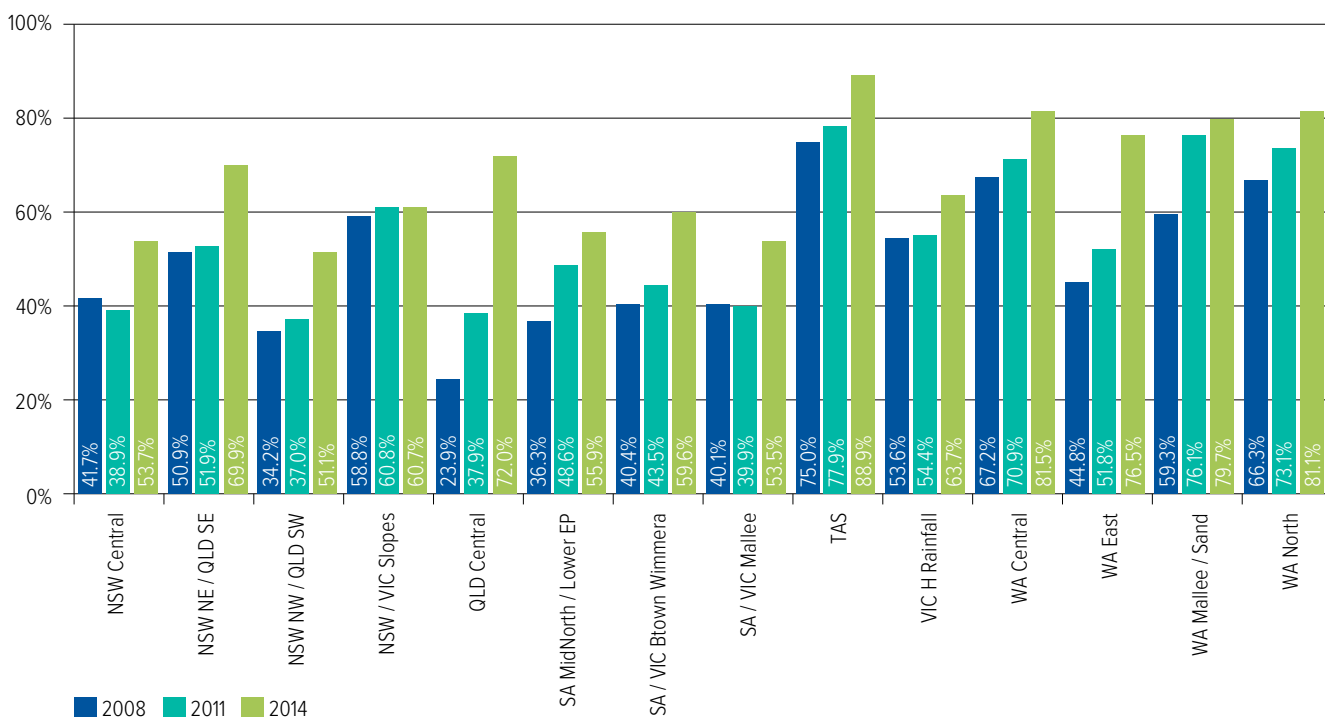
These data in a general sense align with the data for soil testing per se (as reported above, see Table 68), averaging almost 30% of the cropped area. However that data show a decline as compared with the earlier surveys.

**FIGURE 99** Average percentage of crop area receiving a deep soil tested in the past 5 years.



**FIGURE 100** Average percentage of crop area where the fertiliser program was informed by soil testing.

Percentage (%)



**Average percentage of cropped area having a deep soil test in the past 5 years**

Survey respondents in 2014 were also asked how much of their cropped area received a deep soil test (generally to 60cm) in the past 5 years.

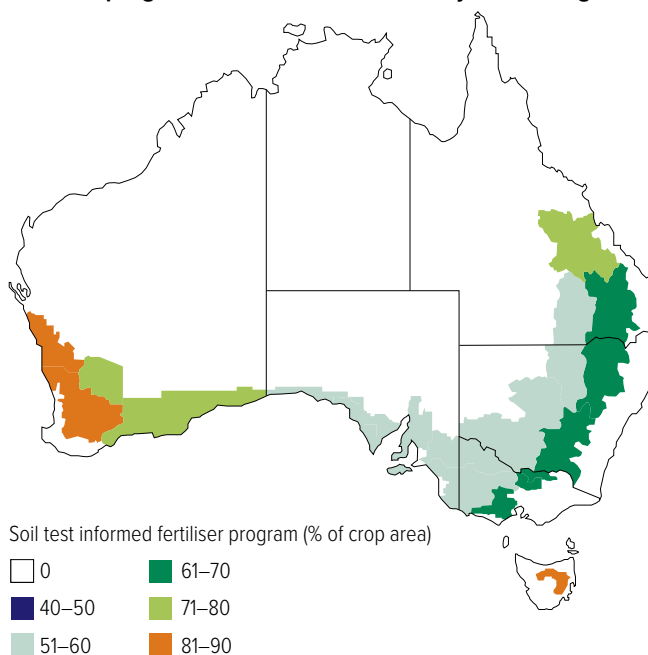
The data is shown in Table 74 and Figure 99, and suggests that just over 15% of the cropped area is deep soil tested across a five-year period, with this being higher in

the northern region (Central Queensland, north-east NSW/ south-east Queensland, NSW Central as well as northern WA). Deep soil testing is generally useful for estimating nitrogen levels through the soil profile, and this may be more valuable in deeper soils (often found in central and northern NSW and Queensland).

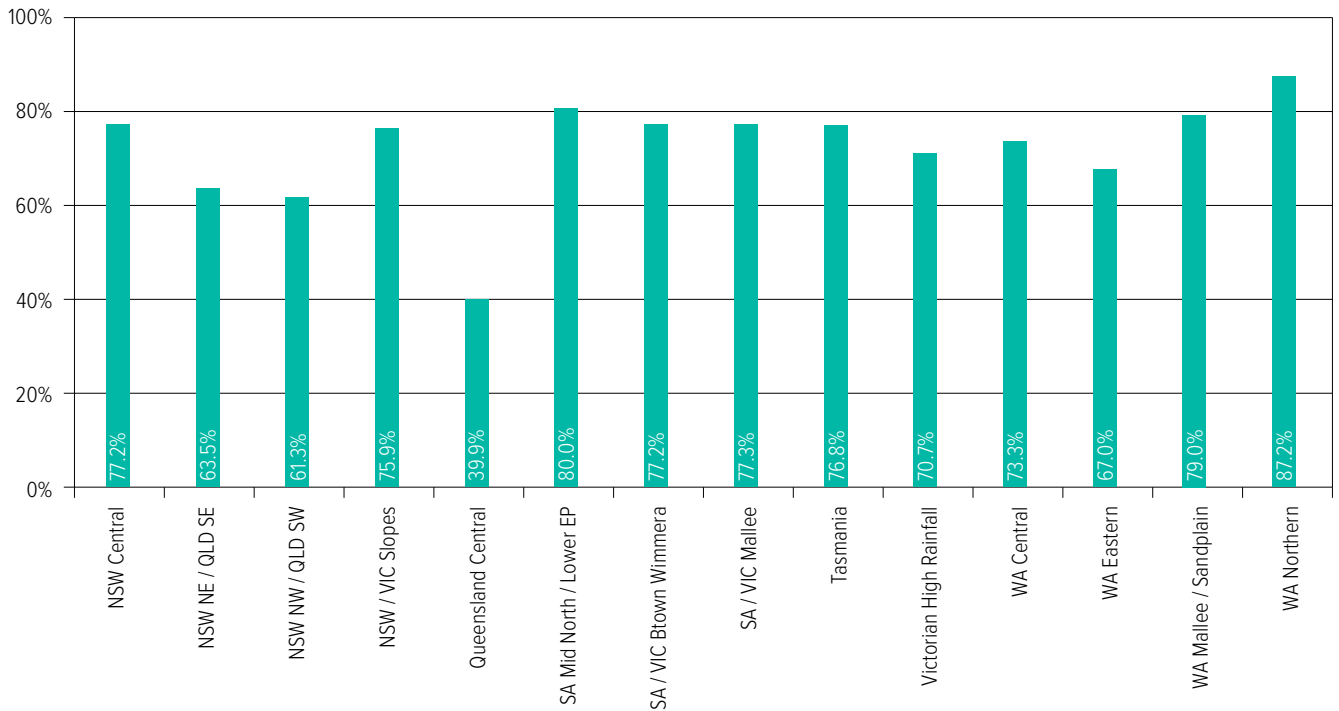
**TABLE 75** Average percentage of crop area where the fertiliser program was informed by soil testing.

Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	41.7	38.9	53.7		
NSW NE / Queensland SE	50.9	51.9	69.9	**	***
NSW NW / Queensland SW	34.2	37.0	51.1		
NSW / Victorian Slopes	58.8	60.8	60.7		
Queensland Central	23.9	37.9	72.0	***	***
SA Mid North / Lower EP	36.3	48.6	55.9		**
SA / VIC Bordertown Wimmera	40.4	43.5	59.6	**	***
SA / Victorian Mallee	40.1	39.9	53.5	**	**
Tasmania	75.0	77.9	88.9		
Victorian High Rainfall	53.6	54.4	63.7		
WA Central	67.2	70.9	81.5	**	***
WA Eastern	44.8	51.8	76.5	***	***
WA Mallee / Sandplain	59.3	76.1	79.7		**
WA Northern	66.3	73.1	81.1		
National averages	49.5	54.5	67.7		

**FIGURE 101** Average percentage of crop area where the fertiliser program in 2014 was informed by soil testing.



**FIGURE 102** Average percentage of crop area where fertiliser rates applied were based on estimates of nutrient removal by the crop in 2014.



Average percentage of crop area where the fertiliser program in 2014 was informed by soil testing. Grower respondents in 2014 were asked about how much of their fertiliser program had been informed by soil testing. The data are shown in Table 75, Figure 100 and Figure 101.

There appears to be a healthy amount of the cropping area where the fertiliser program was informed by soil testing in 2014, averaging two-thirds of the crop area nationally, and with significant increases over the previous survey in NSW NE/Queensland SE, Central Queensland,

**TABLE 76** Average percentage of crop area treated with fertiliser in 2014 at rates based on estimates of nutrient removal rates by the crop.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	77.2	e
NSW NE / Queensland SE (b)	63.5	
NSW NW / Queensland SW (c)	61.3	
NSW / Victorian Slopes (d)	75.9	e
Queensland Central (e)	39.9	
SA Mid North / Lower EP (f)	80.0	e
SA / VIC Bordertown, Wimmera (g)	77.2	e
SA / Victorian Mallee (h)	77.3	e
Tasmania (i)	76.8	
Victorian High Rainfall (j)	70.7	
WA Central (k)	73.3	
WA Eastern (l)	67.0	
WA Mallee/Sandplain (m)	79.0	e
WA Northern (n)	87.2	be
National average	71.9	

Note: Statistically significant differences (P<0.05) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

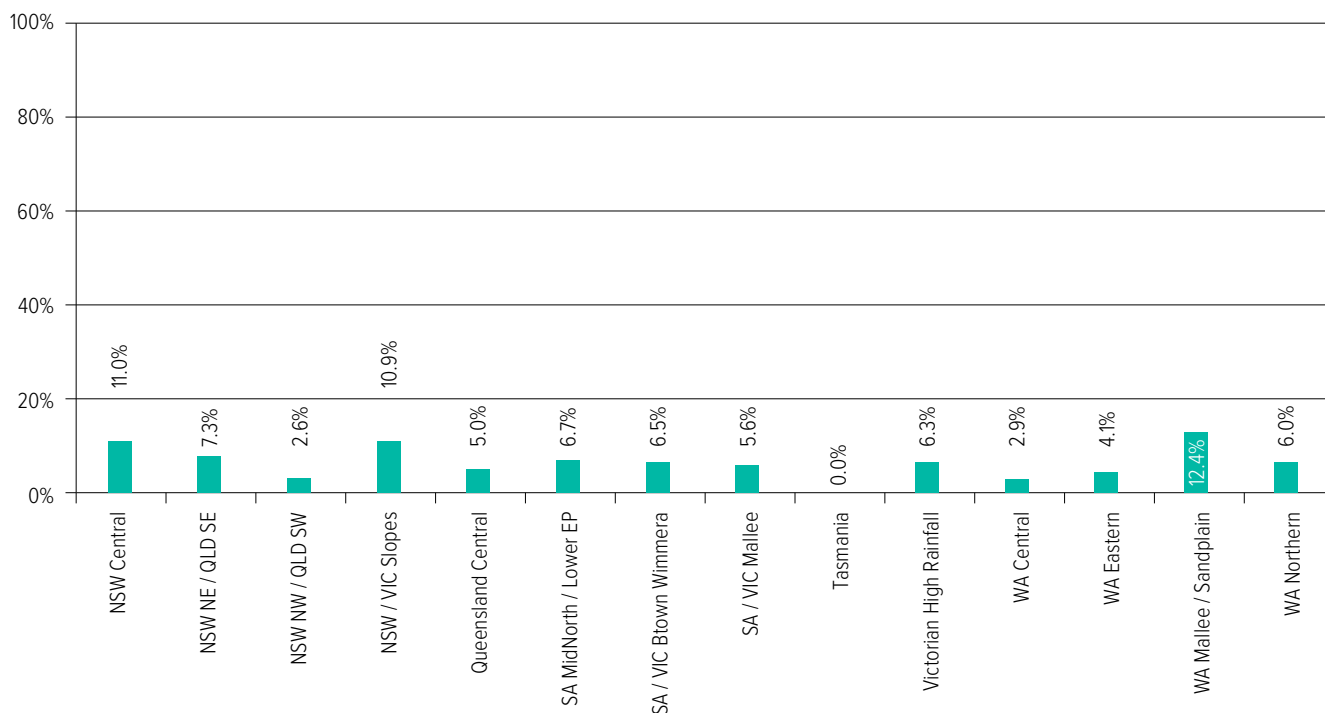
**TABLE 77** Average percentage of crop area having an in-season soil test in 2014.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	11.0	
NSW NE / Queensland SE (b)	7.3	
NSW NW / Queensland SW (c)	2.6	
NSW / Victorian Slopes (d)	10.9	
Queensland Central (e)	5.0	
SA Mid North / Lower EP (f)	6.7	
SA / VIC Bordertown, Wimmera (g)	6.5	
SA / Victorian Mallee (h)	5.6	
Tasmania (i)	0.0	
Victorian High Rainfall (j)	6.3	
WA Central (k)	2.9	
WA Eastern (l)	4.1	
WA Mallee/Sandplain (m)	12.4	
WA Northern (n)	6.0	
National average	6.2	

Note: Statistically significant differences (P<0.05) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.



**FIGURE 103** Average percentage of crop area having an in-season soil test in 2014.



much of SA and Victoria and WA.

One observation is that this data are considerably higher than that for the use of soil testing per se (see Table 68), where barely 30% of the cropped area was reported to have been soil tested in 2014. It is possible that while

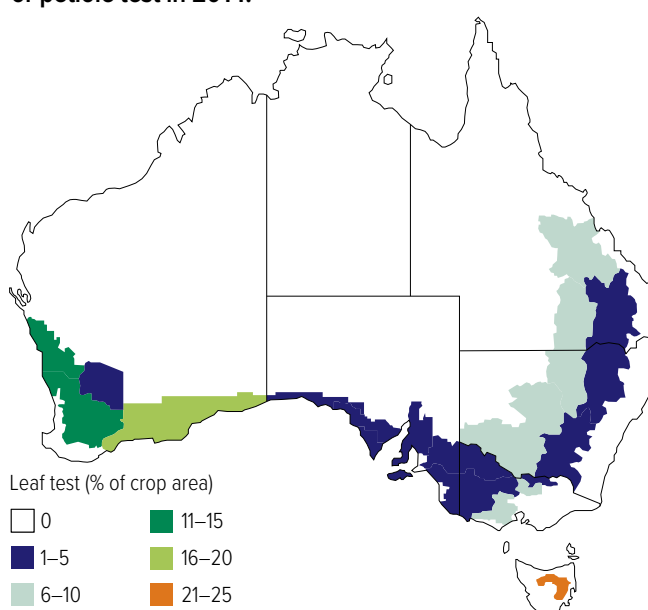
growers report that a considerable proportion of their crop had a fertiliser program informed by soil testing that this may not be soil testing carried out in this year, and could be by referring to previous soil tests, in conjunction with knowledge of crop performance since that test.

**TABLE 78** Average percentage of crop area having a leaf or petiole test in 2014.

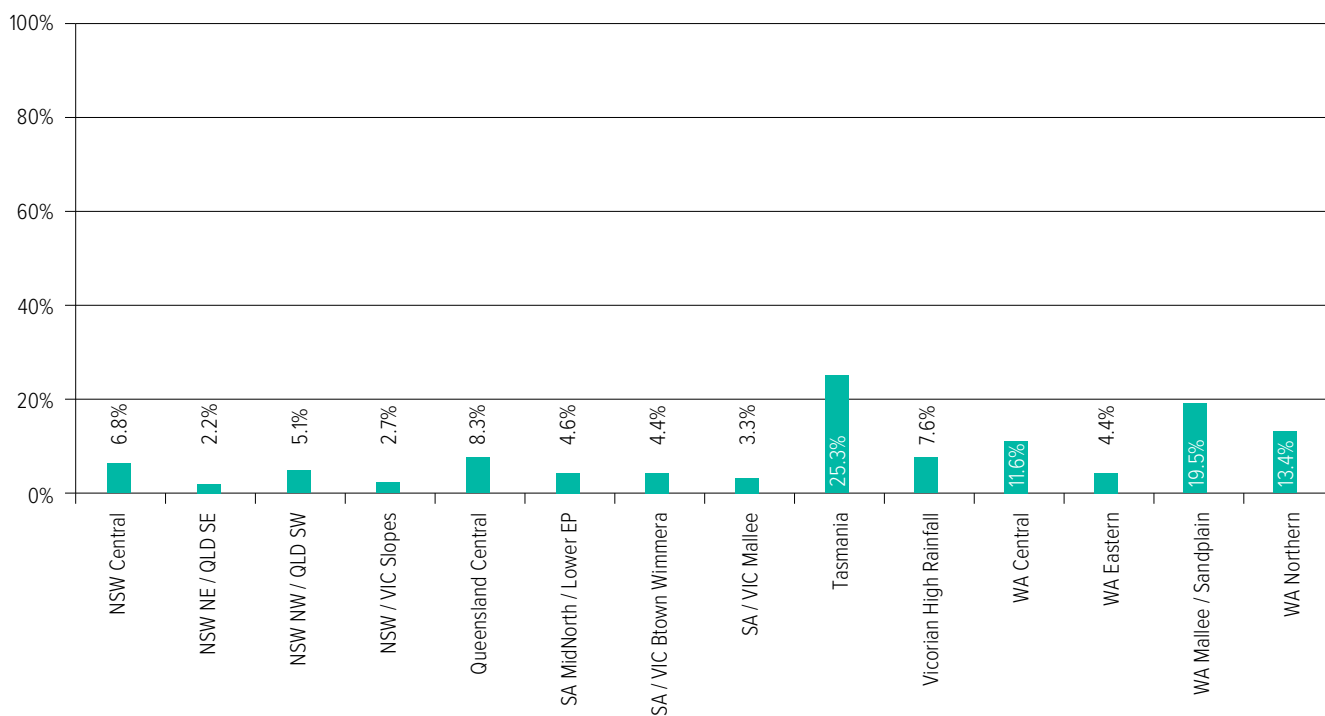
Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	6.8	
NSW NE / Queensland SE (b)	2.2	
NSW NW / Queensland SW (c)	5.1	
NSW / Victorian Slopes (d)	2.7	
Queensland Central (e)	8.3	
SA Mid North / Lower EP (f)	4.6	
SA / VIC Bordertown, Wimmera (g)	4.4	
SA / Victorian Mallee (h)	3.3	
Tasmania (i)	25.3	bdfghi
Victorian High Rainfall (j)	7.6	
WA Central (k)	11.6	bdfghi
WA Eastern (l)	4.4	
WA Mallee/Sandplain (m)	19.5	bcdgfh
WA Northern (n)	13.4	bd
National average	8.5	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

**FIGURE 105** Average percentage of crop area having a leaf or petiole test in 2014.



**FIGURE 104** Average percentage of crop area having a leaf or petiole test in 2014.



**TABLE 79** Average percentage of crop area having an in-season application or top dressing of fertiliser in 2014.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	44.5	bce
NSW NE / Queensland SE (b)	19.2	
NSW NW / Queensland SW (c)	21.6	
NSW / Victorian Slopes (d)	57.9	abcehi
Queensland Central (e)	18.1	
SA Mid North / Lower EP (f)	61.8	abceghl
SA / VIC Bordertown, Wimmera (g)	48.5	bceh
SA / Victorian Mallee (h)	38.2	bce
Tasmania (i)	70.3	bcehl
Victorian High Rainfall (j)	63.7	abceghl
WA Central (k)	76.2	abcdefghijn
WA Eastern (l)	34.9	b
WA Mallee/Sandplain (m)	70.1	abceghl
WA Northern (n)	57.3	bcehl
National average	48.7	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

In any case, there appears to be evidence that growers are using soil tests (whenever these are carried out) to assist with their fertiliser program.

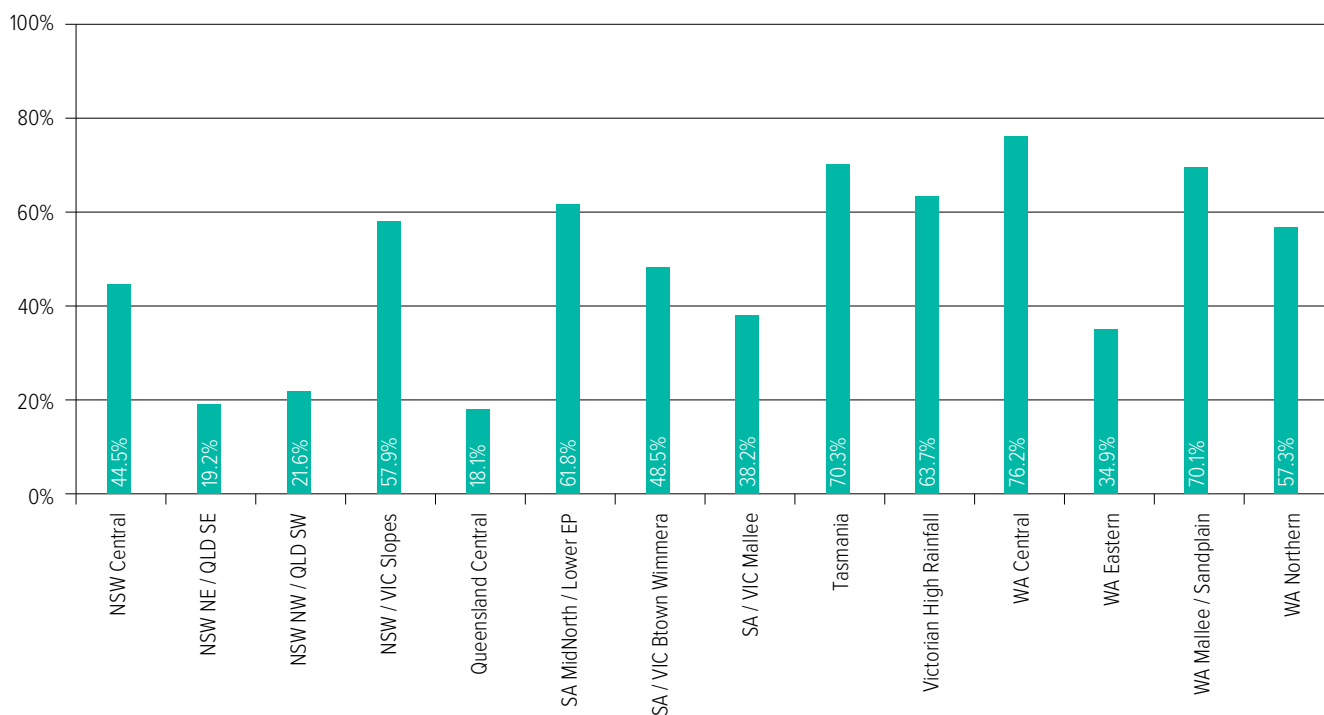
#### Average percentage of crop area where fertiliser rates applied in 2014 were based on estimates of nutrient removal by the crop

Growers were asked what proportion of their cropped area in 2014 had a fertiliser program informed by estimates of nutrient removal rates by the crop (generally the crop in 2013, with estimates of crop needs in 2014).

The data is shown in Table 76 and Figure 102, and suggests that a relatively high proportion of the crop has fertiliser usage informed by estimates of nutrient removal from the current and previous crops, averaging almost 72% nationally, and higher in some AEZs (e.g. much of SA and WA).

When considered in conjunction with the previous data set (i.e. where the fertiliser program was reported as being informed by soil test data), it is possible that growers are making calculations about their fertiliser program based on a combination of soil tests (even if done in the past) in combination with estimates of nutrient removal by crop performance leading up to this year, perhaps with estimates for nutrition needs for the next crop. If so, this indicates a strong adoption of the practice of using various tools and calculations to determine fertiliser needs, including soil testing, and estimates of nutrient needs based on historic and expected crop performance.

**FIGURE 106** Average percentage of crop area having an in-season or top dressed application of fertiliser in 2014



This may assist with explaining the decline in the crop area reported as being soil tested in 2014, whereby growers may be using soil test results from previous tests, and also estimating nutrient needs based on crop performance, in place of a sole reliance on soil testing in the crop year.

#### Average percentage of crop area having an in-season soil test in 2014

Some growers undertake soil testing during the season in the interests of informing their in-season fertiliser program. The data from the 2014 survey is presented in Table 77 and Figure 103, and suggests that less than 10% of the cropped area is soil tested in-season. When it comes to determining the in-season fertiliser needs many growers consider soil moisture levels at least as much as soil nutrient status, which may help explain the data reported here.

#### Average percentage of crop area having a leaf or petiole test in 2014

Other tools available for growers to use in assessing the need for in-season fertiliser applications are leaf and/or petiole testing, which can assist by providing data about plant nutrient levels from testing plant sap from leaves or petioles. The data for the proportion of the crop area using these tools in 2014 is presented in Table 78, Figure 104 and Figure 105, and suggests that these tools are used nationally on less than 10% of the cropped area, although it is higher as reported in much of WA.

#### Average percentage of crop area receiving an in-season application (top-dressing) of fertiliser in 2014

Survey respondents were asked how much of their crop program in 2014 received an in-season, or top-dressing, application of fertiliser. The data is shown in Table 79 and Figure 106. Nationally almost half of the cropped area is reported to have received an in-season application of fertiliser in 2014, with lower rates applied in the northern region, and higher rates in the central NSW and the NSW/Victorian Slopes, Victorian High Rainfall areas, parts of SA and much of WA.

There is likely some relationship between seasonal conditions (principally rainfall/soil moisture levels) and in-season fertiliser applications that would be a significant factor in growers choosing to apply top-dressing fertiliser, with the data suggesting this may be a stronger influencer on fertiliser use than in-season soil or plant testing.



# SOIL MOISTURE MANAGEMENT

PHOTO: STEPHEN DAVIES

Soil moisture is often the greatest limiting factor for crop production in Australia. Soil moisture levels are an obvious determinant of how well crops can germinate, establish and grow, and from a management viewpoint, how well crops can respond to additional inputs or management, for example fertiliser, weed and disease control measures.

Two questions were asked in 2014 regarding the assessment of soil moisture, at planting and through the crop's life:

- What area of your crop did you assess soil moisture at planting?
- What area of your crop did you measure or assess soil moisture through the season?

## Assessment of soil moisture at planting to assist in crop decisions

Knowing the level of soil moisture when planning or carrying out management decisions is seen as an important element in a cropping program, both at planting and through the period of the crop.

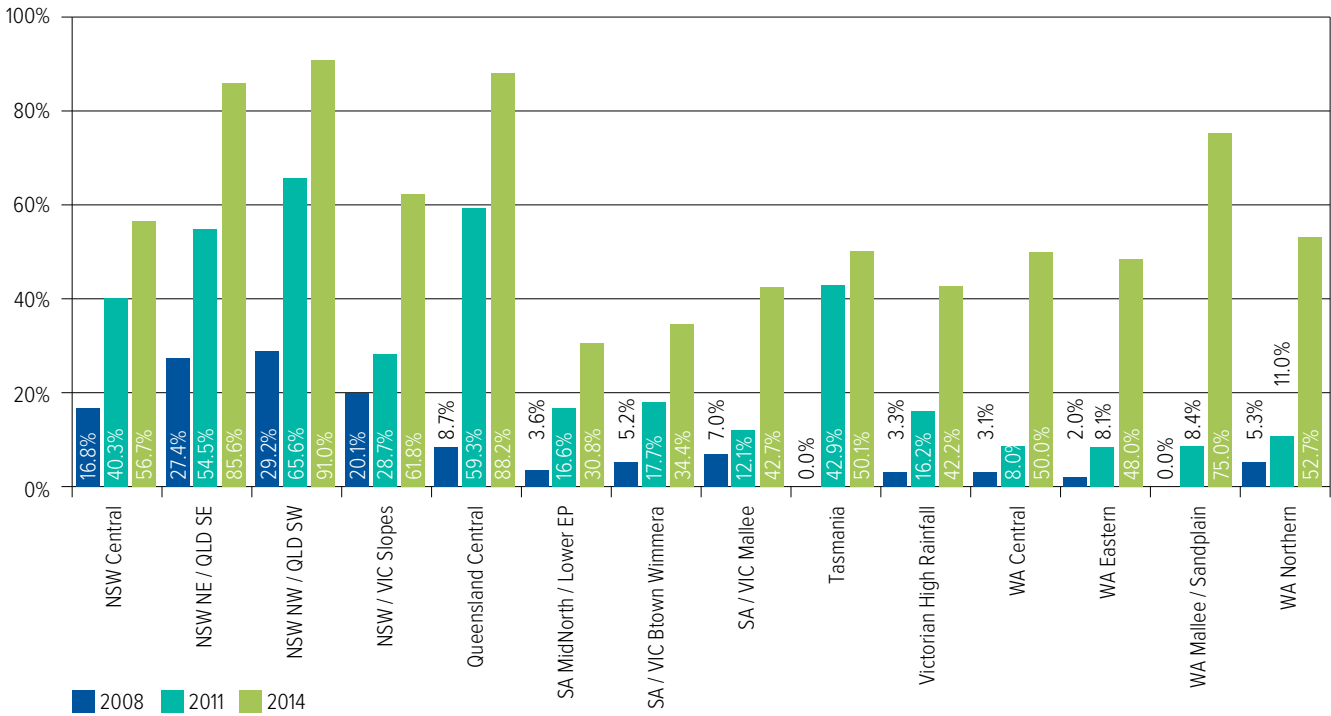
Assessing soil moisture at planting was more highly practiced in New South Wales and southern Queensland than elsewhere in previous surveys. This trend remains, although this practice is now more common in crop production in most AEZs.

There has been a significant increase in growers measuring plant available moisture at planting since 2008 and this has continued through 2011 and 2014 (see Table 80 and Figure 107 and Figure 108).

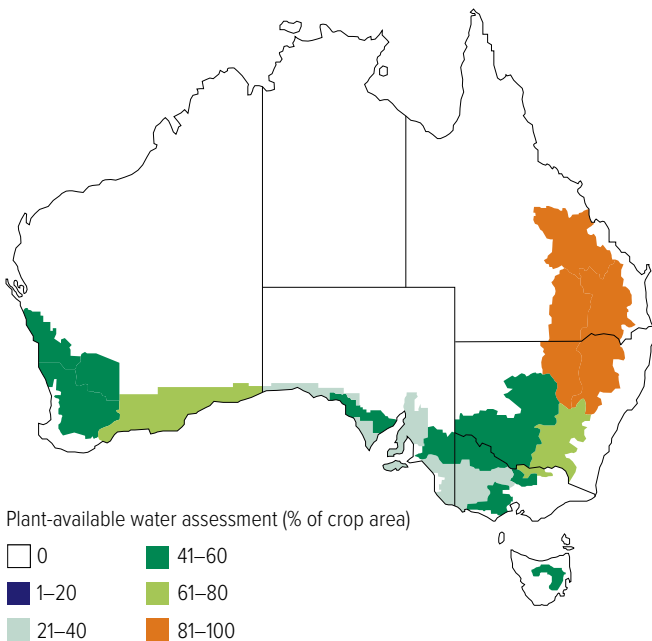
**TABLE 80** Average percentage of crop area where plant-available water was assessed at planting.

Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	16.8	40.3	56.7	**	***
NSW NE / Queensland SE	27.4	54.5	85.6	***	***
NSW NW / Queensland SW	29.2	65.6	91.0	***	***
NSW / Victorian Slopes	20.1	28.7	61.8	***	***
Queensland Central	8.7	59.3	88.2	***	***
SA Mid North / Lower EP	3.6	16.6	30.8	***	***
SA / VIC Bordertown Wimmera	5.2	17.7	34.4	***	***
SA / Victorian Mallee	7.0	12.1	42.7	***	***
Tasmania	0.0	42.9	50.1		
Victorian High Rainfall	3.3	16.2	42.2	***	***
WA Central	3.1	8.0	50.0	***	***
WA Eastern	2.0	8.1	48.0	***	***
WA Mallee / Sandplain	0.0	8.4	75.0	***	***
WA Northern	5.3	11.0	52.7	***	***
<b>National averages</b>	<b>9.4</b>	<b>27.8</b>	<b>57.8</b>	<b>***</b>	<b>***</b>

**FIGURE 107** Percentage of crop area where plant-available water was assessed at planting in 2008, 2011 and 2014.



**FIGURE 108** Percentage of crop area where plant-available water was assessed at planting in 2014.

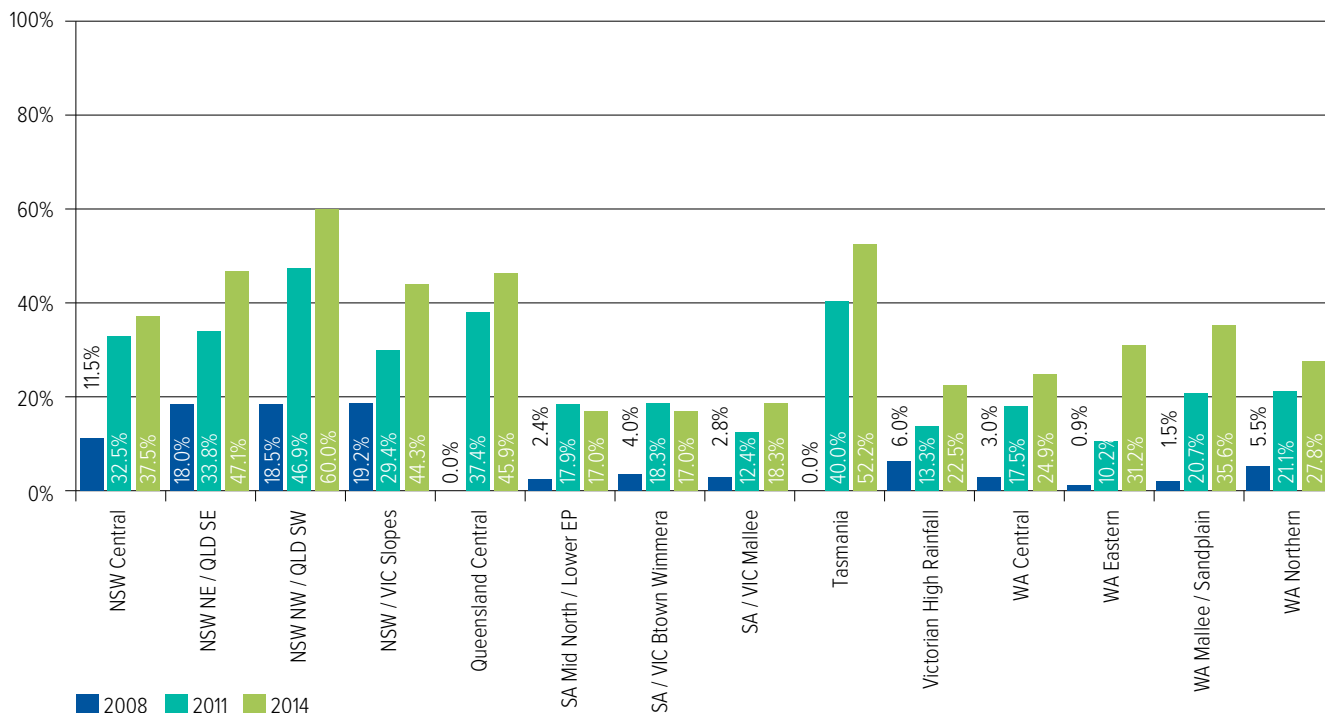


### Proportion of crop where plant-available water was assessed through the crop period

The practice of assessing soil moisture through the cropping season is one that can assist with strategic decision-making, including the application of in-crop fertilisers (for example, nitrogen, refer to the section on fertiliser use, notably the data on in-crop fertiliser applications) and some pesticide or herbicide applications. In partnership with knowledge of soil moisture at planting, this can assist with these and other crop management practices and gives producers confidence for some strategic marketing decisions.

The proportion of the crop where soil moisture is being assessed throughout the cropping season has increased substantially since the previous surveys in all AEZs (Table 81, Figure 109 and Figure 110).

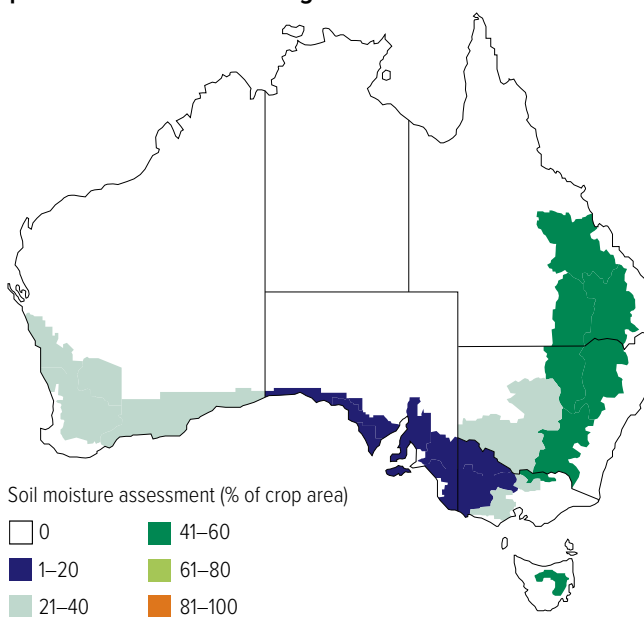
**FIGURE 109** Percentage of crop area where plant-available water was assessed through the crop period in 2008, 2011 and 2014.



**TABLE 81** Average percentage of crop area where soil moisture measured or assessed through the season.

Agro-ecological zone	Average % of crop area			Significant difference between years	
	2008	2011	2014	2011 to 2014	2008 to 2014
NSW Central	11.5	32.5	37.5		***
NSW NE / Queensland SE	18.0	33.8	47.1	**	***
NSW NW / Queensland SW	18.5	46.9	60.0		***
NSW / Victorian Slopes	19.2	29.4	44.3	***	***
Queensland Central	0.0	37.4	45.9		***
SA Mid North / Lower EP	2.4	17.9	17.0		***
SA / VIC Bordertown Wimmera	4.0	18.3	17.0		***
SA / Victorian Mallee	2.8	12.4	18.3		***
Tasmania	0.0	40.0	52.2		**
Victorian High Rainfall	6.0	13.3	22.5		***
WA Central	3.0	17.5	24.9		***
WA Eastern	0.9	10.2	31.2	***	***
WA Mallee / Sandplain	1.5	20.7	35.6		***
WA Northern	5.5	21.1	27.8		***
National averages	6.7	25.1	34.4		***

**FIGURE 110** Percentage of crop area assessing plant-available water during the season in 2014.





# MISCELLANEOUS QUESTIONS IN 2014



PHOTO: EVAN COLLIS

Several questions were included in the 2014 survey that are of a miscellaneous nature.

These include:

- how many tonnes of grain can you store on-farm;
- what area of your farm has been tested for soil nematodes in the last five years;
- what area of your farm do you have where you know you have herbicide-resistant weeds;
- what area of your fallow have you used the 'double-knock' herbicide technique for the management of weeds;
- and what area have you used the double-knock technique where tillage was the second knock used in the fallow period;
- area where you have used non-herbicide techniques to help the management of herbicide-resistant weeds, for example, tillage or grazing, or the use of harvest weed-seed control techniques;
- on what area of your fallow have used residual herbicides;
- what's your best estimate of the area of your crop where you've used Group A herbicides;
- what's your best estimate of the area of your crop where you've used Group B herbicides; and
- are you using some kind of Quality Assurance or Environmental Assurance program that assists in market access or price?

## Average grain storage capacity on farms in 2014

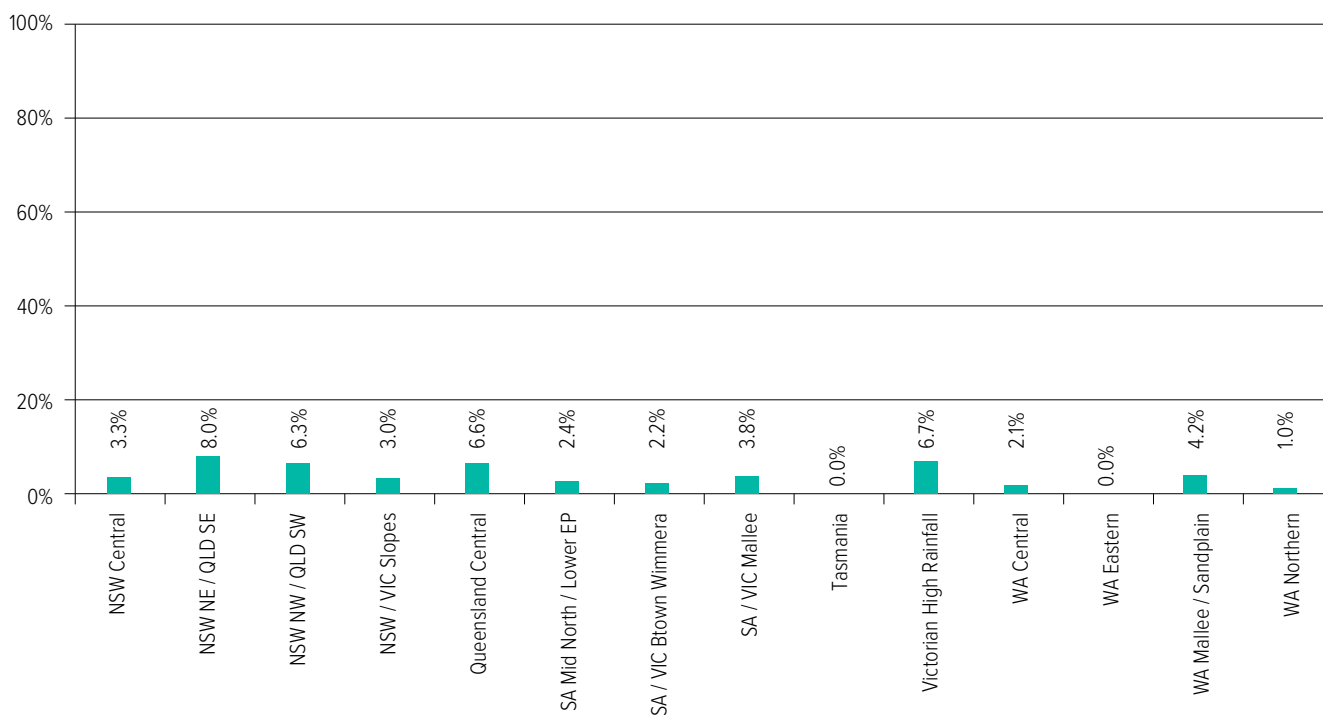
The data for tonnes of grain able to be stored on-farm as reported by growers in the 2014 survey is shown in Table 82. No significant differences were evident in the data.

**TABLE 82** Average tonnes of grain that can be stored on-farm.

Agro-ecological zone	2008	2014	Significant difference between years
NSW Central	1457	1281	
NSW NE / Queensland SE	1411	2100	
NSW NW / Queensland SW	1372	1639	
NSW / Victorian Slopes	1353	1702	
Queensland Central	1498	862	
SA Mid North / Lower EP	363	419	
SA / VIC Bordertown Wimmera	5008	1264	
SA / Victorian Mallee	717	994	
Tasmania	488	269	
Victorian High Rainfall	1962	417	
WA Central	642	905	
WA Eastern	827	996	
WA Mallee / Sandplain	877	994	
WA Northern	960	715	
National averages	1353	1040	

No significant difference between years

**FIGURE 111** Average percentage of farm area tested for nematodes in the past 5 years.



**TABLE 83** Average percentage of farm area tested for nematodes in the past 5 years.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	3.3	
NSW NE / Queensland SE (b)	8.0	gkln
NSW NW / Queensland SW (c)	6.3	
NSW / Victorian Slopes (d)	3.0	
Queensland Central (e)	6.6	
SA Mid North / Lower EP (f)	2.4	
SA / VIC Bordertown, Wimmera (g)	2.2	l
SA / Victorian Mallee (h)	3.8	l
Tasmania (i)	0.0	
Victorian High Rainfall (j)	6.7	l
WA Central (k)	2.1	l
WA Eastern (l)	0.0	
WA Mallee/Sandplain (m)	4.2	
WA Northern (n)	1.0	
National average	3.5	

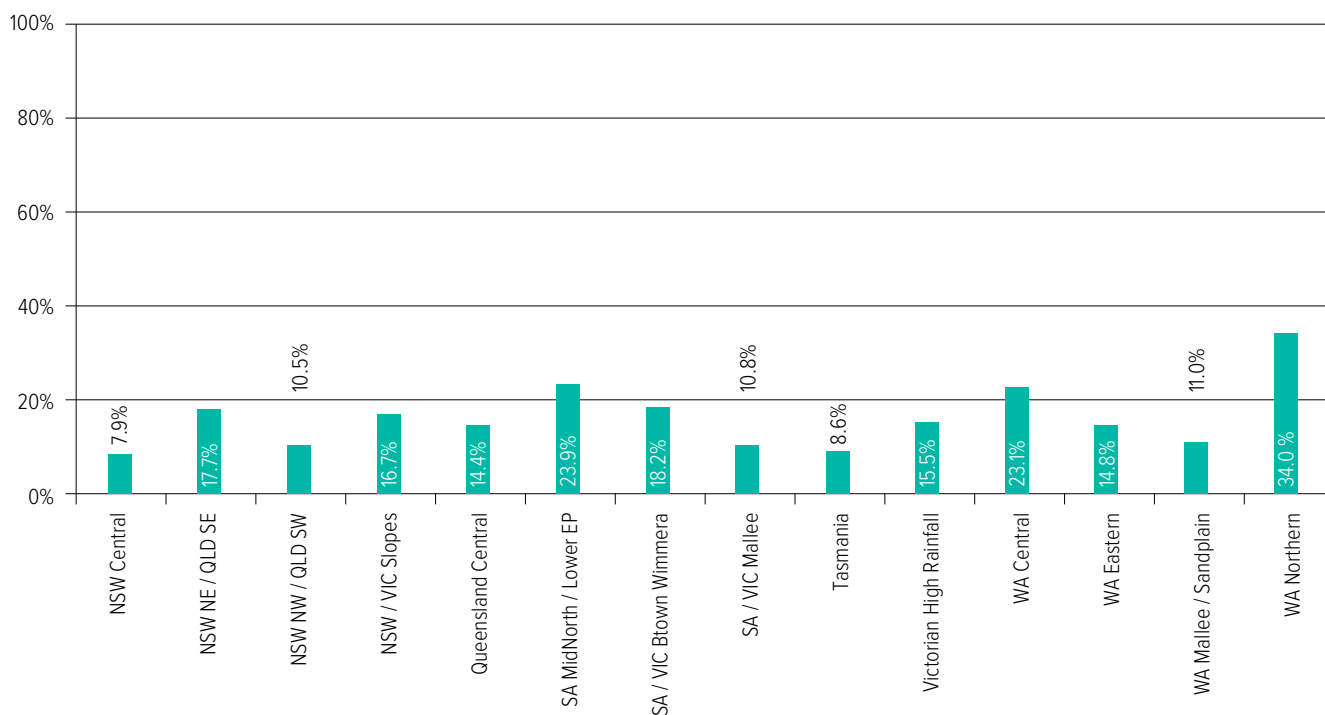
Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

**TABLE 84** Average percentage of farm area known to be affected by herbicide-resistant weeds.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	7.9	
NSW NE / Queensland SE (b)	17.7	a
NSW NW / Queensland SW (c)	10.5	
NSW / Victorian Slopes (d)	16.7	a
Queensland Central (e)	14.4	
SA Mid North / Lower EP (f)	23.9	ach
SA / VIC Bordertown, Wimmera (g)	18.2	a
SA / Victorian Mallee (h)	10.8	
Tasmania (i)	8.6	
Victorian High Rainfall (j)	15.5	
WA Central (k)	23.1	achm
WA Eastern (l)	14.8	
WA Mallee/Sandplain (m)	11.0	acdhljm
WA Northern (n)	34.0	
National average	16.2	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

**FIGURE 112** Average percentage of farm area known to be affected by herbicide-resistant weeds.



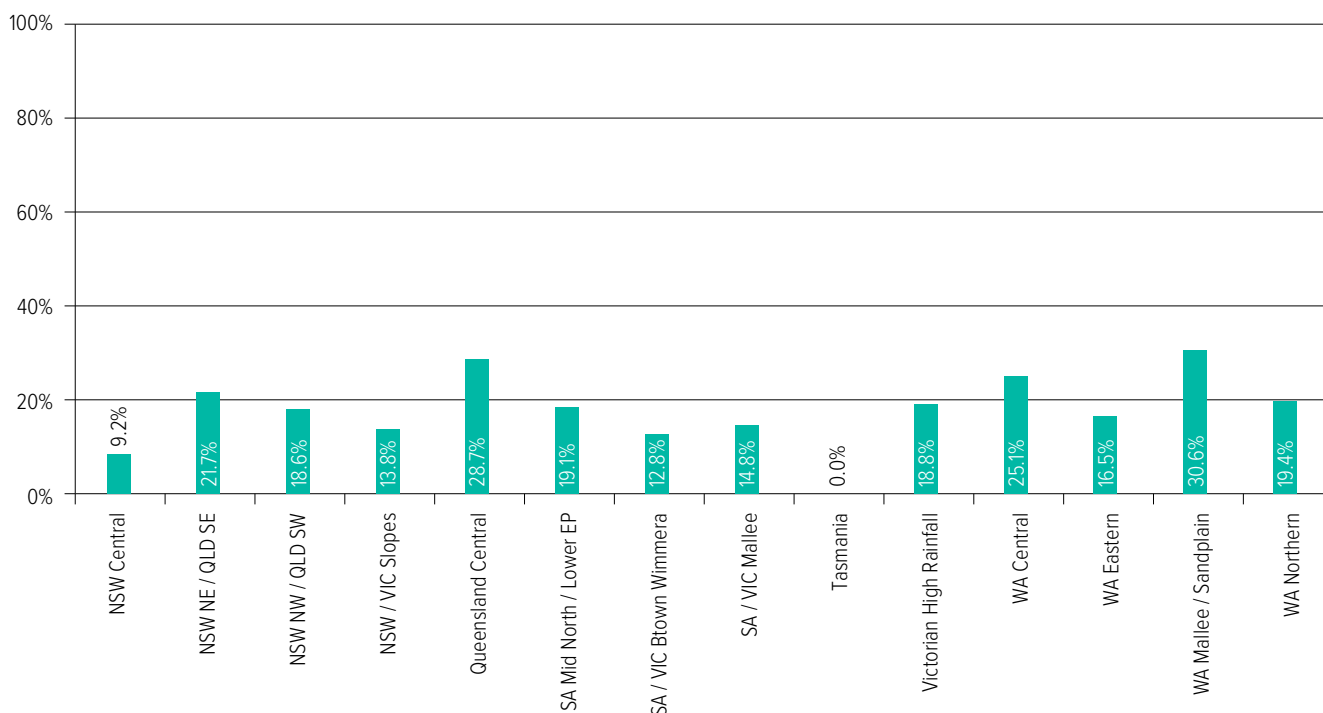
**TABLE 85** Average percentage of fallow area where the double-knock herbicide technique has been used.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	9.2	
NSW NE / Queensland SE (b)	21.7	
NSW NW / Queensland SW (c)	18.6	
NSW / Victorian Slopes (d)	13.8	
Queensland Central (e)	28.7	
SA Mid North / Lower EP (f)	19.1	
SA / VIC Bordertown, Wimmera (g)	12.8	
SA / Victorian Mallee (h)	14.8	
Tasmania (i)		
Victorian High Rainfall (j)	18.8	
WA Central (k)	25.1	
WA Eastern (l)	16.5	
WA Mallee/Sandplain (m)	30.6	
WA Northern (n)	19.4	
National average	19.2	

**TABLE 86** Average percentage of fallow area where tillage has been used as the second knock.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	8.6	
NSW NE / Queensland SE (b)	6.8	
NSW NW / Queensland SW (c)	9.6	
NSW / Victorian Slopes (d)	3.6	
Queensland Central (e)	20.2	
SA Mid North / Lower EP (f)	3.7	
SA / VIC Bordertown, Wimmera (g)	12.5	
SA / Victorian Mallee (h)	13.2	
Tasmania (i)		
Victorian High Rainfall (j)	13.5	
WA Central (k)	1.9	
WA Eastern (l)	4.5	
WA Mallee/Sandplain (m)	5.7	
WA Northern (n)	1.7	
National average	8.1	

**FIGURE 113** Average percentage of fallow area where the double-knock herbicide technique has been used.



**TABLE 87** Average percentage of farm area where non-herbicide techniques have been used to help management of herbicide-resistant weeds.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	31.7	
NSW NE / Queensland SE (b)	45.4	
NSW NW / Queensland SW (c)	26.5	
NSW / Victorian Slopes (d)	39.2	
Queensland Central (e)	26.7	
SA Mid North / Lower EP (f)	41.4	
SA / VIC Bordertown, Wimmera (g)	37.4	
SA / Victorian Mallee (h)	35.4	
Tasmania (i)	14.3	
Victorian High Rainfall (j)	30.5	
WA Central (k)	76.5	abcdgghjn
WA Eastern (l)	65.9	
WA Mallee/Sandplain (m)	74.1	
WA Northern (n)	37.3	
National average	41.6	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

### Average percentage of farm area tested for presence of nematodes in the past 5 years

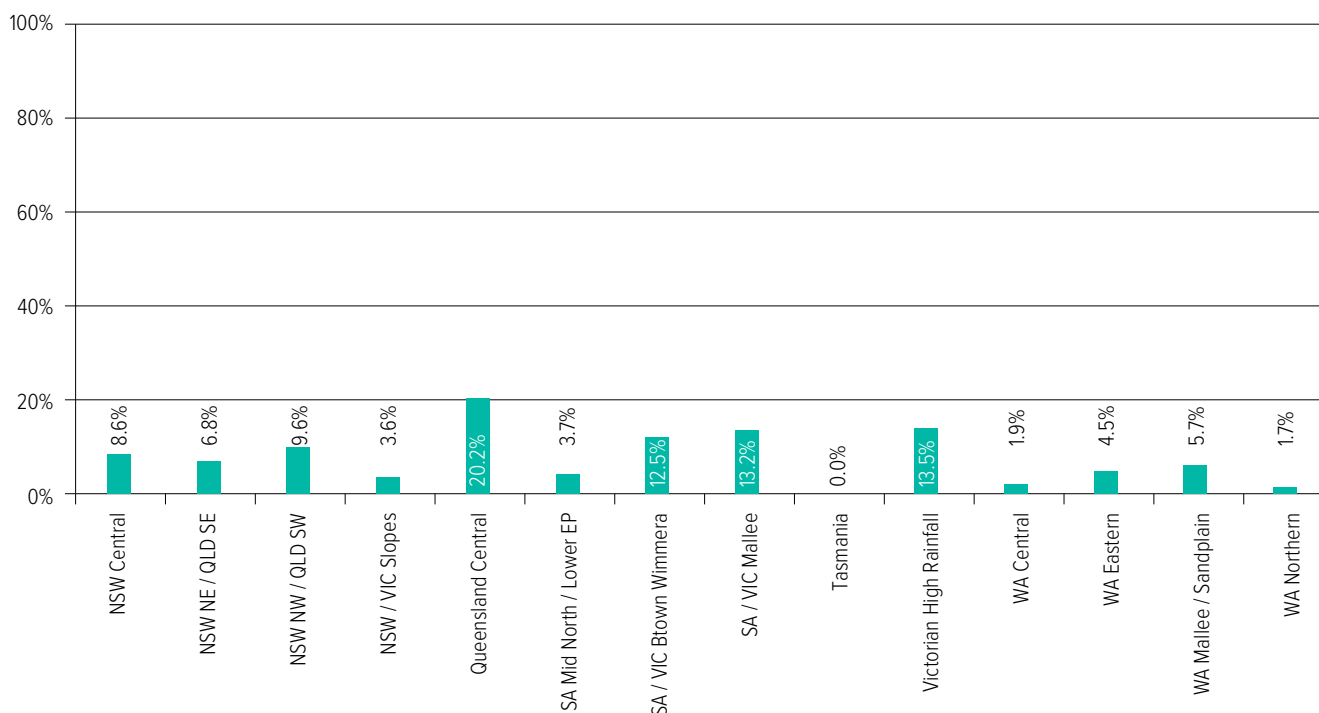
Soil-borne, parasitic nematodes can result in crop yield loss. DNA-based soil testing is available (for example PreDicta® B), and growers were asked how much of their crop area had they tested for nematodes over the past 5 years. The data is shown in Table 83 and Figure 111 and suggests a relatively minor proportion of the crop area had been tested for the presence of soil-borne nematodes in the past 5 years, apart from some area in northern NSW and Queensland, the high rainfall areas of Victoria and southern WA.

### Average percentage of farm area known to be affected by herbicide-resistant weeds

In the 2014 survey, respondents were asked what percentage of their farm was affected by herbicide-resistant weeds. The data is shown in Table 84 and Figure 112 and suggests that in some AEZs herbicide-resistant weeds are known to occupy more than 20% of the farm area (for example, parts of SA and central and northern WA).

Since a similar question was not asked in 2011 or 2008, it is not possible to estimate changes as compared with previous surveys.

**FIGURE 114** Average percentage of fallow area where the tillage has been used as the second knock.



**TABLE 88** Average percentage of fallow area where residual herbicides have been used.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	19.0	
NSW NE / Queensland SE (b)	31.7	gn
NSW NW / Queensland SW (c)	45.2	fgkn
NSW / Victorian Slopes (d)	17.9	n
Queensland Central (e)	55.9	n
SA Mid North / Lower EP (f)	13.8	
SA / VIC Bordertown, Wimmera (g)	11.6	
SA / Victorian Mallee (h)	22.0	n
Tasmania (i)		
Victorian High Rainfall (j)	27.5	
WA Central (k)	12.6	
WA Eastern (l)	27.8	
WA Mallee/Sandplain (m)	16.7	
WA Northern (n)	3.6	
National average	23.5	

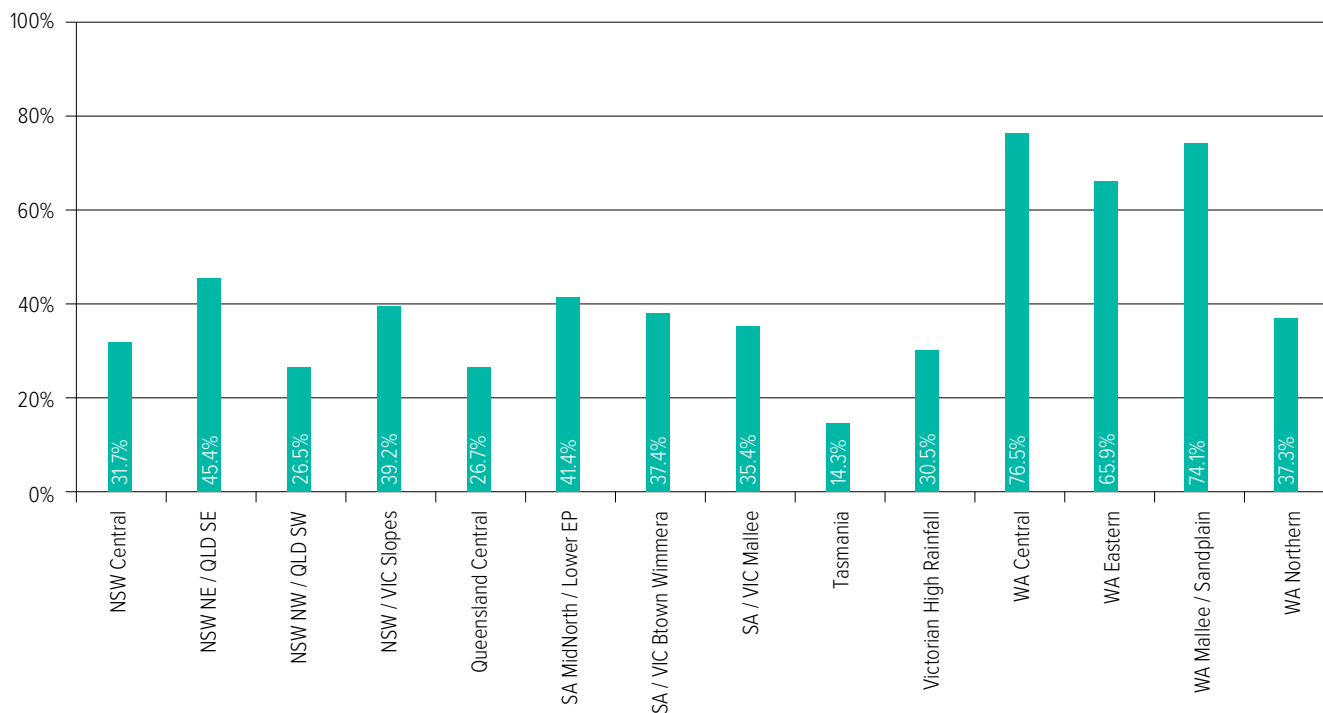
Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

### Average percentage of the fallow area where a double-knock herbicide management technique has been used

One technique for managing difficult to control or suspected herbicide-resistant weeds in fallow is the ‘double-knock’, where weeds receive two treatments separated by several days (for example, 10 days). The first treatment (or ‘knock’) is usually a herbicide, often glyphosate. The second ‘knock’ can be a different herbicide, generally with an alternative mode of action, or a cultivation.

The data for the proportion of the fallow area that was reported as treated in 2014 with a double-knock, where both knocks used were herbicides is presented in Table 85 and Figure 113. The data show that close to 20% of the fallow area nationally had a double herbicide knock used in 2014. The proportion was higher in central and southern WA and Central Queensland, although lower in central NSW and much of SA and Victoria.

**FIGURE 115** Average percentage of farm area where non-herbicide techniques have been used to help management of herbicide-resistant weeds.



### Average percentage of fallow area where tillage has been the second knock where double-knock used

Survey respondents in 2014 were asked what proportion of their fallow area had they used tillage as the second knock where they had used a double-knock technique for weed control. The data is shown in Table 86 and Figure 114 and suggests that nationally less than 10% of the fallow area is treated this way. However, the proportion is higher in Central Queensland and parts of SA and Victoria, and quite low in WA. Reasons behind this data are unable to be speculated about.

### Average percentage of farm area where non-herbicide techniques were used for management of herbicide-resistant weeds

Where herbicide-resistant weeds are present (or strongly suspected) the use of herbicides can be limited, and if used, potentially can make matters worse. Respondents were asked on what proportion of their farm area non-herbicide techniques were as weed control in 2014. The data is shown in Table 87 and Figure 115, showing average 41.6% nationally is quite high in some AEZs, notably in WA. This may not be surprising given that these AEZs also tend to report higher levels of herbicide-resistant weeds as being present (see data above).

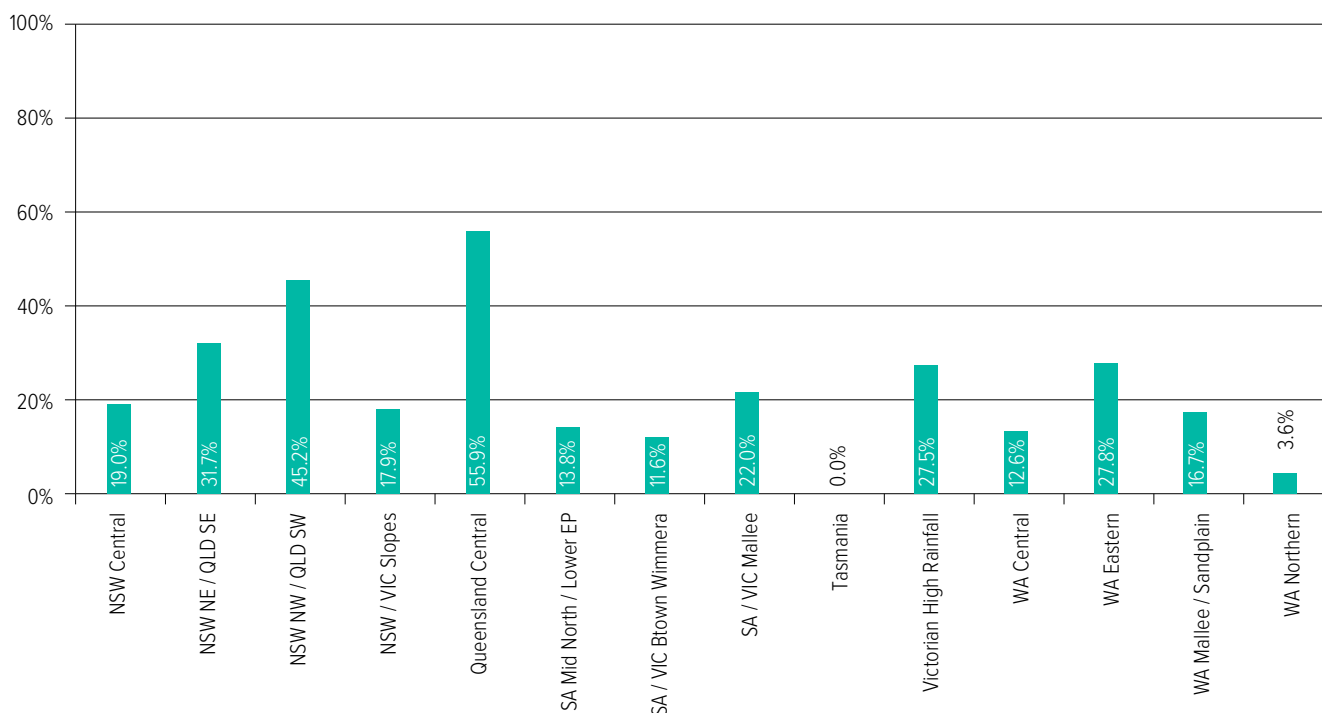
**TABLE 89** Average percentage of crop area where Group A herbicides have been used.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	40.9	hl
NSW NE / Queensland SE (b)	30.8	
NSW NW / Queensland SW (c)	35.9	l
NSW / Victorian Slopes (d)	36.9	hl
Queensland Central (e)	31.9	
SA Mid North / Lower EP (f)	31.7	l
SA / VIC Bordertown, Wimmera (g)	29.9	
SA / Victorian Mallee (h)	26.6	
Tasmania (i)	30.4	
Victorian High Rainfall (j)	33.7	l
WA Central (k)	28.8	
WA Eastern (l)	16.6	
WA Mallee/Sandplain (m)	29.4	
WA Northern (n)	25.6	
National average	30.6	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.



**FIGURE 116** Average percentage of fallow area where residual herbicides have been used.



**TABLE 90** Average percentage of crop area where Group B herbicides have been used.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	41.1	
NSW NE / Queensland SE (b)	32.7	
NSW NW / Queensland SW (c)	41.9	
NSW / Victorian Slopes (d)	33.6	
Queensland Central (e)	53.3	
SA Mid North / Lower EP (f)	38.8	
SA / VIC Bordertown, Wimmera (g)	31.4	
SA / Victorian Mallee (h)	31.3	
Tasmania (i)	8.3	
Victorian High Rainfall (j)	36.8	
WA Central (k)	41.4	
WA Eastern (l)	46.8	
WA Mallee/Sandplain (m)	39.4	
WA Northern (n)	36.4	
National average	36.7	

Note: Statistically significant differences ( $P < 0.05$ ) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

### Average percentage of fallow area where residual herbicides have been used

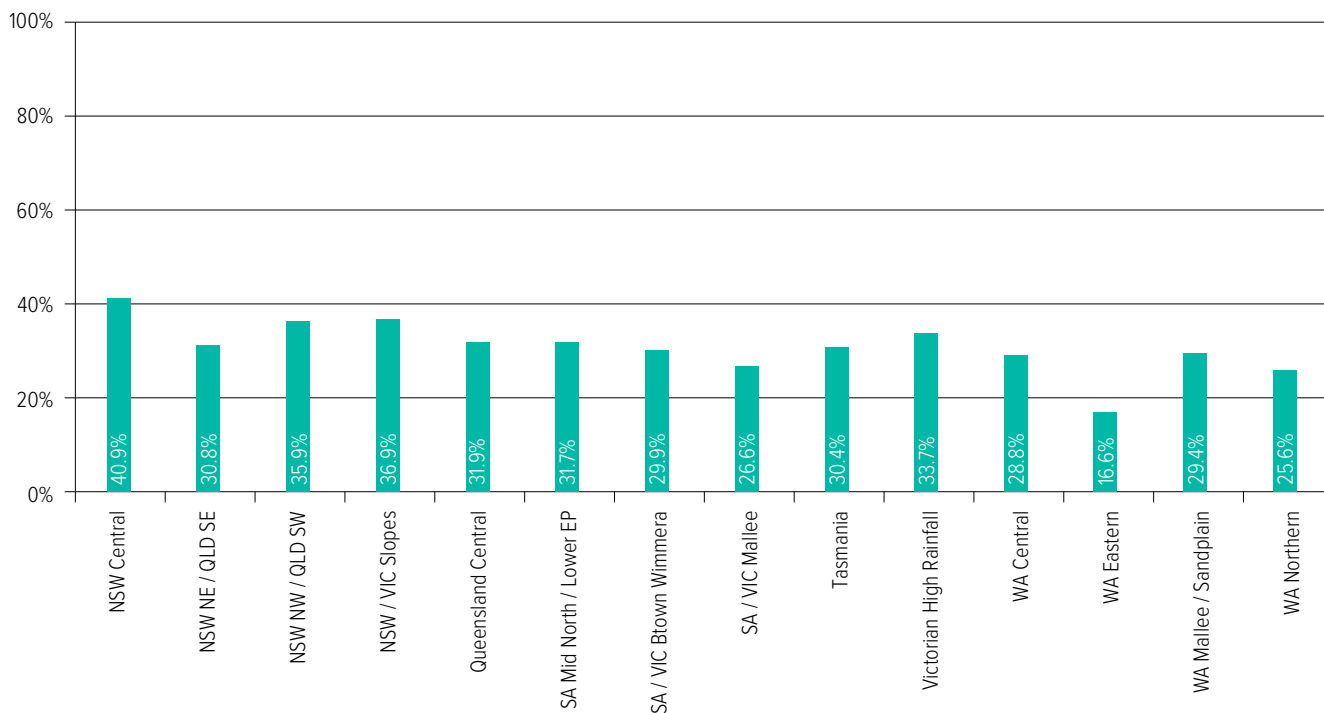
Residual herbicides can be used in fallows to provide protection from weed germination over a period of time. They can be mixed with knockdown herbicides and can play a role in maintaining weed-free fallows. Survey respondents were asked what proportion of their fallow areas had residual herbicides applied in 2014. The data (Table 88 and Figure 116) suggests that more than 20% of the fallow area nationally had used a residual herbicide. This practice was significantly higher in the northern AEZs, eastern WA and high rainfall parts of Victoria than elsewhere.

Residual herbicide use in fallows is often driven by the weed species detected in relation to the products available, and the expectation of rainfall through the fallow period.

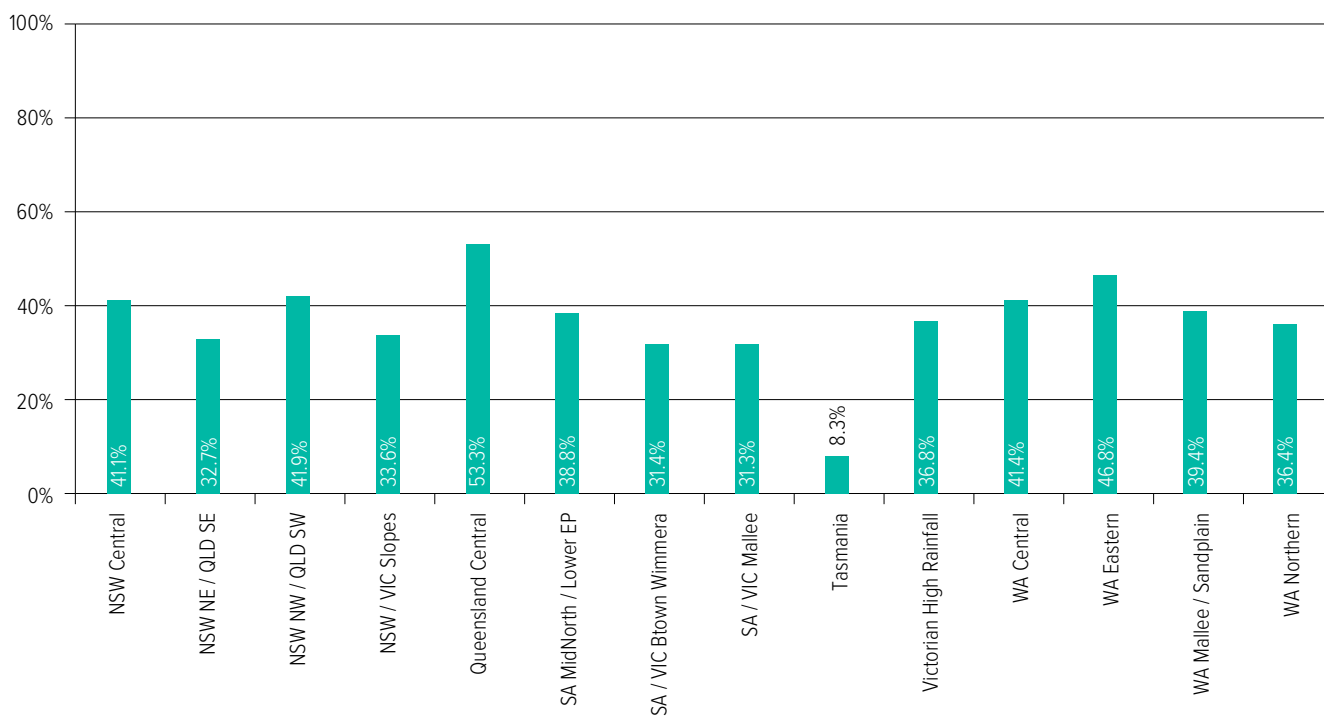
### Average percentage of crop area where Group A herbicides have been used in 2014

Herbicides belonging to the Group A mode of action continue to be used on approximately 30% of the crop area (see Table 89 and Figure 117), with usage higher in central NSW, and lower in eastern WA.

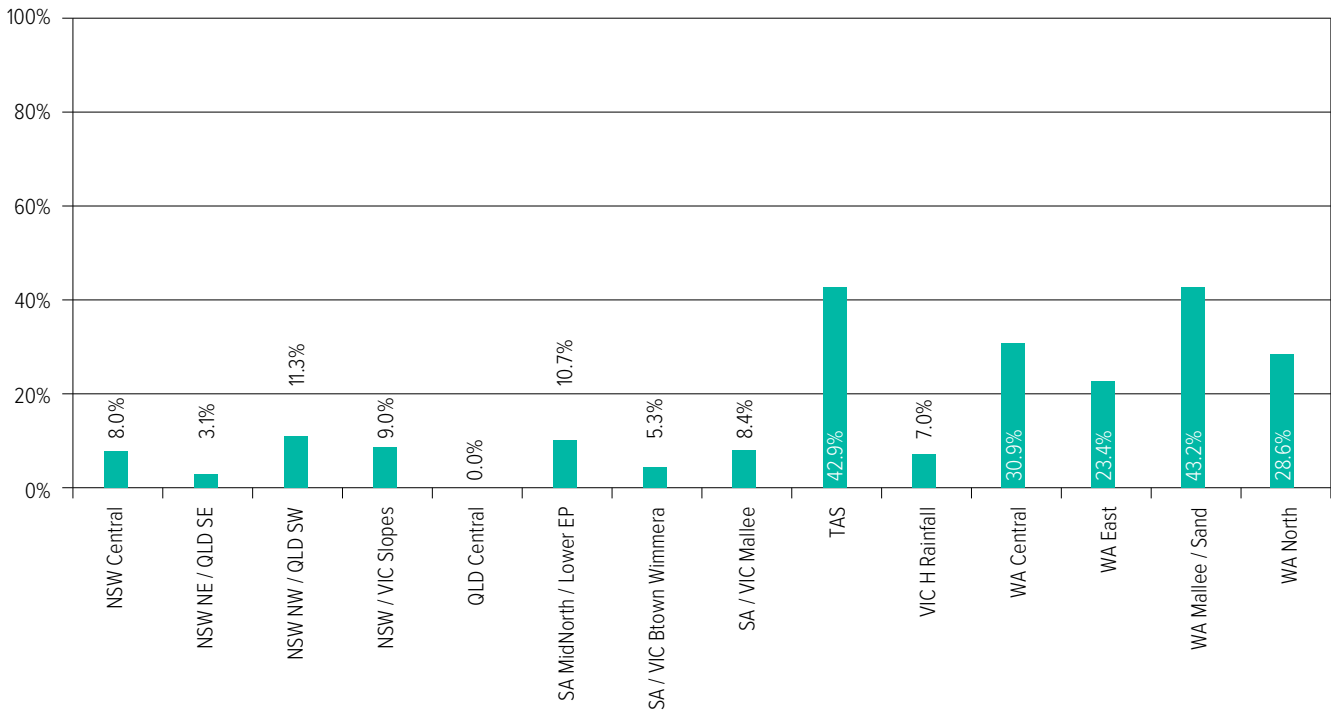
**FIGURE 117** Average percentage of crop area where Group A herbicides have been used.



**FIGURE 118** Average percentage of crop area where Group B herbicides have been used in 2014.



**FIGURE 119** Average percentage of farms with a Quality Assurance or Environmental Assurance program that assists in market access or deriving a price premium.



### Average percentage of crop area where Group B herbicides have been used in 2014

Group B mode of action herbicides continue to be used on more than 35% of the cropped area, as reported by respondents in 2014. See Table 90 and Figure 118.

This data may have been influenced by the use of some Group B herbicides in Clearfield® canola in the southern and western AEZs and potentially in some crops in the northern region.

### Average percentage of farms with a Quality or Environmental Assurance program that assists in market access or deriving a price premium

In 2014 growers were asked if they used a Quality Assurance or Environmental Assurance program, which they saw as assisting them in gaining market access or in receiving a price premium. The data for the proportion of farms that reported the use of such program is shown in Table 91 and Figure 119 and show higher proportions of farms in WA, Tasmania, and some of the northern region AEZs.

There are few direct market signals for programs such as these, although there is one in place in WA, aligned with the main bulk grain handler in that state, that offers growers a small price incentive to participate. This is likely to have assisted with the reported use of a Quality Assurance program in those AEZs. The possible motives in other AEZs are unknown.

**TABLE 91** Average percentage of farms with a Quality or Environmental Assurance Program that assists in market access or deriving a price premium.

Agro-ecological zone	2014	Significant difference between agro-ecological zones
NSW Central (a)	8.0	
NSW NE / Queensland SE (b)	3.1	
NSW NW / Queensland SW (c)	11.3	
NSW / Victorian Slopes (d)	9.0	
Queensland Central (e)	0.0	
SA Mid North / Lower EP (f)	10.7	e
SA / VIC Bordertown, Wimmera (g)	5.3	
SA / Victorian Mallee (h)	8.4	
Tasmania (i)	42.9	bcefg h i k
Victorian High Rainfall (j)	7.0	
WA Central (k)	30.9	bcdefgh i k
WA Eastern (l)	23.4	bcefh i k
WA Mallee/Sandplain (m)	43.2	bcdefgh i k
WA Northern (n)	28.6	bcefg h i k
National average	16.6	

Note: Statistically significant differences (P<0.05) are indicated by the letters in the final column. AEZs are identified by lowercase letters (e.g. (a) = NSW Central). Any mean where a letter is displayed in the final column is significantly different from those for the letter(s) indicated.

