Land manager surveys

Summary results of telephone surveys of agricultural land managers in South Australia, 2000–2017

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Department for Environment and Water
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Summary

In 2000, the Department of Primary Industries and Resources developed a telephone survey for commercial agricultural land managers in South Australia, as part of its program to monitor the health and condition of agricultural soils in South Australia. The surveys were designed to gather data on landholders' understanding of key soil and land management issues and the practices they use to manage them. A baseline survey was undertaken in 2000, then follow-up surveys were conducted in 2002, 2005, 2008, 2011, 2014 and 2017.

Survey data was analysed by geographical areas including agricultural zone Natural Resources Management (NRM) regions, rainfall zones (low <325mm; medium 325–600mm; high >600mm), and population-weighted state means.

Results of the surveys particularly showed:

- Trends in use of a number of land management practices that would contribute to improved soil health and condition
- Variations in the occurrence of, and response to, some soil/land management issues across regions and rainfall zones
- Limited understanding among some respondents about identification and causes of, and treatments for particular soil conditions.

The trends in land management practices identified in these surveys have also provided supporting evidence or reasons for trends in other soil condition monitoring data collected by DEW. For example, the survey results showing increased adoption of no–till cropping methods and stubble retention, correlates well with data from DEW's field surveys. The field surveys showed a substantial improvement in the average protection of agricultural land from the risk of soil erosion over this period.

Property and crop area

The average property area of survey respondents increased by 68% from 1342 ha to 2250 ha over the 2000 to 2017 surveys. Similarly, the average cropped area per property increased by 58% from 547 to 863 ha. There were marked differences across regions and rainfall zones: The largest mean property size and cropped area was on Eyre Peninsula (EP) NRM region; the smallest property size occurred in the Adelaide and Mt Lofty Ranges (AMLR) region, and the lowest cropped area was in the Kangaroo Island (KI) region.

Land management issues

The soil and land management issues of most concern in respondents' districts were; plant pests (84%), animal pests (75%), and soil fertility/nutrition (56%), followed by water repellent soils (38%), wind erosion (36%), and soil salinity (34%). Other issues less frequently reported were soil compaction (31%), soil acidity (27%), waterlogging (26%), soil structure decline (24%), native vegetation decline (20%) and water erosion (18%).

There was considerable variation in the level of responses to many issues across regions and rainfall zones. For example in the 2014 survey:

- Soil salinity was most common in the KI region (41%) and Northern and Yorke (N&Y) region (32%)
- Wind erosion was highest in the low rainfall zone (52%), and the EP and South Australian Murray-Darling Basin (SAMDB) regions (40%)
- Water erosion issue was highest in the AMLR region (29%)
- Soil acidity was most commonly reported in KI (59%) and AMLR region (44%), but considerably lower in the SE (23%) suggesting an under-recognition of soil acidity in the SE by land managers

- Water repellent soils were most common in EP (50%), South East (SE) (47%) and SAMDB regions (45%)
- Waterlogging was highest in KI region (46%) and SE region (30%), and high rainfall zone (33%)
- Soil compaction showed a noticeable downward trend from 2000 to 2014 surveys in EP (42% to 28%) and N&Y regions (50% to 27%), which may be associated with adoption of precision agriculture, reduced tillage and no-till over this period.

Tillage

Large changes in cropping tillage methods were reported over the surveys from 2000 to 2017.

The proportion of cropping respondents using no-till methods for at least some of their cropping increased from 28% to 85% (1999 to 2016 seasons). This trend was fairly consistent across regions and rainfall zones.

There was also a strong increasing trend in the area of crop sown using no-till methods, from 16% to 83% of respondents over this period. This trend occurred in all regions and rainfall zones. The overall largest change occurred in the SAMDB region (9% to 77%) and EP regions (9% to 75%). Results by rainfall zone showed this increase occurred slightly more slowly in the low rainfall zone (7% to 66%).

Other data for tillage practices collected in these surveys correlated with the adoption of no-till methods. For example, those who 'usually' did long cultivated fallowing decreased from 8% to 2% (2000 to 2011 surveys). This downward trend generally occurred across all NRM regions, particularly in the SAMDB region (17% to 3%). The largest decrease was in the low rainfall zone (31% to 6%), where cultivation has generally observed to be more commonly used.

In the 2017 survey, only 14% of croppers reported doing pre-sowing cultivation on at least some of their cropped area. This was highest in the low rainfall zone (27%) and high rainfall zone (24%). The main reasons given for using cultivation were for 'weed control' (45%) and to 'overcome compacted soil' (43%), with similar results across regions. Other significantly reported reasons in regions included 'incorporate clay' (21% in SE), 'incorporate stubble' (21% in AMLR), and 'disease' (15% in EP and SAMDB).

Residue/groundcover management

The surveys indicated changes in a number of practices used by respondents to manage stubbles/residues in cropping rotations, and groundcover in grazed pastures.

The proportion of croppers who reported 'usually' burning stubbles/residues before cropping, generally decreased from 11% to 4% (2000 to 2017 surveys). This was most common in the SE region (average 14%) and N&Y region (10%). There were significant seasonal variation in responses, which tended to be higher following high producing seasons.

In the 2017 survey, 40% of croppers reported they burnt at least some crop land prior to cropping in 2016. When asked what type of burning operation they did, 51% of these respondents did 'full' burning (whole paddock) while 41% did 'windrow' burning of header chaff rows which leaves most stubble in the paddock unburnt. About 11% burnt 'stubble dumps' (piles of header chaff).

The main reasons these respondents gave for burning were to 'manage snails' (73%; and 93% in high rainfall zone), 'control weeds' (63%; and 91% in AMLR region), and 'reduce stubble loads' (50%).

The proportion of cropping respondents who aimed to leave at least 50% groundcover in paddocks prior to cropping increased from 58% to 76% (2008 to 2017 surveys). Results were similar across regions and rainfall zones. This indicated a trend of increasing stubble retention that coincided with the increasing adoption of no-till methods.

The survey results indicated the proportion of respondents with livestock who used confinement feeding (in designated small fenced containment areas) to keep soil protective cover in paddocks, increased from around 25%

to about 50% (2000 to 2014 surveys). This was done slightly more frequently in the low rainfall zone (61% in 2017 survey), and in the N&Y (58%) and EP region (57%).

Soil acidity

Results suggested some under-recognition by land managers of the extent of soil acidity, and a proportion had limited understanding of the diagnosis, causes and appropriate treatments for soil acidity. The cost of liming was a common barrier to applying lime to acid soils.

Across all of the surveys, about 20-30% of respondents stated they had acid soils on their property. The highest was in the KI region (65%), AMLR (45%) and SE region (32%), which are lower than the mapped extent of acid agricultural soils in these regions (84%; 59%; 42% respectively) suggesting under-recognition of this issue.

The proportion of respondents saying they have sub-surface acidity (below 10cm depth) increased from 8% to 13% (2011 to 2017 surveys), possibly indicating increasing incidence and/or awareness of this issue.

About 60% to 80% with acid soils said they did regular soil testing, indicating that at least 20% probably don't monitor soil pH regularly enough.

Responses to survey questions showed there was some misunderstanding of the causes of, and treatments for acid soils. For example, 42% (2017 survey) wrongly believed gypsum could be used to treat acid soils, and more than half wrongly thought that superphosphate application was a direct cause of acidity. A high proportion (81%) correctly understood that it is beneficial to apply lime before signs of production decline appear due to acidity.

Around 50%-60% of acid soil respondents correctly identified the critical soil pH for acidity in the range pH 4.5–6.0 (regardless of test method), indicating that some have limited understanding of soil pH relevant to acidity on agricultural soils.

About 70%-75% of managers overall said they had sought information on treating soil acidity. The main information sources used were 'agronomist/consultant' (44%), DEWNR/PIRSA staff (19%). Responses across regions were similar except for KI, which had lower use of private agronomists/consultants (30%), and higher use of DEWNR/PIRSA staff (38%) for advice.

About 65%-75% of respondents with acid soils reported they had applied lime to some or all of their acid soils at any time, highest in the AMLR region (87%).

In the 2017 survey, about two thirds of these respondents had applied lime on the basis of 'soil test results', and one third according to advice of 'consultant/agronomist'. On EP, respondents indicated less use of consultants' advice (17%) but slightly more reliance on their own experience/knowledge (26%) compared to other regions.

For those that didn't lime some or all of their acid soils, by far the main reason given was 'too expensive' (41%). Other reasons included 'not severe enough' (18%), 'not worthwhile financially' (14%), 'not necessary' (10%), 'lack of time' (7%).

About 37% of acid soil managers had used options other than liming on their acid soils. The more common practices were 'adapting fertiliser strategies' (11%), 'clay spreading' (10%), and 'acid tolerant plants' (9%).

Soil salinity

Soil salinity was a significantly reported issue, but the majority of managers had carried out practices to control salinity.

About 34% of respondents stated they had soil salinity on their property, which was fairly consistent over the 2000-2011 surveys. The highest incidence was on KI (73%) followed by EP (48%).

Of those with salinity, 81% had done on-site treatment(s) to treat salinity. The most common were planting trees (34%), and fencing the saline area to exclude livestock (24%; 49% on KI). In the SE region, 31% had planted salt tolerant pasture, 27% had installed drains, and 27% had planted perennial grass.

About 24% of all land managers reported they had implemented off-site practices to control salinity. The more common practices were 'revegetate surrounding land' (6%), planting trees (6%), perennial grasses (4%), Lucerne (3%), and 'fence off/remove stock' (3%).

Water repellent soils

Soil water repellence was often reported by managers, and the use of practices to overcome this issue, particularly claying, has increased over the survey period.

About 40% of respondents said they had water repellent soils on their property. A higher proportion (40% - 60%) was reported in the EP, KI, SAMDB and SE regions, and less (<30%) in the N&Y and AMLR regions.

The proportion of respondents with water repellent soils using practice(s) to manage or treat water repellent soils increased from 51% (2000 survey) to 71% (2017 survey). Those using clay spreading increased from 19% to 38% over this period, and clay delving from 5% to 28%. The use of modified sowing technology was also common (39%). Claying (spreading or delving) was most commonly done on EP (66% in 2017 survey), the SE (56%), and the medium rainfall (325-600 mm) zone (54%). It was less in the low rainfall zone (9%).

Overall 94% of these respondents stated some benefit(s) of claying, particularly 'increased yields or plant growth' (60%), 'more even/improved plant establishment' (41%), 'better soil wetting/water retention' (26%), and 'reduced wind erosion risk' (23%).

Negative impacts of claying were reported by 71% of respondents. The most common were 'rough surface from delving' (27%), and 'high cost' (17%). Overall these were less frequently reported in 2017 than in the 2014 survey, suggesting that improvements in claying methods had been made.

The time period when claying was first done on respondents' properties (2014 survey) showed overall earlier adoption in the SE (34% pre-1994), and mainly more recent adoption on KI (none before 1999) and in the high rainfall zone (only 5% before 1999).

Soil nutrition

Most managers monitored their paddock nutrition levels, while the sources of advice they used for nutrition management changed somewhat over the survey period.

On average, 67% of managers reported they 'regularly' did soil nutrition testing. This was slightly lower in the SAMDB region (56%) and low rainfall zone (51%).

The average interval between soil tests in any paddock was most commonly 3-5 years (63%), with a slight trend of increasing time interval between soil tests from the 2000 to 2014 surveys.

The most common sources of information used by respondents for deciding fertiliser strategies were 'existing knowledge' (68%) and 'agronomists/consultants' (62%). The use of 'fertiliser companies/agents' decreased from 45% to 18% over this survey period.

Perennial vegetation and revegetation

A significant proportion of respondents had increased or protected perennial vegetation on their properties, with many recognising benefits but also citing barriers to doing this.

In the 2014 survey, the proportion of respondents carrying out perennial vegetation/revegetation activities in the last 10 years included 'revegetation with local native species' (44%), 'fenced off native vegetation' (39%), and 'carried out revegetation with non-native species' (44%). The main regional and rainfall zone variations were: on KI 74% had 'fenced off native vegetation', and in N&Y 33% did 'revegetation with local native species'. Overall these activities were less common in the low rainfall zone.

The highest average area per property that these activities were carried out on included 'fencing off perennial vegetation' - 42 ha on EP, 400 ha on KI, and 34 ha in the SE, with 'revegetation with local native species' highest on EP (19 ha).

An average of 83% of respondents stated benefits to increasing perennial vegetation. The most common were 'shelter belts for stock' (37%), 'fodder for stock' (22%), preventing erosion (20%), and 'shelter breaks for crops/pastures' (17%).

About 86% of respondents reported barriers to increasing perennial vegetation. The more common types were 'lack of time' and 'cost overall' (both average 21%), 'loss of land' (19%), and 'have enough now' (13%). The barrier of 'low rainfall' was more commonly reported in the 2008 survey (25%), coinciding with the 'millennium drought'.

Climate change

In the 2014 to 2017 surveys, many managers believed climate change would impact their property production. The majority said they have already or would implement changes to some farming practices to lessen this impact.

In the 2014 survey, 39% of respondents considered that climate change would impact on their property production in the next 20 years; 25% were 'unsure' and 37% said 'no impact', with 48% of KI respondents saying 'no impact'. In the 2017 survey, 48% believed there would be at least some *negative* impact from climate change; this was highest in the AMLR region (55%), and lowest on KI (44%).

The proportion that have or would change some practice(s) to lessen the impact of climate change was 71% in the 2014 survey, and 80% in the 2017 survey. The most common practices were 'alter crop varieties' (29%; 17% respectively), 'reduce tillage/increase stubble retention' (13%; 20%), while some were not implementing any practices (29%; 20%). On KI, 35% reported they would 'increase perennial pasture/fodder/hay'; 35% in the N&Y said 'reduce tillage/increase stubble retention'; 12% in AMLR stated 'more flexible stocking rates'; and 13% in the SE 'increase/modify irrigation'.

Use of technology

From the 2011 to 2017 surveys, an increasing proportion of cropping managers were using newer (e.g. GPS-based) technologies with their farm management, potentially improving production efficiency and soil condition.

The proportion of cropping respondents using newer technology(s) increased from 58% to 79% over the 2011 to the 2017 surveys. The most common technology used was 'GPS guidance' (auto-steer) which increased from 56% to 77% over this period. Others used were 'yield mapping' (27% in 2017), 'variable rate technology' (19%), 'controlled traffic' (13%), UAVs/drones (6%), and farm robotics/autonomous vehicles (1%).

The highest adoption of these technologies by regions and rainfall zones (2017 survey) were: 'GPS guidance' on EP (90%), and in the N&Y (84%), and 'yield mapping' in the N&Y (37%). 'Variable rate technology' use was 34% in the low rainfall zone, while 17% in the N&Y region were using 'controlled traffic'.

1 Introduction

The Department for Environment and Water (DEW) and its predecessor agencies have collected and analysed data from a range of sources since 1999-2000 to monitor the health and condition of agricultural soils in South Australia. This was done to develop strategies and programs to help facilitate adoption of improved land management practices. An outline of the soil and land management issues in South Australia's agricultural areas and early results of this monitoring are presented in McCord and Payne (2004)[1].

For a full understanding of the health/condition and management of the land it is important to assess the land managers' knowledge and application of sustainable land management techniques.

While some information is available from the Australian Bureau of Statistics (ABS) Agricultural Census and related surveys, this does not provide the detailed information required by DEW to fully understand land management issues. There have been a number of regionally focused surveys related to agricultural land management but these do not provide state-wide data that DEW has sought.

A telephone survey was therefore developed to collect specific information from agricultural land managers. It is a repeatable method designed to identify trends in land management practices, as well as knowledge and attitudes of land managers over time. The survey was structured to gather information at the regional and state scale, and across defined rainfall zones. The trends in the responses are potentially useful indicators of current and future land condition and soil health, and to help explain reasons for observed trends in other soil condition data.

Since the formation of Natural Resources Management (NMR) regions in 2004–2005, data from these surveys at a regional scale has been of interest to the agricultural NRM regions[2] for their monitoring and reporting requirements. Survey data analysed in each NRM region has been provided to the regions, and the regions in turn have had input to design of questions in the surveys, and have contributed funding to the more recent surveys.

While the NRM regions were replaced by Landscape SA regions in 2020 (which had some differences in boundaries), data in this report is presented according to NRM regions which existed for much of the survey period.

An initial forum report was produced that summarised data from the 2000–2008 surveys[3]. This updated report provides a summary of key results of all the surveys 2000–2017, focusing on data that highlights trends relating to soil and land management practices over this period, and geographical areas where soil issues are of particular concern. It also highlights land managers' responses to emerging issues such as climate change.

[1] McCord, AK, and Payne RA, Report on the Condition of Agricultural Land in South Australia, Report No. 1, December 2004, Department of Water, Land and Biodiversity Conservation

[2] Eyre Peninsula (EP), Northern and Yorke (N&Y), South Australian Murray–Darling Basin (SAMDB), Adelaide and Mt Lofty Ranges (AMLR), South East (SE)

[3] Key results of DWLBC Land Manager Surveys 2000–2008: Forum Paper Waite 26 November 2008, Giles Forward, Department of Water, Land and Biodiversity Conservation

2 Methods

2.1 Survey sample

The target audience for these surveys was commercial, broadacre cropping, grazing and dairy properties within the agricultural zone of South Australia. The minimum property size criteria for the surveys was 200 hectares, or 50 hectares in the higher rainfall Mt Lofty Ranges and Kangaroo Island areas.

An experienced market research company was commissioned to conduct each survey, and to provide the survey data and a report summarising the results to DEW (and predecessor agencies). Interviewees were randomly selected from a commercial landline telephone database to participate, and those fitting the survey criteria were asked to be interviewed.

A baseline survey was conducted in 2000, then follow-up surveys were conducted thereafter about every 3 years in 2002, 2005, 2008, 2011, 2014 and 2017 to measure any trends in data over time.

In the baseline 2000 survey, 600 responses were obtained from a representative number of land managers from each of the main agro-ecological regions in the agricultural zone: Eyre Peninsula, Northern and Yorke, Murraylands, South East, Mt Lofty Ranges and Kangaroo Island. In 2002 the total survey sample was increased to 1000. In the 2005 survey onwards, the sampling was targeted according to the newly formed Natural Resources Management regions, so representative numbers of responses were obtained from each of the 6 agricultural NRM regions.

2.2 Topics covered

The exact range of questions varied slightly between surveys, to accommodate varying project interests over time, although a set of core questions was mostly included throughout. The range of topics and survey question design was done in consultation with staff from Primary Industries and Regions SA and staff from NRM regions, as well as with the contracted market research company.

The survey was designed to ask land managers a series of questions that generally covered:

- property size, arable and non-arable land areas, enterprises, crops grown
- soil and land management issues considered to be of concern in the respondent's district and on their property
- understanding of key soil degradation issues and management options
- land management practices used to treat or manage key soil issues (e.g. soil erosion, soil acidity, water repellence, soil nutrition, salinity etc.)
- broader topics and emerging issues including perennial vegetation, climate change, use of newer technology.

2.3 Data analysis

Survey response data was geo-located according to the postcode of the respondents, with individual property data kept confidential. Data was analysed for each region (initially agro-ecological regions, later Natural Resources Management regions), and by rainfall zone for the whole state (i.e. low rainfall <325mm per annum; medium rainfall 325–600mm; high rainfall >600mm) as shown in Figure 2.1. Population-weighted state-wide mean results based on ABS Census population data were also produced. Minor changes to some NRM region boundaries were implemented in 2009, and data analysis was adjusted accordingly.

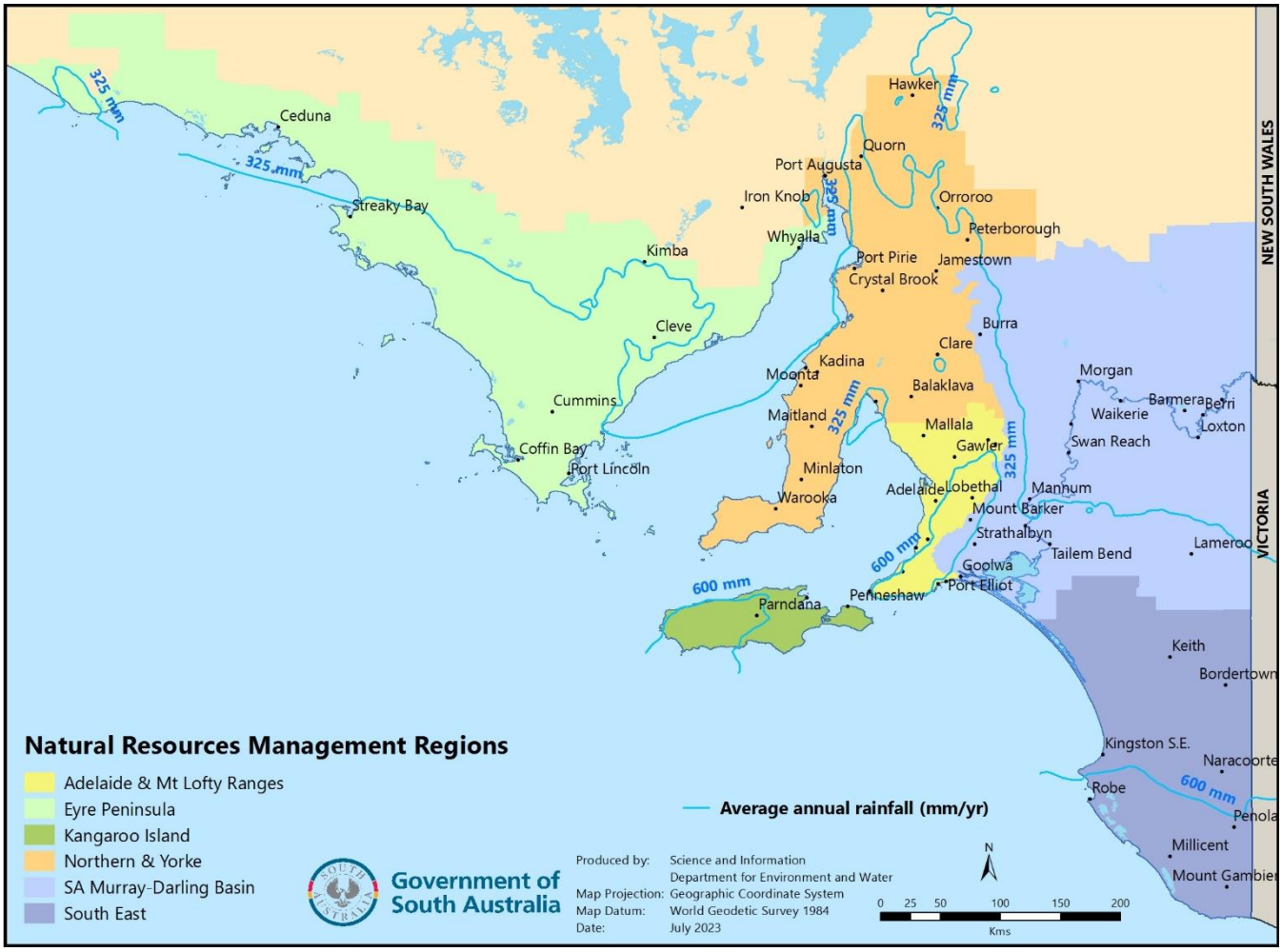


Figure 2.1. Map showing location of NRM regions and rainfall zones used for analysis of land manager survey data

3 Results

Results presented in this section are weighted state means (see Section 2.3) unless otherwise specified.

3.1 Property and crop area

Key points:

- Average property area increased by 68% from 1342 ha to 2250 ha over 2000 to 2017 surveys; highest in EP region (4038 ha in 2017), lowest in AMLR (634 ha)
- Average cropped area per property increased by 58% from 547 to 863 ha; highest in EP (1702 ha in 2017), lowest KI (75 ha)
- Proportion of property area cropped averaged 37% but increased from 547 ha to 863 ha; highest in N&Y region (62% in 2017), lowest KI region (12%)
- Average cropped area as a proportion of property area averaged 37%; no overall change over 2000 to 2017 surveys; highest in N&Y region (62% average); lowest on KI (12%) and the SE (18%) reflecting predominance of other enterprises (e.g. grazed pastures) in these regions.

Property area

The average property area of respondents for the state increased from 1342 ha in the 2000 survey to 2250 ha in the 2017 survey (Figure 3.1). Much of this increase reflected an increasing trend in average property size sampled in the main broadacre cropping regions (EP, SAMDB, N&Y) whereas there was little or no overall change in the SE, AMLR and KI regions. Average property size was inversely related to average rainfall, being highest in the low rainfall zone; for regions this was highest in the EP region (4038 ha in 2017), ranging to lowest in the AMLR region (634 ha).

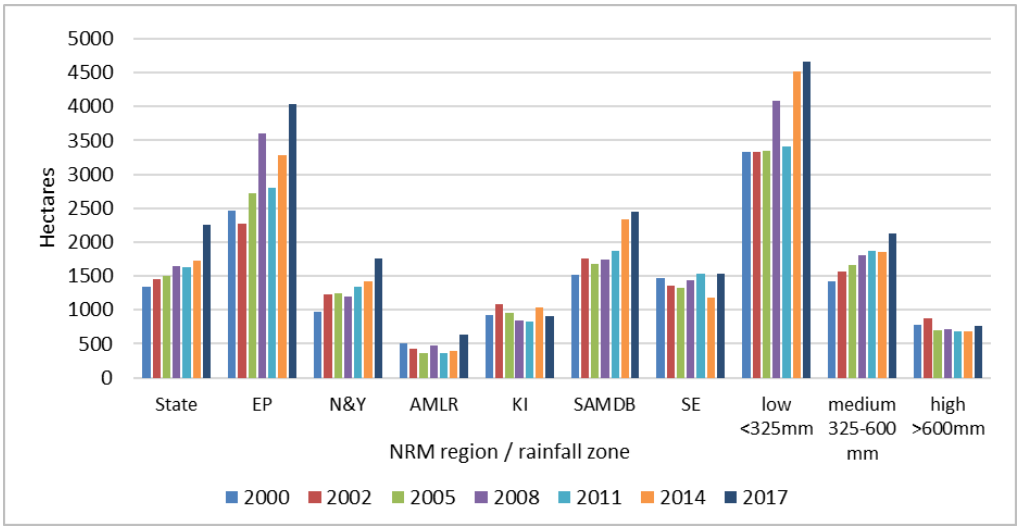


Figure 3.1. Average property area of respondents, 2000–2017 surveys

Cropped area

The average cropped area on respondents' properties generally increased over the survey period in the main cropping regions, i.e. EP, N&Y, SAMDB (Figure 3.2). For the state, this increased from 547 ha in the 2000 survey to 863 ha in the 2017 survey. The highest average cropped area occurred in the low rainfall zone (1753 ha in 2017 survey) and in the EP region (1702 ha), and was lowest in the KI region (75 ha).

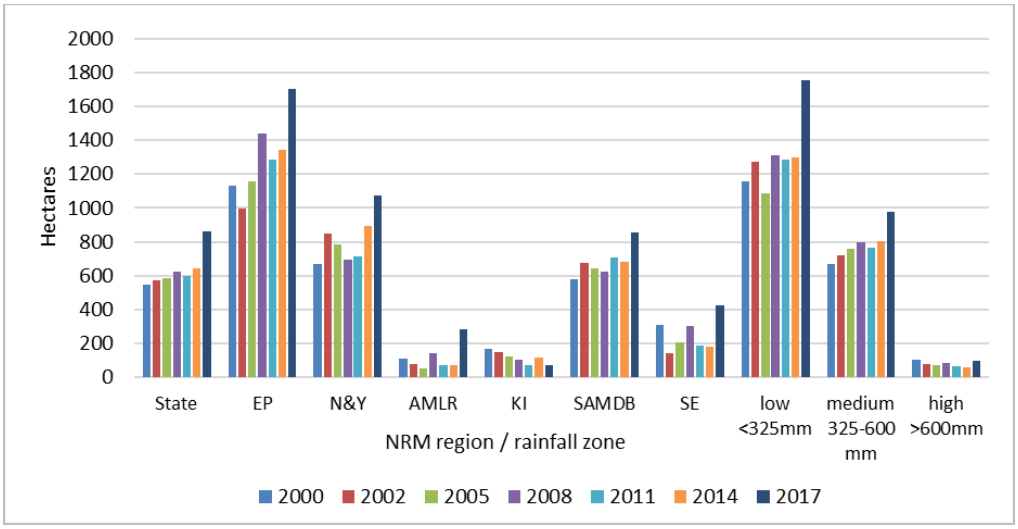


Figure 3.2. Average cropped area on respondents' properties, 2000–2017 surveys

The average cropped area as a proportion of property area averaged 37% for the state, and was fairly constistent throughout the 2000 to 2017 surveys (Table 3.3). The highest proportion was in the N&Y region (62% of property area average), and was lowest in the KI (12%) and SE (18%) regions, reflecting that other enterprises (e.g. grazed pastures) are more predominant in these regions.

Table 3.1. Average cropped area as a proportion (%) of property area for survey respondents (mean of 2000-2017 surveys)

	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325 mm	medium 325-600 mm	high >600 mm
Mean %	37	43	62	25	12	36	18	35	45	11

3.2 Land management issues

Key points:

- Soil/land management issues of most concern in respondents' district: Plant pests (84% mean 2000-2014 surveys), animal pests (75%), soil fertility/nutrition (56%), water repellent soils (38%), wind erosion (36%), soil salinity (34%)
- Other issues less frequently reported: Soil compaction (31%), soil acidity (27%), waterlogging (26%), soil structure decline (24%), native vegetation decline (20%) and water erosion (18%).
- Reported issues of soil salinity, soil structure decline and soil compaction decreased from 2000 to 2014 surveys
- Wind erosion issue more commonly reported in 2000 to 2008 surveys (mean 41%) than 2011 and 2014 surveys (27%)
- Regional variation in many issues: Soil salinity highest in KI (57% mean); wind erosion in EP (54%); soil acidity in KI region (66%)

Soil and land management issues

In surveys from 2000 to 2014, respondents were asked whether they considered various (prompted) soil/land management issues were of concern in their district.

State-wide mean results (Figure 3.3) showed that plant pests (average 84% of respondents over all surveys) and animal pests (75%) were the most highly reported broader land management issues. The animal pests issue appeared to increase over this period, from 67% in the 2000 survey to 81% in 2014.

Of the more specific soil issues, soil fertility/nutrition (i.e. sub-optimal) was the most commonly reported issue (average 56%), followed by water repellent soils (38%) and wind erosion (35%). Soil salinity (34%) was more commonly reported than soil acidity (27%). Soil salinity, soil structure decline and soil compaction tended to show decreasing trends from the 2000 to 2014 surveys. Wind erosion was more commonly reported in the 2000 to 2008 surveys (average 41%) than the 2011 and 2014 surveys (27%), which may reflect a higher incidence of wind erosion events associated with dry seasons which occurred in agricultural areas in the 2002–2009 period that included the 'millennium drought'.

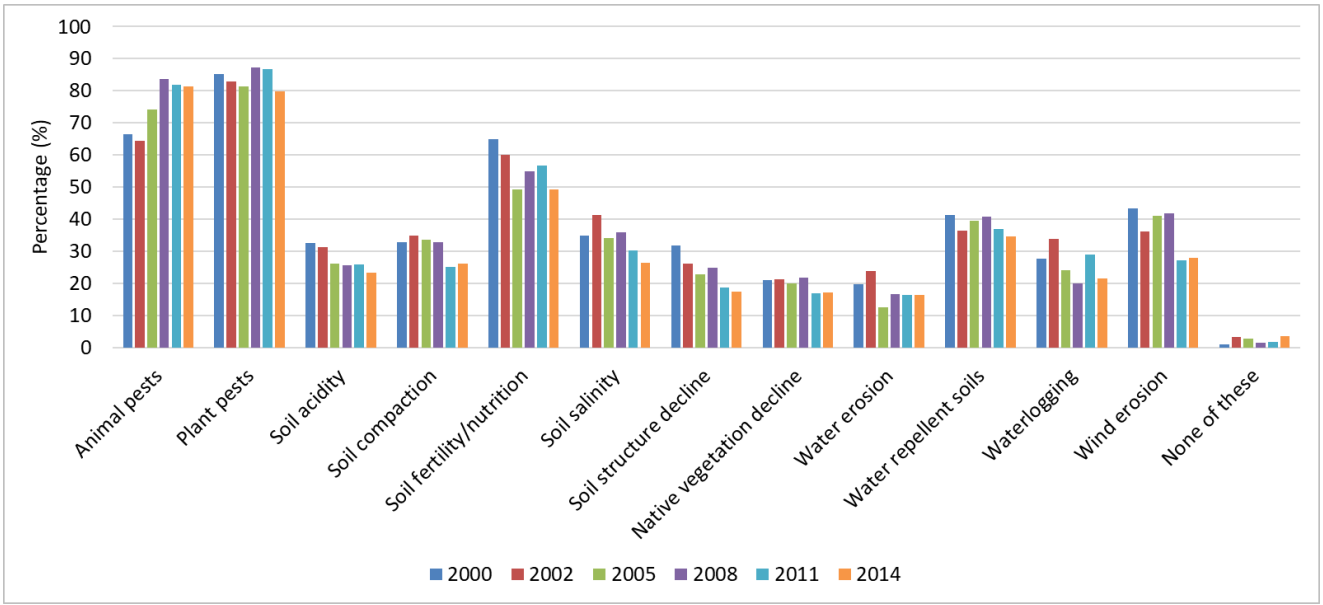


Figure 3.3. Proportion (%) of respondents who consider various soil/land management issues to be important in their district (2000-2014 surveys; prompted responses)

There was considerable variation in the level of responses to some issues across regions and rainfall zones. For example, results of the 2014 survey (Table 3.2) indicated:

- Soil salinity issue was most commonly reported in the KI region (41%) and N&Y region (32%)
- The EP and SAMDB regions were highest for wind erosion (40%), and this issue was highest in the low rainfall zone (52%)
- Water erosion issue was highest in the AMLR (29%)
- Soil acidity was more commonly reported in KI (59%) and AMLR regions (44%), but considerably lower in the SE (23%) suggesting an under-recognition of soil acidity by land managers, as DEW soil data indicate acidity affects about 40% of soils in this region.
- Water repellent soils were most commonly reported in EP region (50%), SE region (47%) and SAMDB region (45%)
- Waterlogging was highest in KI region (46%) and SE region (30%), and high rainfall zone (33%)
- A decreasing trend in the proportion reporting soil compaction, from 2000 to 2014 in EP (42% to 28%) and N&Y regions (50% to 27%), which may be associated with adoption of no-till over this period.

Table 3.2. Proportion (%) of respondents who consider various soil/land management issues to be important in their district (2014 survey; prompted responses)

Issue	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325 mm	medium 325-600 mm	high >600 mm
Animal pests	81	86	77	85	67	79	86	83	82	82
Plant pests	80	85	88	78	57	78	72	81	82	71
Soil fertility/nutrition	49	58	41	42	43	50	57	48	54	44
Water repellent soils	35	50	19	20	37	45	47	39	45	26
Wind erosion	28	40	24	11	9	40	26	52	35	9
Soil compaction	26	28	27	22	20	25	25	19	29	21
Soil salinity	26	26	32	18	41	15	25	22	29	21
Soil acidity	23	25	17	44	59	17	22	11	21	38
Waterlogging	22	20	19	24	46	12	30	3	20	33
Soil structure decline	17	21	14	16	13	16	21	16	20	14
Native veg. decline	17	11	17	25	17	14	21	13	16	20
Water erosion	16	14	21	29	22	14	7	14	14	21

3.3 Tillage

Key points:

- The proportion of croppers reported using no-till methods increased from 28% to 85% (1999 to 2016 seasons); this trend was consistent across regions
- The proportion of reported crop area sown using no-till methods increased from 16% to 83%; this trend was consistent across regions
- Those 'usually' doing long cultivated fallowing decreased from 8% to 2% (2000 to 2011 surveys); the largest change occurred in the low rainfall zone (31% to 6%)
- In 2016, 14% of croppers did some pre-sowing cultivation; mainly for weed control (45%) and to overcome compacted soil (43%); other significant reasons included 'incorporate clay' (21% in SE), 'incorporate stubble' (21% in AMLR), 'disease' (15% in EP and SAMDB).

No-till sowing method

All cropping respondents were asked whether they used no-till methods (defined as low disturbance narrow points or disc openers[4], without prior cultivation) to sow at least some of their crop last year.

Over the survey period, there was a strong upward trend in the percentage of croppers who used no-till methods (Figure 3.4; Table 3.3). In the state overall, this increased from 28% in 1999 (i.e. 2000 survey) to 85% in 2016 (2017 survey). This trend occurred similarly in all regions and rainfall zones. These results are also consistent with the trends in uptake of no-till methods in Australian dryland cropping regions reported by Llewellyn and D'Emden (2009)[5], and in a number of landholder surveys conducted in the Murray Mallee/SAMDB region from 1992 to 2011[6].

Apart from the overall trends, survey by survey results are somewhat variable. This could be partly due to the random sampling of properties each survey, but could also be due to seasonal rainfall variation. After wetter or higher producing seasons, or after significant summer weed growth, it is generally observed that tillage is more often used to manage higher stubble loads and weeds.

[4] Use of narrow disturbance disc openers is usually termed 'zero tillage' but in some surveys this was not specifically asked, so both methods are treated as 'no-till' in analysis of these survey results.

[5] Llewellyn, RS, D'Emden, F (2009). Adoption of no-till farming practices in Australian grain growing regions, report for SA No-till Farmers Association and CAAANZ, June 2009, CSIRO.

[6] McDonough (1992; 2006; 2010); Nelson (2011).

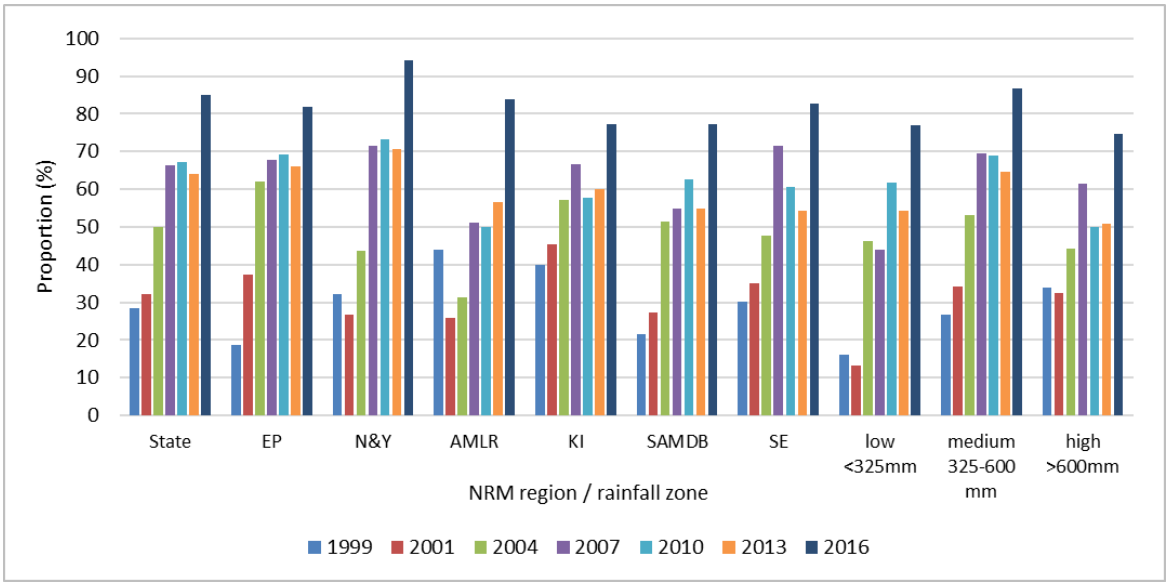


Figure 3.4. Proportion (%) of respondents who use no-till for sowing at least some of their crop

Table 3.3. Proportion (%) of respondents who used no-till for sowing at least some of their crop

Year	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325 mm	medium 325-600 mm	high >600 mm
1999	28	19	32	44	40	21	30	16	27	34
2001	32	37	27	26	45	27	35	13	34	32
2004	50	62	44	31	57	51	48	46	53	44
2007	66	68	72	51	67	55	72	44	70	61
2010	67	69	73	50	58	63	60	62	69	50
2013	64	66	71	57	60	55	54	54	65	51
2016	85	82	94	84	77	77	83	77	87	75

Croppers who used no-till were also asked what area of their crop was sown last year using no-till or other methods.

According to the survey responses, the proportion of crop area sown using no-till across the state increased from 16% in 1999 to 83% in 2016 (Figure 3.5; Table 3.4). This strong upward trend occurred in all NRM regions and rainfall zones. In 2016, at least 70% of the crop area was reported to be sown with no-till in all regions.

The uptake of no-till was slightly lower overall in the low rainfall zone, reaching 66% in 2016. This tends to support general observations that tillage is more commonly used in the low rainfall or marginal cropping areas for cropping preparation and/or summer weed control, where the marginal cost of applying herbicides is higher, relative to cropping returns per hectare.

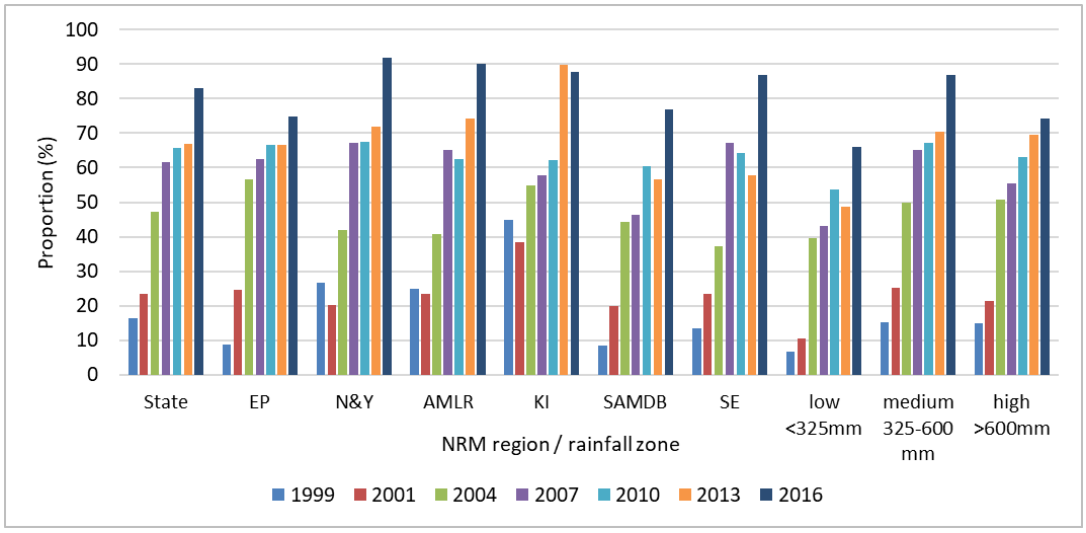


Figure 3.5. Proportion (%) of crop area sown using no-till

Table 3.4. Proportion (%) of crop area sown using no-till

Year	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325 mm	medium 325-600 mm	high >600 mm
1999	16	9	27	25	45	9	14	7	15	15
2001	23	25	20	23	38	20	23	10	25	21
2004	47	57	42	41	55	44	37	40	50	51
2007	62	63	67	65	58	46	67	43	65	55
2010	66	67	67	63	62	60	64	54	67	63
2013	67	67	72	74	90	57	58	49	70	69
2016	83	75	92	90	88	77	87	66	87	74

Cultivated fallowing

Other data for tillage practices collected in these surveys correlated with the adoption of no-till methods. For example, long cultivated fallowing is a cropping preparation method where the soil is cultivated a number of times for a period of months prior to sowing. This was a commonly used method in cropping systems in South Australia in decades prior to this survey period. In these surveys, long cultivated fallowing was defined as where the first cultivation was done before 1st December in the year prior to cropping.

In the 2000 to 2011 surveys, cropping respondents were asked whether they 'usually' did long cultivated fallowing when preparing for cropping. The mean responses for the state decreased from 8% in the 2000 survey to only 2% in 2011 (Figure 3.6). This downward trend generally occurred in the main cropping NRM regions, particularly in the SAMDB region, where this decreased from 17% (2000 survey) to 3% (2011 survey). This is supported by results of a 1992 landholder survey in the Murray Mallee (McDonough, 1992) where 75% of croppers in the northern Mallee and 15% in the southern Mallee used long cultivated fallowing. This trend is highlighted in the results for the low rainfall zone, where responses decreased from 31% to 6% over this period.

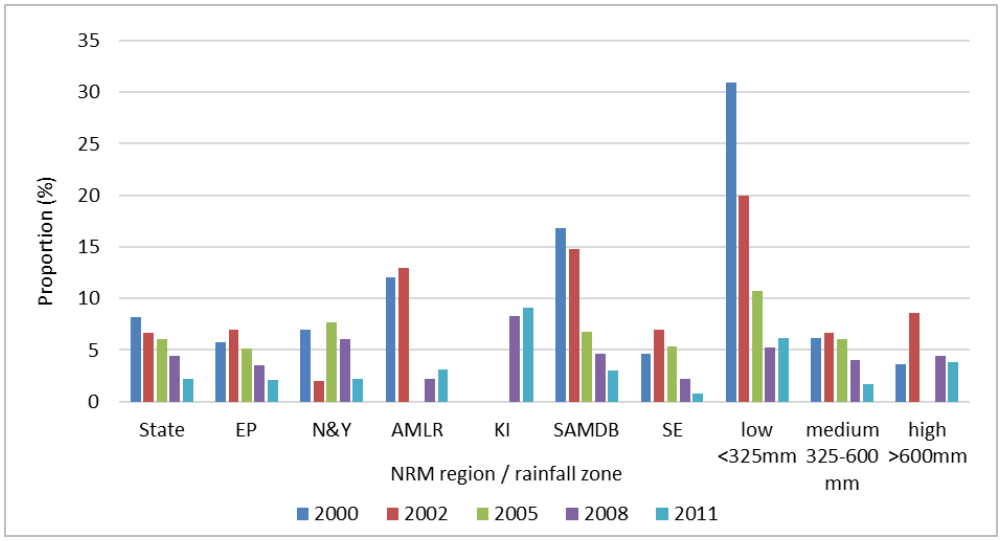


Figure 3.6. Proportion (%) of croppers who usually do long fallowing in preparation for cropping (2000-2011 surveys)

The decreasing use of long fallowing correlates with the increasing adoption of no-till methods by cropping managers over this period. Long cultivated fallowing has traditionally been more commonly used in low rainfall cropping areas, where the cost of using herbicides for weed control relative to crop returns per hectare is typically higher.

Pre-sowing cultivation

In the 2017 survey, a new question asked cropping managers whether they used prior cultivation on any of their crop area last year (2016).

Overall in the state, only 14% used (at least some) pre-sowing cultivation (Figure 3.7), while higher proportions of respondents did this in the low rainfall and high rainfall zones, followed by the SAMDB and EP regions. This data is limited to only one survey year, but does indicate some use of cultivation despite the high adoption of no-till methods by 2016.

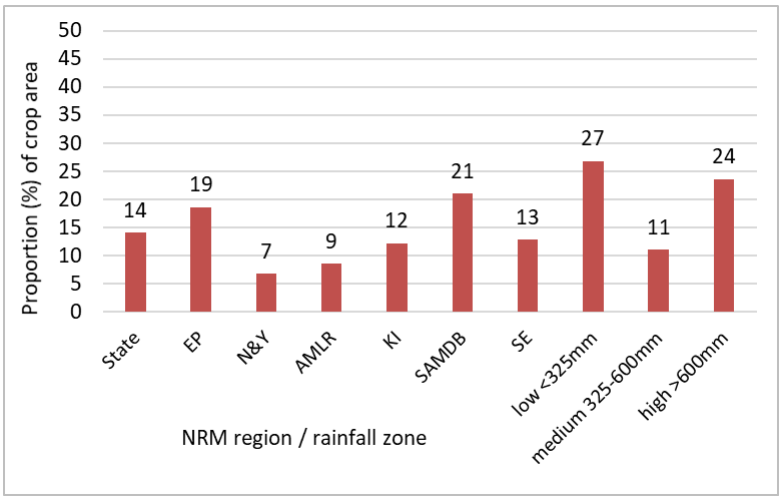


Figure 3.7. Proportion (%) of crop area sown with prior cultivation in 2016 (2017 survey)

Cropping respondents who used cultivation on at least some of their crop land in 2016 were asked the main reasons why they cultivated.

By far the most common reasons given were 'weeds' (45%) and 'to break up compacted soil' (43%), and this was consistent across regions (Table 3.5). Other significantly reported reasons at the regional scale included 'incorporate clay' (21% in SE), 'incorporate stubble' (21% in AMLR), 'disease' (15% in EP and SAMDB).

Table 3.5. Reasons given (%) for cultivation prior to cropping, according to those who used (at least some) cultivation in 2016 (2017 survey; unprompted responses)

Reason	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325 mm	medium 325-600 mm	high >600 mm
Weeds	45	56	50	36	33	48	33	64	43	28
Break up compacted soil	43	35	55	50	56	47	36	42	43	48
Disease	8	15	3	0	0	15	3	13	9	0
Incorporate clay	8	2	0	0	11	4	21	0	9	7
Level uneven ground	8	4	3	0	0	8	14	4	8	10
Incorporate stubble	8	5	8	21	0	1	14	4	6	21
Summer weeds	7	5	8	0	0	6	9	8	7	0
Snails	6	9	8	0	0	4	6	4	5	10
Incorp. other soil amendments	3	2	8	0	0	2	3	0	4	0
Machinery configuration	2	0	0	0	0	6	2	2	3	0
Mice	1	0	3	0	0	0	2	0	1	0
Other	14	13	13	29	44	13	12	4	17	17

It is often noted that cultivation is more commonly done on paddocks being prepared for cropping following a grazed pasture phase or longer term pasture, where the soil can become compacted to some degree.

These results help show that by the end of the survey period, cultivation was usually only done strategically, to manage specific agronomic or soil issues, rather than more routinely for crop preparation, as observed in the past.

3.4 Residue and groundcover management

Key points:

- The proportion of croppers 'usually' burning stubbles/residues before cropping generally decreased: 11% to 4% (2000 to 2017 surveys); most common in the SE region (average 14%) and N&Y region (10%); significant seasonal variation
- In 2016, 40% of croppers burnt (at least some crop land) prior to cropping; 51% did 'full burn' while 41% did 'windrow burn' leaving most stubble unburnt
- Main reasons for burning were 'manage snails' (73%), (93% in high rainfall zone); 'control weeds' (63%); 'reduce stubble loads' (50%)
- Proportion of croppers aiming to leave at least 50% groundcover prior to cropping increased from 58% to 76% (2008 to 2017 surveys)
- Managers implementing confinement feeding of livestock to keep soil protective cover in paddocks increased from 20%-30% to about 50% (2000 to 2014 surveys); slightly more common in the low rainfall zone (61% in 2017 survey), and in N&Y (58%) and EP (57%).

Burning stubbles/residues

Cropping respondents were asked whether they 'usually' burn stubbles or residues prior to cropping.

Results showed marked seasonal variation in the use of burning, but also a general trend of decreasing use of burning over the survey period, from 11% to 4% for the state (2000 to 2017 surveys) (Figure 3.8). It is generally recognised that some of the main reasons for the seasonal variation in burning include the volume of stubble/residues remaining from the previous year (i.e. high volumes can interfere with the seeding operation) and the perceived threat to crops from pests such as mice or snails.

Overall, burning was most commonly done in the SE region, followed by the KI and N&Y regions. This was a more common practice in high to medium rainfall zones, where high stubble loads and pest threats are likely to be greater issues.

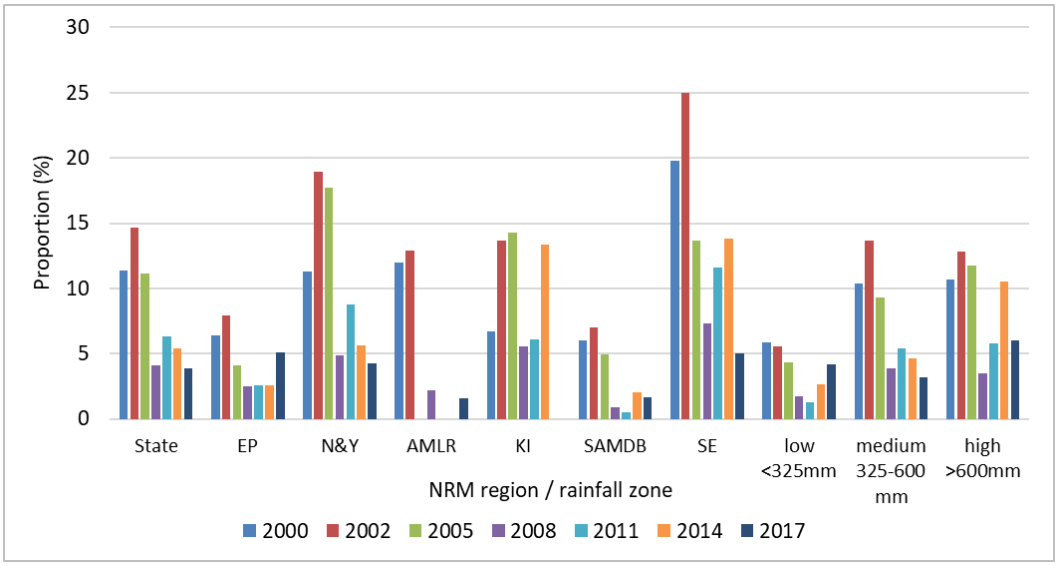


Figure 3.8. Proportion (%) of croppers who usually burn stubbles/residues prior to cropping

In the 2017 survey, an average of 40% of croppers (state mean) burnt at least some of their cropping land prior to cropping in 2016 (Table 3.6).

Table 3.6. Proportion (%) croppers who burnt (at least some) stubbles/residues prior to cropping in 2016 (2017 survey)

	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325 mm	medium 325-600 mm	high >600 mm
%	40	44	42	35	33	35	38	31	42	28

Cropping respondents who burnt in 2016 were also asked about the type(s) of burning operation they did (unprompted). Overall, 'full' burning (51% for the state) and 'windrow' burning (41%) were the most commonly used methods (Figure 3.9). Windrow burning was most common in the high rainfall zone (56%).

Windrow burning refers to the narrow row of chaff left by the header, where stubble in the rest of the paddock is not burnt and remains to protect the soil from erosion. This method is strategically used to destroy weed seeds in the chaff. 'Stubble dump' burning similarly burns heaps of chaff left from harvest, leaving most of the paddock with unburnt stubble.

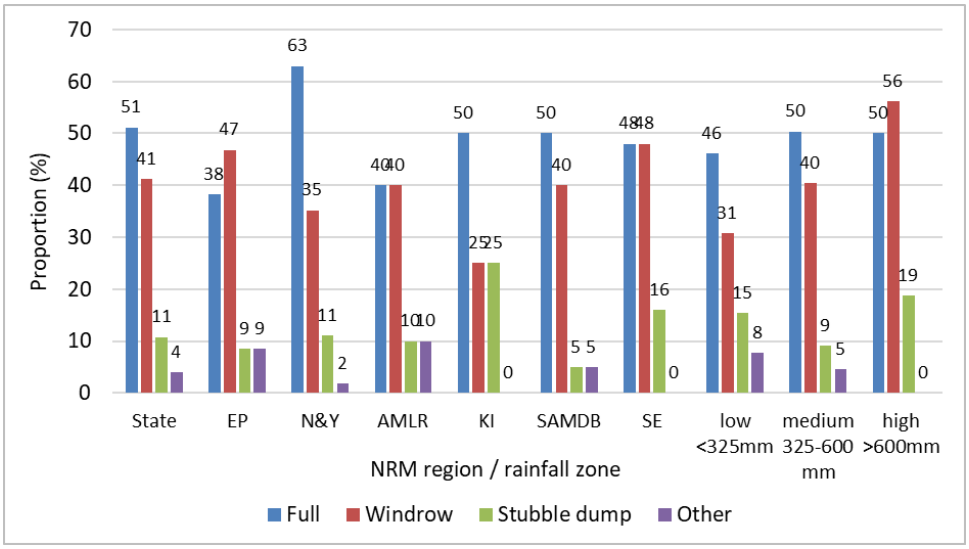


Figure 3.9. Type(s) of burning done (%), croppers who burnt stubbles/residues in 2016 (2017 survey; unprompted responses)

Cropping respondents who burnt some stubbles or residues in 2016 were asked in a new question what their main reasons were for burning (prompted responses).

The responses (Figure 3.10) showed there were three main reasons for burning: 'Manage snails' (73% for the state), 'control weeds' (63%) and 'reduce stubble loads' (50%) which were all reported by over 30% of managers across the regions and rainfall zones. Burning to manage snails was highest in the high rainfall zone (93%), while burning for weed control was most common in the AMLR region (91%).

These results show that issues of high stubble load and snails tend to be greater in higher rainfall areas.

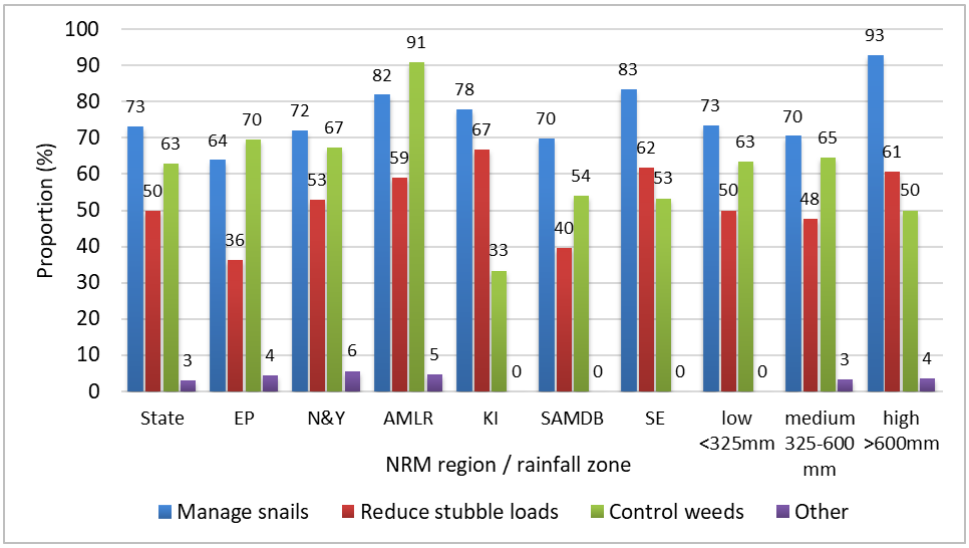


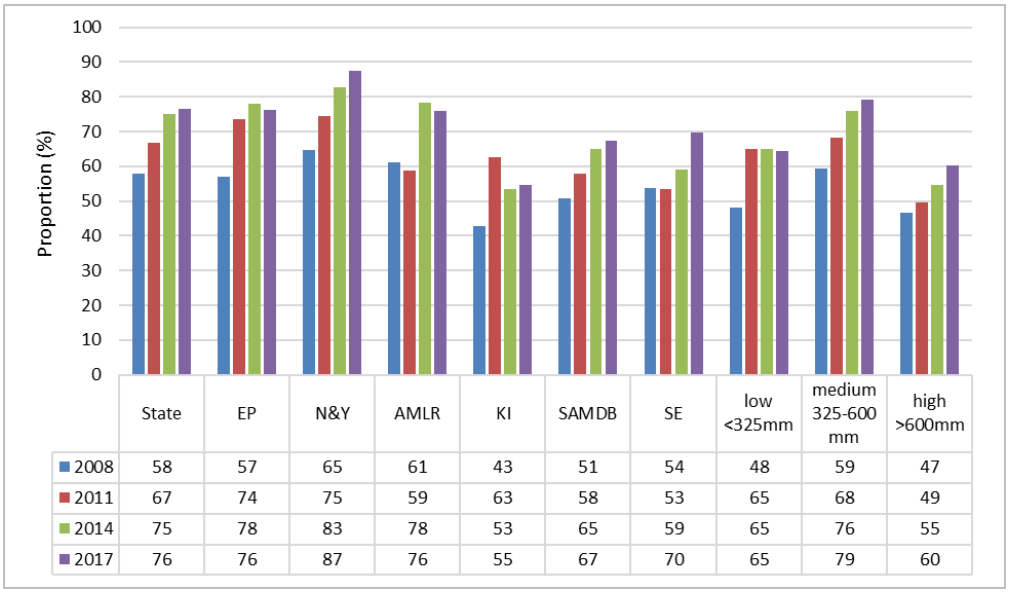
Figure 3.10. Reasons (%) for burning, croppers who burnt stubbles/residues in 2016 (2017 survey; prompted responses)

Stubble retention

In the 2008 to 2017 surveys, cropping respondents were asked the approximate groundcover percentage of stubble/residue they aim to leave on the soil immediately prior to sowing (prompted nearest to 0%, 25%, 50%, 75% or 100%).

Results (Figure 3.11) show that the proportion of cropping farmers aiming to leave on average at least 50% cover of stubble/residues on the surface immediately prior to sowing their crops increased from 58% (state; 2008 survey) to 76% (2017 survey). This trend was fairly consistent in all regions, and is consistent with the increased use of no-till over this period.

Retention of increasingly higher levels of stubble/residue cover prior to cropping has been facilitated by improvements in trash clearance of seeding implements and GPS guidance technology (i.e. ability to sow between last year's standing stubble rows).



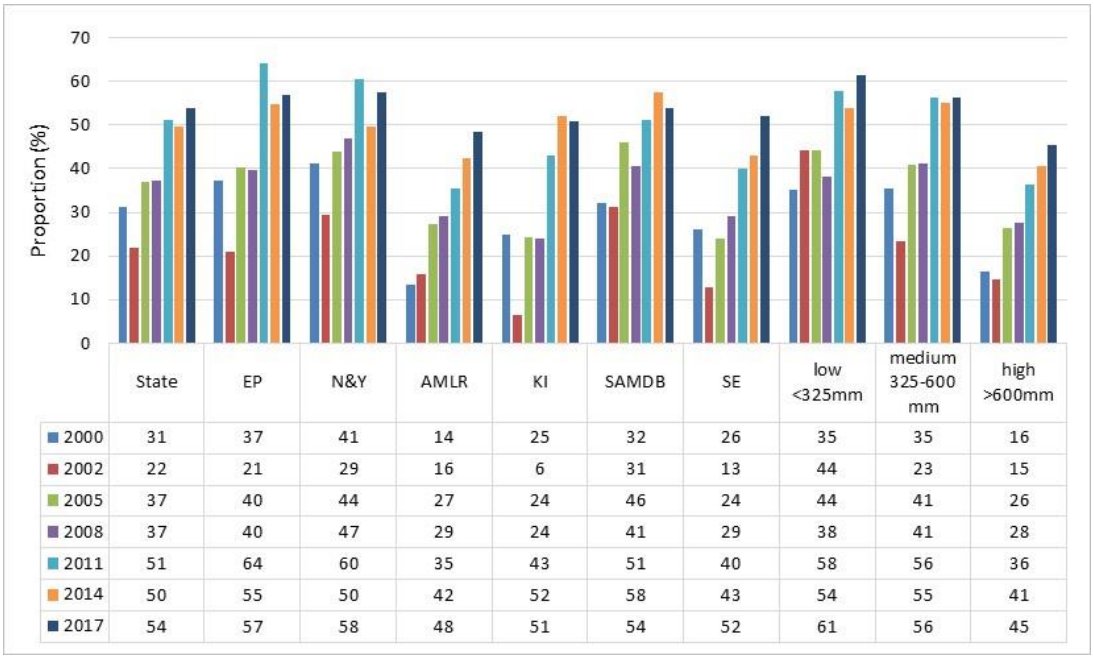
	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325mm	medium 325-600 mm	high >600mm
2008	58	57	65	61	43	51	54	48	59	47
2011	67	74	75	59	63	58	53	65	68	49
2014	75	78	83	78	53	65	59	65	76	55
2017	76	76	87	76	55	67	70	65	79	60

Figure 3.11. Proportion (%) of croppers who aim to leave at least 50% ground cover in paddocks prior to sowing (2008-2017 surveys)

Confinement feeding livestock

Removing stock from paddocks and feeding them in containment areas, particularly in the autumn to early winter period helps retain protective surface cover in paddocks. The proportion of managers in SA (who have or manage livestock) who reported using this practice increased from around 20%-30% in the 2000-2002 surveys to about 50% in the 2011-2014 surveys (Figure 3.12). This was done slightly more frequently in the low rainfall zone (61% in 2017 survey), and in the N&Y (58%) and EP region (57%). In the 2011 and 2014 surveys this was done by over 50% of managers in low to medium rainfall zones.

Supplementary feeding of stock in paddocks (i.e. not confinement areas) is also commonly done through summer and autumn when pasture feed quantity and quality declines, although this may not necessarily preserve surface cover in paddocks.



	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325mm	medium 325-600 mm	high >600mm
2000	31	37	41	14	25	32	26	35	35	16
2002	22	21	29	16	6	31	13	44	23	15
2005	37	40	44	27	24	46	24	44	41	26
2008	37	40	47	29	24	41	29	38	41	28
2011	51	64	60	35	43	51	40	58	56	36
2014	50	55	50	42	52	58	43	54	55	41
2017	54	57	58	48	51	54	52	61	56	45

Figure 3.12. Proportion (%) of land managers with livestock who confinement feed their stock when necessary to maintain paddock cover

These survey results indicate that most farmers are increasingly using practices that protect the soil from erosion, apart from burning residues where they are perceived to be likely to cause problems for establishment of next season's crops.

The uptake of improved land management practices over the survey period, particularly no-till and stubble retention, correlates with the improving trend in protection of agricultural cropping land from wind and water erosion, which has been monitored by DEW since 2000[7].

[7] Forward GR (2021). Soil protection progress report July 2021, South Australia's agricultural lands, DEW.

3.5 Soil acidity

Key points:

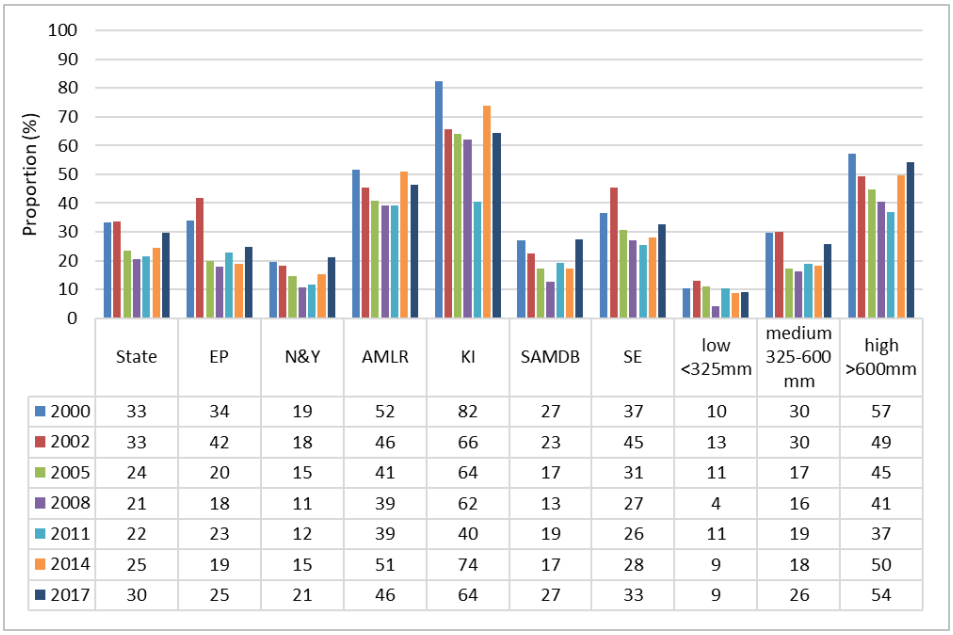
- About 20-30% of respondents (mean of all surveys) stated they had acid soils; highest in KI region (65%) and AMLR (45%); 32% in SE region
- Proportion of respondents saying they have sub-surface acidity (below 10cm depth) increased from 8% to 13% (2011 to 2017 surveys)
- About 60% to 80% with acid soils said they do regular soil testing, indicating some don't regularly monitor soil pH
- Survey questions asked of acid soil managers show there is some misunderstanding of the causes of, and treatments for acid soils; for example, 42% (2017 survey) wrongly believed gypsum could be used to treat acid soils
- Around 50% - 60% of acid soil managers could correctly identify the critical soil pH for acidity in the range pH 4.5 – 6.0 (regardless of test method), indicating the remainder have limited understanding of soil pH
- The main information sources used to manage acid soils were 'agronomist/consultant' 44%, and DEWNR/PIRSA staff 19%
- About 65%-75% had applied lime to some or all of their acid soils at any time
- On average, two thirds limed on the basis of 'soil test results', one third according to advice of 'consultant/agronomist'
- For those that didn't lime (some/all of acid soils), the main reason given was 'too expensive' (41% mean)
- About 37% of acid soil managers had used options other than liming on acid soils: Adapting fertiliser strategies (11%), clay spreading (10%), and acid tolerant plants (9%).

Incidence of acid soils

According to surveys from 2000 to 2017, around 20-30% of respondents in the state considered they had acid soils on their property (Figure 3.13). Responses were highest in the KI region (65%; mean of all surveys), followed by the AMLR region (45%). This issue was most commonly reported by respondents in the high rainfall zone overall (48%), which correlates with the known higher incidence of soil acidity in higher rainfall agricultural areas in the state. The highest regional incidence reported was in the KI region (65%), AMLR (45%) and SE region (32%), which are lower than the mapped extent of acid agricultural soils in these regions (84%; 59%; 42% respectively)[8].

In the 2011 to 2017 surveys, respondents were also asked if they considered they had sub-surface soil acidity (below 10cm) on their property). On average, 10% of respondents said sub-surface acidity existed on their property; the highest response was from KI (28% on average) followed by AMLR (23%) (Figure 3.14). The results interestingly show an increase in reported sub-surface acidity from the 2011 to 2017 surveys in most regions, suggesting increased diagnosis and/or awareness of this issue, particularly on KI.

[8] State Land and Soil and Land Information Framework, Department for Environment and Water



	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325mm	medium 325-600 mm	high >600mm
2000	33	34	19	52	82	27	37	10	30	57
2002	33	42	18	46	66	23	45	13	30	49
2005	24	20	15	41	64	17	31	11	17	45
2008	21	18	11	39	62	13	27	4	16	41
2011	22	23	12	39	40	19	26	11	19	37
2014	25	19	15	51	74	17	28	9	18	50
2017	30	25	21	46	64	27	33	9	26	54

Figure 3.13. Proportion (%) of land managers reporting they have acid soils on their property

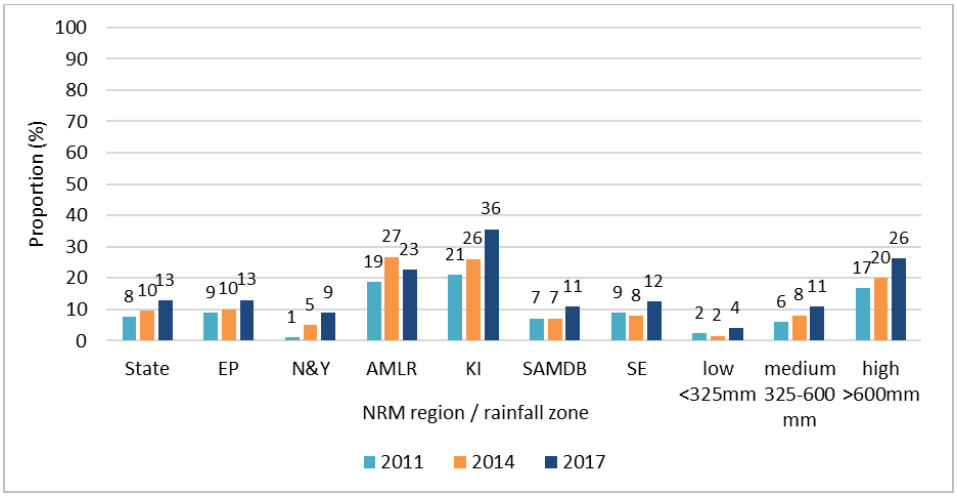


Figure 3.14. Proportion (%) of land managers reporting they have sub-surface acidity on their property (2011, 2014, 2017 surveys)

Soil pH testing

Survey respondents were asked whether they did regular soil testing (for nutrition/pH; 2000 to 2014 surveys).

Results indicated that around 60–80% of landholders in SA with acid soils do regular soil testing (Figure 3.15). This is a good result although it is a concern that the remaining 20–30% don't appear to monitor their soil pH regularly enough. Results for KI appeared to drop following the 2002 survey; this may partly reflect inaccurate results from a limited sample size.

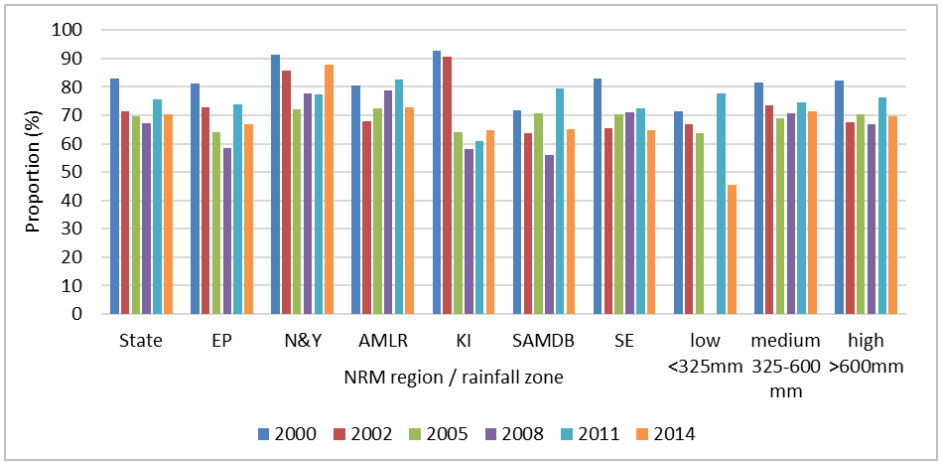


Figure 3.15. Proportion (%) of land managers with acid soils who regularly soil test, (2000 – 2014 surveys; low rainfall zone has low sample size)

Understanding of causes and treatments

In the surveys, managers with acid soils were read out a set of statements about acid soils and asked to say whether they thought the statements were true or false (or don't know).

Results indicated some misunderstanding about the causes and treatments of soil acidity (Figure 3.16). For example, in 2017, 42% of acid soil respondents mistakenly considered that gypsum could be used to treat soil acidity, and more than half wrongly thought that superphosphate application was a direct cause of acidity. A high proportion (81%) correctly understood that it is beneficial to apply lime before signs of production decline appear due to acidity. Results were similar in earlier surveys. Across regions (Table 3.7) the results were generally similar, except that KI respondents had a better understanding that gypsum is not suited to treating acid soils (only 28% answered 'true' on average).

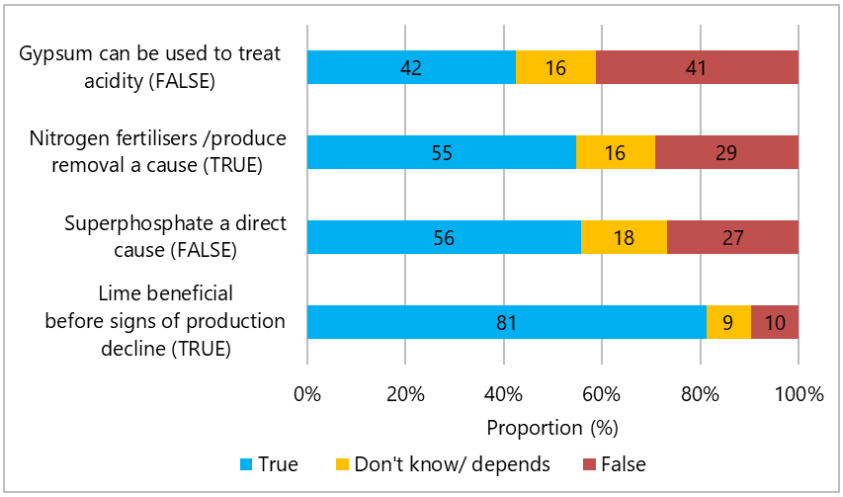


Figure 3.16. Responses (%) of land managers with acid soils to statements about acid soils (state means, 2017 survey)

Table 3.7. Responses (%) of land managers with acid soils to statements about acid soils (2017 survey)

Region / rainfall zone	Response	Lime beneficial before signs of production decline (TRUE)	Superphosphate a direct cause (FALSE)	Nitrogen fertilisers / produce removal are causes (TRUE)	Gypsum can be used to treat acidity (FALSE)
State	True	81	56	55	42
	Don't know	9	18	16	16
	False	10	27	29	41
EP	True	86	56	62	52
	Don't know	10	16	14	4
	False	4	28	24	44
N&Y	True	83	47	59	41
	Don't know	7	17	15	15
	False	10	36	25	44
AMLR	True	85	58	52	48
	Don't know	11	21	23	10
	False	4	21	25	42
KI	True	85	58	48	28
	Don't know	3	10	18	33
	False	13	33	35	40
SAMDB	True	66	59	49	45
	Don't know	18	22	19	22
	False	16	19	32	33
SE	True	86	58	54	37
	Don't know	5	16	12	19
	False	10	27	34	43
Low <325mm	True	62	38	46	77
	Don't know	38	31	31	8
	False	0	31	23	15
Medium 325 – 600mm	True	80	54	54	44
	Don't know	10	17	13	16
	False	10	29	32	40
High >600mm	True	85	60	54	38
	Don't know	6	17	20	18
	False	10	23	26	44

Critical pH for acidity

Managers with acid soils were asked if they could give the critical soil pH level for acidity in relation to agricultural crops and pastures.

The proportion who could correctly identify the critical soil pH for acidity in the range pH 4.5 – 6.0 (regardless of test method) was around 50% - 60% in the state. There appeared to be a slight increase in correct responses in some regions over the period from the 2000 to 2014 surveys (Figure 3.17). Overall however, this suggests there is limited understanding among some managers of critical soil pH levels in relation to soil acidity in agricultural systems as at least 40% of respondents could not identify the critical pH range for acidity.

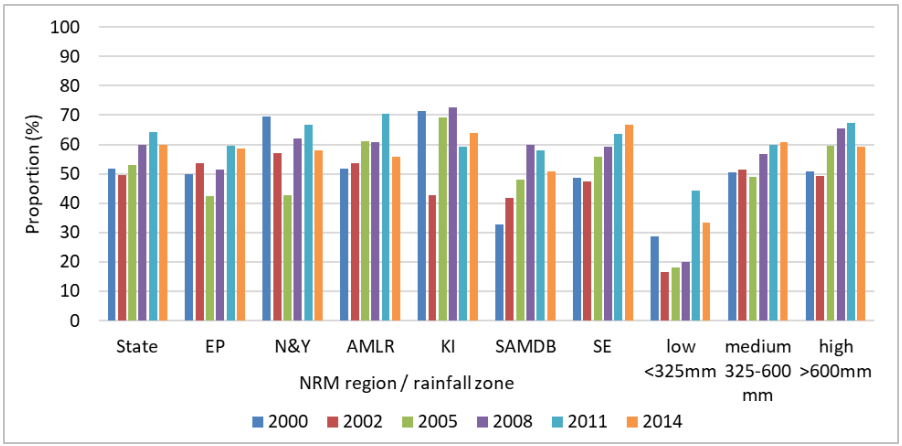


Figure 3.17. Proportion (%) of land managers with acid soils who could correctly state the critical soil pH level for acidity (within range pH 4.5-6) (2000–2014 surveys)

Sources of information

Managers with acid soils were asked what sources of information (if any) they had used in regard to treating acid soils (2005 surveys onwards).

About 70%-75% of managers overall said they had sought information on treating soil acidity. By far the most common source used was agronomists/consultants (44%) followed by DEWNR/PIRSA staff (19%) (Figure 3.18). Responses across regions were similar except for KI which had lower use of private agronomists/consultants (30% average), and higher use of DEWNR/PIRSA staff (38%) for advice.

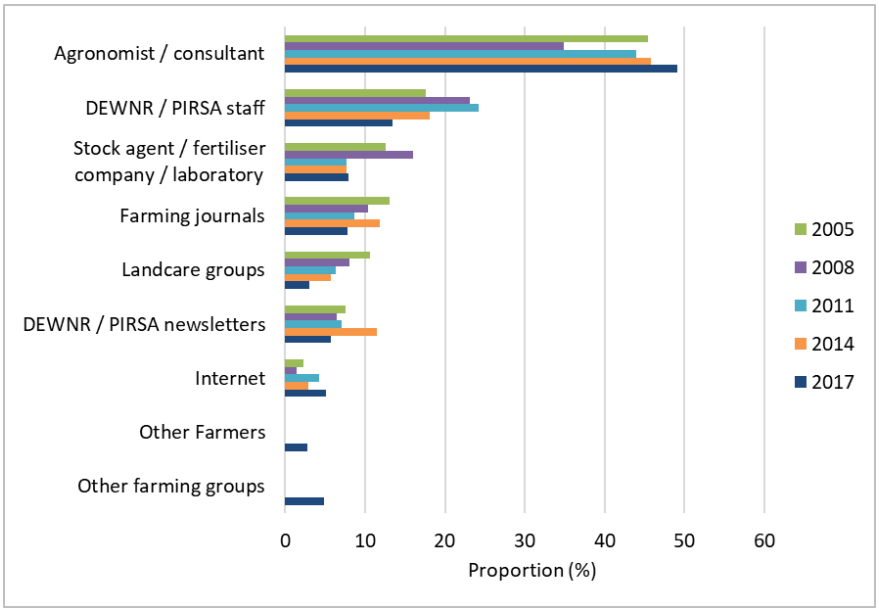
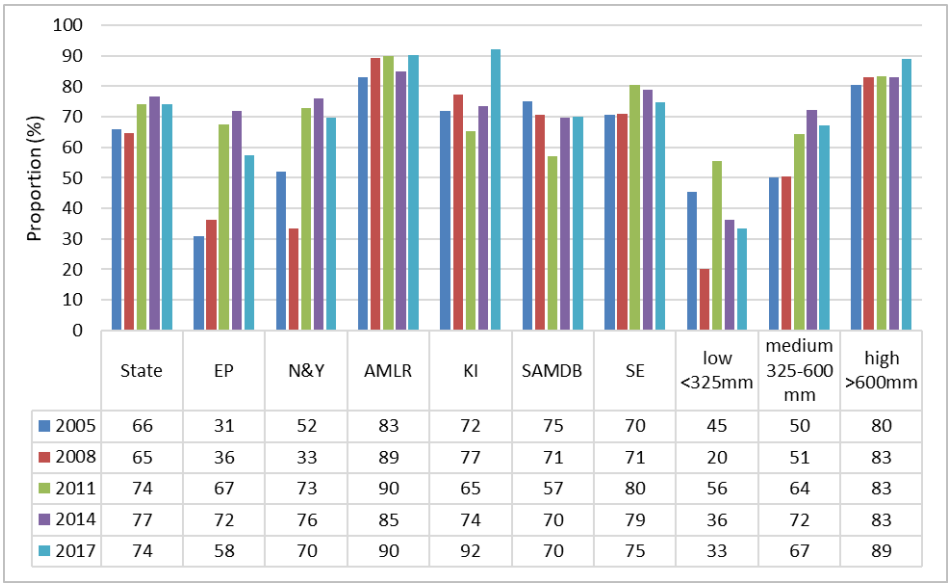


Figure 3.18. Sources of information (%) used by managers with acid soils to manage/treat soil acidity (state means, 2005–2017 surveys; unprompted responses)

Liming

The proportion of managers with acid soils who said they had applied lime products to at least some of their acid soils at any time was around 65% in the 2005-2008 surveys, increasing slightly to 74% in the 2017 survey (Figure 3.19). Application of lime was most common in the AMLR region (mean 87%). In the EP and N&Y regions, liming was less common compared to other regions in the 2005 and 2008 surveys but increased in the later surveys to similar levels to the other regions.

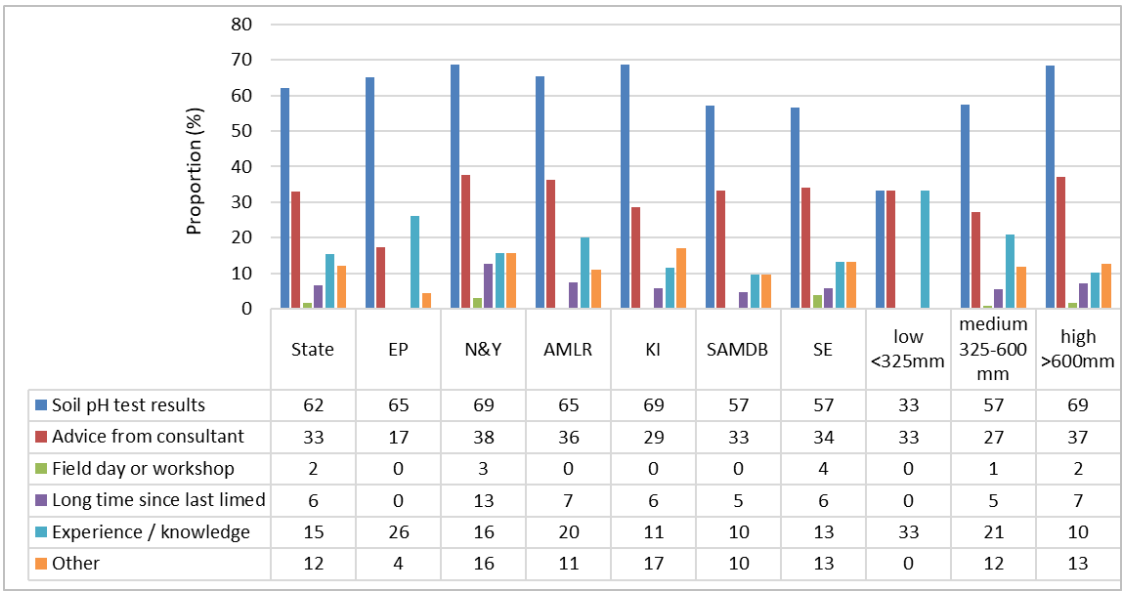


	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325mm	medium 325-600 mm	high >600mm
2005	66	31	52	83	72	75	70	45	50	80
2008	65	36	33	89	77	71	71	20	51	83
2011	74	67	73	90	65	57	80	56	64	83
2014	77	72	76	85	74	70	79	36	72	83
2017	74	58	70	90	92	70	75	33	67	89

Figure 3.19. Proportion (%) of land managers with acid soils who had applied lime products to some/all of their acid soils at any time (2005 – 2017 surveys)

In the 2014 and 2017 surveys, these respondents were asked what prompted them to apply lime.

Results from the 2017 survey showed that overall, about two thirds of managers limed on the basis of soil pH test results, while about a third did this on advice from consultants (Figure 3.20). Responses were similar for the 2014 survey. Eyre Peninsula respondents indicated less use of consultants' advice (17%) but slightly more reliance on experience/knowledge (26%) compared to other regions.



	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325mm	medium 325-600 mm	high >600mm
Soil pH test results	62	65	69	65	69	57	57	33	57	69
Advice from consultant	33	17	38	36	29	33	34	33	27	37
Field day or workshop	2	0	3	0	0	0	4	0	1	2
Long time since last limed	6	0	13	7	6	5	6	0	5	7
Experience / knowledge	15	26	16	20	11	10	13	33	21	10
Other	12	4	16	11	17	10	13	0	12	13

Figure 3.20. Reasons (%) prompting managers with acid soils to apply lime (2017 survey, unprompted responses; low sample size in low rainfall zone)

The main reason given by landholders for not liming some or all of their acid soils was the perceived high cost of lime (41%) (Figure 3.21). Other reasons included 'not severe enough' (18%), 'not worthwhile financially' (14%), 'not necessary' (10%), and 'lack of time' (7%). There are anecdotal indications that many managers tend to make liming

a lower priority than annual farming input costs such as fertiliser and chemicals, leaving it until after better producing seasons.

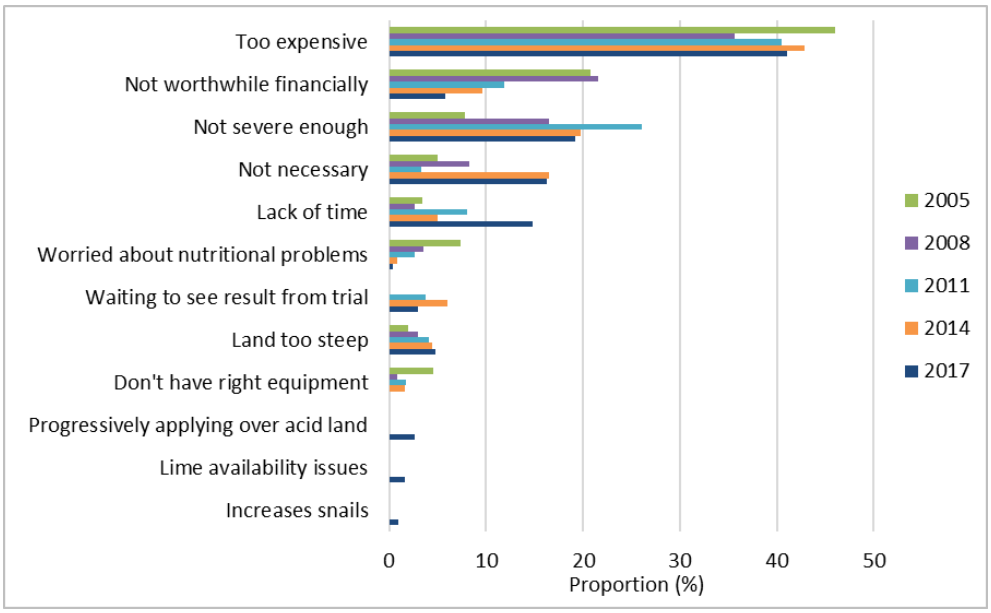
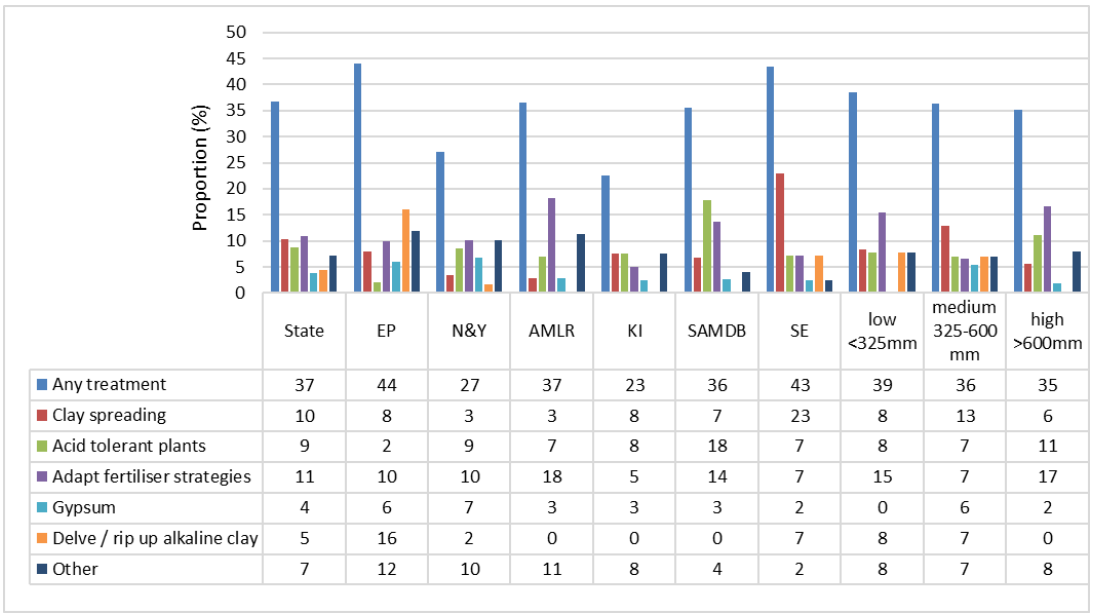


Figure 3.21. Reasons (%) given by managers with acid soils for not applying lime to some/all of their acid soils (state means, 2005-2017 surveys; unprompted responses)

Other management options

In the 2017 survey, about 37% of respondents with acid soils said they had used options other than liming to manage acid soils, including adapting fertiliser strategies (11%), clay spreading (10%), and acid tolerant plants (9%) (Figure 3.22). There were some regional variations: Clay spreading was higher in the SE (23%); SAMDB had higher use of acid tolerant plants (18%); in AMLR more did 'adapting fertiliser strategies' (18%), and EP had higher use of delving alkaline clay (16%).



	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325mm	medium 325-600 mm	high >600mm
Any treatment	37	44	27	37	23	36	43	39	36	35
Clay spreading	10	8	3	3	8	7	23	8	13	6
Acid tolerant plants	9	2	9	7	8	18	7	8	7	11
Adapt fertiliser strategies	11	10	10	18	5	14	7	15	7	17
Gypsum	4	6	7	3	3	3	2	0	6	2
Delve / rip up alkaline clay	5	16	2	0	0	0	7	8	7	0
Other	7	12	10	11	8	4	2	8	7	8

Figure 3.22. Proportion (%) of acid soil treatments other than liming done by managers with acid soils (2017 survey; unprompted responses)

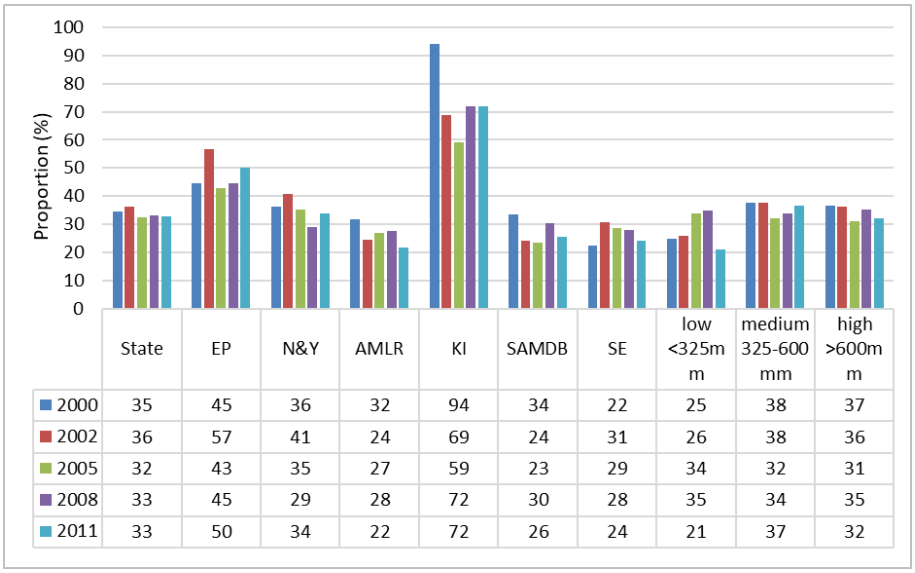
3.6 Soil salinity

Key points:

- About 34% of respondents (mean of 2000-2011 surveys) stated they had soil salinity on their property; highest incidence in KI (73%) and EP (48%)
- Of those with salinity, 81% had done on-site treatment(s); the most common were planting trees (34%), and fencing the saline area to exclude livestock (24%, and 49% on KI); in the SE 31% had planted salt tolerant pasture, 27% installed drains, and 27% planted perennial grass
- About 24% of all land managers reported they had implemented off-site practices to control salinity; the more common practices were 'revegetate surrounding land' (6%), planting trees (6%), perennial grasses (4%), Lucerne (3%), 'fence off/remove stock' (3%; 14% on KI).

Incidence of salinity

Interviewees were asked questions about soil salinity in surveys from 2000 to 2011. On average, about 34% of respondents across the state said they had saline soils; the highest frequency was in KI (73% mean) followed by EP (48%) (Figure 3.23). The interview questions did not probe whether responses included dry saline land (magnesia patches). There were no major trends in the reported incidence of salinity.



	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325mm	medium 325-600 mm	high >600mm
2000	35	45	36	32	94	34	22	25	38	37
2002	36	57	41	24	69	24	31	26	38	36
2005	32	43	35	27	59	23	29	34	32	31
2008	33	45	29	28	72	30	28	35	34	35
2011	33	50	34	22	72	26	24	21	37	32

Figure 3.23. Proportion (%) of respondents who said they had soil salinity on their property (2000 – 2011 surveys)

Management practices

On average, 81% of land managers with saline land across the state indicated they had implemented some form of on-site treatment to manage their saline land (Table 3.8). The most common treatments reported were planting trees (34%), and fencing the saline area to exclude livestock (24%) (Table 3.9). Other treatments included planting saltbush or shrubs (18%), establishing salt tolerant pasture (17%) or perennial grasses (16%), installing drains (10%) and planting Lucerne (7%). 'Fencing off from livestock' was common on KI (49%), while in the SE, 31% had planted salt tolerant pasture, 27% had installed drains, and 27% had planted perennial grass.

Table 3.8. Proportion (%) of respondents with saline land who have done any on-site activities to control salinity (mean of surveys 2000–2011)

	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325 mm	medium 325-600 mm	high >600 mm
Mean %	81	84	81	65	88	74	85	59	84	77

Table 3.9. Proportion (%) of respondents with saline land who have done various on-site activities to control salinity (mean of surveys 2000–2011)

Practice	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325 mm	medium 325-600 mm	high >600 mm
Trees	34	41	35	37	40	35	19	14	38	35
Fence / remove stock	24	34	27	21	49	17	10	10	26	29
Saltbush / shrubs	18	24	24	9	3	15	10	14	22	6
Salt tolerant pasture	17	18	12	8	18	12	31	10	18	16
Perennial grass	16	15	11	13	22	15	27	8	16	19
Install drains	10	10	2	9	8	7	27	5	9	14
Lucerne	7	7	6	1	4	8	10	2	9	3
Mulch / manure	4	4	7	2	5	3	1	9	4	3
Other	10	9	15	5	8	9	7	10	10	7

In addition, about 24% of all land managers (regardless of whether they had saline land on their property) reported they had implemented off-site practices to control salinity (Table 3.10). The more common practices used were 'revegetate surrounding land' (6% mean), planting trees (6%), perennial grasses (4%), Lucerne (3%), and 'fence off/remove stock' (3%) (Table 3.11). The highest proportion of respondents had fenced off/removed stock on KI (14%).

Table 3.10. Proportion (%) of respondents who have done any off-site activities to control salinity (mean of surveys 2000–2011; all respondents)

	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325 mm	medium 325-600 mm	high >600 mm
Mean %	24	27	17	21	37	24	30	16	26	26

Table 3.11. Proportion (%) of respondents with saline land who have done various off-site activities to control salinity (mean of surveys 2005–2011)

Practice	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325 mm	medium 325-600 mm	high >600 mm
Revegetate surrounding land	6	6	6	5	8	5	4	3	6	6
Trees	6	9	6	3	9	6	6	4	7	5
Perennial grass	4	5	2	2	8	3	5	3	4	4
Lucerne	3	3	1	1	1	3	8	2	4	1
Install drains	2	2	1	1	4	1	6	1	2	3
Fence off / remove stock	3	5	2	5	14	3	2	1	3	6
Improve WUE	1	2	1	2	2	1	1	1	2	1
Less tillage	2	4	2	0	0	1	1	2	2	0
Other	1	3	1	2	2	1	1	2	2	1

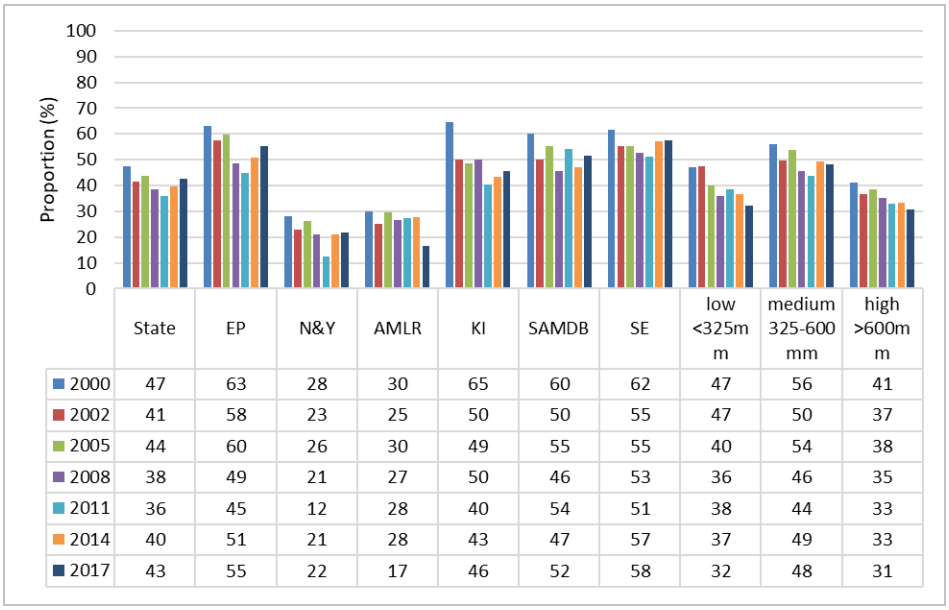
3.7 Water repellent soils

Key points:

- About 40% of respondents (mean of all surveys) had water repellent soils on their property; higher (40% - 60%) in the EP, KI, SAMDB and SE regions; lower (<30%) in the N&Y and AMLR regions
- The proportion of respondents with water repellent soils using practice(s) to manage or treat water repellent soils increased from 51% (2000 survey) to 71% (2017 survey)
- Clay spreading increased from 19% to 38%; clay delving from 5% to 28% over this period; use of modified sowing technology was also common (39% mean)
- Claying (spreading or delving) was most common on EP (66% in 2017 survey), SE (56%), and the medium rainfall (325-600 mm) zone (54%); less common in the lower rainfall zone (9%)
- Overall, 94% of respondents (mean 2014, 2017 surveys) stated some benefit(s) of claying: 'Increased yields or plant growth' (60%); 'more even/improved plant establishment' (41%); 'better soil wetting/water retention' (26%); 'reduced wind erosion risk' (23%)
- Negative impacts of claying were reported by 71% of respondents: Most common were 'rough surface from delving' (27%), 'high cost' (17%); overall these were less frequently reported in 2017 than in 2014 survey
- Time period when claying first done on respondents' properties (2014 survey): Overall earlier adoption in the SE (34% pre-1994); mainly more recently on KI (100% since 1999) and high rainfall zone (95%).

Incidence of water repellent soils

On average, about 40% of survey respondents across the state reported they had water repellent soils on their property (Figure 3.24). This varied considerably between regions: around 40% - 60% in the EP, KI, SAMDB and SE regions; less than 30% in the N&Y and AMLR regions.

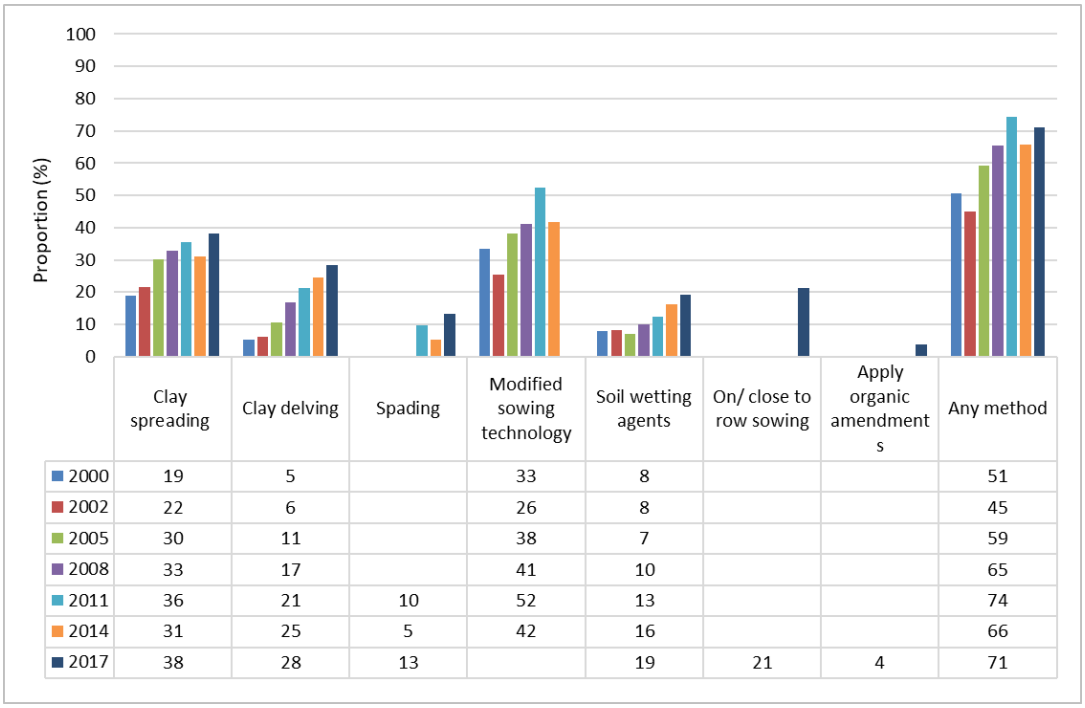


	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325mm	medium 325-600 mm	high >600mm
2000	47	63	28	30	65	60	62	47	56	41
2002	41	58	23	25	50	50	55	47	50	37
2005	44	60	26	30	49	55	55	40	54	38
2008	38	49	21	27	50	46	53	36	46	35
2011	36	45	12	28	40	54	51	38	44	33
2014	40	51	21	28	43	47	57	37	49	33
2017	43	55	22	17	46	52	58	32	48	31

Figure 3.24. Proportion (%) of respondents who reported they had water repellent soils on their property

Management practices / treatments

On average 62% of respondents with water repellent soils reported using some practice(s) specifically to manage or treat water repellent soils (Figure 3.25). This increased over the survey period from 51% (2000 survey) to 71% (2017 survey). The proportion using clay spreading increased from 19% to 38%, and clay delving from 5% to 28% over this period. The use of modified sowing technology (such as press wheels, furrow sowing) was also common (39% mean).

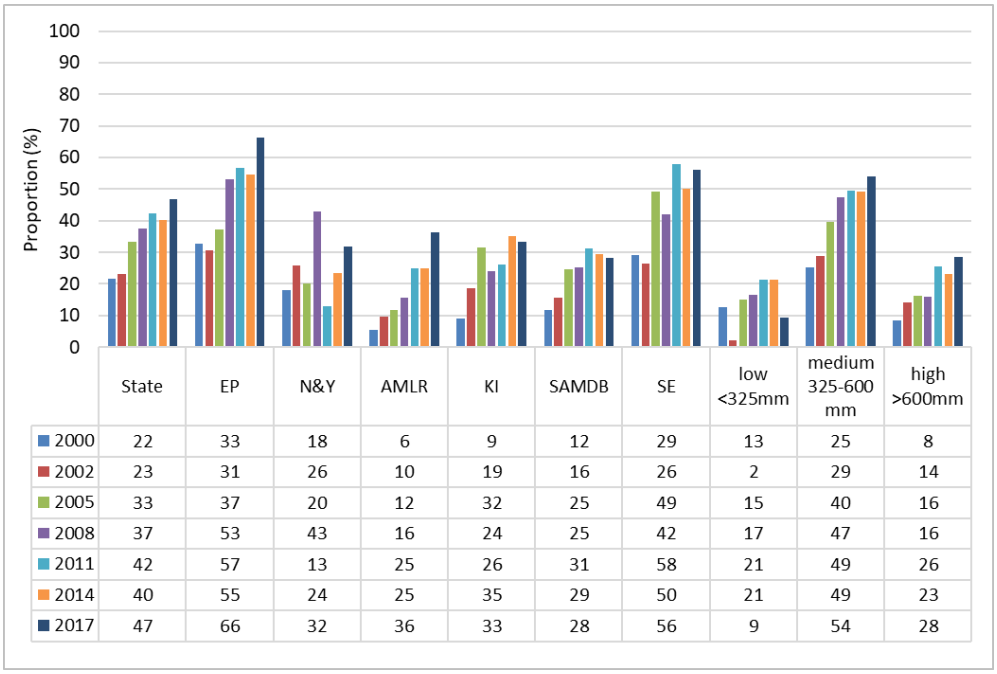


	Clay spreading	Clay delving	Spading	Modified sowing technology	Soil wetting agents	On/ close to row sowing	Apply organic amendments	Any method
2000	19	5		33	8			51
2002	22	6		26	8			45
2005	30	11		38	7			59
2008	33	17		41	10			65
2011	36	21	10	52	13			74
2014	31	25	5	42	16			66
2017	38	28	13		19	21	4	71

Figure 3.25. Use of practices (%) to treat or manage water repellent soils by managers with water repellent soil (state means, prompted responses)

Note: 'on/close to row sowing' option replaced 'modified sowing technology' in 2017 survey; 'spading' added in 2011 survey; 'apply organic amendments' added in 2017 survey

There was significant variation in the frequency of clay spreading or delving used by managers with water repellent soils across regions and rainfall zones (Figure 3.26). These practices were most commonly used on EP (66% in 2017 survey) and the SE (56% in 2017 survey), and more frequently in the medium rainfall zone (54% in 2017 survey) than in the high or low rainfall zones. In lower rainfall agricultural areas, these practices tend to be less frequently done (or done on smaller areas) as they are a higher cost to carry out relative to production returns per hectare.



	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325mm	medium 325-600 mm	high >600mm
2000	22	33	18	6	9	12	29	13	25	8
2002	23	31	26	10	19	16	26	2	29	14
2005	33	37	20	12	32	25	49	15	40	16
2008	37	53	43	16	24	25	42	17	47	16
2011	42	57	13	25	26	31	58	21	49	26
2014	40	55	24	25	35	29	50	21	49	23
2017	47	66	32	36	33	28	56	9	54	28

Figure 3.26. Proportion (%) of respondents with water repellent soils who have done clay spreading or delving to treat or manage water repellent soils (prompted responses)

Benefits of claying

In the 2014 and 2017 surveys, respondents who had done any clay spreading, delving or spading were asked what benefits (if any) they had noticed from using these practices.

Overall, 94% of respondents stated some benefit(s) of claying. About 60% reported increased yields or plant growth. Other commonly stated benefits included 'more even/improved plant establishment', 'reduced wind erosion risk' and 'better soil wetting/water retention' (Figure 3.27). About 6% reported no benefits. Results were similar across regions and rainfall zones. In the 2017 survey most benefits were reported more frequently than in the 2014 survey, which could indicate improvements in claying techniques.

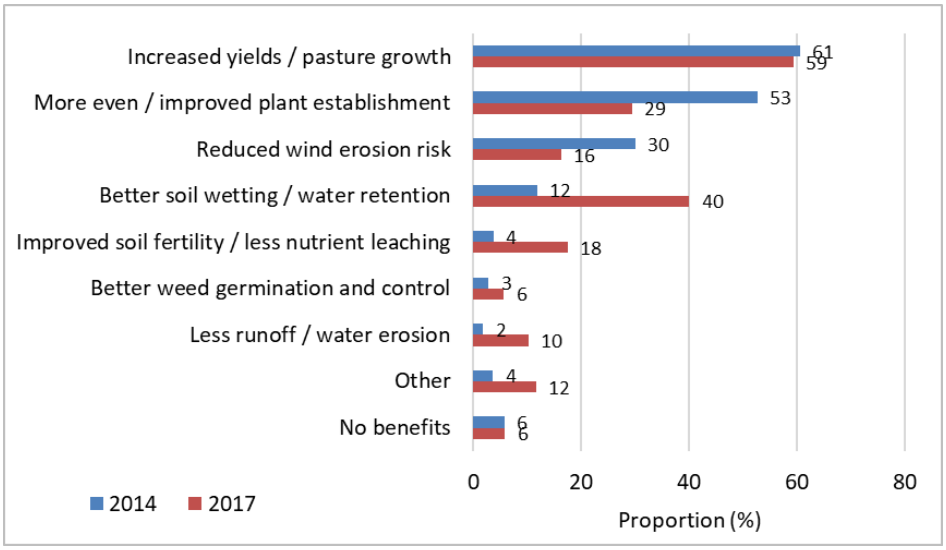


Figure 3.27. Benefits (%) of claying/delving/spading reported by managers with water repellent soil (state means, 2014 and 2017 surveys, unprompted responses)

Negative impacts of claying

These respondents were also asked if they noticed any negative impacts from clay spreading/delving/spading. Overall, 29% stated some negative impacts. The most common issue was 'rough surface from delving', reported by 47% in the 2014 survey, followed by 'high cost' (22%) (Figure 3.28). These problems were less frequently reported in the 2017 survey, as well as a much higher percentage saying 'no negative impacts', suggesting that there could have been improvements made to claying/delving/spading techniques over the period 2014 to 2017.

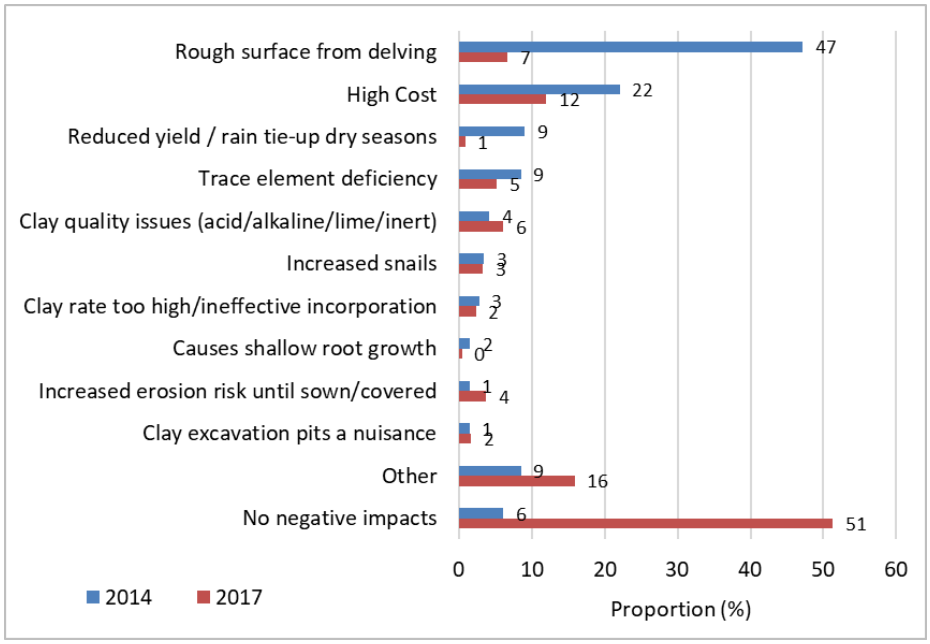


Figure 3.28. Negative impacts (%) of claying/delving/spading reported by managers with water repellent soil (state means, unprompted responses)

Time since first claying

In the 2014 survey, respondents were asked what year had claying treatments first been done on their property. Most of the earlier adoption (i.e. pre 1994) of claying methods occurred in the SE (34% pre 1994), whereas this has mainly occurred more recently on KI (100% since 1999) and in the high rainfall zone (95% since 1999) (Figure 3.29).

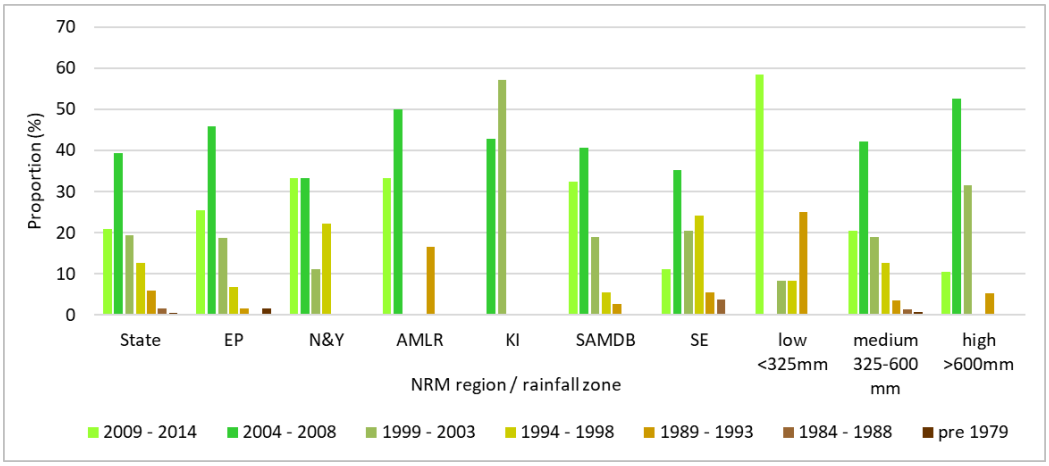


Figure 3.29. Time period when claying was first done on their property (proportion %) by respondents who have done claying treatments (claying/delving/spading; 2014 survey)

3.8 Soil nutrition

Key points:

- On average 67% of managers 'regularly' did soil nutrition testing; slightly lower in the SAMDB region (56%) and low rainfall zone (51%)
- Average interval between soil tests in any paddock was most commonly 3-5 years (63%); and there was a slight trend of increasing time interval between soil tests (2000 to 2014 surveys)
- Most common sources of information for deciding fertiliser strategies: 'Existing knowledge' (68% mean), 'agronomists/consultants' (62%); while use of 'fertiliser companies/agents' decreased from 45% to 18% over 2000 to 2014 surveys.

Soil testing

Results from the 2000 to 2014 surveys indicated that on average, about 67% of managers across the state 'regularly' did soil nutrition testing (Figure 3.30) (note that 'regularly' was not defined in the survey questions). This was slightly lower in the SAMDB region (average 56%) and in the low rainfall zone (51%). These results raise some concern about soil nutrition management given that around 30% to 50% of managers reported they didn't regularly do soil nutrition monitoring.

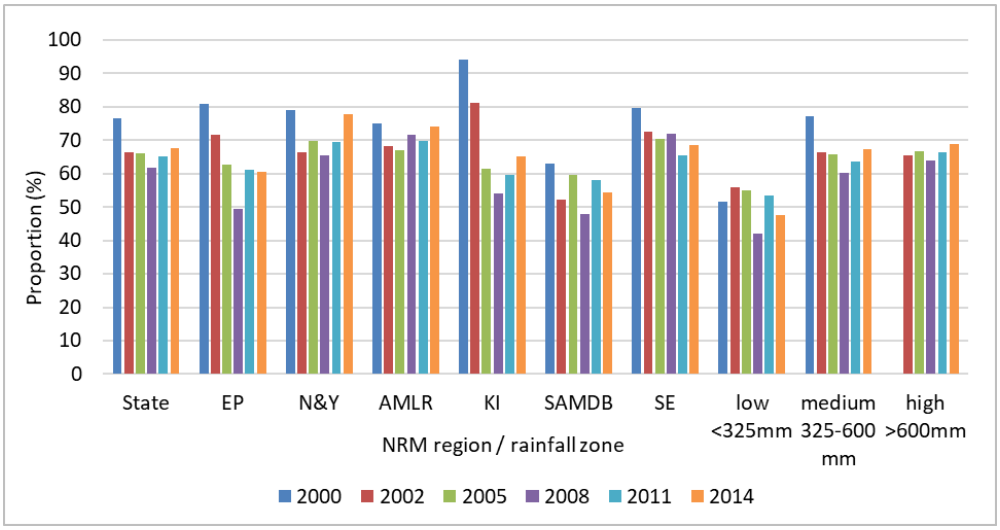


Figure 3.30. Proportion (%) of respondents who regularly soil test for nutrition management (2000 – 2014 surveys)

Of those respondents who reported they regularly soil test for nutrition management, the most common time interval between tests in any paddock was 3-5 years (63% mean) (Figure 3.31). Over this survey period, these results also suggest a slight trend of increasing time interval between soil tests: (i.e. decrease in 1-2 years; increase in 6-10 years).

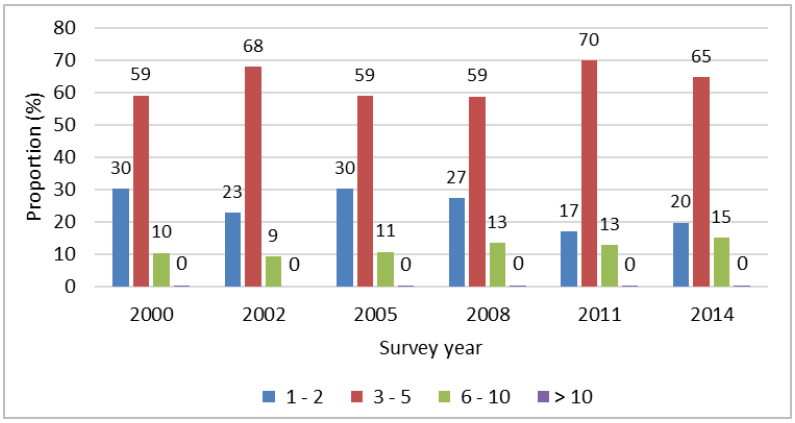


Figure 3.31. Normal number of years between soil tests in any paddock (proportion %), respondents who regularly soil test for nutrition (state means, 2000 – 2014 surveys)

Sources of advice

In the 2000 to 2014 surveys, all respondents were asked what sources of advice they used for deciding fertiliser use strategies.

Overall, the most common sources were 'existing knowledge' (68% mean) and 'agronomists/consultants' (62%) (Figure 3.32). The use of 'fertiliser companies/agents' for advice decreased substantially over the period of these surveys (45% to 18%).

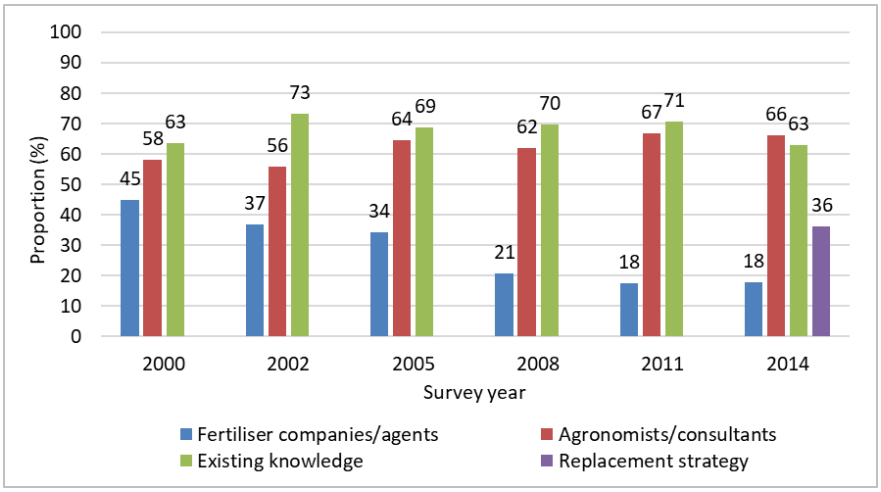


Figure 3.32. Sources of advice (%) used by respondents for deciding fertiliser use strategies (state means, 2000-2014 surveys, prompted response options; 'replacement strategy' added in 2014 survey)

There were notable variations in the sources of advice used across regions and rainfall zones, as shown in Figure 3.33 for the 2014 survey. For example, in the low rainfall zone, more producers relied on their existing knowledge (73%) than using agronomists/consultants (47%), whereas the reverse of this occurred in the N&Y region, where 76% used agronomists/consultants. In the major cropping regions (EP, N&Y, SAMDB) there was significant use of 'replacement strategy' for fertiliser decisions, whereas in higher rainfall regions (KI, AMLR) this was less commonly used.

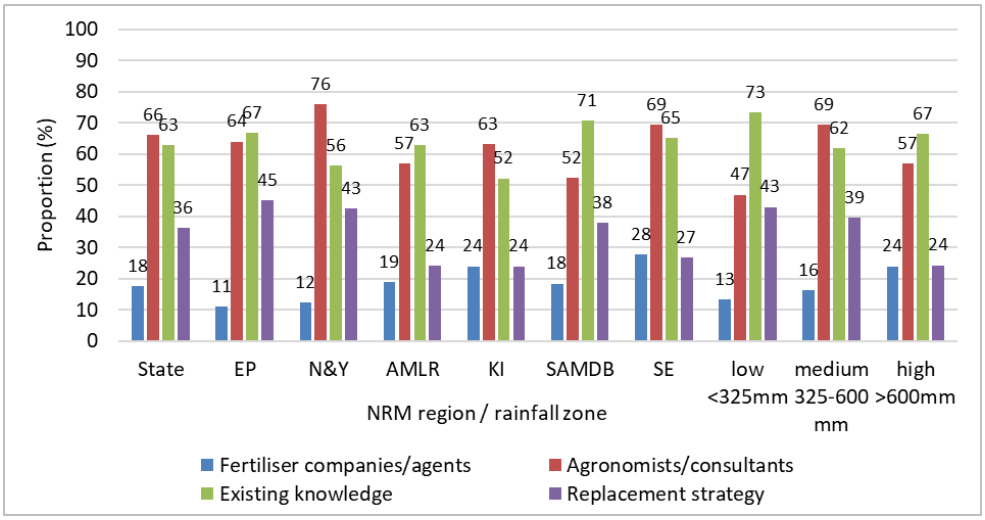


Figure 3.33. Sources of advice (%) used by respondents for deciding fertiliser use strategies (2014 survey, prompted response options)

3.9 Perennial vegetation and revegetation

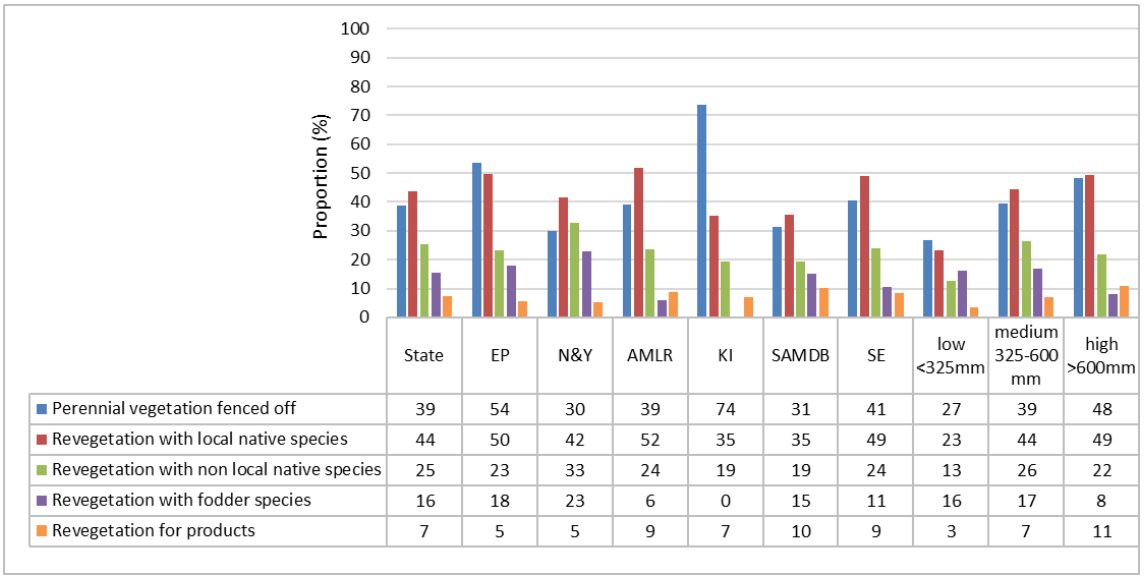
Key points:

- In the last 10 years (2014 survey), main vegetation activities done were: 'Revegetation with local native species' (44%); 'fenced off native vegetation' (39%); 'carried out revegetation with non-native species' (44%)
- Regional and rainfall zone variations included: KI, 74% had 'fenced off native vegetation'; N&Y, 33% did 'revegetation with local native species'; overall these activities less common in the low rainfall zone
- Highest average area per property treated: 'Fencing off perennial vegetation' - EP (42 ha), KI (40 ha), SE (34 ha); 'revegetation with local native species' - EP (19 ha)
- An average of 83% of respondents stated benefits to increasing perennial vegetation: Most common were 'shelter belts for stock' (37% mean of 2000-2014 surveys), 'fodder for stock' (22%), preventing erosion (20%), 'shelter breaks for crops/pastures (17%)
- About 86% of respondents reported barriers to increasing perennial vegetation: More common barriers were 'lack of time' and 'cost overall' (both average 21%), 'loss of land' (19%), 'have enough now' (13%); barrier of 'low rainfall' higher in 2008 survey (25%), during the 'millennium drought'.

Perennial vegetation/revegetation activities

In the 2011 survey respondents were asked about types of perennial vegetation management and revegetation they had done on their property in the last 10 years.

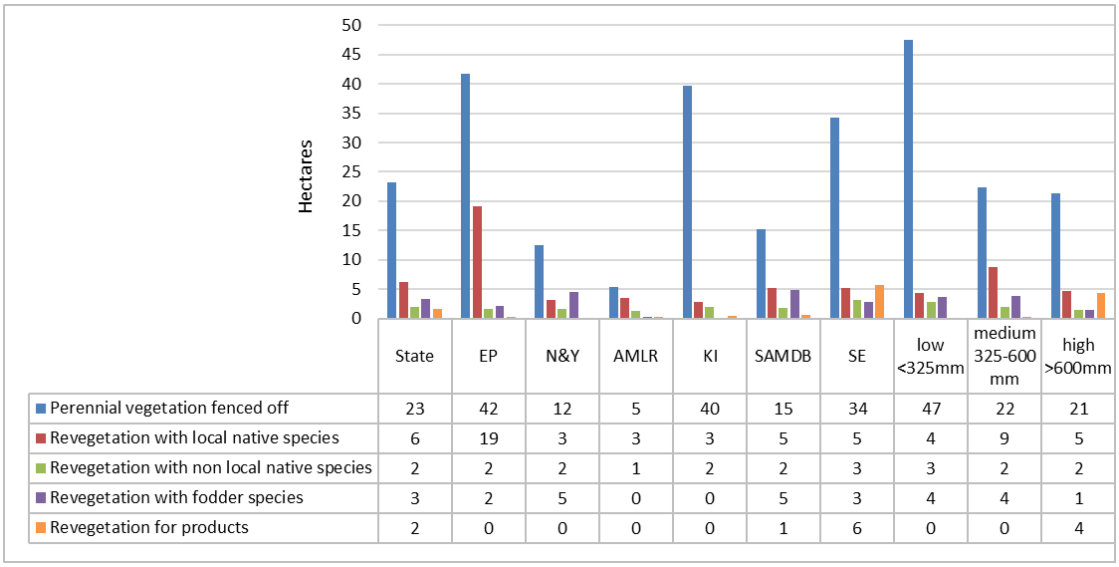
In the state about 44% had done 'revegetation with local native species', 39% had 'fenced off native vegetation' and 25% had 'carried out revegetation with non-native species' (Figure 3.34). There were some variations in the frequency of these activities across regions and rainfall zones. For example on KI, 74% had fenced off native vegetation, while in the N&Y region 33% did 'revegetation with local native species'. Overall these activities were less common in the low rainfall zone.



	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325mm	medium 325-600 mm	high >600mm
Perennial vegetation fenced off	39	54	30	39	74	31	41	27	39	48
Revegetation with local native species	44	50	42	52	35	35	49	23	44	49
Revegetation with non local native species	25	23	33	24	19	19	24	13	26	22
Revegetation with fodder species	16	18	23	6	0	15	11	16	17	8
Revegetation for products	7	5	5	9	7	10	9	3	7	11

Figure 3.34. Proportion (%) of respondents who have undertaken perennial vegetation activities in the last 10 years (2011 survey, prompted)

On an area per property treated basis, by far the most widespread practice reported was 'fencing off perennial vegetation', particularly in the EP region (42 ha), KI (40 ha) and SE region (34 ha) (Figure 3.35). The highest area per property of 'revegetation with local native species' occurred on EP (19 ha).



	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325mm	medium 325-600 mm	high >600mm
Perennial vegetation fenced off	23	42	12	5	40	15	34	47	22	21
Revegetation with local native species	6	19	3	3	3	5	5	4	9	5
Revegetation with non local native species	2	2	2	1	2	2	3	3	2	2
Revegetation with fodder species	3	2	5	0	0	5	3	4	4	1
Revegetation for products	2	0	0	0	0	1	6	0	0	4

Figure 3.35. Average area (ha) per property of perennial vegetation activities undertaken in the last 10 years (2011 survey, all respondents)

Benefits

An average of 83% of respondents across the state considered there were benefits to increasing perennial vegetation. The most common benefits reported were 'shelter belts for stock' (37%, mean of 2000-2014 surveys), followed by 'fodder for stock' (22%), preventing erosion (20%) and 'shelter breaks for crops/pastures (17%) (Figure 3.36). These results were fairly similar across regions and rainfall zones.

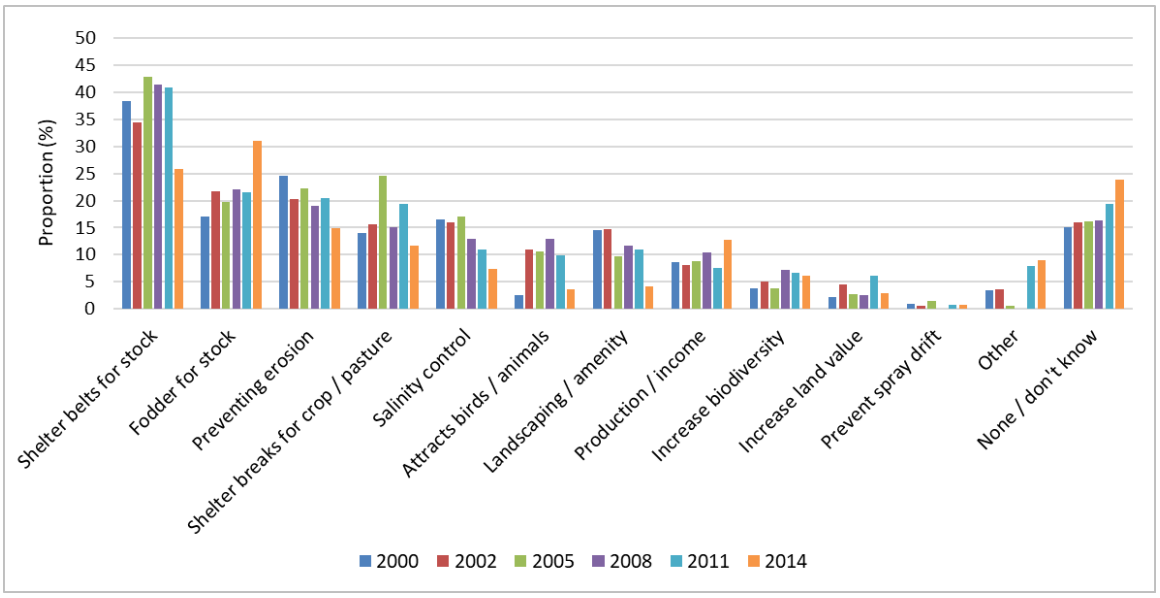


Figure 3.36. Proportion (%) of respondents reporting benefits of increasing perennial vegetation on their property (state means, all respondents, unprompted responses)

Barriers

About 86% of respondents on average across the state also reported some forms of barriers to increasing perennial vegetation on their property (Figure 3.37). The most common barriers were 'lack of time' and 'cost overall' (both average 21% for 2000-2014 surveys), 'loss of land' (19%), and 'have enough now' (13%). The barrier of 'low rainfall' was much more commonly cited in the 2008 survey (25%), when conditions were very dry during the 'millennium drought'.

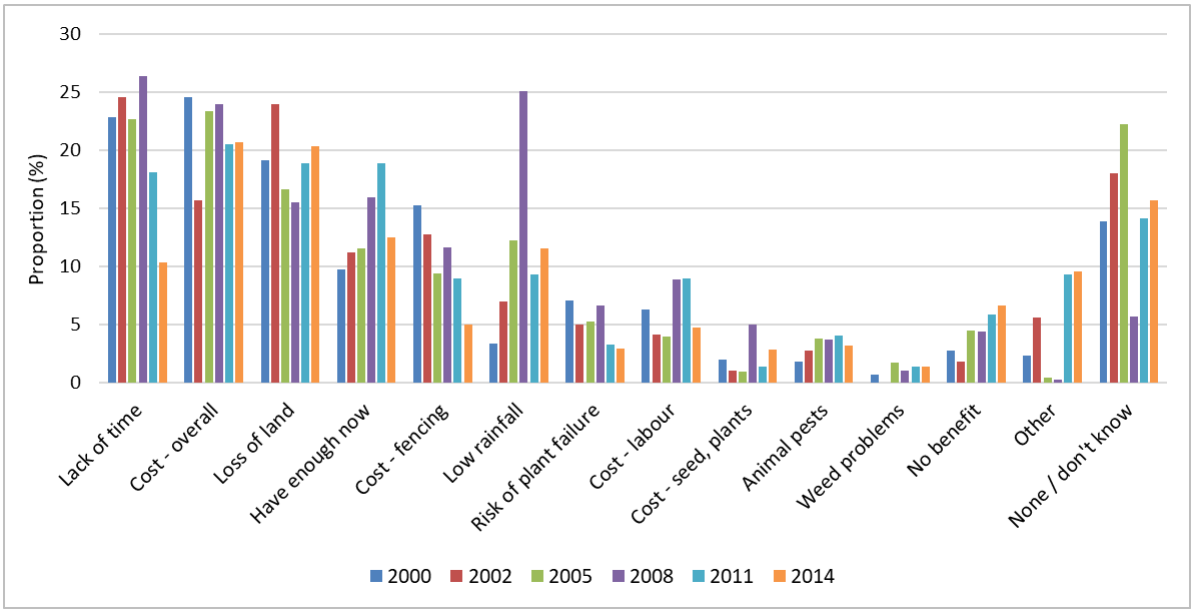


Figure 3.37. Proportion (%) of respondents reporting barriers to increasing perennial vegetation on their property (state means, all respondents, unprompted responses)

3.10 Climate change

Key points:

- In the 2014 survey, 39% of respondents considered climate change will impact on their property production in the next 20 years; 25% were 'unsure' and 37% said 'no impact; 48% of KI respondents said 'no impact'.
- In the 2017 survey, 48% considered there would be at least some *negative* impact from climate change; highest in AMLR region (55%), lowest on KI (44%)
- Proportion that have or would change some practice(s) to lessen the impact of climate change: 71% in 2014 survey' 80% in 2017; most common practices were 'alter crop varieties' (29%; 17%), 'reduce tillage/increase stubble retention' (13%; 20%); with some not implementing any practices (29%; 20%)
- Regional differences in 2017 survey: On KI, 35% stated 'increase perennial pasture/fodder/hay'; 35% in N&Y said 'reduce tillage/increase stubble retention'; 12% in AMLR said 'more flexible stocking rates'; 13% in SE 'increase/modify irrigation'.

Potential impacts on property production

In the 2014 and 2017 surveys, interviewees were asked about climate change.

Results from the 2014 survey indicated that 39% of respondents considered that climate change will impact on their property production in the next 20 years (Figure 3.38). About 25% were 'unsure' and 37% believed there would not be any impact. There were slight differences in responses across regions and rainfall zones, with 48% of KI respondents saying 'no impact'.

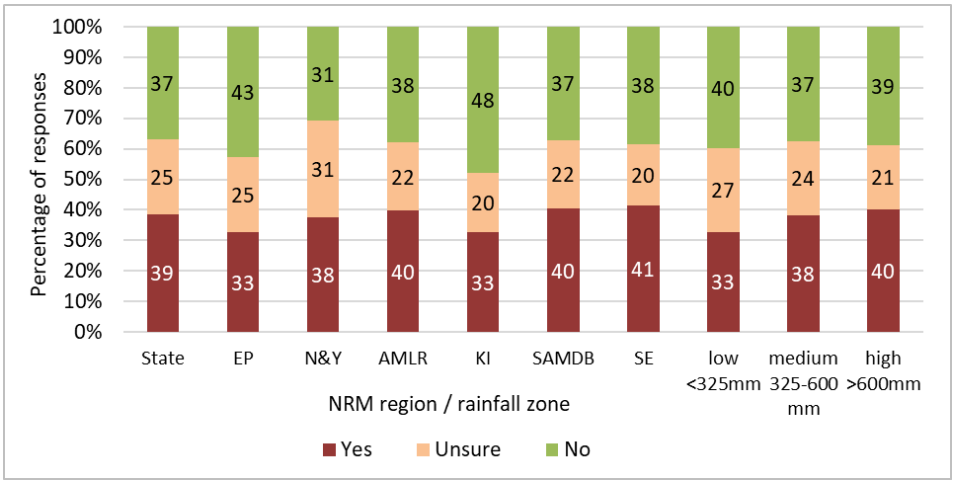


Figure 3.38. Responses (%) to the question "will climate change impact on your property production in the next 20 years?"(2014 survey, prompted response options)

This question was worded differently in the 2017 survey, asking whether climate change will *negatively* impact on respondents' property production in the next 20 years.

For the state, 48% considered there would be at least some negative impact (Figure 3.39). The highest reporting of potential negative impacts of climate change occurred in the AMLR region (55%), while on KI, only 44% considered there would be some negative impact.

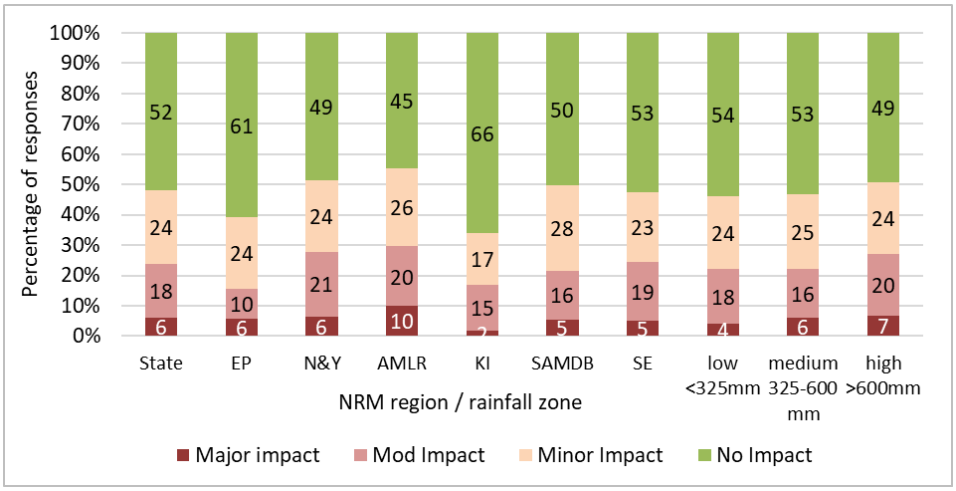


Figure 3.39. Responses (%) to the question "will climate change *negatively* impact on your property production in the next 20 years?"(2017 survey, prompted response options)

Management practices

Respondents who reported some impact (2014 survey) or negative impact (2017 survey) of climate change on their property production were asked what practices they had, or will, put into place to lessen the impact of climate change (Figure 3.40).

Overall, 71% (2014 survey) to 80% (2017 survey) of respondents stated they would change some practices on their property. A wide range of practices were reported, including changes to cropping and grazing, perennial vegetation and fodder. The most common practices for the state were 'alter crop varieties' (29% in 2014 survey; 17% in 2017 survey), and 'reduce tillage/increase stubble retention' (13%; 20%). A significant proportion reported no implementation of practices (29%; 20%).

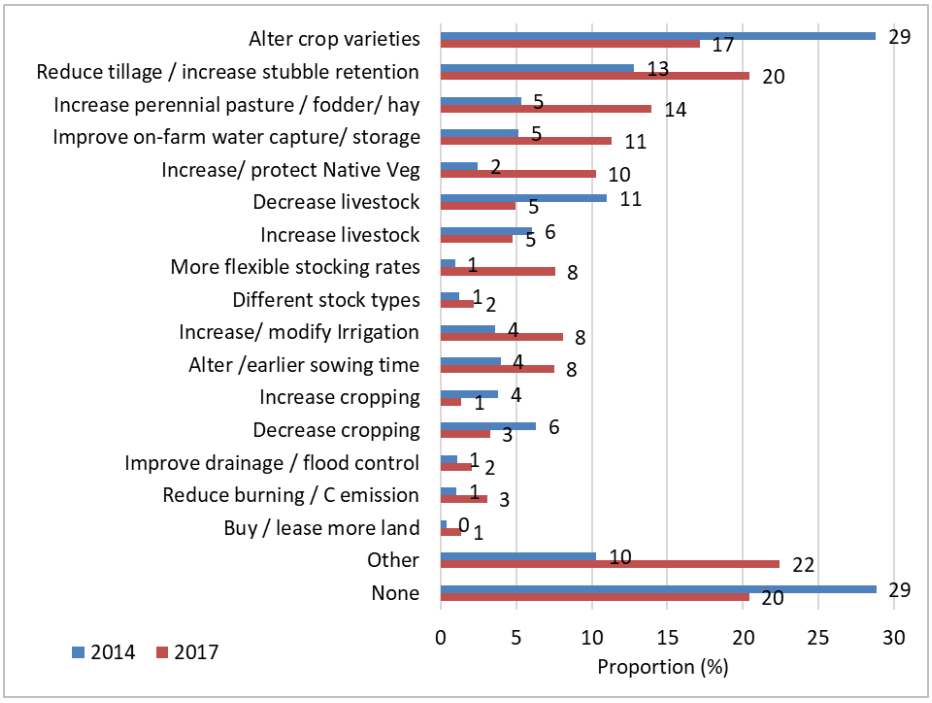


Figure 3.40. Practices (%) that respondents said they have, or will, put into place to lessen the impact of climate change; respondents citing climate change would impact/negatively impact on their property production (state means, 2014 and 2017 surveys, unprompted responses)

A breakdown of the more commonly reported practices by region and rainfall zone from the 2017 survey are given in Table 3.12. Some of the main differences across regions were:

- On KI, 35% stated 'increase perennial pasture/fodder/hay'
- 35% in N&Y 'reduce tillage/increase stubble retention'
- 12% in AMLR 'more flexible stocking rates'
- 13% in SE 'increase/modify irrigation'

Table 3.12. Practices (%) that respondents said they have, or will, put into place to lessen negative impacts of climate change; respondents citing climate change would negatively impact on their property production (2017 survey; unprompted responses)

Practice	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325 mm	medium 325-600 mm	high >600 mm
Alter crop varieties	17	16	23	7	10	13	19	13	17	16
Reduce till. incr. stubble ret.	20	32	35	3	0	18	11	37	23	5
Perennial pasture / fodder / hay	14	2	8	16	35	14	23	13	12	20
On-farm water capture / storage	11	13	10	16	20	11	10	7	11	17
Incr. / protect native veg.	10	3	7	10	15	16	13	4	9	15
Decrease livestock	5	2	3	5	5	4	10	7	3	9
Increase livestock	5	10	5	3	0	6	2	15	5	1
More flexible stocking rates	8	0	6	12	10	8	10	7	7	10
Different livestock types	2	0	2	4	0	1	4	0	1	5
Increase / modify irrigation	8	3	6	8	0	8	13	7	9	6
Alter / earlier sowing time	8	8	9	7	5	6	8	4	10	2
Increase cropping	1	0	3	0	0	2	1	2	1	1
Decrease cropping	3	3	3	1	5	6	3	7	3	2
Other	22	21	21	29	30	26	19	28	22	25

3.11 Use of technology

Key points:

- Proportion using newer technology(s) increased from 58% to 79% in 2011 to 2017 surveys: Most common was 'GPS guidance' (auto-steer) 56% to 77%. Other technologies used were 'yield mapping' (27% in 2017 survey), 'variable rate technology' (19%), 'controlled traffic' (13%), UAVs/drones (6%), farm robotics/autonomous vehicles (1%)
- Highest use of technologies by regions/rainfall zones (2017 survey): EP 'GPS guidance' 90%, N&Y 84%; 'yield mapping' N&Y 37%; 'variable rate technology' 34% in low rainfall zone; in N&Y 17% were using 'controlled traffic'.

Use of different technologies

Respondents who undertook cropping were asked in the 2011 to 2017 surveys whether they use any type(s) of newer technologies (e.g. GPS-based) with their cropping management. These could potentially help to improve production efficiency and soil health/condition.

The proportion using any technology(s) increased from 58% to 79% (Figure 3.41). The most common technology was 'GPS guidance' (auto-steer) which increased from 56% in the 2011 survey to 77% in the 2017 survey (Figure 3.42). Other technologies were relatively less commonly used (i.e. 27% or less).

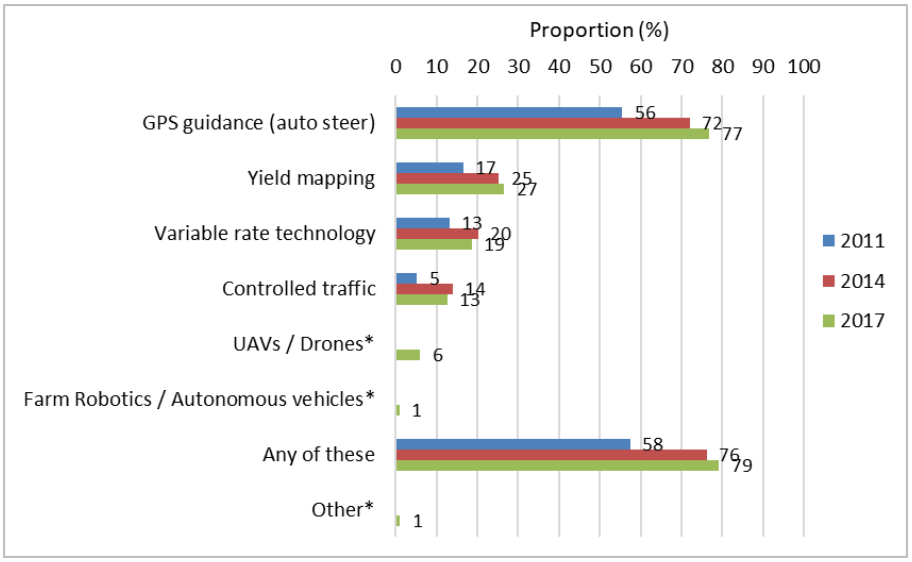


Figure 3.41. Proportion (%) of cropping respondents who use newer technologies in their farm management (state means; 2011 to 2017 surveys; prompted responses)
**options added in 2017 survey*

There was some variation in the proportion of croppers using these technologies across regions and rainfall zones, as shown for the 2017 survey in Table 3.13:

- EP had highest use of GPS guidance (90%); N&Y 84%
- Yield mapping was highest in N&Y (37%)
- Variable rate technology used by 34% in low rainfall zone
- N&Y had 17% using controlled traffic

Table 3.13. Proportion (%) of cropping respondents who use any newer technologies in their farm management (2017 survey)

Practice	State	EP	N&Y	AMLR	KI	SAMDB	SE	low <325 mm	medium 325-600 mm	high >600 mm
GPS guidance / autosteer	77	90	84	66	41	74	65	85	80	47
Yield mapping	27	32	37	26	11	18	18	19	29	16
Variable rate technology	19	19	22	15	0	23	13	34	18	5
Controlled traffic	13	10	17	15	7	7	13	8	13	8
UAVs / drones	6	6	8	8	0	4	4	4	7	3
Farm robotics / autonomous veh.	1	1	1	0	0	1	1	2	1	1
Any of these	79	91	88	69	41	75	68	85	82	48
Other	1	0	1	0	0	2	1	1	1	1

4 References

Forward, GR (2021). Soil protection progress report July 2021, South Australia's agricultural lands, Department for Environment and Water.

Key results of DWLBC Land Manager Surveys 2000–2008: Forum Paper Waite 26 November 2008, Forward GR, Department of Water, Land and Biodiversity Conservation.

Llewellyn, RS, D'Emden, F (2009). Adoption of no-till farming practices in Australian grain growing regions, report for SA No-till Farmers Association and CAAANZ, June 2009, CSIRO.

McCord, AK, and Payne RA (2004). Report on the Condition of Agricultural Land in South Australia, Report No. 1, December 2004, Department of Water, Land and Biodiversity Conservation.

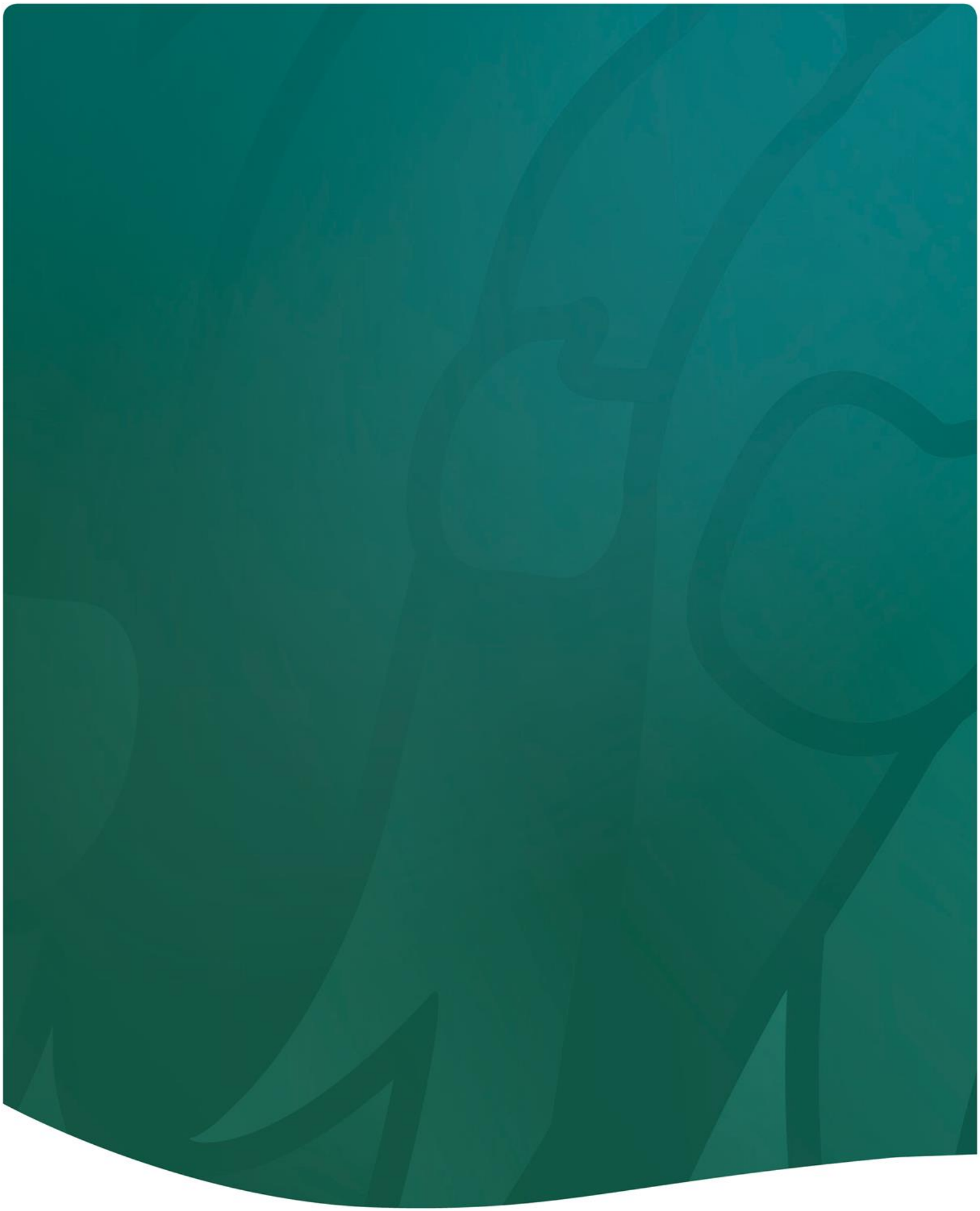
McDonough, C (2010). Report on the tillage practice and cropping intensities in the SA Murray Mallee, 2010 update, for DWLBC, Rural Solutions SA, PIRSA.

McDonough, C, 2006, Murraylands Soil Management Survey, Rural Solutions SA, PIRSA.

McDonough, C, 1992 Murraylands Agricultural Bureaux soil management survey summary, PISA, for the 'Sustainable Land Management for the Murray Mallee' Project.

Nelson, J (2011). Mallee Landholder Survey Results Summary (draft) 2010-11, South Australian Murray-Darling Basin Natural Resources Management Board in conjunction with Caring for Our Country and the Department of Environment and Natural Resources.

State Land and Soil Information Framework, Department for Environment and Water.



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