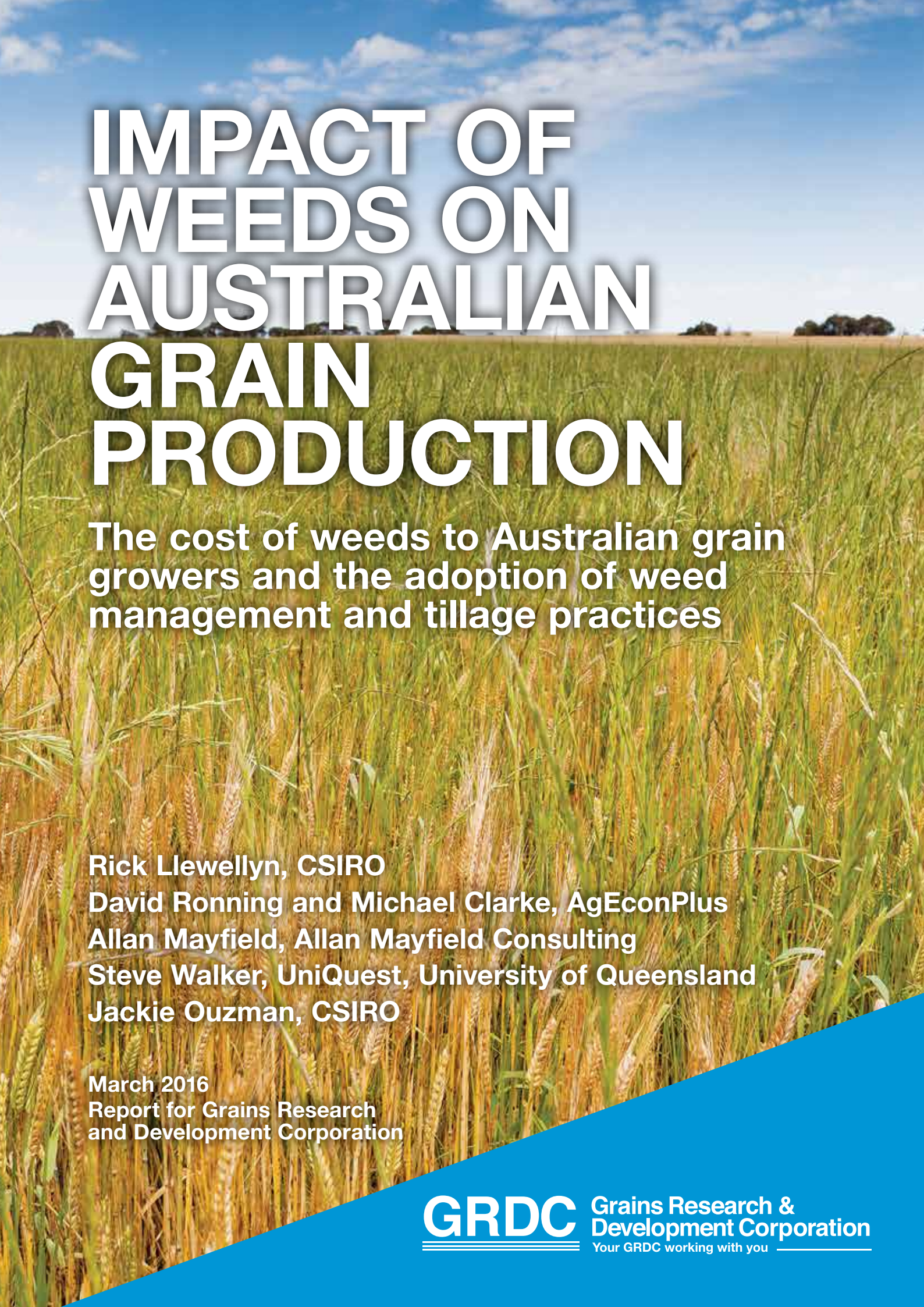

IMPACT OF WEEDS ON AUSTRALIAN GRAIN PRODUCTION

The cost of weeds to Australian grain growers and the adoption of weed management and tillage practices

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Report for Grains Research and Development Corporation

GRDC Grains Research & Development Corporation
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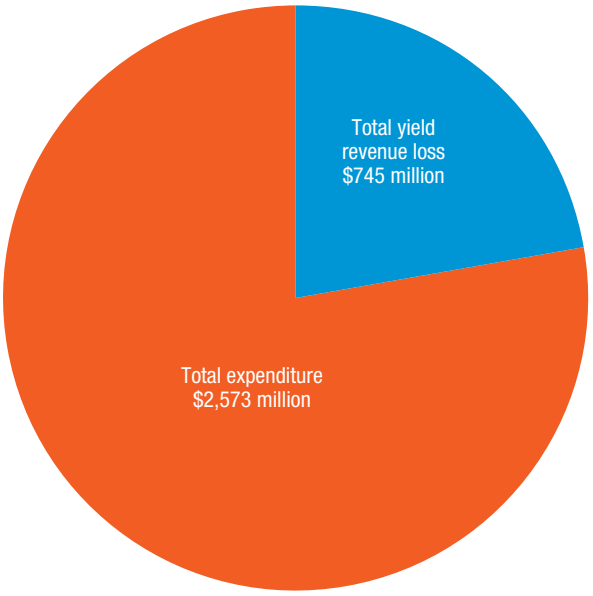
EXECUTIVE SUMMARY

Weeds present one of the largest costs to grain growers and are one of the biggest influences on the management of cropping systems. Their impact is multifaceted; they affect yield and management across all seasons, and sometimes crop price. In addition, the weed challenge faced by growers is constantly evolving, with changes in weed types and their characteristics, such as herbicide resistance, requiring the ongoing adaptation of management. This dynamic nature of weed management often leads to shifting demands for research, development and extension specific to particular weeds and local farming systems. This study is aimed at informing decisions on how to best meet these demands by identifying the costs and management challenges faced by growers across Australia's grain-growing regions and their various crops and weed types.

FIGURE 1 The total cost of weeds (revenue loss plus expenditure) to Australian grain growers is estimated at $3,318 million.



The last major study of the distribution and economic impact of weeds in Australian cropping systems was conducted over 15 years ago (Jones *et al.* 2000). This study focused only on winter crop production and did not include fallow weed management or weed management practices other than selective herbicides and cultivation. It indicated a 1998 financial weed cost of $1.2 billion.

The results in this report represent the most comprehensive national analysis of the cost of weeds to Australian grain growers. It includes the cost of yield loss due to in-crop and fallow weeds and grain contamination costs as well as weed control costs such as herbicide and non-herbicide practices. The study covers the 13 major agro-ecological zones (AEZs) across the Western, Southern and Northern grain-growing regions and the major crop types of wheat, barley, oats, canola, pulses and grain sorghum. In Part II, the report examines the rate of uptake of established and emerging weed management practices, as well as looking in more detail at the associated analysis of changes in crop seeding systems.

Primary data for the analysis came from interviews with 600 grain growers who represent approximately two million hectares of cropping land selected at random to represent each AEZ. Information on residual in-crop weed densities was combined with yield loss coefficients for each identified weed to generate estimates of crop yield loss, together with costs attributed to weed management practices and grain contamination.

We identified important differences between regions and AEZs. Key results at a national level include the following.

- The overall cost of weeds (Figure 1) to Australian grain growers is estimated to be $3,300 million.
- Weeds are costing Australian grain growers $146/ha in expenditure and losses.
- Average expenditure on weed control, including herbicide and non-herbicide practices, was estimated to be $113/ha.
- Yield losses due to weeds amounted to 2.76 million tonnes of grain.
- Based on extent and cost, the most costly weeds nationally in terms of total yield loss remain ryegrass, wild radish and wild oats, with brome grass being the most notable major new weed.
- Barnyard grass, feathertop Rhodes grass, fleabane and sweet summer grass were found to be most costly in sorghum.
- Ryegrass remains the major weed in terms of the cost of herbicide resistance, with the cost being greater than the sum of all other forms of resistance.
- Herbicide resistance was estimated to cost $187 million in additional herbicide treatment costs, in addition to the costs of using extra integrated weed management practices.
- Most growers expect that a new selective or knockdown herbicide able to control weeds that are resistant to current herbicides will become available in the next decade.
- Nationally, the most costly weeds in fallow in terms of estimated yield loss were melons, heliotrope, fleabane, caltrop, barnyard grass and panic grass.
- The study estimates $487 million is spent on fallow weed control through herbicide application and cultivation.
- Despite this, weeds in fallows are still estimated to be costing more than $430 million through reduced crop yields.
- Overall, revenue loss due to weed populations reducing crop yields was $33/ha, which is similar to the cost of some herbicide applications.
- Yield losses due to weed competition from residual in-crop weeds were valued at $278 million.
- Using cultivation in crop seeding systems and as a weed control practice has declined dramatically since the 1998-99 study of Jones *et al.* 2000, but other practices including crop-topping, double knockdown and narrow windrow burning have increased.
- Weeds are typically the primary reason for Australian grain growers to use cultivation and burning.

Australian grain growers are investing heavily in weed management, mostly through herbicide-based methods. Despite increasing levels of herbicide resistance, in-crop weed populations are being kept low and yield loss due to weed competition ($708 million) is much lower than total weed management costs ($2,573 million). Reducing the cost of weed management is one of the grains industry's largest challenges.

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PART 1: ECONOMIC IMPACT OF WEEDS ON AUSTRALIAN GRAIN GROWERS

1 INTRODUCTION

Weeds present one of the biggest costs to grain growers and often demand research, development and extension specific to the weed and farming system. Better understanding of the relative costs and benefits of different weed problems and practices will help in identifying priorities and opportunities.

The last major study of the distribution and economic impact of weeds in Australian cropping systems was more than 15 years ago (Jones *et al.* 2000). It quantified the cost of weeds due to forgone financial cost related to production, as well as losses and gains of producers and consumer welfare associated with winter weeds. This report updates and expands on that study. Jones *et al.* (2000) found that as grain prices are largely determined by world export markets, the financial costs of weeds were virtually equivalent to the economic cost (loss in surplus) (see also Jones *et al.* 2005). For this reason, we present only the financial costs of weeds to Australian grain growers.

We evaluated the distribution and economic importance of weeds to Australian grain growers across a range of regions, crops and weed types, including in-crop and fallow weeds. Impacts on production and costs are presented, together with breakdowns of use of weed management practices at the levels of agro-ecological zone (AEZ), region and nationally. We also take herbicide resistance and associated costs into account.

This study, like other studies of the cost of cropping constraints (for example, Murray and Brennan 2009), is aimed at informing current and future decisions on cropping systems research, development and extension. This includes the identification of priority issues and strategic approaches to deal with the multifaceted impact of weeds on grain production and management.

2 METHOD

2.1 Data

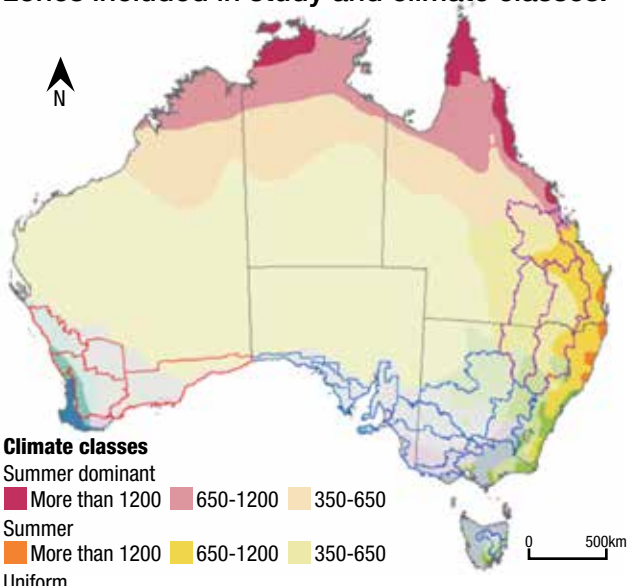
2.1.1 Geographical regions for survey

The study included the breadth of grain production areas of Australia. The survey's geographical units are based on the Grains Research and Development Corporation's (GRDC) AEZ 2006 from each of the three GRDC regions (Figure 2 and Table 2, p14). To represent the relatively small Tasmanian grain and Victorian high-rainfall zones, we merged them into one AEZ for this study.

2.1.2 Crop production

The scope of the analysis was restricted to the major Australian grain crops based on available national Australian Bureau of Statistics (ABS) production figures. Crops selected were wheat, barley, oats, canola, grain sorghum and pulses. Pulses were defined as chickpeas, field peas, lupins, lentils, faba beans, mungbeans, navy beans and vetch.

FIGURE 2 Regions and agro-ecological zones included in study and climate classes.



SOURCE: SEASONAL RAINFALL ZONES OF AUSTRALIA, BUREAU OF METEOROLOGY

Neil Clark & Associates assembled crop production data for the project from ABS data for the period 2010-11 to 2012-13 and provided an average across a range of seasons (Table 1) and for all crops (Appendix A.2.1). We used a midpoint between ABS 'actual' recorded yield data and National Variety Trials (NVT) data compiled from within each AEZ (Appendix 9.2.2) to determine a representative 'weed-free yield' for each crop type for the study period. The crop production data are used to set the lower bound of weed-free yield; the NVT results inform the upper bound. We used weed-free yields in the model to represent potential yield in the absence of weeds that may affect crop yield through in-crop competition and use of resources during a prior fallow. Table 1 shows weed-free yields for wheat (other crops are included in Appendix 9.2.1, p74).

2.1.3 Grower survey

This survey represented the 13 AEZs (Figure 2, Table 1, Table 2) and collected data on weed distribution, relative perceived cost, herbicide resistance, management practices and intentions, and seeding systems (full questionnaire is in Appendix 9.1, p72).

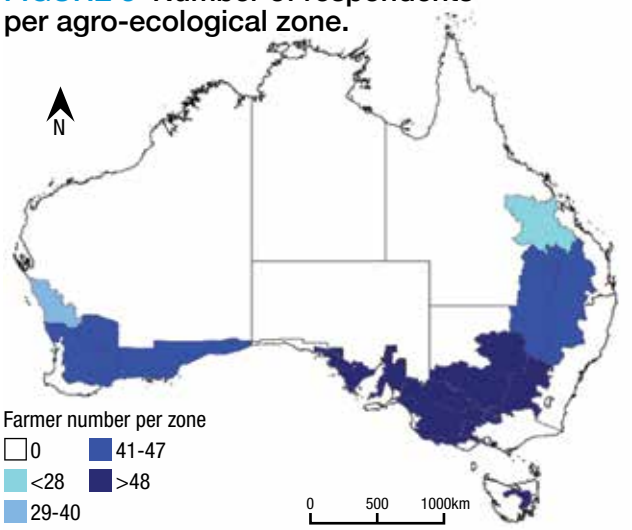
To gain data on a range of farm-specific weed and weed management variables, including extent of weeds and density assessments for residual in-crop weeds, we surveyed 602 grain growers beginning in March 2014, with some of them returning for follow-up interviews that were completed in July 2014. We conducted phone interviews in conjunction with a specialist survey data collection company with the most extensive grower database available to the project (KG2). We used a phone survey rather than a mail-out to facilitate a relatively high response rate to ensure a sound representation of grain growers. We offered participants the chance to win one of 10 $50 gift cards. Growers were randomly contacted from the database until the quota for growers meeting the criteria in each AEZ was met, resulting in 602 complete responses distributed across the AEZs (Table 2, p14 and Figure 3).

Respondents needed to be identified as primary cropping decision-makers and were screened based on their farm's crop area being greater than 500 hectares of crop, with the exception of the Victorian high-rainfall and

TABLE 1 Cropping area and grain production (cereals, canola, pulses, sorghum) for regions and agro-ecological zone (ABS 2011–13) and assumed weed-free yield for wheat.

	Crop area ('000)	Grain production T ('000)	Gross value (S) ($ million)	Assumed weed-free wheat yield (t/ha)
Northern				
Central Queensland	399	711	200	2.62
NSW NE/Queensland SE	2,267	5,294	1,348	2.94
NSW NW/Queensland SW	1,427	2,524	689	2.40
Southern				
NSW Central	1,672	3,580	915	2.87
NSW Victorian Slopes	2,162	4,903	1,390	3.22
SA Mid North – Lower Yorke Eyre	1,730	4,292	1,245	3.33
SA Victorian Bordertown – Wimmera	1,852	3,843	1,133	3.21
SA Victorian Mallee	3,020	5,298	1,398	2.08
Victorian high-rainfall and Tasmanian grain	320	754	225	4.21
Western				
WA Central	4,330	6,802	2,013	2.34
WA Eastern	1,261	1,036	295	1.25
WA Sandplain – Mallee	953	1,753	552	2.47
WA Northern	1,356	2,023	594	2.06
Total / National	**22,746**	**42,812**	**11,996**	-

FIGURE 3 Number of respondents per agro-ecological zone.



Tasmanian zones where this was later reduced to 250ha to reflect the commonly smaller farm size in this region.

Based on the total number of primary cropping decision-makers directly approached for participation, the completion rate was 44 per cent. The 602 grower responses represent a total arable area of 2.0 million hectares.

2.2 Quantifying weed loss and weed control expenditure

Weeds have a direct financial impact on the farm business through costs associated with weed management and through yield losses or downgrades.

The cost of weeds in grain production is a function of yield losses due to reduction in yield from weeds (in-crop and fallow), price penalties and cleaning costs from grain contamination plus expenditure for weed control. Weed controls considered in this study include herbicides, cultivation, burning stubble, brown or green manuring, mouldboard ploughing to bury weed seeds, delayed seeding with knockdown herbicides, double knockdown, crop-topping, pasture spray-topping or hay freezing, chaff cart, baling, narrow windrow burning, chaff tramlining and the Harrington Seed Destructor. Other costs considered are fallow weed control, and extra costs associated with herbicide-resistant weeds.

The costs of weeds (C) is broken down simply into categories of loss (L) and expenditure (E) such that:

$$C = L + E$$

As per Jones *et al.* (2000), we restricted loss (L) to the direct effects caused by weeds in crops (for example, yield loss due to in-crop weeds or weeds in preceding fallows; product contamination). The resources used to control weeds, including labour and application costs, are included in expenditure (E). The influence of weeds on crop choice (for example, growing a less profitable break crop in preference to a cereal due to grass weeds) has been investigated but has not been included in the economic analysis.

2.2.1 Yield losses due to weeds

We asked growers directly about the two main weeds they manage for each crop category (cereal,

TABLE 2 Agro-ecological zones represented in this study and example districts.

Region	Number of growers	Proportion of total	Example districts
Northern			
Central Queensland	28	5%	Emerald; Duaringa; Bauhinia; Banana; Peak Downs; Belyando; Broadsound.
NSW NE/Queensland SE	45	7%	Gunnedah; Inverell; Parry; Tamworth; Yallaroi; Moree Plains; Narrabri; Coolah; Coonabarabran; Dubbo; Mudgee; Wellington; Kingaroy; Chinchilla; Inglewood; Waggamba; Tara; Murilla; Millmerran; Wambo.
NSW NW/Queensland SW	46	8%	Gilgandra; Narromine; Coonamble; Walgett; Warren; Balonne; Bendemere; Booringa; Bungil; Roma; Warroo.
Southern			
NSW Central	49	8%	Bogan; Cobar; Lachlan; Carrathool; Murray; Wakool; Balranald;Wentworth; Berrigan; Deniliquin; Jerilderie.
NSW Victorian Slopes	52	9%	Cowra; Forbes; Parkes; Weddin; Boorowa; Young; Coolamon; Cootamundra; Junee; Lockhart; Temora; Wagga; Hume; Corowa; Culcairn; Holbrook; Urana; Moira; Wangaratta Nth.
SA Mid North – Lower Yorke Eyre	51	8%	Barossa; Blyth-Snowtown; Burra; Bute; Central Yorke Peninsula; Clare (Clare and Gilbert valleys); Crystal Brook-Redhill; Eudunda; Hallett; Jamestown; Kapunda; Light; Mallala; Mount Remarkable; Pirie; Port Broughton; Riverton; Robertstown; Rocky River; Saddleworth and Auburn; Spalding; Nth Wakefield-Burunga West; Pt Pirie Districts; Tumby Bay; Lower Eyre Peninsula; Central Yorke Peninsula; Northern Yorke Peninsula.
SA Victorian Bordertown – Wimmera	50	8%	Horsham; Grampians-St Arnaud; Grampians-Stawell; Hindmarsh; West Wimmera; Yarriambiack Sth; Buloke Sth; Loddon; Campaspe-Rochester; Peake; Naracoorte; Tatiara; Coonalpyn Downs.
SA Victorian Mallee	52	9%	Yarriambiack-North; Mildura Buloke-North Swan Hill; Loxton; Waikerie; Karoonda-East Murray; Lameroo (Southern Mallee); Mannum; Murray Bridge; Pinnaroo; Streaky Bay; Le Hunte; Kimba; Cleve; Ceduna.
Victorian high-rainfall and Tasmanian grain	51	8%	Campaspe; Hepburn West; Pyrenees North and South; Central Goldfields greater; Shepparton B West; Deloraine; Sheffield; Oatlands; Campbelltown; Bothwell.
Western			
WA Sandplain-Mallee	46	8%	Esperance; Ravensthorpe; Jerramungup.
WA Central	45	7%	Boyup; Brook; Broomehill; Gnowerangerup; Katanning; Kent; Kojonup; Tambellup; Woodanilling; Brookton; Cuballing; Dumbleyung; Wickepin.
WA Northern	40	7%	Dalwallinu; Carnamah; Chapman Valley; Coorow; Greenough; Irwin; Mingenew; Morawa; Mullewa; Perenjori; Three Springs.
WA Eastern	47	8%	Koorda; Wyalkatchem; Merredin; Mt Marshall; Mukinbudin; Nungarin; Trayning; Westonia; Yilgarn.

broadleaf crops, sorghum) and fallows. They were asked to nominate the typical area of crop type or fallow affected and late-season (residual) density ranges for these weeds. The common and scientific names of the nominated weeds have been identified; however, in some cases the nominated weed as stated by the grower is not definable by species, so the list of nominated weeds in some cases includes categories (for example, melons, thistles).

Residual cropping weeds

Revenue losses were calculated using survey data, weed-free yield and crop competition factors. The model calculates yield loss and revenue loss for each grower based on the two major weeds they identified for each crop type that they grow. Loss in revenue due to in-crop weed competition from residual weeds is calculated first as yield loss:

Yield loss = area of particular crop type x proportion of crop area infested x assumed weed-free crop yield x yield loss coefficient for that weed

Yield loss is specific to the weed identified for a certain crop and the density that they have specified. The yield loss coefficient is estimated for each weed species and weed density range (low <1/m^2, medium 1–10/m^2, high >10/m^2), which is described in more detail in later sections. As the pulse category represents a range of possible pulse species across the regions, a common standard pulse crop was assumed (lupins) for determining yield loss coefficients in Southern and Western regions. In the Northern region, we assumed chickpeas represented the pulse category (with weed yield loss coefficients 20 per cent higher than those assumed for lupins).

We then calculated revenue loss as:

Revenue loss = yield loss (t) x farm-gate price (t/ha)

The revenue loss in the first instance is calculated at a farm level using grower survey data and farm-gate prices that are relevant to the crop and area. The yield loss and revenue loss were then summed for each farm surveyed in the AEZ and the area represented

by the respondents was 'grossed up' to represent the actual area of the particular crop type in the AEZ.

Fallow weeds

Fallow weed costs are calculated in a similar manner to crop residual weeds. The potential yield loss in the following crops was calculated based on the survey data on weed species and density surviving at the end of the fallow, as well as the percentage of area infested and portion sprayed or unsprayed.

Due to the very limited data on the impact of different weed species on yield loss of the subsequent crop (for example, the relative effect of different summer weeds), we based our calculations of yield loss on consistent density effects rather than species-specific yield loss coefficients.

From the available research data, we estimated the following yield losses (t/ha) for winter cereals, winter pulses and canola, and sorghum for the three regions and different weed densities (Hunt & Kirkegaard 2011, Osten *et al.* 2006, Thomas 2000). For winter cereals, the yield loss estimates were: 0.15, 0.4 and 1.2t/ha for low, medium and high weed densities in the Northern region; 0.1, 0.3 and 0.8 for low, medium and high weed densities in the Southern region; and 0.05, 0.15 and 0.4 for low, medium and high weed densities in the Western region. The values for pulse and canola crops were half of those for winter cereals. The estimates for the three regions differ due to the amount of fallow versus in-season rain that is received and the typical water-holding capacity of the soils. For sorghum, which only applies to the Northern region, the estimates were 0.05, 0.2 and 0.6 for low, medium and high weed densities.

We used the above yield loss values for calculating the costs for the unsprayed area of weed infestation. When a portion of the infested fallow was sprayed but densities of mature fallow weeds were still reported the yield loss values were reduced by 75 per cent.

We calculated the costs for each crop type using the following:

Yield loss due to weeds on fallow land to be cropped ($) = [(weed-free yield x area sprayed x yield loss factor x 0.25) + (weed-free yield x area unsprayed x yield loss factor)] x farm-gate price

We assumed that the proportion of different crops following fallow were represented by the overall proportion of different crop types grown on that farm.

2.2.2 Grain contamination and cleaning

Total grain contamination cost is calculated by summing 'total cost of cleaning' and 'total cost of crop price downgrades due to weeds'. Costs are calculated for each respondent by:

Total cost of cleaning = proportion of total crop tonnage cleaned x total crop tonnage x cost of cleaning

Total price penalty for having weed seed contamination = proportion of total crop tonnage cleaned x total crop tonnage x downgrade penalty

As the most common crop, it was assumed that wheat was affected by any downgrade penalty. Cleaning cost ($25/t) and downgrade penalties ($22/t) are assumed to be the same in all regions.

2.2.3 Weed control expenditure

We asked growers about their farming practices related to weed management. They were asked directly about the following.

Herbicide use in winter and summer crops:

- typical percentage receiving knockdown herbicide application;
- typical percentage receiving pre-emergent herbicide application; and
- typical percentage receiving post-emergent herbicide application.

Herbicide use in fallow:

- percentage of cropped area that receives herbicides for summer weeds (excluding pre-seeding knockdown); and
- number of herbicide applications in winter fallow for winter weed control (Northern region).

Integrated weed management practices

Seedling control:

- delayed seeding with knockdown primarily for controlling weeds
- double knockdown primarily for controlling weeds
- cultivation.

Seed control

Harvest seed control:

- chaff cart;
- bale-direct system;
- narrow windrow burning;
- chaff tramlining; and
- Harrington Seed Destructor.

Other seed control:

- burning stubble for weed management;
- brown or green manure on a sown crop primarily for weed control;
- crop-topping – direct costs primarily for weed control (pulses only);
- pasture spray-topping or hay freezing primarily for weed control; and
- mouldboard ploughing to bury weed seeds.

Herbicide-resistant weeds:

- weeds resistant to herbicides;
- herbicide types affected; and
- area affected by resistant weeds.

In-crop herbicide costs

We estimated standard herbicides and their costs for each AEZ and crop type based on information gained from key advisers in each region (Appendix 9.2.6. p85). We did this for three typical levels of herbicide resistance in each AEZ (see section 3.4 'Herbicide-resistant weeds', p45). The values are used in the model to calculate the cost associated with herbicide use. The model considers (i) standard herbicide cost when no resistance is present and (ii) higher herbicide costs when selective and/or glyphosate resistance is present on proportions of cropping land as reported by respondents. Application costs differ for different crops and regions; generally these costs ranged from $6/ha to $8/ha per application.

For each respondent, herbicide costs are calculated based on crop type and the amount grown.

Herbicide cost = crop area receiving herbicide x cost per ha

'Crop area receiving herbicide' is based on grower's cropping area per crop type and the percentage of cropping area receiving certain herbicide (knockdown, pre-emergent and post-emergent).

Application cost = standard number of applications x cost per application pass

This is calculated for each crop and herbicide when the herbicide is used by the individual grower.

Herbicide cost and application costs per grower are summed per region and the cropping area 'gross up' factor is applied.

Weed-resistant herbicide cost

The study asked growers about herbicide resistance on the land they manage, the two most common herbicide-resistant weeds they manage, the extent of those resistant weeds and what herbicide types the weeds are resistant to. Resistance was defined as 'where a herbicide that once worked on a weed is no longer effective enough to be worth using'.

We estimated the additional herbicide costs to growers with resistant weeds based on information gained from key advisers in each region for herbicides. Herbicide costs due to glyphosate resistance were simply based on the cost of an additional alternative non-selective herbicide application (Appendix A.2.6). We classed resistant weeds as: (i) resistant to selective herbicides (Tier 1), (ii) glyphosate-resistant (Tier 2), or (iii) resistant to both (Tier 3).

Costs for resistant weeds = area of infestation for resistance (per crop type and resistance type) x additional herbicide cost due to that resistance status

The costs of other practices that are likely to be adopted to manage herbicide resistance are included in the overall analysis of expenditure on weeds. However, these costs are not specifically allocated to particular herbicide-resistant weeds. This is because they generally affect multiple weeds and their use may be for preventative reasons rather than simply control of existing resistant weeds.

Fallow herbicide costs

We estimated the standard herbicides and their costs for summer fallows in each region based on information gained from key advisers in each region, and for winter fallows in the Northern region. In the Northern region, additional information was collected and used on the number of fallow herbicide applications. The model considers: (i) standard herbicide cost when no resistant is present, and (ii) herbicide cost when resistance is present, based on what growers nominated as their major fallow weeds and the extent of glyphosate resistance to these weeds.

Integrated weed management practices

Cultivation and whole-paddock burning costs

Total cultivation costs for weed management is the sum of 'cultivation cost prior to seeding' and 'fallow cultivation costs'.

Since not all cultivation prior to seeding can be attributed to weed management, we asked growers to identify what proportion of the reason for cultivating can be attributed to weed management. For example, cultivation may be performed for a number of reasons including disease and residue management. The 'total cost of cultivation prior to seeding for weed management' is calculated using a variation of the above equation, whereby pre-seeding cultivation attributed to weed management is considered:

Total cost of cultivation prior to seeding = area practice used x cost of practice x proportion attributable to weed management

We used the same method to attribute the costs of whole-paddock burning to weed management, with growers being asked to identify the relative importance of weed management as the reason for whole-of-paddock burning. We evaluated narrow windrow burning for weed control separately.

Other practices

The costs for the other practices performed for managing weeds are calculated by:

Total cost of weed control practice = area practice used x cost of practice

The area where the practice is used is calculated from the stated percentage cropping area on which the practice is used and the 'total crop area' on the farm (including all crops).

For crop-topping, we calculated an additional cost based on yield loss due to the treatment. Where growers indicated an area treated by crop-topping, we assumed that only an area of their pulse crop was treated.

3 RESULTS

3.1 Farm and grower characteristics

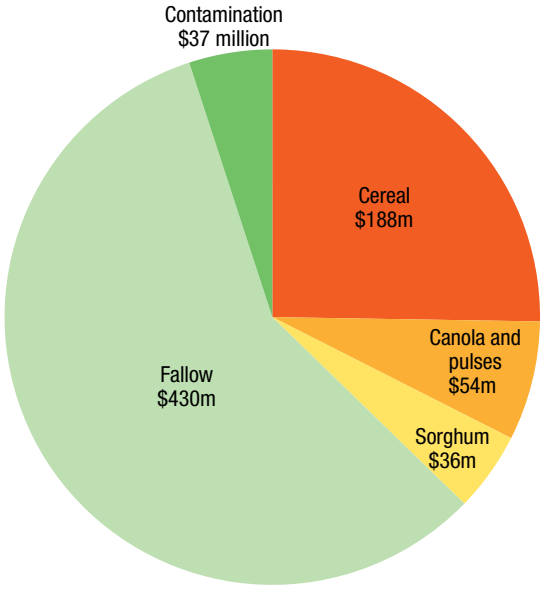
Respondents were mostly mixed growers (73 per cent) rather than cropping specialists and had an average age between 55 and 64 years, with 20 per cent younger than 45 years. For 37 per cent of growers, there was someone involved with the farm who had a university degree and 58 per cent pay a consultant for cropping advice. All but one respondent grew some cereals. A majority (82 per cent) also grew either pulses or canola. The proportion of growers growing other crops is shown in Table 3 and an average crop area of respondents is shown in Table 4. Sorghum was only considered for the Northern region.

TABLE 3 Proportion of growers growing crops other than winter cereals.

	Canola	Pulses	Pulse or canola	Sorghum
Northern	24%	70%	72%	58%
Central Queensland	4%	68%	68%	89%
NSW NE/Queensland SE	22%	64%	69%	84%
NSW NW/Queensland SW	39%	76%	78%	13%
Southern	70%	61%	87%	-
NSW Central	47%	55%	69%	-
NSW Victorian Slopes	87%	44%	92%	-
SA Mid North – Lower Yorke Eyre	45%	84%	88%	-
SA Victorian Bordertown – Wimmera	90%	80%	98%	-
SA Victorian Mallee	62%	67%	79%	-
Victorian high-rainfall and Tasmanian grain	92%	37%	94%	-
Western	68%	42%	80%	-
WA Central	73%	53%	91%	-
WA Eastern	43%	26%	60%	-
WA Sandplain – Mallee	83%	39%	87%	-
WA Northern	75%	53%	85%	-
Total / National	61%	57%	82%	13%

Proportion of growers expressed as percentage of all growers in region/zone.

FIGURE 4 Summary of total revenue losses ($745m).



Note that sorghum and winter fallow are only considered in the Northern region.

3.2 Yield and revenue losses due to weeds

Weeds result in an estimated revenue loss of $745 million (Figure 4). Revenue losses are made up of: yield loss in crop and yield loss from fallow weeds, as well as revenue losses from weed contamination and penalties in crops. Revenue loss due to residual weeds in all crops and fallow is estimated at $708 million (Table 5). Revenue (and yield) losses that occur as a result of fallow weeds ($430 million) are estimated to be higher than residual weeds in crops ($278 million).

3.2.1 Residual cropping weeds

Residual weeds in all crops

Revenue loss caused from residual weeds in all crops (wheat, barley, oats, canola, pulses and sorghum) is estimated at $278 million (Table 6), this equates to $12.21 per hectare. While loss from residual weeds competing for wheat crops is the highest, at $154 million, this equates to a moderate cost of $11.57/ha. Residual weeds in sorghum are most costly per hectare at $56.35 (Figure 5), whereas barley is the lowest at $7.67. Total yield losses are 1,098,570 tonnes or 2.6 per cent of production. The top 20 residual weeds in all crops based on area

TABLE 4 Average crop and arable area (hectares).

	Wheat	Barley	Oats	Canola	Sorghum	Pulses	Total cropping area	Arable land
Northern	826	153	108	90	263	355	1,795	3,568
Central Queensland	739	11	12	-	592	499	1,854	3,033
NSW NE/Queensland SE	627	165	156	44	275	186	1,452	3,616
NSW NW/Queensland SW	1,075	226	120	189	51	432	2,094	3,847
Southern	701	320	52	189	-	180	1,445	2,375
NSW Central	981	275	75	111	-	138	1,581	3,706
NSW Victorian Slopes	755	143	35	302	-	69	1,309	2,343
SA Mid North – Lower Yorke Eyre	613	404	68	95	-	228	1,411	1,843
SA Victorian Bordertown – Wimmera	434	443	50	201	-	332	1,461	2,103
SA Victorian Mallee	1,005	476	41	181	-	285	1,988	2,730
Victorian high-rainfall and Tasmanian grain	419	179	44	239	-	32	915	1,566
Western	1,825	538	100	431	-	129	3,025	4,591
WA Central	1,230	479	163	430	-	128	2,432	3,920
WA Eastern	2,338	416	134	199	-	39	3,126	5,095
WA Sandplain – Mallee	1,210	1,013	50	754	-	118	3,146	4,546
WA Northern	2,597	200	48	335	-	250	3,432	4,807
Total / National	1,058	351	77	241	263	200	1,981	3,266

TABLE 5 Revenue loss due to residual weeds in all crops and fallow.

	Revenue loss	Revenue loss (per hectare)
Northern	$141m	$34.56
Southern	$365m	$33.92
Western	$201m	$25.49
Total / National	$708m	$31.11

Revenue losses include yield loss in crop, and yield loss from fallow weeds. Crops include wheat, barley, oats, canola, pulses and sorghum.

of infestation, yield loss and revenue loss nationally are presented in Table 7, p21. Nationally the ranking of top weeds based on revenue losses are: ryegrass, wild radish and wild oats (Table 7). Ranking of weeds by revenue losses varies region to region (Table 8, p21). In the northern region these are: barnyard grass ($14.7 million), wild turnip ($10.3 million), sweet summer grass ($8.8 million). In the southern region these are: ryegrass ($38.9 million), wild oats ($21.7 million), brome grass ($21.0 million). In the western region these are: ryegrass ($50.3 million), wild radish ($40.1 million), and wild oats ($1.9 million).

Residual weeds in winter cereals

Total yield loss due to weeds in winter cereals is estimated to be 787,150 tonnes, resulting in a revenue loss of $188 million (Table 14, p2), which equates to $10.65/ha. In the Western region this represents a revenue loss of $11.64 for every hectare of crop land (all crops), $10.51 in the South and $8.79 in the Northern region (Table 10, p23). Low weed densities are commonly reported for residual weeds in winter cereals (Table 11, p24).

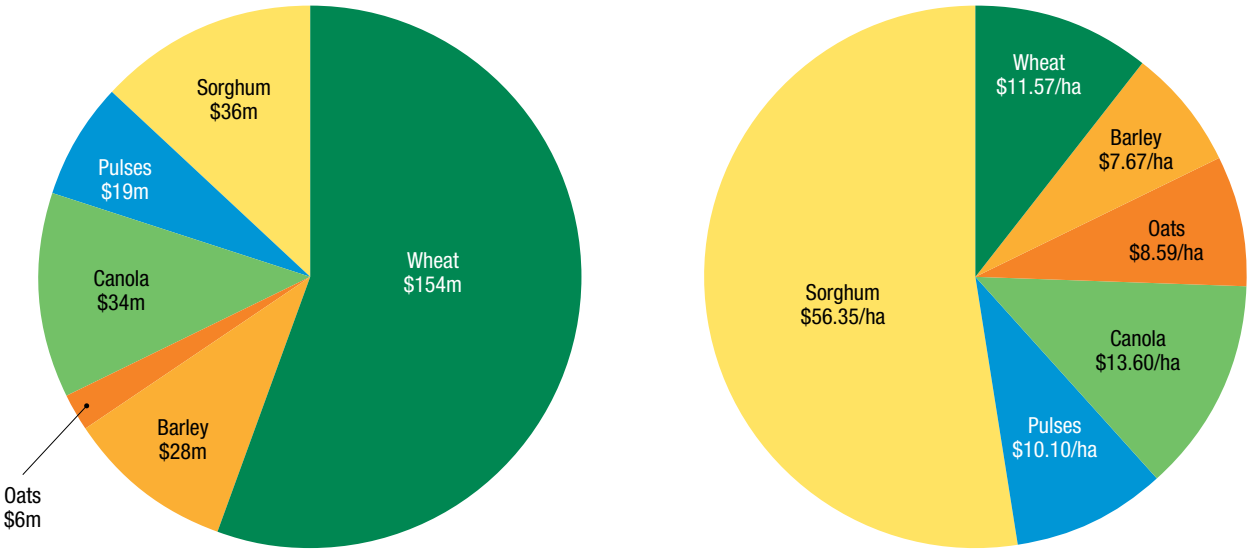
The top 20 residual weeds in winter cereals based on area of infestation, yield loss and revenue loss nationally are presented in Table 12, p24. The top six weeds include three winter grasses – ryegrass, wild oats and brome grass – and three brassica weeds – wild radish, wild turnip and wild mustard. The top 10 weeds account for 96 per cent of all revenue loss of all late season cereal weeds, or $179 million. Rankings by region are shown in Table 13, p25.

Residual weeds in canola and pulses

Total yield loss due to weeds in canola and pulses is estimated to be 122,048 tonnes, resulting in a revenue loss of $54 million, with most of the losses in the Southern and Western regions (Table 14, p26). Nationally revenue losses per hectare are $12.09 (Table 15, p27). Similar to residual weeds in winter cereals, weeds in canola and pulses are commonly reported at low weed densities (Table 16, p27).

Ryegrass and wild radish are the two main weeds causing yield losses in canola and pulses, as in winter cereals; however, wild radish is closer to the level of impact of ryegrass in broadleaf crops. Vetches (including tares) are one of the major weeds affecting yields of these non-cereal crops (Table 17, p28). The top 10 weeds account for $48.2 million (90 per cent) of the loss in revenue (Table 17). Rankings by region are included in Table 18, p29 and by AEZ in Appendix 9.4, Table 93. Weed densities are most commonly reported at low levels similar to residual winter cereal weeds.

FIGURE 5 Total revenue loss and revenue loss per hectare caused by residual weeds in crops.



Note: Total revenue loss expressed per hectare relates to the area of each crop grown.

Residual weeds in sorghum

Residual weeds in sorghum caused a loss of $36 million in the Northern region (Table 19, p30). The most important weeds in terms of revenue loss are barnyard grass, sweet summer grass, feathertop Rhodes grass, noogoora burr and fleabane, resulting in $32 million (90 per cent) of the overall loss in revenue (Table 21, p30). Rankings by AEZ are listed in Appendix 9.5, Table 94. Similar to other crops, residual weed densities are reported as low (Table 20, p30).

3.2.2 Fallow weeds

Summer fallow

Yield loss due to weeds in summer fallow is estimated to be 1,655,974 tonnes, resulting in a revenue loss of $428.5 million (Table 22, p31), equating to $18.84/ha. The top weeds in summer fallow based on area of infestation, yield loss and revenue loss nationally are presented in Table 24, p32. Nationally the ranking of top weeds based on revenue losses are: melons ($89.6 million); heliotrope

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TABLE 6 Yield loss and revenue loss for residual weeds in all crops.

	Residual weeds for all crops			
	Yield loss (tonnes)	Revenue loss	Yield loss (t/ha)	Revenue loss (per hectare)
Northern	313,999	$67.1m	0.08	$16.39
Central Queensland	42,554	$10.0m	0.11	$25.03
NSW NE/Queensland SE	204,967	$41.9m	0.09	$18.50
NSW NW/Queensland SW	66,478	$15.2m	0.05	$10.62
Southern	444,549	$113.8m	0.04	$10.58
NSW Central	37,144	$8.8m	0.02	$5.24
NSW Victorian Slopes	74,407	$19.2m	0.03	$8.89
SA Mid North – Lower Yorke Eyre	140,936	$37.5m	0.08	$21.67
SA Victorian Bordertown – Wimmera	95,724	$24.6m	0.05	$13.27
SA Victorian Mallee	72,895	$17.8m	0.02	$5.90
Victorian high-rainfall and Tasmanian grain	23,443	$5.9m	0.07	$18.60
Western	340,022	$96.8m	0.04	$12.25
WA Central	222,486	$63.4m	0.05	$14.64
WA Eastern	33,244	$8.7m	0.03	$6.87
WA Sandplain - Mallee	27,084	$8.9m	0.03	$9.34
WA Northern	57,208	$15.9m	0.04	$11.69
Total / National	1,098,570	$277.6m	0.05	$12.21

Residual weeds in all crops made up of wheat, barley, oats, canola, pulses and sorghum, expressed per production area (not including fallow weeds).

TABLE 7 National ranking of top residual weeds in all crops.

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
1	Ryegrass	8,009,979	Ryegrass	346,618	Ryegrass	$93.1m
2	Wild radish	5,091,752	Wild radish	192,321	Wild radish	$53.0m
3	Wild oats	2,014,737	Wild oats	114,596	Wild oats	$28.1m
4	Brome grass	1,414,297	Brome grass	91,392	Brome grass	$22.5m
5	Wild turnip	1,239,215	Barnyard grass	77,734	Barnyard grass	$14.7m
6	Wild mustard	973,874	Sweet summer grass	45,888	Wild turnip	$10.6m
7	Fleabane	597,531	Wild turnip	40,770	Sweet summer grass	$8.8m
8	Sow thistle / milk thistle	595,705	Feathertop Rhodes grass	39,329	Feathertop Rhodes grass	$7.7m
9	Barley grass	244,558	Wild mustard	19,885	Wild mustard	$4.9m
10	Cape weed	213,339	Sow thistle / milk thistle	18,107	Vetches	$4.9m
11	Doublegee	177,880	Vetches	11,517	Sow thistle / milk thistle	$4.9m
12	Vetches	174,789	Amsinkia / yellow burr weed	8253	Amsinkia / yellow burr weed	$2.0m
13	Wireweed	169,318	Noogoora burr	7667	Wireweed	$1.7m
14	Cutleaf mignonette	137,131	Wireweed	7398	Barley grass	$1.7m
15	Phalaris	124,930	Barley grass	6294	Noogoora burr	$1.4m
16	Barnyard grass	121,403	Fleabane	5807	Doublegee	$1.4m
17	Black bindweed / climbing buckwheat	121,304	Doublegee	5470	Fleabane	$1.3m
18	Feathertop Rhodes grass	117,512	Cape weed	3848	Black bindweed / climbing buckwheat	$1.2m
19	Thistle species	110,909	Black bindweed / climbing buckwheat	3804	Cape weed	$1.1m
20	Paterson's curse / salvation Jane	90,088	Brassica weeds	3357	Skeleton weed	$866.7k

TABLE 8 Regional ranking of top residual weeds in all crops.

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
Northern						
1	Wild oats	631,207	Barnyard grass	77,677	Barnyard grass	$14.7m
2	Sow thistle / milk thistle	514,250	Sweet summer grass	45,888	Wild turnip	$10.3m
3	Wild turnip	505,560	Wild turnip	39,632	Sweet summer grass	$8.8m
4	Fleabane	345,901	Feathertop Rhodes grass	39,329	Feathertop Rhodes grass	$7.7m
5	Ryegrass	317,210	Wild oats	20,396	Wild oats	$4.5m
6	Wild mustard	138,753	Ryegrass	16,670	Sow thistle / milk thistle	$4.2m
7	Black bindweed / climbing buckwheat	121,304	Sow thistle / milk thistle	16,058	Ryegrass	$3.8m
8	Feathertop Rhodes grass	117,512	Wild radish	10,848	Wild radish	$2.5m
9	Phalaris	116,062	Noogoora burr	7667	Noogoora burr	$1.4m
10	Barnyard grass	111,114	Fleabane	4855	Black bindweed / climbing buckwheat	$1.2m
11	Wild radish	79,440	Wild mustard	4175	Wild mustard	$1.1m
12	Mexican poppy	65,606	Black bindweed / climbing buckwheat	3804	Fleabane	$1.1m
13	Sweet summer grass	64,090	Mexican poppy	1845	Mexican poppy	$458.7k
14	Thistle species	52,381	Wireweed	1843	Marshmallow	$437.5k
15	Wireweed	36,388	Thistle species	1667	Wireweed	$382.2k
16	Doublegee	28,919	Fumitory	1419	Thistle species	$365.9k
17	Brassica weeds	25,083	Bathurst burr	1126	Fumitory	$303.9k

Continued page 22

TABLE 8 Regional ranking of top residual weeds in all crops (continued).

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
18	Bathurst burr	24,879	Phalaris	1081	Phalaris	$238.0k
19	Billy goat weed	13,832	Marshmallow	1011	Brassica weeds	$226.0k
20	Cape weed	13,809	Brassica weeds	991	Bathurst burr	$214.6k
Southern						
1	Ryegrass	3,419,170	Ryegrass	155,332	Ryegrass	$38.9m
2	Wild oats	1,252,299	Wild oats	87,855	Wild oats	$21.7m
3	Brome grass	1,122,207	Brome grass	86,683	Brome grass	$21.0m
4	Wild mustard	822,497	Wild radish	37,169	Wild radish	$10.4m
5	Wild radish	739,339	Wild mustard	15,711	Vetches	$4.9m
6	Wild turnip	586,488	Vetches	11,517	Wild mustard	$3.8m
7	Fleabane	189,422	Amsinkia / yellow burr weed	8253	Amsinkia / yellow burr weed	$2.0m
8	Vetches	174,789	Wireweed	5555	Wireweed	$1.4m
9	Barley grass	152,483	Barley grass	3661	Barley grass	$1.0m
10	Cape weed	138,380	Skeleton weed	3302	Skeleton weed	$866.7k
11	Cutleaf mignonette	137,131	Prickly lettuce / whip thistle	2979	Sow thistle / milk thistle	$730.7k
12	Paterson's curse / salvation Jane	90,088	Doublegee	2768	Prickly lettuce / whip thistle	$729.4k
13	Amsinkia / yellow burr weed	90,024	Brassica weeds	2367	Doublegee	$588.9k
14	Doublegee	89,428	Lincoln weed	2268	Cape weed	$577.0k
15	Wireweed	89,068	Cape weed	2082	Lincoln weed	$533.7k
16	Skeleton weed	86,023	Sow thistle / milk thistle	2049	Brassica weeds	$516.5k
17	Sow thistle / milk thistle	81,454	Paterson's curse / salvation Jane	1834	Paterson's curse / salvation Jane	$422.8k
18	Prickly lettuce / whip thistle	77,518	Thistle species	1501	Cutleaf mignonette	$406.1k
19	Thistle species	55,960	Cutleaf mignonette	1417	Bedstraw	$400.8k
20	Brassica weeds	50,418	Wild turnip	1086	Thistle species	$395.1k
Western						
1	Ryegrass	4,273,599	Ryegrass	174,615	Ryegrass	$50.3m
2	Wild radish	4,272,973	Wild radish	144,304	Wild radish	$40.1m
3	Brome grass	292,090	Wild oats	6345	Wild oats	$1.9m
4	Wild turnip	147,168	Brome grass	4709	Brome grass	$1.4m
5	Wild oats	131,231	Doublegee	2574	Doublegee	$753.9k
6	Barley grass	85,807	Barley grass	2272	Barley grass	$610.2k
7	Fleabane	62,208	Cape weed	1744	Cape weed	$483.2k
8	Cape weed	61,150	Toadrush	541	Toadrush	$139.1k
9	Doublegee	59,532	Marshmallow	266	Marshmallow	$130.2k
10	Wireweed	43,861	Thistle species	147	Thistle species	$79.5k
11	Toadrush	27,433	Fleabane	117	Fleabane	$31.9k
12	Marshmallow	19,799	Wild turnip	53	Wild turnip	$13.8k
13	Wild mustard	12,624	-	-	-	-
14	Khaki weed	3217	-	-	-	-
15	Thistle species	2569	-	-	-	-
16	Silver grass	2120	-	-	-	-

TABLE 9 Yield loss and revenue loss for residual weeds in winter cereals.

	Yield loss (tonnes)				Revenue loss			
	Wheat	Barley	Oats	**Total**	Wheat	Barley	Oats	**Total**
Northern	96,130	8,996	3,114	**108,240**	$21.6m	$1.8m	$522.1k	**$23.9m**
Central Queensland	16,578	27	19	**16,625**	$3.8m	$6.1k	$3.0k	**$3.9m**
NSW NE/Queensland SE	30,239	5268	2321	**37,828**	$6.7m	$1.1m	$387.6k	**$8.2m**
NSW NW/Queensland SW	49,314	3700	774	**53,788**	$11.0m	$714.2k	$131.5k	**$11.8m**
Southern	285,414	94,249	15,425	**395,088**	$68.6m	$19.6m	$3.0m	**$91.1m**
NSW Central	28,637	2968	1709	**33,314**	$6.2m	$575.7k	$290.5k	**$7.1m**
NSW Victorian Slopes	52,894	5745	3117	**61,756**	$11.5m	$1.1m	$539.2k	**$13.2m**
SA Mid North - Lower Yorke Eyre	92,353	33,461	1794	**127,609**	$24.0m	$7.2m	$371.4k	**$31.6m**
SA Victorian Bordertown - Wimmera	46,303	29,676	5636	**81,615**	$10.8m	$6.0m	$1.1m	**$18.0m**
SA Victorian Mallee	51,636	17,459	717	**69,812**	$12.8m	$3.6m	$147.0k	**$16.5m**
Victorian high-rainfall and Tasmanian grain	13,590	4940	2452	**20,982**	$3.2m	$1.0m	$487.9k	**$4.7m**
Western	242,476	27,224	14,122	**283,821**	$64.0m	$6.4m	$2.8m	**$73.2m**
WA Central	159,715	20,816	10,693	**191,224**	$42.2m	$4.9m	$2.1m	**$49.2m**
WA Eastern	25,318	2510	3068	**30,897**	$6.7m	$592.5k	$613.7k	**$7.9m**
WA Sandplain - Mallee	15,880	2764	251	**18,895**	$4.2m	$638.4k	$46.0k	**$4.9m**
WA Northern	41,563	1134	109	**42,807**	$11.0m	$262.1k	$21.5k	**$11.3m**
Total	624,020	130,470	32,660	**787,150**	$154.1m	$27.8m	$6.3m	**$188.2m**

TABLE 10 Yield loss and revenue loss for residual weeds in winter cereals per hectare.

	Yield loss (t/ha)				Revenue loss (per ha)			
	Wheat	Barley	Oats	**Total**	Wheat	Barley	Oats	**Total**
Northern	0.04	0.03	0.03	**0.04**	$9.58	$5.06	$4.60	**$8.79**
Central Queensland	0.10	0.02	0.00	**0.09**	$22.60	$3.58	$0.37	**$21.43**
NSW NE/Queensland SE	0.03	0.02	0.03	**0.03**	$5.97	$4.17	$5.61	**$5.64**
NSW NW/Queensland SW	0.05	0.04	0.02	**0.05**	$11.51	$7.42	$3.60	**$10.88**
Southern	0.05	0.04	0.04	**0.05**	$11.07	$9.27	$8.23	**$10.51**
NSW Central	0.02	0.01	0.02	**0.02**	$5.34	$2.49	$3.46	**$4.78**
NSW Victorian Slopes	0.04	0.03	0.04	**0.04**	$9.11	$4.92	$6.11	**$8.34**
SA Mid North – Lower Yorke Eyre	0.11	0.07	0.09	**0.10**	$27.99	$16.12	$18.66	**$23.84**
SA Victorian Bordertown – Wimmera	0.07	0.06	0.06	**0.06**	$16.78	$11.61	$11.62	**$14.26**
SA Victorian Mallee	0.02	0.03	0.02	**0.03**	$6.04	$5.81	$3.24	**$5.94**
Victorian high-rainfall and Tasmanian grain	0.09	0.08	0.09	**0.09**	$21.72	$16.41	$18.84	**$20.01**
Western	0.05	0.02	0.05	**0.05**	$13.14	$5.55	$10.82	**$11.64**
WA Central	0.06	0.03	0.05	**0.06**	$16.97	$6.62	$9.66	**$14.26**
WA Eastern	0.03	0.02	0.11	**0.03**	$6.58	$4.88	$22.23	**$6.77**
WA Sandplain – Mallee	0.04	0.01	0.06	**0.03**	$10.44	$2.57	$11.50	**$7.45**
WA Northern	0.04	0.03	0.01	**0.04**	$11.28	$6.18	$2.86	**$11.01**
Total / National	0.05	0.04	0.04	**0.04**	$11.57	$7.67	$8.59	**$10.65**

Losses are expressed as production area by crop type.

TABLE 11 Density of most common residual weed in cereal crops as reported by growers.

	Density of residual weed in cereal		
	Low	Medium	High
Northern	60%	29%	11%
Central Queensland	66%	14%	20%
NSW NE/Queensland SE	63%	29%	7%
NSW NW/Queensland SW	54%	36%	9%
Southern	48%	40%	12%
NSW Central	51%	39%	10%
NSW Victorian Slopes	64%	30%	6%
SA Mid North – Lower Yorke Eyre	44%	39%	17%
SA Victorian Bordertown – Wimmera	41%	46%	13%
SA Victorian Mallee	42%	46%	12%
Victorian high-rainfall and Tasmanian grain	45%	43%	11%
Western	61%	28%	11%
WA Central	55%	36%	8%
WA Eastern	66%	21%	14%
WA Sandplain – Mallee	63%	29%	8%
WA Northern	62%	26%	13%
Total / National	54%	34%	11%

Expressed as percentage of reported weed densities per region where growers were asked to report on their two most common residual cereal weeds.
Low = <1/m^2, medium =1–10/m^2, high = >10/m^2.

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(potato weed) ($82.3 million); fleabane ($43.2 million). Ranking of weeds by revenue loss varies from region to region (Table 8, p22). In the northern region these are: barnyard grass ($15.8 million); fleabane ($15.3 million); and sow thistle/milk thistle ($6.5 million) – Table 25, p33. In the southern region these are: heliotrope (potato weed) ($82.3 million); melons ($39.3 million); and fleabane ($17.5 million). In the western region these are: melons ($49.6 million); caltrop/bindi ($16.2 million); and fleabane ($10.5 million). For ranking by AEZs see Appendix 9.7, p97.

Winter fallow

Total yield loss due to weeds in winter fallow in the northern region is estimated to be 7,649 tonnes resulting in a revenue loss of $1.4 million (Table 22, p31). The top weeds in winter fallow based on area of infestation, yield loss and revenue loss nationally are presented in Table 26, p34. Across the northern region, the winter fallow weeds with the largest impact on the sorghum crop are; sow thistle/milk thistle ($354,000), fleabane ($232,500), wild turnip ($185,700). The costs of winter fallow weeds were not calculated for the southern and western regions as winter fallowing and summer cropping are not common practices. Similar to crop weed densities in both summer and winter fallow are reported as low (Table 23, page 31).

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TABLE 12 National ranking of top residual weeds in winter cereals.

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
1	Ryegrass	6,658,330	Ryegrass	309,688	Ryegrass	$76.1m
2	Wild radish	4,374,171	Wild radish	160,051	Wild radish	$40.0m
3	Wild oats	1,817,656	Wild oats	101,617	Wild oats	$22.5m
4	Brome grass	1,239,215	Brome grass	87,194	Brome grass	$20.6m
5	Wild turnip	1,069,606	Wild turnip	34,467	Wild turnip	$7.7m
6	Wild mustard	807,144	Wild mustard	17,874	Wild mustard	$4.0m
7	Fleabane	472,980	Sow thistle / milk thistle	14,437	Sow thistle / milk thistle	$3.2m
8	Sow thistle / milk thistle	458,302	Amsinkia / yellow burr weed	7960	Amsinkia / yellow burr weed	$1.9m
9	Barley grass	202,173	Wireweed	5827	Wireweed	$1.4m
10	Wireweed	151,349	Barley grass	5288	Barley grass	$1.3m
11	Doublegee	136,946	Doublegee	3860	Doublegee	$869.2k
12	Cutleaf mignonette	130,593	Brassica weeds	3296	Cape weed	$754.2k
13	Cape weed	130,531	Cape weed	3216	Brassica weeds	$714.1k
14	Phalaris	123,917	Skeleton weed	2861	Skeleton weed	$672.6k
15	Black bindweed / climbing buckwheat	99,381	Thistle species	2769	Thistle species	$593.3k
16	Amsinkia / yellow burr weed	80,737	Prickly lettuce / whip thistle	2520	Prickly lettuce / whip thistle	$526.3k
17	Skeleton weed	80,075	Black bindweed / climbing buckwheat	2115	Lincoln weed	$453.9k
18	Thistle species	77,619	Lincoln weed	2,064	Black bindweed / climbing buckwheat	$448.2k
19	Brassica weeds	69,479	Fleabane	2,036	Fleabane	$438.9k
20	Vetches	59,504	Feathertop Rhodes grass	1,830	Feathertop Rhodes grass	$423.4k

TABLE 13 Regional ranking of top residual weeds in winter cereals by area, yield loss and revenue loss.

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
Northern						
1	Wild oats	552,933	Wild turnip	33,473	Wild turnip	$7.5m
2	Sow thistle / milk thistle	444,553	Wild oats	18,339	Wild oats	$4.0m
3	Wild turnip	400,488	Ryegrass	15,642	Ryegrass	$3.4m
4	Ryegrass	297,649	Sow thistle / milk thistle	13,517	Sow thistle / milk thistle	$3.0m
5	Fleabane	233,188	Wild radish	10,687	Wild radish	$2.4m
6	Phalaris	115,496	Wild mustard	3402	Wild mustard	$749.6k
7	Wild mustard	105,528	Black bindweed / climbing buckwheat	2115	Black bindweed / climbing buckwheat	$448.2k
8	Black bindweed / climbing buckwheat	99,381	Feathertop Rhodes grass	1830	Feathertop Rhodes grass	$423.4k
9	Wild radish	76,352	Mexican poppy	1693	Mexican poppy	$385.3k
10	Mexican poppy	50,224	Thistle species	1647	Thistle species	$356.5k
11	Thistle species	49,938	Fumitory	1419	Fumitory	$303.9k
12	Wireweed	28,703	Fleabane	1150	Fleabane	$245.6k
13	Doublegee	24,700	Phalaris	1079	Phalaris	$237.1k
14	Feathertop Rhodes grass	24,507	Brassica weeds	960	Brassica weeds	$212.6k
15	Barnyard grass	20,953	Barley grass	361	Barley grass	$71.2k
16	Brassica weeds	20,352	Wireweed	283	Wireweed	$63.1k
17	Cape weed	13,504	Sweet summer grass	203	Sweet summer grass	$47.2k
18	Billy goat weed	13,379	Barnyard grass	121	Barnyard grass	$26.4k
19	Mint weed	9570	Doublegee	50	Doublegee	$10.6k
20	Barley grass	6268	Marshmallow	29	Marshmallow	$5.5k
Southern						
1	Ryegrass	2,957,270	Ryegrass	144,855	Ryegrass	$34.1m
2	Wild oats	1,166,559	Brome grass	83,562	Brome grass	$19.7m
3	Brome grass	1,050,649	Wild oats	78,551	Wild oats	$17.3m
4	Wild mustard	688,992	Wild radish	28,844	Wild radish	$6.5m
5	Wild radish	582,571	Wild mustard	14,471	Wild mustard	$3.2m
6	Wild turnip	525,394	Amsinkia / yellow burr weed	7960	Amsinkia / yellow burr weed	$1.9m
7	Fleabane	178,506	Wireweed	5544	Wireweed	$1.4m
8	Cutleaf mignonette	130,593	Skeleton weed	2861	Barley grass	$687.3k
9	Barley grass	117,485	Barley grass	2830	Skeleton weed	$672.6k
10	Doublegee	82,439	Doublegee	2750	Doublegee	$581.1k
11	Amsinkia / yellow burr weed	80,737	Prickly lettuce / whip thistle	2520	Prickly lettuce / whip thistle	$526.3k
12	Skeleton weed	80,075	Brassica weeds	2335	Brassica weeds	$501.4k
13	Wireweed	78,785	Lincoln weed	2064	Lincoln weed	$453.9k
14	Cape weed	73,171	Paterson's curse / salvation Jane	1675	Vetches	$357.9k
15	Vetches	59,504	Cape weed	1575	Paterson's curse / salvation Jane	$350.3k
16	Paterson's curse / salvation Jane	57,694	Vetches	1535	Cape weed	$330.3k
17	Brassica weeds	49,127	Cutleaf mignonette	1126	Cutleaf mignonette	$292.5k
18	Windmill grass	29,610	Thistle species	1122	Thistle species	$236.8k
19	Prickly lettuce / whip thistle	28,108	Wild turnip	942	Wild turnip	$221.3k
20	Thistle species	27,680	Sow thistle / milk thistle	921	Sow thistle / milk thistle	$204.2k

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TABLE 13 Regional ranking of top residual weeds in winter cereals by area, yield loss and revenue loss continued.

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
Western						
1	Wild radish	3,715,249	Ryegrass	149,191	Ryegrass	$38.6m
2	Ryegrass	3,403,410	Wild radish	120,520	Wild radish	$31.0m
3	Brome grass	188,565	Wild oats	4727	Wild oats	$1.2m
4	Wild turnip	143,724	Brome grass	3631	Brome grass	$944.1k
5	Wild oats	98,164	Barley grass	2097	Barley grass	$528.5k
6	Barley grass	78,420	Cape weed	1619	Cape weed	$419.3k
7	Fleabane	61,285	Doublegee	1060	Doublegee	$277.4k
8	Wireweed	43,861	Toadrush	541	Toadrush	$139.1k
9	Cape weed	43,857	Fleabane	109	Fleabane	$27.3k
10	Doublegee	29,806	Wild turnip	53	Wild turnip	$13.8k
11	Toadrush	27,433	-	-	-	-
12	Wild mustard	12,624	-	-	-	-

TABLE 14 Yield loss and revenue loss for residual weeds in canola and pulses.

	Yield loss (tonnes)			Revenue loss		
	Canola	Pulses	Total	Canola	Pulses	Total
Northern	3293	13,094	16,387	$1.6m	$5.9m	$7.5m
Central Queensland	13	3,927	3940	$4.2k	$2.0m	$2.0m
NSW NE/Queensland SE	2720	5548	8268	$1.3m	$2.4m	$3.7m
NSW NW/Queensland SW	560	3619	4179	$269.9k	$1.5m	$1.7m
Southern	30,387	19,074	49,461	$15.2m	$7.5m	$22.7m
NSW Central	2757	1073	3830	$1.3m	$360.4k	$1.7m
NSW Victorian Slopes	12,171	480	12,651	$5.9m	$141.1k	$6.0m
SA Mid North – Lower Yorke Eyre	5024	8,303	13,327	$2.6m	$3.2m	$5.9m
SA Victorian Bordertown – Wimmera	6615	7,494	14,109	$3.4m	$3.2m	$6.6m
SA Victorian Mallee	1487	1,595	3082	$765.9k	$512.0k	$1.3m
Victorian high-rainfall and Tasmanian grain	2332	129	2461	$1.2m	$51.5k	$1.2m
Western	32,468	23,733	56,200	$17.6m	$6.0m	$23.5m
WA Central	21,600	9,662	31,262	$11.7m	$2.4m	$14.1m
WA Eastern	708	1640	2348	$382.2k	$418.2k	$800.4k
WA Sandplain – Mallee	6768	1421	8189	$3.7m	$355.2k	$4.0m
WA Northern	3392	11,009	14,401	$1.8m	$2.8m	$4.6m
Total / National	**66,147**	**55,901**	**122,048**	**$34.4m**	**$19.4m**	**$53.7m**

From page 24

The NSW NE/Queensland SE zone had the largest loss from winter fallow weeds due to the importance of sorghum in this zone in comparison with the other zones. In the NSW NW/Queensland SW zone, the main weeds were windmill grass, brassica weeds and climbing buckwheat, whereas in Central Queensland the main weeds were feathertop Rhodes grass, sow thistle and brassica weeds. For ranking by AEZs see Appendix 9.8 – Table 98, p104.

3.2.3 Grain contamination and cleaning

Another source of costs from weeds is through weeds contaminating grain samples. Contamination costs come from the cost of cleaning ($25/t) due to the presence of weeds or through downgrade penalties ($22/t). The national cost of grain cleaning and price penalty due to weed contamination is relatively small at $37 million (Figure 6, p27 and Table 28, p35). These costs only contribute one per cent of the total combined yield loss and control expenditure cost, reflecting the low frequency of cleaning and downgrading penalties.

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TABLE 15 Yield loss and revenue loss for residual weeds in canola and pulses per hectare.

	Yield loss (t/ha)			Revenue loss (per hectare)		
	Canola	Pulses	Total	Canola	Pulses	Total
Northern	0.03	0.02	0.02	$12.40	$9.41	$9.91
Central Queensland	0.06	0.05	0.05	$20.85	$24.09	$24.09
NSW NE/Queensland SE	0.04	0.02	0.02	$21.40	$7.67	$9.89
NSW NW/Queensland SW	0.01	0.02	0.01	$4.06	$6.45	$5.91
Southern	0.02	0.03	0.02	$11.41	$10.03	$10.91
NSW Central	0.02	0.02	0.02	$9.60	$7.09	$8.93
NSW Victorian Slopes	0.02	0.01	0.02	$11.44	$2.36	$10.49
SA Mid North – Lower Yorke Eyre	0.03	0.04	0.03	$15.75	$13.73	$14.57
SA Victorian Bordertown – Wimmera	0.02	0.03	0.02	$10.72	$11.66	$11.16
SA Victorian Mallee	0.01	0.01	0.01	$6.47	$4.27	$5.36
Victorian high-rainfall and Tasmanian grain	0.03	0.02	0.03	$15.44	$6.96	$14.69
Western	0.03	0.04	0.03	$16.46	$11.01	$14.63
WA Central	0.03	0.04	0.04	$18.13	$10.43	$16.09
WA Eastern	0.01	0.05	0.02	$5.88	$12.16	$8.05
WA Sandplain - Mallee	0.03	0.02	0.03	$16.04	$5.08	$13.47
WA Northern	0.03	0.05	0.04	$14.24	$13.51	$13.79
Total / National	0.03	0.03	0.03	$13.60	$10.10	$12.09

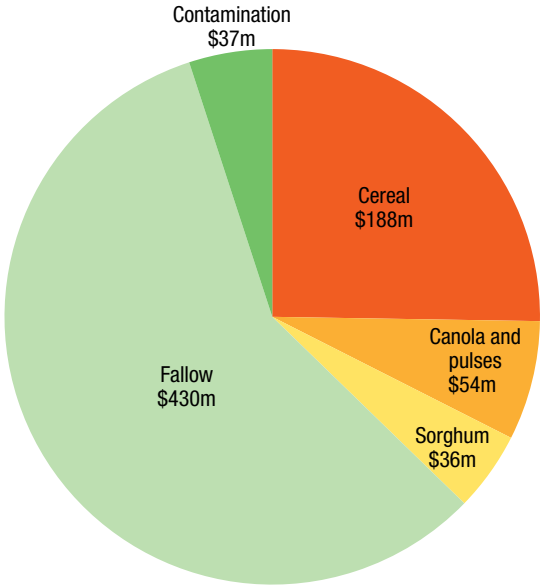
Losses are expressed as production area by crop type.

TABLE 16 Density of most common residual weeds in canola and pulse crops as reported by growers.

	Density of residual weed in canola and pulses		
	Low	Medium	High
Northern	66%	26%	8%
Central Queensland	71%	19%	10%
NSW NE/Queensland SE	52%	38%	10%
NSW NW/Queensland SW	75%	20%	5%
Southern	65%	30%	5%
NSW Central	64%	27%	9%
NSW Victorian Slopes	79%	18%	3%
SA Mid North - Lower Yorke Eyre	52%	41%	6%
SA Victorian Bordertown – Wimmera	65%	32%	2%
SA Victorian Mallee	66%	30%	4%
Victorian high-rainfall and Tasmanian grain	61%	31%	8%
Western	58%	35%	7%
WA Central	51%	44%	4%
WA Eastern	64%	27%	9%
WA Sandplain - Mallee	56%	35%	9%
WA Northern	65%	29%	6%
Total / National	63%	31%	6%

Expressed as percentage of reported weed densities per region where growers were asked to report on their two most common canola and pulse weeds. Low = <1/m^2, medium = 1–10/m^2, high = >10/m^2.

FIGURE 6 Yield revenue loss arising from contamination and cleaning costs is $37m.



The total cost of weeds is estimated at $3.23 billion. This is made up of yield revenue loss ($0.7 billion) and total expenditure ($2.57 billion). Yield revenue loss can be broken down further into: yield loss due to weeds in cereal crops, canola and pulses, sorghum, and fallow, as well as losses from contamination and costs due to cleaning grain.

TABLE 17 National ranking of top residual weeds in canola and pulses by area, yield loss and revenue loss.

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
1	Ryegrass	1,351,506	Ryegrass	36,926	Ryegrass	$17.0m
2	Wild radish	717,581	Wild radish	32,270	Wild radish	$13.1m
3	Wild oats	192,973	Wild oats	11,615	Wild oats	$5.4m
4	Brome grass	175,082	Vetches	9982	Vetches	$4.6m
5	Wild turnip	169,609	Wild turnip	6303	Wild turnip	$2.9m
6	Wild mustard	166,385	Brome grass	4198	Brome grass	$1.8m
7	Sow thistle / milk thistle	136,998	Sow thistle / milk thistle	3658	Sow thistle / milk thistle	$1.7m
8	Vetches	115,285	Wild mustard	2012	Wild mustard	$967.4k
9	Cape weed	82,808	Black bindweed / climbing buckwheat	1689	Black bindweed / climbing buckwheat	$747.4k
10	Fleabane	59,707	Doublegee	1610	Marshmallow	$591.9k
11	Prickly lettuce / whip thistle	52,528	Marshmallow	1310	Doublegee	$517.5k
12	Barley grass	42,385	Barley grass	1006	Barley grass	$421.5k
13	Doublegee	40,934	Bedstraw	909	Bedstraw	$400.8k
14	Marshmallow	39,451	Fleabane	679	Cape weed	$311.1k
15	Thistle species	33,290	Cape weed	632	Fleabane	$286.1k
16	Paterson's curse / salvation Jane	32,394	Thistle species	546	Feathertop Rhodes grass	$249.5k
17	Mexican poppy	28,069	Feathertop Rhodes grass	503	Thistle species	$247.1k
18	Black bindweed / climbing buckwheat	21,208	Prickly lettuce / whip thistle	481	Sweet summer grass	$235.3k
19	Feathertop Rhodes grass	19,590	Sweet summer grass	463	Prickly lettuce / whip thistle	$212.5k
20	Silver grass	17,715	Skeleton weed	441	Skeleton weed	$194.2k

FIGURE 7 Total cost of weeds per hectare is $146, based on total yield revenue loss ($33/ha) and total expenditure ($113/ha).

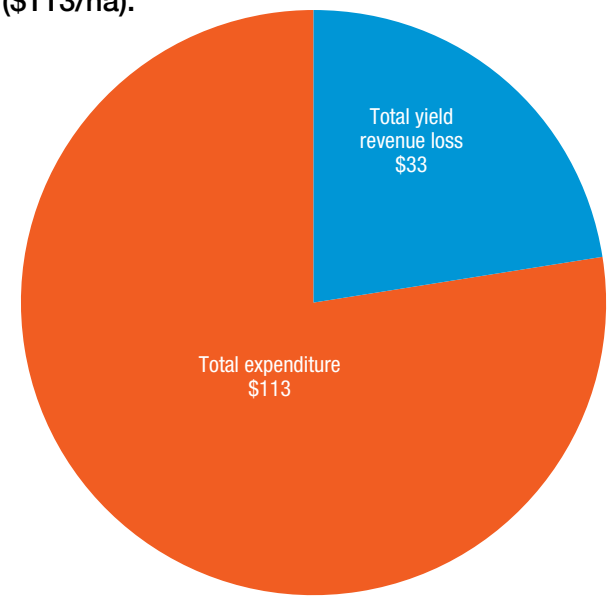


FIGURE 8 Weed control expenditure ($2,573 million) includes in-season and fallow herbicide use (including application costs) and integrated weed management practices.

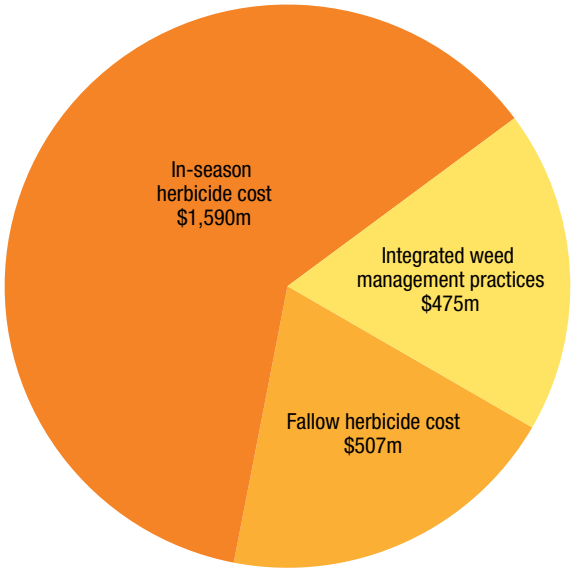


TABLE 18 Regional ranking of top residual weeds in canola and pulses by area, yield loss and revenue loss.

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
Northern						
1	Wild turnip	105,072	Wild turnip	6,159	Wild turnip	$2.8m
2	Wild oats	74,166	Sow thistle / milk thistle	2,529	Sow thistle / milk thistle	$1.2m
3	Sow thistle / milk thistle	69,292	Black bindweed / climbing buckwheat	1,689	Black bindweed / climbing buckwheat	$747.4k
4	Fleabane	47,870	Ryegrass	1,025	Ryegrass	$452.0k
5	Wild mustard	32,880	Marshmallow	982	Marshmallow	$431.9k
6	Black bindweed / climbing buckwheat	21,208	Wild mustard	772	Wild mustard	$370.6k
7	Feathertop Rhodes grass	19,590	Wild oats	692	Wild oats	$284.7k
8	Ryegrass	19,419	Fleabane	613	Fleabane	$255.0k
9	Mexican poppy	15,382	Feathertop Rhodes grass	503	Feathertop Rhodes grass	$249.5k
10	Marshmallow	11,495	Sweet summer grass	463	Sweet summer grass	$235.3k
11	Sweet summer grass	7443	Barnyard grass	212	Barnyard grass	$93.2k
12	Parthenium weed	7190	Wild radish	161	Mexican poppy	$73.5k
13	Wireweed	5542	Mexican poppy	151	Wild radish	$70.7k
14	Brassica weeds	4730	Wireweed	99	Wireweed	$43.0k
15	Doublegee	4219	Doublegee	78	Doublegee	$33.3k
16	Shepherd's purse	4050	Parthenium weed	65	Parthenium weed	$33.1k
17	Prickly lettuce / whip thistle	3119	Brassica weeds	30	Brassica weeds	$13.3k
18	Wild radish	3089	Thornapple	27	Thornapple	$11.7k
19	Barnyard grass	3072	Prickly lettuce / whip thistle	22	Prickly lettuce / whip thistle	$9.4k
20	Thistle species	2442	Thistle species	20	Thistle species	$9.4k
Southern						
1	Ryegrass	461,899	Ryegrass	10,477	Ryegrass	$4.8m
2	Wild radish	156,768	Vetches	9982	Vetches	$4.6m
3	Wild mustard	133,505	Wild oats	9305	Wild oats	$4.4m
4	Vetches	115,285	Wild radish	8325	Wild radish	$3.9m
5	Wild oats	85,741	Brome grass	3121	Brome grass	$1.4m
6	Brome grass	71,558	Wild mustard	1239	Wild mustard	$596.8k
7	Sow thistle / milk thistle	67,706	Sow thistle / milk thistle	1129	Sow thistle / milk thistle	$526.5k
8	Cape weed	65,209	Bedstraw	909	Bedstraw	$400.8k
9	Wild turnip	61,094	Barley grass	831	Barley grass	$339.8k
10	Prickly lettuce / whip thistle	49,410	Cape weed	507	Cape weed	$246.7k
11	Barley grass	34,998	Prickly lettuce / whip thistle	458	Prickly lettuce / whip thistle	$203.1k
12	Paterson's curse / salvation Jane	32,394	Skeleton weed	441	Skeleton weed	$194.2k
13	Thistle species	28,279	Thistle species	379	Thistle species	$158.2k
14	Silver grass	15,595	Amsinkia / yellow burr weed	293	Cutleaf mignonette	$113.7k
15	Bedstraw	14,152	Cutleaf mignonette	291	Amsinkia / yellow burr weed	$110.1k
16	Mexican poppy	12,687	Lincoln weed	204	Lincoln weed	$79.7k
17	Fleabane	10,915	Paterson's curse / salvation Jane	159	Paterson's curse / salvation Jane	$72.4k
18	Wireweed	10,283	Wild turnip	144	Wild turnip	$58.0k
19	Bifora	10,094	Silver grass	102	Mexican poppy	$46.8k
20	Poppy species	9815	Mexican poppy	98	Silver grass	$43.3k

TABLE 18 Regional ranking of top residual weeds in canola and pulses by area, yield loss and revenue loss (continued).

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
Western						
1	Ryegrass	870,188	Ryegrass	25,424	Ryegrass	$11.7m
2	Wild radish	557,724	Wild radish	23,784	Wild radish	$9.1m
3	Brome grass	103,524	Wild oats	1,618	Wild oats	$693.9k
4	Wild oats	33,067	Doublegee	1,515	Brome grass	$480.3k
5	Doublegee	29,726	Brome grass	1,077	Doublegee	$476.5k
6	Marshmallow	19,799	Marshmallow	266	Marshmallow	$130.2k
7	Cape weed	17,294	Barley grass	175	Barley grass	$81.7k
8	Barley grass	7,387	Thistle species	147	Thistle species	$79.5k
9	Wild turnip	3,444	Cape weed	124	Cape weed	$64.0k
10	Khaki weed	3,217				
11	Thistle species	2,569				
12	Silver grass	2,120				
13	Fleabane	922				

TABLE 19 Yield loss and revenue loss for residual weeds in sorghum (total loss and loss per hectare.

	Yield loss (tonnes)	Revenue loss	Yield loss (t/ha)	Revenue loss (per hectare)
Northern	189,372	$35.8m	0.30	$57.19
Central Queensland	21,990	$4.1m	0.16	$30.35
NSW NE/ Queensland SE	158,871	$30.0m	0.36	$68.03
NSW NW/ Queensland SW	8511	$1.6m	0.18	$33.51

Revenue loss per hectare (loss is expressed as production area of crop type).

TABLE 20 Density of most common residual weeds in sorghum crops as reported by growers.

	Density of residual weed in sorghum		
	Low	Medium	High
Northern	54%	31%	15%
Central Queensland	68%	25%	8%
NSW NE/ Queensland SE	48%	34%	18%
NSW NW/ Queensland SW	-	-	-

Expressed as percentage of reported weed densities per region where growers were asked to report on their two most common sorghum weeds.
Low = <1/m^2, medium = 1–10/m^2, high = >10/m^2.

TABLE 21 National ranking of top residual weeds in sorghum by area, yield loss and revenue loss.

	Residual weeds in sorghum					
Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
1	Barnyard grass	87,089	Barnyard grass	77,343	Barnyard grass	$14.6m
2	Feathertop Rhodes grass	73,414	Sweet summer grass	45,221	Sweet summer grass	$8.5m
3	Fleabane	64,844	Feathertop Rhodes grass	36,995	Feathertop Rhodes grass	$7.0m
4	Sweet summer grass	55,920	Noogoora burr	7667	Noogoora burr	$1.4m
5	Bathurst burr	23,969	Fleabane	3092	Fleabane	$584.4k
6	Noogoora burr	10,780	Wireweed	1461	Wireweed	$276.1k
7	Wild oats	4108	Wild oats	1365	Wild oats	$257.9k
8	Thornapple	3286	Bathurst burr	1118	Bathurst burr	$211.3k
9	Caltrop / bindi	3072	Parthenium weed	523	Parthenium weed	$98.3k
10	Bellvine	2947	Thornapple	386	Thornapple	$72.9k
11	Parthenium weed	2171	Caltrop / bindi	357	Caltrop / bindi	$67.5k
12	Wireweed	2143	Bellvine	175	Bellvine	$32.9k
13	Black bindweedt / climbing buckwheat	714	Sow thistle / milk thistle	12	Sow thistle / milk thistle	$2.3k
14	Melons	405	-	-	-	-
15	Sow thistle / milk thistle	405	-	-	-	-
16	Wild mustard	345	-	-	-	-
17	Ryegrass	143	-	-	-	-

TABLE 22 Yield loss and revenue loss from fallow weeds (expressed as total loss and loss per hectare).

	Summer fallow				Winter fallow	
	Yield loss (tonnes)	Yield loss (t/ha)	Revenue loss	Revenue loss ($/ha)	Yield loss (tonnes)	Revenue loss
Northern	290,245	0.07	$72.9m	$17.82	7,649	$1.4m
Central Queensland	23,679	0.06	$7.1m	$17.72	240	$45.2K
NSW NE/Queensland SE	140,604	0.06	$33.5m	$14.77	6970	$1.3m
NSW NW/Queensland SW	125,962	0.09	$32.4m	$22.70	439	$82.1K
Southern	980,700	0.09	$251.0m	$23.34	-	-
NSW Central	148,635	0.09	$33.6m	$20.12	-	-
NSW Victorian Slopes	225,522	0.10	$56.3m	$26.07	-	-
SA Mid North – Lower Yorke Eyre	131,768	0.08	$35.2m	$20.37	-	-
SA Victorian Bordertown – Wimmera	150,646	0.08	$42.2m	$22.79	-	-
SA Victorian Mallee	298,469	0.10	$76.8m	$25.45	-	-
Victorian high-rainfall and Tasmanian grain	25,661	0.08	$6.7m	$21.07	-	-
Western	385,030	0.05	$104.6m	$13.24	-	-
WA Central	209,871	0.05	$57.0m	$13.15	-	-
WA Eastern	86,678	0.07	$23.2m	$18.41	-	-
WA Sandplain – Mallee	41,285	0.04	$11.8m	$12.39	-	-
WA Northern	47,196	0.03	$12.6m	$9.31	-	-
Total / National	1,655,974	0.07	$428.5m	$18.84	7649	$1.4m

Loss per hectare expressed as area of production per region/zone. Winter fallow only considered for northern region.

TABLE 23 Density of most common fallow weeds as reported by growers.

	Summer fallow				Winter fallow	
	Low	Medium	High	Low	Medium	High
Northern	48%	36%	16%	50%	44%	6%
Central Queensland	53%	31%	16%	58%	33%	8%
NSW NE/Queensland SE	51%	34%	15%	60%	35%	6%
NSW NW/Queensland SW	41%	42%	18%	37%	58%	5%
Southern	47%	40%	13%	-	-	-
NSW Central	44%	38%	19%	-	-	-
NSW Victorian Slopes	55%	35%	10%	-	-	-
SA Mid North – Lower Yorke Eyre	49%	38%	13%	-	-	-
SA Victorian Bordertown – Wimmera	44%	48%	8%	-	-	-
SA Victorian Mallee	42%	44%	14%	-	-	-
Victorian high-rainfall and Tasmanian grain	49%	38%	13%	-	-	-
Western	45%	42%	13%	-	-	-
WA Central	47%	42%	11%	-	-	-
WA Eastern	32%	44%	24%	-	-	-
WA Sandplain - Mallee	41%	47%	12%	-	-	-
WA Northern	63%	33%	4%	-	-	-
Total / National	47%	40%	14%	-	-	-

Expressed as percentage of reported weed densities per region where growers were asked to report on their two most common fallow weeds.
Low = <1/m^2, medium = 1–10/m^2, high = >10/m^2.

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Results indicate that there are major differences between regions and, overall, 19 per cent of growers have cleaned seed due to weeds in the past three years. On average, those growers who conducted some grain cleaning cleaned 14 per cent of their grain (Table 27, p35).
Price penalties due to weed contamination are a related source of costs from weeds. Only 12 per cent of growers have incurred grain price penalties (Table 27) and typically this has been for only a small proportion of their tonnage (approximately 8 per cent, data not shown).

3.3 Weed control expenditure

Nationally, weed control expenditure makes up the majority of total weed cost at $2,573 million (or 78 per cent) equating to $113/ha (Figure 7, p28 and Table 29, p36, AEZ tabulated in Appendix 9.3 – Table 92, p89).

The Northern region spends the most at $149/ha, while the Southern region spends $116/ha and Western region only $91/ha. Most of these costs occur due to in-season herbicide use.

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TABLE 24 National ranking of summer fallow weeds by area, yield loss and revenue loss.

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
1	Melons	6,380,669	Melons	344,847	Melons	$89.6m
2	Heliotrope (potato weed)	2,804,650	Heliotrope (potato weed)	313,900	Heliotrope (potato weed)	$82.3m
3	Fleabane	2,793,252	Fleabane	173,291	Fleabane	$43.2m
4	Caltrop / bindi	1,695,521	Caltrop / bindi	115,217	Caltrop / bindi	$31.0m
5	Barnyard grass	635,900	Barnyard grass	74,514	Barnyard grass	$17.3m
6	Wild radish	592,238	Panic grass	58,700	Panic grass	$15.9m
7	Sow thistle / milk thistle	582,905	Windmill grass	36,871	Windmill grass	$9.1m
8	Windmill grass	533,495	Lincoln weed	34,578	Nut grass	$8.4m
9	Panic grass	434,372	Nut grass	32,042	Lincoln weed	$8.3m
10	Marshmallow	368,166	Sow thistle / milk thistle	27,739	Sow thistle / milk thistle	$8.0m
11	Wireweed	316,945	Sweet summer grass	27,615	Sweet summer grass	$7.0m
12	Sweet summer grass	280,640	Ryegrass	24,892	Ryegrass	$6.5m
13	Nut grass	264,028	Wireweed	24,818	Wireweed	$6.5m
14	Ryegrass	229,595	Wild radish	20,794	Wild radish	$5.8m
15	Mint weed	215,187	Mint weed	17,312	Mint weed	$4.1m
16	Cutleaf mignonette	188,564	Thistle species	13,453	Thistle species	$3.4m
17	Feathertop Rhodes grass	178,879	Marshmallow	11,536	Marshmallow	$3.2m
18	Bathurst burr	178,431	Barley grass	11,208	Feathertop Rhodes grass	$3.1m
19	Lincoln weed	152,772	Feathertop Rhodes grass	11,028	Paterson's curse / salvation Jane	$2.6m
20	Skeleton weed	138,532	Paterson's curse / salvation Jane	10,036	Barley grass	$2.5m

FIGURE 9 Weed control expenditure per hectare of cropping area in each region. In-season and fallow herbicide use included in application costs.

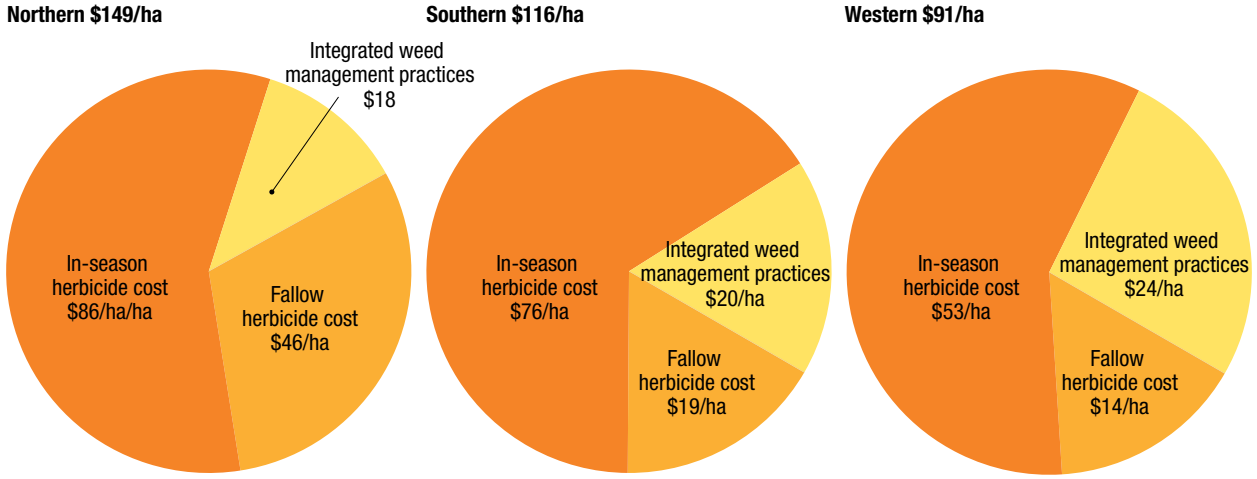

TABLE 25 Regional ranking of summer fallow weeds by area, yield loss and revenue loss.

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
Northern						
1	Fleabane	1,096,593	Barnyard grass	68,609	Barnyard grass	$15.8m
2	Barnyard grass	586,610	Fleabane	62,205	Fleabane	$15.3m
3	Sow thistle / milk thistle	469,720	Sow thistle / milk thistle	22,551	Sow thistle / milk thistle	$6.5m
4	Feathertop Rhodes grass	178,879	Sweet summer grass	13,923	Sweet summer grass	$3.5m
5	Sweet summer grass	169,410	Feathertop Rhodes grass	11,028	Feathertop Rhodes grass	$3.1m
6	Windmill grass	133,209	Windmill grass	8752	Windmill grass	$2.2m
7	Melons	68,794	Caltrop / bindi	7551	Caltrop / bindi	$1.7m
8	Ryegrass	54,873	Melons	2980	Wireweed	$759.3k
9	Caltrop / bindi	52,626	Wireweed	2907	Melons	$710.0k
10	Wireweed	42,144	Ryegrass	2369	Thistle species	$675.3k
11	Bathurst burr	35,317	Mint weed	2231	Ryegrass	$598.3k
12	Mint weed	28,780	Thistle species	1972	Mint weed	$494.5k
13	Thistle species	27,684	Wild oats	1663	Wild oats	$386.1k
14	Bellvine	26,823	Black bindweed / climbing buckwheat	1482	Black bindweed / climbing buckwheat	$340.9k
15	Nut Grass	22,516	Bathurst burr	1005	Bathurst burr	$229.2k
16	Parthenium weed	21,582	Bellvine	924	Bellvine	$222.1k
17	Wild oats	17,721	Khaki weed	912	Parthenium weed	$201.4k
18	Khaki weed	9122	Nut grass	653	Khaki weed	$198.0k
19	Nodding thistle	8992	Parthenium weed	649	Nut grass	$154.6k
20	Marshmallow	8093	Panic grass	523	Panic grass	$120.7k
Southern						
1	Heliotrope (potato weed)	2,803,274	Heliotrope (potato weed)	313,884	Heliotrope (potato weed)	$82.3m
2	Melons	2,485,980	Melons	159,460	Melons	$39.3m
3	Fleabane	804,261	Fleabane	73,117	Fleabane	$17.5m
4	Caltrop / bindi	617,639	Panic grass	58,178	Panic grass	$17.4m
5	Panic grass	429,143	Caltrop / bindi	48,151	Caltrop / bindi	$15.8m
6	Windmill grass	279,686	Lincoln weed	34,578	Lincoln weed	$13.2m
7	Marshmallow	279,597	Windmill grass	22,437	Ryegrass	$5.4m
8	Wireweed	236,620	Ryegrass	20,614	Windmill grass	$5.3m
9	Cutleaf mignonette	188,564	Wireweed	17,893	Wireweed	$4.6m
10	Lincoln weed	152,772	Sweet summer grass	13,129	Sweet summer grass	$3.4m
11	Bathurst burr	150,308	Paterson's curse / salvation Jane	10,036	Paterson's curse / salvation Jane	$2.6m
12	Skeleton weed	138,150	Marshmallow	9069	Marshmallow	$2.4m
13	Sow thistle / milk thistle	113,185	Thistle species	9003	Thistle species	$2.0m
14	Whip thistle (prickly lettuce)	106,439	Barley grass	8719	Bathurst burr	$2.0m
15	Barnyard grass	96,940	Skeleton weed	8161	Skeleton weed	$1.9m
16	Ryegrass	96,663	Mint weed	8097	Barley grass	$1.9m
17	Sweet summer grass	88,559	Black bindweed / climbing buckwheat	7769	Wild radish	$1.8m
18	Paterson's curse / salvation Jane	60,799	Bathurst burr	7493	Mint weed	$1.7m
19	Wild oats	59,164	Wild radish	6704	Black bindweed / climbing buckwheat	$1.6m
20	Barley grass	59,061	Barnyard grass	5905	Sow thistle / milk thistle	$1.6m

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TABLE 25 Regional ranking of summer fallow weeds by area, yield loss and revenue loss (continued).

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
Western						
1	Melons	3,826,327	Melons	182,408	Melons	$49.6m
2	Caltrop / bindi	1,016,960	Caltrop / bindi	59,515	Caltrop / bindi	$16.2m
3	Fleabane	825,830	Fleabane	37,969	Fleabane	$10.5m
4	Wild radish	549,864	Nut Grass	29,549	Nut Grass	$7.8m
5	Nut grass	221,507	Wild radish	14,090	Wild radish	$4.0m
6	Windmill grass	173,063	Mint weed	6,984	Mint weed	$1.9m
7	Mint weed	139,135	Windmill grass	5,682	Windmill grass	$1.6m
8	Goosefoots	99,131	Wireweed	4,018	Wireweed	$1.1m
9	Wild geranium / storksbill	94,938	Goosefoots	2,503	Marshmallow	$713.1k
10	Marshmallow	84,523	Barley grass	2,488	Goosefoots	$682.8k
11	Ryegrass	78,059	Thistle species	2,478	Thistle species	$665.5k
12	Wireweed	54,884	Marshmallow	2,332	Barley grass	$663.9k
13	Barley grass	42,750	Ryegrass	1,909	Ryegrass	$554.0k
14	Thistle species	41,256	Doublegee	1,498	Doublegee	$402.8k
15	Doublegee	38,087	Dock	1,481	Dock	$371.8k
16	Wild oats	23,855	Wild oats	1,256	Brome grass	$325.6k
17	Sweet summer grass	20,152	Brome grass	1,167	Wild oats	$324.0k
18	Dock	14,811	Wild geranium / storksbill	1,137	Wild geranium / storksbill	$297.1k
19	Brome grass	10,542	Sweet summer grass	564	Sweet summer grass	146.8k
20	Parthenium weed	7,723	Parthenium weed	290	Parthenium weed	74.7k

TABLE 26 Northern ranking of winter fallow weeds by area, yield loss and revenue loss.

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
1	Sow thistle / milk thistle	63,239	Sow thistle / milk thistle	1,874	Sow thistle / milk thistle	$354.0k
2	Fleabane	46,308	Fleabane	1,230	Fleabane	$232.5k
3	Wild oats	46,067	Wild turnip	983	Wild turnip	$185.7k
4	Wild turnip	38,347	Wild oats	867	Wild oats	$163.8k
5	Other brassicas	22,913	Barnyard grass	420	Barnyard grass	$79.5k
6	Barnyard grass	19,767	Phalaris	416	Phalaris	$78.7k
7	Wild radish	14,034	Other brassicas	365	Other Brassicas	$69.1k
8	Wild mustard	13,191	Black bindweed / climbing buckwheat	245	Black bindweed / climbing buckwheat	$46.1k
9	Phalaris	9,310	Wild radish	228	Wild radish	$43.1k
10	Black bindweed / climbing buckwheat	6,801	Wild mustard	165	Wild mustard	$30.9k
11	Deadnettle	3,468	Windmill grass	150	Windmill grass	$28.0k
12	Feathertop Rhodes grass	3,426	Feathertop Rhodes grass	142	Feathertop Rhodes grass	$26.8k
13	Windmill grass	2,997	Deadnettle	43	Deadnettle	$8.2k
14	Ryegrass	1,366	Wireweed	35	Wireweed	$6.6k
15	Thistle species	1,194	Ryegrass	28	Ryegrass	$5.2k
16	Wireweed	694	Mexican poppy	23	Mexican poppy	$4.3k
17	Mexican poppy	461	Thistle species	15	Thistle species	$2.8k
18	Field bindweed	211	-	-	-	-
19	Marshmallow	139	-	-	-	-

TABLE 27 Growers cleaning grain and penalised for contamination.

	Growers cleaning grain	Average proportion of crop cleaned	Growers penalised for contamination
Northern	10%	19%	5%
Central Queensland	18%	16%	4%
NSW NE/Queensland SE	4%	28%	4%
NSW NW/Queensland SW	11%	17%	7%
Southern	20%	14%	18%
NSW Central	2%	6%	6%
NSW Victorian Slopes	6%	3%	8%
SA Mid North - Lower Yorke Eyre	41%	14%	24%
SA Victorian Bordertown - Wimmera	32%	17%	40%
SA Victorian Mallee	17%	6%	13%
Victorian high-rainfall and Tasmanian grain	20%	18%	18%
Western	25%	13%	7%
WA Central	18%	8%	11%
WA Eastern	11%	10%	11%
WA Sandplain - Mallee	41%	16%	2%
WA Northern	33%	13%	5%
Total / National	19%	14%	12%

Growers cleaning grain is expressed as a percentage of all growers cleaning grain before delivery to remove weed contamination in any crops in any of the past three seasons. For average proportion of crop cleaned, data displayed is the stated average proportion of total crop tonnage cleaned over the past three years by those who have cleaned some grain. Growers penalised for contamination is defined as a percentage of all growers penalised for having any weed contamination when selling grain in any of the past three seasons.

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Individual control expenditure is broken down further and discussed in this section. Costs include in-season herbicide cost, fallow herbicide cost, integrated weed management (IWM) practices and additional herbicide costs related to herbicide resistance. IWM practices include cultivation, burning and a range of practices aimed at reducing the weed seedbank (for full list see section 3.3.2 'Integrated weed management', p36).

Nationally the cost of weed control expenditure ($2,573 million) include: in-season ($1,590 million) and fallow herbicide use including application costs ($507 million) and IWM practices ($475 million) as seen in Figure 8, p28. The costs per hectare per region can be seen in Figure 9, p32, Northern growers are the biggest users of in-season herbicide at $86/ha, and apply more herbicide to manage herbicide-resistant weeds, while Western growers invest more in IWM than other regions at $24/ha and spend less on in-season herbicide cost ($53/ha).

3.3.1 Herbicide use

Cropping season

On average, 91 per cent of the cropped area farmed by respondents receives a knockdown herbicide prior to seeding each year, 74 per cent receives a pre-emergent herbicide and 80 per cent received a post-emergent selective herbicide each year (Table 30, p36). Knockdown herbicide use was consistent across the zones, but there was greater variation in use of pre-emergent and post-emergent herbicides. Almost all growers use knockdown, pre-emergent and post-emergent herbicides (Table 31, p37).

TABLE 28 Grain contamination and cleaning costs.

	Crop cleaning cost	Crop penalty loss	Total contamination loss	Total contamination loss (per hectare)
Northern	$10.2m	$700.1k	$10.9m	$2.66
Central Queensland	$477.1k	$7.1k	$484.2k	$1.21
NSW NE/Queensland SE	$6.4m	$225.2k	$6.6m	$2.93
NSW NW/Queensland SW	$3.3m	$467.8k	$3.8m	$2.65
Southern	$13.5m	$6.0m	$19.4m	$1.81
NSW Central	$46.0k	$38.8k	$84.8k	$0.05
NSW Victorian Slopes	$207.4k	$264.6k	$472.0k	$0.22
SA Mid North - Lower Yorke Eyre	$6.2m	$2.5m	$8.7m	$5.02
SA Victorian Bordertown - Wimmera	$5.7m	$2.4m	$8.0m	$4.33
SA Victorian Mallee	$837.7k	$662.5k	$1.5m	$0.50
Victorian high rainfall and Tas grain	$534.6k	$166.8k	$701.4k	$2.19
Western	$5.6m	$1.5m	$7.1m	$0.90
WA Central	$1.3m	$639.2k	$2.0m	$0.45
WA Eastern	$181.8k	$93.3k	$275.2k	$0.22
WA Sandplain - Mallee	$2.9m	$697.4k	$3.6m	$3.73
WA Northern	$1.2m	$80.4k	$1.3m	$0.96
Total / National	$29.3m	$8.2m	$37.4m	$1.65

Loss per hectare based on total area of production per region/zone.

TABLE 29 Total expenditure per region including application costs. Total cost per region expressed as a percentage attributed from fallow herbicide cost, in-season herbicide cost and IWM.

	Total expenditure cost	Fallow herbicide cost	In-season herbicide cost	IWM
Northern	$610m	31%	57%	12%
Southern	$1,244m	17%	66%	17%
Western	$719m	16%	58%	26%
Total / National	$2,573m	20%	62%	18%

Note that in-season and fallow herbicide costs shown in this table include the additional herbicide costs due to resistant weeds.

Expenditure on knockdown, pre-emergent and post-emergent herbicides, including application costs, is estimated to be $1,423 million, comprising herbicide costs ($956 million) and application costs (Table 32. p37). Note that additional herbicide costs due to herbicide-resistant weeds and IWM practices are considered later.

The total knockdown, pre-emergent and post-emergent herbicide costs average $63/ha. This cost ranges from more than $85/ha in the southern region, which has higher rainfall areas (NSW Victorian Slopes and SA Mid North – Lower Yorke Eyre), to $38/ha in the low-rainfall region of SA Victorian Mallee (Table 33, p38).

Fallow

We asked growers in Southern and Western regions about how much area to be cropped has herbicide applied for summer weeds (not counting any pre-seeding knockdown). On average, 65 per cent of land to be cropped received a summer herbicide application (Table 34, p38).

We asked northern growers how many herbicide applications they apply to summer and winter fallow paddocks to control summer weeds. These figures are used in the costings and we assumed all Northern growers used some fallow weed control. The most common number of applications in summer fallow is three, although a small portion spray six or more times (Table 35, p39). Likewise, the most common number of applications in winter fallow is three (Table 36, p39).

Herbicide weed control in summer fallows incurs a total cost of $431 million, which represents an average cost per hectare of crop area of $18.96 (Table 37, p39). Costs (per hectare) for the northern region are estimated to be at least twice those in the southern and western regions. Winter fallow costs are substantial in the northern region and in Central Queensland and NSW Central. Additional fallow weed control costs involving cultivation are shown in Table 41, p41.

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TABLE 30 Average proportion of the cropped area receiving a knockdown herbicide prior to seeding, a pre-emergent herbicide and post-emergent herbicide as stated by growers.

	Average proportion of crop area receiving		
	Knockdown herbicide application prior to seeding	Pre-emergent Herbicide application	Post-emergent Herbicide
Northern	90%	45%	80%
Central Queensland	82%	55%	68%
NSW NE/Queensland SE	88%	46%	83%
NSW NW/Queensland SW	96%	38%	83%
Southern	90%	77%	80%
NSW Central	77%	53%	71%
NSW Victorian Slopes	95%	76%	76%
SA Mid North – Lower Yorke Eyre	97%	92%	87%
SA Victorian Bordertown – Wimmera	85%	81%	87%
SA Victorian Mallee	91%	79%	84%
Victorian high-rainfall and Tasmanian grain	95%	78%	77%
Western	92%	89%	80%
WA Central	91%	86%	81%
WA Eastern	91%	92%	76%
WA Sandplain – Mallee	98%	91%	70%
WA Northern	87%	89%	97%
Total / National	91%	74%	80%

Average percentage of cropping land is the average of the nominated proportion of cropping land receiving this treatment.

TABLE 31 Percentage of growers using herbicide.

	Herbicide use		
	Knockdown	Pre-emergent	Post-emergent
Northern	97%	82%	95%
Central Queensland	93%	81%	89%
NSW NE/Queensland SE	98%	76%	96%
NSW NW/Queensland SW	100%	89%	98%
Southern	98%	95%	97%
NSW Central	94%	79%	94%
NSW Victorian Slopes	100%	98%	98%
SA Mid North – Lower Yorke Eyre	98%	100%	96%
SA Victorian Bordertown – Wimmera	98%	100%	100%
SA Victorian Mallee	98%	92%	96%
Victorian high-rainfall and Tasmanian grain	100%	98%	96%
Western	99%	99%	98%
WA Central	98%	98%	98%
WA Eastern	98%	100%	98%
WA Sandplain – Mallee	100%	98%	98%
WA Northern	100%	100%	100%
Total / National	98%	93%	97%

Expressed as percentage of all growers for region/zone.

TABLE 32 Cost of knockdown, pre-emergent and post-emergent herbicide.

	Herbicide cost				
	Knockdown	Pre-emergent	Post-emergent	Application costs	Total costs
Northern	$57.3m	$63.5m	$87.3m	$98.9m	$307.1m
Central Queensland	$5.9m	$7.2m	$6.5m	$9.4m	$29.0m
NSW NE/Queensland SE	$32.4m	$38.2m	$47.3m	$55.0m	$172.8m
NSW NW/Queensland SW	$19.1m	$18.1m	$33.5m	$34.6m	$105.3m
Southern	$122.8m	$185.3m	$209.2m	$238.0m	$755.3m
NSW Central	$18.8m	$31.2m	$35.6m	$32.9m	$118.5m
NSW Victorian Slopes	$28.8m	$47.4m	$51.9m	$56.6m	$184.8m
SA Mid North – Lower Yorke Eyre	$23.6m	$47.7m	$44.8m	$45.5m	$161.5m
SA Victorian Bordertown – Wimmera	$20.5m	$37.8m	$47.4m	$42.7m	$148.4m
SA Victorian Mallee	$27.0m	$14.7m	$21.9m	$52.2m	$115.8m
Victorian high-rainfall and Tasmanian grain	$4.0m	$6.6m	$7.6m	$8.2m	$26.4m
Western	$81.0m	$73.9m	$75.2m	$130.3m	$360.4m
WA Central	$46.4m	$39.3m	$41.2m	$71.3m	$198.1m
WA Eastern	$11.2m	$12.2m	$9.4m	$20.1m	$52.9m
WA Sandplain – Mallee	$10.7m	$10.8m	$10.0m	$16.0m	$47.5m
WA Northern	$12.8m	$11.7m	$14.6m	$22.9m	$62.0m
Total / National	$261.1m	$322.7m	$371.7m	$467.3m	$1422.8m

TABLE 33 Cost of herbicide per hectare of crop production area.

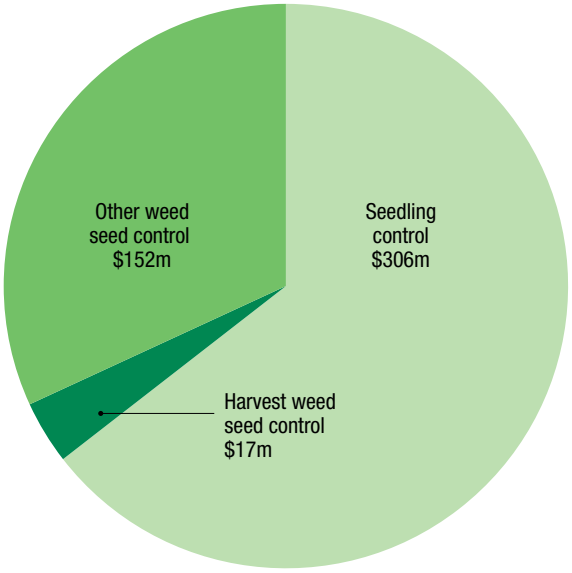
	Herbicide cost per hectare				
	Knockdown	Pre-emergent	Post-emergent	Application costs	Total costs
Northern	$14.01	$15.51	$21.33	$24.17	$75.02
Central Queensland	$14.87	$17.97	$16.26	$23.48	$72.57
NSW NE/Queensland SE	$14.28	$16.83	$20.87	$24.26	$76.25
NSW NW/Queensland SW	$13.35	$12.72	$23.47	$24.23	$73.77
Southern	$11.42	$17.23	$19.45	$22.13	$70.24
NSW Central	$11.24	$18.69	$21.30	$19.65	$70.89
NSW Victorian Slopes	$13.33	$21.93	$24.03	$26.18	$85.47
SA Mid North – Lower Yorke Eyre	$13.63	$27.55	$25.89	$26.29	$93.36
SA Victorian Bordertown – Wimmera	$11.08	$20.39	$25.61	$23.05	$80.13
SA Victorian Mallee	$8.95	$4.85	$7.24	$17.30	$38.35
Victorian high-rainfall and Tasmanian grain	$12.61	$20.72	$23.69	$25.64	$82.67
Western	$10.26	$9.36	$9.52	$16.50	$45.63
WA Central	$10.71	$9.07	$9.51	$16.46	$45.75
WA Eastern	$8.90	$9.65	$7.45	$15.97	$41.97
WA Sandplain – Mallee	$11.21	$11.35	$10.52	$16.77	$49.86
WA Northern	$9.41	$8.60	$10.77	$16.90	$45.69
Total / National	$11.48	$14.19	$16.34	$20.54	$62.55

TABLE 34 Herbicide use for fallow weed control.

	Growers using herbicide for summer fallow	Growers using herbicide for winter fallow	Proportion of cropping area treated for summer weeds
Northern	98%	97%	-
Central Queensland	96%	100%	-
NSW NE/Queensland SE	98%	98%	-
NSW NW/Queensland SW	100%	96%	-
Southern	90%	-	67%
NSW Central	90%	-	79%
NSW Victorian Slopes	96%	-	78%
SA Mid North – Lower Yorke Eyre	94%	-	73%
SA Victorian Bordertown – Wimmera	90%	-	52%
SA Victorian Mallee	96%	-	78%
Victorian high-rainfall and Tasmanian grain	76%	-	45%
Western	88%	-	59%
WA Central	84%	-	51%
WA Eastern	91%	-	64%
WA Sandplain – Mallee	87%	-	67%
WA Northern	88%	-	53%
Total / National	-	-	65%

Note: We asked only northern growers about winter fallow. Growers treating summer weeds are expressed as percentage of all growers in region/zone. Fallow herbicide use does not include using pre-seeding knockdown herbicide.

FIGURE 10 The costs of integrated weed management practices are grouped into three classes: seedling control, harvest weed seed control and other weed seed control.



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3.3.2 Integrated weed management

Integrated weed management (IWM) practices make up $475 million (18 per cent) of the estimated $2,573 million Australian grain growers spend on controlling weeds. The survey considered a number of IWM practices, and grouped them into three classes (Figure 10 and Table 38, p40):

- seedling control, which includes cultivation, delayed seeding with knockdown or double knockdown primarily for weed control;
- harvest weed seed control, which includes chaff cart, bale-direct system, narrow windrow burning, chaff tramlining, Harrington Seed Destructor; and
- other weed seed control, which includes burning stubble for weed management, brown or green manure on a

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TABLE 35 Number of herbicide applications for weed control in summer fallows in the Northern region.

	None	1	2	3	4	5	>6
Central Queensland	4%	7%	29%	32%	21%	4%	4%
NSW NE/Queensland SE	2%	13%	13%	47%	20%	4%	-
NSW NW/Queensland SW	-	-	20%	65%	11%	-	4%
Total	**2%**	**7%**	**19%**	**50%**	**17%**	**3%**	**3%**

Expressed as % of growers using herbicides to control weeds in summer fallow not counting pre-seeding knockdown.

TABLE 36 Average number of herbicide applications for weed control in winter fallows in the Northern region.

	None	1	2	3	4	5	>6
Central Queensland	-	3%	9%	45%	18%	17%	7%
NSW NE/Queensland SE	6%	6%	26%	29%	16%	12%	5%
NSW NW/Queensland SW	11%	7%	21%	23%	18%	11%	9%
Total	**6%**	**6%**	**20%**	**31%**	**18%**	**13%**	**7%**

Expressed as % of growers using herbicides to control weeds in winter fallow not counting pre-seeding knockdown.

TABLE 37 Cost of herbicides to control weeds in fallows.

	Fallow herbicide control costs		Fallow herbicide control costs (per hectare)	
	Summer	Winter	Summer	Winter
Northern	$141.4m	$24.8m	$34.54	$6.07
Central Queensland	$13.4m	$6.9m	$33.57	$17.26
NSW NE/Queensland SE	$63.7m	$16.4m	$28.11	$7.25
NSW NW/Queensland SW	$64.3m	$1.5m	$45.02	$1.06
Southern	$179.6m	$28.9m	$16.70	$2.69
NSW Central	$33.8m	$21.9m	$20.19	$13.07
NSW Victorian Slopes	$41.7m	$5.8m	$19.29	$2.70
SA Mid North – Lower Yorke Eyre	$31.4m	-	$18.13	-
SA Victorian Bordertown – Wimmera	$24.0m	$1.3m	$12.95	$0.68
SA Victorian Mallee	$45.0m	-	$14.90	-
Victorian high-rainfall and Tasmanian grain	$3.8m	-	$12.05	-
Western	$110.4m	$2.2m	$13.97	$0.28
WA Central	$59.6m	-	$13.77	-
WA Eastern	$15.2m	$2.2m	$12.09	$1.76
WA Sandplain – Mallee	$17.1m	-	$17.96	-
WA Northern	$18.4m	-	$13.54	-
Total / National	**$431.3m**	**$56.0m**	**$18.96**	**$2.46**

Per hectare figures are based on costs per total area of production not just area treated.

TABLE 38 National cost and usage of integrated weed management practices.

	Integrated weed management practice	Cost	Growers using practice
Seedling control	Total cultivation costs prior to seeding and fallow	$110m	-
	Growers citing weed management as the main reason for cultivation	$48m	25%
	Cultivation for fallow weed control	$62m	40%
	Delayed seeding with knockdown	$99m	62%
	Double knockdown	$97m	61%
	Total seedling control cost	**$306m**	-
Weed seed control	Chaff cart	$10m	3%
	Bale-direct system	$3m	3%
	Narrow windrow burning	$4m	30%
	Chaff tramlining	$472k	7%
	Harrington Seed Destructor	-	-
	Total seed control cost	**$17m**	-
Other weed seed control	Burning stubble	$1m	41%
	Brown / green manure	$53m	24%
	Crop-topping	$28m	42%
	Direct costs (pulses only)	$12m	
	Yield revenue loss impact (pulses only)	$16m	-
	Pasture spray-topping or hay freezing	$64m	52%
	Mouldboard ploughing	$4m	3%
	Total other seed control cost	**$152m**	-

Growers using practices expressed as % of all growers.

TABLE 39 Percentage of growers who ranked weed management as the main reason for cultivating prior to seeding.

	Growers who cite weed management as the main reason for cultivation	
	Expressed as percentage of growers seeding with prior cultivation	Expressed as percentage of all growers
Northern	**78%**	**27%**
Central Queensland	92%	24%
NSW NE/Queensland SE	75%	33%
NSW NW/Queensland SW	67%	21%
Southern	**67%**	**30%**
NSW Central	70%	43%
NSW Victorian Slopes	68%	37%
SA Mid North – Lower Yorke Eyre	47%	14%
SA Victorian Bordertown – Wimmera	77%	34%
SA Victorian Mallee	78%	27%
Victorian high-rainfall and Tasmanian grain	57%	24%
Western	**76%**	**15%**
WA Central	75%	13%
WA Eastern	100%	15%
WA Sandplain – Mallee	80%	9%
WA Northern	64%	23%
Total / National	**71%**	**25%**

'The main reason for practice' was defined as 'at least 50% attributable to weed management'.
Left column shows growers citing weed management as main reason for cultivation expressed as proportion of growers cultivating.
Right column shows growers citing weed management as main reason for cultivation expressed as proportion of all growers.

TABLE 40 Percentage of growers that use seedling control practices.

	Cultivation for fallow weed control		Delay seeding with knockdown		Double knockdown for weed control	
	Growers	Crop land	Growers	Crop land	Growers	Crop land
Northern	66%	28%	48%	44%	63%	32%
Central Queensland	61%	30%	36%	57%	54%	28%
NSW NE/Queensland SE	69%	33%	42%	47%	73%	35%
NSW NW/Queensland SW	65%	23%	61%	37%	59%	31%
Southern	37%	31%	61%	34%	53%	34%
NSW Central	71%	50%	53%	41%	53%	45%
NSW Victorian Slopes	35%	19%	69%	25%	52%	34%
SA Mid North – Lower Yorke Eyre	22%	12%	65%	21%	73%	35%
SA Victorian Bordertown – Wimmera	40%	29%	68%	45%	46%	21%
SA Victorian Mallee	35%	21%	52%	33%	37%	35%
Victorian high-rainfall and Tasmanian grain	20%	28%	59%	39%	57%	34%
Western	30%	19%	73%	40%	73%	43%
WA Central	33%	18%	76%	39%	84%	40%
WA Eastern	32%	22%	74%	40%	49%	31%
WA Sandplain – Mallee	20%	22%	67%	47%	89%	65%
WA Northern	35%	15%	75%	37%	70%	26%
Total / National	40%	28%	62%	37%	61%	37%

Percentage of growers that use delayed seeding with knockdown, double knockdown, and percentage of cropping land on which they use this practice. Practices tabulated are used primarily for weed control. Growers expressed as percentage of all growers in region/zone.
'Average percentage of cropping land' is the average nominated proportion of cropping land receiving this practice over the past three years.

TABLE 41 Cultivation costs for fallow weed control and prior to seeding.

	Cultivation costs prior to seeding	Fallow weed cultivation costs	Cultivation costs prior to seeding per hectare	Fallow weed cultivation costs per hectare
Northern	$9.1m	$21.9m	$2.23	$5.36
Central Queensland	$612.5k	$1.8m	$1.53	$4.63
NSW NE/Queensland SE	$4.5m	$15.6m	$2.01	$6.87
NSW NW/Queensland SW	$4.0m	$4.5m	$2.78	$3.16
Southern	$32.2m	$30.9m	$2.99	$2.87
NSW Central	$10.0m	$15.0m	$5.97	$8.97
NSW Victorian Slopes	$5.7m	$3.3m	$2.63	$1.52
SA Mid North – Lower Yorke Eyre	$1.7m	$828.9k	$0.99	$0.48
SA Victorian Bordertown – Wimmera	$6.9m	$5.7m	$3.71	$3.08
SA Victorian Mallee	$7.2m	$5.8m	$2.40	$1.91
Victorian high-rainfall and Tasmanian grain	$713.3k	$333.0k	$2.23	$1.04
Western	$6.4m	$9.3m	$0.81	$1.17
WA Central	$3.8m	$3.6m	$0.88	$0.82
WA Eastern	$773.3k	$2.7m	$0.61	$2.11
WA Sandplain - Mallee	$835.4k	$723.0k	$0.88	$0.76
WA Northern	$1.0m	$2.3m	$0.75	$1.70
Total / National	$47.7m	$62.1m	$2.10/ha	$2.73/ha

Cultivation costs prior to seeding attributable to weed management includes: 'seeding using no-till or zero-till seeding implement but with prior cultivation' and 'seeding with full-cut seeding pass with prior cultivation'. Fallow weed cultivation costs include 'cultivation to kill fallow weeds used primarily for weed control' and 'cultivation to kill fallow weeds used primarily for weed control'. Per hectare figures are based on costs per total area of production not just area treated.

TABLE 42 Cost of seedling control practices.

	Total cultivation costs	Delayed seeding with knockdown	Double knockdown	Total cultivation costs per hectare	Delayed seeding with knockdown per hectare	Double knockdown primarily per hectare
Northern	$31.0m	$17.2m	$15.5m	$7.59	$4.21	$3.79
Central Queensland	$2.5m	$2.0m	$1.0m	$6.16	$4.90	$2.54
NSW NE/Queensland SE	$20.1m	$9.1m	$10.8m	$8.88	$4.00	$4.75
NSW NW/Queensland SW	$8.5m	$6.2m	$3.7m	$5.94	$4.36	$2.62
Southern	$63.1m	$39.7m	$35.4m	$5.87	$3.69	$3.29
NSW Central	$25.0m	$7.2m	$7.2m	$14.94	$4.33	$4.31
NSW Victorian Slopes	$9.0m	$7.1m	$7.1m	$4.15	$3.28	$3.28
SA Mid North – Lower Yorke Eyre	$2.5m	$4.2m	$8.4m	$1.47	$2.45	$4.88
SA Victorian Bordertown – Wimmera	$12.6m	$9.9m	$4.1m	$6.78	$5.36	$2.23
SA Victorian Mallee	$13.0m	$9.8m	$6.9m	$4.31	$3.25	$2.28
Victorian high-rainfall and Tasmanian grain	$1.0m	$1.4m	$1.6m	$3.27	$4.46	$5.15
Western	$15.7m	$42.3m	$46.4m	$1.99	$5.36	$5.88
WA Central	$7.4m	$23.2m	$26.3m	$1.70	$5.35	$6.08
WA Eastern	$3.4m	$7.3m	$4.0m	$2.73	$5.83	$3.14
WA Sandplain – Mallee	$1.6m	$5.7m	$12.4m	$1.64	$6.03	$12.98
WA Northern	$3.3m	$6.1m	$3.8m	$2.45	$4.50	$2.79
Total / National	$109.8m	$99.3m	$97.3m	$4.83/ha	$4.37/ha	$4.28/ha

Total cultivation costs include fallow weed cultivation and prior to seeding. Practices tabulated are used primarily for weed control. Note: Total cultivation costs prior to seeding attributable to weed management includes: 'seeding using no-till or zero-till seeding implement but with prior cultivation' and 'seeding with full-cut seeding pass with prior cultivation'. Fallow weed cultivation costs include 'cultivation to kill fallow weeds used primarily for weed control' and 'cultivation to kill fallow weeds used primarily for weed control'. Per hectare figures are based on costs per total area of production not just area treated.

TABLE 43 Percentage of growers that use harvest seed control methods and extent of use for these growers.

	Chaff cart		Bale-direct system		Narrow windrow burning		Chaff tramlining	
	Growers	Cropping land	Growers	Cropping land	Growers	Cropping land	Growers	Cropping land
Northern	1%	78%	1%	15%	4%	23%	13%	77%
Central Queensland	4%	78%	-	-	-	-	18%	88%
NSW NE/Queensland SE	-	-	-	-	-	-	18%	71%
NSW NW/Queensland SW	-	-	2%	15%	11%	23%	4%	75%
Southern	1%	63%	4%	27%	28%	23%	6%	70%
NSW Central	-	-	2%	10%	12%	30%	2%	100%
NSW Victorian Slopes	-	-	12%	14%	33%	29%	12%	63%
SA Mid North – Lower Yorke Eyre	4%	50%	-	-	31%	15%	-	-
SA Victorian Bordertown – Wimmera	-	-	4%	45%	38%	13%	2%	100%
SA Victorian Mallee	-	-	6%	37%	21%	18%	6%	39%
Victorian high-rainfall and Tasmanian grain	2%	90%	2%	60%	33%	34%	12%	82%
Western	7%	59%	1%	13%	51%	30%	4%	86%
WA Central	13%	57%	2%	5%	56%	25%	7%	70%
WA Eastern	-	-	-	-	45%	33%	4%	90%
WA Sandplain – Mallee	9%	73%	2%	20%	33%	23%	4%	100%
WA Northern	8%	47%	-	-	75%	36%	3%	100%
Total / National	3%	61%	3%	25%	30%	26%	7%	76%

Percentage of growers that use narrow windrow burning for weed management, chaff tramlining, chaff carts, bale-direct systems, and percentage of cropping land on which they use this practice. Practices tabulated are used primarily for weed control. Growers expressed as percentage of all growers in region/zone. Average percentage of cropping land is the average nominated proportion of cropping land receiving this practice over the past three years.

TABLE 44 Cost of harvest weed seed control practices.

	Chaff cart	Bale-direct system	Narrow windrow burning	Chaff tramlining	Chaff cart per hectare	Bale-direct system per hectare	Narrow windrow burning per hectare	Chaff tramlining per hectare
Northern	$145.0k	$153.8k	$52.9k	$164.7k	$0.04	$0.04	$0.01	$0.04
Central Queensland	$145.0k	-	-	$22.7k	$0.36	-	-	$0.06
NSW NE/Queensland SE	-	-	-	$133.9k	-	-	-	$0.06
NSW NW/Queensland SW	-	$153.8k	$52.9k	$8.1k	-	$0.11	$0.04	$0.01
Southern	$482.1k	$2.7m	$1.1m	$211.0k	$0.04	$0.25	$0.10	$0.02
NSW Central	-	$82.0k	$134.8k	$20.1k	-	$0.05	$0.08	$0.01
NSW Victorian Slopes	-	$819.1k	$318.9k	$92.8k	-	$0.38	$0.15	$0.04
SA Mid North – Lower Yorke Eyre	$434.2k	-	$116.9k	-	$0.25	-	$0.07	-
SA Victorian Bordertown – Wimmera	-	$865.5k	$173.9k	$37.4k	-	$0.47	$0.09	$0.02
SA Victorian Mallee	-	$927.7k	$267.1k	$46.0k	-	$0.31	$0.09	$0.02
Victorian high-rainfall and Tasmanian grain	$47.8k	$28.4k	$101.5k	$14.7k	$0.15	$0.09	$0.32	$0.05
Western	$9.2m	$245.5k	$2.6m	$96.6k	$1.16	$0.03	$0.34	$0.01
WA Central	$7.6m	$225.5k	$1.3m	$52.5k	$1.75	$0.05	$0.31	$0.01
WA Eastern	-	-	$386.6k	$18.9k	-	-	$0.31	$0.02
WA Sandplain – Mallee	$816.4k	$20.0k	$158.3k	$6.0k	$0.86	$0.02	$0.17	$0.01
WA Northern	$804.2k	-	$756.1k	$19.3k	$0.59	-	$0.56	-
Total / National	$9.8m	$3.1m	$3.8m	$472.3k	$0.43/ha	$0.14/ha	$0.17/ha	-

Per hectare figures are based on costs per total area of production not just area treated

TABLE 45 Percentage of growers that use other weed seed control practices.

	Burn stubble on cropping land		Brown /green manure		Crop-topping		Spray-topping or hay freezing		Mouldboard plough	
	Growers	Crop land	Growers	Crop land	Growers	Crop land	Growers	Crop land	Growers	Crop land
Northern	12%	3%	10%	30%	11%	37%	18%	16%	2%	30%
Central Queensland	11%	4%	7%	15%	11%	53%	4%	10%	-	-
NSW NE/Queensland SE	9%	3%	13%	32%	4%	45%	16%	16%	4%	30%
NSW NW/Queensland SW	15%	1%	9%	34%	17%	29%	28%	17%	-	-
Southern	52%	19%	28%	14%	47%	19%	50%	19%	3%	20%
NSW Central	37%	16%	18%	22%	20%	18%	35%	8%	4%	38%
NSW Victorian Slopes	71%	25%	23%	9%	25%	21%	56%	11%	2%	5%
SA Mid North – Lower Yorke Eyre	53%	13%	22%	11%	78%	21%	75%	25%	2%	-
SA Victorian Bordertown – Wimmera	42%	8%	42%	15%	70%	19%	38%	22%	4%	-
SA Victorian Mallee	27%	6%	52%	15%	46%	18%	44%	29%	-	-
Victorian high-rainfall and Tasmanian grain	82%	44%	8%	12%	43%	19%	55%	15%	8%	30%
Western	40%	11%	26%	11%	52%	18%	78%	46%	5%	3%
WA Central	62%	15%	29%	7%	58%	12%	82%	41%	9%	1%
WA Eastern	40%	14%	21%	26%	45%	23%	72%	59%	-	-
WA Sandplain - Mallee	30%	8%	20%	7%	43%	27%	72%	49%	2%	-
WA Northern	28%	8%	35%	7%	65%	12%	88%	35%	10%	7%
Total / National	41%	13%	24%	15%	42%	20%	52%	31%	3%	14%

Percentage of growers that burn stubble, use brown green manure, crop-topping, spray-topping, mouldboarding plough, and percentage of cropping land they use for this practice. Practices tabulated are used primarily for weed control. Growers expressed as percentage of all growers in region/zone. 'Average percentage of cropping land' is the average nominated proportion of cropping land receiving this practice over the past three years.

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sown crop primarily for weed control and crop-topping – direct costs primarily for weed control (pulses only), pasture spray-topping or hay freezing primarily for weed control, mouldboard ploughing to bury weed seeds.

On average, growers spend most on seedling control practices, such as cultivation ($110 million), delayed seeding with knockdown ($99 million) and double knockdown ($97 million). Harvest weed seed control practices contribute modestly to the total cost of IWM. Practices such as chaff cart and bale-direct systems are not widespread and are not used in all AEZs. Non-selective herbicide-based practices, such as double knockdown (61 per cent of growers), spray-topping (52 per cent) and crop-topping (42 per cent), are commonly used practices (Table 40, p41 and Table 45, p43).

Seedling control costs

Cultivation costs during fallow and in preparation for seeding totalled $110 million (Table 38. p40). Fallow cultivation costs exceeded pre-seeding cultivation overall. The pre-seeding cultivation costs are much lower than those estimated in the Jones *et al.* (2000) report ($206 million). This can be largely explained by the dramatic increase in no-till and reduction in tillage passes over the past 15 years. Of the growers cultivating prior to seeding, 71 per cent cite weed management as the main reason for its use (Table 39, p40).

TABLE 46 Percentage of growers who ranked weed management as the main reason for whole-paddock stubble burning prior to seeding.

	Growers who cite weed management as main reason for burning stubble	
	Expressed as percentage of growers who burn	Expressed as percentage of all growers
Northern	29%	3%
Central Queensland	33%	4%
NSW NE/Queensland SE	50%	4%
NSW NW/Queensland SW	14%	2%
Southern	66%	34%
NSW Central	50%	18%
NSW Victorian Slopes	59%	42%
SA Mid North – Lower Yorke Eyre	59%	31%
SA Victorian Bordertown – Wimmera	90%	38%
SA Victorian Mallee	50%	13%
Victorian high-rainfall and Tas grain	76%	63%
Western	68%	28%
WA Central	71%	44%
WA Eastern	79%	32%
WA Sandplain – Mallee	36%	11%
WA Northern	82%	23%
Total / National	64%	26%

Weed management as main reason for whole-paddock stubble burning prior to seeding defined as at least 50% attributable to weed management. Left column shows this expressed as proportion of growers burning and right column as proportion of all growers.

Harvest weed seed control costs

We asked growers about five harvest weed control practices:

- chaff cart – chaff is collected at harvest, dumped and burnt or removed;
- bale-direct system – chaff and straw are collected during harvest and baled directly using a baler attached to the harvester;
- narrow windrow burning – chaff is placed in narrow windrows at harvest and is later burnt;
- chaff tramlining – chaff is concentrated at harvest on dedicated tramlines used in a controlled-traffic system; and
- Harrington Seed Destructor – this trailer is attached to the harvester and processes chaff in order to destroy weed seeds.

With the exception of narrow windrow burning, adoption of harvest weed seed kill practices remains at low levels, although the use of chaff carts by growers is higher in the Western region than in other regions (Table 43, p42). Only one grower reported using the newly available Harrington Seed Destructor (data not shown). Part II (p54) of this report outlines trends in uptake of a range of practices.

The total cost of using the four harvest weed seed control practices is estimated at $17 million, with $13 million of this in the Western region (Table 44, p43). The Western region has more than three times the per hectare expenditure on harvest weed seed control compared to the other regions. Overall, expenditure on harvest weed seed control is low, but trends shown in Part II (p54) suggest it is growing. The relatively low cost of the most widely used practice, narrow windrow burning, means that extensive use will not lead to high costs (except where loss of particular nutrients substantially affects crop yield or fertiliser requirements).

Other weed seed control practices

We asked growers about seed control practices (other than harvesting weed seed burning stubble for weed management):

- brown or green manure on a sown crop primarily for weed control;
- crop-topping – direct costs primarily for weed control (pulses only);

- pasture spray-topping or hay freezing primarily for weed control; and
- mouldboard ploughing to bury weed seeds.

Of the growers burning whole paddocks of stubble, 64 per cent rate weed management as the main reason for burning; by contrast a minority in the Northern region rate weed management as the main reason (Table 46, p44). Overall, only 26 per cent of growers are burning with weed management as the main reason. The cost estimates for burning are relatively small (Table 47). This study conservatively assumed that burning had only a minor net cost, attributable mainly to labour, with no cost of nutrient losses (note also that narrow windrow burning costs are included in Table 43, p42).

Nationally, growers spend $152 million on seed control practices. The most costly practices are pasture spray-topping at $64 million and brown green manure at $53 million, as seen in Table 47 and Table 48, p46. Growers spend $53 million on brown or green manure, with Southern growers spending the most $34 million.

3.4 Herbicide-resistant weeds

We asked growers about the presence of weeds with herbicide resistance. Based only on additional herbicide costs, including application, we estimated herbicide resistance to cost $187 million (Table 49, p47). However, the true cost of managing weeds with herbicide resistance is likely to be higher, as a variety of weed management practices other than applying additional herbicides is used. In fact, only 6 per cent of growers stated they adopt no additional practices to manage herbicide resistance. Most growers adopt a wide variety of practices to manage resistance and many use more than one. Practices include: herbicide rotation, use of double knockdown, pre-emergent herbicides, modifying current herbicide practices by using higher rates and better applications methods, crop-topping or hay freezing. Other methods include cultivation, burning, green and brown manure, hay, use of livestock and crop rotation, and altering sowing times or density. Chemical rotation is used by 36 per cent of growers as a method of managing herbicide resistance, followed by crop rotation at 26 per cent and livestock at 19 per cent.

The costs of some of these other practices are included in the overall analysis of expenditure on weeds. They are not specifically allocated to particular herbicide-resistant weeds as they generally affect multiple weeds and may be used for prevention rather than control of existing resistant weeds. Other practices, such as use of livestock and crop rotation, cannot be easily costed and are absent from the total cost of weeds. Further, there is also the assumption that only the area of land identified as having resistant weeds incurs the additional costs of resistance. In reality, a small area of resistance in a paddock is likely to mean that the larger area incurs the cost of resistance management; for example, the entire paddock that contains a patch of resistance.

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TABLE 47 Cost of other seed control practices.

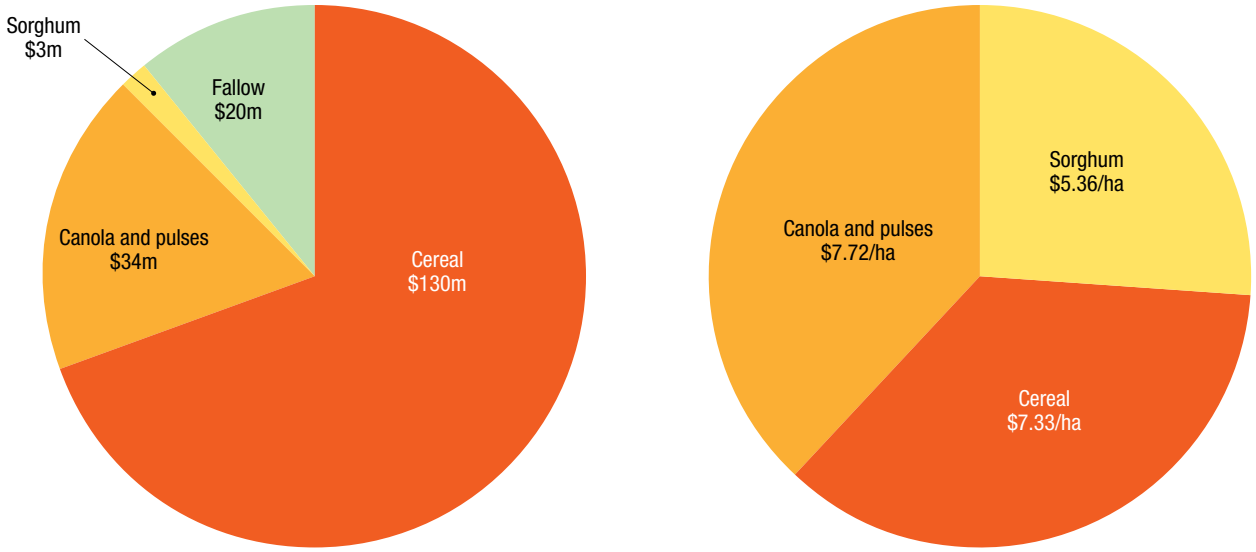
	Burning stubble (whole paddock)	Brown / green manure on a sown crop	Crop-topping: direct costs (pulses only)	Crop-topping: yield revenue loss impact (pulses only)	Pasture spray-topping or hay freezing	Mouldboard ploughing to bury weed seeds
Northern	$18.9k	$4.8m	$575.6k	$851.1k	$1.4m	$1.3m
Central Queensland	$6.6k	$94.7k	$176.6k	$316.7k	$14.2k	-
NSW NE/Queensland SE	$11.0k	$3.7m	$221.0k	$296.4k	$690.8k	$1.3m
NSW NW/Queensland SW	$1.2k	$971.6k	$178.0k	$237.9k	$705.4k	-
Southern	$658.7k	$33.5m	$6.8m	$11.6m	$17.6m	$2.0m
NSW Central	$115.7k	$3.7m	$159.8k	$178.9k	$917.2k	$1.7m
NSW Victorian Slopes	$236.6k	$4.9m	$205.0k	$251.1k	$2.5m	$102.8k
SA Mid North – Lower Yorke Eyre	$96.1k	$2.5m	$2.5m	$5.0m	$4.8m	-
SA Victorian Bordertown – Wimmera	$80.9k	$10.9m	$2.8m	$4.9m	$2.1m	-
SA Victorian Mallee	$39.4k	$11.4m	$1.1m	$1.2m	$6.8m	-
Victorian high-rainfall and Tasmanian grain	$89.9k	$163.5k	$57.3k	$82.3k	$456.5k	$201.8k
Western	$594.5k	$14.8m	$4.8m	$3.9m	$45.2m	$1.1m
WA Central	$358.2k	$10.2m	$2.3m	$1.6m	$21.7m	$552.6k
WA Eastern	$154.4k	$1.7m	$167.7k	$53.4k	$8.8m	-
WA Sandplain - Mallee	$13.5k	$1.2m	$718.3k	$548.7k	$5.4m	-
WA Northern	$68.3k	$1.7m	$1.7m	$1.7m	$9.2m	$573.0k
Total / National	$1.3m	$53.1m	$12.2m	$16.4m	$64.1m	$4.4m

Practices tabulated are used primarily for weed control.

The cost of applying additional herbicide to manage herbicide-resistant weeds is highest in cereal crops at $130 million. Costs for cereal and canola, and pulses are similar at $7.33/ha and $7.72/ha respectively (Figure 11). All regions spend similar amounts applying additional herbicides, with Southern growers spending $65 milllion, followed by Northern growers $64m, and Western growers spending $59 million (Table 49). Nationally, on average an additional $8.24/ha is spent on herbicides due to weeds with herbicide resistance (Table 50). Nationally, 64 per cent of growers report a weed population on their farm resistant to selective herbicides (Table 51, p48). A resistant weed population was defined as when a herbicide that once worked is no longer worth using on that population.

Based on grower reporting, herbicide resistance affects 43

FIGURE 11 National breakdown of additional herbicide cost due to weed resistance by crop type: (left) total cost ($187 million) and (right) cost per hectare.



Note: Total revenue loss expressed per ha relates to the area of each crop grown.

TABLE 48 Cost of other seed control practices per hectare.

	Burning stubble (whole paddock) per hectare	Brown / green manure on a sown crop per hectare	Crop-topping: direct costs (pulses only) per hectare	Crop-topping: yield revenue loss impact (pulses only) per hectare	Pasture spray-topping or hay freezing per hectare	Mouldboard ploughing per hectare
Northern	-	$1.16	$0.92	$1.36	$0.34	$0.32
Central Queensland	$0.02	$0.24	$2.13	$3.83	$0.04	-
NSW NE/Queensland SE	-	$1.63	$0.70	$0.93	$0.30	$0.58
NSW NW/Queensland SW	-	$0.68	$0.79	$1.06	$0.49	-
Southern	$0.06	$3.12	$9.11	$15.50	$1.63	$0.18
NSW Central	$0.07	$2.19	$3.14	$3.52	$0.55	$0.99
NSW Victorian Slopes	$0.11	$2.29	$3.43	$4.21	$1.15	$0.05
SA Mid North – Lower Yorke Eyre	$0.06	$1.42	$10.77	$21.01	$2.77	-
SA Victorian Bordertown – Wimmera	$0.04	$5.89	$10.10	$17.85	$1.13	-
SA Victorian Mallee	$0.01	$3.77	$9.01	$10.21	$2.26	-
Victorian high-rainfall and Tasmanian grain	$0.28	$0.51	$7.74	$11.12	$1.43	$0.63
Western	$0.08	$1.87	$8.96	$7.23	$5.72	$0.14
WA Central	$0.08	$2.36	$9.91	$6.97	$5.02	$0.13
WA Eastern	$0.12	$1.38	$4.87	$1.55	$7.01	-
WA Sandplain – Mallee	$0.01	$1.23	$10.28	$7.85	$5.62	-
WA Northern	$0.05	$1.24	$8.11	$8.27	$6.80	$0.42
Total / National	$0.06	$2.33	$6.39	$8.55	$2.82	$0.19

Practices tabulated are those used primarily for weed control. Per hectare figures are based on costs per total area of production not just area treated. Crop-topping cost per hectare is based on area of pulses.

per cent of cropping land on average. The average figure of 48 per cent for the Western region is lower than indicated in random field surveys of resistance in Western Australia (Owen *et al.* 2014). Differences may be explained in part by the relatively high resistance threshold in the survey definition of resistance compared to 20 per cent survival of weeds in the resistance testing. There is also the possibility of under-reporting by growers and a likelihood that paddocks where the resistant weed population has been reduced to extremely low levels are reported as not having a resistant population. However, a study of resistance in the Southern region by Boutsalis *et al.* (2012) indicated the potential for the extent of resistance to be similar to the results of our study for some districts. They identified districts with between 70 and 96 per cent of paddocks

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TABLE 49 Additional cost of herbicides due to weed resistance.

	Cereal	Canola and pulses	Sorghum	Fallow	Total for all crops
Northern	$28.6m	$11.5m	$3.4m	$20.2m	$63.7m
Central Queensland	$2.2m	$1.2m	$1.3m	$7.3m	$11.9m
NSW NE/Queensland SE	$22.1m	$9.5m	$1.9m	$12.4m	$46.0m
NSW NW/Queensland SW	$4.3m	$784.2k	$178.7k	$483.5k	$5.8m
Southern	$50.6m	$14.4m	-	-	$65.0m
NSW Central	$8.5m	$1.0m	-	-	$9.5m
NSW Victorian Slopes	$11.6m	$4.4m	-	-	$15.9m
SA Mid North – Lower Yorke Eyre	$10.3m	$3.7m	-	-	$14.0m
SA Victorian Bordertown - Wimmera	$10.0m	$4.1m	-	-	$14.2m
SA Victorian Mallee	$8.1m	$780.6k	-	-	$8.9m
Victorian high-rainfall and Tasmanian grain	$2.1m	$431.6k	-	-	$2.5m
Western	$50.3m	$8.4m	-	-	$58.8m
WA Central	$31.6m	$4.8m	-	-	$36.4m
WA Eastern	$4.4m	$524.1k	-	-	$5.0m
WA Sandplain – Mallee	$2.6m	$761.9k	-	-	$3.4m
WA Northern	$11.6m	$2.3m	-	-	$14.0m
Total / National	$129.6m	$34.3m	$3.4m	$20.2m	$187.4m

TABLE 50 Additional cost of herbicide due to weed resistance per hectare.

	Cereal per hectare	Canola and pulses per hectare	Sorghum per hectare	Total for all crops and fallow per hectare
Northern	$10.55	$15.23	$5.44	$15.56
Central Queensland	$12.08	$14.53	$9.37	$29.88
NSW NE/Queensland SE	$15.31	$25.03	$4.40	$20.28
NSW NW/Queensland SW	$3.97	$2.69	$3.76	$4.04
Southern	$5.84	$6.92	-	$6.04
NSW Central	$5.71	$5.45	-	$5.67
NSW Victorian Slopes	$7.31	$7.59	-	$7.37
SA Mid North – Lower Yorke Eyre	$7.79	$9.12	-	$8.10
SA Victorian Bordertown – Wimmera	$7.97	$6.97	-	$7.65
SA Victorian Mallee	$2.91	$3.27	-	$2.93
Victorian high-rainfall and Tasmanian grain	$8.99	$5.10	-	$7.96
Western	$8.00	$5.24	-	$7.44
WA Central	$9.16	$5.47	-	$8.42
WA Eastern	$3.82	$5.27	-	$3.93
WA Sandplain - Mallee	$4.00	$2.55	-	$3.55
WA Northern	$11.39	$7.01	-	$10.31
Total / National	$7.33	$7.72	-	$8.24

For cereal, canola and pulses, and sorghum value per hectare is expressed as the total area of each crop production. While value per hectare for 'total crops' and 'fallow' is expressed as total production area.

TABLE 51 Growers with herbicide-resistant weed populations and the average proportion of cropping land that has herbicide resistance.

	Growers reporting resistance	Proportion of land with resistance	Growers reporting type of resistance seen on farm:		
			Glyphosate resistance	Selective resistance	Glyphosate and selective resistance
Northern	60%	46%	39%	30%	9%
Central Queensland	61%	74%	54%	11%	4%
NSW NE/Queensland SE	62%	45%	53%	29%	18%
NSW NW/Queensland SW	57%	29%	17%	43%	4%
Southern	66%	38%	14%	63%	12%
NSW Central	45%	36%	12%	43%	8%
NSW Victorian Slopes	81%	40%	13%	75%	10%
SA Mid North - Lower Yorke Eyre	76%	50%	24%	71%	18%
SA Victorian Bordertown - Wimmera	78%	31%	10%	78%	10%
SA Victorian Mallee	52%	30%	6%	50%	6%
Victorian high-rainfall and Tas grain	63%	40%	20%	61%	20%
Western	62%	48%	6%	60%	5%
WA Central	62%	53%	-	60%	-
WA Eastern	64%	42%	4%	62%	4%
WA Sandplain - Mallee	48%	28%	17%	43%	13%
WA Northern	78%	66%	3%	78%	3%
Total / National	64%	43%	17%	56%	9%

Growers with resistance reported as a percentage of all growers in zone/region. Data shows the average proportion of cropping land with herbicide resistance as reported by growers. Cases of glyphosate resistance, selective resistance or both are expressed as a percentage of all growers in the region/zone.

TABLE 52 National ranking of top herbicide-resistant weeds most costly to manage.

Rank	Herbicide-resistant weeds			
	Winter cereal	Extra herbicide cost	Sorghum	Extra herbicide cost
1	Ryegrass	$103.2m	Feathertop Rhodes grass	$1.1m
2	Wild radish	$19.7m	Barnyard grass	$810.5k
3	Wild turnip	$7.8m	Fleabane	$326.0k
4	Wild oats	$6.2m	Sweet summer grass	$218.4k
5	Barnyard grass	$4.1m	Ryegrass	$146.6k
6	Wild mustard	$4.1m	Mint weed	$144.6k
7	Fleabane	$3.6m	Wild oats	$118.5k
8	Brome grass	$3.2m	Thistle species	$106.5k
9	Feathertop Rhodes grass	$2.6m	Wild radish	$92.5k
10	Phalaris	$2.1m	Black bindweed / climbing buckwheat	$46.4k
11	Sow thistle / milk thistle	$1.3m	Wild mustard	$29.9k
12	Windmill grass	$1.2m	Wild turnip	$27.2k
13	Sweet summer grass	$644.3k	Doublegee	$21.4k
14	Mint weed	$636.7k	Windmill grass	$13.5k
15	Cape weed	$326.7k	-	-
16	Black bindweed / climbing buckwheat	$233.9k	-	-
17	Paterson's curse / salvation Jane	$212.7k	-	-
18	Barley grass	$203.7k	-	-
19	Thistle species	$183.6k	-	-
20	Mexican poppy	$113.1k	-	-

Herbicide-resistant weed costs are based on extent of resistance and additional herbicide application to manage the resistance.

TABLE 53 Ranking of top herbicide-resistant weeds most costly to manage – Northern region.

Rank	Winter cereal	Extra herbicide cost	Sorghum	Extra herbicide cost
Northern				
1	Ryegrass	$16.1m	Feathertop Rhodes grass	$1.1m
2	Wild turnip	$6.5m	Barnyard grass	$810.5k
3	Barnyard grass	$4.1m	Fleabane	$326.0k
4	Feathertop Rhodes grass	$2.6m	Sweet summer grass	$218.4k
5	Wild oats	$2.3m	Ryegrass	$146.6k
6	Phalaris	$2.1m	Mint weed	$144.6k
7	Fleabane	$1.5m	Wild oats	$118.5k
8	Sow thistle / milk thistle	$1.2m	Thistle species	$106.5k
9	Sweet summer grass	$644.3k	Wild radish	$92.5k
10	Mint weed	$636.7k	Black bindweed / climbing buckwheat	$46.4k
11	Wild mustard	$596.8k	Wild mustard	$29.9k
12	Wild radish	$374.9k	Wild turnip	$27.2k
13	Windmill grass	$269.9k	Doublegee	$21.4k
14	Black bindweed / climbing buckwheat	$233.9k	Windmill grass	$13.5k
15	Thistle species	$183.6k	-	-
16	Mexican poppy	$113.1k	-	-
17	Brassica weeds	$75.5k	-	-
18	Doublegee	$57.0k	-	-

Herbicide-resistant weed costs include additional herbicide application to manage resistant weeds, in either winter cereal crops or sorghum.

From page 47

containing ryegrass, and 2 and 60 per cent of those having Group A resistance (diclofop-methyl) and between 19 and 88 per cent having Group B resistance (chlorsulfuron).

Growers in the Northern region most commonly report glyphosate resistance. Central Queensland has the highest extent of reported herbicide resistance at 74 per cent (average proportion of land), followed by WA Northern (66 per cent) and WA Central at 53 per cent, while WA Mallee and Sandplain is the lowest at 28 per cent – Table 51, p48.

The most costly resistant weeds in cereal crops in terms of extra herbicide costs are presented in Table 52, p48. Nationally the ranking of most costly resistant weeds are: ryegrass ($103.2 million); wild radish ($19.7 million); and wild turnip ($7.8 million). Ranking of herbicide-resistant weeds varies from region to region but ryegrass is dominant in each (Table 53, p49 and Table 54, p50). For ranking by AEZs see Appendix 9.9, p104. Feathertop Rhodes grass ($1.1 million), barnyard grass ($810,500), and fleabane ($326,000) have the most costly resistance in sorghum in terms of additional herbicide costs (Table 53, p49).

A simple comparison of total weed costs (yield loss as revenue loss, total contamination cost, total cultivation cost, standard herbicide cost, extra weed control practices, extra herbicide cost due to herbicide resistance and fallow herbicide yield costs) for growers with and without a herbicide-resistant weed population is shown in Table 55. Overall, the total cost of weeds for growers with resistance is $55/ha higher than those without resistance. Growers from Central Queensland and SA Victorian Bordertown – Wimmera who have herbicide-resistant weeds on their land have a total cost of weeds close to $100/ha more than growers from the same area without herbicide-resistant weeds.When the cost of weeds is calculated

TABLE 54 Ranking of top herbicide-resistant weeds most costly to manage – Southern and Western regions.

Rank	Winter cereal	Extra herbicide cost
Southern		
1	Ryegrass	$50.6m
2	Wild oats	$3.3m
3	Brome grass	$2.6m
4	Wild mustard	$2.4m
5	Wild radish	$1.9m
6	Fleabane	$1.7m
7	Windmill grass	$979.8k
8	Wild turnip	$413.2k
9	Cape weed	$267.3k
10	Paterson's curse / salvation Jane	$212.7k
11	Sow thistle / milk thistle	$101.7k
12	Prickly lettuce / whip thistle	$43.0k
13	Skeleton weed	$38.7k
14	Silver grass	$7.2k
Western		
1	Ryegrass	$36.6m
2	Wild radish	$17.4m
3	Wild mustard	$1.0m
4	Wild turnip	$831.5k
5	Brome grass	$578.9k
6	Wild oats	$533.1k
7	Fleabane	$287.7k
8	Barley grass	$203.7k
9	Toadrush	$107.3k
10	Cape weed	$59.4k
11	Doublegee	$13.4k

Herbicide-resistant weed costs include additional herbicide application to manage resistant weeds in winter cereal crops.

TABLE 55 Comparison of total weed costs for growers with and without reported herbicide resistance on their farm.

	Herbicide resistance on farm (per hectare)	No herbicide resistance on farm (per hectare)
Northern	$122.81	$57.67
Central Queensland	$150.22	$53.02
NSW NE/Queensland SE	$127.38	$58.11
NSW NW/Queensland SW	$107.88	$58.27
Southern	$98.11	$44.81
NSW Central	$72.39	$86.33
NSW Victorian Slopes	$116.27	$42.72
SA Mid North – Lower Yorke Eyre	$128.30	$37.77
SA Victorian Bordertown – Wimmera	$134.47	$23.80
SA Victorian Mallee	$58.83	$40.78
Victorian high-rainfall and Tasmanian grain	$106.87	$39.74
Western	$80.05	$28.07
WA Central	$85.73	$22.81
WA Eastern	$69.42	$30.30
WA Sandplain – Mallee	$61.53	$60.06
WA Northern	$84.81	$20.29
Total / National	$96.28/ha	$41.31/ha

Total weed costs comprise: yield loss as revenue loss, total contamination cost, total cultivation cost, standard herbicide cost, extra weed control practices, extra herbicide cost due to herbicide resistance and fallow herbicide yield costs.

without considering the assumed extra herbicide cost associated with resistance (Figure 12) clear differences can still be seen between farms with and without resistance.

3.5 Additional impacts of weeds

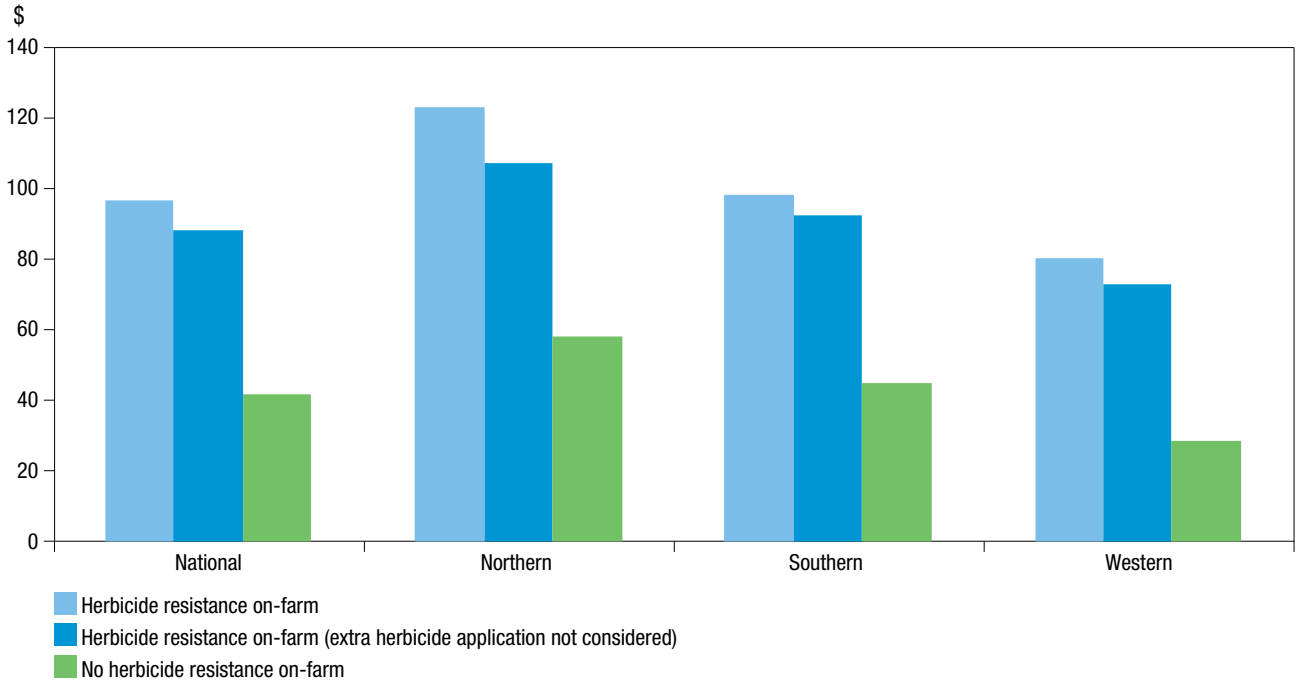
Weeds also impact on crop sequence and land-use decisions. Although this could not be included in the financial analysis, the data are presented here as evidence of an additional impact of weeds on crop management that is likely to have economic cost. The results provide clear evidence that one of the costs of weeds for a substantial number of growers is a shift from preferred land use and crop choice (Table 56). We asked growers if they would change what they would grow if they had no weed considerations and 27 per cent said they would. This varies between regions, but most commonly growers would grow more wheat (typically the most profitable crop) if weeds had less effect (Appendix 9.11, p107).

TABLE 56 Percentage of growers who would change what they grow if they had no weed considerations.

	Yes	No	Unsure
Northern	32%	65%	3%
Central Queensland	26%	67%	7%
NSW NE/Queensland SE	38%	58%	4%
NSW NW/Queensland SW	29%	71%	-
Southern	25%	72%	3%
NSW Central	31%	67%	2%
NSW Victorian Slopes	13%	85%	2%
SA Mid North – Lower Yorke Eyre	26%	66%	8%
SA Victorian Bordertown – Wimmera	28%	70%	2%
SA Victorian Mallee	25%	75%	-
Victorian high-rainfall and Tasmanian grain	25%	71%	4%
Western	26%	71%	2%
WA Central	38%	60%	2%
WA Eastern	19%	79%	2%
WA Sandplain – Mallee	20%	76%	4%
WA Northern	30%	70%	-
Total / National	27%	71%	3%

Expressed as percentage of all growers in region/zone.

FIGURE 12 Total cost of weeds per hectare for farms with herbicide resistance present versus farms with no herbicide resistance.



4 SUMMARY: ECONOMIC IMPACT OF WEEDS ON AUSTRALIAN GRAIN GROWERS

The overall cost of weeds to Australian grain growers is estimated to be $3,318 million, which includes yield losses of 2.76 million tonnes of grain (Table 57). Weeds are costing Australian grain growers $146 per hectare in expenditure and losses. Costs range between $105/ha in the low-rainfall South Australian/ Victorian Mallee and $213/ha in the summer and winter cropping Central Queensland zone. Expenditure on weed control ($2,573 million) far exceeds revenue loss from reduced crop yields ($745 million).

The most costly weeds nationally in terms of yield loss in winter crops are ryegrass, wild radish, wild oats, brome and wild turnip. The increased importance of brome grass is the most notable difference from the weed rankings of Jones *et al.* (2000) and is reinforced by the high ranking of brome when growers were asked to directly state their most costly weeds (Appendix 9.10, p105). Barnyard grass is the most costly weed in sorghum. Ryegrass remains the dominant weed in terms of the cost of herbicide resistance nationally, with the cost being greater than the sum of all other forms of resistance.

Nationally, the most costly weeds in fallow in terms of estimated yield loss were melons, heliotrope, fleabane, caltrop, barnyard grass and panic grass. The study highlights the high and likely increasing cost of fallow weeds and their control. The study estimates $507 million is spent on fallow weed control compared with $1.59 billion on knockdown, pre-emergent and post-emergent herbicides. Based on the reported densities of mature fallow weeds, weeds in fallows are estimated to be costing more than $430 million through reduced crop yields.

Overall, revenue loss due to weed populations reducing crop yields was $33/ha, which is similar to the cost of a typical selective herbicide application. Average

TABLE 57 The cost of weeds in Australian grain-growing regions.

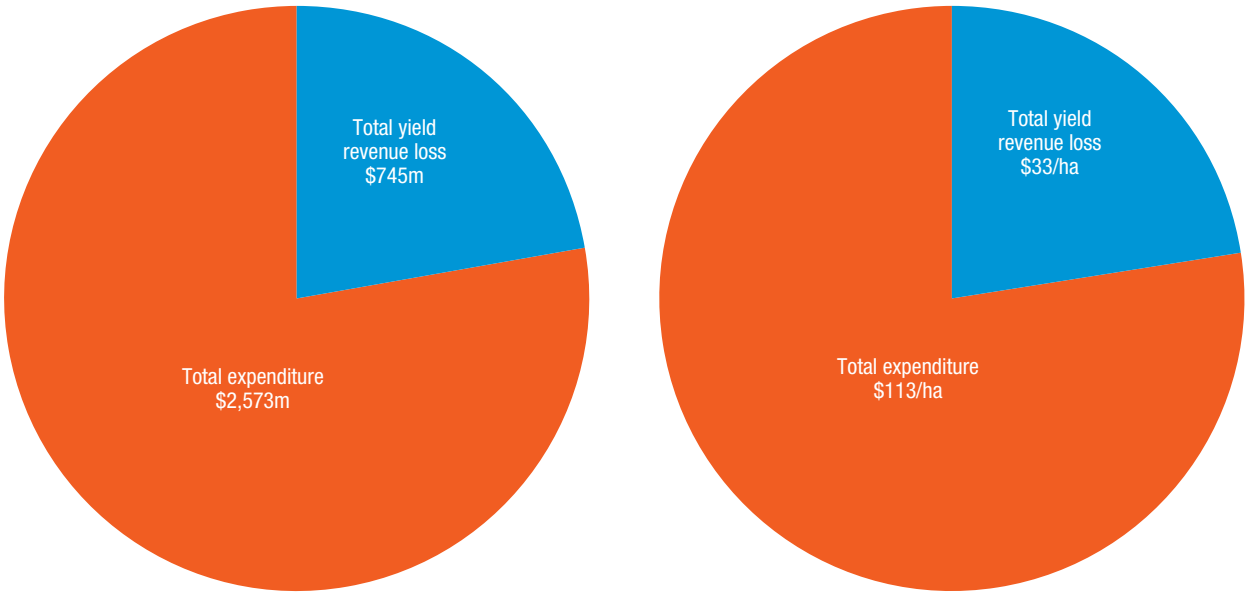
	Total yield loss (tonnes)	Total revenue loss	Total expenditure	Total costs	Total yield loss (t/ha)	Total revenue loss per hectare	Total expenditure per hectare	Total costs per hectare
Northern	611,893	$152m	$610m	$763m	0.15	37.23	$149.08	$186.31
Central Queensland	66,473	$18m	$67m	$85m	0.17	44.07	$168.82	$212.90
NSW NE/Queensland SE	352,541	$83m	$345m	$429m	0.16	36.78	$152.32	$189.10
NSW NW/Queensland SW	192,879	$51m	$198m	$249m	0.14	36.02	$138.42	$174.45
Southern	1,425,249	$384m	$1,244m	$1,628m	0.13	35.73	$115.66	$151.39
NSW Central	185,778	$42m	$230m	$272m	0.11	25.41	$137.54	$162.96
NSW Victorian Slopes	299,929	$76m	$281m	$357m	0.14	35.17	$129.91	$165.09
SA Mid North – Lower Yorke Eyre	272,704	$81m	$237m	$319m	0.16	47.06	$137.28	$184.35
SA Victorian Bordertown – Wimmera	246,370	$75m	$236m	$311m	0.13	40.39	$127.59	$167.98
SA Victorian Mallee	371,363	$96m	$221m	$317m	0.12	31.84	$73.24	$105.09
Victorian high-rainfall and Tasmanian grain	49,104	$13m	$38m	$52m	0.15	41.87	$119.45	$161.32
Western	725,052	$208m	$719m	$927m	0.09	26.39	$91.00	$117.39
WA Central	432,357	$122m	$397m	$519m	0.10	28.24	$91.67	$119.91
WA Eastern	119,922	$32m	$101m	$134m	0.10	25.50	$80.46	$105.96
WA Sandplain – Mallee	68,368	$24m	$96m	$121m	0.07	25.46	$101.25	$126.71
WA Northern	104,404	$30m	$124m	$154m	0.08	21.96	$91.44	$113.40
Total / National	2,762,193	$745m	$2,573m	$3,318m	0.12/ha	32.76/ha	$113.11/ha	$145.87/ha

expenditure on weed control, including herbicide and non-herbicide practices, was $113/ha (Figure 13).

The use of non-herbicide practices other than cultivation is increasing through practices such as narrow-windrow burning, but the overall expenditure on practices such as harvest weed seed control remains relatively low.

The results demonstrate the high cost of weed management to Australian grain growers and highlight that grower expenditure on control costs far exceeds the direct cost of competition from weeds in-crop. Essentially, growers are investing heavily in weed management, mostly through herbicide applications, to keep in-crop weed competition relatively low. The relatively high cost of management as well as impact of fallow weeds on crop yield, including summer weeds in southern winter cropping systems, suggests that this is an increasingly important area for investigating the potential for productivity gains.

FIGURE 13 Total costs of weeds showing revenue loss and expenditure on control (total and per hectare).



PART II: ADOPTION OF WEED MANAGEMENT AND TILLAGE PRACTICES BY AUSTRALIAN GRAIN GROWERS

5 INTRODUCTION

The study of the cost of weeds to Australian growers in Part I represents the current impact of weeds and the cost of managing them. To better explore trends and opportunities to improve weed management and profitability through weed management, it is important to consider changes in use of weed management practices and farming systems that have had an influence and will influence future cropping management.

Part II of this report explores results that have not all been directly used in the weed cost analysis but provide relevant context to weed management by grain growers. It includes a focus on changes in tillage systems and future adoption intentions for no-tillage and stubble retention, together with emerging weed management practices. The tillage system results are comparable to studies of no-till adoption conducted in 2003 and 2008 (D'Emden *et al.* 2008; Llewellyn *et al.* 2012) and some weed management perception results can be compared to an earlier study of Western Australian grain growers (see Llewellyn *et al.* 2004).

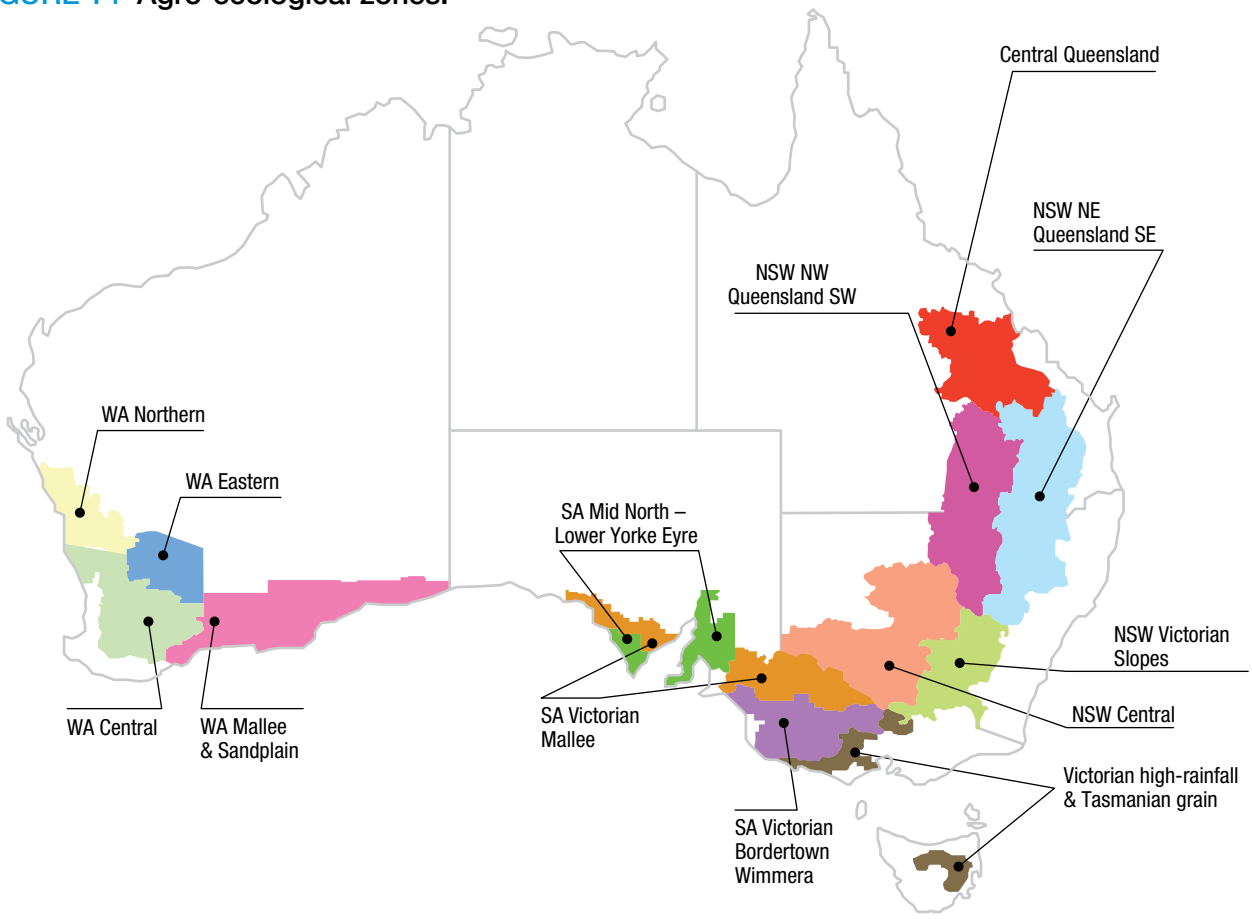
The results are intended to complement the analysis of weed management costs, as well as provide insight into opportunities to promote greater use of profitable weed management and no-tillage systems.

6 METHOD

Data presented in this section is based on the grower survey described in Part I. The data from 602 growers represents the same AEZs (Figure 14). Additional questions that directly asked growers to identify the most costly weeds on their farm and provide perceptions on the impact of no-tillage systems on weed management were included to supplement the findings of the economic analysis in Part I. Data on time of first adoption (used in cumulative adoption curves) was collected by asking growers in which year did they first use the particular practice on their farm, so therefore is based on recollection of current growers not historical data.

No-till in this study is defined as seeding with no prior cultivation and low soil disturbance and includes knife points, zero-till with disc machines, super seeders and inverted-T. This is the same definition as in previous studies to allow for comparison of results.

FIGURE 14 **Agro-ecological zones.**



7 RESULTS

7.1 Farm and farmer characteristics

The age of respondent growers is shown in Table 58; 34 per cent of all growers were between 55 and 64 years old (Table 58). Nationally, 37 per cent have someone on the farm with a university degree (Table 59) and 58 per cent pay a consultant for cropping advice (Table 60); only 33 per cent of growers in NSW Central reported they paid for advice. Growers who self-classified as mixed growers made up 73 per cent, with the rest classifying themselves as cropping specialists (Table 60).

7.2 Adoption of no-tillage and use of tillage for weed control

On average, 92 per cent of growers have previously used no-till and less than 20 per cent would use tillage as part of seeding in 2014 (Table 61, p58). In this study, no-till is defined as seeding with no prior cultivation and includes knife points, zero-till with disc machines, super seeders and inverted-T. No-till use remains lowest in NSW Central and is highest in the Western region. Of the growers planning to use no-till, knife points (or narrow points) still dominate the Southern region, with disc use only exceeding 20 per cent in the Northern region. However, there is evidence of increasing disc use in some Southern AEZs, with the highest use in WA Sandplain/Mallee (Table 62, p58).

7.2.1 Cultivation for weed control

Using cultivation to manage weeds is discussed in Part I, section 3.3.2 'Integrated weed management', p36. Overall, 71 per cent of growers seeding with prior cultivation cite weed management as the main reason for using cultivation (Table 39, p40). While the proportion of growers using no-till is peaking near 90 per cent, substantial areas are still cultivated and 25 per cent of all growers use some cultivation for weed management purposes (Table 63, p59).

Continued page 59

TABLE 58 Percentage of growers by age bracket.

	Age in years					
	18–24	25–34	35–44	45–54	55–64	65 and over
Northern	1%	3%	13%	29%	37%	18%
Central Queensland	-	7%	7%	36%	36%	14%
NSW NE/Queensland SE	-		4%	27%	47%	22%
NSW NW/Queensland SW	2%	2%	24%	26%	28%	17%
Southern	1%	5%	16%	31%	32%	15%
NSW Central	-	2%	12%	35%	35%	16%
NSW Victorian Slopes	-	2%	23%	37%	25%	13%
SA Mid North – Lower Yorke Eyre	-	8%	22%	27%	27%	16%
SA Victorian Bordertown – Wimmera	2%	6%	20%	28%	28%	16%
SA Victorian Mallee	-	4%	4%	33%	38%	21%
Victorian high-rainfall and Tasmanian grain	2%	8%	18%	25%	37%	10%
Western	2%	4%	15%	30%	35%	15%
WA Central	-	4%	18%	27%	33%	18%
WA Eastern	2%	2%	13%	28%	40%	15%
WA Sandplain – Mallee	2%	2%	17%	30%	37%	11%
WA Northern	3%	8%	10%	35%	30%	15%
Total / National	1%	4%	15%	30%	34%	16%

TABLE 59 Proportion of respondents that have someone involved in managing the farm with a university degree.

	Yes	No	Don't know
Northern	43%	57%	-
Central Queensland	21%	79%	-
NSW NE/Queensland SE	53%	47%	-
NSW NW/Queensland SW	46%	54%	-
Southern	39%	60%	1%
NSW Central	35%	65%	-
NSW Victorian Slopes	38%	60%	2%
SA Mid North – Lower Yorke Eyre	35%	65%	-
SA Victorian Bordertown – Wimmera	36%	62%	2%
SA Victorian Mallee	37%	63%	-
Victorian high rainfall and Tas grain	53%	47%	-
Western	30%	69%	1%
WA Central	38%	62%	-
WA Eastern	15%	85%	-
WA Sandplain – Mallee	41%	57%	2%
WA Northern	28%	73%	-
Total / National	37%	62%	-

Expressed as percentage of all growers per region/zone.

TABLE 60 Percentage of growers that pay for cropping advice per region and percentage of growers who specialise in grain.

	Pay for advice		Specialise in grain	
	Yes	No	Grain	Grain and livestock
Northern	61%	39%	22%	78%
Central Queensland	68%	32%	32%	68%
NSW NE/Queensland SE	56%	44%	22%	78%
NSW NW/Queensland SW	63%	37%	15%	85%
Southern	58%	42%	29%	71%
NSW Central	33%	67%	35%	65%
NSW Victorian Slopes	62%	38%	21%	79%
SA Mid North – Lower Yorke Eyre	55%	45%	22%	78%
SA VictorianBordertown – Wimmera	60%	40%	38%	62%
SA Victorian Mallee	62%	38%	37%	63%
Victorian high-rainfall and Tasmanian grain	76%	24%	20%	80%
Western	57%	43%	27%	73%
WA Central	56%	44%	27%	73%
WA Eastern	45%	55%	26%	74%
WA Sandplain – Mallee	65%	35%	22%	78%
WA Northern	63%	38%	35%	65%
Total / National	58%	42%	27%	73%

Expressed as percentage of all growers per region/zone.

FIGURE 15 Cumulative adoption curves showing time of first use of no-till — Northern agro-ecological zones.

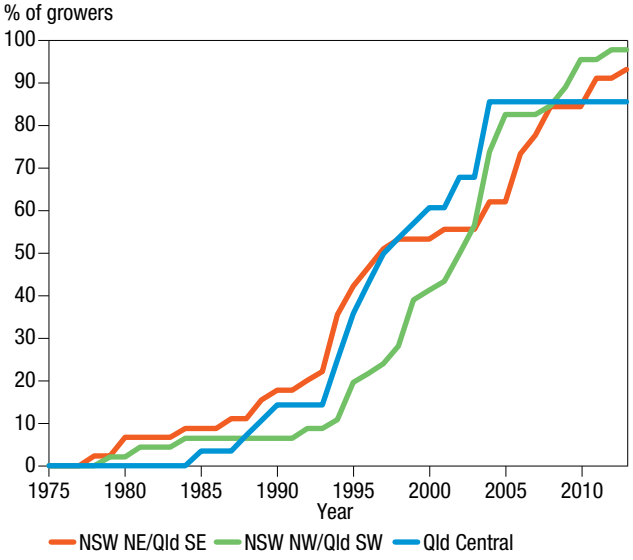


FIGURE 16 Cumulative adoption curves showing time of first use of no-till — Southern agro-ecological zones.

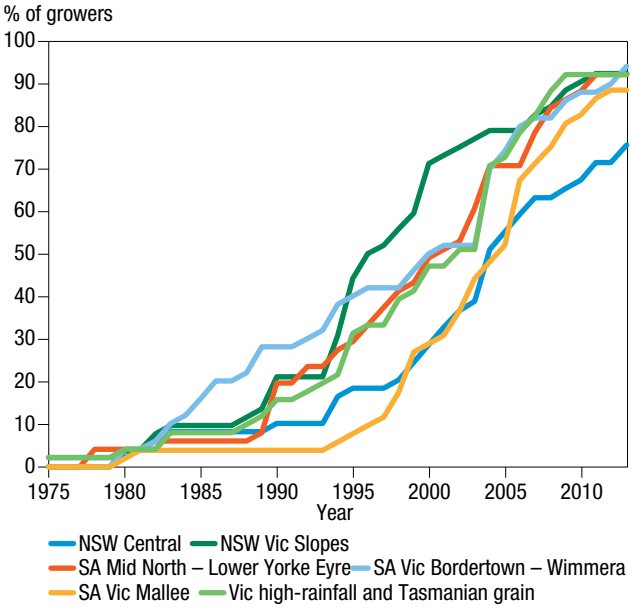


TABLE 61 Percentage of growers who have used no-till in the past. Proportion of crop area sown in 2014 with no prior cultivation or cultivation.

	Percentage of growers	Average percentage of crop sown with no prior cultivation		Average percentage of crop sown with prior cultivation	
	Used no-till or zero-till in the past	Sown with no-till or zero-till	Sown with full-cut seeding pass	Sown with no-till or zero-till implement	Sown with full-cut seeding pass
Northern	**93%**	**80%**	**2%**	**9%**	**8%**
Central Queensland	86%	80%	-	7%	13%
NSW NE/Queensland SE	93%	82%	4%	8%	6%
NSW NW/Queensland SW	98%	79%	2%	12%	6%
Southern	**89%**	**73%**	**6%**	**10%**	**9%**
NSW Central	76%	52%	8%	17%	21%
NSW VictorianSlopes	92%	74%	6%	17%	3%
SA Mid North – Lower Yorke Eyre	92%	85%	4%	5%	6%
SA Victorian Bordertown – Wimmera	94%	76%	-	12%	8%
SA Victorian Mallee	88%	72%	10%	8%	8%
Victorian high-rainfall and Tasmanian grain	92%	77%	7%	4%	12%
Western	**96%**	**91%**	**2%**	**4%**	**3%**
WA Central	91%	88%	1%	2%	8%
WA Eastern	98%	93%	3%	4%	-
WA Sandplain - Mallee	93%	91%	2%	3%	5%
WA Northern	100%	93%	-	6%	-
Total / National	**92%**	**80%**	**4%**	**8%**	**7%**

'Percentage of growers' is expressed as percentage of all growers per region/zone. 'Average percentage of cropping land' is the average nominated proportion of cropping land (stated by the grower) that was to be sown in 2014 using this practice.

FIGURE 17 Cumulative adoption curves showing time of first use of no-till — Western agro-ecological zones.

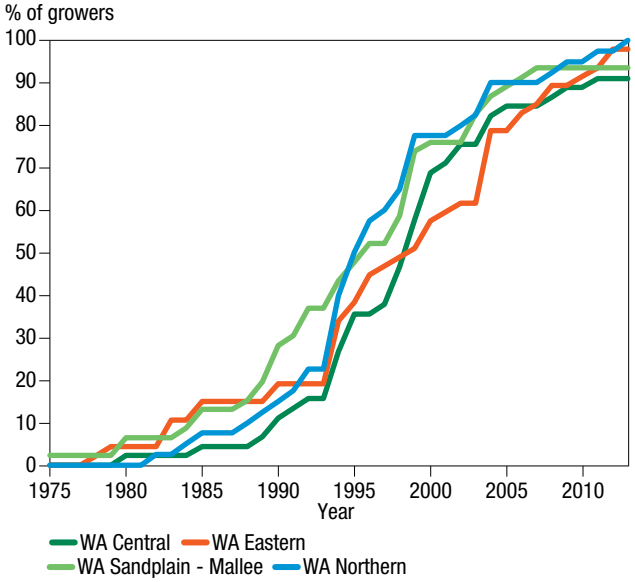


TABLE 62 Proportion of growers using discs and/or narrow points expressed as percentage of growers using no-till in 2014.

	Discs	Narrow points	Both
Northern	**25%**	**60%**	**16%**
Central Queensland	17%	50%	33%
NSW NE/Queensland SE	28%	53%	19%
NSW NW/Queensland SW	26%	71%	2%
Southern	**7%**	**85%**	**8%**
NSW Central	9%	71%	20%
NSW Victorian Slopes	7%	83%	11%
SA Mid North – Lower Yorke Eyre	11%	83%	6%
SA Victorian Bordertown – Wimmera	4%	91%	4%
SA Victorian Mallee	5%	90%	5%
Victorian high-rainfall and Tasmanian grain	9%	86%	5%
Western	**5%**	**91%**	**5%**
WA Central	-	95%	5%
WA Eastern	-	98%	2%
WA Sandplain – Mallee	18%	77%	5%
WA Northern	-	93%	8%
Total / National	**10%**	**81%**	**9%**

'Proportion of growers' is expressed as percentage of growers who were planning to use no-till or zero-till to sow crops in 2014.

From page 56

Cultivation in fallows for the primary purpose of weed control is most common, particularly in the Northern region (66 per cent) and Central NSW (Table 64). Seventy-one percent of growers in Central NSW cultivate in fallow period on 50 per cent of their cropping land. The use of cultivation is lowest in the Western region.

7.3 Grower perceptions of the crop protection and production implications of no-till with stubble retention

Most growers believe that weed costs will be higher under a no-till system that retains stubble compared to one based on cultivation, with only 17 per cent believing costs will be less (Table 65, p60). Almost half of growers believe the efficacy of pre-emergent herbicides will be less under no-till stubble retention. More than half of growers believe that no-till stubble retention will increase the reliability of wheat yields, particularly in the Northern region where fallow water efficiency is of greater importance. Overall, growers also believe that average crop disease and pest costs will increase under no-till stubble retention (Table 66, p60).

7.4 Adoption of weed management practices

The cost of IWM practices is discussed in section 3.3.2 'Integrated weed management', p36 and is estimated at $475 million (18 per cent of the total weed control expenditure). The adoption curves for weed management practices across all regions are shown in Figure 18, p61, including no-till use for comparison. Results show that adoption of double knockdown continues to increase, with rapid rises in the past six years reflecting the increasing threat of glyphosate resistance. The

Continued page 59

TABLE 64 Percentage of growers using cultivation to kill fallow weeds and proportion of their cropping land cultivated during the fallow period.

	Average percentage of growers using cultivation to kill fallow weeds	Average proportion of cropping land cultivated during fallow period
Northern	66%	28%
Central Queensland	61%	30%
NSW NE/Queensland SE	69%	33%
NSW NW/Queensland SW	65%	23%
Southern	37%	31%
NSW Central	71%	50%
NSW Victorian Slopes	35%	19%
SA Mid North – Lower Yorke Eyre	22%	12%
SA Victorian Bordertown – Wimmera	40%	29%
SA Victorian Mallee	35%	21%
Victorian high-rainfall and Tasmanian grain	20%	28%
Western	30%	19%
WA Central	33%	18%
WA Eastern	32%	22%
WA Sandplain – Mallee	20%	22%
WA Northern	35%	15%
Total / National	40%	28%

'Percentage of growers' is expressed as percentage of all growers per region/zone. 'Average percentage of cropping land' is the average nominated proportion of cropping land that will be cultivated in the last three seasons using this practice.

TABLE 63 Average percentage of growers cultivating in fallow and prior to seeding and average proportion of cropping land cultivated.

	Southern	Western	Northern	Total
Average percentage of growers cultivating cropping land prior to or at seeding (i.e. not under no-till).	15%	4%	8%	10%
Proportion of cropping land in region cultivated prior to or at seeding (i.e. not under no-till)	27%	9%	20%	20%
Average percentage of growers who cite weed management as the main reason for cultivation prior to seeding as proportion of growers seeding with prior cultivation	67%	76%	78%	71%
Growers who cite weed management as main reason for cultivation prior to seeding expressed as proportion of all growers	30%	15%	27%	25%
Growers using cultivation of fallows primarily for weed control	37%	30%	66%	40%
Average proportion of land to be cropped that is cultivated by users of cultivation during the fallow	31%	19%	28%	28%

'Percentage of growers not planning on using no-till to sow 2014 crops' is expressed as a percentage of all growers in region/zone.
'Cropping land cultivated prior to or at seeding' is the average nominated proportion of cropping land (stated by the grower) to be sown in 2014 using other methods (rather than no-till or zero-till). 'Weed management as main reason for cultivation' is defined as at least 50% attributable to weed management.
'Percentage of growers using cultivation to kill fallow weeds' is expressed as a percentage of all growers in region/zone. Cropping land cultivated during fallow is the average nominated proportion of cropping land (stated by the grower).

TABLE 65 Perception of no-till and stubble retention. Average percentage of all growers who perceive no-till with stubble retention will lead to changes, when compared to a tillage-based system without stubble retention, for weed cost, herbicides and wheat yields.

	Growers' perception of the long-term effects of no-till seeding with stubble retention								
	Weed cost			Effectiveness of pre-emergent herbicides			Reliability of wheat yields		
	Less	Same	More	Less	Same	More	Less	Same	More
Northern	22%	36%	42%	45%	34%	22%	3%	25%	72%
Central Queensland	21%	54%	25%	36%	25%	39%	-	25%	75%
NSW NE/Queensland SE	22%	29%	49%	40%	40%	20%	7%	22%	71%
NSW NW/Queensland SW	22%	33%	46%	54%	33%	13%	-	28%	72%
Southern	14%	25%	61%	50%	26%	24%	17%	38%	45%
NSW Central	10%	24%	65%	47%	29%	24%	20%	37%	43%
NSW Victorian Slopes	15%	33%	52%	60%	19%	21%	10%	42%	48%
SA Mid North – Lower Yorke Eyre	14%	27%	59%	47%	27%	25%	10%	31%	59%
SA Victorian Bordertown – Wimmera	10%	26%	64%	58%	16%	26%	18%	34%	48%
SA Victorian Mallee	17%	25%	58%	33%	40%	27%	19%	44%	37%
Victorian high-rainfall and Tasmanian grain	18%	16%	67%	57%	25%	18%	25%	37%	37%
Western	18%	33%	49%	44%	29%	26%	8%	40%	52%
WA Central	22%	24%	53%	53%	22%	24%	9%	36%	56%
WA Eastern	15%	38%	47%	36%	36%	28%	15%	30%	55%
WA Sandplain – Mallee	15%	37%	48%	54%	26%	20%	2%	54%	43%
WA Northern	20%	33%	48%	33%	33%	35%	8%	40%	53%
Total / National	17%	30%	53%	47%	29%	24%	12%	36%	52%

'Percentage of growers' is expressed as percentage of all growers per region/zone.

TABLE 66 Perception of no-till and stubble retention. Average percentage of all growers who perceive no-till with stubble retention will lead to changes, when compared to a tillage-based system without stubble retention, for crop disease, nitrogen costs and pest costs.

	Growers' perception on the long-term effects of no-till seeding with stubble retention								
	Crop disease			Nitrogen fertiliser costs			Pest costs		
	Less	Same	More	Less	Same	More	Less	Same	More
Northern	7%	34%	60%	17%	39%	44%	14%	49%	37%
Central Queensland	4%	54%	43%	7%	39%	54%	14%	64%	21%
NSW NE/Queensland SE	4%	29%	67%	18%	40%	42%	16%	40%	44%
NSW NW/Queensland SW	11%	26%	63%	22%	39%	39%	13%	48%	39%
Southern	13%	30%	56%	21%	33%	47%	9%	38%	52%
NSW Central	8%	37%	55%	18%	39%	43%	6%	43%	51%
NSW Victorian Slopes	10%	19%	71%	13%	38%	48%	8%	44%	48%
SA Mid North – Lower Yorke Eyre	22%	41%	37%	24%	24%	53%	6%	39%	55%
SA Victorian Bordertown – Wimmera	12%	36%	52%	20%	28%	52%	12%	30%	58%
SA Victorian Mallee	10%	42%	48%	21%	37%	42%	10%	48%	42%
Victorian high-rainfall and Tasmanian grain	20%	8%	73%	27%	31%	41%	14%	25%	61%
Western	12%	36%	52%	18%	40%	42%	18%	44%	38%
WA Central	16%	22%	62%	27%	27%	47%	22%	29%	49%
WA Eastern	4%	45%	51%	9%	40%	51%	9%	62%	30%
WA Sandplain – Mallee	11%	41%	48%	26%	37%	37%	22%	43%	35%
WA Northern	18%	35%	48%	10%	58%	33%	20%	40%	40%
Total / National	12%	33%	56%	19%	36%	45%	13%	42%	45%

'Percentage of growers' is expressed as percentage of all growers per region/zone.

From page 59

relatively rapid rise of narrow windrow burning from a low base 10 years ago is also demonstrated. Chaff cart use remains very low nationally but other results show notable use in some AEZs (Figure 18, p61).

7.4.1 Seedling control practices – double knockdown

Across all growers, 61 per cent use double knockdown for weed control; its estimated cost is $97m. Figure 19, Figure 20 and Figure 21 show the adoption curves for double knockdown. Curves in the Western region show slow sustained growth, whereas other regions show more rapid growth from 2005 onwards. The highest use of double knockdown can be seen in WA Mallee and Sandplain (89 per cent) and is the lowest in SA Victorian Mallee (37 per cent).

7.4.2 Weed seed control practices

With the exception of narrow windrow burning (30 per cent of growers), adoption of harvest weed seed kill

Continued page 63

FIGURE 18 Adoption curves for weed management practices and no-till – all regions.

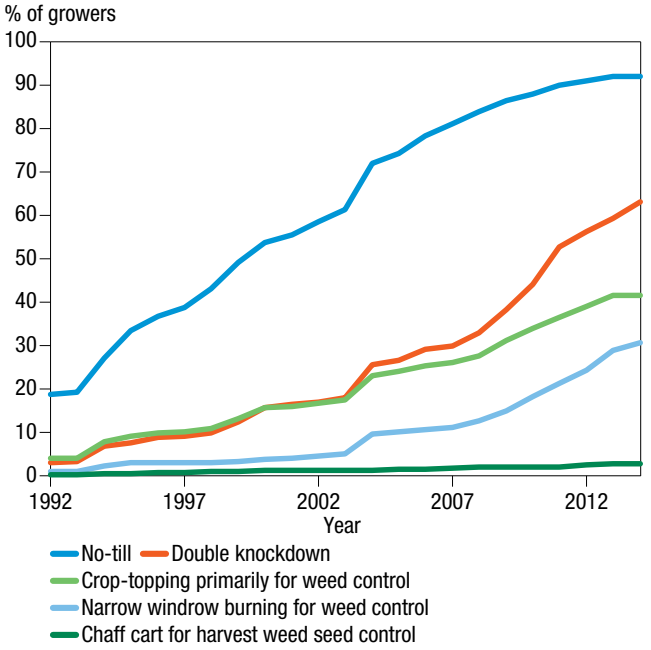


FIGURE 19 Cumulative adoption curves for double knockdown in Northern region agro-ecological zones.

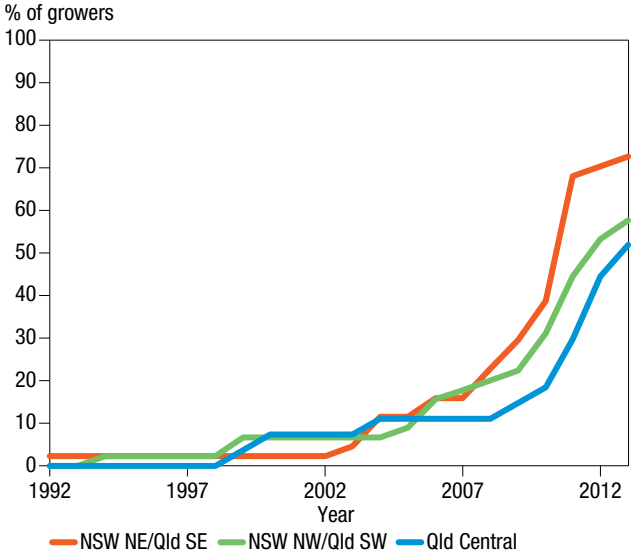


FIGURE 20 Cumulative adoption curves for double knockdown in Southern region agro-ecological zones.

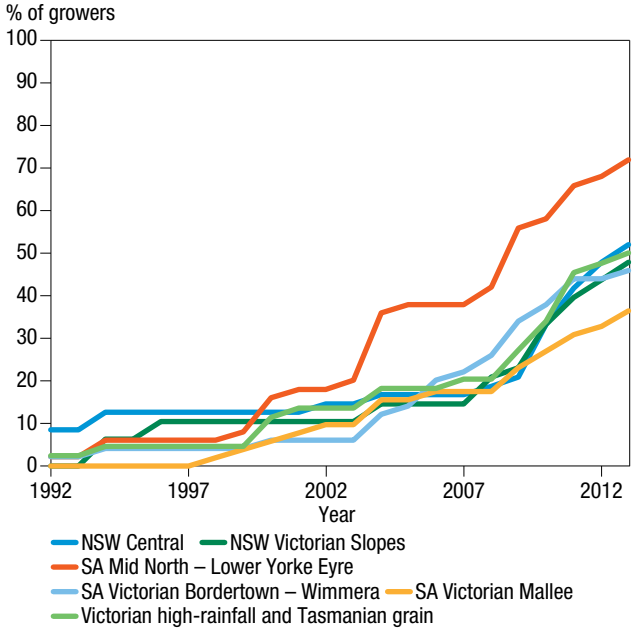


FIGURE 21 Cumulative adoption curves for double knockdown in Western region agro-ecological zones.

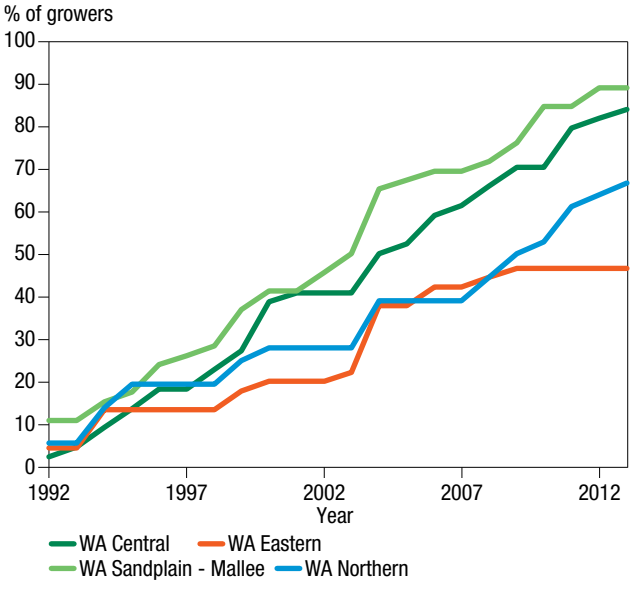


TABLE 67 Proportion of growers planning to use windrow burning, chaff tramlining, chaff cart, bale direct or Harrington Seed Destructor in the next five years.

	Windrow burning			Chaff tramlining			Chaff cart			Bale direct			Harrington Seed Destructor		
	Yes	No	Unsure	Yes	No	Unsure	Yes	No	Unsure	Yes	No	Unsure	Yes	No	Unsure
Northern	10%	80%	10%	15%	76%	8%	3%	92%	6%	3%	90%	8%	3%	88%	9%
Central Queensland		89%	11%	18%	71%	11%	2%	93%	4%		96%	4%		96%	4%
NSW NE/Queensland SE	4%	91%	4%	20%	78%	2%	2%	89%	9%	2%	89%	9%	2%	87%	11%
NSW NW/Queensland SW	22%	63%	15%	9%	78%	13%	4%	93%	4%	4%	87%	9%	4%	85%	11%
Southern	47%	43%	10%	15%	75%	10%	5%	84%	11%	5%	88%	7%	6%	85%	9%
NSW Central	29%	63%	8%	14%	78%	8%	4%	88%	8%	2%	96%	2%	2%	94%	4%
NSW Victorian Slopes	50%	40%	10%	15%	71%	13%	2%	88%	10%	12%	79%	10%	4%	87%	10%
SA Mid North – Lower Yorke Eyre	55%	33%	12%	12%	78%	10%	14%	69%	18%	2%	88%	10%	18%	71%	12%
SA Victorian Bordertown – Wimmera	68%	20%	12%	14%	68%	18%	4%	82%	14%	6%	84%	10%	6%	80%	14%
SA Victorian Mallee	35%	56%	10%	12%	81%	8%	4%	83%	13%	6%	90%	4%	6%	87%	8%
Victorian high-rainfall and Tasmanian grain	47%	45%	8%	25%	73%	2%	4%	92%	4%	4%	90%	6%	2%	90%	8%
Western	67%	26%	7%	13%	78%	9%	22%	66%	12%	4%	93%	3%	12%	72%	15%
WA Central	73%	18%	9%	13%	71%	16%	31%	58%	11%	4%	93%	2%	11%	67%	22%
WA Eastern	64%	34%	2%	15%	83%	2%	11%	81%	9%	4%	94%	2%	11%	83%	6%
WA Sandplain – Mallee	52%	33%	15%	17%	70%	13%	24%	63%	13%	7%	87%	7%	11%	70%	20%
WA Northern	83%	18%		8%	88%	5%	23%	60%	18%		100%		18%	70%	13%
Total / National	46%	45%	9%	15%	76%	9%	10%	80%	10%	4%	90%	6%	7%	82%	11%

'Percentage of growers' is expressed as percentage of all growers per region/zone. Note that growers currently using are assumed to be future users.

FIGURE 22 Cumulative adoption curves for narrow windrow burning by agro-ecological zones.

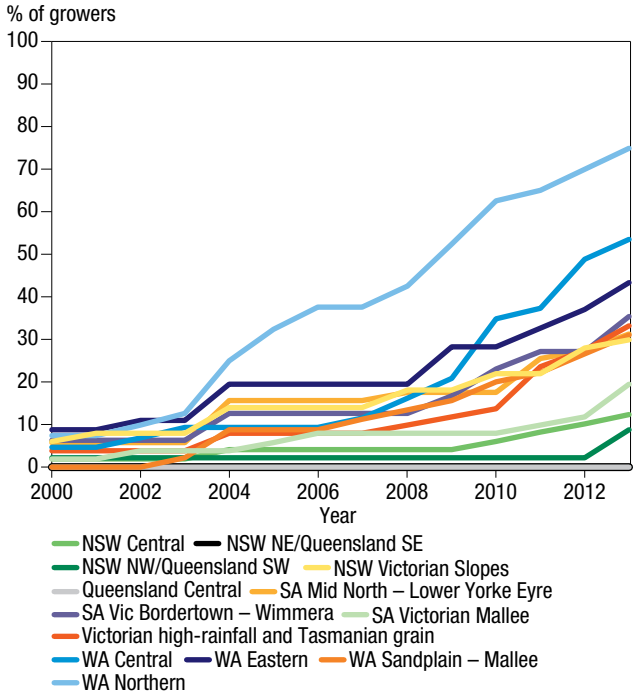
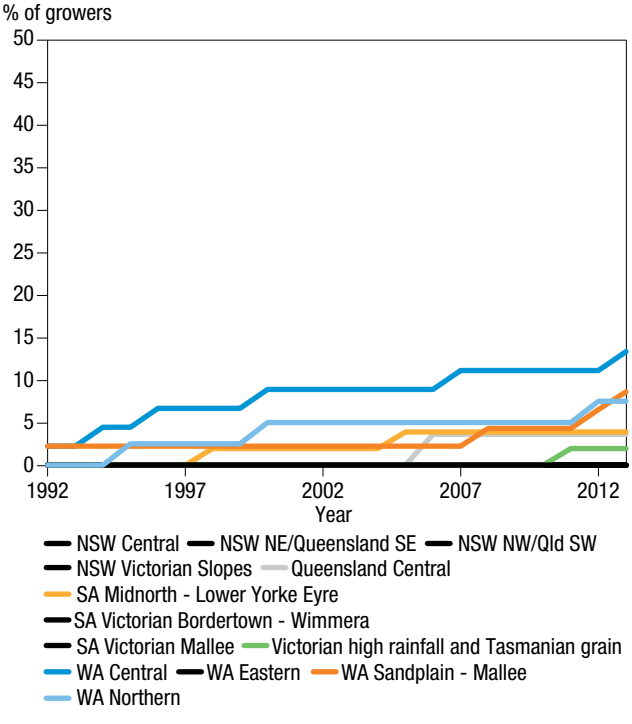


FIGURE 23 Cumulative adoption curves of chaff cart by agro-ecological zones.



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practices remains at low levels, although the use of chaff carts is substantially higher in the Western region than in others (Table 43, p42). Only one grower reported using the newly available Harrington Seed Destructor (data not shown). Nationally, growers' intended use of these practices follows similar trends. Windrow burning has the largest expected growth, from its current use of 30 per cent to an expected use of 46 per cent over the next five years (Table 67). Chaff tramlining has expected growth from current use of 7 per cent to 15 per cent and chaff cart from 3 per cent to 10 per cent.

In many regions, the adoption rate for narrow windrow burning has started to rise over the past five years (Figure 22). Western Australian growers lead the way in this practice, in particular WA Northern zone, which has shown substantial increases in adoption since 2003. Adoption of chaff carts is yet to increase substantially, although there is some evidence of an upward trend in recent years in WA AEZs (Figure 23).

In addition to what they expected to be using in five years, growers were asked what harvest weed seed control they would prefer to be using in the future (Table 68). Narrow windrow burning and Harrington Seed Destructor were the two harvest weed seed control practices that growers would most prefer to be using.

The relatively high preference for the Harrington Seed Destructor demonstrates the potential for a cost-effective harvest weed seed destructor should one become widely commercially available.

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TABLE 68 Percentage of growers with preference for using either chaff cart, bale direct, chaff tramlining, narrow windrow burning or Harrington Seed Destructor in five years.

	Chaff cart	Bale-direct system	Narrow windrow burning	Chaff tramlining	Harrington Seed Destructor
Northern	10%	9%	40%	17%	10%
Central Queensland	18%	-	25%	29%	18%
NSW NE/Queensland SE	9%	7%	44%	18%	9%
NSW NW/Queensland SW	7%	17%	46%	9%	7%
Southern	9%	11%	44%	6%	9%
NSW Central	16%	8%	45%	10%	16%
NSW Victorian Slopes	2%	17%	50%	8%	2%
SA Mid North – Lower Yorke Eyre	14%	2%	41%	-	14%
SA Victorian Bordertown – Wimmera	2%	18%	38%	6%	2%
SA Victorian Mallee	6%	8%	44%	4%	6%
Victorian high-rainfall and Tasmanian grain	12%	14%	45%	6%	12%
Western	18%	2%	40%	6%	18%
WA Central	16%	4%	33%	9%	16%
WA Eastern	21%	-	51%	4%	21%
WA Sandplain – Mallee	20%	4%	37%	4%	20%
WA Northern	15%	-	40%	5%	15%
Total / National	12%	8%	42%	8%	12%

'Percentage of growers' is expressed as percentage of all growers per region/zone.

FIGURE 24 Cumulative adoption curves of crop-topping by Northern region agro-ecological zones.

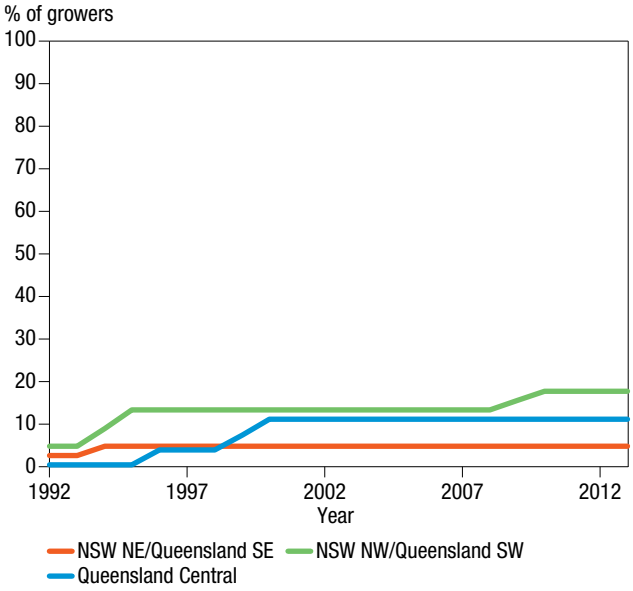


FIGURE 25 Cumulative adoption curves of crop-topping by Southern region agro-ecological zones.

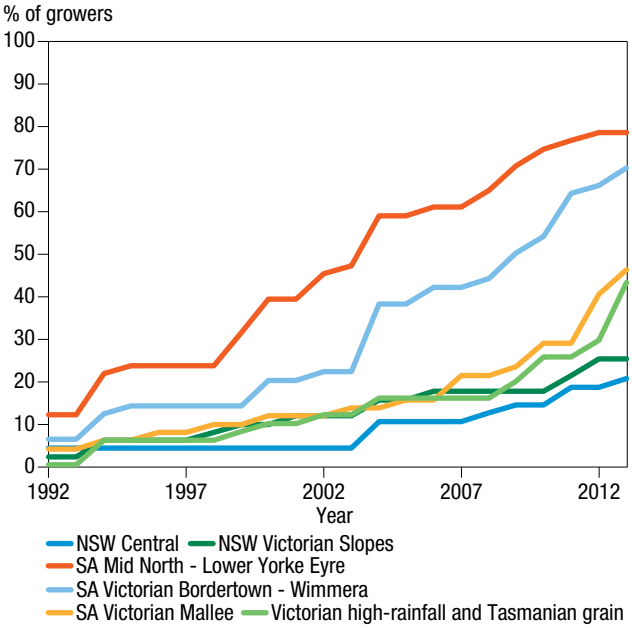
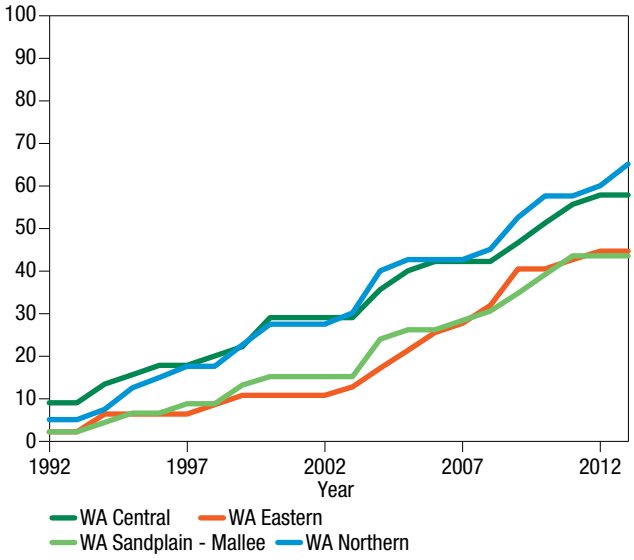


FIGURE 26 Cumulative adoption curves of crop-topping by Western region agro-ecological zones.



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7.4.3 Other weed seed control practices – crop-topping

Across all growers, 42 per cent use crop-topping for weed control; its direct costs are estimated at $12 million and yield revenue loss is estimated at $16 million. Figure 24, Figure 25 and Figure 26 show how crop-topping adoption patterns differ between regions. They show the high use in Southern and Western regions compared with low adoption in the Northern region, partly highlighting the extent of pulses in some regions. The highest usage is in SA Mid North – Lower Yorke Eyre (78 per cent) and SA Victorian Bordertown – Wimmera (70 per cent), followed by WA Northern (65 per cent) and WA Central (58 per cent).

7.5 Perceptions of herbicide-resistance risks

Herbicide use and cost is discussed in section 3.3.1; in-season herbicide use is estimated at $1,590 million whereas fallow herbicide cost is $507 million. On average, 91 per cent of the cropped area receives a knockdown herbicide prior to seeding; 74 per cent receives pre-emergent and 80 per cent receives post-emergent selective herbicide (Table 30, p36). Herbicide resistance is discussed in section 3.4, p45; the average extent of resistance is 43 per cent of cropping land and 64 per cent of growers identified some herbicide resistance. When growers identified their most costly herbicide-resistant weed, 56 per cent stated the weed showed resistance to a selective herbicide. For 17 per cent of growers the top weed showed glyphosate resistance (and 9 per cent both glyphosate and selective).

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TABLE 69 Grower perception that a new selective herbicide able to control weeds that have become resistant to current selective herbicides will become available in the next 10 years, expressed as percentage of growers in region.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Northern	1%	14%	30%	40%	14%
Central Queensland	-	21%	36%	32%	11%
NSW NE/Queensland SE	-	16%	29%	33%	22%
NSW NW/Queensland SW	2%	9%	28%	52%	9%
Southern	1%	10%	20%	58%	10%
NSW Central	-	8%	29%	43%	20%
NSW Victorian Slopes	-	13%	17%	60%	10%
SA Mid North – Lower Yorke Eyre	2%	6%	29%	55%	8%
SA Victorian Bordertown – Wimmera	2%	12%	20%	62%	4%
SA Victorian Mallee	-	12%	13%	65%	10%
Victorian high-rainfall and Tasmanian grain	2%	12%	14%	63%	10%
Western	1%	10%	27%	52%	11%
WA Central	2%	7%	18%	64%	9%
WA Eastern	-	11%	23%	51%	15%
WA Sandplain – Mallee	-	11%	28%	52%	9%
WA Northern	-	10%	40%	38%	13%
Total / National	1%	11%	24%	53%	11%

'Percentage of growers' is expressed as percentage of all growers per region/zone.

TABLE 70 Grower perception that a new knockdown herbicide able to control weeds that have become resistant to glyphosate will become available in the next 10 years, expressed as percentage of growers in region.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Northern	3%	13%	25%	48%	12%
Central Queensland	4%	14%	25%	46%	11%
NSW NE/Queensland SE	-	13%	33%	42%	11%
NSW NW/Queensland SW	4%	11%	17%	54%	13%
Southern	2%	17%	21%	50%	10%
NSW Central	-	6%	22%	55%	16%
NSW Victorian Slopes	-	23%	23%	46%	8%
SA Mid North – Lower Yorke Eyre	2%	18%	24%	47%	10%
SA Victorian Bordertown - Wimmera	8%	20%	24%	44%	4%
SA Victorian Mallee	2%	19%	15%	56%	8%
Victorian high-rainfall and Tasmanian grain	2%	18%	16%	53%	12%
Western	4%	19%	24%	47%	6%
WA Central	2%	13%	27%	51%	7%
WA Eastern	-	19%	28%	43%	11%
WA Sandplain – Mallee	9%	26%	15%	46%	4%
WA Northern	5%	18%	28%	48%	3%
Total / National	3%	17%	23%	49%	9%

'Percentage of growers' is expressed as percentage of all growers per region/zone.

TABLE 71 Grower perception of glyphosate resistance mobility through seed or pollen movement expressed as percentage of growers in region.

	Even if I stop using glyphosate in a paddock I will still end up with a glyphosate-resistant weed population in that paddock within 10 years through seed or pollen movement				
	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Northern	-	32%	24%	38%	7%
Central Queensland	-	32%	29%	29%	11%
NSW NE/Queensland SE	-	36%	20%	38%	7%
NSW NW/Queensland SW	-	28%	24%	43%	4%
Southern	2%	34%	18%	41%	4%
NSW Central	2%	27%	27%	41%	4%
NSW Victorian Slopes	-	35%	17%	46%	2%
SA Mid North – Lower Yorke Eyre	2%	35%	24%	33%	6%
SA Victorian Bordertown – Wimmera	2%	40%	14%	38%	6%
SA Victorian Mallee	4%	33%	12%	52%	-
Victorian high-rainfall and Tasmanian grain	4%	35%	18%	37%	6%
Western	8%	41%	16%	29%	6%
WA Central	13%	33%	13%	33%	7%
WA Eastern	6%	43%	15%	30%	6%
WA Sandplain – Mallee	9%	43%	17%	26%	4%
WA Northern	3%	45%	20%	28%	5%
Total / National	3%	36%	19%	37%	5%

'Percentage of growers' is expressed as percentage of all growers per region/zone.

TABLE 72 Weeds most commonly cited as most costly to control as stated by Australian grain growers (considering both fallow and crop weeds).

Rank	Weed name	Growers citing weed
1	Ryegrass	76%
2	Wild radish	41%
3	Brome grass	25%
4	Wild oats	25%
5	Fleabane	20%
6	Barley grass	12%
7	Cape weed	11%
8	Marshmallow	7%
9	Feathertop Rhodes grass	6%
10	Barnyard grass	5%

Growers citing most costly weed expressed as percentage of all growers per region/zone.

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7.5.1 Perceptions of selective herbicide risks

Growers generally expect that a new selective herbicide able to control weeds that are resistant to current selective herbicides will become available in the next decade (Table 69). Only 12 per cent don't expect this outcome. Overall, 64 per cent agree that such a product will become available, but only 11 per cent strongly agree, indicating a degree of uncertainty.

7.5.2 Perceptions of non-selective herbicide risks and glyphosate resistance mobility

Considerable optimism also exists among growers regarding the likelihood of a new non-selective herbicide becoming available to control glyphosate-resistant weeds (Table 70, p65). However, there are more growers (20 per cent) who don't expect such a herbicide to become available in the next 10 years.

Growers perceptions appear divided over the likelihood of gaining glyphosate resistance in one of their paddocks through movement of pollen or seed (Table 71). Northern and Southern region growers appear more likely to expect mobile glyphosate resistance than growers in the Western region. This is likely to partly reflect differences in common weed types.

7.6 Most costly weeds to control as stated by growers

We asked growers about the type of weeds they manage and to list the four most costly weeds to control considering both fallow and crops. We also asked specifically about the two most common weeds found in winter cereal crops, canola and/or pulse crops and sorghum crops later in the season. They were also asked to list the two most common mature weeds they find in summer fallow and winter fallow paddocks, which are discussed in section 3.2 'Yield and revenue losses due to weeds', p18.

7.6.1 Most costly weeds to manage in crop and fallow

The most costly crop weed, as stated by growers nationally, was ryegrass, followed by wild radish and brome grass (Table 72). The most costly crop weeds for Northern, Southern and Western growers by region are given in Table 73. Generally, as ryegrass is less dominant in the Northern region, Northern growers identified a more diverse list of costly weeds.

TABLE 73 Weeds most commonly cited as most costly to control as stated by grain growers by region.

Rank	National		Northern		Southern		Western	
1	Ryegrass	76%	Fleabane	51%	Ryegrass	82%	Ryegrass	90%
2	Wild radish	41%	Feathertop Rhodes grass	33%	Wild radish	33%	Wild radish	76%
3	Brome grass	25%	Ryegrass	31%	Wild oats	31%	Brome grass	30%
4	Wild oats	25%	Barnyard grass	22%	Brome grass	30%	Barley grass	23%
5	Fleabane	20%	Wild oats	20%	Fleabane	15%	Cape weed	19%
6	Barley grass	12%	Sow thistle / milk thistle	18%	Cape weed	10%	Wild oats	16%
7	Cape weed	11%	Sweet summer grass	10%	Marshmallow	10%	Fleabane	7%
8	Marshmallow	7%	Phalaris	7%	Barley grass	8%	Melons	6%
9	Feathertop Rhodes grass	6%	Marshmallow	5%	Paterson's curse / salvation Jane	7%	Doublegee	6%
10	Barnyard grass	5%	Thistle species	5%	Melons	6%	Wild turnip	5%
11	Melons	5%	Windmill grass	5%	Wild mustard	5%	Marshmallow	4%
12	Sow thistle / milk thistle	4%	Wild turnip	4%	Skeleton weed	5%	Caltrop / bindi	3%
13	Wild turnip	4%	Wireweed	4%	Silver grass	4%	Silver grass	3%
14	Paterson's curse / salvation Jane	4%	Parthenium weed	3%	Wild turnip	4%	Geranium	1%
15	Wild mustard	3%	Barley grass	3%	Wireweed	4%	Dock	1%
16	Wireweed	3%	Caltrop / bindi	3%	Thistle species	4%	Sorrel	1%
17	Caltrop / bindi	3%	Wild radish	3%	Vetches	4%	Vetches	1%
18	Thistle species	3%	Black bindweed / climbing buckwheat	2%	Caltrop / bindi	3%	Wild mustard	1%
19	Silver grass	3%	Cape weed	2%	Heliotrope (potato weed)	3%	Windmill grass	1%
20	Doublegee	2%	Mexican poppy	2%	Bifora	3%	Wireweed	1%

Most costly weed to control considering both fallow and crop weeds.

8 SUMMARY: ADOPTION OF WEED MANAGEMENT PRACTICES AND TILLAGE PRACTICES BY AUSTRALIAN GRAIN GROWERS

On average, 92 per cent of growers used no-till and less than 20 per cent used tillage as part of seeding in 2014. Use of some cultivation to kill summer fallow weeds was common (40 per cent of growers nationally). On farms where fallow cultivation is used, it is often used on on more than a quarter of the cropping land.

Use of knife points still dominated the Southern region and the proportion of growers using discs instead of knife points only exceededs 20 per cent in the Northern region.

Almost half of growers believed the efficacy of pre-emergent herbicides would be less under no-till stubble retention compared to a cultivation-based system without stubble retention. Most growers believed that weed costs would be higher under a stubble-retained no-till system compared to one based on cultivation, with only 17 per cent believing costs will be less.

As weed control through cultivation has declined, adoption of a range of other weed management practices has increased. Crop-topping, double knockdown and narrow windrow burning have increased, with the latter showing rapid recent increases in some areas, particularly Western Australia.

Adoption of chaff carts remains low at a national level, although there is some evidence of an upward trend in recent years in WA AEZs. When comparing harvest weed seed control practices, growers show a preference for using narrow windrow burning and harvest weed seed destruction in the future (should the product become commercially available).

When asked about weeds that are most costly to control on their farm in crop or fallow, the five weeds most commonly cited were: ryegrass (76 per cent of growers), wild radish (41 per cent), brome grass (25%), wild oats (25 per cent) and fleabane (20 per cent). Ryegrass was the dominant herbicide-resistant weed; 83 per cent of growers listed it as their main herbicide resistance problem.

Considerable optimism existed among growers regarding the likelihood of new herbicides becoming available to control herbicide-resistant weeds. Most growers expected that a new selective or knockdown herbicide able to control weeds that are resistant to current herbicides will become available in the next decade. Overall, 64 per cent agreed that such a selective herbicide would become available and slightly less agreed a new knockdown herbicide to control glyphosate-resistant weeds would become available.

Important differences in weed issues, resistance status, use of weed management practices by growers and perceptions exist between AEZs and regions. The differences found at this level highlight opportunities for improving weed management strategies.

APPENDIX

9.1 Survey script

Q1 Introduction and permissions

Q2 Are you the main cropping decision-maker on the farm? If they are not, ask for the relevant person and continue with them, or arrange a call back.

Q2b What farm type best describes your operation, grain specialist or grain and livestock?

Q3 What is the total area of arable land that you currently manage? Definition of arable land: land which is suitable for growing crops

Q4 Thinking of the past 3 seasons, how many hectares (or acres) do you crop each year on average?

Q5c Which of the following crops will you grow this year, or have you grown in the past three years?

Q6a Which legumes and pulses have you grown in the past three seasons?

Q6b And what about the area of winter fallow?

Q7 Thinking of the past three years, what do you see as the four most costly weeds to control, considering both in crop and fallow weeds?

Q7b I am now going to ask you about the two weeds you most commonly find competing in your winter cereal crops later in the season. So what is the first weed you most commonly find?

Q7bA And what percentage of your cropped area has this weed present?

Q7bB And for [Q7b], what is your estimate of a typical density of that weed near harvest time: usually low (less than 1 per square metre), usually medium (between 1 and 10 per square metre) or usually high (greater than 10 per square metre)?

Q7bC And what is the second weed you most commonly find competing in your winter cereal crops later in the season?

Q7bD And what percentage of your cropped area has this weed present?

Q7bE And for [Q7bC], what is your estimate of a typical density of that weed near harvest time: usually low, usually medium or usually high? Low is less than 1 per square metre, medium is 1–10 per square metre, high is more than 10 per square metre.

Q7bF I am now going to ask you about the two weeds you most commonly find competing in your broadleaf (i.e. canola and pulses) crops later in the season. So what is the first weed you most commonly find?

Q7bG And what percentage of your cropped area has this weed present?

Q7bH And for [Q7bF], what is your estimate of a typical density of that weed near harvest time: usually low (less than 1 per square metre), usually medium (between 1 and 10 per square metre) or usually high (greater than 10 per square metre)?

Q7bI And what is the second weed you most commonly find competing in your broadleaf crops later in the season?

Q7I I am now going to ask you about the two weeds you most commonly find competing in your sorghum crops later in the season. So what is the first weed you most commonly find?

Q7bM And what percentage of your cropped area has this weed present?

Q7bN And for [Q7i], what is your estimate of a typical density of that weed near harvest time: usually low (less than 1 per square metre), usually medium (between 1 and 10 per square metre) or usually high (greater than 10 per square metre)?

Q7bO And what is the second weed you most commonly find competing in your sorghum crops later in the season?

Q7bP And what percentage of your cropped area has this weed present?

Q7bQ And for [Q7bO], what is your estimate of a typical density of that weed near harvest time: usually low, usually medium or usually high? Low is less than 1 per square metre, medium is 1–10 per square metre, high is more than 10 per square metre.

Q7c I am now going to ask you about the two weeds you most commonly find in your cropping paddocks in summer. So what is the first weed you most commonly find?

Q7cA And what percentage of your area to be cropped has this weed present?

Q7cB And for [Q7c], what is your estimate of a typical density of mature plants during summer: usually low (less than 1 per square metre), usually medium (between 1 and 10 per square metre) or usually high (greater than 10 per square metre)?

Q7cC And what is the second weed you most commonly find in your cropping paddocks in summer?

Q7cD And what percentage of your area to be cropped has this weed present?

Q7cE And for [Q7cC], what is your estimate of a typical density of mature plants during summer: usually low, usually medium or usually high?

Q7d I am now going to ask you about the two weeds you most commonly find in your fallows in the winter. So what is the first weed you most commonly find?

Q7dA And what percentage of your area to be cropped has this weed present?

Q7dB And for [Q7d], what is your estimate of a typical density of mature plants during a winter fallow: usually low (less than 1 per square metre), usually medium (between 1 and 10 per square metre) or usually high (greater than 10 per square metre)?

Q7dC And what is the second weed you most commonly find in your winter fallows?

Q7dD And what percentage of your area to be cropped has this weed present?

Q7dE And for [Q7dC], what is your estimate of a typical density of mature plants during a winter fallow: usually low, usually medium or usually high?

Q9n1 Thinking of the past three seasons. Typically, what % of your area to be cropped receives a herbicide application for summer weeds (not counting any pre-seeding knockdown)?

Q9b Typically what percentage of your crop area receives a knockdown herbicide application (e.g. glyphosate) prior to seeding?

Q9c Typically, what percentage of your crop area receives a pre-emergent herbicide application (e.g. trifluralin etc.)?

Q9d Typically, what percentage of your crop area receives a post-emergent herbicide?

Q9a Thinking of your typical total crop protection costs over the past three seasons (i.e. herbicides, pesticides and fungicides etc.), what proportion of that do you think is spent on herbicides?

Q10 If you had no weed considerations at all, would you change the areas of what you grow?

Q10b What would be the main difference? If they are stuck, say 'for example, would you grow more or less of anything?'

Q11 Thinking of the last three seasons, what proportion of your cropped area is burnt each year on average? (Don't include burning where only windrows are burnt). You are asking for a %.

Q11a Thinking of the past 3 seasons, how important is weed management as a reason for burning stubble on a scale of 1–10, where 10 is the entire reason for burning and 1 is not a reason at all for burning? Answer If [Q11] >= 1.

Q12 Thinking of the last three seasons, have you had to clean grain before delivery to remove weed contamination in any crops?

Q12a What percentage of your total crop tonnage over the past three years have you had to clean? If true go to Q13.

Q13 Thinking of the last three seasons, when selling your grain have you been penalised for having any weed contamination? For example, did they have to accept a lower price? Yes 1 No 555.

Q13 If [Q13] = 555 go to Q14.

Q13a What percentage of your total crop tonnage over the past three years have you been penalised for? You are asking for a % If true go to Q14.

Q14 Have you ever used no-till or zero-till for cropping? That is seeding with no prior cultivation and includes knife points, zero-till with disc machines, super seeder, inverted-t etc., i.e. not full-cut seeding. Yes 1. No 2.

Q14 If [Q14] = 2 go to Q16.

Q15 In what year did you first try no-till or zero-till for cropping?

Q16 For the crop area that you will sow this year, what percentage will be sown using...READ OUT
No-till or zero-till (i.e. seeding with discs or knife points with no prior cultivation) 1.

Q16_1 Seeding using no till or zero-till seeding implement but with prior cultivation 2.

Q16_2 Seeding with full-cut seeding pass with no prior cultivation 3.

Q16_3 Seeding with full-cut seeding pass with prior cultivation 4.

Q17bC Thinking of the past three seasons, how important is weed management as a reason for cultivating on a scale of 1–10, where 10 is weed management is the entire reason for cultivating and 1 is that weed management is not a reason at all for cultivating?

Q18 For seeding, do you usually use discs, narrow points or both? Answer If [Q16_1] > 0 Discs 1 Narrow points 2 Both 3.

Q20 I am now going to ask if you use the following seven practices primarily for weed control purposes.

Q20B First of all, do you use cultivation to kill fallow weeds, do you use that practice primarily for weed control purposes?

Q20b2 On what percentage of your annual cropped area did you use this practice, as an average over the past three seasons? (or % that will be cropped in the coming crop season if they have not previously used this practice). If true go to Q20e.

Q20e Do you use brown/green manure of a sown crop primarily for weed control purposes?

Q20e/ Q20e2 On what percentage of your annual cropped area did you use this practice, as an average over the past three seasons? (or % that will be cropped in the coming crop season if they have not previously used this practice). If true go to Q20f.

Q20f Do you use mouldboard ploughing to bury weed seeds primarily for weed control purposes?

Q20f2 On what percentage of your annual cropped area did you use this practice, as an average over the past three seasons? (or % that will be cropped in the coming crop season if they have not previously used this practice). Answer is a %. Could also be % to be cropped in the coming crop season. If true go to Q20h.

Q20h Do you use delayed seeding with knockdown primarily for weed control purposes? This means deliberate delay of at least one week past when paddock would have been first sown. Yes 1 No 555. Q20h If [Q20h] = 555 go to Q20i.

Q20h2 On what percentage of your annual cropped area did you use this practice, as an average over the past three seasons? (or % that will be cropped in the coming crop season if they have not previously used this practice). Answer is a %. Could also be % to be cropped in the coming crop season. If true go to Q20i.

Q20i Do you use double knockdown primarily for weed control purposes? Double knockdown means two different knockdown herbicides in succession. Yes 1 No 555. Q20i.If [Q20i] = 555 go to Q20l.

Q20i1 In what year did you first start using this practice?

Q20i2 On what percentage of your annual cropped area did you use this practice, as an average over the past three seasons? (or % that will be cropped in the coming crop season if they have not previously used this practice). Answer is a %. Could also be % to be cropped in the coming crop season. If true go to Q20l

Q20l Do you use crop-topping primarily for weed control purposes? Crop-topping is spraying a grain crop with herbicide to reduce weed seed set at or near crop maturity. Yes 1. No 555.

Q20l If [Q20l] = 555 go to Q20m.

Q20l1 In what year did you first start using this practice?

Q20l2 On what percentage of your annual cropped area did you use this practice, as an average over the past three seasons? (or % that will be cropped in the coming crop season if they have not previously used this practice). Answer is a %. Could also be % to be cropped in the coming crop season. If true go to Q20m.

Q20m Do you use pasture spray-topping or hay freezing primarily for weed control purposes? Yes 1. No 555. Q20m If [Q20m] = 555 go to Q21.

Q20m2 On what percentage of your annual cropped area did you use this practice, as an average over the past three seasons? (or % that will be cropped in the coming crop season if they have not previously used this practice) If true go to Q21.

Q21 I am now going to read you out a list of five harvest weed control systems. Can you please tell me which ones you use?

Q21a Do you use a chaff cart for harvest weed seed control? Yes 1. No 555 Q21aIf [Q21a] = 555 go to Q21a3.

Q21a1 In what year did you first start using this practice?

Q21a2 On what percentage of your annual cropped area did you use this practice, as an average over the past three seasons? (or % that will be cropped in the coming crop season if they have not previously used this practice) Answer is a %. Could also be % to be cropped in the coming crop season. If true go to Q21b

Q21a3 Do you expect to be using this practice in five years? Yes 1. No 555. Q21a3. Unsure 666

Q21b Do you use a bale-direct system for weed control purposes? A bale-direct system is a baler attached to harvester. Yes 1. No 555. Q21b If [Q21b] = 555 go to Q21b3

Q21b2 On what percentage of your annual cropped area did you use this practice, as an average over the past three seasons? (or % that will be cropped in the coming crop season if they have not previously used this practice). Answer is a %. Could also be % to be cropped in the coming crop season. If true go to Q21c

Q21b3 Do you expect to be using this practice in five years? Yes 1. No 555. Q21b3 Unsure 666

Q21c Do you use narrow windrow burning for weed control purposes? Narrow windrow burning is placing chaff in narrow windrows at harvest and later burning them. Yes 1. No 555. Q21c If [Q21c] = 555 Go to Q21c3

Q21c1 In what year did you first start using this practice?

Q21c2 On what percentage of your annual cropped area did you use this practice, as an average over the past three seasons? (or % that will be cropped in the coming crop season if they have not previously used this practice). Answer is a %. Could also be % to be cropped in the coming crop season. If true go to Q21d.

Q21c3 Do you expect to be using this practice in five years? Yes 1. No 555. Q21c3 Unsure 666

Q21d Do you use chaff tramlining for weed control? Chaff tramlining is concentrating chaff at harvest on dedicated tramlines used in a controlled traffic system. Yes 1. No 555. Q21d.If [Q21d] = 555 go to Q21d3.

Q21d2 On what percentage of your annual cropped area did you use this practice, as an average over the past three seasons? (or % that will be cropped in the coming crop season if they have not previously used this practice) Could also be % to be cropped in the coming crop season. If true go to Q21e.

Q21d3 Do you expect to be using this practice in five years? Yes 1. No 555. Q21d3 Unsure 666.

Q21e Do you use a Harrington Seed Destructor for weed control? Yes 1 No 555. Q21elf [Q21e] = 555 go to Q21e3.

Q21e2 On what percentage of your annual cropped area did you use this practice, as an average over the past three seasons? (or % that will be cropped in the coming crop season if they have not previously used this practice). Answer is a %. Could also be % to be cropped in the coming crop season. If true go to Q21f

Q21e3 Do you expect to be using this practice in five years? Yes 1 No 555. Q21e3 Unsure 666.

Q21f Which of the five harvest weed seed control systems I just mentioned would you most prefer to be using in five years time, if you had to select one? Chaff cart 1, Bale-direct system 2, Narrow windrow burning 3, Chaff tramlining 4, Harrington Seed Destructor 5.

Q21g What are the main reasons you are not using this practice now? Answer If ([Q21f] = 1 AND [Q21a] = 555) OR ([Q21f] = 2 AND [Q21b] = 555) OR ([Q21f] = 3 AND [Q21c] = 555) OR ([Q21f] = 4 AND [Q21d] = 555) OR ([Q21f] = 5 AND [Q21e] = 555)Q21g.

Q22a What proportion of your cropping land has a herbicide resistant weed population? A herbicide-resistant weed population is where a herbicide that once worked on a weed is no longer effective enough to be worth using for controlling that weed. If [Q22a] = 0 go to Q23.

Q22b1 I am now going to ask you about the two most costly types of resistance that you manage. Can you tell me the first of the two most costly resistant weeds you manage?

Q22b2 What herbicide types is it resistant to?

Q22b3 What percentage of your annual cropping area has this type of resistance? You are asking for a %.

Q22b4 Can you tell me the second of the two most costly resistant weeds you manage? If [22b4] = 139 go to Q23.

Q22b5 What herbicide types is it resistant to? Don't know 999, Q22b5_1, Q22b5_O.

Q22b6 What percentage of your annual cropping area has this type of resistance?

Q23 What extra practices have you adopted or used more of to manage herbicide resistance? Any other practices that you can think of?

Q25 For the following statements, please indicate whether you:
strongly disagree;
disagree;
neither disagree nor agree;
agree; or strongly agree with them?
Strongly disagree
Disagree
Neither agree nor disagree
Agree
Strongly agree
Do not answer If true I prefer to keep my farming operations very simple.

Q25_1 A lack of labour is one of the biggest constraint to my farm operations rank 1, 2, 3, 4, 5.

Q25_2 A new selective herbicide able to control weeds that have become resistant to current selective herbicides will become available in the next 10 years.

Q25_3 A new knockdown herbicide able to control weeds that have become resistant to glyphosate will become available in the next 10 years rank 1, 2, 3, 4, 5.

Q25_4 Do not answer if true:
Even if I tried to prevent any herbicide resistance in paddocks, I would still end up with herbicide resistance within 10 years through other ways such as pollen flow, resistant seed blown or brought in?

Q25_5 Even if I stop using glyphosate in a paddock I will still end up with a glyphosate resistant weed population in that paddock within 10 years through seed or pollen movement, rank 1, 2, 3, 4, 5.

Q26 Now I am going to read some cropping related issues. As I do so, could you tell me how you think the long-term effects of no-till seeding with stubble retention will differ to the long-term effects of cultivation and full-cut seeding without stubble retention?
So do you think no-till with stubble retention will lead to:
more
less
or the same levels of (READ OUT ATTRIBUTE)
If more ask:
Is that a little more
or lot more?
If less ask:
Is that a little less
or a lot less?
Less?
The same? More crop disease.

Q26_1 Do not answer if true
Soil moisture retention rank 1, 2, 3.

Q26_2 Weed costs

Q26_3 Nitrogen fertiliser costs rank 1, 2, 3.

Q26_4 Pest costs.

Q26_5 Effectiveness of pre-emergent herbicides rank 1, 2, 3.

Q26_6 Do not answer if true
Long-term wheat yields.

Q26_7 Reliability of wheat yields rank 1, 2, 3.

Q27 Do you pay a consultant, advisor or agronomist for cropping advice? Yes 1 No 555.

Q28 Finally, I have a few demographic questions. Can you please tell me into which of the following age groups you fall?

Q29 Has anyone involved with managing the farm completed a university degree or diploma?

9.2 Economic model input data

9.2.1 Crop production areas and assumed weed-free yields

The National Variety Trial (NVT) yield used in the model is based on an average for all trials conducted in each region over the three years 2011–13. The NVT dataset has no sorghum recorded online over the three years, therefore sorghum weed-free yields were estimated using locally known equivalents.

TABLE 74 Wheat model input data: area, yield and production.

Region	Area (ha) ('000)	Yield (t/ha)	Production (t) ('000)	Gross value ($'million)	Local value ($'million)	Crop price ($/t)	Weed-free yield (t/ha)	NVT yield
NSW Central	1,164.7	2.3	2,630.6	638.5	572.0	217	2.9	3.43
NSW NE/Queensland SE	1,124.8	2.3	2,552.2	634.4	567.0	222	2.9	3.58
NSW NW/Queensland SW	955.3	2.0	1,868.6	465.6	416.6	223	2.4	2.79
NSW Victorian Slopes	1,265.1	2.6	3,324.7	807.3	724.3	218	3.2	3.84
Central Queensland	170.2	1.8	311.1	81.0	72.1	232	2.6	3.44
SA Mid North – Lower Yorke Eyre	857.8	2.8	2,377.4	648.6	617.0	260	3.3	3.86
SA Victorian Bordertown – Wimmera	645.8	2.5	1,615.9	412.4	378.0	234	3.2	3.92
SA Victorian Mallee	2,110.9	1.8	3,750.3	989.2	924.5	247	2.1	2.37
Victorian high-rainfall and Tasmanian grain	147.7	2.9	422.8	109.3	99.9	236	4.2	5.51
WA Central	2,484.4	1.7	4,160.5	1,170.2	1,096.3	264	2.3	2.98
WA Eastern	1,012.2	0.8	854.8	240.4	225.2	263	1.2	1.70
WA Sandplain – Mallee	401.6	2.2	887.4	250.0	234.1	264	2.5	2.75
WA Northern	972.8	1.6	1,597.4	450.0	421.3	264	2.1	2.51
Total	**13,313.3**	**2.0**	**26,353.7**	**6,896.9**	**6,348.3**	**241**	**-**	**-**

Annual average based on 2010-11 to 2012-13 ABS data and NVT average yields.

TABLE 75 Barley model input data: area, yield and production.

Region	Area (ha) ('000)	Yield (t/ha)	Production (t) ('000)	Gross value ($'million)	Local value ($'million)	Crop price ($/t)	Weed-free yield (t/ha)	NVT yield
NSW Central	231.3	2.3	535.0	116.4	104.0	194	2.7	3.05
NSW NE/Queensland SE	252.4	2.3	571.4	128.3	114.2	200	3.0	3.73
NSW NW/Queensland SW	96.3	1.7	158.9	34.5	30.7	193	2.2	2.78
NSW Victorian Slopes	229.1	2.4	543.9	119.1	106.4	196	3.1	3.87
Central Queensland	1.7	1.6	2.7	0.6	0.6	222	2.4	3.14
SA Mid North – Lower Yorke Eyre	448.5	2.7	1,208.1	280.8	260.5	216	3.2	3.79
SA Victorian Bordertown – Wimmera	516.2	2.4	1,249.7	279.6	252.6	202	3.2	4.00
SA Victorian Mallee	624.7	1.9	1,212.9	275.9	251.9	208	2.2	2.49
Victorian high-rainfall and Tas grain	61.4	2.5	152.3	34.3	31.0	204	3.4	4.25
WA Central	745.5	1.9	1,394.0	354.0	329.9	237	2.7	3.57
WA Eastern	121.4	1.0	118.0	30.0	27.9	236	1.7	2.41
WA Sandplain - Mallee	248.7	2.0	506.6	125.8	116.9	231	2.5	3.09
WA Northern	42.4	1.3	54.9	13.6	12.7	231	1.8	2.31
Total	**3,619.6**	**2.1**	**7,708.4**	**1,792.9**	**1,639.3**	**213**	**-**	**-**

Annual average based on 2010-11 to 2012-13 ABS data and NVT average yields.

TABLE 76 Oats model input data: area, yield and production.

Region	Area (ha) ('000)	Yield (t/ha)	Production (t) ('000)	Gross value ($'million)	Local value ($'million)	Crop price ($/t)	Weed-free yield (t/ha)	NVT yield
NSW Central	84.0	1.5	122.1	23.5	20.8	170	2.5	3.49
NSW NE/Queensland SE	69.1	0.8	54.0	10.1	9.0	167	2.0	3.17
NSW NW/Queensland SW	36.5	0.9	33.6	6.4	5.7	170	0.9	-
NSW Victorian Slopes	88.2	1.6	140.8	27.3	24.3	173	2.6	3.58
Central Queensland	8.0	0.2	1.3	0.2	0.2	154	0.2	-
SA Mid North – Lower Yorke Eyre	19.9	2.0	39.2	8.7	8.1	207	2.5	3.10
SA Victorian Bordertown – Wimmera	97.5	1.6	160.8	35.6	32.4	201	2.6	3.61
SA Victorian Mallee	45.4	1.4	61.6	13.7	12.6	205	1.3	1.17
Victorian high-rainfall and Tas grain	25.9	1.7	43.7	9.6	8.7	199	1.7	
WA Central	222.5	1.9	433.6	94.7	87.1	201	2.7	3.55
WA Eastern	27.6	0.7	20.0	4.4	4.0	200	1.5	2.32
WA Sandplain – Mallee	4.0	1.5	6.0	1.3	1.1	183	2.7	3.90
WA Northern	7.5	0.9	6.6	1.4	1.3	197	0.9	-
Total	**736.1**	**1.5**	**1,123.3**	**236.9**	**215.3**	**192**	**-**	**-**

Annual average based on 2010-11 to 2012-13 ABS data and NVT average yields.

TABLE 77 Canola model input data: area, yield and production.

Region	Area (ha) ('000)	Yield (t/ha)	Production (t) ('000)	Gross value ($'million)	Local value ($'million)	Crop price ($/t)	Weed-free yield (t/ha)	NVT yield
NSW Central	138.1	1.6	220.5	112.1	106.1	481	1.6	1.64
NSW NE/Queensland SE	61.4	1.6	98.4	50.1	47.5	483	1.8	2.04
NSW NW/Queensland SW	66.5	1.2	81.3	41.4	39.2	482	1.5	1.83
NSW Victorian Slopes	514.0	1.5	796.3	406.0	384.8	483	1.9	2.31
Central Queensland	0.2	1.5	0.3	0.1	0.1	333	1.5	-
SA Mid North – Lower Yorke Eyre	167.5	1.6	264.1	143.0	138.7	525	1.9	2.13
SA Victorian Bordertown – Wimmera	316.0	1.4	434.9	232.7	222.8	512	1.8	2.21
SA Victorian Mallee	118.4	1.1	129.8	69.7	66.9	515	1.2	1.27
Victorian high-rainfall and Tas grain	77.2	1.6	125.5	67.2	64.1	511	1.6	1.62
WA Central	645.9	0.9	599.8	336.9	325.2	542	1.4	1.88
WA Eastern	65.0	0.4	28.5	16.0	15.4	540	0.4	
WA Sandplain - Mallee	228.3	1.2	274.7	154.0	148.7	541	1.4	1.53
WA Northern	128.9	0.8	106.7	59.8	57.7	541	1.2	1.51
Total	**2,527.4**	**1.3**	**3,160.8**	**1,689.0**	**1,617.2**	**512**	**-**	**-**

Annual average based on 2010-11 to 2012-13 ABS data and NVT average yields.

TABLE 78 Pulses model input data: area, yield and production.

Region	Area (ha) ('000)	Yield (t/ha)	Production (t) ('000)	Gross value ($'million)	Local value ($'million)	Crop price ($/t)	Weed-free yield (t/ha)	NVT yield
NSW Central	50.8	1.2	62.8	22.8	21.1	336	1.6	1.95
NSW NE/Queensland SE	317.6	1.1	340.8	159.1	149.6	439	1.7	2.28
NSW NW/Queensland SW	224.9	1.2	273.2	117.2	109.5	401	1.6	2.01
NSW Victorian Slopes	59.7	1.5	90.0	28.8	26.5	294	1.8	2.05
Central Queensland	82.8	1.2	99.5	53.6	50.5	508	1.9	2.56
SA Mid North – Lower Yorke Eyre	235.8	1.7	403.3	163.6	157.1	390	2.1	2.47
SA Victorian Bordertown – Wimmera	275.8	1.4	380.7	172.1	163.4	429	1.9	2.36
SA Victorian Mallee	120.0	1.2	142.6	48.9	45.8	321	1.5	1.79
Victorian high-rainfall and Tas grain	7.4	1.3	9.8	4.2	3.9	398	1.3	-
WA Central	231.7	0.9	213.6	57.6	53.5	250	1.6	2.32
WA Eastern	34.4	0.4	14.5	3.9	3.7	255	0.9	1.49
WA Sandplain – Mallee	69.9	1.1	78.5	21.1	19.6	250	1.9	2.67
WA Northern	204.6	1.3	257.0	69.3	64.4	251	1.9	2.46
Total	**1,915.4**	**1.2**	**2,366.3**	**922.2**	**868.6**	**367**	**-**	**-**

Annual average based on 2010-11 to 2012-13 ABS data and NVT average yields. Pulses are defined as chickpeas, field peas, lupins, lentils, faba beans, mung bean, and navy bean and vetch.

TABLE 79 Sorghum model input data: area, yield and production.

Region	Area (ha) ('000)	Yield (t/ha)	Production (t) ('000)	Gross value ($'million)	Local value ($'million)	Crop price ($/t)	Weed-free yield (t/ha)	NVT yield
NSW Central	2.9	3.2	9.4	2.1	1.8	191	3.2	-
NSW NE/Queensland SE	441.4	3.8	1,676.9	365.7	316.7	189	4.7	5.56
NSW NW/Queensland SW	47.5	2.3	108.7	23.6	20.3	187	2.8	3.37
NSW Victorian Slopes	5.6	1.2	7.0	1.4	1.2	171	1.2	-
Central Queensland	136.2	2.2	295.7	64.6	55.5	188	2.9	3.69
SA Mid North – Lower Yorke Eyre	0.1	3.0	0.3	0.0	0.0	-	3.0	-
SA Victorian Bordertown – Wimmera	0.3	2.3	0.7	0.2	0.2	-	2.3	-
SA Victorian Mallee	0.2	4.0	0.8	0.3	0.3	-	4.0	-
WA Eastern	-	-	-	-	-	-		-
Total	**634.5**	**3.3**	**2,099.6**	**458.0**	**396.1**	**189**	**3.3**	**-**

Annual average based on 2010-11 to 2012-13 ABS data and NVT average yields.

9.2.2 National Variety Trial yield data

TABLE 80 National Variety Trial yield data for 2011–13 as used to inform yield potential assumptions.

		Wheat	Oat	Barley	Canola	Chickpeas	Faba Beans	Field peas	Lupins	Lentils	Pulses
NSW Central	Average	3.43	3.49	3.05	1.64	1.50	4.29	1.90	0.79	1.28	1.95
	Median	3.22	2.35	3.18	1.66	1.55	4.68	1.71	0.82	1.28	-
	Trials 2011	325	20	57	41	12	4	29	4		-
	Trials 2012	295	9	54	43	10	4	35	7	11	-
	Trials 2013	238	21	38		12	5	29	-	11	-
NSW NE/ Queensland SE	Average	3.58	3.17	3.73	2.04	2.08	2.65	-	2.12	-	2.28
	Median	3.40	2.71	3.62	1.79	1.79	2.47	-	2.29	-	-
	Trials 2011	721	10	190	25	64	15	-	11	-	-
	Trials 2012	685	9	164	41	36	31	-	4	-	-
	Trials 2013	543	10	173	45	54	24	-	11	-	-
NSW NW/ Queensland SW	Average	2.79	-	2.78	1.83	2.03	2.44	1.86	1.73	-	2.01
	Median	2.83	-	2.71	1.85	1.91	2.93	1.77	1.80	-	-
	Trials 2011	237	-	50	107	35	5	14	11	-	-
	Trials 2012	286	-	46	118	30	18	10	11	-	-
	Trials 2013	169	-	48	-	18	3	10	11	-	-
NSW Victorian Slopes	Average	3.84	3.58	3.87	2.31	1.40	2.48	2.38	2.36	1.65	2.05
	Median	3.71	3.62	3.56	2.32	1.34	2.50	-	2.18	1.58	-
	Trials 2011	883	60	123	380	19	15	-	80	11	-
	Trials 2012	674	68	112	309	17	15	-	106	11	-
	Trials 2013	640	74	113	382	19	16	-	136	11	-
Central Queensland	Average	3.44	-	3.14	-	2.56	-	-	-	-	2.56
	Median	3.24	-	2.88	-	2.67	-	-	-	-	-
	Trials 2011	156	-	26	-	6	-	-	-	-	-
	Trials 2012	157	-	32	-	10	-	-	-	-	-
	Trials 2013	138	-	36	-	16	-	-	-	-	-
SA Mid North – Lower Yorke Eyre	Average	3.86	3.10	3.79	2.13	2.33	2.98	2.53	1.88	2.66	2.47
	Median	3.83	3.14	3.80	2.05	2.47	2.93	2.69	1.90	2.63	-
	Trials 2011	343	69	249	221	71	44	94	21	108	-
	Trials 2012	320	96	268	201	76	48	96	36	112	-
	Trials 2013	240	96	277	203	84	39	84	40	104	
SA Victorian Bordertown –Wimmera	Average	3.92	3.61	4.00	2.21	1.72	3.05	2.76	2.10	2.17	2.36
	Median	4.02	3.67	3.98	2.27	1.57	2.99	2.62	1.79	1.98	-
	Trials 2011	432	50	247	332	84	30	61	27	61	-
	Trials 2012	481	43	210	381	70	20	35	30	46	-
	Trials 2013	456	57	231	299	90	41	47	12	75	-

Continued page 78

TABLE 80 National Variety Trial yield data for 2011–13 as used to inform yield potential assumptions (continued).

		Wheat	Oat	Barley	Canola	Chickpeas	Faba Beans	Field peas	Lupins	Lentils	Pulses
SA Victorian Mallee	Average	2.37	1.17	2.49	1.27	1.18	3.19	1.79	1.52	1.29	1.79
	Median	2.09	1.32	2.39	1.41	1.13	3.07	1.85	1.26	1.24	-
	Trials 2011	600	20	244	81	32	11	55	21	50	-
	Trials 2012	571	9	242	72	24	11	72	18	32	-
	Trials 2013	434	20	196	29	38	14	22	6	27	-
Victorian high-rainfall and Tasmania	Average	5.51	-	4.25	1.62	-	-	-	-	-	-
	Median	4.31	-	4.46	1.46	-	-	-	-	-	-
	Trials 2011	25	-	44	39	-	-	-	-	-	-
	Trials 2012	17	-	38	-	-	-	-	-	-	-
	Trials 2013	35	-	45	26	-	-	-	-	-	-
WA Central	Average	2.98	3.55	3.57	1.88	2.06	-	2.04	2.87	-	2.32
	Median	2.60	3.59	3.33	2.00	2.24	-	2.34	3.00	-	-
	Trials 2011	558	158	218	328	14	-	33	56	-	-
	Trials 2012	520	90	208	331	11	-	32	42	-	-
	Trials 2013	414	99	242	337	25	-	34	42	-	-
WA Eastern	Average	1.70	2.32	2.41	-	0.79	-	2.42	1.26	-	1.49
	Median	1.44	2.37	2.41	-	0.79	-	2.77	0.88	2.98	-
	Trials 2011	112	17	-	-	14	-	16	8	11	-
	Trials 2012	132	-	-	-	-	-	0	6	-	-
	Trials 2013	95	-	26	-	-	-	17	6	-	-
WA Sandplain – Mallee	Average	2.75	3.90	3.09	1.53	-	-	1.85	3.48	-	2.67
	Median	2.89	4.07	3.29	1.54	-	-	1.93	4.16	-	-
	Trials 2011	138	17	71	133	-	-	17	8	-	-
	Trials 2012	160	11	73	121	-	-	42	6	-	-
	Trials 2013	132	11	74	103	-	-	27	-	-	-
WA Northern	Average	2.51	-	2.31	1.51	1.80	-	2.49	2.57	2.98	2.46
	Median	2.17	-	1.87	1.64	1.56	-	2.59	2.79	2.98	-
	Trials 2011	335	-	68	80	53	-	24	56	11	-
	Trials 2012	285	-	51	81	42	-	16	30	-	-
	Trials 2013	200	-	78	28	25	-	16	36	-	-

9.2.3 Commodity prices

TABLE 81 Model input data for crop price used to calculate losses from fallow weeds per region.

	Cereal crops	Broadleaf crops	Sorghum
NSW Central	$211	$448	$191
NSW NE/Queensland SE	$217	$448	$189
NSW NW/Queensland SW	$219	$419	$187
NSW Victorian Slopes	$213	$464	$171
Central Queensland	$231	$507	$188
SA Mid North – Lower Yorke Eyre	$244	$443	-
SA Victorian Bordertown – Wimmera	$219	$473	-
SA Victorian Mallee	$236	$413	-
Victorian high-rainfall and Tasmanian grain	$225	$502	-
WA Central	$252	$465	-
WA Eastern	$258	$444	-
WA Sandplain - Mallee	$251	$476	-
WA Northern	$262	$448	-

Cereal crops include wheat, barley and oats, broadleaf crops include canola and pulses. Based on ABARES (2013) data.
Note that commodity prices used to calculate yield losses from residual weeds are listed in Appendix 9.2.1

9.2.4 Yield damage coefficients

TABLE 82 Model input data for residual weed yield loss coefficient.

		Resultant yield loss coefficients					
Weed name	Density	Wheat	Barley	Oats	Canola	Pulses	Sorghum
Amsinkia / yellow burr weed	High	0.130	0.130	0.130	0.130	0.130	0.130
	Medium	0.060	0.060	0.060	0.060	0.060	0.060
	Low	0.004	0.004	0.004	0.004	0.004	0.004
Barley grass	High	0.102	0.085	0.132	0.148	0.148	0.278
	Medium	0.011	0.011	0.015	0.017	0.017	0.037
	Low	0.001	0.001	0.002	0.002	0.002	0.004
Barnyard grass	High	0.185	0.148	0.233	0.258	0.258	0.435
	Medium	0.022	0.018	0.029	0.034	0.034	0.071
	Low	0.002	0.002	0.003	0.003	0.003	0.008
Bathurst burr	High	0.222	0.178	0.275	0.303	0.303	0.490
	Medium	0.028	0.028	0.036	0.042	0.042	0.088
	Low	0.003	0.003	0.004	0.004	0.004	0.010
Bedstraw	High	0.130	0.130	0.130	0.130	0.130	0.130
	Medium	0.060	0.060	0.060	0.060	0.060	0.060
	Low	0.004	0.004	0.004	0.004	0.004	0.004
Bellvine	High	0.328	0.262	0.394	0.427	0.427	0.622
	Medium	0.047	0.038	0.061	0.069	0.069	0.142
	Low	0.005	0.004	0.006	0.007	0.007	0.016
Bifora	High	0.051	0.043	0.066	0.074	0.074	0.139
	Medium	0.006	0.006	0.008	0.009	0.009	0.019
	Low	0.001	0.001	0.001	0.001	0.001	0.002
Black bindweed / climbing buckwheat	High	0.050	0.040	0.040	0.060	0.060	0.00
	Medium	0.010	0.000	0.000	0.010	0.010	0.00
	Low	0.000	0.000	0.000	0.000	0.000	0.00

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TABLE 82 Model input data for residual weed yield loss coefficient (continued).

		Resultant yield loss coefficients					
Weed name	Density	Wheat	Barley	Oats	Canola	Pulses	Sorghum
Blue lupin	High	0.328	0.262	0.394	0.427	0.427	0.622
	Medium	0.047	0.038	0.061	0.069	0.069	0.142
	Low	0.005	0.004	0.006	0.007	0.007	0.016
Brassica weeds (other)	High	0.200	0.160	0.140	0.210	0.240	0.000
	Medium	0.020	0.020	0.010	0.020	0.020	0.000
	Low	0.000	0.000	0.000	0.000	0.000	0.000
Brome grass	High	0.146	0.119	0.185	0.207	0.207	0.366
	Medium	0.017	0.009	0.022	0.025	0.025	0.055
	Low	0.002	0.002	0.002	0.003	0.003	0.006
Button grass	High	0.255	0.204	0.312	0.343	0.343	0.536
	Medium	0.033	0.026	0.043	0.050	0.050	0.103
	Low	0.003	0.002	0.005	0.005	0.005	0.011
Caltrop (bindi)	High	0.050	0.040	0.040	0.060	0.060	0.186
	Medium	0.010	0.000	0.000	0.010	0.010	0.025
	Low	0.000	0.000	0.000	0.000	0.000	0.003
Cape weed	High	0.068	0.057	0.088	0.099	0.099	0.186
	Medium	0.007	0.007	0.010	0.011	0.011	0.025
	Low	0.001	0.001	0.001	0.001	0.001	0.003
Cutleaf mignonette	High	0.290	0.235	0.345	0.372	0.372	0.526
	Medium	0.043	0.029	0.056	0.064	0.064	0.129
	Low	0.005	0.000	0.006	0.007	0.007	0.015
Dandelion	High	0.068	0.057	0.088	0.099	0.099	0.186
	Medium	0.007	0.007	0.010	0.011	0.011	0.025
	Low	0.001	0.001	0.001	0.001	0.001	0.003
Doublegee	High	0.068	0.057	0.088	0.099	0.099	0.186
	Medium	0.007	0.007	0.010	0.011	0.011	0.025
	Low	0.001	0.001	0.001	0.001	0.001	0.003
Feathertop Rhodes grass	High	0.255	0.204	0.312	0.343	0.343	0.536
	Medium	0.033	0.026	0.043	0.050	0.050	0.103
	Low	0.003	0.002	0.005	0.005	0.005	0.011
Fleabane	High	0.047	0.038	0.061	0.069	0.069	0.142
	Medium	0.005	0.004	0.006	0.007	0.007	0.016
	Low	0.000	0.000	0.001	0.001	0.001	0.002
Foxtail	High	0.185	0.148	0.233	0.258	0.258	0.435
	Medium	0.022	0.018	0.029	0.034	0.034	0.071
	Low	0.002	0.002	0.003	0.003	0.003	0.008
Fumitory	High	0.083	0.083	0.083	0.083	0.083	0.083
	Medium	0.033	0.033	0.033	0.033	0.033	0.033
	Low	0.002	0.002	0.002	0.002	0.002	0.002
Indian hedge mustard	High	0.200	0.160	0.140	0.210	0.240	0.000
	Medium	0.020	0.020	0.010	0.020	0.020	0.000
	Low	0.000	0.000	0.000	0.000	0.000	0.000
Lincoln weed	High	0.133	0.133	0.133	0.133	0.133	0.133
	Medium	0.060	0.060	0.060	0.060	0.060	0.060
	Low	0.004	0.004	0.004	0.004	0.004	0.004

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TABLE 82 Model input data for residual weed yield loss coefficient (continued).

		Resultant yield loss coefficients					
Weed name	Density	Wheat	Barley	Oats	Canola	Pulses	Sorghum
Liverseed grass	High	0.255	0.204	0.312	0.343	0.343	0.536
	Medium	0.033	0.026	0.043	0.050	0.050	0.103
	Low	0.003	0.002	0.005	0.005	0.005	0.011
Marshmallow	High	0.222	0.178	0.275	0.303	0.303	0.490
	Medium	0.028	0.028	0.036	0.042	0.042	0.088
	Low	0.003	0.003	0.004	0.004	0.004	0.010
Medic	High	0.328	0.262	0.394	0.427	0.427	0.622
	Medium	0.047	0.038	0.061	0.069	0.069	0.142
	Low	0.005	0.004	0.006	0.007	0.007	0.016
Mexican poppy	High	0.222	0.178	0.275	0.303	0.303	0.490
	Medium	0.028	0.028	0.036	0.042	0.042	0.088
	Low	0.003	0.003	0.004	0.004	0.004	0.010
Milk thistle	High	0.222	0.178	0.275	0.303	0.303	0.490
	Medium	0.028	0.028	0.036	0.042	0.042	0.088
	Low	0.003	0.003	0.004	0.004	0.004	0.010
Musk	High	0.200	0.160	0.140	0.210	0.240	0.000
	Medium	0.020	0.020	0.010	0.020	0.020	0.000
	Low	0.000	0.000	0.000	0.000	0.000	0.000
Mustard	High	0.200	0.160	0.140	0.210	0.240	0.00
	Medium	0.020	0.020	0.010	0.020	0.020	0.00
	Low	0.000	0.000	0.000	0.000	0.000	0.00
Native jute	High	0.222	0.178	0.275	0.303	0.303	0.490
	Medium	0.028	0.028	0.036	0.042	0.042	0.088
	Low	0.003	0.003	0.004	0.004	0.004	0.010
Noogoora burr	High	0.363	0.293	0.431	0.465	0.465	0.658
	Medium	0.054	0.036	0.070	0.080	0.080	0.161
	Low	0.006	0.000	0.008	0.009	0.009	0.019
Parthenium weed	High	0.222	0.178	0.275	0.303	0.303	0.490
	Medium	0.028	0.028	0.036	0.042	0.042	0.088
	Low	0.003	0.003	0.004	0.004	0.004	0.010
Paterson's curse / salvation Jane	High	0.068	0.057	0.088	0.099	0.099	0.186
	Medium	0.007	0.007	0.010	0.011	0.011	0.025
	Low	0.001	0.001	0.001	0.001	0.001	0.003
Phalaris	High	0.094	0.076	0.121	0.137	0.137	0.259
	Medium	0.010	0.005	0.014	0.016	0.016	0.034
	Low	0.001	0.001	0.001	0.002	0.002	0.003
Pig weed	High	0.222	0.178	0.275	0.303	0.303	0.490
	Medium	0.028	0.028	0.036	0.042	0.042	0.088
	Low	0.003	0.003	0.004	0.004	0.004	0.010
Prickly lettuce / whip thistle	High	0.222	0.178	0.275	0.303	0.303	0.490
	Medium	0.028	0.028	0.036	0.042	0.042	0.088
	Low	0.003	0.003	0.004	0.004	0.004	0.010
Wild radish	High	0.363	0.293	0.431	0.465	0.465	0.658
	Medium	0.054	0.036	0.070	0.080	0.080	0.161
	Low	0.006	0.000	0.008	0.009	0.009	0.019

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TABLE 82 Model input data for residual weed yield loss coefficient (continued).

		Resultant yield loss coefficients					
Weed name	Density	Wheat	Barley	Oats	Canola	Pulses	Sorghum
Rape seed	High	0.200	0.160	0.140	0.210	0.240	0.000
	Medium	0.020	0.020	0.010	0.020	0.020	0.000
	Low	0.000	0.000	0.000	0.000	0.000	0.000
Ryegrass	High	0.094	0.076	0.121	0.137	0.137	0.259
	Medium	0.010	0.005	0.014	0.016	0.016	0.034
	Low	0.001	0.001	0.001	0.002	0.002	0.003
Saffron thistle	High	0.222	0.178	0.275	0.303	0.303	0.490
	Medium	0.028	0.028	0.036	0.042	0.042	0.088
	Low	0.003	0.003	0.004	0.004	0.004	0.010
Scotch thistle	High	0.222	0.178	0.275	0.303	0.303	0.490
	Medium	0.028	0.028	0.036	0.042	0.042	0.088
	Low	0.003	0.003	0.004	0.004	0.004	0.010
Sesbania	High	0.047	0.038	0.061	0.069	0.069	0.142
	Medium	0.005	0.004	0.006	0.007	0.007	0.016
	Low	0.000	0.000	0.001	0.001	0.001	0.002
Silver grass	High	0.064	0.052	0.083	0.095	0.095	0.187
	Medium	0.007	0.007	0.009	0.010	0.010	0.023
	Low	0.001	0.001	0.001	0.001	0.001	0.002
Skeleton weed	High	0.290	0.235	0.345	0.372	0.372	0.526
	Medium	0.043	0.029	0.056	0.064	0.064	0.129
	Low	0.005	0.000	0.006	0.007	0.007	0.015
Sorghum alum	High	0.255	0.204	0.312	0.343	0.343	0.536
	Medium	0.033	0.026	0.043	0.050	0.050	0.103
	Low	0.003	0.002	0.005	0.005	0.005	0.011
Sow thistle / milk thistle	High	0.222	0.178	0.275	0.303	0.303	0.490
	Medium	0.028	0.028	0.036	0.042	0.042	0.088
	Low	0.003	0.003	0.004	0.004	0.004	0.010
Spear thistle	High	0.222	0.178	0.275	0.303	0.303	0.490
	Medium	0.028	0.028	0.036	0.042	0.042	0.088
	Low	0.003	0.003	0.004	0.004	0.004	0.010
Statice	High	0.102	0.102	0.102	0.102	0.102	0.102
	Medium	0.041	0.041	0.041	0.041	0.041	0.041
	Low	0.003	0.003	0.003	0.003	0.003	0.003
Sweet summer grass	High	0.185	0.148	0.233	0.258	0.258	0.435
	Medium	0.022	0.018	0.029	0.034	0.034	0.071
	Low	0.002	0.002	0.003	0.003	0.003	0.008
Tares	High	0.328	0.262	0.394	0.427	0.427	0.622
	Medium	0.047	0.038	0.061	0.069	0.069	0.142
	Low	0.005	0.004	0.006	0.007	0.007	0.016
Thistle species other (incl. saffron, scotch, soldier, spear, star, variegated)	High	0.222	0.178	0.275	0.303	0.303	0.490
	Medium	0.028	0.028	0.036	0.042	0.042	0.088
	Low	0.003	0.003	0.004	0.004	0.004	0.010
Thornapple	High	0.363	0.293	0.431	0.465	0.465	0.658
	Medium	0.054	0.036	0.070	0.080	0.080	0.161
	Low	0.006	0.000	0.008	0.009	0.009	0.019

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TABLE 82 Model input data for residual weed yield loss coefficient (continued).

		Resultant yield loss coefficients					
Weed name	Density	Wheat	Barley	Oats	Canola	Pulses	Sorghum
Toadrush	High	0.094	0.076	0.121	0.137	0.137	0.259
	Medium	0.010	0.005	0.014	0.016	0.016	0.034
	Low	0.001	0.001	0.001	0.002	0.002	0.003
Turnip weed	High	0.200	0.160	0.140	0.210	0.240	0.00
	Medium	0.020	0.020	0.010	0.020	0.020	0.00
	Low	0.000	0.000	0.000	0.000	0.000	0.00
Vetches	High	0.328	0.262	0.394	0.427	0.427	0.622
	Medium	0.047	0.038	0.061	0.069	0.069	0.142
	Low	0.005	0.004	0.006	0.007	0.007	0.016
Wild geranium / storksbill	High	0.068	0.057	0.088	0.099	0.099	0.186
	Medium	0.007	0.007	0.010	0.011	0.011	0.025
	Low	0.001	0.001	0.001	0.001	0.001	0.003
Wild mustard	High	0.200	0.160	0.140	0.210	0.240	0.00
	Medium	0.020	0.020	0.010	0.020	0.020	0.00
	Low	0.000	0.000	0.000	0.000	0.000	0.00
Wild oats	High	0.185	0.147	0.233	0.258	0.258	0.435
	Medium	0.022	0.017	0.029	0.034	0.034	0.071
	Low	0.002	0.002	0.003	0.003	0.003	0.008
Wild radish	High	0.363	0.293	0.431	0.465	0.465	0.658
	Medium	0.054	0.036	0.070	0.080	0.080	0.161
	Low	0.006	0.000	0.008	0.009	0.009	0.019
Wild sunflower	High	0.222	0.178	0.275	0.303	0.303	0.490
	Medium	0.028	0.028	0.036	0.042	0.042	0.088
	Low	0.003	0.003	0.004	0.004	0.004	0.010
Wild turnip	High	0.200	0.160	0.140	0.210	0.240	0.000
	Medium	0.020	0.020	0.010	0.020	0.020	0.000
	Low	0.000	0.000	0.000	0.000	0.000	0.000
Wireweed	High	0.050	0.040	0.040	0.060	0.060	0.186
	Medium	0.010	0.000	0.000	0.010	0.010	0.025
	Low	0.000	0.000	0.000	0.000	0.000	0.003

SOURCES: WEED SEED WIZARD (RENTON *et al.* 2008) , JONES *et al.* 2000.

9.2.5 Fallow yield loss factors

TABLE 83 Model input data for fallow yield loss factors.

	Fallow yield loss factors (t/ha)					
	Density	Summer fallow weed cereal crops	Summer fallow weed broadleaf crops	Winter fallow weeds grain sorghum	Summer weed yield loss net % after spraying	Winter weed yield loss net % after spraying
NSW Central	High	0.8	0.4	-	25%	25%
	Medium	0.3	0.15	-	25%	25%
	Low	0.1	0.05	-	25%	25%
NSW NE/Queensland SE	High	1.2	0.6	0.6	25%	25%
	Medium	0.4	0.2	0.2	25%	25%
	Low	0.15	0.075	0.05	25%	25%
NSW NW/Queensland SW	High	1.2	0.6	0.6	25%	25%
	Medium	0.4	0.2	0.2	25%	25%
	Low	0.15	0.075	0.05	25%	25%
NSW Victorian Slopes	High	0.8	0.4	-	25%	25%
	Medium	0.3	0.15	-	25%	25%
	Low	0.1	0.05	-	25%	25%
Central Queensland	High	1.2	0.6	0.6	25%	25%
	Medium	0.4	0.2	0.2	25%	25%
	Low	0.15	0.075	0.05	25%	25%
SA Mid North – Lower Yorke Eyre	High	0.8	0.4	-	25%	25%
	Medium	0.3	0.15	-	25%	25%
	Low	0.1	0.05	-	25%	25%
SA Victorian Bordertown – Wimmera	High	0.8	0.4	-	25%	25%
	Medium	0.3	0.15	-	25%	25%
	Low	0.1	0.05	-	25%	25%
SA Victorian Mallee	High	0.8	0.4	-	25%	25%
	Medium	0.3	0.15	-	25%	25%
	Low	0.1	0.05	-	25%	25%
Victorian high-rainfall and Tasmanian grain	High	0.8	0.4	-	25%	25%
	Medium	0.3	0.15	-	25%	25%
	Low	0.1	0.05	-	25%	25%
WA Central	High	0.4	0.2	-	25%	25%
	Medium	0.15	0.075	-	25%	25%
	Low	0.05	0.025	-	25%	25%
WA Eastern	High	0.4	0.2	-	25%	25%
	Medium	0.15	0.075	-	25%	25%
	Low	0.05	0.025	-	25%	25%
WA Sandplain – Mallee	High	0.4	0.2	-	25%	25%
	Medium	0.15	0.075	-	25%	25%
	Low	0.05	0.025	-	25%	25%
WA Northern	High	0.4	0.2	-	25%	25%
	Medium	0.15	0.075	-	25%	25%
	Low	0.05	0.025	-	25%	25%

SOURCES: HUNT & KIRKEGAARD 2011, OSTEN *et al.* 2006, THOMAS 2000

9.2.6 Herbicide costs

TABLE 84 Wheat model input data for herbicide cost.

		Standard herbicide cost							Additional cost of herbicides attributed to resistance		
	Application cost ($/ha)	Number of applications for			Cost of herbicide for: ($/ha)			Cost	Cost of herbicide for: ($/ha)		
		Knock down	Pre-em.	Post-em.	Knock-down	Pre-em.	Post-em.	Total	Tier 1	Tier 2	Tier 3
NSW Central	7	1	1	2	14	35	31	108	19	26	45
NSW NE/Queensland SE	8	1	1	2	14	35	31	112	20	27	47
NSW NW/Queensland SW	8	1	1	2	14	35	31	112	20	27	47
NSW Victorian Slopes	8	1	1	2	14	35	31	112	20	27	47
Central Queensland	8	1	2	2	14	35	31	120	20	23	43
SA Mid North – Lower Yorke Eyre	7	1	1	2	14	35	31	108	19	23	42
SA Victorian Bordertown - Wimmera	7	1	1	2	14	35	31	108	19	26	45
SA Victorian Mallee	7	1	1	1	10	6	8	45	19	16	35
Victorian high-rainfall and Tasmanian grain	8	1	1	2	14	35	31	112	20	27	47
WA Central	6	1	1	1	12	6	7	43	16	19	35
WA Eastern	6	1	1	1	10	10	8	46	18	12	30
WA Sandplain – Mallee	6	1	1	1	12	6	7	43	16	19	35
WA Northern	6	1	1	1	12	6	7	43	16	19	35

SOURCES: BASED ON LOCAL EXPERT AGRONOMIST INPUT AND STATE-BASED FARM BUDGET GUIDES

TABLE 85 Barley model input data for herbicide cost.

	Barley										
	Standard herbicide cost								Additional cost of herbicides attributed to resistance		
	Application cost ($/ha)	Number of applications for			Cost of herbicide for: ($/ha)			Cost	Cost of herbicide for: ($/ha)		
		Knock down	Pre-em.	Post-em.	Knock-down	Pre-em.	Post-em.	Total	Tier 1	Tier 2	Tier 3
NSW Central	7	1	1	1	14	35	31	108	19	26	45
NSW NE/Queensland SE	8	2	1	2	14	35	31	120	12	27	47
NSW NW/Queensland SW	8	1	1	1	14	35	31	112	20	27	47
NSW Victorian Slopes	8	1	1	1	14	35	31	112	20	27	20
Central Queensland	8	1	2	1	14	35	31	120	20	23	43
SA Mid North – Lower Yorke Eyre	7	1	1	1	14	35	31	108	19	23	42
SA Victorian Bordertown - Wimmera	7	1	1	1	14	35	31	108	19	26	45
SA Victorian Mallee	7	1	1	1	10	6	8	45	19	16	35
Victorian high-rainfall and Tasmanian grain	8	1	1	1	14	35	31	112	20	27	47
WA Central	6	1	1	1	12	12	7	49	16	16	32
WA Eastern	6	1	1	1	10	10	8	46	18	12	30
WA Sandplain – Mallee	6	1	1	1	12	12	7	49	16	16	32
WA Northern	6	1	1	1	12	12	7	49	16	16	32

SOURCES: BASED ON LOCAL EXPERT AGRONOMIST INPUT AND STATE-BASED FARM BUDGET GUIDES

TABLE 86 Canola model input data for herbicide cost.

		Standard herbicide cost							Additional cost of herbicides attributed to resistance		
	Application cost ($/ha)	Number of applications for			Cost of herbicide for: ($/ha)			Cost	Cost of herbicide for: ($/ha)		
		Knock down	Pre-em.	Post-em.	Knock-down	Pre-em.	Post-em.	Total	Tier 1	Tier 2	Tier 3
NSW Central	7	1	1	2	14	9	39	90	19	17	36
NSW NE/Queensland SE	8	1	1	2	14	9	39	94	20	17	37
NSW NW/Queensland SW	8	1	1	2	14	9	39	94	20	17	37
NSW Victorian Slopes	8	1	1	2	14	9	39	94	20	17	37
Central Queensland	8	1	1	2	14	9	39	94	20	17	37
SA Mid North – Lower Yorke Eyre	7	1	1	2	14	9	39	90	19	17	36
SA Victorian Bordertown - Wimmera	7	1	1	2	14	9	39	90	19	17	36
SA Victorian Mallee	7	1	1	1	10	12	20	63	19	15	34
Victorian high-rainfall and Tasmanian grain	8	1	1	2	14	9	39	94	20	17	37
WA Central	6	1	1	1	10	20	27	75	18	8	26
WA Eastern	6	1	1	1	10	12	20	60	18	11	29
WA Sandplain – Mallee	6	1	1	1	10	20	27	75	18	8	26
WA Northern	6	1	1	1	10	20	27	75	18	8	26

SOURCES: BASED ON LOCAL EXPERT AGRONOMIST INPUT AND STATE-BASED FARM BUDGET GUIDES

TABLE 87 Pulses model input data for herbicide cost.

		Standard herbicide cost							Additional cost of herbicides attributed to resistance		
	Application cost ($/ha)	Number of applications for			Cost of herbicide for: ($/ha)			Cost	Cost of herbicide for: ($/ha)		
		Knock down	Pre-em.	Post-em.	Knock-down	Pre-em.	Post-em.	Total	Tier 1	Tier 2	Tier 3
NSW Central	7	1	2	2	14	28	18	95	19	20	39
NSW NE/Queensland SE	8	1	2	2	14	28	18	100	20	21	41
NSW NW/Queensland SW	8	1	2	2	14	28	18	100	20	21	41
NSW Victorian Slopes	8	1	2	2	14	18	24	96	20	19	39
Central Queensland	8	1	2	2	14	28	18	100	20	21	41
SA Mid North – Lower Yorke Eyre	7	1	2	2	14	18	18	85	19	36	55
SA Victorian Bordertown - Wimmera	7	1	2	2	14	15	29	93	19	24	43
SA Victorian Mallee	7	1	1	2	10	9	24	71	19	19	38
Victorian high-rainfall and Tasmanian grain	8	1	2	2	14	18	18	90	20	37	57
WA Central	6	1	1	2	10	18	24	76	18	15	33
WA Eastern	6	1	1	2	10	18	24	76	18	15	33
WA Sandplain – Mallee	6	1	1	2	10	18	24	76	18	15	33
WA Northern	6	1	1	2	10	18	24	76	18	15	33

SOURCES: BASED ON LOCAL EXPERT AGRONOMIST INPUT AND STATE-BASED FARM BUDGET GUIDES

TABLE 88 Sorghum model input data for herbicide cost.

	Standard herbicide cost								Additional cost of herbicides attributed to resistance		
	Application cost ($/ha)	Number of applications for			Cost of herbicide for: ($/ha)			Cost	Cost of herbicide for: ($/ha)		
		Knock down	Pre-em.	Post-em.	Knock-down	Pre-em.	Post-em.	Total	Tier 1	Tier 2	Tier 3
NSW Central	7	1	1	1	24	26	20	91	20		20
NSW NE/Queensland SE	8	1	1	1	24	26	20	94	20		20
NSW NW/Queensland SW	8	1	1	1	24	26	20	94	20		20
Central Queensland	8	1	1	1	24	26	20	94	20		20

SOURCE: BASED ON LOCAL EXPERT AGRONOMIST INPUT

TABLE 89 Summer and winter fallow model input data for herbicide cost.

	Standard herbicide cost								Additional cost of herbicides attributed to resistance	
	Application cost ($/ha)		Number of knockdown applications		Cost of knockdown ($/ha)		Standard cost total ($/ha)		Tier 1	Tier 2
	summer	winter	summer	winter	summer	winter	summer	winter	summer	winter
NSW Central	8	7	1	3	16	45	24	66	46	20
NSW NE/Queensland SE	8	8	1	1	7	7	15	15	48	20
NSW NW/Queensland SW	8	8	1	1	7	7	15	15	48	20
NSW Victorian Slopes	8	8	1	1	16	12	24	20	16	20
Central Queensland	8	8	1	1	7	7	15	15	48	20
SA Mid North – Lower Yorke Eyre	7	7	1	1	16	12	23	19	15	20
SA Victorian Bordertown – Wimmera	7	7	1	1	16	12	23	19	15	20
SA Victorian Mallee	7	7	1	1	12	10	19	14	8	20
Victorian high rainfall and Tas grain	8	8	1	1	16	12	24	20	16	20
WA Central	6	6	1	1	16	12	22	18	14	20
WA Eastern	6	6	1	1	12	10	18	16	8	20
WA Sandplain – Mallee	6	6	1	1	16	10	22	16	19	20
WA Northern	6	6	1	1	16	12	22	18	14	20

SOURCE: BASED ON LOCAL EXPERT AGRONOMIST INPUT AND STATE-BASED FARM BUDGET GUIDES

9.2.7 Weed management practices and grain cleaning contamination costs

TABLE 90 Cost of cultivation, burning and IWM practices.

Practice	Cost per hectare
Cultivation	$30.00
Brown / green manure	$50.00
Mouldboard ploughing	$100.00
Delayed seeding with knockdown	$22.00
Double knockdown	$20.00
Crop-topping: direct costs	$18.00
Crop-topping: yield loss impact (on pulses)	5%
Pasture spray=topping / hay freezing	$20.00
Chaff cart	$14.93
Bale-direct system	$38.00
Narrow windrow burning	$2.00
Burning crop / stubble - whole paddock	$1.00
Chaff tramlining	$0.50
Harrington Seed Destructor	$24.40

Cultivation cost based on gross margin guide figures including labour, repairs and maintenance – plus machinery cost, Stock journal supplement - farm budget guide; RIM/AHRI fact sheet.

TABLE 91 Grain cleaning and downgrade costs

	Cost per tonne
Grain cleaning	$25.00
Price downgrade penalty	$22.00

Based on typical grain cleaning and downgrade costs provided by industry experts.

9.3 Weed control expenditure

TABLE 92 Total expenditure per AEZ including application costs. Total cost per AEZ expressed as a percentage attributed from fallow herbicide cost, in-season herbicide cost and IWM.

	Total expenditure cost	Fallow herbicide cost	In-season herbicide cost	IWM
Northern	**$610m**	**31%**	**57%**	**12%**
Central Queensland	$67m	41%	50%	9%
NSW NE/Queensland SE	$345m	27%	60%	13%
NSW NW/Queensland SW	$198m	34%	56%	11%
Southern	**$1,244m**	**17%**	**66%**	**17%**
NSW Central	$230m	24%	56%	20%
NSW Victorian Slopes	$281m	17%	71%	12%
SA Mid North – Lower Yorke Eyre	$237m	13%	74%	13%
SA Victorian Bordertown – Wimmera	$236m	11%	69%	21%
SA Victorian Mallee	$221m	20%	56%	23%
Victorian high-rainfall and Tasmanian grain	$38m	10%	76%	14%
Western	**$719m**	**16%**	**58%**	**26%**
WA Central	$397m	15%	59%	26%
WA Eastern	$101m	17%	57%	26%
WA Sandplain – Mallee	$96m	18%	53%	30%
WA Northern	$124m	15%	61%	24%
Total / National	**$2,573m**	**20%**	**62%**	**18%**

Note that in-season and fallow herbicide costs shown in this table include the additional herbicide costs due to resistant weeds.

9.4 Weed rankings in winter cereals

TABLE 93 Residual weeds in winter cereals ranked by revenue loss due to yield loss showing overall ranking for agro-ecological zone.

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
Central Queensland						
1	Sow thistle / milk thistle	61,997	Wild radish	4696	Wild radish	$1.1m
2	Wild turnip	46,579	Wild turnip	3776	Wild turnip	$876.0k
3	Mexican poppy	35,835	Sow thistle / milk thistle	3631	Sow thistle / milk thistle	$842.2k
4	Wild mustard	35,374	Feathertop Rhodes grass	1747	Feathertop Rhodes grass	$405.3k
5	Feathertop Rhodes grass	14,953	Mexican poppy	1232	Mexican poppy	$285.8k
6	Thistle species	7761	Wild mustard	587	Wild mustard	$136.1k
7	Wild radish	4938	Thistle species	439	Thistle species	$101.8k
8	Parthenium weed	2000	Sweet summer grass	203	Sweet summer grass	$47.2k
9	Ryegrass	1059	Ryegrass	147	Ryegrass	$33.0k
10	Brassica weeds	576	Parthenium weed	16	Parthenium weed	$3.6k
NSW NE/Queensland SE						
1	Sow thistle / milk thistle	330,263	Wild oats	8936	Wild oats	$1.9m
2	Wild oats	266,703	Sow thistle / milk thistle	8333	Sow thistle / milk thistle	$1.8m
3	Wild turnip	200,224	Wild radish	5072	Wild radish	$1.1m
4	Fleabane	198,433	Wild turnip	3991	Wild turnip	$874.8k
5	Phalaris	78,787	Ryegrass	3418	Ryegrass	$721.5k
6	Black bindweed / climbing buckwheat	76,656	Black bindweed / climbing buckwheat	2052	Black bindweed / climbing buckwheat	$434.0k
7	Ryegrass	35,559	Wild mustard	1641	Wild mustard	$353.1k
8	Wild radish	32,984	Fumitory	1419	Fumitory	$303.9k
9	Wild mustard	29,014	Fleabane	1124	Fleabane	$240.1k
10	Thistle species	26,745	Thistle species	1123	Thistle species	$237.1k
NSW NW/Queensland SW						
1	Wild oats	286,231	Wild turnip	25,706	Wild turnip	$5.7m
2	Ryegrass	261,032	Ryegrass	12,077	Ryegrass	$2.6m
3	Wild turnip	153,685	Wild oats	9403	Wild oats	$2.0m
4	Sow thistle / milk thistle	52,294	Sow thistle / milk thistle	1553	Sow thistle / milk thistle	$337.1k
5	Wild mustard	41,140	Wild mustard	1174	Wild mustard	$260.3k
6	Wild radish	38,429	Wild radish	919	Wild radish	$202.6k
7	Phalaris	36,709	Phalaris	852	Phalaris	$188.8k
8	Fleabane	34,754	Brassica weeds	766	Brassica weeds	$170.3k
9	Black bindweed / climbing buckwheat	22,725	Mexican poppy	433	Mexican poppy	$93.4k
10	Barnyard grass	20,435	Barley grass	361	Barley grass	$71.2k
NSW Central						
1	Ryegrass	323,588	Ryegrass	11,012	Ryegrass	$2.3m
2	Wild oats	203,068	Wild oats	5900	Wild oats	$1.3m
3	Wild mustard	176,352	Brome grass	3404	Brome grass	$728.2k
4	Fleabane	163,018	Brassica weeds	2335	Brassica weeds	$501.4k
5	Brome grass	80,635	Wild mustard	2294	Wild mustard	$487.4k
6	Wild turnip	79,543	Wild radish	1748	Wild radish	$358.9k
7	Doublegee	74,727	Paterson's curse / salvation Jane	1675	Paterson's curse / salvation Jane	$350.3k
8	Paterson's curse / salvation Jane	57,694	Doublegee	1153	Doublegee	$242.9k
9	Brassica weeds	49,127	Thistle species	1099	Thistle species	$231.9k
10	Thistle species	25,637	Fleabane	767	Fleabane	$164.2k

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TABLE 93 Residual weeds in winter cereals ranked by revenue loss due to yield loss showing overall raking for agro-ecological zone (continued).

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
NSW Victorian Slopes						
1	Ryegrass	598,118	Wild oats	36,357	Wild oats	$7.8m
2	Wild oats	388,601	Ryegrass	15,557	Ryegrass	$3.3m
3	Wild mustard	267,180	Wild radish	5008	Wild radish	$1.1m
4	Wild radish	149,863	Doublegee	1597	Doublegee	$338.3k
5	Wild turnip	127,457	Brome grass	1283	Brome grass	$278.9k
6	Cape weed	50,100	Cape weed	927	Cape weed	$194.4k
7	Brome grass	27,226	Wild mustard	610	Wild mustard	$128.6k
8	Fleabane	15,489	Barley grass	140	Barley grass	$29.1k
9	Skeleton weed	10,554	Skeleton weed	92	Skeleton weed	$19.4k
10	Barley grass	10,432	Toadrush	77	Toadrush	$16.9k
SA Mid North - Lower Yorke Eyre						
1	Ryegrass	854,422	Ryegrass	78,837	Ryegrass	$19.6m
2	Wild oats	245,606	Brome grass	31,024	Brome grass	$7.6m
3	Brome grass	155,116	Wild oats	6274	Wild oats	$1.5m
4	Cutleaf mignonette	130,593	Barley grass	1744	Barley grass	$439.2k
5	Wild mustard	50,315	Wild mustard	1353	Wild mustard	$332.3k
6	Barley grass	47,769	Cutleaf mignonette	1126	Cutleaf mignonette	$292.5k
7	Wild turnip	43,671	Wild radish	1107	Wild radish	$281.5k
8	Vetches	43,453	Vetches	674	Vetches	$167.7k
9	Wild radish	34,160	Wild turnip	655	Wild turnip	$157.5k
10	Dandelion	15,943	Dandelion	389	Dandelion	$93.7k
SA Victorian Bordertown - Wimmera						
1	Ryegrass	416,255	Wild oats	26,658	Wild oats	$5.9m
2	Wild oats	238,430	Brome grass	19,575	Brome grass	$4.3m
3	Wild radish	139,464	Ryegrass	18,817	Ryegrass	$4.1m
4	Brome grass	118,304	Wild mustard	7556	Wild mustard	$1.6m
5	Wild mustard	117,874	Prickly lettuce / whip thistle	2520	Prickly lettuce / whip thistle	$526.3k
6	Prickly lettuce / whip thistle	28,108	Lincoln weed	2064	Wild radish	$470.4k
7	Vetches	12,223	Wild radish	2049	Lincoln weed	$453.9k
8	Wild geranium / storksbill	11,596	Vetches	805	Vetches	$178.2k
9	Lincoln weed	10,728	Skeleton weed	565	Skeleton weed	$127.1k
10	Wild turnip	7,308	Sow thistle / milk thistle	426	Sow thistle / milk thistle	$97.1k
SA Victorian Mallee						
1	Brome grass	664,046	Brome grass	28,213	Brome grass	$6.7m
2	Ryegrass	620,712	Ryegrass	12,729	Ryegrass	$2.9m
3	Wild turnip	267,414	Amsinkia / yellow burr weed	7960	Wild radish	$1.9m
4	Wild radish	197,367	Wild radish	7860	Amsinkia / yellow burr weed	$1.9m
5	Amsinkia / yellow burr weed	80,737	Wireweed	5335	Wireweed	$1.3m
6	Wild mustard	75,947	Wild mustard	2552	Wild mustard	$589.8k
7	Wild oats	66,248	Skeleton weed	1952	Skeleton weed	$474.7k
8	Skeleton weed	56,769	Wild oats	1825	Wild oats	$430.8k
9	Wireweed	51,864	Barley grass	599	Barley grass	$144.6k
10	Barley grass	48,285	-	-	-	-

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TABLE 93 Residual weeds in winter cereals ranked by revenue loss due to yield loss showing overall raking for agro-ecological zone (continued).

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
Victorian high-rainfall and Tas grain						
1	Ryegrass	144,176	Wild radish	11,072	Wild radish	$2.5m
2	Wild radish	49,085	Ryegrass	7903	Ryegrass	$1.8m
3	Wild oats	24,606	Wild oats	1537	Wild oats	$344.6k
4	Cape weed	7516	Cape weed	182	Cape weed	$40.7k
5	Brome grass	5322	Wild mustard	107	Wild mustard	$24.8k
6	Phalaris	2607	Phalaris	98	Phalaris	$22.8k
7	Thistle species	1850	Brome grass	64	Brome grass	$14.5k
8	Wild mustard	1325	Thistle species	20	Thistle species	$4.2k
9	Fat hen	687	-	-	-	-
10	Silver grass	118	-	-	-	-
WA Central						
1	Ryegrass	2,019,346	Ryegrass	107,552	Ryegrass	$27.8m
2	Wild radish	2,018,729	Wild radish	77,995	Wild radish	$20.0m
3	Brome grass	117,812	Wild oats	4421	Wild oats	$1.1m
4	Wild turnip	71,948	Brome grass	583	Brome grass	$147.7k
5	Wild oats	61,979	Toadrush	541	Toadrush	$139.1k
6	Wireweed	43,861	Cape weed	131	Cape weed	$29.5k
7	Toadrush	27,433	-	-	-	-
8	Cape weed	5857	-	-	-	-
WA Eastern						
1	Wild radish	724,582	Wild radish	18,122	Wild radish	$4.6m
2	Ryegrass	459,191	Ryegrass	8382	Ryegrass	$2.1m
3	Cape weed	33,683	Cape weed	1422	Cape weed	$372.5k
4	Barley grass	33,152	Barley grass	1188	Barley grass	$307.5k
5	Wild oats	31,956	Doublegee	1060	Doublegee	$277.4k
6	Doublegee	29,806	Brome grass	498	Brome grass	$128.4k
7	Wild turnip	15,324	Wild oats	172	Wild oats	$44.3k
8	Brome grass	13,000	Wild turnip	53	Wild turnip	$13.8k
9	Wild mustard	8858	-	-	-	-
WA Sandplain - Mallee						
1	Ryegrass	360,923	Ryegrass	15,032	Ryegrass	$3.9m
2	Wild radish	173,655	Wild radish	2175	Wild radish	$571.9k
3	Fleabane	61,285	Barley grass	908	Barley grass	$221.0k
4	Wild turnip	56,453	Brome grass	396	Brome grass	$101.4k
5	Barley grass	45,268	Fleabane	109	Fleabane	$27.3k
6	Brome grass	18,370	-	-	-	-
7	Wild mustard	3765	-	-	-	-
WA Northern						
1	Wild radish	798,283	Wild radish	22,228	Wild radish	$5.9m
2	Ryegrass	563,951	Ryegrass	18,225	Ryegrass	$4.8m
3	Brome grass	39,383	Brome grass	2154	Brome grass	$566.7k
4	Cape weed	4317	Wild oats	134	Wild oats	$35.3k
5	Wild oats	4230	Cape weed	66	Cape weed	$17.3k

9.5 Weed rankings in canola and pulses

TABLE 94 Residual weeds in canola and pulses ranked by revenue loss due to yield loss showing overall ranking for agro-ecological zone.

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
Central Queensland						
1	Wild mustard	23,293	Wild turnip	1625	Wild turnip	$825.3k
2	Sow thistle / milk thistle	18,995	Sow thistle / milk thistle	691	Sow thistle / milk thistle	$348.7k
3	Feathertop Rhodes grass	11,869	Wild mustard	492	Wild mustard	$250.0k
4	Wild turnip	9464	Sweet summer grass	463	Sweet summer grass	$235.3k
5	Sweet summer grass	7368	Feathertop Rhodes grass	427	Feathertop Rhodes grass	$216.9k
6	Parthenium weed	7190	Mexican poppy	86	Mexican poppy	$43.6k
7	Mexican poppy	6704	Parthenium weed	65	Parthenium weed	$33.1k
8	Marshmallow	118	Marshmallow	11	Marshmallow	$5.7k
NSW NE/Queensland SE						
1	Wild turnip	33,878	Wild turnip	2754	Wild turnip	$1.3m
2	Sow thistle / milk thistle	29,879	Black bindweed / climbing buckwheat	1689	Black bindweed / climbing buckwheat	$747.4k
3	Black bindweed / climbing buckwheat	20,971	Sow thistle / milk thistle	1490	Sow thistle / milk thistle	$681.6k
4	Fleabane	12,932	Marshmallow	971	Marshmallow	$426.2k
5	Marshmallow	11,377	Ryegrass	234	Ryegrass	$106.9k
6	Mexican poppy	7701	Barnyard grass	212	Barnyard grass	$93.2k
7	Wild oats	6147	Wild mustard	205	Wild mustard	$89.9k
8	Wild mustard	5120	Fleabane	182	Fleabane	$79.9k
9	Feathertop Rhodes grass	4892	Wild oats	143	Wild oats	$63.0k
10	Ryegrass	4661	Wild radish	131	Wild radish	$58.0k
NSW NW/Queensland SW						
1	Wild oats	68,018	Wild turnip	1780	Wild turnip	$713.8k
2	Wild turnip	61,729	Ryegrass	791	Ryegrass	$345.1k
3	Fleabane	34,938	Wild oats	549	Wild oats	$221.7k
4	Sow thistle / milk thistle	20,418	Fleabane	431	Fleabane	$175.1k
5	Ryegrass	14,758	Sow thistle / milk thistle	348	Sow thistle / milk thistle	$149.0k
6	Wild mustard	4468	Doublegee	78	Doublegee	$33.3k
7	Doublegee	4219	Wild mustard	76	Wild mustard	$30.7k
8	Brassica weeds	3972	Wireweed	34	Wireweed	$13.8k
9	Prickly lettuce / whip thistle	3119	Wild radish	30	Wild radish	$12.8k
10	Feathertop Rhodes grass	2829	Feathertop Rhodes grass	27	Feathertop Rhodes grass	$10.9k
NSW Central						
1	Ryegrass	30,636	Wild radish	1595	Wild radish	$696.1k
2	Paterson's curse / salvation Jane	21,411	Brome grass	1350	Brome grass	$607.5k
3	Brome grass	14,995	Ryegrass	463	Ryegrass	$207.2k
4	Wild radish	11,522	Paterson's curse / salvation Jane	129	Paterson's curse / salvation Jane	$58.2k
5	Sow thistle / milk thistle	6633	Skeleton weed	88	Skeleton weed	$39.6k
6	Cape weed	6611	Sow thistle / milk thistle	41	Thistle species	$14.0k
7	Thistle species	5915	Thistle species	39	Sow thistle / milk thistle	$13.9k
8	Wild oats	5332	Barley grass	29	Barley grass	$12.8k
9	Wild mustard	4744	Wild oats	24	Wild oats	$9.7k
10	Fleabane	3186	Wild mustard	18	Cape weed	$6.1k

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TABLE 94 Residual weeds in canola and pulses ranked by revenue loss due to yield loss showing overall ranking for agro-ecological zone (continued).

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
NSW Victorian Slopes						
1	Ryegrass	165,618	Wild oats	8489	Wild oats	$4.1m
2	Wild radish	50,142	Ryegrass	1762	Ryegrass	$835.9k
3	Wild oats	49,844	Wild radish	1350	Wild radish	$635.0k
4	Wild mustard	42,067	Wild mustard	309	Wild mustard	$137.8k
5	Cape weed	23,419	Skeleton weed	205	Skeleton weed	$97.3k
6	Silver grass	14,694	Mexican poppy	98	Mexican poppy	$46.8k
7	Mexican poppy	12,687	Cape weed	97	Cape weed	$45.1k
8	Barley grass	12,024	Prickly lettuce / whip thistle	79	Prickly lettuce / whip thistle	$37.9k
9	Paterson's curse / salvation Jane	10,983	Fleabane	52	Fleabane	$24.1k
10	Prickly lettuce / whip thistle	10,470	Sow thistle / milk thistle	51	Sow thistle / milk thistle	$23.0k
SA Mid North - Lower Yorke Eyre						
1	Ryegrass	125,886	Ryegrass	4327	Ryegrass	$2.0m
2	Vetches	44,367	Vetches	3903	Vetches	$1.8m
3	Wild mustard	25,850	Bedstraw	769	Bedstraw	$336.6k
4	Wild turnip	23,784	Barley grass	756	Barley grass	$309.8k
5	Barley grass	21,671	Wild radish	636	Wild radish	$282.6k
6	Sow thistle / milk thistle	16,120	Wild oats	565	Wild oats	$221.7k
7	Wild radish	15,361	Brome grass	401	Brome grass	$159.3k
8	Bedstraw	12,883	Cutleaf mignonette	291	Wild mustard	$148.6k
9	Wild oats	10,813	Wild mustard	283	Cutleaf mignonette	$113.7k
10	Bifora	10,044	Sow thistle / milk thistle	246	Sow thistle / milk thistle	$106.2k
SA Victorian Bordertown - Wimmera						
1	Vetches	70,764	Vetches	5989	Vetches	$2.7m
2	Ryegrass	67,993	Wild radish	3777	Wild radish	$1.8m
3	Wild radish	59,407	Ryegrass	1524	Ryegrass	$710.2k
4	Wild mustard	39,507	Sow thistle / milk thistle	770	Sow thistle / milk thistle	$376.8k
5	Sow thistle / milk thistle	37,861	Brome grass	377	Brome grass	$176.3k
6	Prickly lettuce / whip thistle	31,703	Wild mustard	315	Wild mustard	$150.3k
7	Brome grass	29,506	Cape weed	267	Cape weed	$132.4k
8	Cape weed	21,535	Prickly lettuce / whip thistle	234	Prickly lettuce / whip thistle	$107.6k
9	Wild oats	13,279	Wild oats	184	Wild oats	$86.9k
10	Thistle species	9696	Wild mustard	315	Bedstraw	$64.2k
SA Victorian Mallee						
1	Ryegrass	40,246	Ryegrass	1094	Ryegrass	$464.4k
2	Wild turnip	33,611	Brome grass	977	Brome grass	$405.1k
3	Brome grass	21,567	Amsinkia / yellow burr weed	245	Amsinkia / yellow burr weed	$87.3k
4	Wild mustard	20,548	Wild radish	198	Wild radish	$85.0k
5	Wild radish	14,728	Wild mustard	153	Wild mustard	$72.3k
6	Wild oats	4919	Skeleton weed	148	Skeleton weed	$57.3k
7	Prickly lettuce / whip thistle	3423	Prickly lettuce / whip thistle	116	Prickly lettuce / whip thistle	$43.6k
8	Amsinkia / yellow burr weed	2848	Wild turnip	41	Wild turnip	$18.8k
9	Skeleton weed	2746	Brassica weeds	31	Brassica weeds	$15.1k
10	Wireweed	2264	Wild oats	22	Wild oats	$7.0k

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TABLE 94 Residual weeds in canola and pulses ranked by revenue loss due to yield loss showing overall ranking for agro-ecological zone (continued).

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
Victorian high rainfall and Tas grain						
1	Ryegrass	31,520	Ryegrass	1306	Ryegrass	$662.7k
2	Wild radish	5608	Wild radish	769	Wild radish	$392.5k
3	Cape weed	3268	Wild mustard	161	Wild mustard	$81.6k
4	Thistle species	1730	Vetches	90	Vetches	$38.9k
5	Wild oats	1554	Cape weed	50	Cape weed	$25.0k
6	Wild geranium / storksbill	1280	Wild geranium / storksbill	23	Wild geranium / storksbill	$12.0k
7	Wild mustard	789	Wild oats	20	Wild oats	$9.1k
8	Wireweed	634	Brome grass	16	Brome grass	$8.1k
9	Silver grass	577	Thistle species	11	Thistle species	$5.7k
10	Phalaris	447	Silver grass	10	Silver grass	$4.9k
WA Central						
1	Ryegrass	492,589	Ryegrass	15,790	Ryegrass	$7.6m
2	Wild radish	288,335	Wild radish	12,838	Wild radish	$5.4m
3	Brome grass	84,827	Wild oats	1606	Wild oats	$691.0k
4	Wild oats	32,284	Brome grass	729	Brome grass	$324.4k
5	Cape weed	13,342	Doublegee	181	Cape weed	$61.7k
6	Doublegee	10,266	Cape weed	118	Doublegee	$45.2k
7	Khaki Weed	3217	-	-	-	-
8	Wild turnip	1586	-	-	-	-
9	Silver grass	869	-	-	-	-
WA Eastern						
1	Ryegrass	57,774	Ryegrass	1226	Ryegrass	$420.5k
2	Wild radish	57,126	Wild radish	1102	Wild radish	$373.2k
3	Cape weed	2972	Wild oats	11	Wild oats	$2.9k
4	Silver grass	1251	-	-	-	-
5	Wild oats	652	-	-	-	-
6	Barley grass	224	-	-	-	-
7	Wild turnip	187	-	-	-	-
WA Sandplain - Mallee						
1	Ryegrass	125,095	Ryegrass	4940	Ryegrass	$2.5m
2	Wild radish	39,053	Wild radish	1722	Wild radish	$848.5k
3	Marshmallow	19,799	Brome grass	293	Brome grass	$139.4k
4	Brome grass	8073	Marshmallow	266	Marshmallow	$130.2k
5	Barley grass	5348	Thistle species	147	Thistle species	$79.5k
6	Thistle species	2569	Barley grass	123	Barley grass	$66.3k
7	Wild turnip	1671	-	-	-	-
8	Fleabane	922	-	-	-	-
9	Wild oats	130	-	-	-	-
WA Northern						
1	Ryegrass	194,730	Wild radish	8122	Wild radish	$2.5m
2	Wild radish	173,210	Ryegrass	3468	Ryegrass	$1.2m
3	Doublegee	19,460	Doublegee	1334	Doublegee	$431.2k
4	Brome grass	10,624	Brome grass	56	Brome grass	$16.5k
5	Barley grass	1815	Barley grass	53	Barley grass	$15.4k
6	Cape weed	889	-	-	-	-

9.6 Weed rankings in sorghum

TABLE 95 Residual weeds in sorghum ranked by revenue loss due to yield loss showing overall ranking for agro-ecological zone.

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
Central Queensland						
1	Feathertop Rhodes grass	31,313	Sweet summer grass	14,402	Sweet summer grass	$2.7m
2	Sweet summer grass	24,093	Feathertop Rhodes grass	6455	Feathertop Rhodes grass	$1.2m
3	Parthenium weed	2171	Parthenium weed	523	Parthenium weed	$98.3k
4	Bellvine	1661	Bellvine	78	Bellvine	$14.7k
5	Fleabane	1571	-	-	-	-
6	Wild mustard	345	-	-	-	-
7	Barnyard grass	329	-	-	-	-
8	-	-	-	-	-	-
NSW NE/Queensland SE						
1	Barnyard grass	80,264	Barnyard grass	70,166	Barnyard grass	$13.3m
2	Fleabane	62,868	Sweet summer grass	30,820	Sweet summer grass	$5.8m
3	Feathertop Rhodes grass	37,649	Feathertop Rhodes grass	29,241	Feathertop Rhodes grass	$5.5m
4	Sweet summer grass	31,827	Noogoora burr	7655	Noogoora burr	$1.4m
5	Bathurst burr	23,969	Fleabane	3065	Fleabane	$579.3k
6	Noogoora burr	10,538	Wireweed	1461	Wireweed	$276.1k
7	Wild oats	4108	Wild oats	1365	Wild oats	$257.9k
8	Thornapple	3286	Bathurst burr	1118	Bathurst burr	$211.3k
9	Caltrop / bindi	3072	Thornapple	386	Thornapple	$72.9k
10	Wireweed	2143	Caltrop / bindi	357	Caltrop / bindi	$67.5k
NSW NW/Queensland SW						
1	Barnyard grass	6496	Barnyard grass	7170	Barnyard grass	$1.3m
2	Feathertop Rhodes grass	4452	Feathertop Rhodes grass	1299	Feathertop Rhodes grass	$242.9k
3	Fleabane	405	Fleabane	18	Fleabane	$3.4k
4	Melons	405	Noogoora burr	12	Noogoora burr	$2.3k
5	Sow thistle / milk thistle	405	Sow thistle / milk thistle	12	Sow thistle / milk thistle	$2.3k
6	Noogoora burr	243	-	-	-	-

9.7 Weed rankings in all crops

TABLE 96 Residual weeds in all crops ranked by revenue loss due to yield loss showing overall ranking for agro-ecological zone.

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
Central Queensland						
1	Sow thistle / milk thistle	80,992	Sweet summer grass	15,068	Sweet summer grass	$3.0m
2	Wild mustard	59,012	Feathertop Rhodes grass	8629	Feathertop Rhodes grass	$1.8m
3	Feathertop Rhodes grass	58,135	Wild turnip	5400	Wild turnip	$1.7m
4	Wild turnip	56,043	Wild radish	4696	Sow thistle / milk thistle	$1.2m
5	Mexican poppy	42,539	Sow thistle / milk thistle	4322	Wild radish	$1.1m
6	Sweet summer grass	31,880	Mexican poppy	1318	Wild mustard	$386.1k
7	Parthenium weed	11,361	Wild mustard	1079	Mexican poppy	$329.4k
8	Thistle species	7761	Parthenium weed	604	Parthenium weed	$135.0k
9	Wild radish	4938	Thistle species	439	Thistle species	$101.8k
10	Bellvine	1661	Ryegrass	147	Ryegrass	$33.0k
NSW NE/Queensland SE						
1	Sow thistle / milk thistle	360,142	Barnyard grass	70,410	Barnyard grass	$13.4m
2	Wild oats	276,958	Sweet summer grass	30,820	Sweet summer grass	$5.8m
3	Fleabane	274,233	Feathertop Rhodes grass	29,373	Feathertop Rhodes grass	$5.6m
4	Wild turnip	234,103	Wild oats	10,443	Sow thistle / milk thistle	$2.5m
5	Black bindweed / climbing buckwheat	98,341	Sow thistle / milk thistle	9823	Wild oats	$2.2m
6	Barnyard grass	83,854	Noogoora burr	7655	Wild turnip	$2.2m
7	Phalaris	78,787	Wild turnip	6745	Noogoora burr	$1.4m
8	Feathertop Rhodes grass	52,096	Wild radish	5204	Black bindweed / climbing buckwheat	$1.2m
9	Ryegrass	40,362	Fleabane	4371	Wild radish	$1.2m
10	Wild radish	34,201	Black bindweed / climbing buckwheat	3740	Fleabane	$899.2k
NSW NW/Queensland SW						
1	Wild oats	708,498	Wild turnip	27,486	Wild turnip	$6.4m
2	Ryegrass	551,579	Ryegrass	12,868	Ryegrass	$3.0m
3	Wild turnip	430,827	Wild oats	9953	Wild oats	$2.3m
4	Sow thistle / milk thistle	146,232	Barnyard grass	7259	Barnyard grass	$1.4m
5	Fleabane	140,195	Sow thistle / milk thistle	1914	Sow thistle / milk thistle	$488.4k
6	Wild mustard	91,215	Feathertop Rhodes grass	1326	Wild mustard	$291.1k
7	Wild radish	80,603	Wild mustard	1250	Feathertop Rhodes grass	$253.8k
8	Phalaris	74,549	Wild radish	948	Wild radish	$215.3k
9	Barnyard grass	53,862	Phalaris	854	Phalaris	$189.7k
10	Black bindweed / climbing buckwheat	45,926	Brassica weeds	766	Fleabane	$184.0k

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TABLE 96 Residual weeds in all crops ranked by revenue loss due to yield loss showing overall ranking for agro-ecological zone (continued).

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
NSW Central						
1	Ryegrass	354,224	Ryegrass	11,475	Ryegrass	$2.6m
2	Wild oats	208,400	Wild oats	5924	Brome grass	$1.3m
3	Wild mustard	181,096	Brome grass	4754	Wild oats	$1.3m
4	Fleabane	166,204	Wild radish	3343	Wild radish	$1.1m
5	Brome grass	95,629	Brassica weeds	2335	Brassica weeds	$501.4k
6	Wild turnip	81,124	Wild mustard	2312	Wild mustard	$493.4k
7	Paterson's curse / salvation Jane	79,105	Paterson's curse / salvation Jane	1805	Paterson's curse / salvation Jane	$408.5k
8	Doublegee	76,939	Doublegee	1158	Thistle species	$246.0k
9	Brassica weeds	49,127	Thistle species	1138	Doublegee	$244.9k
10	Thistle species	31,552	Fleabane	772	Fleabane	$166.7k
NSW Victorian Slopes						
1	Ryegrass	763,736	Wild oats	44,846	Wild oats	$11.9m
2	Wild oats	438,445	Ryegrass	17,319	Ryegrass	$4.1m
3	Wild mustard	309,246	Wild radish	6358	Wild radish	$1.7m
4	Wild radish	200,006	Doublegee	1610	Doublegee	$344.0k
5	Wild turnip	127,457	Brome grass	1283	Brome grass	$278.9k
6	Cape weed	73,519	Cape weed	1023	Wild mustard	$266.4k
7	Brome grass	27,226	Wild mustard	918	Cape weed	$239.5k
8	Fleabane	23,218	Skeleton weed	297	Skeleton weed	$116.7k
9	Barley grass	22,456	Barley grass	185	Mexican poppy	$46.8k
10	Silver grass	14,694	Mexican poppy	98	Barley grass	$46.0k
SA Mid North – Lower Yorke Eyre						
1	Ryegrass	980,308	Ryegrass	83,164	Ryegrass	$21.6m
2	Wild oats	256,418	Brome grass	31,425	Brome grass	$7.8m
3	Brome grass	160,166	Wild oats	6839	Vetches	$1.9m
4	Cutleaf mignonette	137,131	Vetches	4577	Wild oats	$1.8m
5	Vetches	87,820	Barley grass	2500	Barley grass	$749.1k
6	Wild mustard	76,165	Wild radish	1743	Wild radish	$564.1k
7	Barley grass	69,440	Wild mustard	1636	Wild mustard	$480.9k
8	Wild turnip	67,456	Cutleaf mignonette	1417	Cutleaf mignonette	$406.1k
9	Wild radish	49,521	Bedstraw	769	Bedstraw	$336.6k
10	Sow thistle / milk thistle	16,120	Wild turnip	740	Wild turnip	$190.7k
SA Victorian Bordertown – Wimmera						
1	Ryegrass	484,249	Wild oats	26,842	Wild oats	$5.9m
2	Wild oats	251,709	Ryegrass	20,341	Ryegrass	$4.8m
3	Wild radish	198,871	Brome grass	19,952	Brome grass	$4.5m
4	Wild mustard	157,380	Wild mustard	7871	Vetches	$2.9m
5	Brome grass	147,810	Vetches	6794	Wild radish	$2.3m
6	Vetches	82,987	Wild radish	5826	Wild mustard	$1.8m
7	Prickly lettuce / whip thistle	59,812	Prickly lettuce / whip thistle	2755	Prickly lettuce / whip thistle	$633.9k
8	Sow thistle / milk thistle	42,590	Lincoln weed	2064	Sow thistle / milk thistle	$473.9k
9	Cape weed	21,535	Sow thistle / milk thistle	1196	Lincoln weed	$453.9k
10	Wild geranium / storksbill	12,357	Skeleton weed	565	Cape weed	$132.4k

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TABLE 96 Residual weeds in all crops ranked by revenue loss due to yield loss showing overall ranking for agro-ecological zone (continued).

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
SA Victorian Mallee						
1	Brome grass	685,613	Brome grass	29,189	Brome grass	$7.1m
2	Ryegrass	660,958	Ryegrass	13,824	Ryegrass	$3.4m
3	Wild turnip	301,025	Amsinkia / yellow burr weed	8204	Wild radish	$2.0m
4	Wild radish	212,095	Wild radish	8058	Amsinkia / yellow burr weed	$1.9m
5	Wild mustard	96,495	Wireweed	5339	Wireweed	$1.3m
6	Amsinkia / yellow burr weed	83,585	Wild mustard	2706	Wild mustard	$662.1k
7	Wild oats	71,168	Skeleton weed	2100	Skeleton weed	$532.0k
8	Skeleton weed	59,516	Wild oats	1847	Wild oats	$437.8k
9	Wireweed	54,129	Barley grass	600	Barley grass	$144.9k
10	Barley grass	48,488	Prickly lettuce / whip thistle	116	Prickly lettuce / whip thistle	$43.6k
Victorian high-rainfall and Tasmanian grain						
1	Ryegrass	175,696	Wild radish	11,840	Wild radish	$2.9m
2	Wild radish	54,693	Ryegrass	9209	Ryegrass	$2.4m
3	Wild oats	26,159	Wild oats	1557	Wild oats	$353.7k
4	Cape weed	10,784	Wild mustard	268	Wild mustard	$106.4k
5	Brome grass	5763	Cape weed	233	Cape weed	$65.8k
6	Thistle species	3580	Phalaris	99	Vetches	$38.9k
7	Phalaris	3054	Vetches	90	Phalaris	$23.4k
8	Wild mustard	2114	Brome grass	79	Brome grass	$22.6k
9	Wild geranium / storksbill	1280	Thistle species	31	Wild geranium / storksbill	$12.0k
10	Silver grass	694	Wild geranium / storksbill	23	Thistle species	$9.9k
WA Central						
1	Ryegrass	2,511,935	Ryegrass	123,342	Ryegrass	$35.4m
2	Wild radish	2,307,064	Wild radish	90,833	Wild radish	$25.4m
3	Brome grass	202,639	Wild oats	6027	Wild oats	$1.8m
4	Wild oats	94,263	Brome grass	1311	Brome grass	$472.1k
5	Wild turnip	73,534	Toadrush	541	Toadrush	$139.1k
6	Wireweed	43,861	Cape weed	249	Cape weed	$91.2k
7	Toadrush	27,433	Doublegee	181	Doublegee	$45.2k
8	Cape weed	19,199	-	-	-	-
9	Doublegee	10,266	-	-	-	-
10	Khaki weed	3217	-	-	-	-
WA Eastern						
1	Wild radish	781,708	Wild radish	19,224	Wild radish	$5.0m
2	Ryegrass	516,965	Ryegrass	9609	Ryegrass	$2.5m
3	Cape weed	36,655	Cape weed	1426	Cape weed	$373.7k
4	Barley grass	33,377	Barley grass	1188	Barley grass	$307.5k
5	Wild oats	32,607	Doublegee	1060	Doublegee	$277.4k
6	Doublegee	29,806	Brome grass	498	Brome grass	$128.4k
7	Wild turnip	15,510	Wild oats	183	Wild oats	$47.2k
8	Brome grass	13,000	Wild turnip	53	Wild turnip	$13.8k
9	Wild mustard	8858	-	-	-	-
10	Silver grass	1,251	-	-	-	-

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TABLE 96 Residual weeds in all crops ranked by revenue loss due to yield loss showing overall ranking for agro-ecological zone (continued).

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
WA Sandplain – Mallee						
1	Ryegrass	486,018	Ryegrass	19,972	Ryegrass	$6.4m
2	Wild radish	212,708	Wild radish	3897	Wild radish	$1.4m
3	Fleabane	62,208	Barley grass	1031	Barley grass	$287.2k
4	Wild turnip	58,124	Brome grass	690	Brome grass	$240.8k
5	Barley grass	50,616	Marshmallow	266	Marshmallow	$130.2k
6	Brome grass	26,444	Thistle species	147	Thistle species	$79.5k
7	Marshmallow	19,799	Fleabane	117	Fleabane	$31.9k
8	Wild mustard	3765	-	-	-	-
9	Thistle species	2569	-	-	-	-
WA Northern						
1	Wild radish	971,493	Wild radish	30,350	Wild radish	$8.3m
2	Ryegrass	758,681	Ryegrass	21,692	Ryegrass	$6.0m
3	Brome grass	50,007	Brome grass	2210	Brome grass	$583.1k
4	Doublegee	19,460	Doublegee	1334	Doublegee	$431.2k
5	Cape weed	5206	Wild oats	134	Wild oats	$35.3k
6	Wild oats	4230	Cape weed	69	Cape weed	$18.3k
7	Barley grass	1815	Barley grass	53	Barley grass	$15.4k

9.8 Weed rankings in summer fallow

TABLE 97 Residual weeds in summer fallow ranked by revenue loss due to yield loss showing overall ranking by agro-ecological zone.

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
Central Queensland						
1	Feathertop Rhodes grass	129,281	Feathertop Rhodes grass	7455	Feathertop Rhodes grass	$2.2m
2	Sow thistle / milk thistle	43,615	Sow thistle / milk thistle	3837	Sow thistle / milk thistle	$1.2m
3	Sweet summer grass	28,467	Thistle species	1972	Thistle species	$675.3k
4	Thistle species	27,684	Sweet summer grass	1545	Sweet summer grass	$472.6k
5	Parthenium weed	21,582	Black bindweed / climbing buckwheat	1384	Black bindweed / climbing buckwheat	$319.7k
6	Caltrop / bindi	12,304	Parthenium weed	649	Parthenium weed	$201.4k
7	Panic grass	5228	Panic grass	523	Panic grass	$120.8k
8	Black bindweed / climbing buckwheat	4614	Caltrop / bindi	317	Caltrop / bindi	$113.1k
9	Bellvine	4460	Bellvine	156	Bellvine	$39.2k
10	Boggabri weed	2538	Boggabri weed	74	Boggabri weed	$23.0k
NSW NE/Queensland SE						
1	Fleabane	800,724	Barnyard grass	45,553	Fleabane	$11.0m
2	Barnyard grass	354,292	Fleabane	44,796	Barnyard grass	$10.4m
3	Sweet summer grass	87,440	Feathertop Rhodes grass	3573	Feathertop Rhodes grass	$894.4k
4	Sow thistle / milk thistle	50,243	Sweet summer grass	2889	Sweet summer grass	$717.0k
5	Feathertop Rhodes grass	49,598	Wild oats	1663	Sow thistle / milk thistle	$412.9k
6	Ryegrass	44,208	Sow thistle / milk thistle	1592	Wild oats	$386.1k
7	Caltrop / bindi	29,657	Caltrop / bindi	1546	Windmill grass	$385.1k
8	Bathurst burr	22,128	Windmill grass	1535	Ryegrass	$364.7k
9	Windmill grass	20,041	Ryegrass	1303	Caltrop / bindi	$360.4k
10	Wild Oats	17,721	Mint weed	956	Mint weed	$207.5k

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TABLE 97 Residual weeds in summer fallow ranked by revenue loss due to yield loss showing overall ranking by agro-ecological zone (continued).

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
NSW NW/Queensland SW						
1	Sow thistle / milk thistle	375,862	Barnyard grass	23,057	Barnyard grass	$5.4m
2	Fleabane	294,715	Fleabane	17,366	Sow thistle / milk thistle	$4.8m
3	Barnyard grass	232,317	Sow thistle / milk thistle	17,122	Fleabane	$4.3m
4	Windmill grass	113,168	Sweet summer grass	9489	Sweet summer grass	$2.3m
5	Melons	62,057	Windmill grass	7217	Windmill grass	$1.8m
6	Sweet summer grass	53,503	Caltrop / bindi	5688	Caltrop / bindi	$1.2m
7	Wireweed	42,144	Wireweed	2907	Wireweed	$759.3k
8	Nut grass	22,516	Melons	2735	Melons	$655.0k
9	Mint weed	17,903	Mint weed	1275	Mint weed	$287.1k
10	Bathurst burr	13,188	Ryegrass	1067	Ryegrass	$233.6k
NSW Central						
1	Melons	456,252	Fleabane	24,051	Heliotrope / potato weed	$5.5m
2	Heliotrope / potato weed	310,677	Heliotrope /potato weed	23,768	Fleabane	$5.5m
3	Fleabane	195,115	Melons	22,975	Melons	$5.2m
4	Windmill grass	105,767	Windmill grass	12,022	Windmill grass	$2.8m
5	Barnyard grass	65,236	Mint weed	8097	Mint weed	$1.7m
6	Mint weed	51,948	Black bindweed / climbing buckwheat	7769	Black bindweed / climbing buckwheat	$1.6m
7	Skeleton weed	51,674	Thistle species	6151	Thistle species	$1.3m
8	Caltrop / bindi	45,023	Barnyard grass	4533	Barnyard grass	$1.1m
9	Black bindweed / climbing buckwheat	38,847	Caltrop / bindi	4500	Caltrop / bindi	$950.0k
10	Panic grass	28,385	Skeleton weed	3859	Skeleton weed	$894.5k
NSW Victorian Slopes						
1	Melons	559,975	Melons	62,316	Panic grass	$14.6m
2	Fleabane	546,905	Panic grass	53,423	Melons	$14.4m
3	Panic grass	393,570	Fleabane	41,779	Fleabane	$10.2m
4	Heliotrope / potato weed	229,698	Windmill grass	9503	Heliotrope / potato weed	$2.3m
5	Windmill grass	156,810	Barley grass	8719	Windmill grass	$2.3m
6	Bathurst burr	79,545	Heliotrope / potato weed	8692	Barley grass	$1.9m
7	Wireweed	75,610	Wireweed	6855	Wireweed	$1.7m
8	Barley grass	59,061	Bathurst burr	2763	Goosefoots	$731.9k
9	Sow thistle / milk thistle	53,995	Goosefoots	2649	Bathurst burr	$654.0k
10	Goosefoots	32,725	Ryegrass	1906	Ryegrass	$437.8k
SA Mid North – Lower Yorke Eyre						
1	Heliotrope / potato weed	727,750	Heliotrope / potato weed	77,913	Heliotrope / potato weed	$20.7m
2	Melons	210,338	Melons	12,551	Melons	$3.3m
3	Cutleaf mignonette	188,564	Caltrop / bindi	7596	Caltrop / bindi	$2.1m
4	Marshmallow	172,373	Cutleaf mignonette	5390	Cutleaf mignonette	$1.1m
5	Caltrop / bindi	94,863	Lincoln weed	4500	Lincoln weed	$1.1m
6	Wireweed	40,780	Marshmallow	4144	Marshmallow	$1.0m
7	Geranium	40,381	Toadrush	3344	Toadrush	$727.6k
8	Brassica weeds	36,055	Geranium	2776	Geranium	$422.4k
9	Lincoln weed	34,578	Brassica weeds	1335	Brassica weeds	$325.0k
10	Toadrush	32,690	Wireweed	1173	Wireweed	$1.1m

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TABLE 97 Residual weeds in summer fallow ranked by revenue loss due to yield loss showing overall ranking by agro-ecological zone (continued).

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
SA Victorian Bordertown - Wimmera						
1	Heliotrope / potato weed	455,687	Heliotrope / potato weed	55,039	Heliotrope / potato weed	$15.2m
2	Melons	237,770	Caltrop / bindi	16,263	Caltrop / bindi	$4.7m
3	Caltrop / bindi	109,133	Ryegrass	13,577	Melons	$3.7m
4	Marshmallow	88,477	Melons	13,348	Ryegrass	$3.6m
5	Wireweed	58,191	Bathurst burr	4039	Bathurst burr	$1.2m
6	Whip thistle / prickly lettuce	53,546	Marshmallow	3776	Sow thistle / milk thistle	$1.1m
7	Wild oats	52,608	Sow thistle / milk thistle	3632	Marshmallow	$1.0m
8	Bathurst burr	52,394	Wireweed	3038	Wireweed	$829.1k
9	Sow thistle / milk thistle	50,242	Wild mustard	2624	Whip thistle / prickly lettuce	$743.4k
10	Ryegrass	49,848	Whip thistle / prickly lettuce	2459	Wild mustard	$660.7k
SA Victorian Mallee						
1	Heliotrope / potato weed	1,024,462	Heliotrope / potato weed	144,698	Heliotrope / potato weed	$37.5m
2	Melons	991,018	Melons	47,473	Melons	$12.6m
3	Caltrop / bindi	367,635	Lincoln weed	30,078	Lincoln weed	$7.2m
4	Lincoln weed	118,195	Caltrop / bindi	19,772	Caltrop / bindi	$5.4m
5	Skeleton weed	77,835	Sweet summer grass	11,683	Sweet summer grass	$3.0m
6	Sweet summer grass	65,423	Paterson's curse / salvation Jane	9551	Paterson's curse / salvation Jane	$2.5m
7	Paterson's curse / salvation Jane	54,324	Fleabane	5695	Fleabane	$1.3m
8	Whip thistle / prickly lettuce	45,270	Skeleton weed	3167	Skeleton weed	$775.5k
9	Nut grass	25,412	Thistle species	2001	Thistle species	$508.2k
10	Fleabane	18,984	Nut grass	1839	Nut grass	$445.9k
Victorian high rainfall and Tas grain						
1	Heliotrope / potato weed	54,999	Wild radish	5960	Wild radish	$1.6m
2	Wireweed	39,813	Wireweed	4338	Wireweed	$1.2m
3	Melons	30,628	Ryegrass	4251	Ryegrass	$1.1m
4	Wild radish	28,838	Panic grass	4099	Panic grass	$967.4k
5	Ryegrass	19,233	Heliotrope / potato weed	3773	Heliotrope / potato weed	$966.1k
6	Fleabane	9414	Melons	797	Melons	$189.9k
7	Panic grass	7189	Chickweed	615	Chickweed	$152.2k
8	Thistle species	3527	Fleabane	398	Goosefoots	$98.8k
9	Bathurst burr	3362	Goosefoots	390	Fleabane	$97.8k
10	Sow thistle / milk thistle	3038	Cape weed	270	Cape weed	$60.7k
WA Central						
1	Melons	2,127,723	Melons	110,916	Melons	$30.4m
2	Fleabane	525,959	Nut grass	29,138	Nut grass	$7.7m
3	Caltrop / bindi	474,385	Caltrop / bindi	21,011	Caltrop / bindi	$5.8m
4	Wild radish	235,762	Fleabane	19,594	Fleabane	$5.2m
5	Nut grass	212,028	Wild radish	7622	Wild radish	$2.2m
6	Goosefoots	99,131	Mint weed	4685	Mint weed	$1.2m
7	Wild geranium / storksbill	94,938	Goosefoots	2503	Goosefoots	$682.8k
8	Mint weed	45,188	Ryegrass	1184	Ryegrass	$350.8k
9	Ryegrass	38,133	Wild geranium / storksbill	1137	Wild geranium / storksbill	$297.1k
10	Barley grass	19,067	Wireweed	600	Wireweed	$151.3k

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TABLE 97 Residual weeds in summer fallow ranked by revenue loss due to yield loss showing overall ranking by agro-ecological zone (continued).

Rank	Weed	Area (ha)	Weed	Yield loss (t)	Weed	Revenue loss
WA Eastern						
1	Melons	616,179	Caltrop / bindi	36,620	Caltrop / bindi	$9.9m
2	Caltrop / bindi	409,705	Melons	29,568	Melons	$7.9m
3	Wild radish	60,582	Barley grass	2291	Barley grass	$605.5k
4	Windmill grass	26,151	Wild radish	1952	Wild radish	$520.2k
5	Doublegee	24,193	Windmill grass	1425	Windmill grass	$374.9k
6	Barley grass	23,684	Doublegee	1249	Doublegee	$326.5k
7	Sweet summer grass	15,446	Wild oats	1133	Wild oats	$292.2k
8	Wild oats	13,730	Mint weed	809	Mint weed	$215.4k
9	Mint weed	8452	Parthenium weed	290	Parthenium weed	$74.7k
10	Parthenium weed	7723	Sweet summer grass	193	Sweet summer grass	$49.8k
WA Sandplain-Mallee						
1	Melons	330,057	Fleabane	18,237	Fleabane	$5.3m
2	Fleabane	291,957	Melons	11,859	Melons	$3.3m
3	Wild radish	133,914	Marshmallow	2332	Marshmallow	$713.1k
4	Windmill grass	99,993	Wild radish	2121	Wild radish	$646.8k
5	Marshmallow	84,523	Windmill grass	1594	Windmill grass	$472.3k
6	Mint weed	67,474	Dock	1481	Dock	$371.8k
7	Ryegrass	28,964	Mint weed	974	Mint weed	$281.2k
8	Dock	14,811	Nut grass	411	Nut grass	$109.9k
9	Nut grass	9479	Sweet summer grass	371	Ryegrass	$101.5k
10	Doublegee	5594	Ryegrass	345	Sweet summer grass	$97.0k
WA Northern						
1	Melons	752,368	Melons	30,064	Melons	$8.0m
2	Caltrop / bindi	132,870	Wireweed	3418	Wireweed	$904.7k
3	Wild radish	119,606	Windmill grass	2663	Windmill grass	$710.5k
4	Wireweed	50,882	Wild radish	2395	Wild radish	$659.4k
5	Windmill grass	46,920	Thistle species	2151	Thistle species	$568.5k
6	Thistle species	33,345	Caltrop / bindi	1884	Caltrop / bindi	$509.1k
7	Mint weed	18,021	Brome grass	1167	Brome grass	$325.6k
8	Ryegrass	10,962	Mint weed	517	Mint weed	$136.3k
9	Brome grass	10,542	Ryegrass	381	Ryegrass	$101.7k
10	Doublegee	8299	Vetches	241	Vetches	$64.4k

9.9 Weed rankings in winter fallow

TABLE 98 Residual weeds in winter fallow ranked by revenue loss due to yield loss showing overall ranking by agro-ecological zone.

Rank	Weed	Yield loss (t)	Weed	Revenue loss
Central Queensland				
1	Feathertop Rhodes grass	72	Feathertop Rhodes grass	$13.5k
2	Sow thistle / milk thistle	64	Sow thistle / milk thistle	$12.1k
3	Wild turnip	60	Wild turnip	$11.2k
4	Mexican poppy	23	Mexican poppy	$4.3k
5	Thistle species	14	Thistle species	$2.6k
NSW NE/Queensland SE				
1	Sow thistle / milk thistle	1769	Sow thistle / milk thistle	$334.3k
2	Fleabane	1215	Fleabane	$229.7k
3	Wild turnip	923	Wild turnip	$174.5k
4	Wild oats	853	Wild oats	$161.3k
5	Barnyard grass	420	Barnyard grass	$79.5k
6	Phalaris	416	Phalaris	$78.7k
7	Wild radish	228	Wild radish	$43.1k
8	Black bindweed / climbing buckwheat	191	Black bindweed / climbing buckwheat	$36.0k
9	Feathertop Rhodes grass	70	Feathertop Rhodes grass	$13.3k
10	Deadnettle	43	Deadnettle	$8.2k
NSW NW/Queensland SW				
1	Windmill grass	150	Windmill grass	$28.0k
2	Wild mustard	139	Wild mustard	$26.0k
3	Black bindweed / climbing buckwheat	54	Black bindweed / climbing buckwheat	$10.1k
4	Sow thistle / milk thistle	41	Sow thistle / milk thistle	$7.6k
5	Ryegrass	27	Ryegrass	$5.0k
6	Fleabane	15	Fleabane	$2.8k
7	Wild oats	14	Wild oats	$2.5k

9.10 Weed rankings based on additional cost of herbicide application due to managing herbicide-resistant weeds

TABLE 99 Additional cost of herbicide application due to managing herbicide-resistant weeds ranked by revenue loss due to yield loss showing overall ranking by agro-ecological zone.

Rank	Weed	Yield loss (t)	Weed	Revenue loss
Central Queensland				
1	Feathertop Rhodes grass	$2.3m	Feathertop Rhodes grass	$944.0k
2	Wild mustard	$596.8k	Sweet summer grass	$174.7k
3	Sweet summer grass	$139.5k	Thistle species	$106.5k
4	Thistle species	$99.1k	Wild mustard	$29.9k
5	Wild turnip	$18.4k	Wild turnip	$3.0k
NSW NE/ Queensland SE				
1	Ryegrass	$14.8m	Barnyard grass	$743.7k
2	Wild turnip	$6.3m	Fleabane	$326.0k
3	Barnyard grass	$3.6m	Feathertop Rhodes grass	$173.2k
4	Phalaris	$1.5m	Mint weed	$144.6k
5	Fleabane	$1.3m	Ryegrass	$141.6k
6	Sow thistle / milk thistle	$1.2m	Wild oats	$118.5k
7	Wild oats	$800.0k	Black bindweed / climbing buckwheat	$46.4k
8	Mint weed	$636.7k	Sweet summer grass	$43.7k
9	Sweet summer grass	$504.8k	Doublegee	$21.4k
10	Feathertop Rhodes grass	$284.8k	Wild turnip	$14.5k
NSW NW /Queensland SW				
1	Wild oats	$1.5m	Wild radish	$89.0k
2	Ryegrass	$1.2m	Barnyard grass	$66.8k
3	Phalaris	$632.3k	Wild turnip	$9.8k
4	Barnyard grass	$556.0k	Windmill grass	$8.2k
5	Wild radish	$347.6k	Ryegrass	$4.9k
6	Fleabane	$276.8k	-	-
7	Windmill grass	$195.6k	-	-
8	Wild turnip	$158.1k	-	-
9	Mexican poppy	$113.1k	-	-
10	Sow thistle / milk thistle	$43.6k	-	-
NSW Central				
1	Ryegrass	$4.6m	-	-
2	Fleabane	$1.7m	-	-
3	Brome grass	$1.3m	-	-
4	Windmill grass	$979.8k	-	-
5	Wild oats	$611.7k	-	-
6	Paterson's curse / salvation Jane	$212.7k	-	-
7	Wild radish	$66.0k	-	-
NSW Victorian Slopes				
1	Ryegrass	$12.7m	-	-
2	Wild oats	$2.1m	-	-
3	Wild radish	$707.9k	-	-
4	Cape weed	$266.5k	-	-
5	Sow thistle / milk thistle	$101.7k	-	-

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TABLE 99 Additional cost of herbicide application due to managing herbicide-resistant weeds ranked by revenue loss due to yield loss showing overall ranking by agro-ecological zone (continued).

Rank	Weed	Yield loss (t)	Weed	Revenue loss
SA Mid North – Lower Yorke Eyre				
1	Ryegrass	$12.8m	-	-
2	Wild turnip	$413.2k	-	-
3	Brome grass	$360.2k	-	-
4	Wild oats	$234.2k	-	-
5	Wild mustard	$70.2k	-	-
6	Wild radish	$65.4k	-	-
SA Victorian Bordertown – Wimmera				
1	Ryegrass	$12.6m	-	-
2	Wild radish	$722.9k	-	-
3	Brome grass	$434.1k	-	-
4	Wild oats	$365.7k	-	-
5	Prickly lettuce / whip thistle	$43.0k	-	-
SA Victorian Mallee				
1	Ryegrass	$5.7m	-	-
2	Wild mustard	$2.3m	-	-
3	Brome grass	$531.1k	-	-
4	Wild radish	$70.3k	-	-
5	Skeleton weed	$38.7k	-	-
6	Wild oats	$23.0k	-	-
Victorian high-rainfall and Tasmanian grain				
1	Ryegrass	$2.2m	-	-
2	Wild radish	$296.5k	-	-
3	Wild oats	$24.3k	-	-
4	Silver grass	$7.2k	-	-
5	Wild mustard	$6.1k	-	-
6	Cape weed	$0.8k	-	-
WA Central				
1	Ryegrass	$25.8m	-	-
2	Wild radish	$9.4m	-	-
3	Wild turnip	$433.1k	-	-
4	Wild oats	$276.6k	-	-
5	Toadrush	$107.3k	-	-
WA Eastern				
1	Ryegrass	$2.7m	-	-
2	Wild radish	$1.1m	-	-
3	Wild mustard	$403.6k	-	-
4	Barley grass	$203.7k	-	-
5	Wild oats	$116.0k	-	-
6	Wild turnip	$14.6k	-	-
7	Doublegee	$13.4k	-	-
WA Sandplain-Mallee				
1	Ryegrass	$2.2m	-	-
2	Wild turnip	$383.8k	-	-
3	Fleabane	$287.7k	-	-
4	Wild radish	$222.8k	-	-

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TABLE 99 Additional cost of herbicide application due to managing herbicide-resistant weeds ranked by revenue loss due to yield loss showing overall ranking by agro-ecological zone (continued).

Rank	Weed	Yield loss (t)	Weed	Revenue loss
WA Northern				
1	Wild radish	$6.7m	-	-
2	Ryegrass	$5.9m	-	-
3	Wild mustard	$642.4k	-	-
4	Brome grass	$578.9k	-	-
5	Wild oats	$140.5k	-	-
6	Cape weed	$59.4k	-	-

9.11 Weed rankings based on growers top four most costly weeds to manage

TABLE 100 Weed rankings based on growers top four most costly weeds to manage, overall ranking by agro-ecological zone.

Rank	Central Queensland		NSW NE/Queensland SE		NSW NW/Queensland SW	
1	Feathertop Rhodes grass	68%	Fleabane	76%	Ryegrass	57%
2	Sweet summer grass	29%	Feathertop Rhodes grass	40%	Fleabane	46%
3	Fleabane	21%	Barnyard grass	31%	Wild oats	37%
4	Sow thistle / milk thistle	18%	Sow thistle / milk thistle	22%	Barnyard grass	24%
5	Parthenium weed	14%	Ryegrass	20%	Sow thistle / milk thistle	15%
6	Mexican poppy	7%	Wild oats	13%	Phalaris	13%
7	Ryegrass	7%	Caltrop / bindi	4%	Windmill grass	11%
8	Thistle species	7%	Marshmallow	4%	Marshmallow	9%
9	Wild turnip	7%	Phalaris	4%	Wireweed	9%
10	Barnyard grass	4%	Sweet summer grass	4%	Barley grass	4%
Rank	**NSW Central**		**NSW Victorian Slopes**		**SA Mid North – Lower Yorke Eyre**	
1	Ryegrass	73%	Ryegrass	88%	Ryegrass	94%
2	Fleabane	31%	Wild oats	40%	Brome grass	41%
3	Wild oats	29%	Wild radish	38%	Wild oats	37%
4	Paterson's curse / salvation Jane	24%	Fleabane	29%	Wild radish	33%
5	Brome grass	16%	Cape weed	19%	Bifora	14%
6	Melons	14%	Barley grass	13%	Marshmallow	14%
7	Wild mustard	14%	Brome grass	12%	Barley grass	12%
8	Barley grass	12%	Marshmallow	10%	Bedstraw	6%
9	Wild radish	12%	Silver grass	10%	Lincoln weed	6%
10	Cape weed	10%	Paterson's curse / salvation Jane	8%	Caltrop / bindi	4%
Rank	**SA Victorian Mallee**		**Victorian high-rainfall and Tasmanian grain**		**SA Victorian Bordertown – Wimmera**	
1	Ryegrass	69%	Ryegrass	84%	Ryegrass	84%
2	Brome grass	60%	Wild radish	49%	Wild oats	42%
3	Wild radish	33%	Wild oats	22%	Brome grass	40%
4	Skeleton weed	17%	Brome grass	14%	Wild radish	34%
5	Wild oats	15%	Toadrush	10%	Marshmallow	18%
6	Fleabane	12%	Thistle species	8%	Cape weed	14%
7	Melons	12%	Wireweed	8%	Vetches	14%
8	Barley grass	10%	Cape weed	6%	Fleabane	10%
9	Marshmallow	10%	Fleabane	6%	Wild mustard	8%
10	Caltrop / bindi	8%	Bathurst burr	4%	Caltrop / bindi	6%

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TABLE 100 Weed rankings based on growers top 4 most costly weeds to manage, overall ranking by agro-ecological zone (continued).

Rank	WA Central		WA Eastern		WA Sandplain - Mallee		WA Northern	
1	Ryegrass	96%	Ryegrass	85%	Ryegrass	89%	Ryegrass	93%
2	Wild radish	84%	Wild radish	77%	Wild radish	57%	Wild radish	88%
3	Brome grass	38%	Wild oats	23%	Brome grass	30%	Brome grass	35%
4	Barley grass	36%	Barley grass	21%	Barley grass	24%	Doublegee	23%
5	Cape weed	33%	Cape weed	21%	Fleabane	17%	Cape weed	15%
6	Wild oats	29%	Brome grass	19%	Marshmallow	11%	Barley grass	10%
7	Silver grass	7%	Melons	6%	Wild oats	9%	Melons	10%
8	Wild turnip	7%	Wild turnip	6%	Cape weed	7%	Caltrop / bindi	3%
9	Caltrop / bindi	4%	Caltrop / bindi	4%	Melons	7%	Fleabane	3%
10	Fleabane	4%	Marshmallow	4%	Wild turnip	7%	Wild mustard	3%

9.12 Influence of weeds on cropping choice

TABLE 101 How growers would change what they grew if they did not have to consider weeds, expressed as a percentage of growers stating they would change.

	More wheat	More barley	More oats	More canola	More sorghum	More pulses/ legumes
Northern	24%	11%	3%	11%	24%	24%
Central Queensland	-	-	-	-	43%	43%
NSW NE/Queensland SE	18%	6%		18%	29%	29%
NSW NW/Queensland SW	46%	23%	8%	8%	8%	8%
Southern	58%	23%	7%	15%	-	14%
NSW Central	73%	7%	-	13%	-	7%
NSW Victorian Slopes	57%	-	-	14%	-	14%
SA Mid North – Lower Yorke Eyre	77%	23%		8%	-	15%
SA Victorian Bordertown – Wimmera	31%	23%	15%	8%	-	23%
SA Victorian Mallee	75%	42%		25%	-	8%
Victorian high-rainfall and Tas grain	31%	38%	23%	23%	-	15%
Western	66%	26%	9%	13%	2%	13%
WA Central	41%	29%	12%	12%	-	6%
WA Eastern	100%	33%	11%	11%	11%	11%
WA Sandplain – Mallee	44%	44%	11%	33%	-	33%
WA Northern	92%	-	-	-	-	8%
Total / National	52%	21%	6%	13%	6%	16%

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