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Adoption of no-till cropping practices in Australian grain growing regions

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

ADOPTION OF NO-TILL FARMING PRACTICES IN AUSTRALIAN GRAIN GROWING REGIONS

Executive Summary

No-till cropping is not a new technology, but for large parts of the Australian cropping landscape the uptake of no-till farming systems is a relatively recent and on-going process. This study was designed to determine the current status of no-till and conservation cropping practices in major grain growing regions of Australia and to identify opportunities for research, development and extension to further develop widespread and sustainable use.

The study included a total of 1172 grain growers from 19 selected grain growing regions from Western Australia, South Australia, Victoria, New South Wales and southern Queensland. Based on a smaller survey conducted in 2003, phone interviews were conducted from March to July 2008. Of all potential respondents contacted nationally, 14 per cent refused to complete the survey.

Findings relating to the current status and no-till adoption trends include:

- the proportion of growers using no-till is starting to plateau near 90 per cent in many districts;
- rapid increases in adoption over the past 5 to 10 years have resulted in several regions with previously lower no-till adoption, increasing to levels similar to early-adopting regions;
- most growers who adopt no-till use it on a large proportion of their crop area;
- extensive and on-going use of no-till is being sustained. It is very uncommon for growers who start to use no-till to disadopt;
- it appears likely that adoption levels in a few slower to adopt regions will remain relatively lower with a substantial proportion of growers not expecting to adopt in the medium-term future;
- the use of disc openers remains relatively low, with the exception of the northern Australian cropping regions of NSW and southern Queensland; and
- higher glyphosate prices have led to many growers' increasing their use of tillage in some regions but not all.

The interviews elicited data on a wide range of factors that can be associated with no-till use or non-adoption. These include farm characteristics, farmer characteristics and attitudinal variables, perceptions of specific effects and open-ended responses on the reasons for current adoption/non-adoption.

Common characteristics of non-adopters relative to no-till users included:

- less use of paid cropping advisors;
- a greater tendency to prefer livestock rather than cropping;
- a lower likelihood of having someone with higher education involved with managing the farm;
- a smaller increase in arable area managed over the past 10 years;
- less herbicide resistance;
- older seeding machinery; and
- less likely to perceive that using no-till with stubble retention will: increase the economic value of the land; increase moisture retention; increase wheat yields; increase reliability of wheat yields; result in less rain needed for reliable seeding; lower fuel costs.

In the medium term at least, there will still be a few regions with a combination of relatively lower no-till adoption levels and lower extent of use. As for most technologies, this is not unexpected. Differences in the relative advantage of technologies in different environments will affect both the rate of adoption and final adoption levels.

By profiling adopters and non-adopters at the regional level, some possible opportunities for research, development, extension and expertise to accelerate adoption through learning have been identified. However, as the growers with the current intention to adopt do so, the population of non-adopting growers becomes fewer and more distinct. In some regions, new and innovative approaches to promoting no-till adoption are likely to be needed if no-tillage cropping is to reach the high level of use already observed in many regions.

The ongoing adoption and lack of disadoption across diverse regions has further confirmed that no-till systems can be highly adaptable and adoptable. Extensive use has also so far been sustained across a wide range of regions. The no-till 'revolution' across diverse Australian cropping landscapes has been highly successful but is not yet complete.

PHOTO: EVAN COLLIS

1. BACKGROUND

Reduced soil disturbance through no-till and conservation farming methods is seen as a key practice change that has led to greater profitability, sustainability and reduced environmental impact in the Australian cropping belt. As well as the private economic gains to grain growers, the reduction in wind erosion can have significant public benefits (for example, Williams and Young 1999). Previous national studies have shown that adoption of these soil-conserving practices has been recognised as very high in many regions but remained relatively low in others, including regions particularly susceptible to wind erosion.

This study expands on a socio-economic study of no-till adoption conducted in 2003 (see D'Emden & Llewellyn 2006; D'Emden et al 2008) which focused largely on South Australian and Western Australian cropping districts. This 2008–09 study has been expanded to include selected cropping regions across WA, SA, Victoria, NSW and southern Queensland.

The main objectives are to identify no-till adoption trends across cropping regions and identify opportunities for research, extension and policy to facilitate farming systems change for both private and public good. In this report, summary statistics and trends are presented together with analyses of farm and farmer characteristics of adopters and non-adopters across states and regions. Implications for research, extension and policy aimed at no-till adoption and soil conservation are discussed.

The study identifies region-specific factors influencing the current and future extent of the use of conservation farming practices and the potential to specifically target research, development and extension activities to achieve more rapid adoption.

2. AIMS

The overall aims of the study are:

- to utilise practice use and socio-economic data collected from Australian grain growers to identify levels and trends in adoption of no-till and conservation farming practices across cropping regions;
- to identify factors influencing decisions to adopt, not adopt or disadopt no-till and conservation farming practices; and
- to provide recommendations for research, development and extension (R, D & E) and policy.

3. METHODS

The study follows on from a smaller 2003 study conducted in a limited range of predominantly SA and WA cropping regions (see D'Emden & Llewellyn 2006; D'Emden et al 2008). To allow results to be compared, the 2008 questionnaire was largely based on selected questions from the 2003 study and used a similar methodology. The survey was developed in consultation with farming systems and no-till experts from across the Australian cropping belt, including the South Australian No-till Farmers Association, Western Australian No-till Farmers Association, Department of Agriculture and Food Western Australia and CSIRO.

3.1 Regions

Regions were identified using clusters of Statistical Local Areas (SLAs – which are typically aligned with local government boundaries) in consultation with local farming systems experts in each state. The regions of SA and WA used in the previous survey were used again in this survey as well as the additional regions of Victoria, NSW and southern Queensland. Growers were contacted randomly from the database compiled for each region. It should be noted that each SLA in each region is not equally represented. There was no set target number of respondents for each SLA, only a set target for each region comprising a cluster of SLAs. Low grain grower numbers (but large property sizes) in the SLAs identified for the NSW Mallee led to an exceptionally small sample size for that region (11). Where results from this region have been presented the low sample size needs to be kept in mind. In several cases results have not been presented from his region because of the limitations of such a small number of observations.

It should be noted that the set of regions selected in each state were not intended to be representative of all cropping areas in the state. For example, cropping regions where no-till practices have not been widely adopted were of particular interest and were therefore more likely to be chosen, whereas higher rainfall regions on the margin of the cropping belt were less likely to be included. For this reason, the state averages presented in this report are not intended to be representative of cropping practices across the whole state but are simply unweighted averages of all respondents from that state.

3.2 Data collection

The surveying began in April 2008 and all call backs were completed by early July 2008. Data was gathered from 1172 respondents from the specified regions shown in Table 1, Figure 1 and Figure 2. Data were collected from a primary cropping decision maker in each household and only farms cropping greater than 200 hectares in a 'normal' season were included. In the regions that were part of the 2003 survey, some extra effort was made to contact as many of the 2003 respondents as possible. Respondents from 2003 were randomly selected at the time from a similar agricultural contact database. The farmer interviews in 2008 were performed by Solutions Research using their extensive farm contact database with the aim of achieving the most representative sample of grain growers as possible.

A phone interview was used due to the higher response rates usually achieved with this method compared to mail-out surveys. A high response rate helps to reduce self selection bias (for example, where characteristics of respondents are biased towards those with an interest in the subject). Of all households contacted, 14 per cent refused to complete the survey. Forty-nine per cent of first calls to households led to an invitation to call back as the primary cropping decision maker was unavailable to take part in the survey at the time of the first call. Thirty-seven per cent of all households first contacted led to a complete usable response by a primary cropping decision maker.

For regions where recent comparable data on no-till adoption was available, results from state-based studies have been compared to the results of this study as a check. A study of Victorian Mallee growers (RMCG Consultants 2008) showed that 76 per cent of their sample used some no-till seeding in 2007 compared to 75 per cent reporting having used some no-till in this study and a cropping intensity of 77 per cent in 2007 compared to a 72 per cent 3-year average reported in this study. A 2008 South Australia-wide study (Forward 2008) showed that 67 per cent of their sample, including high-rainfall zones that were not part of this study, reported using some no-till in 2007 compared to 76 per cent of SA respondents reporting expected no-till use in 2008 in this study. Recent ABS Data (ABS, 2009) on land management practices also provided some opportunity for comparison although much larger and diverse natural resource management regions were used, respondents were not restricted to grain growers with a substantial crop area, and different tillage definitions were used with the ABS also including pasture establishment. In the regions where comparisons are most possible based on geography, the differences in estimated per cent area established without prior tillage (based on results presented in Table 8) were: NSW Central West 1 per cent; Vic Mallee 6 per cent; SA Eyre Peninsula (using average of EP regions) 3 per cent; WA Northern 5 per cent. Although not directly comparable in terms of region, sample and definition, the data available suggests an encouraging level of consistency.

3.3 Definition of no-till

A relatively broad definition of no-till seeding was used in the study based on seeding with low soil disturbance and no prior cultivation. This was the same definition used in the 2003 study. No-till was defined early in the questionnaire as including sowing techniques using either zero-till with disc machines, knifepoints, super-seeder, or inverted-t equipment, provided that they were used with no prior cultivation.

3.4 Statistical analysis

Statistical tests were used to compare differences between no-till users and non-users based on their use of no-till in 2008 (Section 4.8). The questionnaire involved a range of data types including continuous, binary, categorical and ordinal variables. This required a range of statistical tests including non-parametric methods.

Where possible t-tests were used, however much of the continuous data did not meet criteria for normal distribution. Where possible, transformations were made to allow t-tests. In other cases non-parametric tests were employed such as Kolgmorov-smirnov tests for equality of distributions and K-sample median tests.

Pearson chi-square tests were used for most binary and categorical data. For analysis of some regional data, some merging of response sets was performed (for example, more and a lot more) to allow adequate observation numbers per category.

Where differences between adopters and non-adopters at the regional level were statistically significant, this is reported in the text indicated by * P<0.1; **P<0.05 and ***P<0.01.

To allow data to be presented consistently and succinctly for ease of interpretation, means have generally been presented. Therefore, in some cases, means are presented where the statistical test used a median-based method. For binary and other categorical data, not all categorical response proportions are always shown.

Low observation numbers in the NSW Mallee meant that statistical tests could not be performed on that region. WA regions were clustered into three main regions (Table 1) to increase observation numbers. This allowed WA Central to be included in the statistical analyses but not WA Northern or Southwest due to the low number of non-users. Because of the relatively low proportion of growers who have not adopted use of at least some no-till and therefore the low number of 'non-adopter' observations in most regions, most results are presented by state. Those using some no-till in 2008 (see Table 2) have been classified as a no-till user. The number of no-till users and non-users based on this classification are:

State	Users	Non-users
NSW all	255	73
(NSW Northern)	120*	26*
QLD (Southern)	88	35
SA	225	71
VIC	162	54
WA	184	24
All respondents	914	257

* These figures are also included in NSW all.

In many cases the ability to statistically test differences at the regional level was limited by the low number of non-users and some care should be taken in interpreting results. A low number of observations in a region may be the reason why a difference was not found to be significant and therefore not presented in the tables.

Logistic regressions of selected variables to explain no-till adoption and extensive use have been conducted. The extensive use measure was designed to capture growers using no-till to establish practically their entire cropping program (>90 per cent of the 2008 crop). Due to the generally high proportion of adopters across the sample, the analyses are largely focused on explaining extensive use of no-till and factors influencing adoption in the lower-adopting regions.

FIGURE 1 Location of target regions based on ABS Statistical Local Areas (NB: not all SLAs labelled).

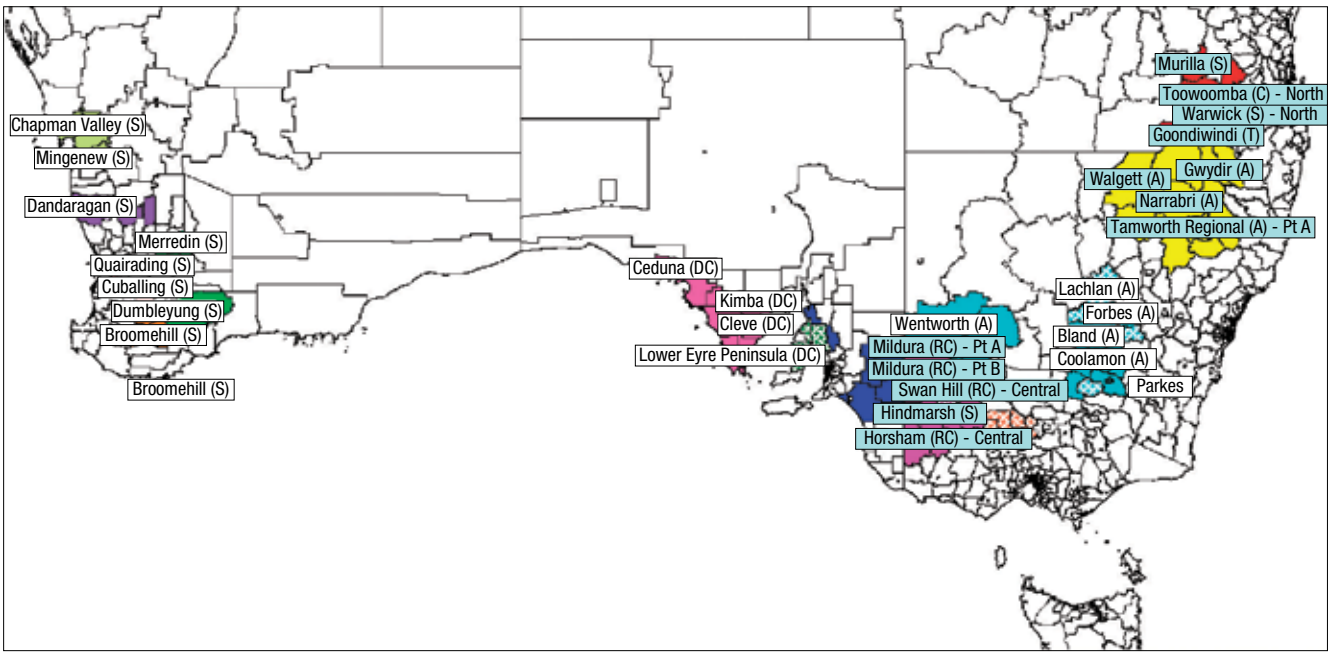


FIGURE 2 Distribution of respondents based on ABS Statistical Local Areas (SLA)

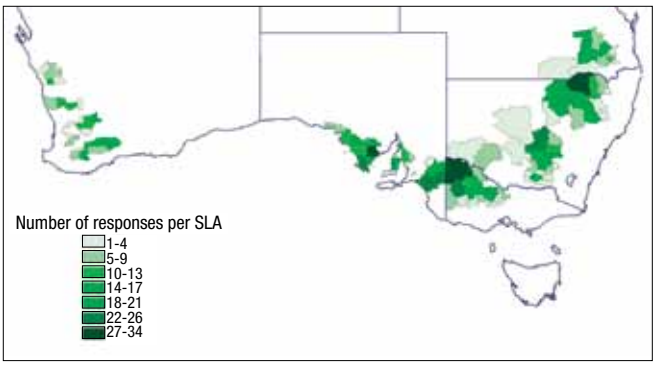


Table 1 Sample Regions, respondent numbers and Statistical Local Areas. Alternative classification of WA regions into Northern[N], Central[C] and Southwest[SW] as indicated.

State	Regions	Respondents	Statistical Local Areas
NSW	NSW Central West	81	Lachlan; Forbes; Weddin; Bland
	NSW Mallee	11	Wentworth; Balranald
	NSW Northern	146	Moree Plains; Gwydir; Narrabri; Walgett; Coonamble; Tamworth; Liverpool Plains;
	NSW Southern	90	Urana; Lockhart, Wagga; Junee; Coolamon; Narrandera; Temora;
	All NSW	**328**	
QLD	Southern	123	Waggamba, Tara, Murilla, Wambo, Dalby, Toowoomba, Cambooya, Clifton, Warwick N. Goondiwindi
SA	SA Central	60	Clare and Gilbert Valleys; Yorke Peninsula N-Wakefield-Burunga West; Pt Pirie Districts
	SA Lower EP	50	Lower Eyre Peninsula DC; Tumby Bay DC;
	SA Mallee	90	Loxton-Waikerie West and East; Karoonda East-Murray, Southern Mallee, Coorong
	SA Upper EP	56	Kimba DC; Cleve DC; Le Hunte DC;
	SA Western EP	40	Elliston DC; Streaky Bay DC; Ceduna DC;
	All SA	**296**	
VIC	VIC Loddon	66	Loddon, Ganawarra, Campaspe, Greater Bendigo
	VIC Mallee	80	Mildura, Swan Hill(s), Buloke N,Yarriambiack N
	VIC Wimmera	70	West Wimmera; Horsham, Hindmarsh, Yarriambiack S, Buloke S
	All Vic	**216**	
WA	WA Northern[N]	25	Mingenew, Morawa, Mullewa and Chapman Valley
	WA Midlands (NE)[N]	34	Wongan-Ballidu, Dalwallinu, Dandaragan, Koorda, Moora
	WA Central / Eastern[C]	44	Quairading, Kellerberrin, Merredin and Bruce Rock
	WA SE Central[C]	34	Kent, Dumbleyung and Lake Grace
	WA Upper Great Southern[SW]	37	Tambellup, Katanning, Broomehill; Woodanilling; Kojonup
	WA Western Central[SW]	29	Wagin, Williams, Wandering, Narrogin and Cuballing
	All WA	**209***	
	TOTAL	**1172**	

* This figure includes six WA growers located in regions not listed

4. RESULTS AND DISCUSSION

4.1 Adoption of no-till

The total proportion of growers who have previously used some no-till at the time of the survey is shown in Table 2. This also shows the proportion of growers who reported in 2008 that they had first used some no-till prior to 2004.

The cumulative adoption patterns for Victoria, NSW, Queensland Southern, SA and WA are shown in Figures 3 to 6 respectively, and adoption patterns for each state and region are compared in Figures 7 and 8 respectively. It should be noted that Figures 3 to 8 only take into account the cumulative proportion of growers who have decided to try some use of no-till. They do not take into account potential disadoption or extent of use once adopted. This is discussed in the following section.

It should also be noted that the times of first no-till use represented in the Figures are based on respondent recall and should therefore be considered approximate, particularly for early times of adoption. It also should be noted that the figures represent the time of first use of some no-till by the current farming population. For example, the total farming population a decade ago was different to the farming population now with many growers having left the industry. Therefore, the percentage of growers using some no-till reflected in the figures may not reflect the percentage of no-till adoption observed at the time.

Figures 3 to 8 generally show the characteristic adoption pattern, with features of a period of slow adoption preceding an acceleration of adoption, and an eventual slowing of the adoption rate as the total adoption approaches a likely plateau. One of the most important features of these cumulative adoption curves is the rapid increase in adoption over the past decade in regions that had relatively lower adoption at the start of the decade such as the Mallee regions and Lower and Upper Eyre Peninsula.

Many of the differences between regions and states 10 years ago appears to have been a reflection of time lags in the diffusion process, particularly the timing of the surge in which most middle-majority adopters began using the practice. This narrowing of differences becomes even more

Continued on page 12

Table 2 Proportion (%) of respondents who have used, currently use and are planning to use no-till

State	Region	Used no-till prior to 2004	Using no-till in 2008	Have used no-till
NSW	**All**	**72**	**78**	**85**
	Central West	56	62	72
	Mallee	18	45	45
	Northern	79	82	90
	Southern	83	89	92
QLD	Southern	78	72	85
SA	All	60	76	79
	Central	65	85	87
	Lower EP	70	84	86
	Mallee	50	70	74
	Upper EP	71	84	86
	Western EP	48	55	63
VIC	**All**	**60**	**75**	**81**
	Loddon	74	77	86
	Mallee	40	68	75
	Wimmera	69	81	83
WA	**All**	**81**	**88**	**89**
	Central/Eastern	80	88	88
	Midlands	82	94	94
	Northern	84	92	92
	SE Central	77	77	83
	Upper Great Southern	78	86	89
	Western Central	90	93	93
All respondents		**69**	**78**	**83**

Table 3 Proportion (%) of no-till users using disc openers, points and both disc openers and points in 2008

State	Region	Disc openers only	Points only	Disc openers and points
NSW	**All**	**13**	**74**	**13**
	Central West	14	82	4
	Mallee	0	100	0
	Northern	22	55	23
	Southern	1	95	3
QLD	Southern	36	40	24
SA	**All**	**4**	**88**	**8**
	Central	8	82	10
	Lower EP	5	88	7
	Mallee	3	87	10
	Upper EP	2	92	6
	Western EP	9	91	0
VIC	**All**	**6**	**90**	**4**
	Loddon	14	80	6
	Mallee	2	94	4
	Wimmera	4	95	2
WA	**All**	**4**	**91**	**5**
	Central / Eastern	4	95	2
	Midlands	3	88	9
	Northern	4	83	13
	SE Central	7	89	4
	Upper Great Southern	6	91	3
	Western Central	4	93	4
All respondents		**12**	**88**	**10**

FIGURE 3 Cumulative adoption of no-till (decision to first use no-till) across Victorian study areas

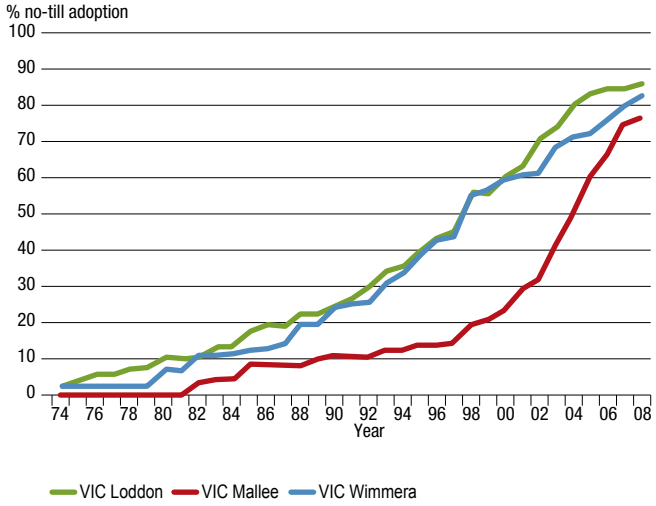


FIGURE 4 Cumulative adoption of no-till (decision to first use no-till) across NSW and the Queensland study area. NB: NSW Mallee has only a small sample size.

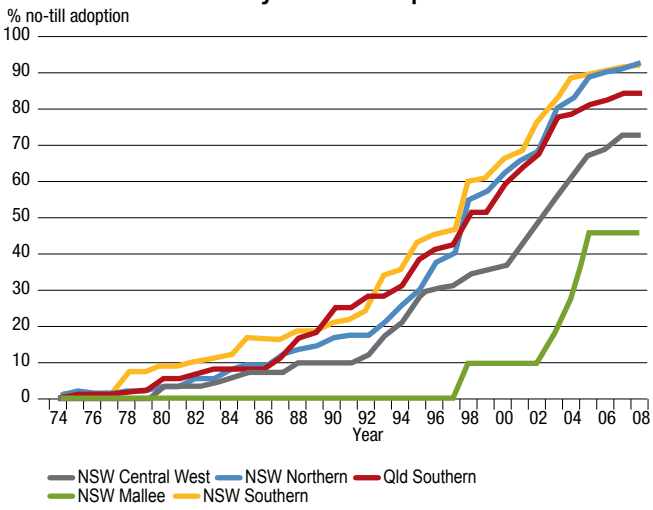


FIGURE 5 Cumulative adoption of no-till (decision to first use no-till) across SA study areas

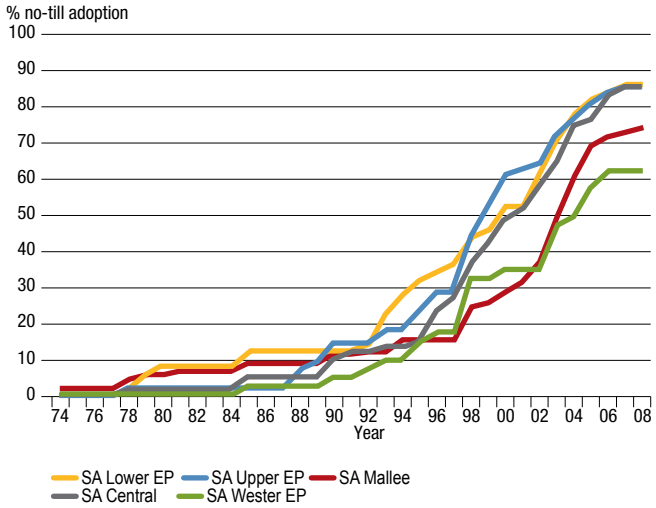


FIGURE 6 Cumulative adoption of no-till (decision to first use no-till) across WA study areas

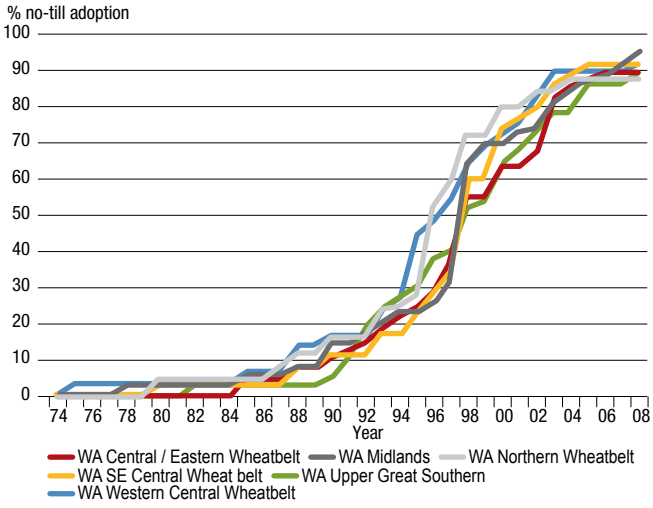


FIGURE 7 Cumulative adoption of no-till (decision to first use no-till) by respondents classified by state

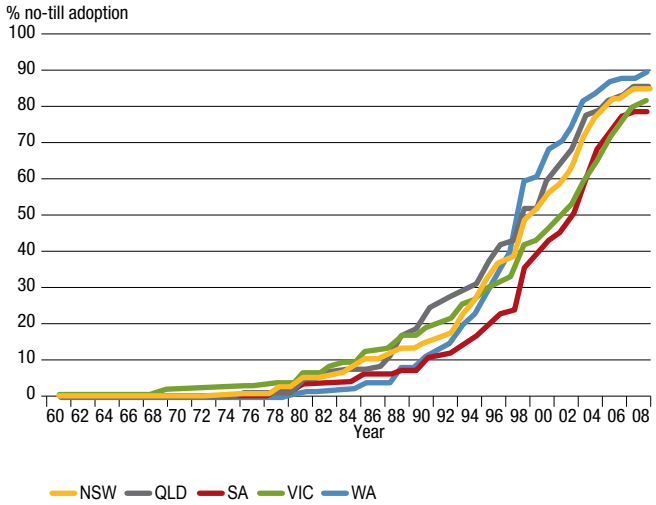
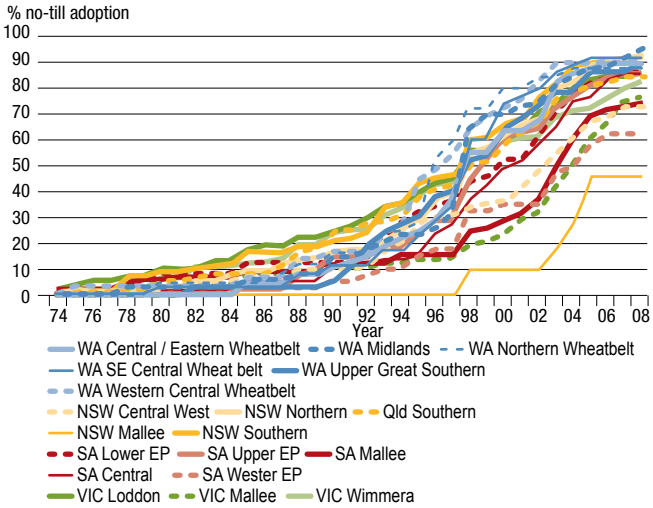


FIGURE 8 Cumulative adoption of no-till (decision to first use no-till) across all study areas



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evident when comparing expected adoption rates in 2013 (Table 4). For example, the dramatic differences between no-till adoption in the selected WA and SA regions in the late 1990s where WA adoption rates were almost double the adoption rates in SA was largely a result of the major surge in no-till adoption occurring earlier in WA and later in SA. However, it is clear that some significant differences between peak regional adoption rates are likely to remain (see Tables 2 and 4).

Another important feature of the curves is that following the adoption of no-till by the innovators and early adopters, adoption has increased substantially in all districts. The results provide evidence that the experience and observation of the first adopters in all of these diverse districts has led, or will lead, to the majority of growers trying no-till.

In terms of the equipment used by the respondents, the vast majority of no-till is performed using narrow points with the exception of the northern (summer) cropping regions (northern NSW and southern Queensland) where disc seeding is common (Table 3).

4.1.1 Peak no-till adoption and disadoption

Overall large increases in no-till adoption have been experienced since 2003 with high levels of growers using no-till to establish crops in 2008 (Table 2).

Table 4 shows the proportion of growers who expect to be using no-till in 2013, five years from the time of survey, based on their stated expectation. The results show that overall the proportion of adopters is expected to increase over the next five years. The only area showing a net reduction in the proportion of growers using some no-till from 2003 to 2008 (Table 2) was Queensland Southern. This small reduction is likely to be seasonally related rather than a strong ongoing trend to disadoption. Table 4 shows a level of adoption expected in 2013 of at least 80 per cent in Queensland Southern and no stated expectation of disadoption among current users.

Figures 3 to 8 together with Table 4 give an indication of where adoption is currently reaching a plateau and at what level that plateau might be. The results indicate that in several regions, no-till adoption is likely to peak at around 90 per

Table 4 Proportion (%) of all respondents and current (2008) users of no-till who state they do (and do not) expect to be using no-till in 5 years' time (2013). Balance of responses were 'don't know'.

State	Region	All respondents		Current no-till users	
		Yes	No	Yes	No
NSW	**All**	**81**	**11**	**92**	**2**
	Central West	69	17	96	2
	Mallee	82	18	100	0
	Northern	83	8	89	2
	Southern	90	2	94	1
QLD	Southern	80	8	92	0
SA	**All**	**78**	**12**	**94**	**0**
	Central	83	8	96	0
	Lower EP	84	8	95	0
	Mallee	74	12	92	2
	Upper EP	88	9	98	0
	Western EP	60	23	82	0
VIC	**All**	**78**	**9**	**91**	**2**
	Loddon	86	6	98	0
	Mallee	76	10	91	0
	Wimmera	71	11	86	2
WA	**All**	**86**	**6**	**92**	**2**
	Central/Eastern	86	4	91	0
	Midlands	74	6	78	3
	Northern	92	4	100	0
	SE Central	81	14	93	3
	Upper Great Southern	87	5	94	3
	Western Central	97	0	100	0
All respondents		**80**	**9**	**92**	**2**

Table 5 Proportion (%) of growers who have used some no-till who have reduced the proportion of crop sown using no-till (Reduced NT) and the proportion of growers who have used some no-till who have ceased using no-till (Ceased NT)

State	Region	Reduced No-till	Ceased No-till
NSW	**All**	**12**	**5**
	Central West	14	9
	Mallee	0	0
	Northern	13	6
	Southern	11	2
QLD	Southern	10	10
SA	**All**	**9**	**3**
	Central	6	2
	Lower EP	7	5
	Mallee	13	3
	Upper EP	10	0
	Western EP	8	4
VIC	**All**	**12**	**5**
	Loddon	23	4
	Mallee	8	12
	Wimmera	5	0
WA	**All**	**4**	**2**
	Central / Eastern	2	2
	Midlands	6	0
	Northern	0	0
	SE Central	3	3
	Upper Great Southern	6	3
	Western Central	4	0
All respondents		**10**	**5**

cent of growers using no-till. While the cumulative adoption curves in Figures 3 to 8 show a relatively low number of new adopters over the widespread drought years 2006–07, results of expected no-till use in 2013 shown in Table 4 indicate that adoption is yet to fully plateau in many regions. The proportion of no-till adopters ceasing use of no-till is low (Table 5) and very few current no-till adopters state that they will not be using no-till in 2013 (Table 4). The low level of disadoption is again emphasised by the finding that only 4.6 per cent of all growers who have ever used some no-till indicate that they no longer use some form of no-till.

While it is expected that some respondents will tend to state 'don't know' when presented with a 2013 scenario, in some regions such as the WA Midlands and SA Western EP, a particularly high proportion of respondents stated they 'don't know' their expected tillage practices in 2013 despite high adoption levels in 2008. The reason for the regional differences in the 'unsure' responses is not clear; however it is possible that it reflects differences in general farm business uncertainty and not just differences relating to future tillage practices.

The no-till adoption results clearly indicate that in most regions there are relatively few growers who have made the decision not to adopt no-till. In general, the vast majority of growers have either already adopted or have the intention to adopt over the next five years. However, there are several regions such as SA Western EP and NSW Central West with a notably higher proportion of growers stating that no-till is not expected to be used on their farm in the next five years (Table 4). This suggests that there are some regions where relying on current ongoing diffusion processes is not likely to result in the 85 to 90 per cent adoption levels that have already been achieved or are expected to be reached in other regions.

4.2 Extent of use

Results in section 4.1 only refer to use of no-till on some area of the farm as a binary (Yes/No) variable. On average, no-till users tend to use no-till for a high proportion of their cropping program (Table 6). However, a substantial proportion of no-till users in many areas still use cultivation to establish crops on some of their land, that is a pass involving full soil disturbance

Table 6 Average proportion (%) of crop area sown using no-till in 2008 by growers using no-till; proportion of no-till users sowing entire crop area with no-till in 2008; and proportion of expected future no-till users (2013) who expect to sow entire crop area

State	Region	Average proportion (%) of crop sown no-till 2008	Proportion (%) of no-till users sowing entire crop no-till 2008	Proportion (%) of no-till users expecting to sow entire crop no-till 2013
NSW	**All**	**77**	**44**	**58**
	Central West	73	42	63
	Mallee	-	-	-
	Northern	79	48	62
	Southern	75	35	44
QLD	Southern	75	43	49
SA	**All**	**83**	**60**	**64**
	Central	89	69	80
	Lower EP	93	76	83
	Mallee	70	40	48
	Upper EP	88	66	65
	Western EP	82	55	42
VIC	**All**	**80**	**51**	**56**
	Loddon	75	33	42
	Mallee	81	65	70
	Wimmera	83	54	54
WA	**All**	**92**	**78**	**84**
	Central Eastern	89	70	83
	Midlands	92	81	93
	Northern	92	70	74
	SE Central	84	63	79
	Upper Great Southern	96	84	91
	Western Central	100	100	93
All respondents		**82**	**54**	**65**

Table 7 Proportion (%) of respondents using seeding methods other than no-till in 2008.

State	Region	Prior cultivation with no-till seeding[1]	Full-cut seeding[2]	Full-cut seeding with prior cultivation[3]
NSW	**All**	**38**	**8**	**28**
	Central West	28	14	43
	Mallee	27	9	45
	Northern	36	5	25
	Southern	49	7	18
QLD	Southern	33	15	36
SA	**All**	**27**	**10**	**27**
	Central	20	7	22
	Lower EP	16	2	22
	Mallee	39	11	33
	Upper EP	21	9	20
	Western EP	30	23	35
VIC	**All**	**29**	**14**	**31**
	Loddon	44	17	32
	Mallee	19	15	34
	Wimmera	27	10	26
WA	**All**	**17**	**6**	**12**
	Central / Eastern	18	6	20
	Midlands	15	6	6
	Northern	28	8	4
	SE Central	29	6	23
	Upper Great Southern	14	5	8
	Western Central	3	3	0
All respondents		**29**	**10**	**26**

1. Low disturbance points or disc openers with prior cultivation
2. Full-cut seeding (e.g. using sweeps) with no prior cultivation (i.e. direct drill)
3. Full-cut seeding with prior cultivation

(Table 7). In WA, where adoption is currently highest, the extent of no-till use by adopters is also highest. In five years time, it is expected that a majority of no-till users will still be using some cultivation in several regions (Table 6).

No-till users were asked if they had generally reduced the proportion of crop sown using no-till, seasonal variation aside. Table 5 shows that relatively few growers have chosen to generally reduce their extent of use. In WA, where no-till has been extensively practiced over the longest period, there was the smallest proportion of growers indicating that they have reduced their use of no-till. The relatively high proportion of growers stating reduced use in Vic. Loddon needs further local investigation.

4.3 Extrapolated regional extent of tillage methods

A relatively crude indicator of the extent of tillage use at a regional scale is presented in Table 8 and should only be used as a guide to the extent of use at the landscape scale. The farm-level data on the extent of tillage methods used in each region was extrapolated using the Australian Bureau of Statistics (ABS) Agricultural Commodities Small Area Data on land use. State-based averages are not shown due to not all regions within each state being sampled.

The estimates for each region were calculated by simply multiplying the sum of all individual areas of a particular tillage method within a region by the inverse of the sampling proportion for that region, as represented by the following formula:

Where:	$1/s \times \Sigma_i(ti \times ai)$
	s = sample % of ABS-estimated total regional cropping area[4]
	ti = individual proportion of crop sown using tillage method
	ai = total individual cropping area

Regions within Western Australia generally had the highest estimated proportions of no-till.

4.3.1 Glyphosate price and extent of use

Previous studies identified that the falling price of the predominant pre-seeding knockdown herbicide, glyphosate (relative to diesel price) had a significant positive effect on no-till adoption rates in southern Australian cropping areas (D'Emden et al 2006). In 2007–08, the downward price trend rapidly reversed and glyphosate prices increased substantially. Growers were asked in this survey whether the increase in glyphosate price had caused them to use more tillage, less tillage, or caused no change. Results are shown for all growers in Table 9.

Overall, 21 per cent of no-till users reported increased use of tillage as a result of increased glyphosate prices (72 per cent reporting no change and 7 per cent reporting less tillage), compared to 32 per cent of non-users reporting increased use of tillage as a result of increased glyphosate prices (61 per cent reporting no change and 7 per cent reporting less tillage).

4. Cat no. 7125.0 - Agricultural Commodities: Small Area Data, Australia, 2006-07. For explanatory notes see: www.abs.gov.au/ausstats/abs@.nsf/exnote/7125.0

The overall results indicate that increasing glyphosate prices have increased growers' use of tillage, but there is large variation between regions. Increases have occurred to a greater extent among non no-till users (who are likely to have used more tillage passes), but a substantial proportion of no-till users have also reported increased tillage use as a direct result of glyphosate price increases. In WA regions, where no-till adoption and extent of use is generally highest and long-established, glyphosate price increases had relatively little or no effect on reported tillage use.

4.4 Cereal stubble management

Table 10 shows the proportion of all growers in the study burning a proportion of their cereal stubbles. Across all regions, on average, those burning some stubble burnt 29 per cent of their stubble area.

Southern NSW had both a high proportion of growers using some burning (47%) and a high median proportion of cereal stubble area burnt by those growers (50%) (Table 10). WA Western Central also had an exceptionally higher

Table 8 Extrapolated area cropping land ('000 ha) sown using no-till, no-till seeding equipment with prior cultivation and full-cut seeding in 2008. Shown in parentheses as an estimated proportion (%) of ABS-estimated total 2006/-07 crop area.

State	Region	No-till	Full-cut seeding[5]	Prior cultivation with no-till seeding[6]	Full cut seeding with prior cultivation[7]
NSW	Central West	326 (49)	45 (7)	81 (12)	201 (30)
	Mallee	61 (53)	3 (2)	15 (13)	36 (31)
	Northern	1404 (74)	21 (1)	308 (16)	141 (7)
	Southern	536 (66)	59 (7)	127 (16)	85 (10)
QLD	Southern	407 (59)	49 (7)	115 (17)	97 (14)
SA	Central	647 (83)	28 (4)	45 (6)	63 (8)
	Lower EP	247 (81)	1 (0)	26 (9)	29 (9)
	Mallee	371 (54)	58 (8)	104 (15)	142 (21)
	Upper EP	397 (80)	16 (3)	44 (9)	37 (8)
	Western EP	216 (50)	57 (13)	58 (13)	95 (22)
VIC	Loddon	208 (65)	6 (2)	33 (10)	65 (20)
	Mallee	475 (63)	45 (6)	67 (9)	185 (24)
	Wimmera	644 (74)	36 (4)	67 (8)	111 (13)
WA	Central / Eastern	440 (86)	25 (5)	31 (6)	64 (13)
	Midlands	444 (82)	17 (3)	42 (8)	8 (1)
	Northern	534 (84)	11 (2)	90 (14)	1 (0)
	SE Central	541 (80)	15 (2)	77 (11)	84 (12)
	Upper Great Southern	173 (84)	17 (8)	4 (2)	11 (5)
	Western Central	199 (98)	2 (1)	3 (2)	0 (0)
All respondents		**8270 (71)**	**510 (4)**	**1338 (12)**	**1848 (16)**

5. Full-cut seeding (e.g. using sweeps) with no prior cultivation (i.e. direct drill)

6. Low disturbance points or disc openers with prior cultivation

7. Full-cut seeding with prior cultivation

proportion of all growers burning greater than 10 per cent of their cereal stubble area (45%).

Across all regions, 20 per cent of no-till users burnt some stubble and 28 per cent of non-users burnt some stubble.

4.5 Farm and farmer characteristics

A wide range of information was collected relating to farm and farmer characteristics including attitudinal and perception measures. This is presented here to provide background and context for the no-till adoption data presented for each region. Further analyses aimed at defining adopter and non-adopter characteristics by state and region are presented in later sections.

4.5.1 Farm characteristics

Mean total property size and arable area managed for each region is shown in Table 11, together with mean arable area managed 10 years ago. Using medians, the percentage increase in arable area managed since 1998 is also shown.

Changes and expectations in cropping intensity are shown in Table 12. Growers were asked to provide average cropping land proportions over the most recent three-year period, however, the figures may still be influenced by drought experienced in some of the regions such as those in WA.

Overall, growers in most regions expect to maintain similar levels of cropping intensity over the next five years. Exceptions include an expected decline in NSW Central West and what appears to be an expected return to typical cropping intensities in some Western Australian regions (Table 12).

The majority of farms in the study run some livestock (Table 13) including those in regions with very extensive no-till use. The Victorian Mallee and SA Central regions have a combination of smaller proportions of growers with some sheep and fewer farmers with sheep running more than 1000 head. Cattle are the most common livestock in the northern cropping regions of northern NSW and southern Queensland.

Table 9 Effect of recent glyphosate price increases on use of tillage as reported by growers (% of all growers)

State	Region	More tillage	No change	Less tillage
NSW	**All**	**36**	**57**	**7**
	Central West	38	52	10
	Mallee	55	36	9
	Northern	39	58	3
	Southern	28	63	9
QLD	Southern	37	57	5
SA	**All**	**16**	**75**	**9**
	Central	10	85	5
	Lower EP	6	78	16
	Mallee	29	64	7
	Upper EP	11	77	12
	Western EP	18	75	8
VIC	**All**	**25**	**67**	**8**
	Loddon	30	64	6
	Mallee	31	59	10
	Wimmera	13	80	7
WA	**All**	**6**	**91**	**3**
	Central / Eastern	4	94	2
	Midlands	12	88	0
	Northern	4	88	8
	SE Central	5	92	3
	Upper Great Southern	11	86	3
	Western Central	0	97	3
All respondents		**24**	**69**	**7**

Table 10 Proportion (%) of respondents who burn cereal stubble, average (and median) proportion burned by those burning cereal stubble and proportion of all respondents burning greater than 10% of cereal stubbles

State	Region	Growers burning some cereal stubble (%)	Median area of cereal stubble burned (%)	Proportion of all respondents burning ≥ 10%
NSW	**All**	**25**	**42**	**23**
	Central West	33	40	30
	Mallee	0	-	-
	Northern	10	30	8
	Southern	47	50	46
QLD	Southern	7	9	3
SA	**All**	**7**	**10**	**9**
	Central	23	10	17
	Lower EP	38	10	20
	Mallee	9	10	8
	Upper EP	2	-	-
	Western EP	3	-	-
VIC	**All**	**23**	**20**	**19**
	Loddon	30	23	27
	Mallee	9	10	6
	Wimmera	33	15	24
WA	**All**	**33**	**10**	**23**
	Central / Eastern	33	10	25
	Midlands	35	6	15
	Northern	24	10	12
	SE Central	23	10	16
	Upper Great Southern	32	10	22
	Western Central	55	18	45
All respondents		**22**	**20**	**12**

The proportion of farms reporting herbicide resistance varies greatly across regions, reaching as high as 74 per cent in the WA Northern and remaining relatively low in the lower rainfall regions of the central west NSW, SA Western EP and the Mallee regions (Table 13). Defined as where a herbicide that once worked is no longer effective enough on a weed to be worth using for its control, an overall majority of farms in this study have not reported a herbicide resistance problem of this severity.

4.5.2 Farm management characteristics

The proportion of farms with someone involved with managing the farm having completed a university degree or diploma is shown in Table 14. NSW was shown to have an overall higher proportion of farm managers with higher education compared to SA.

The SA Mallee is shown to have the lowest proportion of growers (23%) using a directly paid consultant for advice regarding cropping (Table 14). This is in contrast to the neighbouring Victorian Mallee which has one of the higher rates of crop consultant use (51%). Across all respondents in all states, 41 per cent were using a paid consultant for cropping advice.

The proportion of growers who have ever been a member of a no-tillage or conservation farming association is shown in Table 14. Queensland Southern is shown to have a substantially lower proportion of growers stating membership of a local farmer group looking at cropping issues in their district.

Table 15 shows the responses to hypothetical scenarios

Table 11 Mean farm size; mean arable area currently managed and 10 years ago and % increase in median arable area managed 1998 to 2008

State	Region	Property area (ha)	Arable area currently managed (ha)	Arable area managed 10 years ago (ha)	Increase in median arable area managed 1998-2008 (%)
NSW	NSW Central West	2921	2428	2327	11
	NSW Mallee	13035	6308	6723	25
	NSW Northern	4555	3275	2808	49
	NSW Southern	2031	1836	1480	28
	All	**3743**	**2773**	**2456**	**27**
QLD	QLD Southern	4424	1747	1346	24
SA	SA Central	1691	1456	1137	36
	SA Lower EP	2466	1680	1389	20
	SA Mallee	2806	2549	2062	12
	SA Upper EP	3274	2866	2309	21
	SA Western EP	5744	3860	3001	21
	All	**3008**	**2418**	**1934**	**25**
VIC	VIC Loddon	2075	1907	1401	38
	VIC Mallee	3660	3090	2372	34
	VIC Wimmera	1790	1663	1366	18
	All	**2570**	**2272**	**1743**	**26**
WA	WA Central/ Eastern	4070	3557	2894	3
	WA Midlands	3766	3173	2999	5
	WA Northern	7277	5633	4617	37
	WA SE Central	3448	3099	2608	19
	WA Upper Great Southern	2686	2267	1810	36
	WA Western Central	2650	2112	1860	20
	All	**3858**	**3262**	**2746**	**20**
All respondents		**3434**	**2570**	**2128**	**27**

Table 12 Cropping intensity by region. Data shown is the mean proportion of land cropped as a percentage of arable land managed currently (as an average of most recent 3 seasons); 10 years ago and expected cropping intensity in 5 years time.

State	Region	Arable land cropped (3 year average) (%)	Arable land cropped 10 years ago (%)	Expected arable area cropped in 5 years time (%)
NSW	NSW Central West	62	47	49
	NSW Mallee	53	43	61
	NSW Northern	71	68	73
	NSW Southern	62	52	62
	All	**66**	**57**	**63**
QLD	Southern	74	73	77
SA	SA Central	80	72	77
	SA Lower EP	83	71	84
	SA Mallee	57	51	63
	SA Upper EP	73	60	74
	SA Western EP	66	54	63
	All	**70**	**60**	**69**
VIC	VIC Loddon	59	53	59
	VIC Mallee	72	59	76
	VIC Wimmera	73	65	71
	All	**68**	**59**	**69**
WA	WA Central/ Eastern	66	59	73
	WA Midlands	61	52	74
	WA Northern	67	67	79
	WA SE Central	61	49	63
	WA Upper Great Southern	51	47	53
	WA Western Central	53	36	73
	All	**60**	**52**	**68**
All respondents		**67**	**59**	**67**

relating to no-till and cropping versus livestock. When asked to think of their personal preference and choose between cropping or livestock, a majority in each state chose cropping (Table 15). NSW Central West was the only region with a majority preferring livestock. Regions with an exceptionally high proportion of growers preferring cropping were the WA Northern, Midlands, Central Eastern and the Victorian Mallee.

To gain an indication of perceived net long term value of no-till, stubble retention systems to the productivity of cropping land, growers were presented with a hypothetical scenario where they were considering the purchase of neighbouring land. They were asked whether they would be willing to pay more for land that had been cropped under no-till and stubble retention for the past 10 years compared to land that had had multiple cultivations and stubble burnt over the past 10 years (Table 15). The results show that overall approximately 50 per cent of respondents stated a willingness to pay more, with only SA Western EP and Vic Wimmera recording less than 30 per cent of growers with a positive willingness to pay. Only 3 per cent of growers overall stated a willingness to pay less for the no-till land, with no region having greater than 8 per cent willing to pay less.

Growers were asked to consider what proportion of their farm they considered prone to wind or water erosion if it was not managed carefully (Table 15). The region with clearly the lowest mean (and median) percentage of land stated to be in this category was WA Western Central (only means are presented). Other regions with both relatively low means (<35%) and low medians (≤15%) were

Table 13 Growers with livestock; the proportion of those with sheep typically having >1000 adult sheep typically run in winter and; the proportion of growers with an acknowledged herbicide resistant weed population on their farm

State	Region	Proportion of growers with some sheep (%)	Proportion of those with sheep having >1000 head (%)	Proportion of growers with some cattle (%)	Proportion of growers with herbicide resistant weed population on farm (%)
NSW	NSW Central West	75	67	30	14
	NSW Mallee	55	84	36	9
	NSW Northern	32	68	67	32
	NSW Southern	83	74	27	44
	All	**57**	**71**	**46**	**30**
QLD	QLD Southern	8	30	60	27
SA	SA Central	62	27	20	68
	SA Lower EP	72	42	10	54
	SA Mallee	85	54	29	34
	SA Upper EP	82	33	5	36
	SA Western EP	88	63	13	25
	All	**78**	**45**	**17**	**44**
VIC	VIC Loddon	89	68	14	35
	VIC Mallee	56	43	15	25
	VIC Wimmera	64	51	7	63
	All	**69**	**55**	**12**	**40**
WA	WA Central/ Eastern	89	74	12	51
	WA Midlands	79	67	21	53
	WA Northern	68	88	16	74
	WA SE Central	86	89	8	47
	WA Upper Great Southern	97	100	8	65
	WA Western Central	93	96	12	28
	All	**87**	**85**	**13**	**53**
All respondents		**65**	**63**	**28**	**39**

Table 14 Education and information-related characteristics

State	Region	Farms with manager with higher education (%)	Using a paid advisor for crop advice (%)	Member of a local farmer group that looks at cropping issues (%)	Ever been a member of a no-till or cons. farming group (%)
NSW	NSW Central West	40	26	44	23
	NSW Mallee	36	27	64	9
	NSW Northern	43	49	39	33
	NSW Southern	38	38	51	12
	All	**41**	**40**	**45**	**24**
QLD	QLD Southern	35	36	32	28
SA	SA Central	25	55	70	25
	SA Lower EP	14	58	40	34
	SA Mallee	24	23	58	30
	SA Upper EP	20	27	70	39
	SA Western EP	25	48	53	18
	All	**22**	**40**	**59**	**30**
VIC	VIC Loddon	39	29	52	17
	VIC Mallee	28	51	60	38
	VIC Wimmera	33	37	61	27
	All	**33**	**40**	**58**	**28**
WA	WA Central/ Eastern	26	51	67	30
	WA Midlands	29	38	35	32
	WA Northern	33	37	67	37
	WA SE Central	29	32	50	47
	WA Upper Great Southern	43	62	49	41
	WA Western Central	41	55	48	34
	All	**33**	**47**	**49**	**37**
All respondents		**33**	**41**	**50**	**29**

NSW Central West, Vic Wimmera and WA Central Eastern and WA Upper Great Southern. SA Mallee, SA Upper EP, Vic Mallee, WA Midlands and WA Northern had the highest mean proportion of land stated to be prone to erosion.

Table 16 shows the proportion of growers with older seeding machinery. Yield mapping and the use of variable rate fertiliser on identified paddock zones are included as indicators of adoption of relatively new cropping technologies in the regions (Table 16). The highest proportion of growers with at least one yield map was in WA Central Eastern and WA Northern and the lowest in Western EP. The use of variable fertiliser rates on identified zones is most commonly practiced in the Vic Mallee and SA Upper EP.

4.6 Stated reasons for no-till adoption and non-adoption

Reasons for adoption stated by current no-till users

Growers who had used no-till were asked to give the main reasons why they started using no-till for cropping. The open-ended responses have been categorised and presented in Tables 17 and 18. The results show that in all regions except those in the northern cropping zone, reasons relating to reduced fuel and labour costs at seeding (cost of seeding) and/or soil conservation (including erosion) were the most commonly stated. In NSW Northern and Queensland, soil moisture management was the more common reason given (Table 17).

Overall, the most commonly stated reason for no-till users increasing their extent of no-till use was reduced fuel and labour costs at seeding (cost of seeding), followed by soil

Table 15 Farmer orientation to crop Vs livestock; influence of no-till and stubble retention on land valuation an assessment of erosion risk

State	Region	Stated preference for cropping rather than livestock (%)	Growers stating a willingness to pay more for no-till stubble retained cropping land (%)	Mean proportion of farm described as prone to erosion if not managed carefully (%)
NSW	NSW Central West	47	40	32
	NSW Mallee	73	45	30
	NSW Northern	58	56	44
	NSW Southern	58	47	44
	All	**56**	**49**	**40**
QLD	QLD Southern	59	54	37
SA	SA Central	67	45	39
	SA Lower EP	78	38	40
	SA Mallee	58	49	51
	SA Upper EP	68	43	48
	SA Western EP	68	28	32
	All	**66**	**42**	**44**
VIC	VIC Loddon	61	42	38
	VIC Mallee	83	34	47
	VIC Wimmera	74	29	33
	All	**73**	**35**	**32**
WA	WA Central / Eastern	83	43	26
	WA Midlands	85	44	50
	WA Northern	96	40	52
	WA SE Central	76	38	34
	WA Upper Great Southern	51	54	25
	WA Western Central	55		
	59	12		
	All	**75**	**46**	**32**
All respondents		**65**	**45**	**39**

Table 16 Age of seeding machinery and adoption of other practices

State	Region	Main seeding machine ≥ 15 years old (%)	Have a yield map for a crop paddock (%)	Using variable rate fertiliser on identified paddock zones (%)
NSW	NSW Central West	23	19	20
	NSW Mallee	54	36	9
	NSW Northern	16	28	19
	NSW Southern	19	26	17
	All	**20**	**25**	**18**
QLD	QLD Southern	25	26	14
SA	SA Central	15	20	13
	SA Lower EP	20	32	20
	SA Mallee	30	17	23
	SA Upper EP	28	20	32
	SA Western EP	**39**	**8**	**15**
	All	**26**	**19**	**21**
VIC	VIC Loddon	27	24	20
	VIC Mallee	24	24	35
	VIC Wimmera	21	23	11
	All	**24**	**24**	**23**
WA	WA Central / Eastern	12	49	26
	WA Midlands	12	38	18
	WA Northern	20	44	15
	WA SE Central	18	26	18
	WA Upper Great Southern	18	41	16
	WA Western Central	14	14	28
	All	**15**	**37**	**20**
All respondents		**22**	**25**	**20**

conservation and soil moisture management.

Reasons for non-adoption stated by those who have not used no-till

Table 19 shows the most common reasons cited for non-adoption by those who have not used no-till. The generally high proportion of growers who have used no-till limits the ability to analyse stated reasons for non-adoption in each region. Only the four regions with the lowest level of adoption are shown (NSW Mallee is excluded due to a low number of observations).

The most common reasons cited for non-adoption fall into the non-specific category of 'lack of observed benefits'. This includes responses such as 'doesn't suit my farm' and 'happy with current method'. Other reasons cited included machinery constraints and weed control (including herbicide) concerns, particularly in SA Mallee and SA Western EP.

4.7 Perceived effects of no-till and stubble retention

All respondents were asked to consider a range of cropping-related factors and rate how they thought the long-term effects of no-till seeding with stubble retention would compare to the long-term effects of cultivation and full-cut seeding without stubble retention. The proportion of growers stating more (the sum of 'a little more' and 'a lot more') or less (the sum of 'a little less' and 'a lot less') for a range of agronomic factors are shown in Tables 20-23, with the balance of growers stating 'no-difference'.

In most regions 40 to 50 per cent of growers expected the no-till scenario to lead to more crop disease. Although not specified, disease was considered inclusive of root, stem and/or foliar diseases (Table 20). The northern cropping zone regions of NSW Northern and Queensland Southern were

Table 17 Reasons cited for adopting no-till (% of cited reasons)

	QLD Southern	NSW Central West	NSW Mallee	NSW Northern	NSW Southern
Fuel and labour costs	21	35	30	20	43
Soil conservation	22	19	50	22	19
Soil moisture management	41	11	10	33	15
Soil structure	5	11	-	9	11
Information and observed benefits	3	11	-	3	5
Weed control and herbicide use	5	5	-	2	1
Improved crop yields	2	3	10	7	3
Cropping frequency / timeliness	2	2	-	2	2
Seeding accuracy	1	2	-	2	1
	SA Central	**SA Lower EP**	**SA Mallee**	**SA Upper EP**	**SA Western EP**
Fuel and labour costs	28	32	32	30	35
Soil conservation	31	28	39	38	24
Soil moisture management	14	12	10	11	17
Soil structure	9	7	4	4	12
Information and observed benefits	5	4	7	3	3
Weed control and herbicide use	3	5	2	3	2
Improved crop yields	4	1	3	1	1
Cropping frequency / timeliness	4	9	3	3	1
Seeding accuracy	2	3	1	5	2

Table 18 Reasons cited for adopting no-till (% of cited reasons) (continued)

	WA Central / Eastern	WA Midlands	WA Northern	WA SE Central	WA Upper Great Southern
Fuel and labour costs	32	40	24	35	35
Soil conservation	26	23	38	25	18
Soil moisture management	26	13	11	23	12
Soil structure	6	4	4	-	9
Information and observed benefits	5	2	-	4	5
Weed control and herbicide costs	9	2	4	5	5
Improved crop yields	1	2	4	4	5
Cropping frequency / timeliness	-	9	7	5	5
Seeding accuracy	2	6	7	-	7
	WA Western Central	**Vic Loddon**	**Vic Mallee**	**Vic Wimmera**	
Fuel and labour costs	29	38	33	41	
Soil conservation	12	24	32	27	
Soil moisture management	14	17	12	19	
Soil structure	12	12	5	3	
Information and observed benefits	8	3	6	4	
Weed control and herbicide costs	8	2	7	2	
Improved crop yields	2	1	2	1	
Cropping frequency / timeliness	6	1	3	3	
Seeding accuracy	8	2	2	-	

Table 19 Reasons for non-adoption cited by those who have not used no-till (% of cited reasons). Only regions with ≤75% having used no-till included. NSW Mallee also excluded due to low observations.

	NSW Central West	SA Mallee	SA Western EP	Vic Mallee
Lack of observed benefits	56	39	43	47
Machinery constraints	16	18	14	18
Weed control	6	27	19	6
Fuel and labour costs	6	6	14	9
Soil moisture management	6	3	-	12
Soil structure	6	-	5	3
Soil conservation	3	3	-	-
Diseases	-	3	5	3

higher, with greater than 60 per cent of growers expecting more disease.

A high proportion of all growers expected the no-till scenario to result in greater soil moisture retention, though NSW Central West and Vic Mallee had notably lower proportions than other regions (Table 20). Overall, a vast majority of growers also expected the no-till systems to result in less soil erosion. The proportion was below 70 per cent in NSW Central West, SA Upper EP, SA Western EP and WA Upper Great Southern.

The proportion of growers expecting the no-till with stubble retention scenario to lead to higher average wheat yields over the longer term varied greatly between regions (Table 21). In Queensland Southern and WA Western Central, 72 per cent of growers expected higher yields. In the lower rainfall regions of NSW Central West, SA Mallee, SA Upper EP and SA Western EP, less than 40 per cent expected higher yields.

A minority of growers expected fertiliser costs to be higher under the no-till and stubble retention system,

Table 20 Perceived influence of long-term no-till with stubble retention relative to multiple cultivations and no stubble retention on crop disease, moisture retention and soil erosion

	Crop disease		Moisture retention		Soil erosion	
	Less	More	Less	More	Less	More
NSW Central West	21	58	17	67	63	10
NSW Mallee	18	55	18	55	55	0
NSW Northern	10	68	4	86	76	10
NSW Southern	12	47	7	82	82	7
NSW All	**14**	**59**	**9**	**79**	**74**	**9**
QLD Southern	7	63	3	86	74	7
SA Central	20	52	2	90	72	10
SA Lower EP	24	30	8	84	78	10
SA Mallee	22	41	2	77	80	4
SA Upper EP	21	41	9	75	66	14
SA Western EP	25	43	10	68	68	15
SA All	**22**	**42**	**5**	**79**	**74**	**10**
VIC Loddon	12	45	6	80	65	14
VIC Mallee	15	51	9	66	91	4
VIC Wimmera	11	43	9	76	70	4
VIC All	**13**	**47**	**8**	**74**	**76**	**7**
WA Central Eastern	11	45	0	89	80	4
WA Midlands	12	41	6	82	74	9
WA Northern	11	44	0	89	92	0
WA SE Central	9	50	6	76	77	3
WA Upper Great Sthn	14	49	8	84	65	19
WA Western Central	10	45	0	100	90	3
WA All	**11**	**46**	**3**	**87**	**78**	**7**

Table 21 Perceived influence of long-term no-till with stubble retention relative to multiple cultivations and no stubble retention on fuel costs, long-term wheat yields, reliability of wheat yields, fertiliser costs

	Fuel costs		Long-term wheat yields		Reliability of wheat yields		Fertiliser costs	
	Less	More	Less	More	Less	More	Less	More
NSW Central West	78	7	19	38	15	33	28	22
NSW Mallee	73	9	9	55	18	36	27	18
NSW Northern	80	16	5	64	7	66	16	33
NSW Southern	87	8	4	54	4	43	23	18
NSW All	**81**	**12**	**9**	**55**	**9**	**51**	**22**	**26**
QLD Southern	78	10	5	72	6	75	9	38
SA Central	83	7	2	62	2	50	18	25
SA Lower EP	76	16	6	62	2	62	20	32
SA Mallee	80	7	11	36	10	33	13	43
SA Upper EP	71	11	7	36	9	34	5	30
SA Western EP	70	13	10	38	13	40	10	22
SA All	**77**	**10**	**7**	**46**	**7**	**43**	**14**	**32**
VIC Loddon	70	18	3	53	11	38	18	32
VIC Mallee	83	10	6	45	10	36	15	31
VIC Wimmera	84	7	3	41	10	30	19	27
VIC All	**79**	**12**	**4**	**46**	**10**	**35**	**17**	**30**
WA Central Eastern	74	6	0	47	9	47	12	27
WA Midlands	74	6	3	62	6	65	12	24
WA Northern	85	4	4	44	4	44	8	24
WA SE Central	76	6	15	50	3	53	5	36
WA Upper Great Sthn	73	5	5	51	11	46	16	32
WA Western Central	76	10	0	72	0	72	28	14
WA All	**76**	**7**	**4**	**54**	**6**	**54**	**15**	**25**

although the proportion was near 40 per cent in the SA Mallee and Queensland Southern (Table 21).

Overall, a majority of growers expected the no-till system would require less rain to allow reliable seeding (Table 22). Only 35 per cent held this belief on SA Western EP.

The highest proportions of growers expecting that the no-till system would lead to greater herbicide resistance were in NSW Northern and Queensland Southern (Table 23). Growers tended to be divided over expectations of the effectiveness of pre-emergent herbicides under the two systems. Overall, more expected poorer performance under no-till with stubble retention. Growers in most WA regions and Vic. Mallee were more likely to expect pre-emergent herbicides like trifluralin to perform better under the no-till system. SA Western EP had very few growers expecting better performance under no-till (Table 23). Responses to this question may have been influenced by awareness of the trifluralin label recommendations for higher rates in conservation tillage systems.

Differences between no-till user and non-adopter responses are explored further in the next section.

4.8 Profiling adopters and non-adopters

In this section the characteristics of adopters and non-adopters of no-till are presented with the aim of identifying differences that may help in understanding no-till decision making and inform R, D & E planning.

Tables 24 to 34 show the results of statistical analysis testing differences in farm and farmer characteristics between no-till users and non-users in each state and most regions. Where differences were significant they have been included in the table. Also presented are significant differences in beliefs relating to the relative effects on the range of agronomic factors of no-till seeding with stubble retention compared to cultivation and full-cut seeding without stubble retention over the longer-term (see section 4.7).

The age of the main seeding machine on each farm was tested but not presented. In all states and tested regions, with the exception of Vic. Wimmera, no-till users had

Table 22 Perceived influence of long-term no-till with stubble retention relative to multiple cultivations and no stubble retention on days needed to sow crop, rain needed for reliable seeding and weed emergence

	Days needed to get crop in		Rain needed to allow reliable seeding		Weed emergence	
	Less	More	Less	More	Less	More
NSW Central West	33	16	47	16	42	16
NSW Mallee	9	27	36	9	45	27
NSW Northern	22	28	63	19	51	23
NSW Southern	64	6	49	14	48	26
NSW All	**36**	**19**	**54**	**17**	**48**	**22**
QLD Southern	28	30	68	17	51	24
SA Central	65	7	62	8	53	10
SA Lower EP	68	6	62	18	46	32
SA Mallee	62	6	51	14	49	21
SA Upper EP	54	13	52	13	34	34
SA Western EP	60	15	35	13	23	38
SA All	**62**	**8**	**53**	**13**	**43**	**25**
VIC Loddon	58	15	42	27	42	29
VIC Mallee	24	44	50	23	56	16
VIC Wimmera	46	16	57	10	24	33
VIC All	**41**	**26**	**50**	**20**	**42**	**25**
WA Central Eastern	68	2	55	13	38	34
WA Midlands	62	9	65	6	38	26
WA Northern	52	7	78	4	26	33
WA SE Central	68	12	71	9	44	26
WA Upper Great Sthn	54	5	62	11	46	32
WA Western Central	83	0	86	7	28	21
WA All	**64**	**6**	**68**	**8**	**37**	**29**

Table 23 Perceived influence of long-term no-till with stubble retention relative to multiple cultivations and no stubble retention on herbicide resistance, effectiveness of pre-emergent herbicide like trifluralin and herbicide costs

	Herbicide resistance		Effectiveness of pre-emergent herbicides		Herbicide costs	
	Less	More	Less	More	Less	More
NSW Central West	22	47	38	17	17	60
NSW Mallee	18	55	27	36	18	64
NSW Northern	8	75	45	18	10	80
NSW Southern	8	67	47	20	14	56
NSW All	**12**	**65**	**43**	**19**	**13**	**68**
QLD Southern	7	70	47	19	7	75
SA Central	13	55	43	13	10	73
SA Lower EP	10	62	38	20	8	82
SA Mallee	7	66	38	18	8	78
SA Upper EP	11	64	30	23	2	73
SA Western EP	15	55	40	8	10	85
SA All	**10**	**61**	**38**	**17**	**7**	**78**
VIC Loddon	14	44	50	21	6	58
VIC Mallee	8	68	38	34	9	79
VIC Wimmera	6	56	44	13	7	74
VIC All	**9**	**56**	**44**	**23**	**7**	**71**
WA Central Eastern	4	62	34	26	13	60
WA Midlands	12	50	35	32	9	50
WA Northern	15	59	30	44	11	78
WA SE Central	9	53	50	6	9	65
WA Upper Great Sthn	14	57	35	35	5	68
WA Western Central	7	62	34	28	7	79
WA All	**10**	**58**	**37**	**27**	**9**	**66**

Table 24 NSW all respondents – differences between current no-till users and non-users. Results presented only where significant differences were found.

State/ Region	Characteristic	Non-users	Users	Sig.
NSW All	Mean increase in arable area managed since 10 years ago (%)	27	45	**
	Pay a consultant for cropping advice (%)	23	44	***
	Stated preference for cropping rather than livestock (%)	42	60	***
	Have a herbicide resistant weed population (%)	14	35	***
	Have a yield map (%)	14	29	**
	Stated willingness to pay a premium (or penalty) for no-till-stubble retention cropping land (mean premium %)	2	8	***
	Ever been member of no-till or conservation farming association (%)	8	29	***
	Proportion (%) of growers with belief that no-till with stubble retention will lead to:			
	• More soil moisture retention	63	84	***
	• Less weed emergence	33	52	**
	• Higher long-term wheat yields	38	59	**
	• Less rain needed to allow reliable seeding	38	59	*
	• Higher reliability of wheat yields	38	54	*
	• Less soil erosion	52	80	***

Table 25 NSW regions – differences between current no-till users and non-users. Results presented only where significant differences were found.

State/ Region	Characteristic	Non-users	Users	Sig.
NSW Central West	Pay a consultant for cropping advice (%)	16	32	*
	Have a herbicide resistant weed population (%)	3	20	**
	Stated willingness to pay a premium (or penalty) for no-till-stubble retention cropping land (mean premium %)	-0.1	9	***
	Proportion of farm described as erosion prone if not managed carefully (mean %)	25	35	**
	Ever been member of no-till or conservation farming association (%)	10	32	**
	Proportion (%) of growers with belief that no-till with stubble retention will lead to:			
	• More soil moisture retention	52	76	***
	• Less weed emergence	29	50	*
	• Higher long-term wheat yields	26	46	*
	• Less soil erosion	42	76	*
NSW Northern	Pay a consultant for cropping advice (%)	27	54	**
	Stated willingness to pay a premium (or penalty) for no-till-stubble retention cropping land (median premium %)	0	10	***
	Stated preference for cropping rather than livestock (%)	42	62	*
	Have a herbicide resistant weed population (%)	19	35	*
	Variable rate fertiliser applied to paddock zones (%)	8	22	*
	Have a yield map (%)	8	33	**
	Ever been member of no-till or conservation farming association (%)	12	38	***
	Proportion (%) of growers with belief that no-till with stubble retention will lead to:			
	• Higher long-term wheat yields	42	68	**
	• Higher reliability of wheat yields	50	69	*
NSW Sthn.	Member of local farmer group looking at cropping issues in the district (%)	20	55	**

significantly newer seeding machinery by 4 to 8 years.

There was no significant difference between no-till users and non-users relating to the perceived relative effect of a no-till stubble retention system on herbicide costs and herbicide resistance in any state or region so these do not appear in the tables. Essentially, an equally high proportion of no-till users and non-users believed that herbicide costs and herbicide resistance would be higher under the no-till scenario described.

Comments on the results in the Tables 24 to 34 have been limited mainly to common results at the state level. However, it should be recognised that there are many region-specific differences between adopters and non-adopters.

No-till users have tended to have a greater increase in their arable area managed over the past 10 years than non-users. In Queensland Southern and Vic. Loddon, non-users have a particularly smaller arable area managed relative to no-till users. In other states and regions the difference is either not significant or much smaller.

There is an exceptionally strong association between the use of a cropping consultant and no-till adoption, with use often more than twice as common among no-till users.

A key finding is that in many states and regions a significantly higher proportion of non-users have a preference for managing livestock rather than cropping systems. For example 58 per cent of non-users in NSW regions would prefer livestock to cropping if able to choose one. In the SA Mallee, only 33 per cent of non-adopters of no-till prefer cropping over livestock. This compares to 70 per cent of no-till users.

Several perception-based variables indicate that many non-users have preconceived ideas that no-till systems are lower performing. While it is recognised that people who are adherents of a practice are more likely to speak favourably of, or promote, that practice, it also follows that non-users (of no-till) are less likely to expect production gains as a result of no-till systems.

Non-users are also much less likely to expect advantages of moisture retention and the ability to seed on less opening rain under a no-till system than no-till users. In many regions, adopters and non-adopters did not have significantly

Table 26 QLD region – differences between current no-till users and non-users. Results presented only where significant differences were found.

State/ Region	Characteristic	Non-users	Users	Sig.
QLD (Southern)	Arable area managed (ha)	1047	2025	***
	Pay a consultant for cropping advice (%)	23	41	**
	Stated willingness to pay a premium for no-till-stubble retention cropping land (mean %)	3	11	***
	Proportion of farm described as erosion prone if not managed carefully (mean %)	22	41	**
	Proportion (%) of growers with belief that no-till with stubble retention will lead to:			
	• More soil moisture retention	74	91	***
	• Less weed emergence	29	60	***
	• Higher long-term wheat yields	49	81	***
	• Less rain needed to allow reliable seeding	51	75	**
	• Higher reliability of wheat yields	54	83	***
	• Lower fuel costs	63	84	**

different perceptions of the ability of the no-till with stubble retention system to reduce soil erosion. However, in NSW Central West, SA Mallee and VIC Wimmera, a substantial proportion of non-users expressed the belief that no-till with stubble retention would not lead to less erosion than a system with multiple cultivations and stubble burnt over the longer term.

While users and non-users generally did not have differences in beliefs about the likelihood of herbicide resistance or higher herbicide costs, overall, it was more common for no-till users to expect less weed emergence under no-till with stubble retention systems. SA Western EP was the only region where non-users were much more likely than users to expect pre-emergent herbicides to be less effective under no-till and stubble retention.

As expected, joining a no-till or conservation farming group is widely and very strongly associated with no-till adoption.

Table 27 SA all respondents – differences between current no-till users and non-users. Results presented only where significant differences were found.

State/ Region	Characteristic	Non-users	Users	Sig.
SA All	Mean increase in arable area managed since 10 years ago (%)	21	43	***
	Member of local farmer group looking at cropping issues in the district (%)	45	63	***
	Pay a consultant for cropping advice (%)	20	46	***
	Higher education (%)	7	26	***
	Stated preference for cropping rather than livestock (%)	49	72	***
	Average proportion of arable land cropped over past 3 years (%)	61	73	***
	Have a herbicide resistant weed population (%)	25	49	***
	Stated willingness to pay a premium (or penalty) for no-till-stubble retention cropping land (median premium %)	2	7	**
	Proportion of farm described as erosion prone if not managed carefully (mean %)	31	47	***
	Number of sheep (mean)	1406	999	*
	Ever been member of no-till or conservation farming association (%)	6	37	***
	Proportion (%) of growers with belief that no-till with stubble retention will lead to:			
	• More soil moisture retention	56	86	***
	• Less weed emergence	29	60	***
	• Higher long-term wheat yields	25	52	***
	• Less rain needed to allow reliable seeding	32	60	***
	• Higher reliability of wheat yields	21	49	***
	• Less days to get the crop in	42	68	***
	• Lower fuel costs	58	83	***
	• Higher fertiliser costs	42	29	*
	• Less soil erosion	55	80	***

Table 28 SA Mallee – differences between current no-till users and non-users. Results presented only where significant differences were found.

State/ Region	Characteristic	Non-users	Users	Sig.
SA Mallee	Mean increase in arable area managed since 10 years ago (%)	22	41	*
	Member of local farmer group looking at cropping issues in the district (%)	37	67	***
	Pay a consultant for cropping advice (%)	4	32	***
	Higher education (%)	11	29	*
	Stated preference for cropping rather than livestock (%)	33	70	***
	Average proportion of arable land cropped over past 3 years (%)	50	60	**
	Have a yield map (%)	4	23	*
	Stated willingness to pay a premium (or penalty) for no-till-stubble retention cropping land (mean premium %)	1	9	***
	Ever been member of no-till or conservation farming association (%)	11	38	***
	Proportion (%) of growers with belief that no-till with stubble retention will lead to:			
	• More soil moisture retention	56	86	***
	• Lower fuel costs	59	89	***
	• Less rain needed to allow reliable seeding	33	59	*
	• Higher reliability of wheat yields	7	44	***
	• Less days to get the crop in	37	73	***
	• Less soil erosion	59	94	***

Table 29 SA Central and Western EP regions – differences between current no-till users and non-users. Results presented only where significant differences were found.

State/ Region	Characteristic	Non-users	Users	Sig.
SA Central	Arable area managed (ha)	1100	1519	*
	Pay a consultant for cropping advice (%)	22	61	**
	Higher education (%)	0	30	*
	Stated preference for cropping rather than livestock (%)	33	73	**
	Have a herbicide resistant weed population (%)	22	76	***
	Ever been member of no-till or conservation farming association (%)	0	29	*
	Proportion (%) of growers with belief that no-till with stubble retention will lead to:			
	• More soil moisture retention	67	94	**
	• Higher long term wheat yields	22	69	**
	• Higher reliability of wheat yields	22	55	*
	• Less rain needed to allow reliable seeding	33	67	*
SA Western EP	Higher education (%)	6	41	**
	Average proportion of arable land cropped over past 3 years (%)	57	73	**
	Stated willingness to pay a premium (or penalty) for no-till-stubble retention cropping land (mean premium %)	0	4	**
	Number of sheep (mean)	2372	1342	**
	Ever been member of no-till or conservation farming association (%)	0	32	***
	Proportion (%) of growers with belief that no-till with stubble retention will lead to:			
	• Lower effectiveness of pre-emergent herbicides	56	27	*
	• Less rain needed to allow reliable seeding	17	50	**

Table 30 SA Upper and Lower EP regions – differences between current no-till users and non-users. Results presented only where significant differences were found.

State/ Region	Characteristic	Non-users	Users	Sig.
SA Lower EP	Pay a consultant for cropping advice (%)	25	64	*
	Stated preference for cropping rather than livestock (%)	50	83	*
	Proportion of farm described as erosion prone if not managed carefully (mean %)	11	47	**
	Variable rate fertiliser applied to identified paddock zones (%)	50	14	**
	Ever been member of no-till or conservation farming association (%)	0	40	**
	Proportion (%) of growers with belief that no-till with stubble retention will lead to:			
	• More crop disease	63	24	**
	• Less fuel costs	38	83	**
	• Less days to get the crop in	38	74	*
	• Higher reliability of wheat yields	25	69	**
SA Upper EP	Arable area managed (ha)	2132	3006	*
	Mean increase in arable area managed since 10 years ago (%)	11	41	*
	Member of local farmer group looking at cropping issues in the district (%)	44	74	*
	Stated willingness to pay a premium (or penalty) for no-till-stubble retention cropping land (mean premium %)	1	6	*
	Proportion of farm described as erosion prone if not managed carefully (mean %)	19	53	**
	Ever been member of no-till or conservation farming association (%)	11	45	*
	Proportion (%) of growers with belief that no-till with stubble retention will lead to:			
	• More soil moisture retention	44	81	**
	• Higher long term wheat yields	11	40	*
	• Less days to get the crop in	22	60	**

Table 31 Victorian all respondents – differences between current no-till users and non-users. Results presented only where significant differences were found.

State/ Region	Characteristic	Non-users	Users	Sig
Vic All	Arable area managed (ha)	1800	2430	**
	Mean increase in arable area managed since 10 years ago (%)	14	45	***
	Pay a consultant for cropping advice (%)	17	48	***
	Higher education (%)	21	37	**
	Average proportion of arable land cropped over past 3 years (%)	56	71	***
	Have a herbicide resistant weed population (%)	24	46	***
	Have a yield map (%)	7	29	***
	Stated willingness to pay a premium (or penalty) for no-till-stubble retention cropping land (mean premium %)	0	5	*
	Ever been member of no-till or conservation farming association (%)	7	35	***
	Proportion (%) of growers with belief that no-till with stubble retention will lead to:			
	• More crop disease	59	43	**
	• More soil moisture retention	52	81	***
	• Higher long-term wheat yields	28	52	*
	• Less rain needed to allow reliable seeding	28	57	**
	• Higher reliability of wheat yields	13	42	***

Table 32 Victorian Mallee region – differences between current no-till users and non-users. Results presented only where significant differences were found.

State/ Region	Characteristic	Non-users	Users	Sig
Vic Mallee	Pay a consultant for cropping advice (%)	12	70	***
	Stated preference for cropping rather than livestock (%)	69	89	**
	Average proportion of arable land cropped over past 3 years (%)	61	77	***
	Stated willingness to pay a premium (or penalty) for no-till-stubble retention cropping land (mean premium %)	-2	6	**
	Proportion of farm described as erosion prone if not managed carefully (mean %)	8	38	***
	Variable rate fertiliser applied to identified paddock zones (%)	19	43	**
	Have a yield map (%)	4	32	***
	Ever been member of no-till or conservation farming association (%)	12	50	***
	Proportion (%) of growers with belief that no-till with stubble retention will lead to:			
	• More crop disease	65	44	*
	• More moisture retention	46	76	*
	• Less weed emergence	42	63	*
	• Less rain needed to allow reliable seeding	23	63	***
	• Higher reliability of wheat yields	15	46	*

Table 33 Victorian Loddon and Wimmera regions – differences between current no-till users and non-users. Results presented only where significant differences were found.

State/ Region	Characteristic	Non-users	Users	Sig
Vic Loddon	Arable area managed (ha)	1117	2167	**
	Mean increase in arable area managed since 10 years ago (%)	9	58	*
	Pay a consultant for cropping advice (%)	7	35	**
	Have a herbicide resistant weed population (%)	13	41	**
	Proportion (%) of growers with belief that no-till with stubble retention will lead to:			
	• More crop disease	67	39	*
	• Higher reliability of wheat yields	20	43	*
Vic Wimmera	Mean increase in arable area managed since 10 years ago (%)	4	33	***
	Member of local farmer group looking at cropping issues in the district (%)	38	67	*
	Higher education (%)	8	39	**
	Ave. proportion of arable land cropped past 3yrs (%)	44	77	***
	Ever been member of no-till or conservation farming association (%)	0	33	**
	Belief that no-till with stubble retention will lead to:			
	• Less fuel costs	62	89	**
	• Lower effectiveness of pre-emergent herbicides	23	49	*
	• Higher long-term wheat yields	8	49	***
	• Less rain needed to allow reliable seeding	23	65	***
	• Higher reliability of wheat yields	0	37	***
	• Less soil erosion	31	79	**

Table 34 WA regions all respondents – differences between current no-till users and non-users. Results presented only where significant differences were found.

State/ Region	Characteristic	Non-users	Users	Sig
WA All	Pay a consultant for cropping advice (%)	29	49	*
	Higher education (%)	17	36	**
	Stated preference for cropping rather than livestock (%)	50	78	***
	Average proportion of arable land cropped over past 3 years (%)	50	61	***
	Number of sheep (mean)	5025	3142	*
	Ever been member of no-till or conservation farming association (%)	4	41	***
	Proportion (%) of growers with belief that no-till with stubble retention will lead to:			
	• More moisture retention	54	91	***
	• More weed emergence	17	31	*
	• Lower fuel costs	46	80	**
	• Higher long-term wheat yields	17	59	***
	• Less rain needed to allow reliable seeding	42	71	*
	• Higher reliability of wheat yields	13	59	***
WA Central	Pay a consultant for cropping advice (%)	8	50	***
	Higher education (%)	8	31	*
	Stated preference for cropping rather than livestock (%)	54	85	**
	Stated willingness to pay a premium (or penalty) for no-till-stubble retention cropping land (mean premium %)	1	6	*
	Ever been member of no-till or conservation farming association (%)	8	43	**
	Proportion (%) of growers with belief that no-till with stubble retention will lead to:			
	• More moisture retention	46	91	***
	• Less fuel costs	46	81	**
	• Higher long-term wheat yields	8	56	***
	• Less rain needed to allow reliable seeding	38	66	*
	• Higher reliability of wheat yields	8	57	***

4.9 Identifying significant drivers of adoption

In the previous section differences between adopters and non-adopters were presented as a number of variables. In this section a range of variables are used together in regression-based analyses to identify the variables that most significantly explain no-till adoption and extent of use. This process is aimed at better understanding the drivers of changes in adoption and extensive no-till use.

The results of these regression analyses help to identify the perceptions and other variables that may have a significant influence on adoption if they were to change. Also, variables identified as not being significantly associated with adoption may be less important when targeting extension activity. For example, in the previous section a number of differences in perceptions about no-till between adopters and non-adopters have been identified. Some of these perceptions may be both more influential in the adoption decision and more able to be influenced through learning than others. Therefore, they may be more effective targets for extension activities.

The results in Table 35 show the factors significantly explaining whether growers in lower-adopting regions (where less than 75 per cent of respondents are using no-till, that is SA Mallee, SA Western EP, Vic. Mallee, NSW Central West) are using at least some no till (some crop area sown to no-till in 2008) and the factors significantly explaining whether growers are using no-till extensively on their farm (using no-till to establish at least 90 per cent of the 2008 crop area). As a vast majority of respondents across all regions have already adopted at least some no-till, only an analysis of extensive no-till use has been conducted across all regions. It should be noted that the factors that led to the decision to first try no-till are not always expected to be the same as the factors associated with the subsequent decision to extensively use no-till. A range of regression methods have been used. Only logit results are presented in this report.

Factors significantly associated with use

Predictable factors consistently associated with no-till use in the lower-adopting regions and extensive use regions include newer seeding machinery and higher proportion of land cropped (Table 35). Use of a consultant is highly significant in each case. In lower adopting regions, higher education is significantly associated with no-till use and extensive use (it is also significantly associated with the decision to use some no-till across all regions (data not presented)).

Perceptions of most consistent influence are perceptions of greater soil moisture retention under no-till with stubble retention compared to a cultivation-based system with no stubble retention (Table 35). The results suggest that positive shifts in this perception are associated with more extensive no-till use. Negative perceptions of crop disease and long-term reliability of wheat yields under a no-till system are also shown to be significantly associated with less extensive no-till use. Perceptions of reduced pre-emergent herbicide effectiveness and a perceived lack of reduction in the amount of rainfall needed to allow for reliable seeding were shown to be influential constraints to extensive no-till use across the full sample.

Although not shown in Table 35, it is worth noting that with the other variables considered, WA growers still have a significantly ($P<0.001$) higher likelihood of extensive use than growers in the other states. This indicates that there are other positive factors leading to higher extensive use in WA that are not being captured by the included variables.

Factors not associated with use

Factors shown to have no influence included the proportion of the farm deemed to be erosion-prone if not carefully managed. The perception that a no-till system with stubble retention will reduce soil erosion risk compared to a cultivation-based system with no stubble retention was also not significant. Extension targeting these perceptions is unlikely to be able to significantly influence no-till use. However, it is worth noting that there is evidence that the relatively small subset of growers who do not expect to be using any no-till in five-years time are much more likely to perceive that a no-till system does not offer erosion benefits and this is significantly associated with no expected use in five-years time (data not presented).

Membership of a no-till farming association could not be included in the models for statistical reasons because almost all no-till association members are no-till users. Membership of local farming groups looking at cropping issues was not significant. The greater amount of time a farmer observes no-till being used in their district positively influences the decision to first try no-till but has no significant effect on the decision to use no-till extensively on the farm.

Table 35 Variables shown to be significantly[a] associated with no-till adoption, extensive use of no-till (≥90% cropped using no-till) and stated expectation of use in 5 years time based on logit regression analyses using all respondents (n=1020) and respondents from lower adopting regions (n= 258)[b]

Variable	All regions	Lower-adopting regions	
	Extensive use	Extensive use	Use
Arable area managed	+*	ns	ns
Average annual rainfall	ns	ns	+*
Average proportion cropped	+***	+**	+*
Age of current seeding machine	-***	-***	-***
Proportion of soil on farm described as prone to erosion	ns	ns	ns
Pay a consultant for cropping advice	+***	+**	+***
Higher education	ns	+**	+**
Member of local farmer group	ns	ns	ns
Years since aware of local no-till use	ns	ns	+**
Belief that no-till system will:			
• Increase moisture retention	+***	+***	+*
• Reduce pre-emergent herbicide effectiveness	-***	ns	ns
• Reduce fuel costs	ns	ns	ns
• Reduce long-term wheat yield reliability	-***	-**	ns
• Reduce rain needed for reliable seeding	+**	ns	ns
• Increase crop disease	-***	-**	ns
• Reduce days needed to get crop in	ns	ns	ns
• Reduce soil erosion	ns	ns	ns
Correct classifications (%):			
All	74	80	80
Adopters/Non-adopters	72/75	66/87	91/51

NB: Not all variables discussed in previous sections were included in regression analyses.
a * P<0.1; **P<0.05; ***P<0.01; **ns**: not significant. All models are significant P<0.001.
b SA Mallee, SA Western EP, Vic. Mallee, NSW Central West
+/- symbols indicate the direction of influence.

5. SUMMARY

5.1 Current use and trends

The current status and trends relating to adoption of no-till seeding systems across Australian broadacre grain growing regions have been analysed using data from a survey of 1172 grain growers.

The results show that no-till seeding practices have now been adopted by the majority of grain growers across all regions. The proportion of growers using at least some no-till is now peaking at levels around 90 per cent in many regions. In regions with relatively low adoption five years ago, there have been very rapid increases in adoption, particularly in the period 2003–06. This result is consistent with the surge in adoption forecast in the 2003 survey (D'Emden and Llewellyn 2006).

Many of the very large relative differences in adoption between states and regions that were clearly evident in 1998 have now closed substantially and are expected to close further over the next five years. Although some key regions appear likely to peak at a lower level of adoption, it is now clear that for most regions the large differences in adoption 10 years ago were reflecting time lags in the extension of no-till more so than major differences in the likely final proportion of growers using no-till.

In general, relatively few growers appear to have made the decision to crop without adopting no-till in the near future. The proportion of growers using no-till is expected to exceed 80 per cent in a majority of regions by 2013. However it should be noted that there are key regions where peak adoption and extent of use by adopters is likely to remain considerably lower than average.

The use of disc openers remains relatively low, with the exception of the northern cropping region of NSW and Queensland.

Importantly, there has been very little evidence of disadoption of no-till over the past five years. That is, very few growers who have used at least some no-till have decided to no longer use no-till. This includes regions where no-till has been an extensive practice over a longer-term, for example several WA regions. Substantial net gains in no-till adoption have been observed and further net increases are expected in the future, except where no-till adoption is already reaching a plateau as it approaches full potential adoption. It needs to be noted however that the severe drought conditions appears to have affected the certainty of responses about future plans in several regions.

Because a majority of growers in most districts still use some tillage, it should be expected that economic and agri-environmental factors may cause seasonal shifts in extent of tillage use. Just as glyphosate price falls led to increased no-till adoption (D'Emden et al 2006), growers in this study have indicated that recent glyphosate price rises have led to increased use of tillage in many regions. In regions such as those in WA where it is more common that 100 per cent of crop area is sown no-till, the glyphosate price rise has had little or no reported influence on tillage use.

For no-till practices to be widespread in the landscape, there needs to be both high adoption rates and extensive use by adopters. The results show that it remains common for no-till adopters in most regions to still use some cultivation. However, the extent of no-till use by no-till adopters is typically high. The average percentage of crop sown using no-till by no-till adopters exceeds 70 per cent in all regions.

It should be noted that relatively low adoption rates together with relatively low extent of use mean that substantial crop areas are still being cultivated in some key erosion-prone regions. The results indicate that substantial areas will still be cultivated in five years' time in these regions. While the proportion of growers using some no-till will generally be high, very large differences in the proportion of growers using only no-till will exist between regions.

5.2 Farm and farmer characteristics associated with no-till adoption status

This study has elicited a wide range of factors that can be associated with no-till use or non-adoption. These include attitudinal variables, perceptions of specific effects, other responses to hypothetical scenarios and open-ended responses on the reasons for current adoption/non-adoption. Profiling adopter and non-adopters in this way is aimed at better understanding sub-groups so that ways to target R, D & E can be considered.

By eliciting perceptions relating to the impact of no-till with stubble retention systems relative to a system with multiple cultivations and no stubble retention it is possible to gain an understanding of the perceived costs and benefits of no-till at a regional level. Only around 40 to 60 per cent of growers in each region expected higher wheat yields over the longer term under the no-till system, with the exception of Queensland Southern where a higher percentage expected greater yields. This is supported by the fact that yield advantages were not commonly cited as a reason for no-till adoption by adopters with cost-related factors being more important (see below).

A majority of growers in all regions expected the no-till system with stubble retention to lead to:

- less fuel costs;
- less erosion;
- more moisture retention;
- more herbicide costs; and
- more herbicide resistance.

Some factors had a greater tendency to divide growers as to whether the impact would be positive, negative or the same. These included:

- fertiliser costs;
- weed emergence;
- effectiveness of pre-emergent herbicides; and
- crop disease.

Characterising non-adopters

The most commonly stated reasons for adoption stated by adopters were associated with reduced fuel and time-related costs at seeding followed by improved soil conservation and moisture retention. These reasons were consistent across all regions. A challenge for increasing adoption is that the most common stated reasons for non-adoption in the regions with lowest adoption relate to the broad and potentially complex 'lack of observed benefits' relative to their existing system. Given that most non-adopters are likely to have observed no-till being practiced and extended in their local district over many years, the result suggests that further simple observation and information is not going to address this for remaining non-adopters.

Differences between adopters and non-adopters are often region-specific and should usually be considered at the regional level. In the summary below we list differences that were more commonly identified. Note that there may be some regional exceptions to these general statements.

Relative to adopters of no-till, non-adopters are generally more likely to:

- expect more crop disease under a no-till stubble retention system;
- not use paid cropping advisors;
- prefer livestock enterprises rather than cropping;
- be less likely to have someone with higher education involved with managing the farm;
- had a smaller increase in arable area managed over past 10 years;
- have less herbicide resistance;
- have older seeding machinery;
- be less willing to pay a premium for land that has been under long-term no-till stubble retention compared to land under a system of multiple cultivations and stubble burning; and
- perceive that no-till with stubble retention is less likely to lead to:
  increased moisture retention;
  higher wheat yields;
  greater reliability of wheat yields;
  less rain needed for reliable seeding; and
  lower fuel costs.

It is also useful to look at variables that do not differ greatly between adopters and non-adopters. These are less likely to be factors that can be targeted by extension in a way that will influence adoption. Note that there are regional exceptions to some of these general statements.

Variables generally not shown to be associated with whether a grower is no-till user or non-user include:

- age; and
- use of variable rate fertiliser.

Perceived relative effect of no-till with stubble retention on:

- herbicide costs;
- herbicide resistance; and
- fertiliser costs.

The no-till adoption trends over time have shown distinct regional differences. While the adoption and extent of use in many regions is now appearing to reach a high plateau, other regions appear set to peak at lower levels of adoption and extent of use. Local experience and information has been shown to be very important to understanding no-till adoption (see D'Emden et al 2006).

Understanding the current reasons for adoption and non-adoption and the characteristics of non-adopters will be most effective if it is done at a regional level. For some of the low-adopting regions, potentially useful differences in perceptions of non-adopters have been identified that may allow improved targeting of extension to increase learning of some of the specific effects of no-till systems that have been experienced.

Regression analyses show that for some perceptions, not only are there differences in between adopters and non-adopters but they are significantly associated with the adoption and extent of use decision when a range of explanatory factors are considered. Examples include increased soil moisture retention, long-term wheat yield reliability, crop disease and the effectiveness of pre-emergent herbicides. Together with these potential opportunities goes the consistently strong association between no-till adoption and extensive no-till use with the use of agronomic advisory support.

The study has also identified characteristics of non-adopters that are expected to be more complex, entrenched, and less likely to be influenced by simple information and learning. These relate to the lack of overall perceived short and long-term advantages of no-till to the individual's farming system and personal preferences. As current non-adopters with plans to shift to no-till in the near future do so, it is likely that the remaining non-adopting growers will increasingly have characteristics very different to the majority of the grain growing population that have been part of the remarkable shift to no-till systems becoming the conventional cropping system across Australia.

Finally, the results of this study show the remarkable diffusion of no-till across Australian cropping regions, confirming that no-till is highly adoptable and that extensive use has so far been sustained across a wide range of agro-ecosystems. The last five years have seen many regions with previously lower no-till adoption rapidly increase adoption to levels similar to early-adopting regions. However, it needs to be recognised that based on current indicators, over the next five years, and possibly at peak adoption, there will still be several regions with a combination of a relatively lower no-till adoption levels and lower extent of use. Achieving the same reductions in cultivation use and erosion risk in these regions will most likely require new and innovative approaches to encourage adoption through R, D & E of soil conservation practices.

Further analysis of the data from this study and the related 2003 study is being conducted.

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