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Drivers of practice change in land management in Australian agriculture

Synthesis report—Stages I, II and III

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Contents

Summary.....	1
1 Introduction	3
Background.....	3
DPC 2012 and DPC 2013 survey objectives.....	3
Methods	5
Report structure	9
2 Results from the 2012 survey—broadacre and dairy	10
Adoption of land management practices	10
Motivations for adoption in broadacre and dairy	12
Barriers to adoption in broadacre and dairy.....	23
Support, information and learning in broadacre and dairy	24
Characteristics of adopters, considerers and non-adopters	31
3 Results from the DPC 2013 survey—horticulture	44
Adoption of land management practices in horticulture	44
Motivations for adoption in horticulture	44
Barriers to adoption in horticulture	53
Support, information, learning and planning in horticulture	54
4 Industry comparison.....	61
Adoption of land management practices	61
Motivations for adoption.....	61
Barriers to adoption.....	62
Support, information and learning networks	63
5 Comparisons between 2010 and 2012 surveys—broadacre and dairy	65
Adoption of land management practices	65
Motivations for adopting.....	67
Barriers to adoption.....	71
Information and learning networks.....	72
6 Discussion	77
Motivations.....	77
Support, information and learning networks	80
Barriers	82
7 Implications.....	84
Responding to farm manager motivations.....	84
Engagement and capacity building	86
Further research.....	87
Appendix 1 Annotated bibliography.....	90
Appendix 2 Case study: Experiences in adopting conservation agriculture	104
Introduction.....	105
Appendix 3 DPC stage 1 workshops summary	113
Appendix 4 Methods—inferential statistics	122
References.....	124

Tables

Table 1 Adoption of land management practices in 2012.....	11
Table 2 Adoption of land management practice by industry in 2012	11
Table 3 Motivations for adoption of management practices by category in 2012	13
Table 4 Motives for adopting each management practice in 2012, ordered by importance	13
Table 5 Barriers to changing land management practice—industry comparison.....	23
Table 6 Sought support for land management practices—industry comparison.....	24
Table 7 Awareness of and participation in Australian Government NRM programs	28
Table 8 Extension activities attended in the last two years and incorporation of outcomes	29
Table 9 Focus of extension activities	29
Table 10 Delivery agent for extension activities.....	30
Table 11 Characteristics more likely amongst adopters than non-adopters of specified practices.....	31
Table 12 Characteristics of adopters, considerers and non-adopters of no-till, reduced tillage or direct drilling	33
Table 13 Characteristics of adopters, considerers and non-adopters of fallowing.....	34
Table 14 Characteristics of adopters, considerers and non-adopters of stubble retention	35
Table 15 Characteristics of adopters, considerers and non-adopters of cell or strip grazing.....	36
Table 16 Characteristics of adopters, considerers and non-adopters of setting minimum groundcover targets.....	37
Table 17 Characteristics of adopters, considerers and non-adopters of planting deep rooted perennials.....	38
Table 18 Characteristics of adopters, considerers and non-adopters of planting native pastures.....	39
Table 19 Characteristics of adopters, considerers and non-adopters of planting native vegetation.....	40
Table 20 Characteristics of adopters, considerers and non-adopters of fencing native vegetation.....	42
Table 21 Characteristics of adopters/considerers and non-adopters of weed management.....	43
Table 22 Adoption of land management practices in horticulture	44
Table 23 Motivations for adoption of land management practices in horticulture, 2013.....	46
Table 24 Motives for management practices in horticulture 2013, ordered by importance.....	46
Table 25 Support sought in adoption of land management practices—horticulture.....	54

Table 26 Awareness of and participation in Australian Government programs.....	57
Table 27 Activities and events attended	58
Table 28 Focus of activities and events attended	58
Table 29 Delivery agent for extension activities for horticulture	59
Table 30 Property plans	60
Table 31 Adoption of management practices—industry comparison	61
Table 32 Motivations for management practices ‘to a great extent’—industry comparison	62
Table 33 Barriers to adoption—industry comparison	62
Table 34 Support sought for management practices—industry comparison	63
Table 35 Group membership—industry comparison.....	63
Table 36 Activities attended and incorporation of outcomes—industry comparison....	64
Table 37 Awareness of and participation in programs and initiatives—industry comparison	64
Table 38 Changes in adoption and considered adoption of land management practices 2010 and 2012	66
Table 39 Motivations for crop management practices 2010 and 2012	67
Table 40 Motivations for grazing management practices 2010 and 2012	68
Table 41 Motivations for native vegetation management practices 2010 and 2012	69
Table 42 Motivations for native weed management practices 2010 and 2012.....	70
Table 43 Barriers to changing land management practices 2010 and 2012	71
Table 44 Group membership 2010 and 2012	72
Table 45 Awareness of government programs 2010 and 2012.....	72
Table 46 Participation in government programs 2010 and 2012.....	73
Table 47 Change in the skills and knowledge of program participants 2010 and 2012 .	73
Table 48 Benefits gained from participation in programs and initiatives 2010 and 2012	74
Table 49 Activities and events attended 2010 and 2012	74
Table 50 Comparisons of the activities respondents attended by event focus 2010 and 2012.....	76

Figures

Figure 1 Motivations of crop management practice decisions ‘to a great extent’	14
Figure 2 Financial motives for adopting crop management practices	15
Figure 3 Environmental motives for adopting crop management practices	15
Figure 4 Personal motives for adopting crop management practices	16
Figure 5 Motivations of grazing management practice decisions ‘to a great extent’	16
Figure 6 Financial motives for adopting grazing management practices	17
Figure 7 Environmental motives for adopting grazing management practices	17
Figure 8 Personal motives for adopting grazing management practices	18
Figure 9 Motivations of native vegetation management decisions ‘to a great extent’	18
Figure 10 Financial motives for adopting native vegetation management practices	19
Figure 11 Environmental motives for adopting native vegetation management practices	20
Figure 12 Personal motives for adopting native vegetation management practices	20
Figure 13 Motivations of weed management practice decisions ‘to a great extent’	21
Figure 14 Financial motives for adopting weed management practices	21
Figure 15 Environmental motives for adopting weed management practices	22
Figure 16 Personal motives for adopting weed management practices	22
Figure 17 Barriers to changing land management practices	23
Figure 18 Support agents utilised for crop management practices	25
Figure 19 Support agents utilised for grazing management practices	25
Figure 20 Support agents utilised for native vegetation management practices	26
Figure 21 Support agents utilised for weed management practices	26
Figure 22 Membership of groups supporting sustainable land management	27
Figure 23 Benefits gained from participation in Australian Government programs	28
Figure 24 Motivations of soil management practice decisions ‘to a great extent’	47
Figure 25 Financial motives for adopting soil management practices	47
Figure 26: Environmental motives for adopting soil management practices	48
Figure 27 Personal motives for adopting soil management practices	48
Figure 28 Motivations of native vegetation management decisions ‘to a great extent’ ...	49
Figure 29 Financial motives for adopting native vegetation management practices	49
Figure 30 Environmental motives for adopting native vegetation management	50
Figure 31 Personal motives for adopting native vegetation management practices	50
Figure 32 Motivations of weed management practice decisions ‘to a great extent’	51
Figure 33 Financial motives for adopting weed management practices	51
Figure 34 Environmental motives for adopting weed management practices	52

Figure 35 Personal motives for adopting weed management practices.....	52
Figure 36 Barriers to changing land management practices	53
Figure 37 Support agents utilised for soil management practices—horticulture	54
Figure 38 Support agents utilised for native vegetation management practices.....	55
Figure 39 Support agents utilised for weed management practices.....	55
Figure 40 Membership of groups supporting land management.....	56
Figure 41 Benefits from participation in Australian Government programs and initiatives.....	57

Summary

Significant investment in natural resource management (NRM) is targeted towards fostering changes in land management practices. There is value in better understanding the drivers and motivations of practice change and ways that practice change can be successfully supported. This report details the outcomes of the ABARES Drivers of Practice Change in Australian Agriculture project (2009–2013). The aim of the project was to better understand the motivations of landholders to adopt sustainable soil and land management practices relating to cropping, grazing, native vegetation and management of Weeds of National Significance (WoNS).

The project commenced with an extensive review of current information and consultative workshops with experts and practitioners across key regions of Australia. The second stage involved a national survey of farm managers in 2010 and the survey was repeated in 2012. Farm managers were asked about their adoption of specific land management practices and influences on their decision to adopt, as well as other factors relevant to adoption, including key barriers and participation in programs and extension activities. This report presents a synthesis of findings from the first, second and third stages of the project with a main focus on the survey conducted in 2012–13. This study was commissioned by the Sustainable Resource Management Division of the former Department of Agriculture, Fisheries and Forestry and was funded through the Caring for our Country program. Key findings include:

- 1) **Farm managers were motivated to adopt sustainable land management practices by relative advantages that span financial, environmental and personal dimensions.** Financial and environmental motivations were of most importance in adopting sustainable grazing, cropping and weed management practices, followed by personal motivations. In comparison, environmental and personal motivations were more likely than financial reasons to motivate native vegetation management. Motivations for adopting sustainable farm practices were largely consistent between surveys.
- 2) **While there was a major motivational influence for each practice, the majority of broadacre, dairy and horticulture farm managers were influenced by more than one motivation in their decision to adopt a given management practice.** The degree to which financial, environmental and personal motivations influenced adoption varied by management practice. There was a slight increase in adoption of most of the nominated sustainable practices between 2010 and 2012. Adoption rates were comparable to those found in other similar research.
- 3) **In 2012, approximately one-third of farm managers sought advice or support (non-financial) in relation to adoption of sustainable land management practices.** Farmers sought support from different agents depending on the practice. For crop management practices, the main agents were private consultants or agribusinesses, peers or neighbours, and farmer production groups. For grazing management, the main agents were private consultants or agribusinesses, government extension officers, and peers or neighbours. For native vegetation management, the main agents were Landcare groups, catchment management authority (CMA) and NRM region facilitators, and government extension officers. For weeds management, the main agents were government extension officers, private consultants or agribusinesses and Landcare groups. Horticulture farm managers sought support from private consultants and peers or neighbours for soil management decision making, Landcare groups and CMA/NRM region facilitators for native vegetation management, and peers or neighbours and farmer production groups for weed management.
- 4) **In 2012, approximately two-thirds of broadacre, dairy and horticulture farm managers were members of a group that supports land management decision making.**

There was a marginal increase in group membership between 2010 and 2012. Broadacre and dairy farm managers most frequently reported they were members of farmer industry organisations and Landcare groups. Horticulture farm managers were mostly members of farmer industry organisations and production or commodity groups.

- 5) **Farm managers who adopted these practices were more likely than non-adopters to be members of a group that provides support for land management decision making.** Group members were more likely to adopt all but one practice: management of WoNS. As well as group membership, the study found a range of characteristics that adopters were more likely to have than non-adopters. Depending on the practice, characteristics that differed between adopters and non-adopters included income, farm size, age, education and participation in extension activities and NRM programs.
- 6) **Field days, training courses, trials and agribusiness organised events were the key sources of information and advice on sustainable practice for farm managers in both survey years.** The focus of activities and events attended by farm managers was mainly production or a combination of production, NRM and financial. Private consultants or agribusiness agents, local farmer networks, Landcare groups and state government agencies were the primary delivery agents for these activities.
- 7) **There was an increase in recognition of most of the Australian Government NRM programs and initiatives between 2010 and 2012.** Most farm managers participating in these programs improved their skills or knowledge and changed their practices. Almost half of the broadacre and dairy respondents participated in at least one Australian Government program. Broadacre and dairy farm managers who adopted a sustainable land management practice were more likely to have participated in an Australian Government program than non-adopters.
- 8) **While communicating production and financial benefits is important, communicating environmental and personal benefits is likely to also play an important role in encouraging uptake of sustainable farm management practices.** Extension that promotes the multiple benefits of adoption and also recognises the different motivations related to 'public good' activities (e.g. native vegetation management) and 'private good' activities is likely to have a greater influence on a wider audience than extension that fails to recognise these multiple benefits and motivations.
- 9) **Recognising the interconnection between factors in decisions to adopt and socio-economic profiles of adopters versus non-adopters has implications for promoting adoption of land management practices.** Information from this study on what 'grows' farmer capacity and encourages adoption can be applied in designing NRM programs. The results also provide insight into the specialist nature of NRM service providers. Understanding the flows of information that support adoption can guide future investment in promotional activities.
- 10) **Research investigating the relationship between group involvement and adoption and the links between financial motivations and other motivations could build on the findings of this study.** Incorporating information on adoption and motivations with the geography of adoption (where practices should be adopted based on land capability), as well as farm financial information, could indicate where investment efforts are best directed to encourage adoption in the future. Developing and testing the effectiveness of messages based on the findings of this study is also suggested. To show trends over time, nationally representative data on a number of measures needs to be collected on a continuing basis.

1 Introduction

Background

This report presents a synthesis of findings from the first, second and third stages of the Drivers of Land Management Practice Change in Australian Agriculture project (also referred to as the Drivers of Practice Change project or DPC). This study was commissioned by the Sustainable Resource Management Division of the former Department of Agriculture, Fisheries and Forestry (DAFF) and funded through the Caring for our Country program.

The DPC project involved a review of adoption literature and regional workshops around Australia (stage 1); a national survey of broadacre and dairy farm managers in 2010 (stage 2); a national survey of broadacre and dairy farm managers in 2012 (stage 3); a qualitative case study involving cropping farm managers in 2012 and a survey of horticulture farm managers in 2013 (stage 4).

This report contains:

- results from the 2012 survey of broadacre and dairy farm managers and the 2013 survey of horticulture farm managers
- a comparison of broadacre, dairy and horticulture motivations to adopt; barriers to adoption; and support, information and learning networks
- a comparison of the results of the 2010 and 2012 survey results of broadacre and dairy farm managers
- a summary of stage 1 workshops
- results of a qualitative case study of reduced tillage adoption by members of conservation tillage groups
- an annotated bibliography of new literature relevant to the topic published in 2010 and later.

The DPC project primarily sought to examine motivations for the adoption of land management practices based on selected practices supported by the Sustainable Farm Practices component of the Caring for our Country initiative, administered by the former DAFF. This research was undertaken to provide information to support adoption of these practices. For policy and program development, it is important to understand what motivates farm managers to implement particular management practices and how these motivations can be used to encourage adoption.

DPC 2012 and DPC 2013 survey objectives

The primary objective of the DPC 2012 broadacre and dairy survey and the DPC 2013 horticulture survey was to quantitatively assess the relative importance to farm managers of a range of social and economic influences on adoption of land management practices on farms.

Other objectives included:

- providing an estimate of adoption levels of sustainable land management practices

- investigating the pathways through which farmers access and use information on NRM
- indicating farmers' awareness of selected Australian Government NRM programs
- investigating the extent to which target groups identified under the Caring for our Country initiative are engaged in the initiative
- determining the best methods to promote participation of landholders in activities that contribute to achieving Caring for our Country goals.

Methods

Analysis framework

DPC stage 1 involved a qualitative study to identify key drivers of practice change in land management. Landholders, extension practitioners, practice change experts, policy staff and researchers reviewed factors influencing adoption at workshops representing Australia's major climatic zones (Appendix 3: Stage 1 DPC workshops summary). Local and regional information relevant to adoption of land management practices was also reviewed.

The extensive literature review undertaken for stage 1 (reported in Ecker et al, 2012) and outcomes from these workshops provided the basis for the framework that was used to collect and analyse the data. Adoption and behaviour change theories were reviewed to determine the most appropriate framework for collecting, assessing and integrating information relevant to understanding the drivers of adoption of sustainable farm practices. The attributes of management practices (e.g. Rogers' (2003) five adoptability factors) and the five capitals (human, social, natural, physical and financial) (Flora, 2005) informed the framework. In addition, the development of the framework drew on a large body of literature which identified the complex nature of adoption, particularly multiple motivations for adoption including financial and non-financial motivations (Chouinard et al. 2006; Pannell et al. 2006; Farmar-Bowers & Lane 2006; Llewellyn & D'Emden 2009; Greiner et al. 2009; Greiner & Gregg 2011). It was also determined that a dynamic systems approach was useful in explaining the interaction between the key components that emerged. The rural livelihood framework developed by Ellis (2000), which describes the social and economic context of behaviour change, within the need to maintain a sustainable livelihood, was found to particularly suit the material from workshop discussions.

The framework developed included five components which emerged from the workshops to describe influences on adopting sustainable farm practices, these were:

- overarching influences on practice change
- drivers of practice change
- enabling activities
- barriers to practice change
- farm manager capacity and characteristics.

These components represent the commonly repeated themes from workshops held around the country and are discussed more fully in Appendix 3. For the purposes of this project, 'drivers' are defined as direct or indirect influences on adoption of sustainable farm practices. Of particular interest were drivers that had potential for program and policy interventions. These 'drivers' interact with and are associated with land manager characteristics and capacity for adoption.

Six key drivers of land management practice adoption were identified from DPC stage 1:

- farm finances, profitability and income
- participation in groups and networks

- access to information, which is influenced by the sources of information and how it is dispersed
- incentives and external pressures (including subsidies and co-funding arrangements; tax deductions, rebates or credits; regulations; awards and other forms of recognition; and market based incentives)
- personal motivations (including environmental motivations)
- market drivers (i.e. market access based on sustainability credentials or environmental certification).

‘Enablers’ were distinguished from ‘drivers’ as they are more about the way business is done to use or promote the drivers identified. A range of ‘enablers’ were also identified including those related to extension approaches, training and education, communication, integrated and holistic approaches, monitoring and evaluation (M&E), and coordination and collaboration. In addition, four overarching contextual factors were identified which influence uptake of soil and land cover management practices—the policy and regulatory environment, climate and other system ‘shocks’ or changes, research and development (R&D) and resource availability.

This framework was used to design the DPC 2010 survey instrument, focusing particularly on the ‘drivers’, land manager characteristics and capacity, and barriers because these were the factors most amenable to collection through a farm manager survey. The survey instrument was developed in consultation with departmental staff and was implemented in 2010 including a survey of 1329 broadacre and dairy farms and a pilot survey for horticulture as described in Ecker et al (2012). In order to assess changes that had occurred in land and soil management during the period of the first stage of Caring for our Country and test the findings from the DPC 2010 survey, the DPC 2012 survey was developed and implemented. The DPC 2013 horticulture survey was also developed from DPC stage 1, based on the 2010 pilot study of horticulture farm managers.

The framework generally resulted in outcomes that were consistent with other published literature and a detailed comparison of the findings from the survey with current literature is presented in the earlier report (Ecker et al, 2012). Findings which are supported by literature since 2010 (Appendix 1: Annotated bibliography) are also reported, mainly in the Discussion section of this report.

Survey design

Broadacre and dairy 2012

The DPC 2012 survey for broadacre and dairy farm managers was based on the DPC 2010 survey instrument, to enable comparisons between the two surveys. A small number of changes and refinements were made to the DPC 2012 survey, based on the results of the DPC 2010 survey, feedback from the ABARES data collection team and feedback from the Australian Bureau of Statistics (ABS) Statistical Clearing House.

Survey participants were asked to indicate which of the selected practices (Table 1) they had adopted on their farms. This was followed with questions about how important different motivations were when choosing whether to adopt these practices. Categories for these were ‘financial or productivity benefits’, ‘personal motivations’, and ‘environmental benefits’. Results from the DPC 2010 survey indicated that the availability of support was not a primary influence on the decision to adopt a given land management practice; however, it did play an important role once the decision to adopt had been made. The question regarding support was therefore

modified for the DPC 2012 survey, to ask if the farm manager had sought support to consider or adopt a given land management practice and, if so, who the support agent was.

Participants were asked to indicate which of these motivations most influenced their decision to adopt the given practices. Questions about each of these motivations were followed by a subset of questions about specific motives for each of the categories. These motivations and the subset of these (the motives), which are the focus of this report, are discussed in the following chapter.

Categories of practices investigated (Table 1) were those generally accepted as representing sustainable land management practices, determined through consultation with industry representatives and outlined under the Caring for our Country initiative. One purpose of the project was to understand levels of adoption for these practices in the different agricultural industries surveyed. Practices included were crop management practices (including tillage and stubble management), native vegetation management (such as fencing of areas and planting), grazing management (including rotational systems) and weed management practices. Weed management in this report refers to management of WoNS. Information was also collected on barriers limiting farm managers' ability to change management practices; on participation in Australian Government programs that improved knowledge, skills and practices; and on the sources of NRM information and group membership of farmers that supported their land management decision making.

Horticulture 2013

In 2010 a small (fewer than 50) sample of horticulture farm managers were surveyed—as part of the DPC 2010 study—to understand the drivers of practice change in the horticulture industry. On the basis of the pilot study a survey was developed to collect data from a larger sample of horticulture farm managers in 2013. The survey mirrored the DPC 2012 survey for broadacre and dairy farm managers, with the exception of the inclusion of industry relevant sustainable land management practices for cropping and the removal of management practice questions related to grazing.

Survey sampling

Broadacre and dairy 2012

The sample for the DPC 2012 survey consisted of a random subsample of 1228 broadacre farm managers from the Australian Agricultural and Grazing Industries Survey (AAGIS) frame and 265 dairy farm managers from the Australian Dairy Industry Survey (ADIS) frame—a total of 1493 respondents. ABARES surveys generally target farming establishments that make a significant contribution to the total value of agricultural output (commercial farms). Farms excluded from the ABARES sampling frame are the smallest units, and in aggregate contribute less than 2 per cent to the total value of agricultural production for the industries covered by the surveys. The measure used to identify commercial farms is 'estimated value of agricultural operations' (EVAO). EVAO is a standardised dollar measure of the annual value of agricultural output from the farm. This survey included farms classified as having an EVAO of \$40 000 or more. The sampling frame for the AAGIS is a list of farm businesses drawn from the Australian Business Register and maintained by the ABS.

Horticulture 2013

The sample for the DPC 2013 horticulture survey consisted of a stratified random sample of 179 horticulture managers within the Murray Darling Basin.

Survey data collection

Broadacre and dairy 2012

The DPC 2012 survey for broadacre and dairy farm managers was delivered as a supplement to the ABARES 2011–12 AAGIS and ADIS. Survey data were cross-referenced at unit (individual) level to the comprehensive set of biophysical, financial, demographic and management data collected in the AAGIS and ADIS. Data for broadacre and dairy farming were collected mostly via single-visit, face-to-face interviews. The draft survey questionnaire for broadacre and dairy farm managers was tested during May and June 2012. The survey data collection commenced in July 2012 and continued until December 2012.

Horticulture 2013

An independent survey of horticulture farm managers was undertaken in 2013. Data for horticulture farming establishments were collected through phone interviews. The survey data collection for horticulture farm managers commenced in March 2013 and continued until June 2013.

Survey data, analysis and reporting

This report combines the analysis of quantitative DPC 2010 survey data and DPC 2012 survey data, DPC 2013 horticulture survey data, case study qualitative data and reviewed literature.

Quantitative—broadacre and dairy 2012

The DPC 2010 survey resulted in 1329 valid responses and the DPC 2012 survey 1493 valid responses. There were 639 respondents that participated in both surveys.

The quantitative survey data were assessed to determine any anomalies and outliers in the data. All quantitative survey data were imported into the Statistical Package for Social Sciences (SPSS) v19. The main type of data analysis was descriptive analysis and a select number of inferential tests. All results were weighted and reported at the national scale.

Quantitative—horticulture 2013

The DPC 2013 horticulture survey contained 179 valid responses. The quantitative survey data were analysed and cleaned to determine any anomalies and outliers in the data. All quantitative survey data were imported into the SPSS v19. The main type of data analysis was descriptive analysis and a select number of inferential tests. All results are weighted and reported at the national scale.

Qualitative—broadacre

The qualitative data used in the case study (see Appendix 2) was generated from a research project carried out by Conservation Agriculture Alliance of Australia and New Zealand (CAAANZ) in conjunction with the University of Queensland. CAAANZ provided the funding and established the research questions, with the methodology reviewed by the University of Queensland School of Geography Planning and Environmental Management (GPEM). The university provided research assistants to collect the data, supervised by a CAAANZ representative.

Research assistants approached farmers attending field days and asked them if they would be willing to participate in the study. Interviews were conducted in the first quarter of the 2012–13 financial year. The primary objective of the study was to obtain qualitative data on the value of extension activities to farmers in making various changes in farm practices.

Report structure

The report is organised as follows. Chapter 2 reports the results from the DPC 2012 broadacre and dairy survey in the following topic order: adoption of land management practices; motivations for adoption (categorised as financial, environmental or personal motivations); motives for adopting the practice (sub-categories of the motivations which describe the specific benefit that influenced adoption); barriers to adoption; and support, information and learning networks. Chapter 3 presents results from the DPC 2013 horticulture survey. Chapter 4 compares industries (broadacre, dairy and horticulture) across a subset of comparable variables. Chapter 5 provides a comparison of results from the DPC 2010 and the DPC 2012 broadacre and dairy surveys. Chapter 6 provides a discussion of the findings and Chapter 7 presents implications for policy. Appendix 1 presents an annotated bibliography of relevant or new literature. Appendix 2 presents the qualitative case study of conservation agriculture adopters in Australia. Appendix 3 presents a summary of findings from the DPC stage 1 study, and Appendix 4 presents the methods used for the inferential statistical analysis.

2 Results from the 2012 survey— broadacre and dairy

Adoption of land management practices

To gather information about the factors influencing adoption of sustainable soil and land management practices, information was collected from farm managers about the use of these practices on farm. Farm managers were not asked about the extent of implementation of these practices—the focus of the survey was on whether they had adopted a specific practice and on the factors that had influenced their adoption. Survey respondents were asked whether they had ‘adopted’, ‘considered adopting’ or ‘never considered adopting’ a range of practices relevant to cropping, grazing, native vegetation and weed management.

Overall, the survey results showed that the percentage of farm managers adopting the nominated sustainable soil and land management practices ranged between 32 per cent and 90 per cent for particular practices (Table 1). The adoption of native vegetation management practices was generally lower than cropping, grazing and weed management practices. The proportion of respondents that had considered but not adopted a nominated sustainable land management practice ranged from 2 per cent to 11 per cent. However the data on ‘considerers’ should be used with caution due to the high standard error associated with the use of smaller sample sizes.

Table 2 presents a comparison of adoption rates for nominated sustainable land management practices in the broadacre and dairy industries. The adoption of cropping practices was lower for dairy than broadacre. The adoption of cell or strip grazing was higher for dairy than broadacre. The planting of native pasture was slightly higher for broadacre, while the planting and fencing of native vegetation was similar for broadacre and dairy. The management of WoNS was slightly higher amongst dairy farm managers than other farm managers.

Table 1 Adoption of land management practices in 2012

	Management practice	Adopted (%)	Standard error (%)	Considered adopting (%)	Standard error (%)
Crop management	No-till, reduced tillage or direct drilling	79	2	5	22
	Periods of fallow in crop rotation	55	5	7	16
	Retained stubble	75	2	6	15
Grazing management	Cell or strip grazing	65	3	8	15
	Set minimum groundcover targets for long term	90	2	2	37
	Planted or maintained deep rooted perennial pastures including fodder shrubs	52	4	11	15
Native vegetation management	Planted native pasture or encouraged regrowth	32	6	6	17
	Planted native vegetation or encouraged regrowth	41	5	6	15
	Fenced native vegetation to control stock access	50	4	8	14
Weed management	Management of WoNS	47	4	NA	NA

Note: Standard error is calculated at the 95% confidence interval.

Table 2 Adoption of land management practice by industry in 2012

	Management practice	Broadacre (%)	Dairy (%)
Crop management	No-till, reduced tillage or direct drilling	83	44
	Periods of fallow in crop rotation	58	29
	Retained stubble	82	19
Grazing management	Cell or strip grazing	60	99
	Set minimum groundcover targets for long term	90	91
	Planted or maintained deep rooted perennial pastures	53	45
Native vegetation management	Planted native pasture or encouraged regrowth	34	13
	Planted native vegetation or encouraged regrowth	41	42
	Fenced native vegetation to control stock access	50	53
Weed management	Management of WoNS	46	53

Motivations for adoption in broadacre and dairy

As with the DPC 2010 survey, the DPC 2012 survey was developed from the outcomes of DPC stage 1 to better understand the mix of motivations influencing adoption of sustainable land management practices. In the 2012 survey, farm managers were asked to rate the degree of influence that financial benefits, environmental benefits and personal motivations had on their decision to adopt or consider adopting a given practice across the four categories of land management practices: crop management, grazing management, native vegetation management and weed management.

Table 3 presents the percentage of responses for each of the motivation categories for each of the land management practice categories. The results show that financial benefits were the key influence for adopting cropping, grazing and weed management practices, while environmental benefits were the key influence for adopting vegetation management practices. The proportion of farm managers citing personal motivations as influencing their decision to adopt was similar across all categories of land management practices.

Motives

Within the three motivation categories and four management practice categories, respondents were asked to select three specific motives from up to six options that had been identified as influencing the adoption of sustainable land management practices. Table 4 presents the top three motives within each motivational and management category. These motives are discussed further in the following pages.

Interrelationship between motivations

The results of the DPC 2010 survey strongly indicated that multiple motivations influence the adoption of a given sustainable land management practice. To investigate this interrelationship further, analysis was undertaken to find whether individual respondents had selected one or more motives as influencing them 'to a great extent' in their decision to adopt or consider adopting a given soil and land management practice. The results of this analysis are presented for each of the four categories of soil and land management practices and discussed in the following pages.

Table 3 Motivations for adoption of management practices by category in 2012

	Crop management practices (%)			Grazing management practices (%)			Native vegetation management practices (%)			Weed management practices (%)		
	Great extent	Some extent	Not at all	Great extent	Some extent	Not at all	Great extent	Some extent	Not at all	Great extent	Some extent	Not at all
Financial benefits	62	29	9	60	34	6	19	33	48	61	35	4
Environmental benefits	49	38	14	40	42	18	38	34	29	54	35	10
Personal motivations	35	33	32	31	34	34	28	34	38	39	42	19

Note: Respondents could nominate more than one option. Results are for adopters and considerers.

Table 4 Motives for adopting each management practice in 2012, ordered by importance

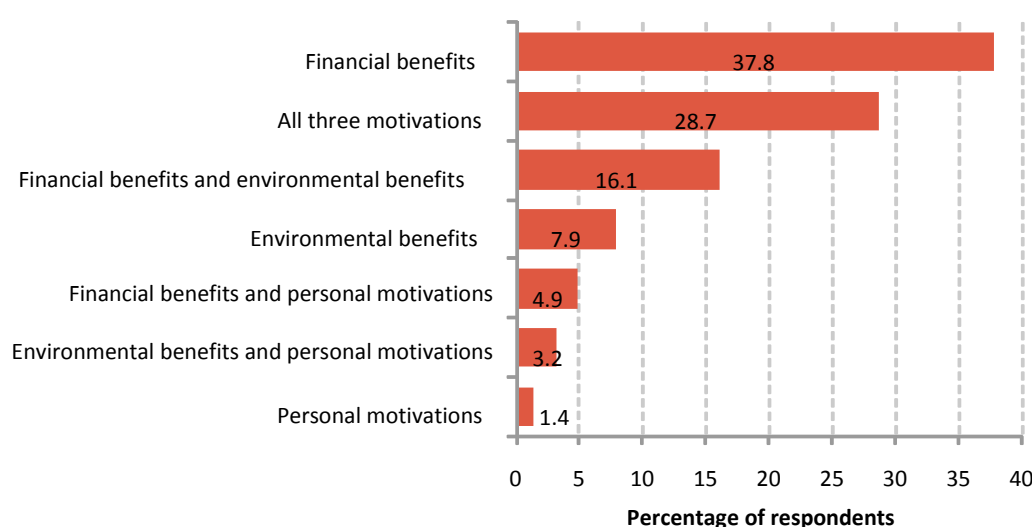
	Financial benefits	Environmental benefits	Personal motivations
Crop management practices	Increased returns or income Reduced financial risk Reduced costs	Improves soil condition Reduces soil loss through erosion Aligns with my environmental goals/beliefs	Desire to protect natural resources for the long term Reduction in workload—provides time for other activities Liked the technologies involved
Grazing management practices	Improved year round feed availability Increased returns/income Cost of not acting would be too high	Improves soil condition Reduces soil loss through wind and water erosion Aligns with my environmental goals/beliefs	Desire to protect natural resources Liked the technologies involved Reduction in workload—provides time for other activities
Native vegetation management practices	Provide shelter for livestock or crops Increased returns/income Reduced costs	Aligns with my environmental goals/beliefs Reduces soil loss/erosion Provide habitat for native fauna	Desire to protect natural resources for the long term Desire to improve amenity of the landscape Family considerations
Weeds management practices (WoNS)	Cost of not acting too high Increase returns Reduced livestock losses	Aligns with my environmental goals/beliefs Corporate social and environmental responsibility Improves soil condition	Desire to protect natural resources Reduction in workload Recognition by neighbours and community

Crop management practices

Farm managers' responses showed that the financial benefits were the greatest influence on whether they adopted or considered adopting the crop management practices, followed by environmental benefits and personal motivations (Table 3).

For many farm managers, the three motivation areas are interconnected. For this reason, the survey was designed to allow respondents to select more than one motivation. As can be seen in Figure 1 below, financial benefits (38 per cent) were still the most influential single factor on farm managers' adopting or considering adopting crop management practices. However, the next two most commonly selected groups of motivations were the combination of all three motivations (financial benefits, environmental benefits and personal motivations) (29 per cent) and the combination of financial benefits and environmental benefits (16 per cent).

Figure 1 Motivations of crop management practice decisions 'to a great extent'

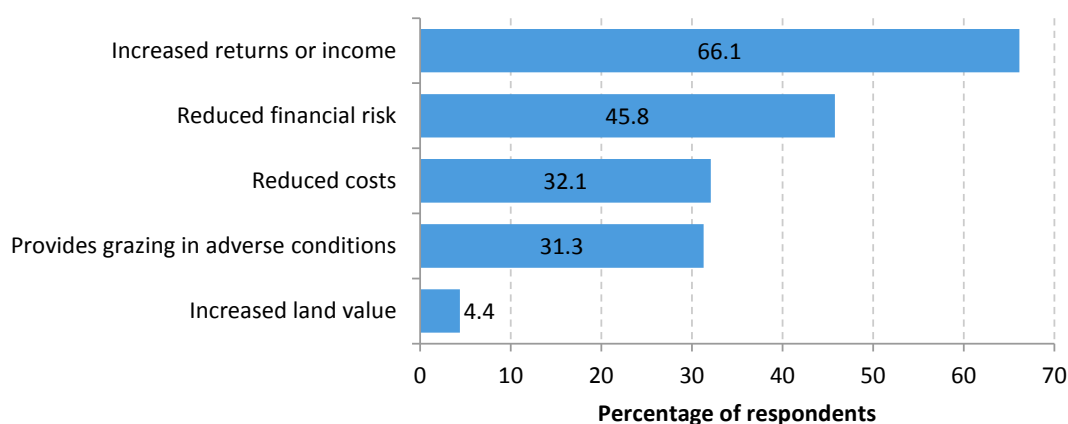


For each motivation, farm managers were asked to select particular motives which were a sub-category of the three motivational areas (financial, environmental and personal). These are discussed in the following pages.

Financial motives for crop management practice decisions

For the 91 per cent of farm managers who said that financial motivations influenced their adopting or considering adopting crop management practices 'to a great extent' or 'to some extent' (Table 3), increasing returns or income was the most frequently stated financial motive (66 per cent), followed by reduced financial risk (46 per cent) (Figure 2).

Figure 2 Financial motives for adopting crop management practices

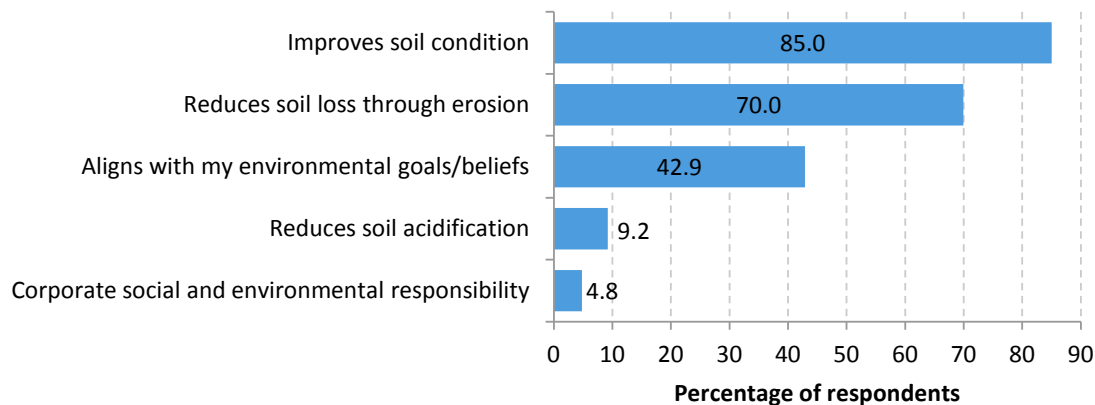


Note: Respondents could nominate more than one option

Environmental motives for crop management practice decisions

For the 87 per cent of farm managers who said environmental benefits influenced their adoption or consideration of adoption of crop management practices 'to a great extent' or 'to some extent' (Table 3), the majority of respondents indicated that improving soil condition was a key motive. The next most important motives were reducing soil loss through erosion. After these, the next most important motive was alignment with environmental beliefs/goals (Figure 3).

Figure 3 Environmental motives for adopting crop management practices

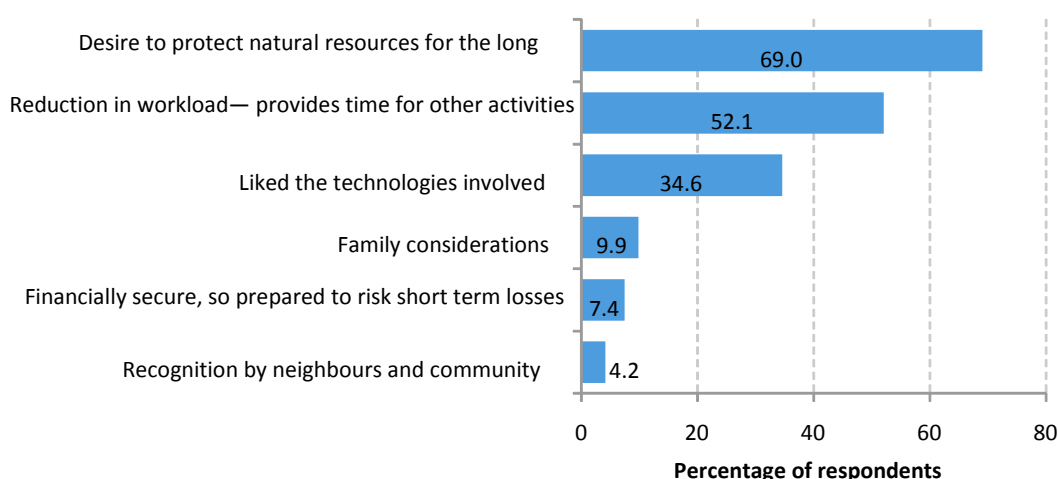


Note: Respondents could nominate more than one option

Personal motives for crop management practice decisions

For the 68 per cent of farm managers who said that personal motivations influenced their adopting or considering adopting crop management practices 'to a great extent' or 'to some extent' (Table 3), personal motives included the desire to protect natural resources (69 per cent), reduction in workload associated with the practice (52 per cent), and liking the technologies involved (35 per cent) (Figure 4).

Figure 4 Personal motives for adopting crop management practices

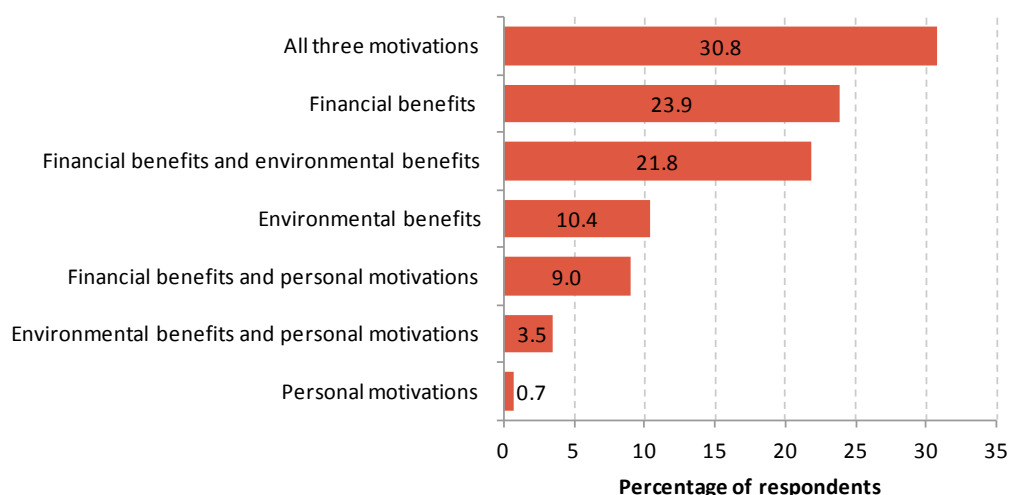


Note: Respondents could nominate more than one option

Grazing management practices

Financial benefits were reported by farm managers as having the greatest influence on their adoption or considered adoption of grazing management practices, followed by environmental benefits and personal motivations (Table 3). As can be seen in Figure 5 below, a combination of all three motivational categories (financial benefits, environmental benefits and personal motivations) influenced 31 per cent of farm managers' decisions about grazing management. The next two most commonly selected groupings of motivations were financial benefits (24 per cent) on their own, and the combination of financial and environmental benefits (22 per cent).

Figure 5 Motivations of grazing management practice decisions 'to a great extent'



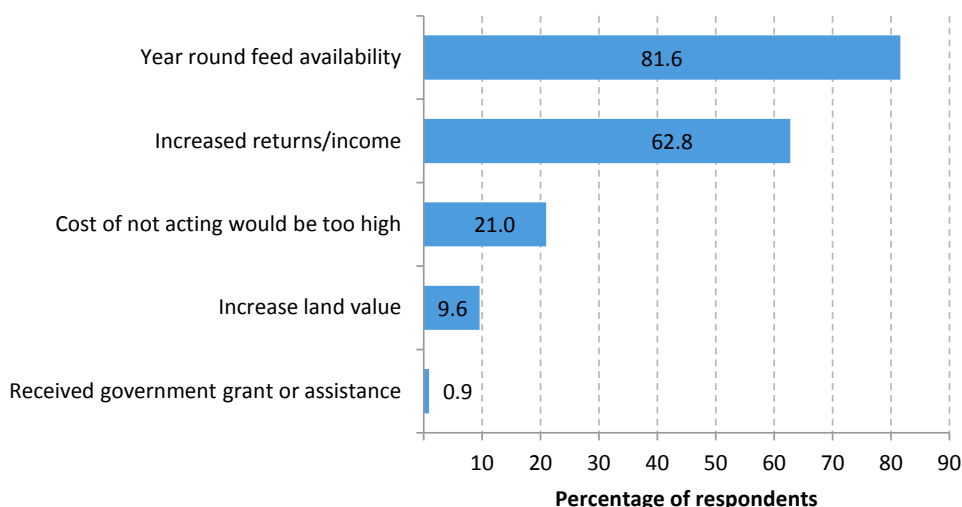
Note: Respondents could nominate more than one option

Financial motives for grazing management practice decisions

For the 94 per cent of farm managers who said that financial motivations influenced their adopting or considering adopting grazing management practices 'to a great extent' or 'to some extent' (Table 3), Figure 6 shows that the main financial motives were financial benefits from

year-round availability of feed (most likely through cell or strip rotation grazing) and increased returns/income. Cost of not acting was the third most nominated motive, but was well behind the other two.

Figure 6 Financial motives for adopting grazing management practices

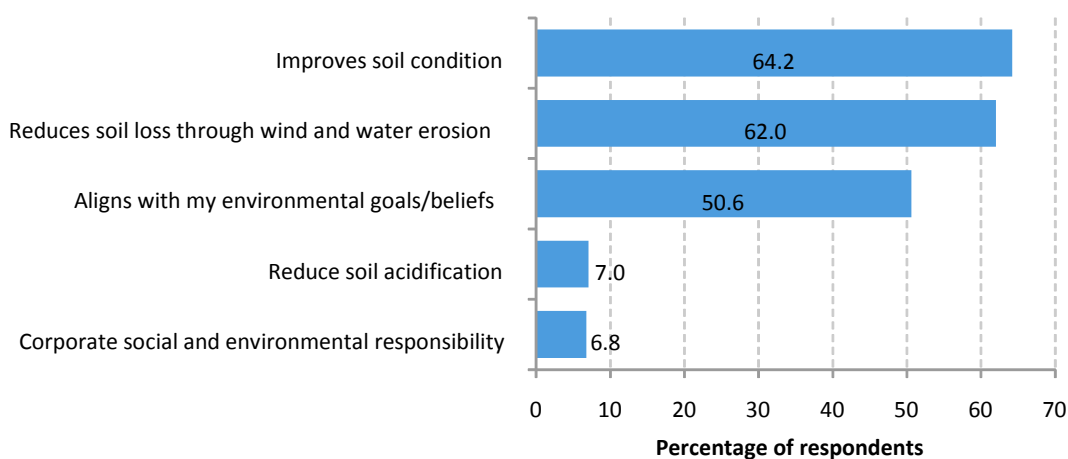


Note: Respondents could nominate more than one option

Environmental motives for grazing management practice decisions

For the 82 per cent of farm managers who said environmental benefits influenced their adopting or considering adopting crop management practices ‘to a great extent’ or ‘to some extent’ (Table 3), the majority of respondents indicated that improving soil condition was a key motive. The next most important motive was reducing soil loss through wind and water erosion. After this, the next most important motive was alignment with environmental beliefs/goals (Figure 7).

Figure 7 Environmental motives for adopting grazing management practices



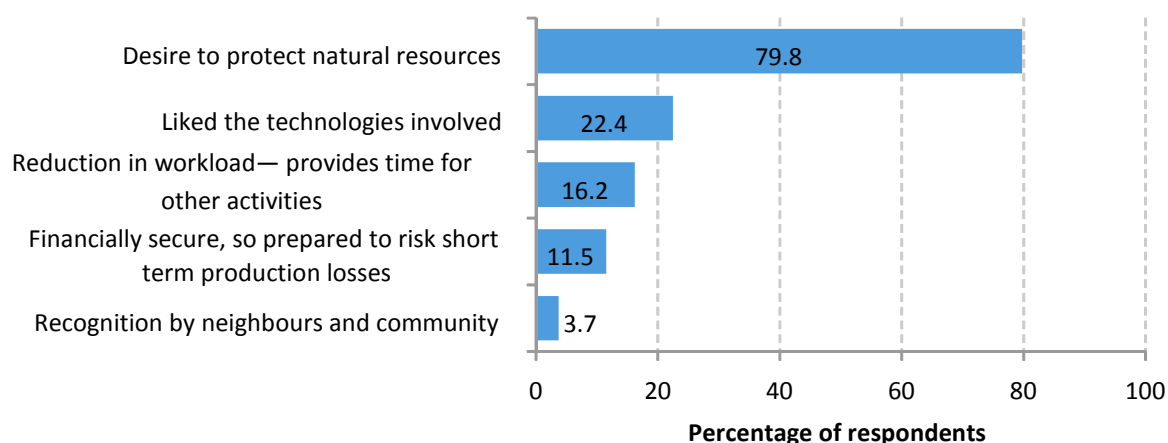
Note: Respondents could nominate more than one option

Personal motives for grazing management practice decisions

For the 65 per cent of farm managers who said that personal motivations influenced adopting or considering adopting grazing management practices ‘to a great extent’ or ‘to some extent’ (Table

3), the desire to protect natural resources was the most frequently selected personal motive (Figure 8). The next highest ranked motive was that they liked the technology involved, followed by a reduction in workload.

Figure 8 Personal motives for adopting grazing management practices



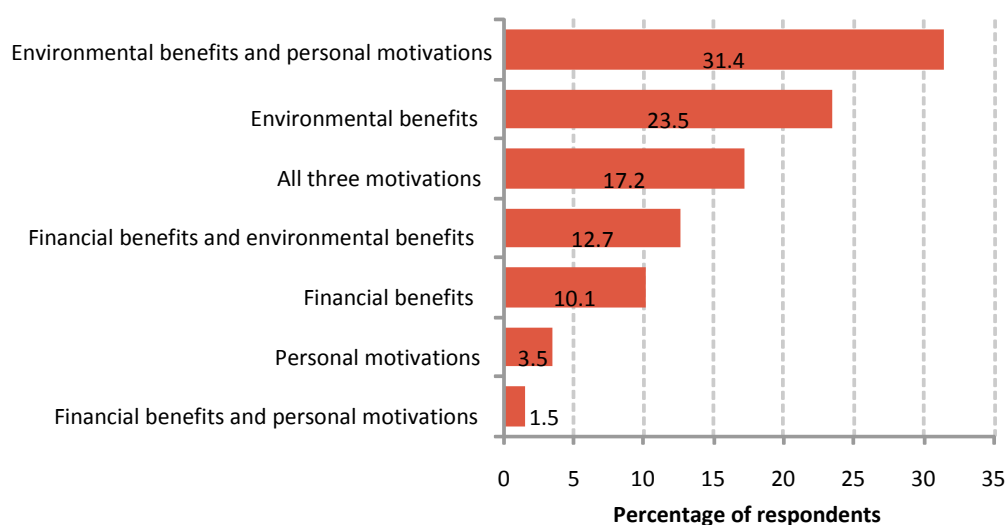
Note: Respondents could nominate more than one option

Native vegetation management practices

Environmental motivations were the most frequently selected motivation for adopting or considering adopting native vegetation management practices in the broadacre and dairy industry, followed by personal motivations and financial benefits (Table 3).

As can be seen in Figure 9 below, the combination of environmental and personal motivations (31 per cent) was the most popular selection, suggesting that for a significant percentage of farm managers the combination of these two motivations played an important role in native vegetation management practice decisions.

Figure 9 Motivations of native vegetation management decisions ‘to a great extent’



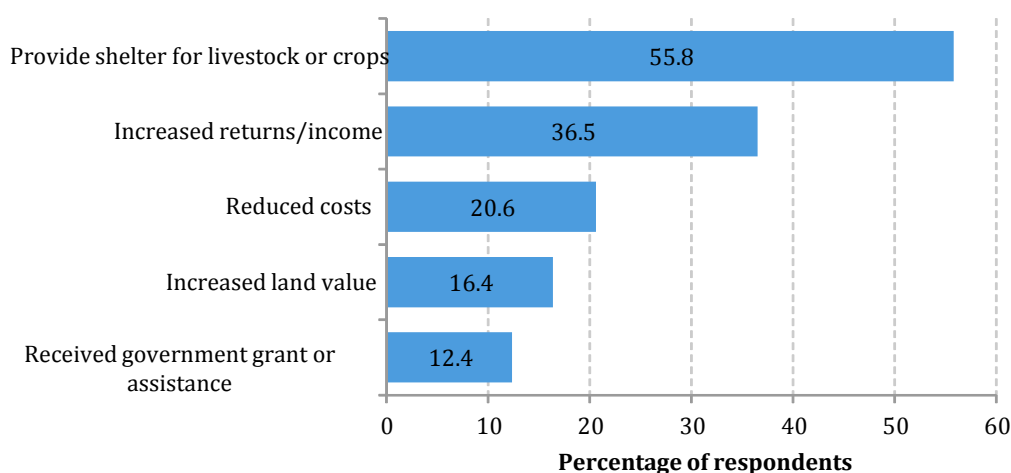
This is a markedly different result from the previously discussed motivations for cropping and grazing management practices, where it was the combination of financial and environmental

motivations that interacted to influence adoption. For vegetation management, the next two most commonly selected motivations were environmental benefits (24 per cent) on their own and the combination of all three motivations (financial benefits, environmental benefits and personal motivations) (17 per cent).

Financial motives for native vegetation management practice decisions

For the 52 per cent of farm managers who said that financial motivations influenced their adopting or considering adopting native vegetation management 'to a great extent' or 'to some extent' (Table 3), providing shelter for livestock was the most frequently chosen financial motivation (Figure 10). Anticipated increased returns or income was also an important motive. Reduction in costs was the third most frequently selected financial motive.

Figure 10 Financial motives for adopting native vegetation management practices

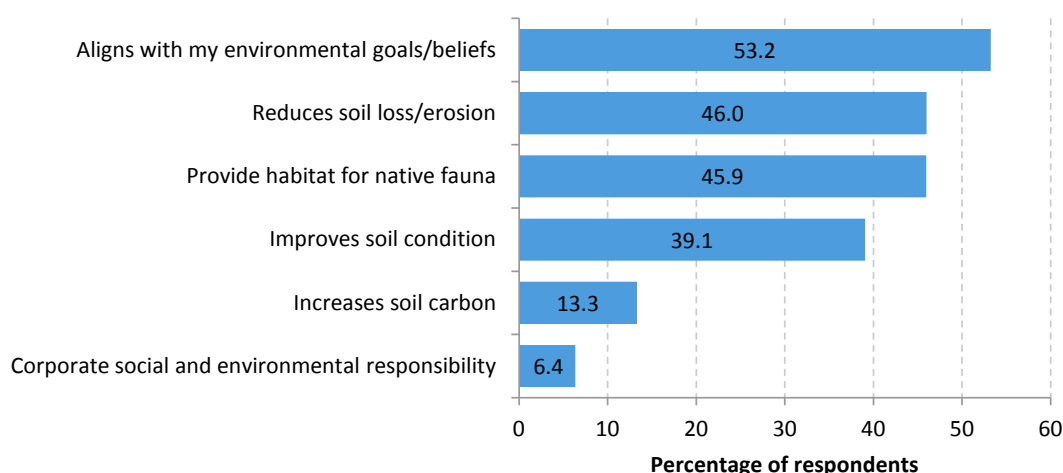


Note: Respondents could nominate more than one option

Environmental motives for native vegetation management practice decisions

For the 72 per cent of farm managers who said that environmental motivations influenced their adopting or considering adopting native vegetation management practices 'to a great extent' or 'to some extent' (Table 3), the highest ranked environmental motives included alignment with environmental beliefs/goals, reductions to soil loss and providing habitat for native fauna (Figure 11). Improved soil condition was also commonly identified as a key motive.

Figure 11 Environmental motives for adopting native vegetation management practices

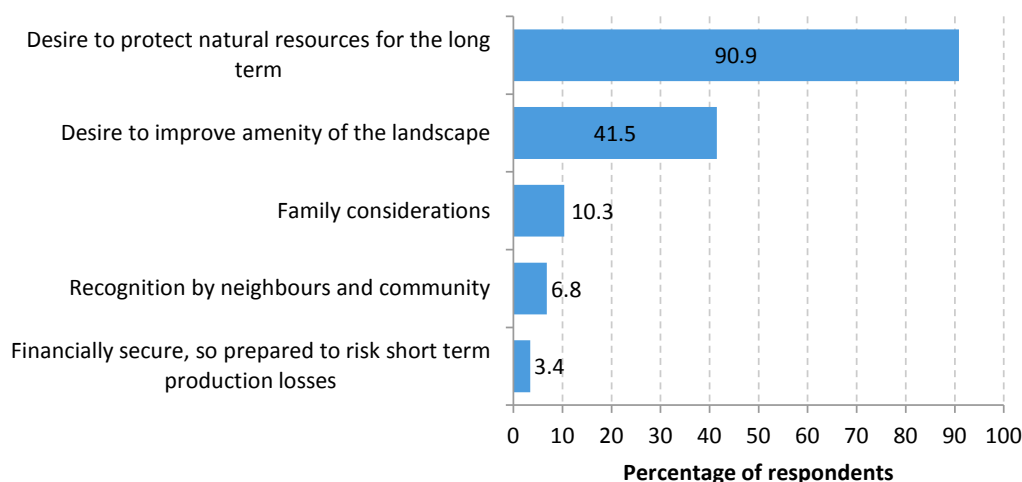


Note: Respondents could nominate more than one option

Personal motives for native vegetation management practice decisions

For the 62 per cent of farm managers who said that personal motivations influenced their adopting or considering adopting native vegetation management practices 'to a great extent' or 'to some extent' (Table 3), the desire to protect natural resources was overwhelmingly the main personal motive (Figure 12). The next highest ranked motive was a desire to improve the amenity of the landscape.

Figure 12 Personal motives for adopting native vegetation management practices

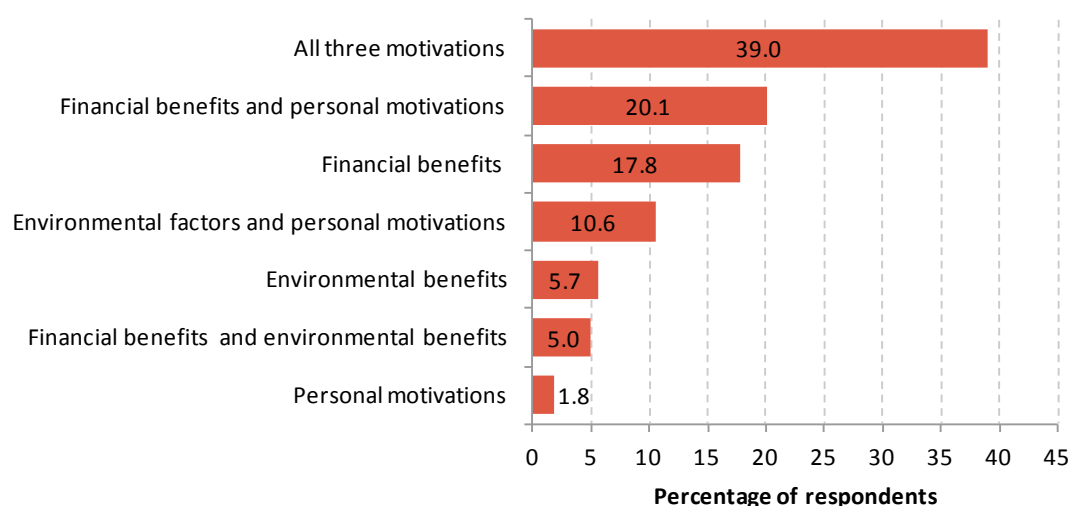


Note: Respondents could nominate more than one option

Weed management practices

Financial benefits were reported as the greatest driver for the adoption or consideration of adoption of weed management practices for WoNS, followed by environmental benefits and personal motivations (Table 3). As can be seen in Figure 13 below, the combination of all three motivations (financial benefits, environmental benefits and personal motivations) (39 per cent) was the most popular selection, suggesting that the combination of all three motivations played an important role in adoption or considered adoption of weed management practices. The next two most commonly selected motivations were a combination of financial benefits and personal motivations (20 per cent) and financial benefits alone (18 per cent).

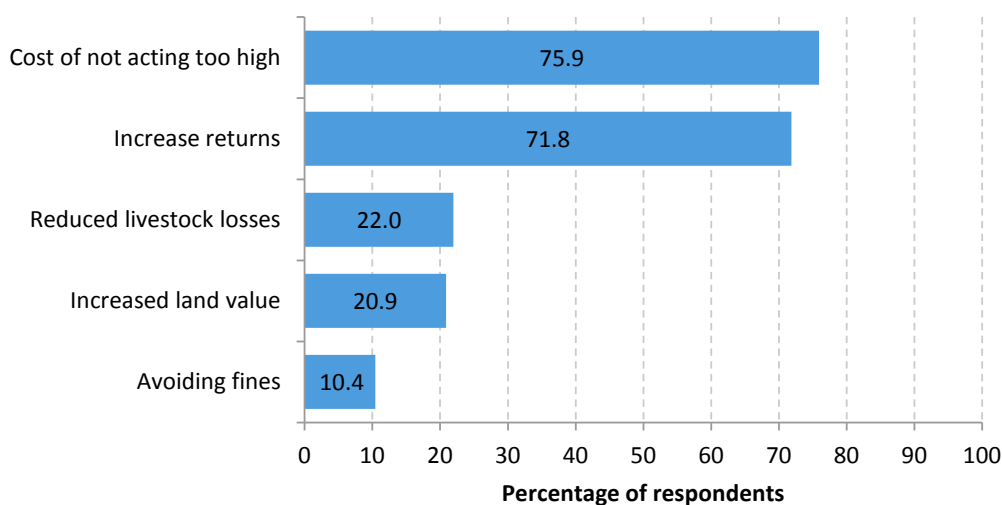
Figure 13 Motivations of weed management practice decisions ‘to a great extent’



Financial motives for weed management practice decisions

For the 96 per cent of farm managers who said that financial motivations influenced adoption of weed management practices ‘to a great extent’ or ‘to some extent’ (Table 3), the cost of not acting being too high and increased returns were nominated as the main motives (Figure 14).

Figure 14 Financial motives for adopting weed management practices

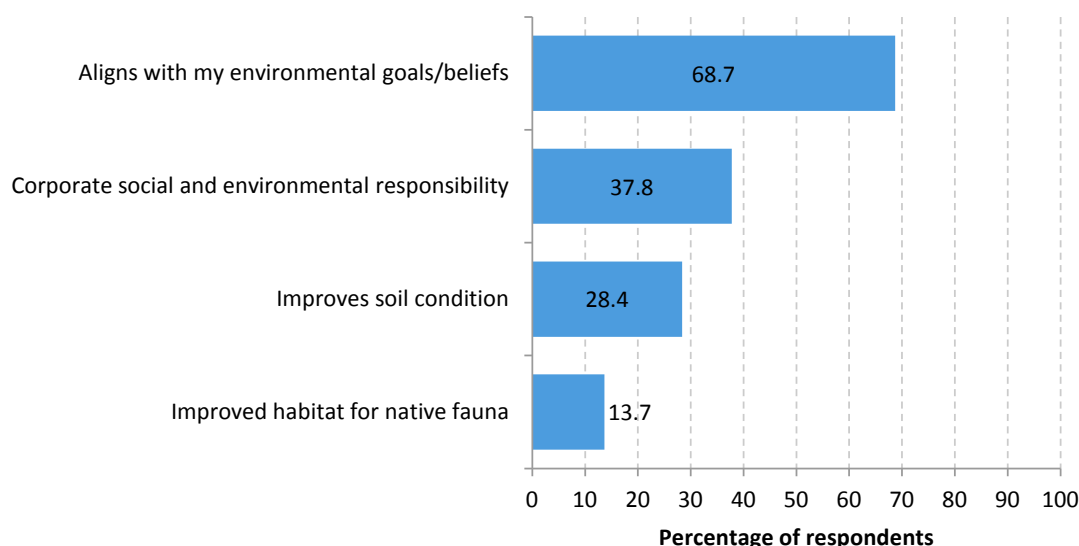


Note: Respondents could nominate more than one option

Environmental motives for weed management practice decisions

For the 89 per cent of farm managers who said that environmental motivations influenced adopting weed management practices ‘to a great extent’ or ‘to some extent’ (Table 3), alignment with environmental goals/beliefs was the primary environmental motive. This motive was followed by corporate social and environmental responsibility and improving soil condition (Figure 15).

Figure 15 Environmental motives for adopting weed management practices

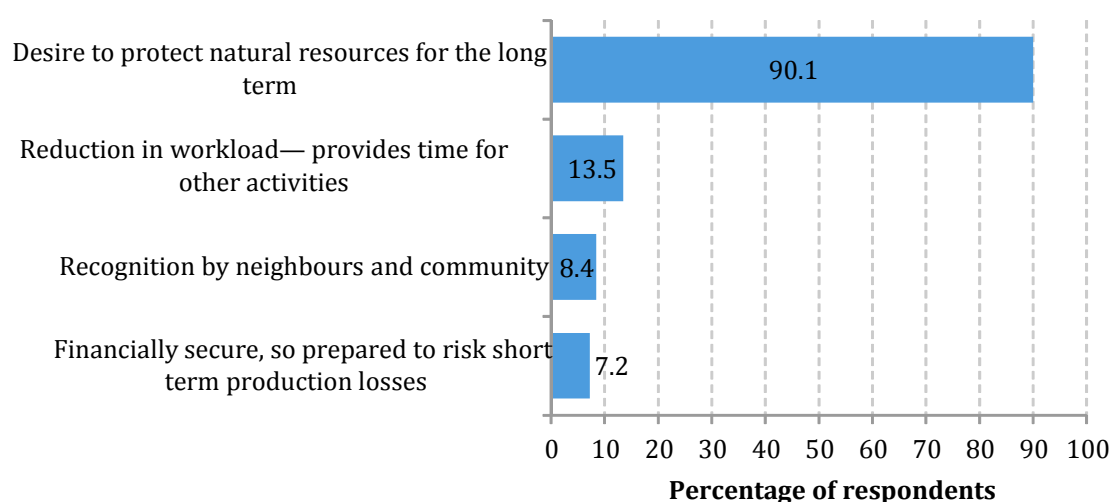


Note: Respondents could nominate more than one option

Personal motives for weed management practice decisions

For the 81 per cent of farm managers who said that personal motivations influenced adoption of weed management practices ‘to a great extent’ or ‘to some extent’ (Table 3), the desire to protect natural resources (90 per cent) was overwhelmingly the key personal motive (Figure 16).

Figure 16 Personal motives for adopting weed management practices

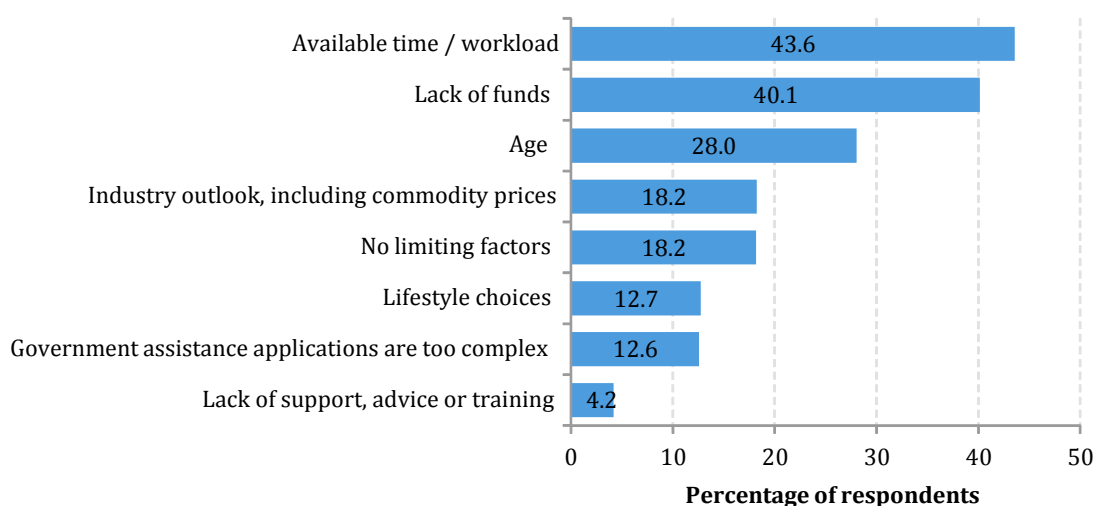


Note: Respondents could nominate more than one option

Barriers to adoption in broadacre and dairy

Broadacre and dairy farm managers reported a number of factors limited their ability to make changes to their current management practices. Available time / workload and lack of funds were the most frequently identified factors limiting farm managers' ability to make changes (Figure 17). A number of farmers (18 per cent) reported no limiting factors.

Figure 17 Barriers to changing land management practices



Note: Respondents could nominate more than one option

Reported barriers to adoption were mostly consistent between respondents from the broadacre and dairy industries (Table 5). The main differences between the two industries were dairy farm managers nominating a lack of funds and industry outlook, including commodity prices, as being more of a barrier to adoption, and a smaller percentage of dairy farm managers believing there were no limiting factors.

Table 5 Barriers to changing land management practice—industry comparison

	Broadacre (%)	Dairy (%)
Available time / workload	43	49
Lack of funds	38	55
Age	29	23
No limiting factors	19	9
Industry outlook, including commodity prices	16	34
Government assistance applications are too complex	13	11
Lifestyle choices, including age	12	15
Lack of support, advice or training	4	2

Note: Respondents could nominate more than one option

Support, information and learning in broadacre and dairy

This section provides results on support agents used by farm managers in the process of adopting a land management practice; group membership that supported land management decision making; awareness of, participation in and benefits of Australian Government NRM programs; and learning activities.

Support

Less than one-third of broadacre and dairy farm managers sought support while adopting or considering the adoption of a given sustainable land management practice (Table 6). For horticulture, the percentages of farmers seeking support were slightly higher.

Table 6 Sought support for land management practices—industry comparison

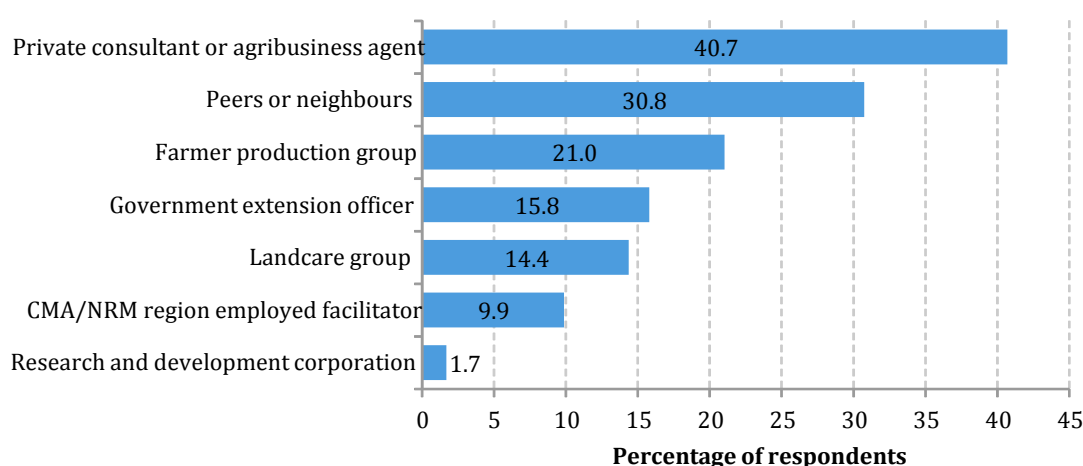
Practice area	Sought support (%)	
	Broadacre/dairy	Horticulture
Crop management	31	NA
Grazing management	22	NA
Soil management	NA	41
Native vegetation management	27	24
Weed management	21	35

The following pages discuss support sought by broadacre and dairy farmers. Support sought by horticulturalists is discussed later in the report under the results for the horticulture survey.

Crop management practices

For the 31 per cent of broadacre and dairy farm managers who sought support in adopting or considering adopting a crop management practice, private consultants or agribusiness agents, peers or neighbours, and farmer production groups were the most frequently cited sources of support (Figure 18).

Figure 18 Support agents utilised for crop management practices

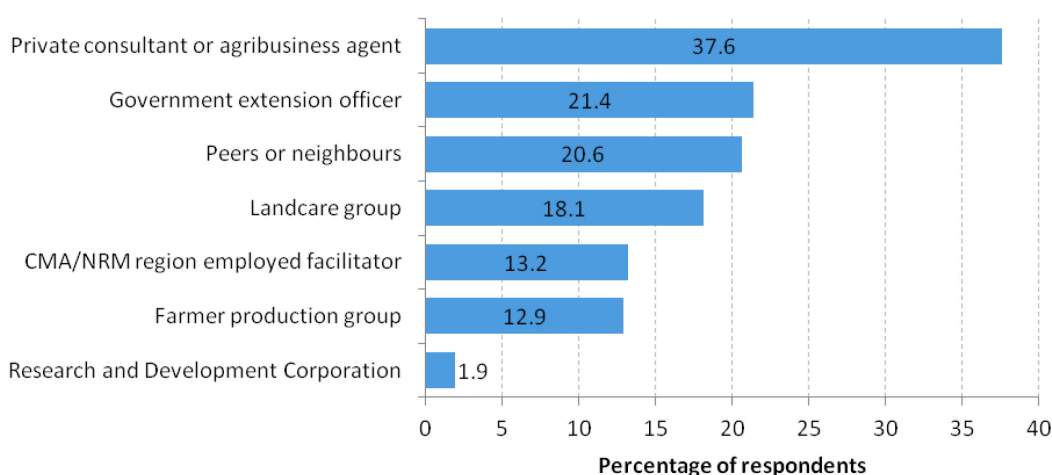


Note: Respondents could nominate more than one option

Grazing management practices

For the 22 per cent of broadacre and dairy farm managers who sought support for adopting or considering adopting grazing management practices, private consultants or agribusiness agents were the most frequently cited sources of support, followed by government extension officers, peers and neighbours and Landcare (Figure 19).

Figure 19 Support agents utilised for grazing management practices

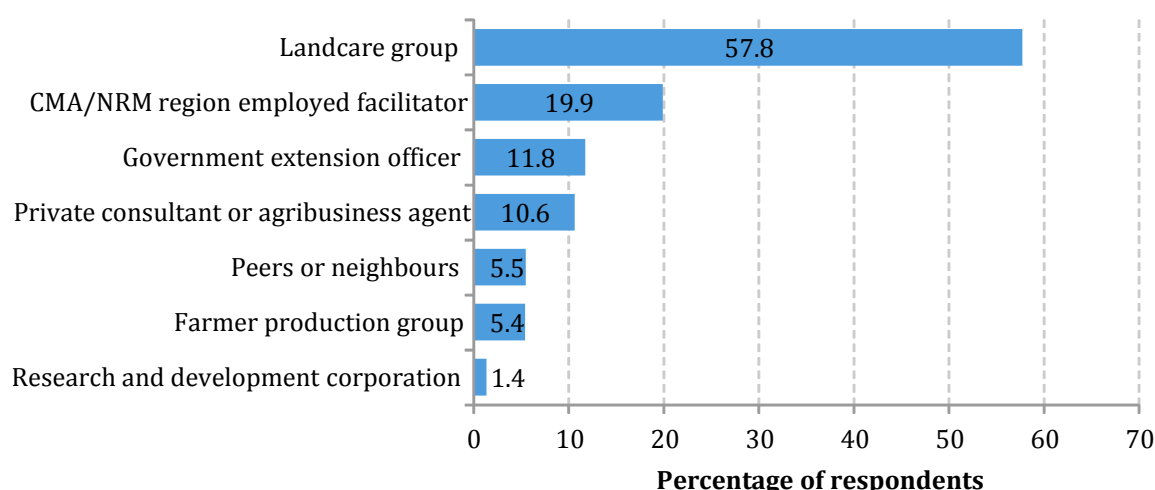


Note: Respondents could nominate more than one option

Native vegetation management practices

For the 27 per cent of broadacre and dairy farm managers who sought support for native vegetation management practices, Landcare groups were the primary form of support sought, followed by CMA/NRM region facilitators (Figure 20).

Figure 20 Support agents utilised for native vegetation management practices

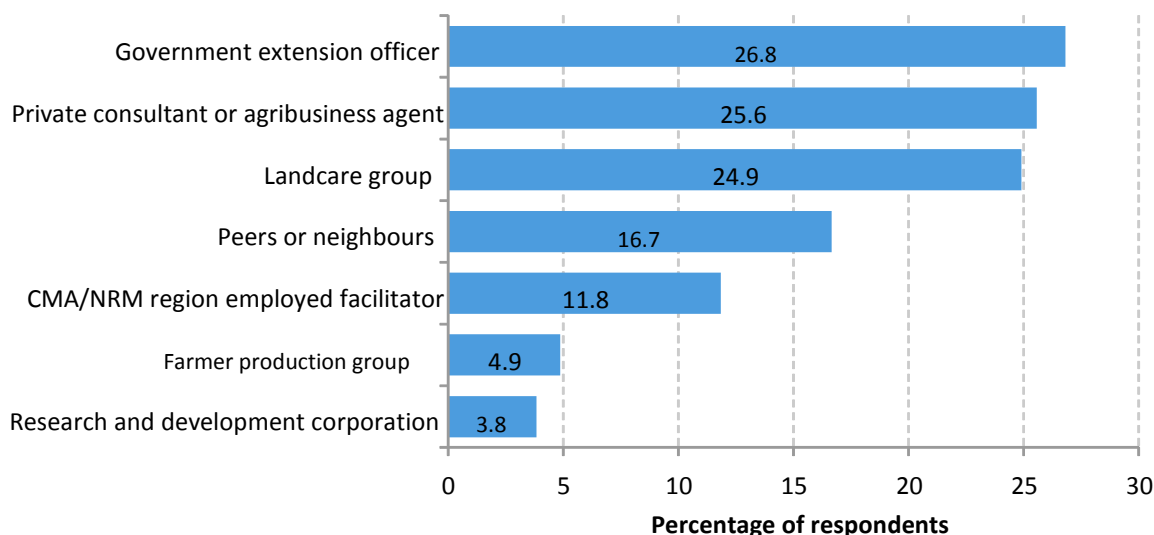


Note: Respondents could nominate more than one option

Weed management practices

For the 21 per cent of broadacre and dairy farm managers who sought support for weed management practices, the top three sources of support were approximately equivalent between government extension officers (27 per cent), private consultants and agribusiness agents (26 per cent), and Landcare groups (25 per cent) (see Figure 21).

Figure 21 Support agents utilised for weed management practices



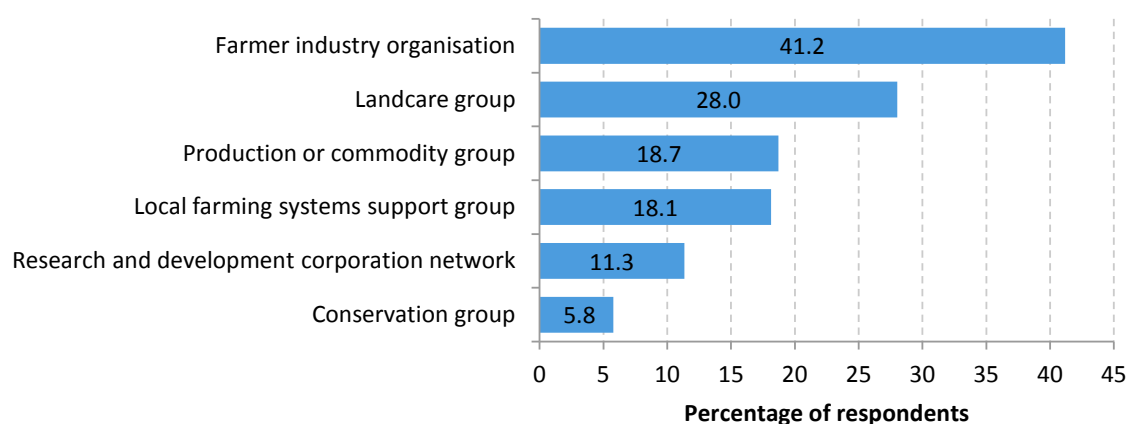
Note: Respondents could nominate more than one option

Group membership

Over two-thirds (67 per cent) of broadacre and dairy farm managers indicated they were members of a group or organisation that supported land management practice decision making. Farm managers held membership with a variety of groups and organisations. The most

frequently reported groups and organisations were farmer industry groups and Landcare groups (Figure 22).

Figure 22 Membership of groups supporting sustainable land management



Note: Respondents could nominate more than one option

Involvement in Australian Government programs and initiatives

Awareness

Awareness of and participation by broadacre and dairy farmers in a number of Australian Government programs was examined, and the results are presented in Table 7. Farm managers' awareness of the Regional Landcare Facilitators initiative was very high, with 90 per cent indicating awareness. It is acknowledged that there may have been confusion with the pre-existing National Landcare Program or other association with the term Landcare influencing the results. The next most frequently recognised initiative was the National Landcare Facilitator, at 48 per cent. Australia's Farming Future and Caring for our Country were the next two programs or initiatives that respondents were most aware of (32 and 31 per cent respectively). Reef Rescue had the lowest level of awareness nationally, which is expected as this program focuses on landholders in regions adjacent to the Great Barrier Reef. Awareness of Reef Rescue was significantly higher among farm managers located in Queensland.

Participation

For the farm managers who were aware of a given program, the Regional Landcare Facilitators initiative had the highest proportion of farmers reporting participation (40 per cent), followed by Farm Ready (39 per cent) and Caring For our Country (16 per cent).

Practice change, improved skills and knowledge

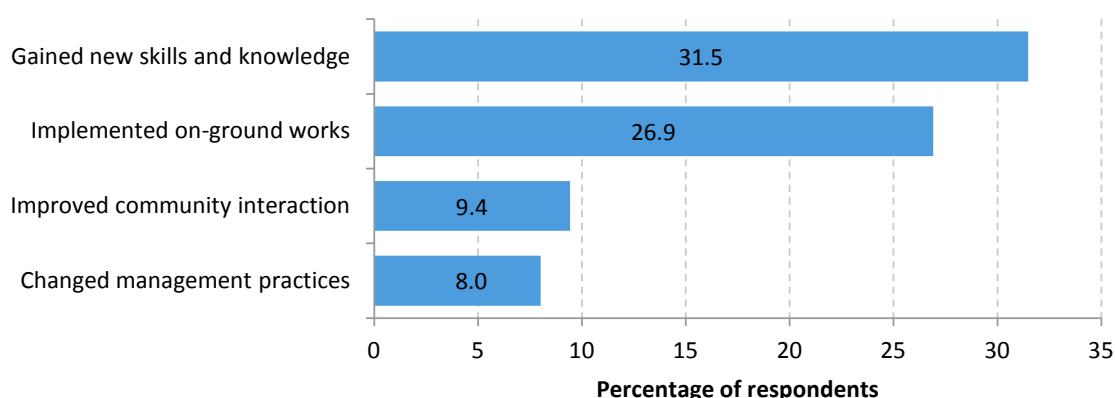
Of the farm managers who participated in any of the Australian Government programs or initiatives, most of them (over 90 per cent) said that it led to improved skills and knowledge or a change in their practices. The exceptions were the National Landcare Facilitator initiative, which still had a high change rate of 86 per cent; and Reef Rescue, which had a lower change rate of 59 per cent. Interpretation of these results needs to acknowledge that the objectives of programs and initiatives are targeted at different scales—for example the National Landcare Facilitator initiative aims more at national coordination than change at farmer scale.

Table 7 Awareness of and participation in Australian Government NRM programs

	Aware (%)	Of those who were aware, % who participated	Of those who participated, % who improved their skills and knowledge or changed practice
Regional Landcare Facilitators	90	40	90
National Landcare Facilitator	48	10	86
Australia's Farming Future	32	5	94
Caring for our Country	31	16	94
Farm Ready	30	39	93
Sustainable Farm Practice Facilitators	23	9	93
Reef Rescue	21	7	59
Reef Rescue (Queensland)	64	13	59

Benefits of participation

Figure 23 presents the benefits farm managers reported from participating in any of the listed Australian Government programs or initiatives. Gaining new skills and knowledge and the implementation of on-ground works were the most frequently reported benefits.

Figure 23 Benefits gained from participation in Australian Government programs

Note: Respondents could nominate more than one option

Learning activities and events

Participation

Broadacre and dairy farm managers reported participating in a variety of learning activities and events that provided land management practice information and advice. Field days were the most frequently reported activity, with 54 per cent of all respondents attending a field day in the last two years; followed by a training course or workshop, with 35 per cent of all respondents attending this type of event in the last two years.

Incorporating outcomes

The majority of farm managers who participated in a learning activity or event in the two years prior to 2012 incorporated the outcomes into their land management (Table 8).

Table 8 Extension activities attended in the last two years and incorporation of outcomes

	Participated (%)	Of those who participated, % who incorporated outcomes into management practices
Field days	54	79
Training course or workshop	35	91
Trials	24	93
Agribusiness organised events or meetings	24	89
Industry group events	21	84
Benchmarking of best practice group activities/events	8	96
Other	3	99

Note: Respondents could nominate more than one option

Focus of activities and events

Table 9 shows the main focus of learning activities and events which farm managers attended.

Table 9 Focus of extension activities

Type of activity	% with a production focus	% with a combined production, NRM and financial focus	% with a financial focus	% with an NRM/ environmental focus
Field days	50	48	1	2
Training course or workshop	56	34	4	6
Trials	85	11	0	5
Agribusiness organised events or meeting	76	20	4	1
Industry group events	71	26	Less than 1%	3
Benchmarking of best practice group activities/ events	46	48	7	Less than 1%

Note: Due to rounding these percentages do not exactly sum to 100%

Overall, most activities and events had a production focus or a combination of production, NRM and financial.

Delivery of extension activities and events

Respondents were asked to identify the delivery agent for the activities they attended. The delivery agents of the attended activities and events are presented in Table 10.

Table 10 Delivery agent for extension activities

Delivery agent	Field days (%)	Training course or workshop (%)	Trials (%)	Agri-business events (%)	Industry group events (%)	Bench-marking group events (%)	Other (%)
Private consultant or agribusiness agent	32	26	16	76	13	37	11
Local farmer network	37	24	37	5	21	12	3
Regional NRM group / CMA	3	9	10	3	4	1	6
Landcare group	5	6	18	0	10	3	16
Local government agency	2	2	1	0	2	1	2
State government agency	4	17	3	0	5	7	8
Federal government agency	1	6	3	1	9	33	16
Other	10	6	12	6	30	7	37
Don't know	8	5	0	10	6	0	0

Note: Due to rounding, these percentages do not exactly sum to 100%

Characteristics of adopters, considerers and non-adopters

To explore if there were any differences between the characteristics of farm managers and farms who had adopted a given soil or land management practice ('adopters'), those who had only considered adopting ('considerers') and those who had not adopted ('non-adopters'), a series of separate one-way analyses of variance (ANOVAs) were undertaken. Table 11 provides a brief summary of characteristics which were more likely to be found in adopters of the land management practices examined than in non-adopters of those practices.

Table 11 Characteristics more likely amongst adopters than non-adopters of specified practices

Land management practice	Higher cash income	Higher rate of return	Higher off-farm income	Larger farms	Younger	Higher level of education	Participate in government program	Participate in extension	Member of group
No-till	yes	yes	yes	yes	yes	yes	yes	no	yes
Fallow	no	no	yes	no	no diff.	no	no	no	no
Retain stubble	yes	no	yes	yes	yes	yes	yes	no	yes
Cell grazing	yes	yes	no	no	no	no	yes	no	yes
Minimum groundcover targets	yes	yes	no	yes	no	yes	yes	yes	yes
Perennial pasture	yes	yes	yes	yes	yes	yes	yes	yes	yes
Native pasture	no	no	no	yes	no	yes	yes	no diff.	yes
Native vegetation	yes	yes	yes	no	yes	yes	yes	no	yes
Fence native vegetation	yes	yes	yes	no	yes	yes	yes	no	yes
Weed management	no	no	no	yes	no	no	no	yes	no diff.

Note: not all variables tested are presented in table 11. No diff. denotes no difference between adopters and non-adopters

A detailed exploration of characteristics associated with each land management practice follows on the next pages.

In the discussion below, for each farm manager or farm characteristic, a ranking is provided based on whether there was a statistically significant difference between groups. In cases where there was no statistically significant difference between two groups but there was a difference between each of these groups and the third group, the same ranking was applied to the two groups. Where there was no difference between one group and all other groups, a ranking was not given for that group; this is noted in the table. The characteristics reported below are for either the highest or lowest rating for adopters relative to considers and/or non-adopters.

Crop management

No-till, reduced tillage or direct drilling

As can be seen in Table 12, relative to non-adopters of no-till, reduced tillage or direct drilling or those who had only considered adopting these practices, farm managers who had adopted these practices tended to:

- have higher farm cash income
- have higher farm rate of return
- have higher gross off-farm income
- have greater area cropped
- have larger farms
- be younger
- have a higher level of education
- be more likely to participate in government programs
- be more likely to be members of a group.

Table 12 Characteristics of adopters, considerers and non-adopters of no-till, reduced tillage or direct drilling

Characteristic	Adopters	Considerers	Non-adopters
Difference between total cash receipts and total cash costs—farm cash income (\$)	Rank: Highest Mean: 174 149.63 SD: 274 970.20	Rank: Lowest Mean: 128 976.15 SD: 156 816.97	Rank: Lowest Mean: 114 363.52 SD: 154 221.20
Rate of return excluding capital appreciation	Rank: Highest Mean: 1.80 SD: 4.92	Rank: Lowest Mean: -0.36 SD: 4.81	Rank: Middle Mean: 1.34 SD: 4.37
Gross off-farm income earned by owner manager and spouse (\$)	Rank: Highest Mean: 30 136.64 SD: 35 949.74	Rank: Lowest Mean: 20 912.81 SD: 19 516.36	Rank: Lowest Mean: 21 245.49 SD: 31 120.84
Area cropped (hectares)	Rank: Highest Mean: 793.14 SD: 1006.65	Rank: Middle Mean: 453.39 SD: 538.64	Rank: Lowest Mean: 260.98 SD: 539.80
Farm size (hectares)	Rank: Highest Mean: 1896.37 SD: 2628.47	Rank: No difference ¹ Mean: 1828.12 SD: 3102.27	Rank: Lowest Mean: 1708.03 SD: 3162.96
Age of owner manager	Rank: Lowest Mean: 55.70 SD: 10.03	Rank: Highest Mean: 60.10 SD: 10.73	Rank: Middle Mean: 57.67 SD: 10.98
Education	Rank: Highest Mean: 3.38 SD: 1.16	Rank: Lowest Mean: 2.92 SD: 0.87	Rank: Lowest Mean: 2.91 SD: 0.97
Participated in extension	Rank: Middle Mean: 0.75 SD: 0.43	Rank: Highest Mean: 0.92 SD: 0.27	Rank: Lowest Mean: 0.72 SD: 0.45
Participated in a government program	Rank: Highest Mean: 0.61 SD: 0.49	Rank: Highest Mean: 0.63 SD: 0.48	Rank: Lowest Mean: 0.36 SD: 0.48
Member of group	Rank: Highest Mean: 0.80 SD: 0.40	Rank: Highest Mean: 0.83 SD: 0.38	Rank: Lowest Mean: 0.55 SD: 0.50

Note: SD stands for standard deviation.¹ There was no significant difference in farm size between considerers and adopters or considerers and non-adopters; therefore, they receive no rank.

Periods of fallow in crop rotation

As can be seen in Table 13, relative to non-adopters of periods of fallow in crop rotation or those who had only considered adopting this practice, farm managers who had adopted tended to:

- have lower farm cash income
- have lower rate of return
- have higher gross off-farm income
- have smaller farms
- have a lower level of education
- be less likely to participate in extension.

Table 13 Characteristics of adopters, considerers and non-adopters of fallowing

Characteristic	Adopters	Considerers	Non-adopters
Difference between total cash receipts and total cash costs—farm cash income (\$)	Rank: Lowest Mean: 155 967.26 SD: 280 580.92	Rank: Highest Mean: 221 677.65 SD: 495 859.50	Rank: Middle Mean: 176 934.32 SD: 234 861.79
Rate of return excluding capital appreciation	Rank: Lowest Mean: 1.02 SD: 4.88	Rank: Lowest Mean: 0.98 SD: 4.91	Rank: Highest Mean: 3.24 SD: 7.10
Gross off-farm income earned by owner manager and spouse (\$)	Rank: Highest Mean: 30 354.63 SD: 35 852.14	Rank: Lowest Mean: 25 172.68 SD: 26 362.63	Rank: Lowest Mean: 26 473.85 SD: 37 329.92
Area cropped (hectares)	Rank: Middle Mean: 783.95 SD: 1010.93	Rank: Highest Mean: 984.50 SD: 2193.95	Rank: Lowest Mean: 574.58 SD: 914.08
Farm size (hectares)	Rank: Lowest Mean: 1963.79 SD: 2680.30	Rank: No difference ¹ Mean: 2022.26 SD: 4458.63	Rank: Highest Mean: 2175.33 SD: 4964.33
Age of owner manager	Rank: No difference ² Mean: 56.86 SD: 11.37	Rank: Highest Mean: 57.42 SD: 10.43	Rank: Lowest Mean: 56.48 SD: 10.22
Education	Rank: Lowest Mean: 3.22 SD: 1.18	Rank: No difference ³ Mean: 3.28 SD: 1.00	Rank: Highest Mean: 3.29 SD: 1.08
Participated in extension	Rank: Lowest Mean: 0.71 SD: 0.46	Rank: Highest Mean: 0.87 SD: 0.34	Rank: Middle Mean: 0.78 SD: 0.42
Participated in a government program	Rank: Middle Mean: 0.56 SD: 0.50	Rank: Highest Mean: 0.66 SD: 0.47	Rank: Lowest Mean: 0.52 SD: 0.50
Member of group	Rank: Middle Mean: 0.75 SD: 0.43	Rank: Highest Mean: 0.84 SD: 0.37	Rank: Lowest Mean: 0.73 SD: 0.44

Note: SD stands for standard deviation. ¹ There was no significant difference in farm size between considerers and adopters, or considerers and non-adopters; therefore considerers received no rank. ² There was no significant difference in age between adopters and considerers, or adopters and non-adopters; therefore adopters received no rank. ³ There was no

significant difference in education levels between considerers and adopters or considerers and non-adopters; therefore considerers received no rank.

Retained stubble

As can be seen in Table 14, relative to non-adopters of stubble retention or those who had only considered adopting this practice, farm managers who had adopted tended to:

- have higher farm cash income
- have higher gross off-farm income
- have greater area cropped
- have larger farms
- be younger
- have a higher level of education
- be more likely to participate in government programs
- be more likely to be members of a group.

Table 14 Characteristics of adopters, considerers and non-adopters of stubble retention

Characteristic	Adopters	Considerers	Non-adopters
Difference between total cash receipts and total cash costs—farm cash income (\$)	Rank: Highest Mean: 175 248.59 SD: 278 471.16	Rank: Lowest Mean: 93 784.45 SD: 130 912.05	Rank: Middle Mean: 124 851.11 SD: 173 809.83
Rate of return excluding capital appreciation	Rank: Middle Mean: 1.48 SD: 5.01	Rank: Lowest Mean: 0.52 SD: 4.33	Rank: Highest Mean: 1.87 SD: 4.44
Gross off-farm income earned by owner manager and spouse (\$)	Rank: Highest Mean: 30 091.05 SD: 35 826.14	Rank: Lowest Mean: 18 621.22 SD: 21 272.95	Rank: Middle Mean: 22 579.26 SD: 31 449.33
Area cropped (hectares)	Rank: Highest Mean: 826.62 SD: 1014.19	Rank: Middle Mean: 476.84 SD: 753.60	Rank: Lowest Mean: 166.92 SD: 212.99
Farm size (hectares)	Rank: Highest Mean: 2033.72 SD: 2670.89	Rank: Lowest Mean: 1548.46 SD: 1877.00	Rank: Lowest Mean: 1367.20 SD: 3242.52
Age of owner manager	Rank: Lowest Mean: 56.78 SD: 10.78	Rank: Highest Mean: 58.01 SD: 12.99	Rank: No difference ¹ Mean: 57.14 SD: 10.29
Education	Rank: Highest Mean: 3.30 SD: 1.14	Rank: Highest Mean: 3.37 SD: 1.09	Rank: Lowest Mean: 3.04 SD: 1.11
Participated in extension	Rank: Middle Mean: 0.75 SD: 0.43	Rank: Highest Mean: 0.88 SD: 0.33	Rank: Lowest Mean: 0.69 SD: 0.46

Characteristic	Adopters	Considerers	Non-adopters
Participated in a government program	Rank: Highest Mean: 0.60 SD: 0.49	Rank: Middle Mean: 0.52 SD: 0.50	Rank: Lowest Mean: 0.43 SD: 0.49
Member of group	Rank: Highest Mean: 0.79 SD: 0.41	Rank: Middle Mean: 0.70 SD: 0.49	Rank: Lowest Mean: 0.64 SD: 0.48

Note: SD stands for standard deviation.¹ There was no significant difference in age between non-adopters and considerers, or non-adopters and adopters; therefore non-adopters received no rank.

Grazing management

Cell or strip grazing

As can be seen in Table 15, relative to non-adopters of cell or strip grazing or those who had only considered adopting these practices, farm managers who had adopted tended to:

- have higher farm cash income
- have higher rate of return
- have smaller farms
- have a lower level of education
- be less likely to participate in extension
- be more likely to be members of a group.

Table 15 Characteristics of adopters, considerers and non-adopters of cell or strip grazing

Characteristic	Adopters	Considerers	Non-adopters
Difference between total cash receipts and total cash costs—farm cash income (\$)	Rank: Highest Mean: 99 098.79 SD: 175 833.35	Rank: No difference ¹ Mean: 93 851.99 SD: 132 665.84	Rank: Lowest Mean: 87 632.18 SD: 159 930.28
Rate of return excluding capital appreciation	Rank: Highest Mean: 0.71 SD: 4.44	Rank: Lowest Mean: -0.02 SD: 4.13	Rank: Lowest Mean: 0.17 SD: 3.43
Gross off-farm income earned by owner manager and spouse (\$)	Rank: Middle Mean: 28 702.05 SD: 38 181.02	Rank: Lowest Mean: 21 997.25 SD: 34 559.58	Rank: Highest Mean: 30 245.41 SD: 35 031.75
Farm size (hectares)	Rank: Lowest Mean: 2140.69 SD: 6416.75	Rank: Highest Mean: 3076.91 SD: 6742.69	Rank: Highest Mean: 3268.27 SD: 9232.21
Age of owner manager	Rank: Middle Mean: 58.21 SD: 11.03	Rank: Lowest Mean: 56.57 SD: 10.10	Rank: Highest Mean: 62.27 SD: 10.85
Education	Rank: Lowest Mean: 3.09 SD: 1.14	Rank: Highest Mean: 3.40 SD: 1.17	Rank: Lowest Mean: 3.05 SD: 1.12
Participated in extension	Rank: Lowest Mean: 0.68 SD: 0.47	Rank: Highest Mean: 0.81 SD: 0.39	Rank: Middle Mean: 0.75 SD: 0.43

Characteristic	Adopters	Considerers	Non-adopters
Participated in a government program	Rank: Middle Mean: 0.46 SD: 0.50	Rank: Highest Mean: 0.62 SD: 0.49	Rank: Lowest Mean: 0.41 SD: 0.49
Member of group	Rank: Highest Mean: 0.72 SD: 0.45	Rank: Middle Mean: 0.67 SD: 0.47	Rank: Lowest Mean: 0.57 SD: 0.49

Note: SD stands for standard deviation.¹ There was no significant difference between total cash receipts and total cash costs between considerers and adopters, or considerers and non-adopters; therefore considerers received no rank.

Set minimum groundcover targets for long term

As can be seen in Table 16, relative to non-adopters of minimum groundcover targets for the long-term or those who had only considered adopting this practice, farm managers who had adopted tended to:

- have lower off-farm income
- have larger farms
- be more likely to participate in extension
- be more likely to participate in government programs
- be more likely to be members of a group.

Table 16 Characteristics of adopters, considerers and non-adopters of setting minimum groundcover targets

Characteristic	Adopters	Considerers	Non-adopters
Difference between total cash receipts and total cash costs—farm cash income (\$)	Rank: Middle Mean: 97 462.19 SD: 171 611.09	Rank: Highest Mean: 128 382.35 SD: 135 094.12	Rank: Lowest Mean: 68 761.78 SD: 135 916.57
Rate of return excluding capital appreciation	Rank: Middle Mean: 0.51 SD: 4.24	Rank: Highest Mean: 2.95 SD: 2.99	Rank: Lowest Mean: -0.05 SD: 3.41
Gross off-farm income earned by owner manager and spouse (\$)	Rank: Lowest Mean: 28 055.52 SD: 36 817.35	Rank: Highest Mean: 36 310.07 SD: 46 300.512	Rank: Highest Mean: 32 860.06 SD: 37 615.83
Farm size (hectares)	Rank: Highest Mean: 2605.62 SD: 7277.40	Rank: No difference ¹ Mean: 2447.90 SD: 7515.83	Rank: Lowest Mean: 1765.15 SD: 7809.53
Age of owner manager	Rank: Middle Mean: 59.11 SD: 11.20	Rank: Lowest Mean: 56.43 SD: 10.13	Rank: Highest Mean: 60.51 SD: 9.71
Education	Rank: Middle Mean: 3.10 SD: 1.13	Rank: Highest Mean: 3.48 SD: 1.09	Rank: Lowest Mean: 3.01 SD: 1.18
Participated in extension	Rank: Highest Mean: 0.72 SD: 0.45	Rank: Lowest Mean: 0.50 SD: 0.50	Rank: Middle Mean: 0.60 SD: 0.49

Characteristic	Adopters	Considerers	Non-adopters
Participated in a government program	Rank: Highest Mean: 0.49 SD: 0.50	Rank: Lowest Mean: 0.13 SD: 0.34	Rank: Middle Mean: 0.27 SD: 0.45
Member of group	Rank: Highest Mean: 0.69 SD: 0.46	Rank: Lowest Mean: 0.27 SD: 0.44	Rank: Middle Mean: 0.54 SD: 0.50

Note: SD stands for standard deviation.¹ There was no significant difference in farm size between considerers and adopters, or considerers and non-adopters; therefore considerers received no rank.

Planted or maintained deep rooted perennial pastures including fodder shrubs

As can be seen in Table 17, relative to non-adopters of planting or maintenance of deep rooted perennial pastures or those who had only considered adopting this practice, farm managers who had adopted tended to:

- have higher farm cash income
- have a higher rate of return
- have higher off-farm income
- have larger farms
- be younger
- have a higher level of education
- be more likely to participate in extension
- be more likely to participate in government programs
- be more likely to be members of a group.

Table 17 Characteristics of adopters, considerers and non-adopters of planting deep rooted perennials

Characteristic	Adopters	Considerers	Non-adopters
Difference between total cash receipts and total cash costs—farm cash income (\$)	Rank: Highest Mean: 106 861.71 SD: 181 433.96	Rank: Lowest Mean: 61 504.58 SD: 115 169.06	Rank: Middle Mean: 91 348.71 SD: 163 768.79
Rate of return excluding capital appreciation	Rank: Highest Mean: 0.79 SD: 4.13	Rank: Lowest Mean: 0.36 SD: 4.02	Rank: Lowest Mean: 0.20 SD: 4.29
Gross off-farm income earned by owner manager and spouse (\$)	Rank: Highest Mean: 31 685.86 SD: 37 440.98	Rank: Lowest Mean: 18 027.65 SD: 22 948.55	Rank: Middle Mean: 27 686.52 SD: 39 609.57
Farm size (hectares)	Rank: Highest Mean: 2763.10 SD: 7240.40	Rank: Highest Mean: 2684.67 SD: 9148.92	Rank: Lowest Mean: 2165.85 SD: 6871.76
Age of owner manager	Rank: Lowest Mean: 58.32 SD: 11.02	Rank: Middle Mean: 59.65 SD: 11.33	Rank: Highest Mean: 60.32 SD: 11.08

Characteristic	Adopters	Considerers	Non-adopters
Education	Rank: Highest Mean: 3.20 SD: 1.18	Rank: Lowest Mean: 2.76 SD: 1.05	Rank: Middle Mean: 3.07 SD: 1.09
Participated in extension	Rank: Highest Mean: 0.72 SD: 0.45	Rank: Lowest Mean: 0.60 SD: 0.49	Rank: Highest Mean: 0.73 SD: 0.45
Participated in a government program	Rank: Highest Mean: 0.55 SD: 0.50	Rank: Middle Mean: 0.45 SD: 0.50	Rank: Lowest Mean: 0.35 SD: 0.45
Member of group	Rank: Highest Mean: 0.72 SD: 0.45	Rank: Lowest Mean: 0.57 SD: 0.50	Rank: Middle Mean: 0.65 SD: 0.48

Note: SD stands for standard deviation

Native vegetation management

Planted native pastures or encouraged its regrowth

As can be seen in Table 18, relative to non-adopters of native pasture planting or encouraging regrowth or those who had only considered adopting this practice, farm managers who had adopted tended to:

- have lower farm cash income
- have lower off-farm income
- have larger farms
- be older
- have a higher level of education
- be less likely to participate in extension
- be more likely to participate in government programs
- be more likely to be members of a group.

Table 18 Characteristics of adopters, considerers and non-adopters of planting native pastures

Characteristic	Adopters	Considerers	Non-adopters
Difference between total cash receipts and total cash costs—farm cash income (\$)	Rank: Lowest Mean: 99 053.61 SD: 197 297.50	Rank: Lowest Mean: 92 019.47 SD: 164 966.39	Rank: Highest Mean: 102 605.13 SD: 182 369.78
Rate of return excluding capital appreciation	Rank: Middle Mean: 0.31 SD: 4.19	Rank: Lowest Mean: -0.12 SD: 5.03	Rank: Highest Mean: 0.71 SD: 4.51
Gross off-farm income earned by owner manager and spouse (\$)	Rank: Lowest Mean: 25 048.21 SD: 34 003.37	Rank: Lowest Mean: 23 787.32 SD: 24 870.29	Rank: Highest Mean: 29 942.15 SD: 37 980.62

Characteristic	Adopters	Considerers	Non-adopters
Farm size (hectares)	Rank: Highest Mean: 3864.39 SD: 9479.96	Rank: Lowest Mean: 1767.89 SD: 7134.09	Rank: Lowest Mean: 1837.51 SD: 5596.13
Age of owner manager	Rank: Highest Mean: 60.84 SD: 11.15	Rank: Lowest Mean: 54.53 SD: 12.71	Rank: Middle Mean: 58.68 SD: 10.65
Education	Rank: Highest Mean: 3.23 SD: 1.27	Rank: Lowest Mean: 3.04 SD: 1.11	Rank: Middle Mean: 3.15 SD: 1.11
Participated in extension	Rank: Lowest Mean: 0.69 SD: 0.46	Rank: Highest Mean: 0.80 SD: 0.40	Rank: Lowest Mean: 0.69 SD: 0.46
Participated in a government program	Rank: Highest Mean: 0.59 SD: 0.49	Rank: Lowest Mean: 0.32 SD: 0.47	Rank: Middle Mean: 0.41 SD: 0.49
Member of group	Rank: Highest Mean: 0.75 SD: 0.43	Rank: Lowest Mean: 0.64 SD: 0.48	Rank: Lowest Mean: 0.64 SD: 0.48

Note: SD stands for standard deviation

Planted native vegetation or encouraged its regrowth

As can be seen in Table 19, relative to non-adopters of native vegetation planting or encouraging regrowth or those who had just considered adopting this practice, farm managers who had adopted tend to:

- have higher farm cash income
- have higher rate of return
- have higher off-farm income
- have smaller farms
- be younger
- have a higher level of education
- be less likely to participate in extension
- be more likely to participate in government programs
- be more likely to be members of a group.

Table 19 Characteristics of adopters, considerers and non-adopters of planting native vegetation

Characteristic	Adopters	Considerers	Non-adopters
Difference between total cash receipts and total cash costs—farm cash income (\$)	Rank: Highest Mean: 114 668.19 SD: 212 690.15	Rank: Lowest Mean: 75 131.43 SD: 141 214.97	Rank: Middle Mean: 93 306.15 SD: 167 471.72

Characteristic	Adopters	Considerers	Non-adopters
Rate of return excluding capital appreciation	Rank: Highest Mean: 0.84 SD: 4.81	Rank: Lowest Mean: 0.02 SD: 3.89	Rank: Middle Mean: 0.36 SD: 4.20
Gross off-farm income earned by owner manager and spouse (\$)	Rank: Highest Mean: 31 689.61 SD: 37 949.87	Rank: Lowest Mean: 21 259.47 SD: 27 142.58	Rank: Middle Mean: 26 046.02 SD: 35 425.86
Farm size (hectares)	Rank: Lowest Mean: 1810.77 SD: 5428.54	Rank: Lowest Mean: 1628.93 SD: 5599.92	Rank: Highest Mean: 3083.07 SD: 8406.62
Age of owner manager	Rank: Lowest Mean: 58.62 SD: 10.23	Rank: Highest Mean: 59.47 SD: 10.53	Rank: Highest Mean: 59.44 SD: 11.67
Education	Rank: Highest Mean: 3.25 SD: 1.18	Rank: Highest Mean: 3.25 SD: 1.10	Rank: Lowest Mean: 3.10 SD: 1.16
Participated in extension	Rank: Lowest Mean: 0.63 SD: 0.48	Rank: Highest Mean: 0.84 SD: 0.37	Rank: Middle Mean: 0.74 SD: 0.44
Participated in a government program	Rank: Highest Mean: 0.56 SD: 0.50	Rank: Middle Mean: 0.43 SD: 0.50	Rank: Lowest Mean: 0.38 SD: 0.49
Member of group	Rank: Highest Mean: 0.74 SD: 0.44	Rank: Lowest Mean: 0.60 SD: 0.49	Rank: Middle Mean: 0.63 SD: 0.48

Note: SD stands for standard deviation

Fenced native vegetation to control stock access

As can be seen in Table 20, relative to non-adopters of fencing of native vegetation to control stock or those who had only considered adopting this practice, farm managers who had adopted tended to:

- have higher farm cash income
- have higher rate of return
- have higher off-farm income
- have smaller farms
- have a higher level of education
- be less likely to participate in extension
- be more likely to participate in government programs
- be more likely to be members of a group.

Table 20 Characteristics of adopters, considerers and non-adopters of fencing native vegetation

Characteristic	Adopters	Considerers	Non-adopters
Difference between total cash receipts and total cash costs—farm cash income (\$)	Rank: Highest Mean: 118 312.69 SD: 203 747.18	Rank: Lowest Mean: 61 518.15 SD: 140 229.29	Rank: Middle Mean: 87 454.21 SD: 168 921.10
Rate of return excluding capital appreciation	Rank: Highest Mean: 1.01 SD: 4.49	Rank: Lowest Mean: -0.94 SD: 4.21	Rank: Middle Mean: 0.23 SD: 4.36
Gross off-farm income earned by owner manager and spouse (\$)	Rank: Highest Mean: 32 964.53 SD: 40 592.39	Rank: Lowest Mean: 18 552.07 SD: 25 314.60	Rank: Middle Mean: 23 723.53 SD: 30 746.50
Farm size (hectares)	Rank: Lowest Mean: 2052.79 SD: 5091.52	Rank: Highest Mean: 4157.19 SD: 12 062.28	Rank: Middle Mean: 2667.27 SD: 8060.75
Age of owner manager	Rank: Middle Mean: 58.27 SD: 11.04	Rank: Lowest Mean: 57.52 SD: 10.65	Rank: Highest Mean: 60.38 SD: 11.00
Education	Rank: Highest Mean: 3.25 SD: 1.17	Rank: Middle Mean: 3.19 SD: 1.04	Rank: Lowest Mean: 3.07 SD: 1.17
Participated in extension	Rank: Lowest Mean: 0.68 SD: 0.47	Rank: Highest Mean: 0.72 SD: 0.45	Rank: Highest Mean: 0.72 SD: 0.45
Participated in a government program	Rank: Highest Mean: 0.59 SD: 0.49	Rank: Middle Mean: 0.35 SD: 0.48	Rank: Lowest Mean: 0.32 SD: 0.47
Member of group	Rank: Highest Mean: 0.75 SD: 0.43	Rank: Middle Mean: 0.67 SD: 0.47	Rank: Lowest Mean: 0.59 SD: 0.49

Note: SD stands for standard deviation

Weed management

Management of WoNS

For the management of WoNS, data collection and analysis was different to the other practices. The management of WoNS survey questions grouped farm managers who had either adopted or considered adopting weed management practices together as one group, meaning that comparisons could only be made between adopters/considerers and non-adopters, and the ANOVA method could not be used. For this reason, independent sample *t*-test comparisons were performed on the WoNS data to find any differences between these two groups.

As can be seen in Table 21, relative to non-adopters of weed management of WoNS, farm managers who had adopted or considered adopting tended to:

- have lower farm cash income
- have lower rate of return
- have lower off-farm income
- have larger farms

- be older
- have a lower level of education
- be more likely to participate in extension
- be less likely to participate in government programs.

Table 21 Characteristics of adopters/considerers and non-adopters of weed management

Characteristic	Adopters/considerers	Non-adopters
Difference between total cash receipts and total cash costs—farm cash income (\$)	Rank: Lowest Mean: 80 949.44 SD: 165 057.49	Rank: Highest Mean: 123 107.61 SD: 211 007.06
Rate of return excluding capital appreciation	Rank: Lowest Mean: 0.29 SD: 4.10	Rank: Highest Mean: 0.83 SD: 4.82
Gross off-farm income earned by owner manager and spouse (\$)	Rank: Lowest Mean: 26 552.31 SD: 37 525.52	Rank: Highest Mean: 29 370.65 SD: 35 084.51
Farm size (hectares)	Rank: Highest Mean: 2902.29 SD: 8614.87	Rank: Lowest Mean: 2198.50 SD: 7106.50
Age of owner manager	Rank: Highest Mean: 60.23 SD: 11.12	Rank: Lowest Mean: 58.12 SD: 10.87
Education	Rank: Lowest Mean: 3.12 SD: 1.22	Rank: Highest Mean: 3.20 SD: 1.11
Participated in extension	Rank: Highest Mean: 0.77 SD: 0.42	Rank: Lowest Mean: 0.63 SD: 0.48
Participated in a government program	Rank: Lowest Mean: 0.44 SD: 0.50	Rank: Highest Mean: 0.47 SD: 0.50
Member of group	Rank: No difference ¹ Mean: 0.68 SD: 0.47	Rank: No difference ¹ Mean: 0.67 SD: 0.47

Note: SD stands for standard deviation.¹ There was no difference in group membership between adopters/considerers and non-adopters; therefore there is no ranking.

3 Results from the DPC 2013 survey—horticulture

Adoption of land management practices in horticulture

Table 22 presents the percentage of farm managers that indicated that they had adopted or considered adopting a given land management practice. Overall, the results show that the level of adoption of the nominated sustainable land management practices ranged from 19 per cent to 90 per cent. The adoption of native vegetation management practices was generally lower than that of soil and weed management practices. The proportion of farm managers that had considered adopting a given land management practice ranged from 2 per cent to 12 per cent.

Table 22 Adoption of land management practices in horticulture

Practice categories	Practices	Adopted (%)	Considered (%)
Soil management	Minimum tillage or cultivation e.g. permanent beds and direct planting	66	2
	Controlled trafficking	49	7
	Incorporation of organic matter	82	4
	Cover crops, inter-row crops, mulching	55	7
	Optimisation of pesticide/fertiliser use and reduced reliance	90	4
Vegetation management	Planted or encouraged regrowth of native vegetation in riparian areas	23	12
	Planted or encouraged regrowth of native vegetation (non riparian)	26	12
	Fenced native vegetation to prevent degradation	19	4
Weed management	Management of WoNS	48	NA

Motivations for adoption in horticulture

The DPC 2013 horticulture survey was developed on the basis of outcomes of DPC stage 1 and a pilot survey of horticulture farm managers in 2011. As with the DPC 2010 and 2012 surveys of broadacre and dairy farm managers, respondents to the DPC 2013 horticulture survey were asked to rate the degree of influence that financial benefits, environmental benefits and personal motivations had on their decision to adopt or consider adopting a given practice across soil management, native vegetation management and weed management.

Table 23 presents the percentage of respondents falling into each of the motivation categories for soil, native vegetation and weed management practices. The results show that financial benefits were the key influence on adopting soil management practices, followed by environmental and personal factors. Adopting native vegetation management practices was primarily driven by personal and environmental factors. Environmental factors were the main motivations for adopting weed management practices, followed by financial benefits. However, a very high percentage (74 per cent) of respondents indicated that personal factors influenced their adoption of weed management practices to some extent.

Motives

For each of the motivational and management practice categories, respondents were asked to select three specific motives that influenced their adoption of a given management practice from the options provided. Table 24 presents the top three motives that farm managers indicated as influencing their decision to adopt a given soil, vegetation or weed management practice. These motives are discussed further in the following pages.

Interrelationship between motivations

Analysis was undertaken to determine if individual respondents had selected one or more motivations as influencing them 'to a great extent' in their decision to adopt or consider adopting a given soil, vegetation or weed management practice. The results of this analysis are presented for each of the management practices and discussed in the following pages.

Table 23 Motivations for adoption of land management practices in horticulture, 2013

	Soil management practices (%)			Vegetation management practices (%)			Weed management practices (%)		
	Great extent	Some extent	Not at all	Great extent	Some extent	Not at all	Great extent	Some extent	Not at all
Financial benefits	73	24	3	22	21	57	61	29	10
Environmental benefits	55	35	9	43	18	39	79	19	2
Personal motivations	38	45	17	54	25	21	25	74	1

Note: Respondents could nominate more than one option. Results are for adopters and considerers.

Table 24 Motives for management practices in horticulture 2013, ordered by importance

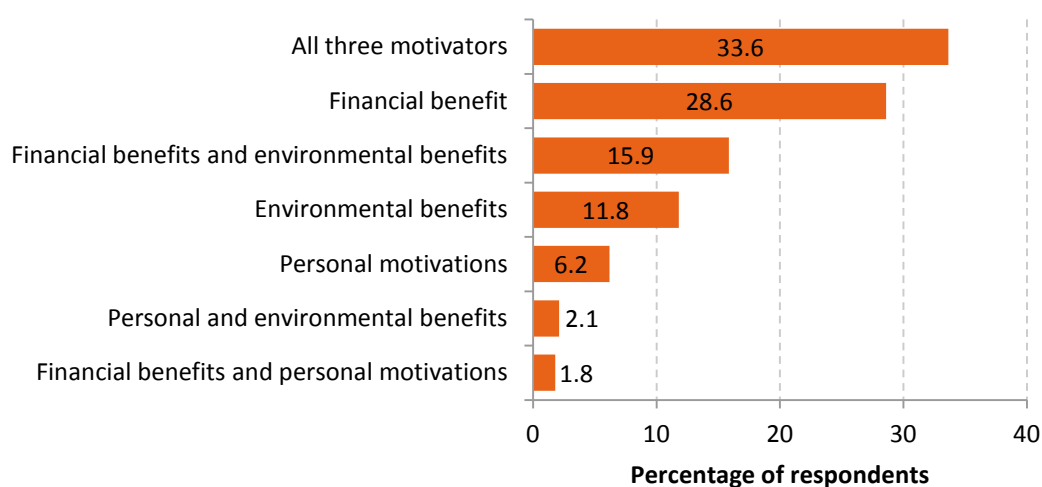
Management practice categories	Financial benefits	Environmental benefits	Personal motivations
Soil management	Reduced costs	Improves soil condition	Reduction in workload
	Increased returns	Reduces erosion	Desire to protect natural resources for the long term
	Reduced financial risk	Aligns with environmental goals and beliefs	Recognition by neighbours and community
Vegetation management	Provides shelter	Improves soil condition	Desire to protect natural resources for the long term
	Increased land value	Reduces erosion	Improve amenity of the landscape
	Increased returns	Aligns with environmental goals and beliefs	Prepared to risk short-term production losses
Weed management	Cost of not acting too high	Aligns with environmental goals and beliefs	Reduction in long-term workload
	Increased land productivity	Improve habitat for native fauna	Desire to protect natural resources for the long term
	Avoiding fines	Corporate social and environmental responsibility	Recognition by neighbours and community

Soil management practices in horticulture

The majority of farm managers indicated that financial benefits were a key influence on their decision to adopt or consider adopting soil management practices, followed by environmental benefits and personal motivations (Table 23).

For many farm managers, the three motivational areas are interconnected. As can be seen in Figure 24 below, a combination of all three motivations was the most commonly selected influence on farm managers' adopting or considering adopting soil management practices. Financial benefits were the next most commonly selected motivation, followed by a combination of financial benefits and environmental benefits and environmental benefits alone.

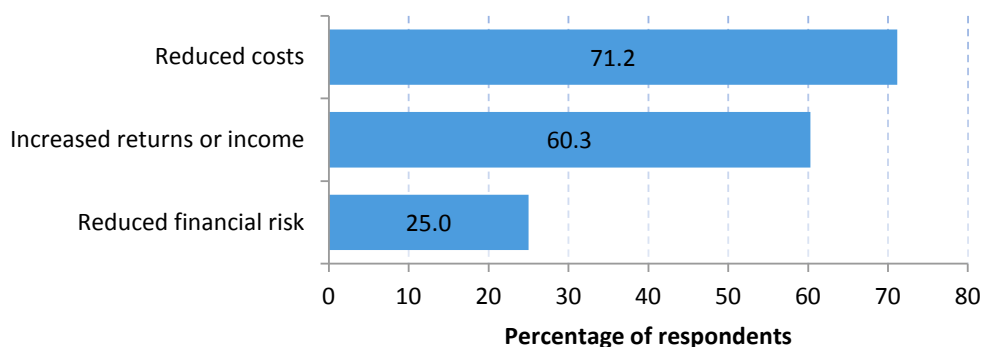
Figure 24 Motivations of soil management practice decisions 'to a great extent'



Financial motives for adopting soil management practices

For farm managers who said that financial benefits influenced their adopting or considering adopting soil management practices 'to a great extent' or 'to some extent' (Table 23), reduced costs (71 per cent) and increased returns or income (60 per cent) were the most frequently stated motives (Figure 25).

Figure 25 Financial motives for adopting soil management practices

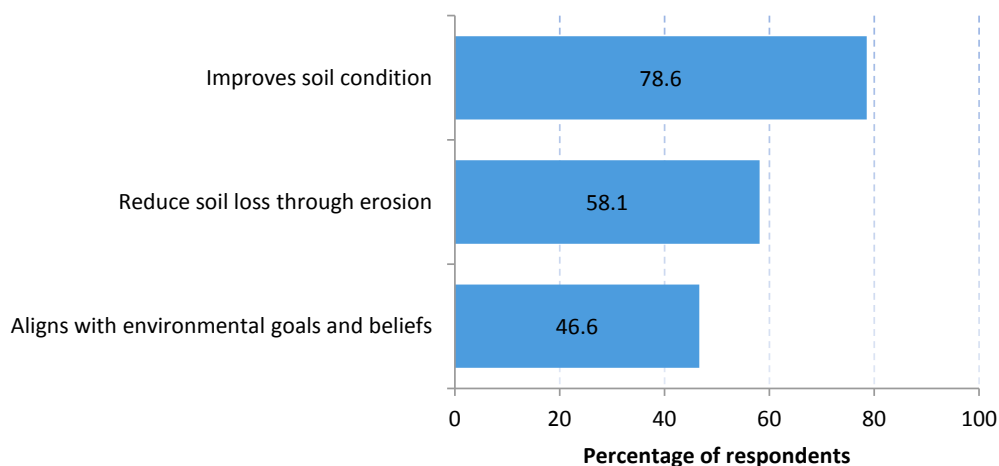


Note: Respondents could nominate more than one option

Environmental motives for adopting soil management practices

For farm managers who said that environmental benefits influenced their adopting or considering adopting soil management practices 'to a great extent' or 'to some extent' (Table 23), improved soil condition and reduced soil loss through erosion were the most frequently stated motives (Figure 26).

Figure 26: Environmental motives for adopting soil management practices

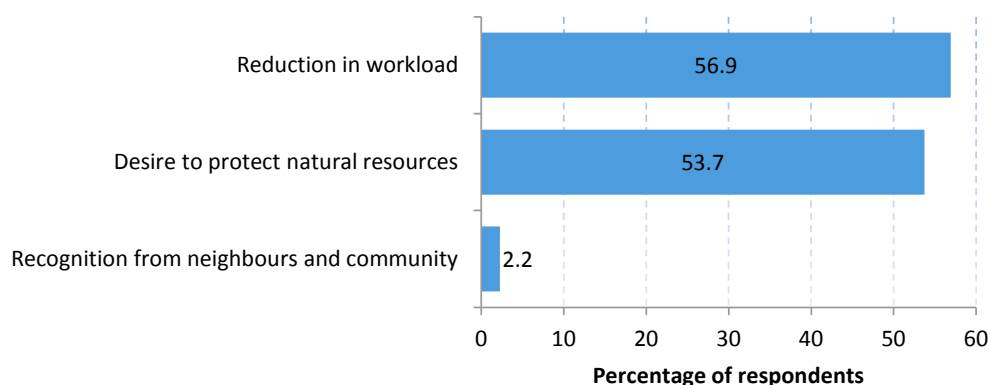


Note: Respondents could nominate more than one option

Personal motives for adopting soil management practices

For farm managers who said that personal motivations influenced their adopting or considering adopting soil management practices 'to a great extent' or 'to some extent' (Table 23), reduction in workload and desire to protect the natural resources were the most frequently stated motives (Figure 27).

Figure 27 Personal motives for adopting soil management practices



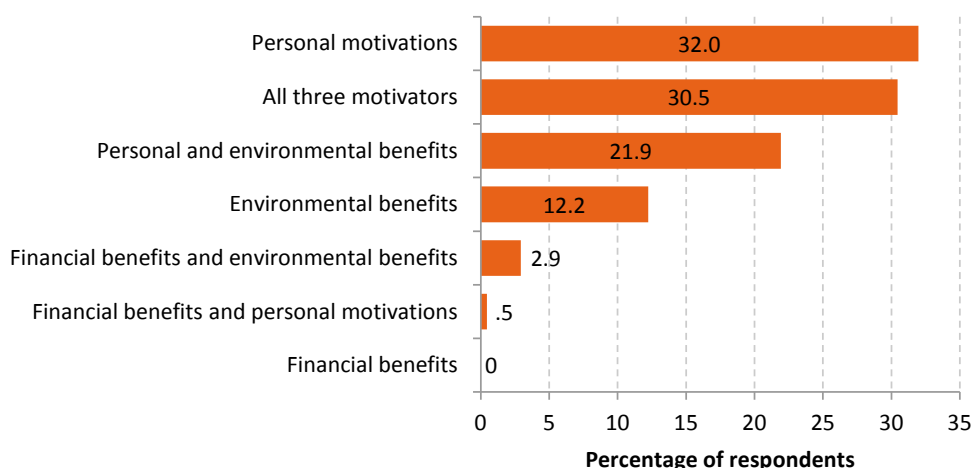
Note: Respondents could nominate more than one option

Native vegetation management practices in horticulture

The majority of farm managers indicated that personal motivations were a key influence on their decision to adopt or consider adopting soil management practices, followed by environmental benefits and financial benefits (Table 23).

As can be seen in Figure 28 below, personal motivations alone were the most commonly cited motivation (32 per cent). However, nearly the same percentage of respondents indicated that all three motivations influenced their decision making (31 per cent).

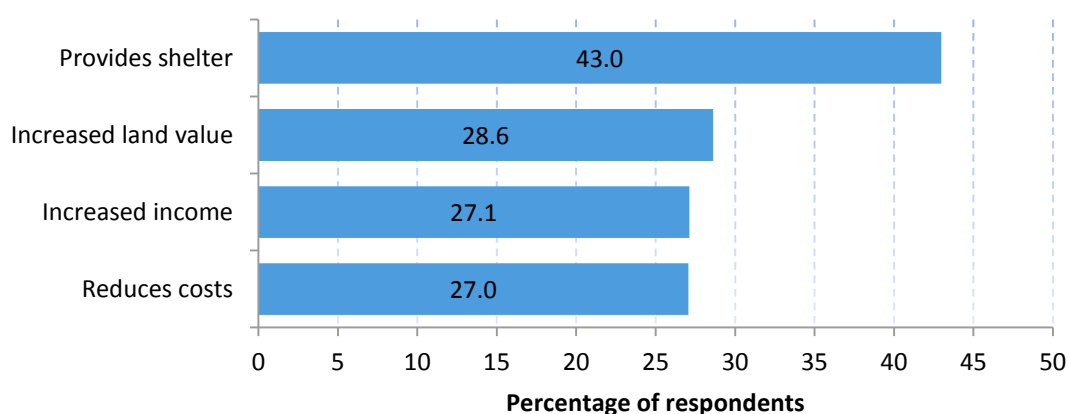
Figure 28 Motivations of native vegetation management decisions ‘to a great extent’



Financial motives for adopting native vegetation management practices

For farm managers who said that financial benefits influenced their adopting or considering adopting native vegetation management practices ‘to a great extent’ or ‘to some extent’ (Table 23), ‘provides shelter’ and ‘increased land value’ were the most frequently stated motives (Figure 29).

Figure 29 Financial motives for adopting native vegetation management practices

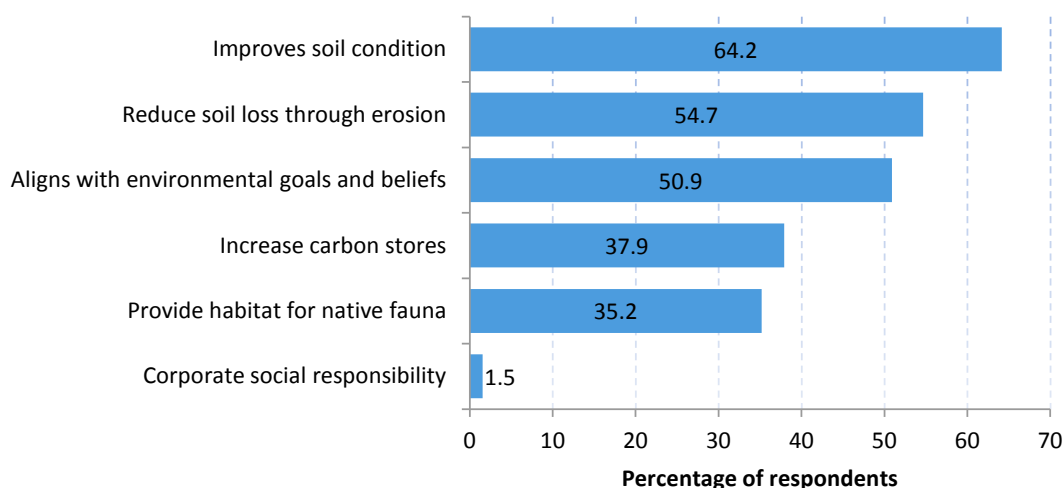


Note: Respondents could nominate more than one option

Environmental motives for adopting native vegetation management practices

For farm managers who said that environmental benefits influenced their adopting or considering adopting native vegetation management practices 'to a great extent' or 'to some extent' (Table 23), 'improves soil condition', 'reduces soil loss through erosion' and 'aligns with my environmental goals and beliefs' were the most frequently stated motives (Figure 30).

Figure 30 Environmental motives for adopting native vegetation management

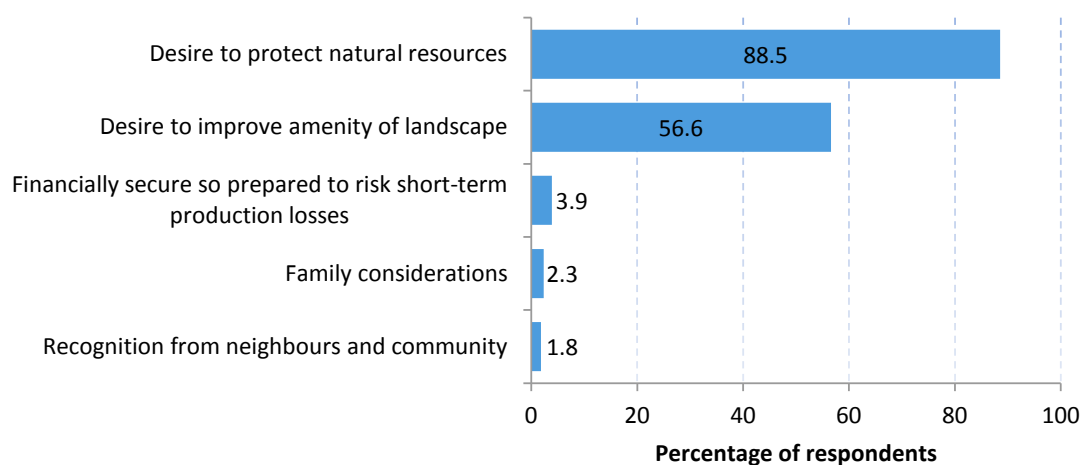


Note: Respondents could nominate more than one option

Personal motives for adopting native vegetation management practices

For farm managers who said that personal motivations influenced their adopting or considering adopting native vegetation management practices 'to a great extent' or 'to some extent' (Table 23), desire to protect natural resources was the most frequently selected option, followed by desire to improve amenity of the landscape (Figure 31), both considerably more important than the remaining options.

Figure 31 Personal motives for adopting native vegetation management practices

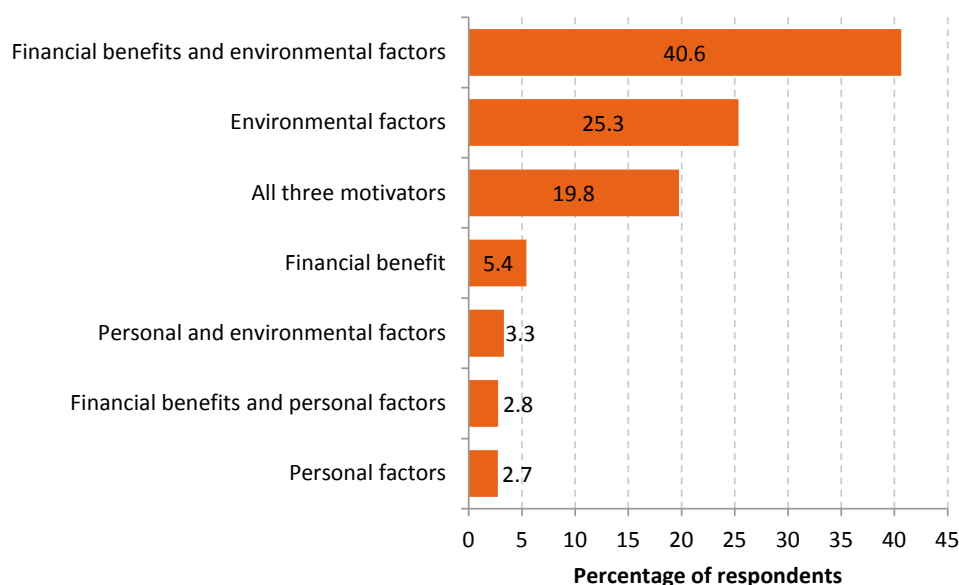


Note: Respondents could nominate more than one option

Weed management practices in horticulture

The majority of farm managers indicated that environmental benefits were a key influence on their decision to adopt or consider adopting soil management practices, followed by financial benefits and personal motivations (Table 23). As can be seen in Figure 32 below, the combination of financial benefits and environmental benefits (41 per cent) was the most commonly selected influence on farm managers' adoption or consideration of adoption of weed management practices. Environmental benefits (25 per cent) were the next most commonly selected motivator, followed by a combination of all three motivations (20 per cent).

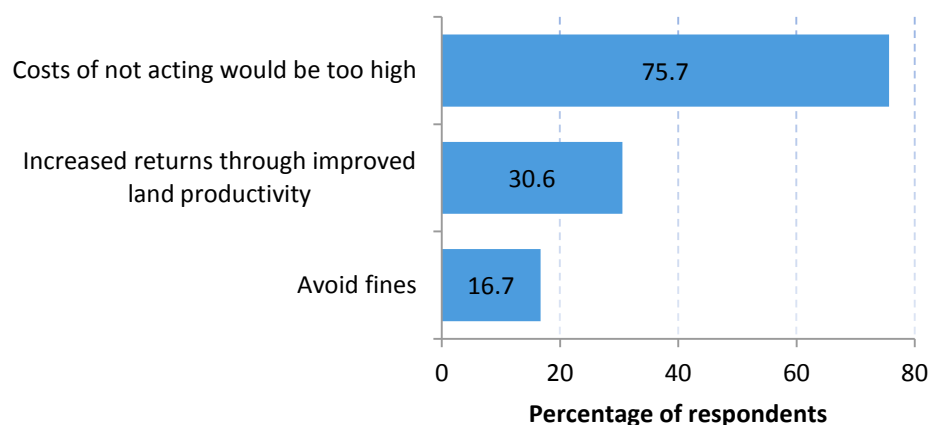
Figure 32 Motivations of weed management practice decisions 'to a great extent'



Financial motives for adopting weed management practices

For farm managers who said that financial benefits influenced their adopting or considering adopting weed management practices 'to a great extent' or 'to some extent' (Table 23), 'costs of not acting would be too high' was by far the most frequently stated motive, followed by 'increased returns through improved land productivity' (Figure 33).

Figure 33 Financial motives for adopting weed management practices

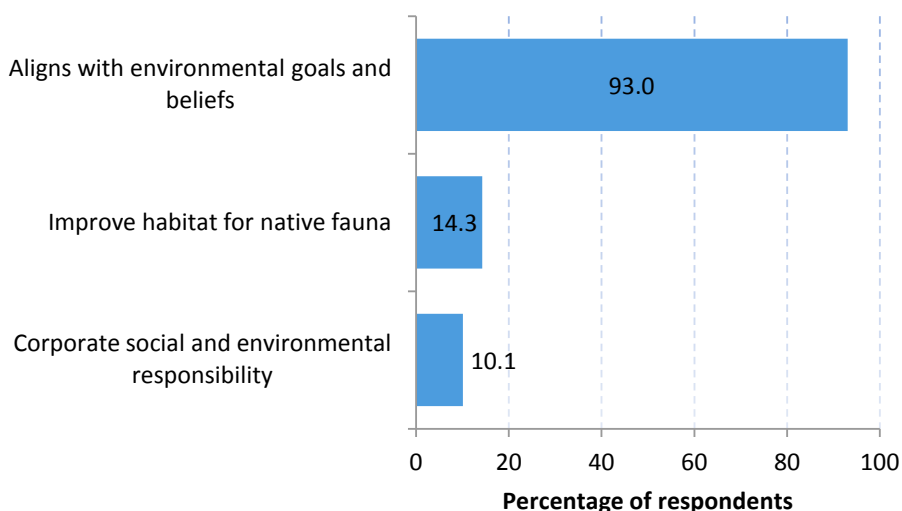


Note: Respondents could nominate more than one option

Environmental motives for adopting weed management practices

For farm managers who said that environmental benefits influenced their adopting or considering adopting weed management practices 'to a great extent' or 'to some extent' (Table 23), 'aligns with my environmental goals and beliefs' was by far the most frequently selected motive, followed by 'improve habitat for native fauna' (Figure 34).

Figure 34 Environmental motives for adopting weed management practices

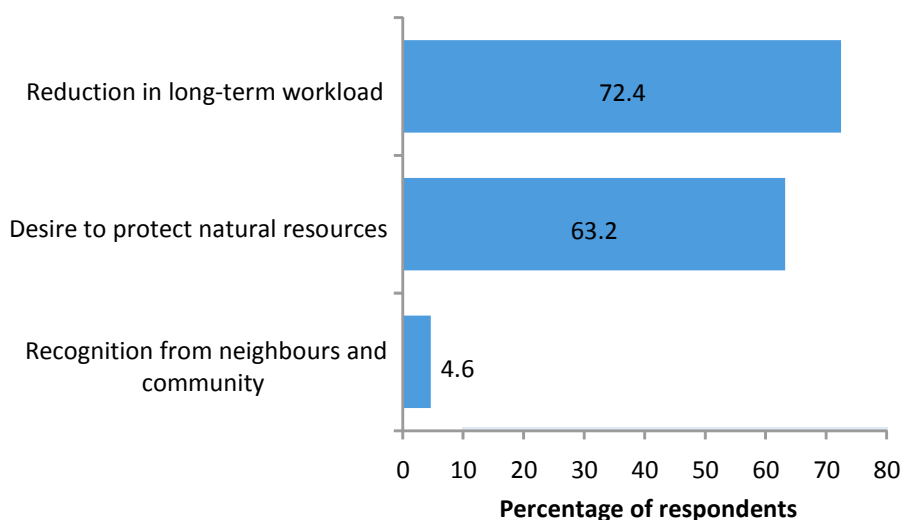


Note: Respondents could nominate more than one option

Personal motives for adopting weed management practices

For farm managers who said that personal motivations influenced their adopting or considering adopting weed management practices 'to a great extent' or 'to some extent' (Table 23), reduction in long-term workload and desire to protect natural resources were the most frequently stated motives (Figure 35).

Figure 35 Personal motives for adopting weed management practices

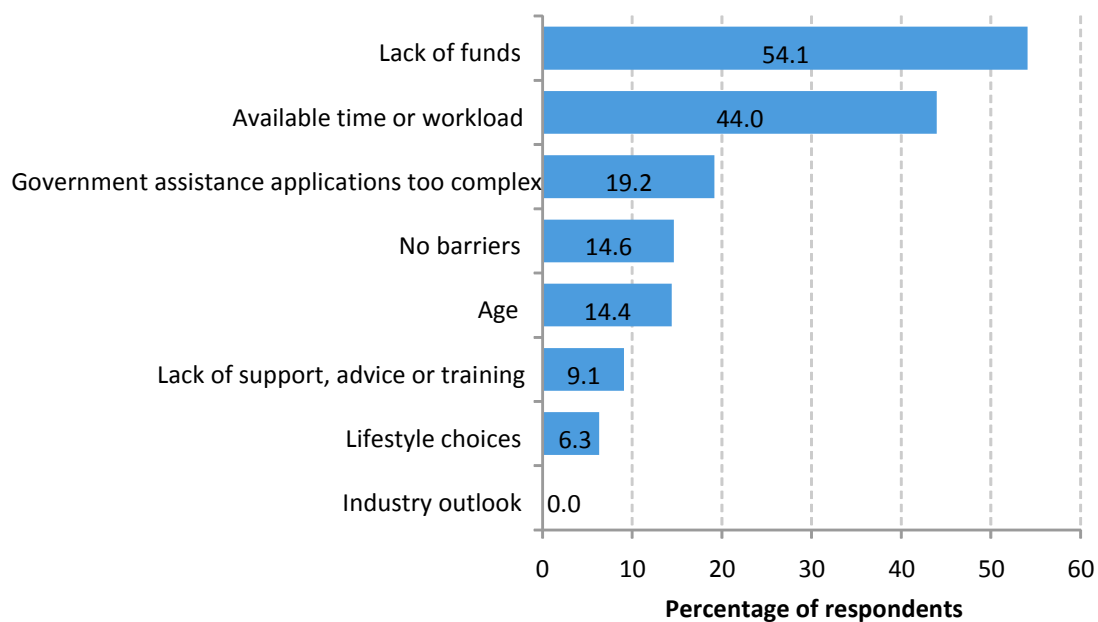


Note: Respondents could nominate more than one option

Barriers to adoption in horticulture

Horticulture farm managers cited a lack of funds and available time and workload as the main barriers to changing land management practices (Figure 36).

Figure 36 Barriers to changing land management practices



Note: Respondents could nominate more than one option

Support, information, learning and planning in horticulture

This section provides results on support agents used by horticulture farm managers in the process of adopting a land management practice; group membership that supported land management practice decisions; awareness of, participation in and benefits of Australian Government NRM programs; learning networks and activities; and property planning.

Support

Horticulture farm managers were more likely to seek support to adopt soil and weed management practices than to adopt native vegetation management practices (Table 25).

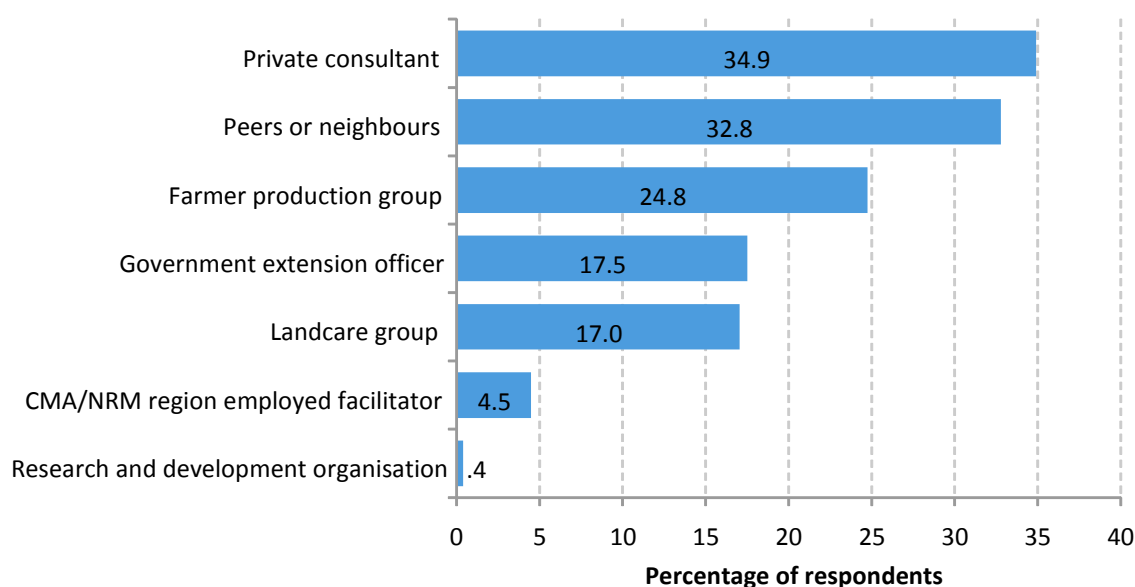
Table 25 Support sought in adoption of land management practices—horticulture

Practice area	Sought support (%)
Soil management	42
Native vegetation management	24
Weeds management	35

Soil management practices

For the 42 per cent of farm managers who sought support to adopt or consider adopting soil management practices, private consultants (35 per cent) and peers or neighbours (33 per cent) were closely matched, followed by farmer production groups (25 per cent) as the most frequently cited sources of support (Figure 37).

Figure 37 Support agents utilised for soil management practices—horticulture

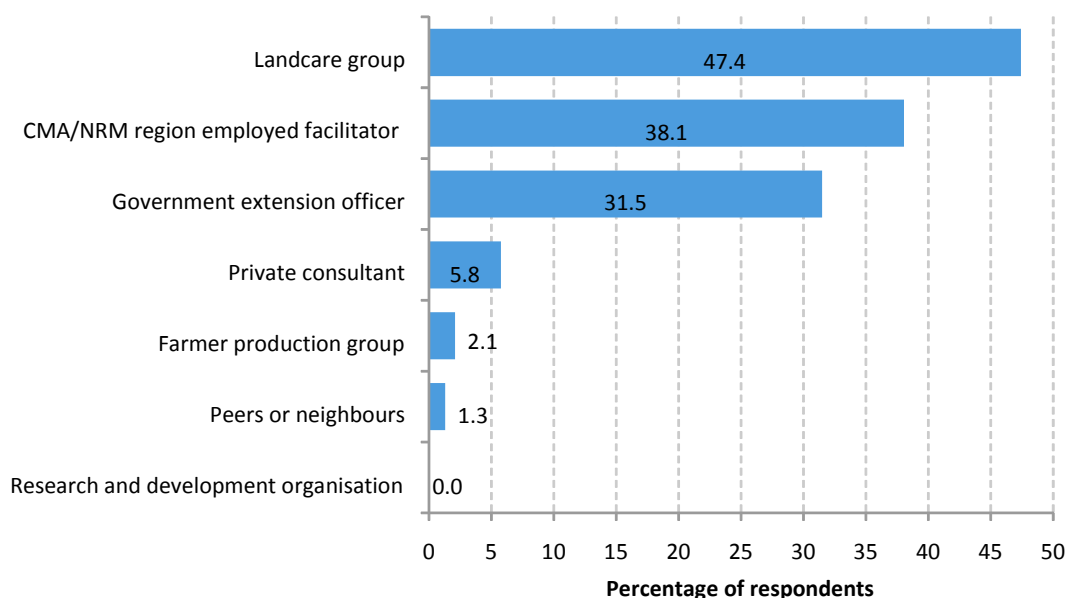


Note: Respondents could nominate more than one option

Native vegetation management practices

For the 24 per cent of farm managers who sought support to adopt or consider adopting native vegetation management practices, Landcare groups, CMA/NRM region employed facilitators and government extension officers were the most frequently cited sources of support (Figure 38).

Figure 38 Support agents utilised for native vegetation management practices

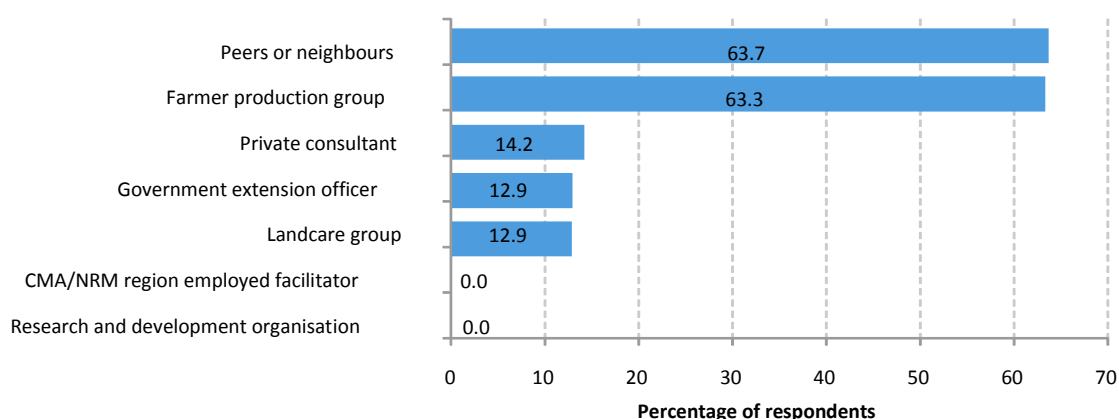


Note: Respondents could nominate more than one option

Weed management practices

For the 35 per cent of farm managers who sought support to adopt or consider adopting weed management practices, peers and neighbours and farmer production groups were the main sources of support (Figure 39). Private consultants were the next most frequently selected source of support.

Figure 39 Support agents utilised for weed management practices

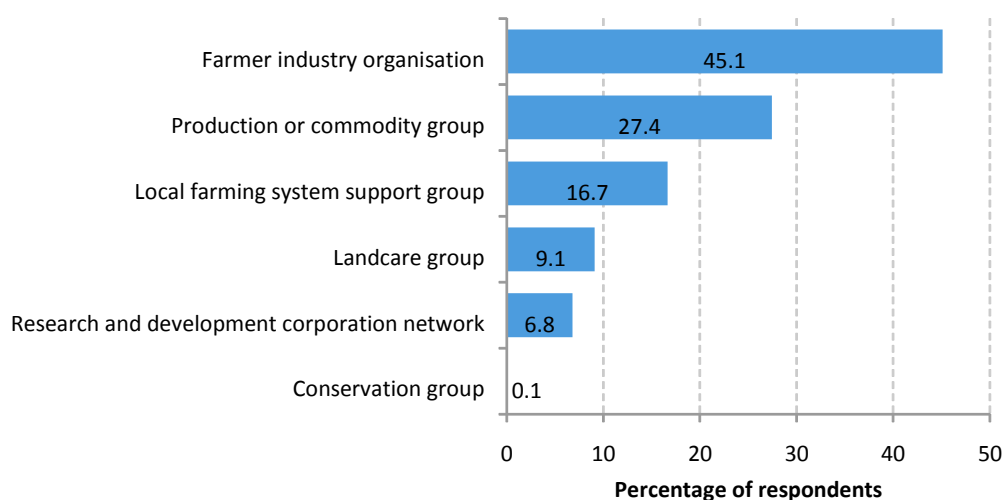


Note: Respondents could nominate more than one option

Group membership

Over half (62.1 per cent) of farm managers indicated they were members of a group or organisation that supported land management decision making. Nearly half (45 per cent) of farm managers indicated they were members of a farmer industry organisation. A smaller proportion of farm managers were members of a production or commodity group (27 per cent), local farming system support group (17 per cent), Landcare group (9 per cent) or research and development corporation network (7 per cent). Less than 1 per cent of respondents were members of a conservation group (Figure 40).

Figure 40 Membership of groups supporting land management



Note: Respondents could nominate more than one option

Involvement in Australian Government programs and initiatives

Awareness

Awareness of a number of Australian Government programs and initiatives was examined, and the results are presented in Table 26. Not surprisingly farm managers' awareness of Landcare was very high (96 per cent). The Regional Landcare Facilitators were known to over half (60 per cent) of farm managers surveyed and the Caring for our Country program was recognised by 45 per cent of farm managers (Table 26).

Participation

Landcare had the highest level of participation across the programs, with 41 per cent of those respondents who were aware of the program participating. Farm Ready had a relatively low level of awareness amongst farm managers surveyed but over one-third of those that were aware were participating in the program. Awareness of Caring for our Country did not translate into participation in the program (Table 26). As mentioned earlier, in the discussion about participation of broadacre and dairy farmers, interpretation of these results needs to consider the targets and audiences for the programs and initiatives considered.

Improved skills and knowledge and changed practice

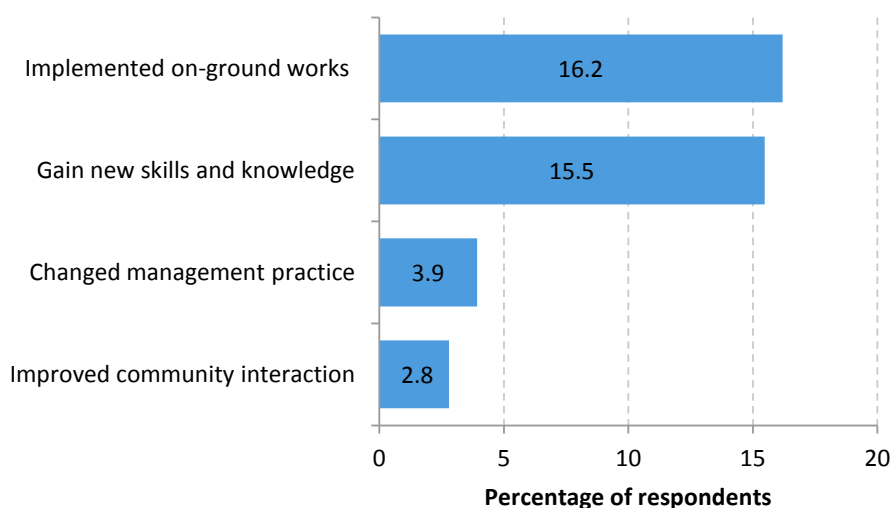
More than 90 per cent of farm managers who participated in a given program or initiative improved their skills and knowledge or changed land management practices (Table 26).

Table 26 Awareness of and participation in Australian Government programs

	Aware (%)	Of those who were aware, % who participated	Of those who participated, % who improved their skills and knowledge or changed practice
Caring for our Country	45	4	100
Landcare	96	41	94
Farm Ready	24	34	90
Australia's Farming Future	16	0	0
Sustainable Farm Practice Facilitators	14	6	100
Regional Landcare Facilitators	60	18	95
National Landcare Facilitator	24	<1	100

Benefits of participation

Figure 41 presents the benefits farm managers reported from participating in any of the listed Australian Government programs or initiatives. Implementation of on-ground works and gaining new skills and knowledge were the most frequently reported benefits.

Figure 41 Benefits from participation in Australian Government programs and initiatives

Note: Respondents could nominate more than one option

Learning activities and events

Participation

Farm managers reported participating in a variety of learning activities and events that provided information and advice about land management practices. Field days were the most frequently reported activity or event, followed by training courses or workshops (Table 27).

Incorporating outcomes

The majority of farm managers who participated in a learning activity or event incorporated the outcomes into their land management practices (Table 27).

Table 27 Activities and events attended

Activity or event	Participated (%)	Of those who participated, % who incorporated outcomes into on-farm management
Training course or workshop	43	97
Trials	15	86
Field days	62	87
Agribusiness organised events or meetings	16	93
Industry group event	12	100
Benchmarking group activities	7	91

Focus of activities and events

Most activities or events attended focused on production or a combination of production, NRM and finance (Table 28).

Table 28 Focus of activities and events attended

Type of activity	% with a production focus	% with a financial focus	% with a combined production, NRM and financial focus	% with an NRM/ environmental focus
Training course or workshop	30	<1	14	55
Trials	82	0	<1	18
Field days	30	0	<1	69
Agribusiness organised events or meetings	71	0	2.3	26
Industry group event	88	0	0	12
Benchmarking group activities	36	5	4	55

Delivery of training activities and events

Respondents were asked to identify the delivery agent for the activities and events they attended; the results are presented in Table 29.

Table 29 Delivery agent for extension activities for horticulture

Delivery agent	Training course or workshop (%)	Trials (%)	Field days (%)	Agribusiness events (%)	Industry group events (%)	Bench-marking group activities (%)
Federal government agency	4	0	0	0	0	0
State government agency	7	0	20	0	0	58
Local government agency	11	4	1	8	0	0
Regional NRM	29	0	0	6	0	0
Landcare group	9	0	1	0	10	9
Private consultant	24	4	35	58	19	4
Local farmer network	14	89	29	2	57	24
Other	2	3	0	26	15	5
Don't know	0	0	14	0	0	0

Property plan

Farm managers were asked to indicate if they had a written property plan and, if so, what types of farm management information it contained. Less than half (46 per cent) of the surveyed farm managers had a written property plan. Property plans mainly contained information on farm production, finance and NRM (Table 30).

Table 30 Property plans

Components of property plans	% of farmers who said their property plan included this component
Farm production activities	42
Management of natural resources	26
Farm financial or business activities	41
Succession plan	4
Management of major weed threats	19

4 Industry comparison

Across the DPC 2012 broadacre and dairy survey and the DPC 2013 horticulture survey there are a number of variables that can be compared to provide insights into differences between these industries. The following section compares adoption rates, motivations, barriers, information and learning networks, and awareness of and participation in Australian Government programs and initiatives.

Adoption of land management practices

Adoption rates for comparable practices across industries are presented in **Error! Not a valid bookmark self-reference**. Broadacre farm managers were more likely than other farm managers to have adopted reduced tillage practices. This may be due to their different operating context—i.e. larger farms, more environmental issues such as erosion, and greater exposure to variable rainfall. Horticulture farm managers reported lower adoption rates for native vegetation management practices than other respondents. Again this may reflect the context of their farm and farming system—i.e. smaller property size and thus less available land to revegetate, and less existing remnant vegetation and habitat for native fauna. Adoption of weed management practices was similar across industry groups.

Table 31 Adoption of management practices—industry comparison

Management practice category	Management practice	Broadacre (%)	Dairy (%)	Horticulture (%)
Crop and soil management	No-till, reduced tillage or direct drilling	83	44	66
Native vegetation management	Planted native vegetation or encouraged regrowth	41	42	26
	Fenced native vegetation to control stock access	50	53	19
Weed management	Management of WoNS	46	53	48

Motivations for adoption

In general, across the three industries the proportions of farm managers' motivations (financial, environmental and personal) influencing the decision to adopt a given land management practice showed similar patterns (Table 32), with some exceptions. Financial motivations were key influences on adopting cropping and soil management practices, and on adopting grazing management practices (applying only to broadacre and dairy).

Horticulture farm managers indicated that personal motivations were paramount in the decision to adopt native vegetation management practices and that environmental motivations were mainly driving the management of weeds. This contrasts with broadacre and dairy farmer managers, who nominated financial reasons as having more influence on weed management than the environmental reasons.

Table 32 Motivations for management practices ‘to a great extent’—industry comparison

Management practice category	Motivational category	Broadacre To a great extent (%)	Dairy To a great extent (%)	Horticulture To a great extent (%)
Cropping/soil	Financial	63	47	73
	Environmental	51	18	55
	Personal	36	19	38
Grazing	Financial	58	74	NA
	Environmental	42	32	NA
	Personal	31	34	NA
Native vegetation	Financial	19	26	22
	Environmental	39	27	43
	Personal	29	23	54
Weeds (WoNS)	Financial	61	62	61
	Environmental	59	27	79
	Personal	41	20	25

Note: Data only for those indicating motivation influenced adoption ‘to a great extent’

Barriers to adoption

Horticulture farm managers were less likely to see age and industry outlook, including commodity prices, as limiting their ability to change land management practices. Dairy farm managers thought that industry outlook, including commodity prices, was more of an issue than broadacre and horticulture farm managers did. Broadacre farm managers were less inclined to cite lack of funds as a barrier compared to dairy and horticulture farm managers (Table 33).

Table 33 Barriers to adoption—industry comparison

Barrier	Broadacre (%)	Dairy (%)	Horticulture (%)
Available time / workload	43	49	44
Lack of funds	38	55	54
Age	29	23	14
No limiting factors	19	9	15
Industry outlook, including commodity prices	16	34	0
Government assistance applications are too complex	13	11	19
Lifestyle choices	13	15	6
Lack of support, advice or training	4	2	9

Support, information and learning networks

Horticulture farm managers were more inclined to seek support in adopting soil and weed management practices than broadacre and dairy farm managers (Table 34).

Table 34 Support sought for management practices—industry comparison

Management practice category	Broadacre (%)	Dairy (%)	Horticulture (%)
Cropping/soil	31	19	42
Grazing	18	23	NA
Native vegetation	27	22	24
Weeds (WoNS)	10	13	35

Dairy farm managers (78 per cent) were more likely to be members of a group supporting land management than broadacre (66 per cent) and horticulture (62 per cent) farm managers. Horticulture farm managers were least likely to be members of a Landcare group. Table 35 presents the percentage of farm managers belonging to the different groups.

Table 35 Group membership—industry comparison

Group	Broadacre (%)	Dairy (%)	Horticulture (%)
Farmer industry organisation	40	53	45
Production or commodity group	17	35	27
Local farming systems support group	17	31	17
Landcare group	28	32	9
Research and development corporation	10	18	7
Conservation group	6	2	<1

Of the activities and events listed in the surveys, broadacre, dairy and horticulture farm managers were most likely to participate in field days and in training courses and workshops for gaining land management practice information (Table 36).

Table 36 Activities attended and incorporation of outcomes—industry comparison

Activity	Participated (%)			Incorporated outcomes into management practices (%)		
	Broad-acre	Dairy	Horti-culture	Broad-acre	Dairy	Horti-culture
Field days	53	65	62	79	78	87
Training course or workshop	34	39	43	90	96	97
Trials	24	23	15	93	94	86
Agribusiness organised events or meeting	23	28	16	88	94	93
Industry group events	19	31	12	83	88	100
Benchmarking activities	8	13	7	95	99	91

Table 37 presents awareness of and participation in Australian Government programs or initiatives. Awareness of the Regional Landcare Facilitators initiative was high compared to the other Australian Government programs or initiatives, with participation also relatively high for broadacre and dairy farm managers. For all industries, Farm Ready had consistently high levels of participation by those farm managers who were aware of the program. Horticulture farm managers reported a relatively high level of awareness of Caring for our Country; however, participation rates were low for horticulture farm managers compared to broadacre and dairy farm managers.

Table 37 Awareness of and participation in programs and initiatives—industry comparison

Program or initiative	Broadacre		Dairy		Horticulture	
	Aware (%)	Participate (%)	Aware (%)	Participate (%)	Aware (%)	Participate (%)
Caring for our Country	33	15	22	29	45	4
Farm Ready	31	40	24	24	24	34
Australia's Farming Future	31	5	41	3	16	0
Sustainable Farm Practice Facilitators	22	9	28	13	14	6
Reef Rescue	21	7	17	9	NA	NA
Regional Landcare Facilitators	90	41	88	31	60	10
National Landcare Facilitator	48	10	49	9	24	<1

5 Comparisons between 2010 and 2012 surveys—broadacre and dairy

A key objective in undertaking the DPC 2012 survey was to examine whether the findings from the DPC 2010 survey were consistent over time, whether any changes had occurred and, if so, what had changed. Because the same survey sampling methodology was used for both surveys—in that it produced a representative sample of the population of interest—we are able to compare the two datasets and derive robust estimates for most variables. There were, however, a number of changes and refinements to survey questions in the DPC 2012 survey. Therefore, some responses are not comparable across the two surveys.

Adoption of land management practices

Survey results regarding adoption rates of the sustainable land management practices indicated an increase in adoption rates across all the land management practices (Table 38). While this finding is encouraging, these results cannot be verified against other datasets, such as those produced by the ABS, as directly comparable data were not collected in the same time period.

Table 38 Changes in adoption and considered adoption of land management practices 2010 and 2012

Management practice category	Management practice	Adopted 2010 (%)	Standard error	Adopted 2012 (%)	Standard error	Percentage change
Crop management	No-till, reduced tillage or direct drilling	59	4	79	2	20
	Periods of fallow in crop rotation	36	5	55	5	19
	Retained stubble	56	3	75	2	19
Grazing management	Cell or strip grazing	47	5	65	3	18
	Set minimum groundcover targets for long term	42	5	90	2	48
	Planted or maintained deep rooted perennial pastures including fodder shrubs	45	6	52	4	7
Native vegetation management	Planted native pasture or encouraged regrowth	23	8	32	6	9
	Planted native vegetation or encouraged regrowth	38	6	41	5	3
	Fenced native vegetation to control stock access	41	6	50	4	9
Weed management	Managed WoNS	50	4	47 ^a	4	-3

Note: (a) This result includes respondents who had adopted or considered adopting this management practice

Motivations for adopting

Motivations for adopting practices were consistent between surveys in that they showed the same pattern of ranking between financial benefits, environmental benefits and personal motivations in 2010 and 2012—with some exceptions, which are discussed below. For the majority of practices, however, the percentage of farm managers reporting that a motivation influenced them ‘to a great extent’ has increased considerably.

Crop management practices

For crop management practices, respondents in both years chose financial benefits as the highest ranked motivation influencing them ‘to a great extent’, followed by environmental benefits and personal motivations (Table 39).

Table 39 Motivations for crop management practices 2010 and 2012

Motivation	Survey 2010			Survey 2012			Percentage change		
	Great extent (%)	Some extent (%)	Not at all (%)	Great extent (%)	Some extent (%)	Not at all (%)	Great extent (%)	Some extent (%)	Not at all (%)
Financial benefits	38	45	17	62	29	9	24	–16	–8
Environmental benefits	31	43	26	49	38	14	18	–5	–12
Personal motivations	11	30	59	35	33	32	24	3	–27

When financial motives from the 2010 and 2012 surveys were compared, the three top-ranked motives remained consistent across the surveys. ‘Increasing returns’ was nominated as the top financial motive in both the 2010 and 2012 surveys. However there was a change in order with regard to the second and third financial motives. The motive ‘reduced financial risk’ replaced ‘reduced costs’ in second place, and in turn the motive ‘reduced costs’ replaced ‘provides grazing in adverse conditions’ in third place. The changes occurred as a result of respondents nominating ‘reduced financial risk’ more frequently as a financial motive in 2012.

The top two environmental motives—‘improving soil condition’ and ‘reducing soil loss erosion’—were in the same order in both surveys. However, as ‘reducing soil loss and water run-off’ became one combined motive in the 2012 survey, ‘aligns with my environmental goals/beliefs’ moved from fourth place in 2010 to third place in the 2012 results.

The top three personal motives were in the same order in both surveys, with ‘desire to protect natural resources’ identified as the most important personal motive.

Grazing management practices

Motivations for grazing management practices showed the same pattern of ranking of importance in both surveys: financial benefits followed by environmental benefits and then personal motivations (Table 40).

When motives from the 2010 and 2012 surveys were compared, the three top-ranked motives remained consistent across the survey years.

The top two financial motives, 'improved year round feed availability' and 'increased returns/income' were in the same order in both surveys. However, the third place ranking changed to 'cost of not acting would be too high' in place of 'increased land value'.

The top two environmental motives, 'improving soil condition' and 'reducing soil loss erosion', were in the same order in both surveys. However, as 'reducing soil loss and water run-off' became one combined motive in the 2012 survey, the motive 'aligns with my environmental goals/beliefs' moved from fourth in 2010 to third position in 2012.

The top personal motive, 'desire to protect natural resources for the long term' was the same in both surveys. However there were changes in the ranking of the two next most important personal motives. The second placed motive, 'liked the technologies involved', replaced 'recognition by neighbours and community', the latter having dropped from 24 per cent to 4 per cent; and in third place 'reduction in workload / provides time for other activities' replaced 'prepared to risk short-term production losses'.

Table 40 Motivations for grazing management practices 2010 and 2012

Motivation	Survey 2010			Survey 2012			Percentage change		
	Great extent (%)	Some extent (%)	Not at all (%)	Great extent (%)	Some extent (%)	Not at all (%)	Great extent (%)	Some extent (%)	Not at all (%)
Financial benefits	49	41	10	60	34	6	11	-7	-4
Environmental benefits	22	47	31	40	42	18	18	-5	-13
Personal motivations	11	32	57	31	34	34	20	2	-23

Native vegetation management practices

Among the motivations for adopting native vegetation management practices, environmental benefits ranked as the most important motivation in both surveys. There was a change in the ranking of motivations, with financial benefits ranking second in the DPC 2010 survey and third in the DPC 2012 survey. The differences between these motivations were marginal in both years, however, and these data confirm that environmental benefits ranked well above the other types of factors in motivating adoption of native vegetation management practices (Table 41).

When the top three motives from the 2010 and 2012 surveys were compared, there was a change with respect to the top environmental motive from 'improves soil quality' to 'aligns with my environmental goals/beliefs'.

The top financial motive, 'provide shelter for livestock crops', was the same in both surveys. However, there were changes in the order of the second and third financial motives. 'Increased returns/income' replaced 'increased land value' in second place and 'reduced costs' (previously ranked sixth) replaced 'increased returns' in third place.

Likewise there was a change in the order of environmental motives. The highest ranked motive in 2010, 'improving soil condition', fell to fourth place. It was replaced by 'aligns with environmental goals/beliefs' (previously in second place). In 2012 'reducing soil loss erosion' moved to second position and 'provide habitat for native fauna' remained in third position.

The top two personal motives were the same in both surveys: 'desire to protect natural resources for the long term' and 'desire to improve amenity of the landscape'. However, there was a change in third place in 2012, with 'family considerations' replacing 'recognition by neighbours and community'.

Table 41 Motivations for native vegetation management practices 2010 and 2012

Motivation	Survey 2010			Survey 2012			Percentage change		
	Great extent (%)	Some extent (%)	Not at all (%)	Great extent (%)	Some extent (%)	Not at all (%)	Great extent (%)	Some extent (%)	Not at all (%)
Financial benefits	17	45	38	19	33	48	2	-12	10
Environmental benefits	32	47	21	38	34	29	6	-13	8
Personal motivations	13	38	49	28	34	38	15	-4	-11

Weed management practices

Motivations for weed management practices showed the same pattern of ranking of importance in both surveys: financial benefits, environmental benefits and then personal motivations (Table 42).

When motives from the 2010 and 2012 surveys were compared, the top-ranked environmental and personal motives remained consistent across the surveys.

There was, however, a change in the order of financial motives, with ‘cost of not acting too high’ moving into first place replacing ‘increased returns’, which moved to second place.

This change in order was a result of an increase in the percentage of farm managers who nominated ‘cost of not acting too high’ as the main motive and a slight drop in the percentage who nominated ‘increased returns’. There was also a change in third place, with ‘reduced livestock losses’ replacing ‘increased land value’.

The top two environmental motives—‘aligns with my environmental goals/beliefs’ and ‘corporate social and environmental responsibility’—were the same in both surveys. However, there was a change in third place in 2012, with ‘improves soil condition’ replacing ‘improved habitat for native fauna’. The motive ‘improves soil condition’ was not included in the DPC 2010 survey.

While ‘desire to protect natural resources’ remained a key personal motivation in the 2012 survey, there was a change in second and third places. The motive ‘reduction in workload / provides time for other activities’ moved into second place replacing ‘recognition by neighbours and community’, which moved to the third place replacing ‘fit in with practice of others in my community’ (which was not included in the DPC 2012 survey).

Table 42 Motivations for native weed management practices 2010 and 2012

Motivation	Survey 2010			Survey 2012			Percentage change		
	Great extent (%)	Some extent (%)	Not at all (%)	Great extent (%)	Some extent (%)	Not at all (%)	Great extent (%)	Some extent (%)	Not at all (%)
Financial benefits	43	45	12	61	35	4	18	–10	–8
Environmental benefits	22	45	33	54	35	10	32	–10	–23
Personal motivations	18	39	43	39	42	19	21	3	–24

Barriers to adoption

The ranking of importance of barriers to changing land management practices stayed largely consistent between the two survey years. Available time / workload was considered a barrier for more respondents in 2012 than in 2010. Lack of funds was chosen by 13 per cent fewer respondents, and 11 per cent fewer said in the second survey year that government assistance applications were too complex. Other variations between the years are considered negligible (Table 43).

Table 43 Barriers to changing land management practices 2010 and 2012

Barrier	Survey 2010 (%)	Survey 2012 (%)	Percentage change
Lack of funds	53	40	-13
Available time / workload	44	44	0
Age	27	28	1
Government assistance applications are too complex	24	13	-11
Lifestyle choices	13	13	0
No limiting factors	12	18	6
Industry outlook, including commodity prices	12	18	6
Lack of support, advice or training	6	4	-2

Note: Respondents could nominate more than one option

Information and learning networks

Group membership

As shown in the table below, membership of groups stayed at similar percentages and also in a similar ranking across groups. Whilst small, the increase in proportion of respondents who were members of farmer industry organisations and production or commodity groups suggests that these groups may be growing and this is worthy of further investigation (Table 44).

Table 44 Group membership 2010 and 2012

	Survey 2010 (%)	Survey 2012 (%)	Percentage change
Farmer industry organisation	36	41	5
Landcare group	27	28	1
Local farming systems support group	16	18	2
Production or commodity group	14	19	5
Research and development corporation network	10	11	1
Conservation group	5	6	1

Note: Respondents could nominate more than one option

Involvement in Australian Government programs

There was an increased awareness of all listed government programs and initiatives except for Farm Ready in the 2012 survey as compared with the 2010 survey. There was a notable increase—35 per cent—in the proportion of respondents in the 2012 survey who recognised the Regional Landcare Facilitators initiative. Otherwise, levels of recognition of different programs or initiatives stayed largely consistent across the survey years (Table 45).

Table 45 Awareness of government programs 2010 and 2012

Program/initiative	Aware Survey 2010 (%)	Aware Survey 2012 (%)	Percentage change
Regional Landcare Facilitators	55	90	35
National Landcare Facilitator	31	48	17
Australia's Farming Future	22	32	10
Caring for our Country	29	31	2
Farm Ready	32	30	-2
Sustainable Farm Practice Facilitators	18	23	5
Reef Rescue	19	21	2

There were only marginal changes (increases and decreases) in participation in most government programs and initiatives (Table 46).

Table 46 Participation in government programs 2010 and 2012

Program/initiative	Of those who were aware, % who participated Survey 2010	Of those who were aware, % who participated Survey 2012	Percentage change
Regional Landcare Facilitators	36	40	4
National Landcare Facilitator	8	10	2
Australia's Farming Future	7	5	-2
Caring for our Country	16	16	0
Farm Ready	40	39	-1
Sustainable Farm Practice Facilitators	16	9	-7
Reef Rescue	5	7	2

The percentages of those who said they improved their skills and knowledge as a result of the programs or initiatives also remained similar across the years—with the exception of Caring for our Country, which 14 per cent more of the 2012 respondents said had improved their skills and knowledge. This result is likely to do with these changes taking effect after a reasonable period of involvement in the program or initiative (Table 47).

Table 47 Change in the skills and knowledge of program participants 2010 and 2012

Program/initiative	Of those who participated, % who improved skills and knowledge Survey 2010	Of those who participated, % who improved skills and knowledge Survey 2012	Percentage change
Regional Landcare Facilitators	94	90	-4
National Landcare Facilitator	97	86	-11
Australia's Farming Future	89	94	5
Caring for our Country	80	94	14
Farm Ready	95	93	-2
Sustainable Farm Practice Facilitators	100	93	-7
Reef Rescue	73	59	-14

The two most important benefits gained from program participation were the same across survey years. 'Gained new skills and knowledge' was the most frequently chosen benefit for both years, followed by 'implementing on-ground works'. 'Changed management practices' and 'improved community interactions' were reported less as benefits in 2012 than in 2010 (Table 48).

Table 48 Benefits gained from participation in programs and initiatives 2010 and 2012

Benefits of participation	Survey 2010 (%)	Survey 2012 (%)	Percentage change
Changed management practices	16	8	-8
Improved community interaction	13	9	-3
Implemented on-ground works	31	27	-4
Gained new skills and knowledge	43	31	-11

Note: Respondents could nominate more than one option

Learning activities and events

Across the survey years, field days remained the most frequently attended activities for gaining knowledge about adopting sustainable farm practices. All other activities also retained the same order of frequency. Changes in attendance were mostly negligible, with 8 per cent fewer involved in trials and 7 per cent fewer involved in agribusiness events in 2012 compared to 2010. Five per cent more 2012 survey respondents attended industry events (Table 49).

Table 49 Activities and events attended 2010 and 2012

Activity or event	Participated Survey 2010 (%)	Participated Survey 2012 (%)	Percentage change
Field days	57	54	-3
Training course or workshop	34	35	1
Trials	32	24	-8
Agribusiness organised events or meetings	31	24	-7
Industry group events	16	21	5
Benchmarking of best practice group activities/events	8	8	0

Note: Respondents could nominate more than one option

Focus of activities and events

Respondents were asked whether the activities they attended were focused on production issues, financial issues, natural resource management issues, or a combination of these. As with the DPC 2010 survey, the majority of respondents in the DPC 2012 survey said that for the majority of all activities the focus was on production issues. Again the finding of the earlier survey was confirmed, with combined focus events being the next most frequent focus of activities and events attended. In both surveys few farm managers said that financial or environmental topics were the main focus of the activity or event they attended (Table 50).

Table 50 Comparisons of the activities respondents attended by event focus 2010 and 2012

Activity	% with a production focus Survey 2010	% with a production focus Survey 2012	% with a combined production, NRM and financial focus Survey 2010	% with a combined production, NRM and financial focus Survey 2012	% with a financial focus Survey 2010	% with a financial focus Survey 2012	% with an NRM/ environmental focus Survey 2010	% with an NRM/ environmental focus Survey 2012
Field days	66	50	33	48	1	1	1	2
Training course or workshop	54	56	38	34	6	4	3	6
Trials	74	85	24	11	1	0	2	5
Agribusiness organised events or meetings	69	76	27	20	4	4	0.1	1
Industry group events	58	71	34	26	5	0.3	3	3
Benchmarking of best practice group activities/events	52	46	38	48	10	7	1	0.4

6 Discussion

Motivations

It is widely acknowledged that the decision to adopt sustainable soil and land management practices depends on a range of personal, social, cultural and economic factors. Moreover, the likelihood of adopting a practice increases where the farm manager perceives that by adopting they will achieve their social, economic and environmental goals and aspirations, such as financial security, environmental protection, social approval, personal integrity and work-life balance (Pannell et al. 2011).

The DPC stage 1 and stage 2 studies identified that motivations for adopting sustainable land management practices can be classified broadly into financial, environmental and personal motivations. Of these motivations, the DPC 2010 survey found that financial benefits and environmental benefits were the primary influence for adopting crop, grazing and weed management practices, while environmental and financial factors were the primary influence for adopting native vegetation management practices.

The results of the DPC 2012 survey also identified that financial benefits and environmental factors were the main influence on adopting crop, grazing and weed management practices, while environmental and personal factors were the primary influence for adopting native vegetation management practices.

The DPC 2013 horticulture survey found that adopting soil management practices was also driven by financial benefits and environmental factors. For horticulture farm managers, personal and environmental factors were influencing adoption of native vegetation practices, while environmental factors followed by financial benefits were influencing adoption of weed management practices.

Further, analysis of the DPC 2012 survey and the DPC 2013 horticulture survey found that the majority (>50 per cent) of farm managers indicated that multiple motivations influenced their decision to adopt a given practice across all practice management categories.

A comparison of the results of the two surveys shows there has been an overall increase in the proportion of respondents who indicated that a given motivation influenced their adoption decision 'to a great extent' rather than 'to some extent' or 'not at all'. The only management practices that had a change in motivation rank were native vegetation practices. For these management practices, personal factors moved to a higher rank than financial benefits in the DPC 2012 survey compared with the DPC 2010 survey. This change is explained by the number of farmers choosing these two motivations (financial and personal) for native vegetation management being similar in both survey years, so a minor increase in respondents choosing personal motivations altered the rankings in favour of personal motivations. In both survey years, environmental motivations ranked higher than both personal and financial motivations for native vegetation management practices.

Motives

The underlying motives for adopting cropping and grazing management practices were very similar in the DPC 2010 and DPC 2012 surveys. The motives included improved financial performance through increasing returns, reducing costs and reducing risk; improved environmental performance through improving soil health and ameliorating erosion; and attaining personal objectives by protecting resources and reducing workload. A key personal

factor contributing to adoption was whether respondents held a positive view of the technology involved in the change, more so for cropping than for grazing management practices.

The DPC 2013 horticulture survey also found that adopting soil management practices by horticulture farm managers was driven by the financial motives: reduced costs, increased returns and reduced financial risk. Similarly environmental motives included 'improves soil condition', 'reduces erosion' and 'aligns with environmental goals'.

The underlying motives for adopting native vegetation management practices were also very similar across both surveys. Both surveys showed that the main motives for adopting native vegetation management practices, as compared with cropping and grazing management practices, were related to beliefs ('aligns with my environmental goals/beliefs' was the most frequently chosen option by broadacre and dairy farmers). Farm managers expressed their environmental beliefs by identifying with both environmental and personal motivations for native vegetation management, suggesting that these motivations may be interchangeable in terms of how they are used to encourage would-be adopters. The qualitative study in DPC stage 1 also suggested that personal motivations and environmental stewardship motivations had some equivalence in the way farm managers understand and describe these aspects.

Beyond this, other factors influencing adopting native vegetation management practices were improved environmental performance through ameliorating erosion and providing habitat for native fauna. Again a desire to protect natural resources was a key personal factor along with improved amenity and family considerations. Horticultural farm managers also reported similar personal and environmental motives.

While financial benefits were a secondary motivator for adopting native vegetation management practices, farm managers indicated that improved financial performance through providing shelter for livestock and crops, increased returns, reduced costs and decreased risk were the most important financial benefits. Horticultural farm managers also reported similar financial motives: 'provides shelter', 'increases land values' and 'increased returns'.

Interestingly, a relatively high proportion (between 19 and 38 per cent) of farm managers in both surveys indicated that none of the motivational areas influenced their adopting native vegetation management practices. This finding for broadacre and dairy was congruent with that for horticulture farm managers. The relatively large percentage of adopters of native vegetation management practices who indicated that their motivations were neither financial, environmental nor personal (>19 per cent) sends a message that motivations for this activity are highly diverse. This may be explained by the DPC 2010 survey, where 9 per cent of farm managers adopting native vegetation management practices said they were motivated by support to a great extent, and 29 per cent to some extent. (This question was not asked in 2012.) This highlights the value in further investigating why farm managers adopt native vegetation management practices.

The underlying motives for adopting weed management practices were consistent across both surveys. Improved financial performance through reducing risk and increasing returns were important motives. The key environmental motives for adopting weed management practices also differed from those of the other practices areas. While environmental beliefs ('desire to protect natural resources for the long term') were a primary motive for adopting weed management practices, a desire to act due to a sense of social and environmental responsibility emerged as a secondary motive ('desire to be recognised by neighbours and community').

Multiplicity and interrelationship of motivations

Farm managers are likely to be strongly influenced by more than one motivation, suggesting that adopting sustainable land management practices is seen to provide multiple benefits across and within financial, environmental and personal dimensions. This was supported by the DPC stage 1 study, by the DPC 2010 survey and in the literature reviewed.

The results of the DPC 2012 survey further support the finding that farm managers are influenced by multiple motivations. Analysis of DPC 2012 survey data with regard to interrelated motivations influencing practice adoption (see 'Motivations for adoption') shows that the majority (>50 per cent) of respondents indicated multiple motivations influenced their decision to adopt a given practice across all practice management categories. For crop management practices, 53 per cent of respondents indicated that more than one motivation influenced their decision. For grazing management practices, 65 per cent of respondents indicated that more than one motivation influenced their decision. For native vegetation management practices, 63 per cent of respondents indicated that more than one motivation influenced their decision. For weed management practices, 75 per cent of respondents indicated that more than one motivation influenced their decision.

The finding within the DPC 2012 survey that multiple factors are driving adoption is supported in the literature. Prager and Posthumus (2010), for example, reviewed socio-economic factors that influence farmer participation in soil conservation efforts and found there is no supporting evidence that economic or social factors alone explain adoption decisions. Instead, they assert that adoption decisions are based on a combination of personal, socio-cultural, economic, institutional and environmental benefits. If the innovation is perceived as 'win-win', providing a relative advantage across multiple dimensions, farm managers are more likely to adopt (Gedikoglu and McCann 2012; Leviston et al. 2011; Reimer et al. 2012). A study by Vitale et al. (2011) highlights how farmers in the United States perceive multiple benefits from conservation agriculture practices, which includes no-till and reduced tillage systems. These practices not only reduce soil erosion but also improve the farmer's economic situation, save energy and promote improved environmental management. Richards and Lawrence (2009), in their study of Queensland graziers, found that graziers who had adopted cell grazing had a holistic view of their approach to grazing where lifestyle, production, economics and environmental performance were seen as interrelated components of sustainability.

The multiple benefits stemming from the adoption of conservation agriculture (CA) practices were also reflected in the case study of CA practitioners undertaken as part of this study (Appendix 2). The majority of participants did not distinguish environmental from financial motivations, and these motivations combined to influence adoption. Recognising the relationship between conserving the resource base and positive financial benefits is evident in statements such as:

'Our farm is benefiting in relation to our soils getting healthier and healthier, our bank balance is benefitting.'

'As time goes, you get to know your soils and you learn about your soils, you see that the healthier your soils are, the more money you can make. So this is a win-win situation. We love this aspect: we are doing something not only for the farm, we are doing more for ourselves.'

'Prior to 1988, I cultivated everything and the country was prone to wind erosion. After 1988, we began reducing tillage and adopted zero-till in 2005. We would have gone broke if we had not implemented these changes.'

This suggests that these farm managers who had adopted sustainable land management practices have a holistic view of their farming enterprise and understand the nexus between

environmental performance and financial performance. For example, adopting conservation tillage practices provides direct short-term economic benefits such as reduced input costs as well as improved environmental performance through increasing soil moisture. This in turn reduces exposure to seasonal climate variability, resulting in long-term financial benefits through greater production stability.

The findings from all stages of the DPC study indicate that farm managers who had adopted a given sustainable land management practice were motivated by the anticipated relative advantages of implementing the practice. These relative advantages are multi-dimensional and span financial, environmental and personal dimensions.

Support, information and learning networks

Farm managers' support, information and learning networks are generally considered to play an important role in promoting and helping implement on-farm innovations. In an environment where there is an excess of information for farmer managers to consider in relation to on-farm management decisions, it is important to be able to distinguish which information and learning networks farm managers consider are credible and reliable (Pannell et al. 2011). Trust in sources of information increases the likelihood that sustainable farm practices are undertaken by farm managers (e.g. Leviston et al. 2011). How learning activities are described is also important. As Andrews et al. (2003) note, describing learning benefits in terms that are relevant to the individual farmer and their enterprise is an important influence on participation.

Outcomes of the DPC study contribute to understanding the information and learning networks farm managers use to support their decision making. In the DPC 2010 survey, DPC 2012 survey and DPC 2013 horticulture survey, three information and learning networks were considered: groups, extension activities or events, and Australian Government programs. Further to this, farm managers were asked directly in the DPC 2012 survey and DPC 2013 horticulture survey if they had sought support to adopt or consider adopting a given land management practice (a question not asked in the DPC 2010 survey) and, if so, who provided the support.

Group membership

In the DPC 2012 survey the majority (67 per cent) of farm managers reported that they were members of at least one group providing support for land management decisions. This result was similar for horticulture farm managers, with 62 per cent reporting group membership. Group membership remained similar across both surveys, with a marginal increase (of between 1 per cent and 5 per cent) in the proportion of farm managers reporting membership of a given group (Table 44). Farmer industry organisations and Landcare groups were the most commonly cited membership groups in both surveys, indicating their relative importance to farm managers.

An analysis comparing group membership rates of adopters, considerers and non-adopters revealed that, for the majority of practice management areas, adopters were more likely to be involved with or belong to a group than considerers and non-adopters. Weed management practices were the most notable exception to this finding.

Across all respondents farmer industry organisations (41 per cent) had the highest percentage of farm managers reporting involvement or membership, followed by Landcare groups (28 per cent), production or commodity groups (19 per cent), local farming systems support groups (18 per cent), RDC networks (11 per cent) and conservation groups (6 per cent).

The positive association of adoption rates with involvement in social networks is confirmed in many surveys and literature. Baumgart-Getz et al. (2012), for example, undertook a meta-analysis of factors related to adoption of practices among American farmers from 46 separate studies. They found that being connected to an agency or to local networks of farmer groups was one of the three greatest influences on adoption compared with almost all other social factors they considered. This does not mean that membership of networks is the cause of adoption, but it does show that there is an association. The importance of information produced locally by applying new innovations is highlighted by Llewellyn (2011). Information produced and disseminated through local networks is more influential than information obtained from other sources as it is perceived as being of better quality and from a more valid source.

Pannell et al. (2006) cite the positive relationship between group membership in organisations such as catchment groups and Landcare groups and the adoption of conservation practices. Further they conclude that the localness of groups is positively related to adoption. Knowler and Bradshaw (2007) note the importance of social capital in improving the adoption of conservation agriculture and, specifically, its role in the success of Landcare in Australia. A study by Lashgarara (2011) of wheat farmers in Iran also found that social participation, including participating in extension classes, was associated with adopting sustainable practices.

Extension activities and events

In the DPC 2012 survey, the majority (70 per cent) of farm managers reported that they had obtained management practice information or advice via at least one of the extension activities or events listed. There was no change between the two surveys in the ranking of which activities or events farm managers attended to increase their knowledge of sustainable land management practices. Further there was minimal change between surveys in the proportion of farm managers participating in these activities and events. The majority (82 per cent) of respondents to the DPC 2013 horticulture survey indicated that they had participated in at least one type of learning activity or event that provided land management information and advice.

Broadacre, dairy and horticulture farm managers indicated that field days and training and workshops were the main extension activities or events they participated in for management practice advice and information. Nearly all participants from the conservation agriculture case study (see Appendix 2) cited field days as an important extension event that introduced them to a range of conservation agriculture practices. Field days were described as an important hub—in their information network—for sharing information, experiences and learning (successes and failures) with others, including farm managers, agronomists and researchers. Sharing knowledge and experience was regarded as the most important way of obtaining valuable, specific, relevant information. After field days, farm managers indicated that they participated in training courses, trials, agribusiness events, industry group events and benchmarking of best practice group events, in that order.

The majority of extension activities and events that respondents participated in had a production focus, across both surveys. After production-focused activities and events, farm managers indicated that they were attending activities and events that focused on giving a combination of production, NRM and financial advice. Participation in events and activities with several different areas of focus was significantly higher than participation in those focusing on just financial or just NRM/environmental issues (Table 50).

Involvement in Australian Government programs and initiatives

Australian Government NRM programs are recognised to a large degree, and the majority of farm managers who participated in these programs gained new skills and knowledge. There was

a marked increase in farm manager awareness of the Regional Landcare Facilitators, the National Landcare Facilitator and Australia's Farming Future programs between the two surveys and a minor increase in recognition of Caring for our Country.

There was an increased awareness of all listed government programs and initiatives, except for Farm Ready, in the 2012 survey as compared with the 2010 survey. There was a notable increase of 35 per cent of respondents in the 2012 survey recognising the Regional Landcare Facilitators. Otherwise, levels of recognition of different programs or initiatives stayed largely consistent across survey years (Table 45).

Australia's Farming Future, Caring for our Country and Farm Ready were recognised by around one-third of farm managers. Reef Rescue, which applies only to farms adjacent to the Great Barrier Reef was less well recognised; this needs to be considered within the context of being relevant only to one region.

Levels of participation in all programs varied between the two surveys, with slight changes across the different programs. In the DPC 2012 survey, 46 per cent of farm managers indicated that they had participated in at least one of the Australian Government programs listed. Regional Landcare Facilitators and Farm Ready had the highest proportions of farm managers participating. For all other programs, participation rates were less than 20 per cent. The majority of farm managers across both surveys gained new skills and knowledge as a result of program participation.

A comparison between adopters, considerers and non-adopters in the DPC 2012 survey revealed that, for the majority of practice management areas, adopters were more likely to have participated in an Australian Government program than non-adopters. This indicates there is an association between program participation and adopting sustainable farm management practices.

Support

In the process of adopting a given sustainable land management practice, between 21 per cent and 31 per cent of farm managers (DPC 2012) indicated that they had sought support. Support agents differed across the different management practice areas. For crop and grazing management practices, the main support agents were private consultants or agribusiness agents, peers and neighbours, farmer production groups, government extension officers and Landcare. The most notable differences can be seen in adopting native vegetation management practices and weed management practices. In adopting native vegetation management practices, Landcare groups and the CMA/NRM region employed facilitator were key sources of support. Government extension officers, private consultants or agribusiness agents and Landcare groups are commonly used as the support agent for weed management practices.

All participants in the conservation agriculture case study said support was an important factor in implementing new on-farm innovations. Support networks included growers' groups, peers and neighbours, family members and private consultants.

Barriers

The DPC 2010 and 2012 surveys and the DPC 2013 horticultural survey showed that the main factors limiting the ability of farmer managers to make changes to their management practices were lack of funds and available time. However, the percentage of broadacre and dairy farm managers reporting a lack of funds as limiting their ability to make changes decreased by 13 per cent between the two surveys. Overall the percentage of broadacre and dairy farm managers

who believed there were no limiting factors in making changes to their management practices increased by 6 per cent between 2010 and 2012, being 18 per cent in 2012.

There was little difference in reported barriers to adoption between the broadacre, dairy and horticulture industries in the surveys reported here. The main differences were:

- A higher percentage of dairy farm managers than broadacre farmers nominated a lack of funds and industry outlook, including commodity prices, as being a barrier to adoption
- A smaller percentage of dairy farm managers than broadacre farm managers believed there were no limiting factors
- Horticulture farm managers reported barriers similar to those reported by broadacre and dairy farm managers, but age was a lesser barrier and the difficulty of completing government assistance applications was a greater barrier.

Financial capacity is highlighted within the literature reviewed as an essential requirement in adopting new innovations and, conversely, lack of funds is an expected barrier to adoption (Baumgart-Getz et al. 2012; Leviston et al. 2011; Pannell et al. 2011; Sutherland et al. 2012; Vanclay 2004).

Leviston et al. (2011) also found that having limited time was a barrier to adopting sustainable land management practices. The need for off-farm income was cited as affecting available time. Further, limited time also leads to fewer social interactions among farmers, which in turn affects information sharing and adopting innovations. Peers, family and friends are important sources of input and information for making on-farm decisions.

Increasing age is a commonly cited barrier to adopting new innovations (Baumgart-Getz et al. 2012; Pannell et al. 2011; Vitale et al. 2011). Pannell et al. (2011) note that age barriers may be particularly relevant for those farm managers who do not have a succession plan for the farm or those with physical health issues.

Vanclay (2004) expands on the barriers measured in the DPC surveys, providing what he terms 'legitimate reasons' for not adopting an innovation: too complex, lack of divisibility, not compatible with objectives, reduces flexibility, perception of profitability, high capital outlay, risk and uncertainty, requires additional learning, conflicting information, perception of problem(s), lack of physical infrastructure, and lack of social infrastructure.

The conservation agriculture case study revealed a number of barriers, constraints and difficulties in adopting conservation agriculture practices, which reflect findings from the DPC study and the literature reviewed, including:

- finding the right approach/methods of applying the innovation to suit the local context (individual, farm and environment) and managing new challenges that resulted from the change in practice, for example herbicide resistance
- complexity of the innovation, which is knowledge intensive and requires the farm manager to develop new skills and knowledge; it can also require the introduction of multiple technologies and in some cases means a fundamental change to every aspect of the farming system
- financial barriers in the form of a lack of financial resources to initially invest; and a concern that the large outlays may not be matched by returns.

7 Implications

The results of the DPC study highlight the diversity of factors influencing adopting sustainable soil and land management practices. There were positive advances in implementing sustainable practices between the DPC 2010 survey and the DPC 2012 survey. This includes upward trends in farm managers' adopting sustainable farm practices; recognising and being involved in Australian government NRM programs; and being involved in NRM-related groups and networks. There were slight decreases in two areas: fewer farm managers were involved in some of the extension activities and fewer farm managers reported benefits from participating in some government programs in the 2012 survey. However, in some programs more respondents reported benefits in 2012 than 2010—such as in Caring for our Country, where there was a 14 per cent increase in reported benefits of participating. These results could be associated with the program implementation cycle, with later parts of the cycle providing greater benefits to farm managers than earlier parts.

Recognition of the overall Caring for our Country initiative increased from 29 to 31 per cent between the DPC 2010 and 2012 surveys. This increased program recognition and involvement may have resulted from effective communication of the Caring for our Country initiative, whether this be through community networks or formal communications (though these factors should not be taken as measures for assessing program effectiveness). Adoption, as the study shows, has varied motivations and a range of kinds of support and advice may be involved. Cause and effect cannot be directly demonstrated. Nevertheless, with the overall favourable trend, it is likely that momentum for sustainable resource management is continuing to grow, as has been evident from nationally representative surveys on NRM issues conducted over the last decade (e.g. studies of adoption rates cited in Ecker et al. 2012).

The implications of this study for policy are described in the following section. This builds on the implications outlined in the 2012 report (Ecker et al. 2012) which maintain relevance. Discussed below are three key areas relevant to sustainable agriculture and natural resource management: responding to farm manager motivations; engagement and capacity building; and further research.

Responding to farm manager motivations

'Desire to protect the resource base for the long term' was consistently the highest ranking personal motive across all practices for both survey years. Of all the motives, this is the only one which was consistent across both surveys. This result suggests that, given adequate capacity, farmers would work to protect the resource base. However, behaviour change is a function of motivation and capacity, as well as other factors such as opportunity. One can have the motivation to change but not the capacity, or vice versa. The implications of these two facets of adoption are considered below, starting with motivations.

As for the previous survey report (Ecker et al, 2012), this report demonstrates the multiple motivations for adopting sustainable farm management practices, which vary with practice and industry. Detailed analysis of the DPC 2012 survey showed variation in motivations between management practices with most farm managers being influenced by more than one motivational area (i.e. financial, environmental, personal). Motivation of weed management adoption was the most complex, with 75 per cent of respondents citing more than one motivation; and cropping practice adoption was the least complex, with 53 per cent considering more than one motivation.

Two main areas emerge which provide supporting logic for designing extension and communicating approaches for encouraging adoption of sustainable land management practices, as discussed below.

Promoting the multiple benefits of adoption to farmers

As confirmed in this and other studies (see literature cited in Appendix 1), environmental and lifestyle goals are important drivers of practice change, in addition to maximising financial returns. A key role of those promoting sustainable practice is to increase awareness of the benefits in all areas, not just productivity.

The multiple motivations confirmed by this study have implications for communicating with farmers. There is awareness of the worth of communicating the costs and benefits of land management practices (e.g. Andrew et al. 2003). The findings indicate that promoting sustainable land management activities needs to extol financial, personal/social and environmental benefits. Land managers motivated by the prospect of all these different benefits will be looking for evidence of relative advantage in all these areas. Information purely on environmental benefits or information purely addressing economic benefits may not provide adequate incentive.

There is extensive evidence that financial motivations are key, from this and other studies, and the dissemination of information on financial benefits of practices remains an important link in adoption and continued practice. This includes details on how practices can improve financial performance, stabilise production, decrease losses and manage long-term risk. Practice adoption is motivated to different degrees by different motivations. Profit orientated motivations, such as increased returns, were more important for motivating cropping and grazing practices than native vegetation management practices, for example. Native vegetation management practices are motivated in a different way from the other practices considered, and this result is worth further consideration in terms of how motivations appear to be related to the way farm managers perceive the public or private benefits from these activities.

For native vegetation management, findings from both survey years placed environmental and personal motivations above financial motivations. Practices seen as leading to private benefits may need to be promoted differently from practices which are seen as leading to public benefits. Whilst financial benefits of native vegetation, for example stock shelter, may be helpful in encouraging adoption, results from the study suggest that information on environmental and personal benefits of native vegetation management are also of interest to farmers.

Recognising the interaction between farmer characteristics and adoption

Results also showed that adoption motivations interact with different farmer characteristics and behaviour, such as group and program involvement and financial status, in different ways depending on the practice. Extension agents would benefit from being aware of the potential relationships between these motivations or characteristics and adoption; for example farmers who were members of a group were more likely to adopt sustainable farm practices than those who were not. Knowledge of these relationships can be applied in promoting adoption in the broad and comprehensive sense, acknowledging that adopting sustainable farm practices is likely to be influenced by a range of interrelated factors.

Engagement and capacity building

Engagement to encourage adoption is relatively advanced in Australia and, in general, service providers take into account the target audience and the suitability of the practice to be adopted. As Pannell et al. (2006) state, communication to promote practices that do not benefit farm managers, without considering additional incentives, causes frustration for all concerned. It goes without saying that engagement and capacity building efforts need to take into consideration the distance between policy directives and farmer realities. For example, local sources of information and local conditions such as social capital need to be considered as part of the program design phase. In promoting sustainable practices, it is valuable to understand how farmer motivations and capacity interact. As mentioned earlier, both are needed to bring about change.

Understanding what ‘grows’ farmer capacity to adopt

The importance of social capital in encouraging adoption is well documented and investment in improving this has been a key factor in government NRM programs, arguably a key element of the success of Landcare in Australia.

Social capital such as membership of groups and networks is highlighted by this study as an important factor in adoption. Farm managers who are more likely to adopt are those who are members of a group, have participated in an Australian Government program, and have participated in extension and learning activities, with some variation between practices. Taking these results at face value, engagement to encourage adoption would include these social capital building activities, within reason. That is not to say that there are not other mechanisms that influence adoption.

The evidence shows that participating in support, information and learning networks is associated with adoption. Measures of participation in these types of engagement are suggested as important in supporting adoption and also as worthwhile indicators to monitor engagement with government or community based NRM programs.

Recognising the importance of groups in fostering sustainable practice adoption

For a number of reasons, group membership is particularly important as both a catalyst for change and a measure of engagement in sustainable farm practices. Firstly, the majority of farm managers (62 per cent in 2010 and 67 per cent in 2012) are members of at least one group that promotes sustainable farm practices. Secondly, for cropping, grazing and native vegetation management practices, farm managers who had adopted these practices were more likely to be members of a group than non-adopter farm managers (DPC 2012 survey results—this analysis was not undertaken for the DPC 2010 survey results). In 2010 for most practices, where farm managers said that adopting was motivated by support for land management decisions, they said this was most influenced by Landcare or production groups. Based on a different question in 2012 where farmers were asked where they went for support, farmer production or Landcare groups occurred in the top three providers for all management practices.

Landcare groups, production groups and farming systems groups are clearly important in supporting adoption of sustainable farm practices. Results from both survey years present a compelling argument for supporting these groups in a form that does not threaten the long-term viability, localness and community-driven nature of these groups that makes them so credible to farmers. The task from here is to determine what sort of support these groups want and need.

Recognising different service provider influences

This study also demonstrated that different service providers are key in supporting different practices. That is, service providers have speciality areas in terms of which practices they support best. For example, in general terms, consultants are important in providing land management advice on sustainable cropping practices, NRM regions support grazing and native vegetation management practices, and state government provides weed management support. Landcare and production groups support all activities.

Potentially support can be understood in terms of perceived gradations of private and public good represented in the different practices. For example, support from the publicly funded not for profit sector (e.g. Landcare groups, NRM regions, government) was more important for adopting native vegetation management practices than for cropping and grazing, and even weed management practices. While this result is clearly affected by more publicly funded support being available for native vegetation management practices than the other more private benefit activities, the relatively low adoption rate and the strength of publicly funded support as a driver for native vegetation management suggests farmers rely on publicly funded support in adopting native vegetation management practices because these are seen as largely public good activities and are not seen as returning direct financial benefits to the farmer.

The implication of this information regarding support providers is many faceted. In general, support provision is defined by the degree of public benefit of the activity, as would be expected. That is, farmers are willing to pay for support (e.g. consultants) if there are clear links to increased returns whereas native vegetation management adoption is largely supported by the not-for-profit sector. Clearly if adoption is to continue to trend favourably, existing support networks need to be maintained. Also, there may be value in helping to broaden the horizons of support providers so they can provide more holistic support, such as cropping consultants also providing native vegetation establishment advice.

Targeting extension appropriately

Policy decisions affecting extension providers need to consider where an increase in adoption is desirable, in terms of both geography and practice. This involves understanding the context in which recommended sustainable farm practices are adopted, to better target investment. For example, given physical conditions and constraints, assessing which geographical areas would be expected to have highest/lowest adoption and how this compares with actual adoption rates. Rather than assuming that adoption rates will be the same in all contexts, biophysical and social data can be analysed to describe the context of adoption and highlight where changes might be expected or are most needed. Overall, the findings demonstrate that policy makers need to take an integrated approach to promoting adoption that correctly targets motivations and capacity.

Further research

This project began with a qualitative study to examine the key drivers and barriers to sustainable land management, drawing on practice change experts around the country (see Appendix 3). The longitudinal DPC survey served to test theories of motivation for practice change, with results being largely consistent across the two survey years. This study has confirmed the importance of a number of key influences on adoption identified in DPC stage 1 as well as in the adoption literature, including financial, environmental and personal motivations; groups and support networks; social capital; and incentives and barriers (including labour and time shortage and age). Practice characteristics are also confirmed as a key element in understanding adoption (Pannell et al. 2011; Rogers 2003), demonstrated by each practice being found to have different motivations, different support mechanisms and different characteristics

of adopters. We have sufficient knowledge to know what the influences are (Pannell et al. 2006), though we can benefit from tracking these over time and better understanding the interaction between them. The particular value of the DPC study is that it has improved understanding of the interaction between adoption and motivations, capacity, extension and program activities.

The next stage of research calls for a return to qualitative methods to investigate major lines of enquiry emerging from this work that are not answerable by another version of the DPC survey. These lines of enquiry combine research recommendations emerging from consultation in DPC stage 1, findings from the surveys and gaps identified by other researchers. The areas considered to be under-researched are outlined below.

Understanding motivations

The link between group involvement and adoption is clearly and irrefutably established through the DPC study, supporting previous research. Further research on groups and networks is required to explore this link between group or network participation and land managers' engagement in practice change, including investigating:

- extension activities currently available to land managers (for comparison with existing data on what activities farmers are participating in) including online forums
- the cause and effect relationship between group involvement and adoption
- qualitative evidence of change in behaviour from group/network involvement
- the perceived relative importance of different groups and networks
- reasons for non-adoption
- group processes most successful in encouraging adoption
- motivations and barriers to joining groups
- the scale of support which works best for different areas and different practices (e.g. degree of localness).

For farm managers, financial motivations provide the core motivations for adoption and it is rare for financial motivations to be absent from the decision to adopt (except for native vegetation management, as reported in this study). The following lines of enquiry are recommended to explore the link between farm financial performance and practice uptake:

- further exploring the interdependence between financial, social and environmental motivations for change
- perception of, and knowledge about, the link between profitability and soil health and other environmental factors
- perceptions of how the condition of natural resources affects profitability.

Integrated approaches to researching sustainable farm practice adoption

As reported in this and other studies, focusing on integrated management (financial, environmental and personal) in extension and promotion efforts may increase adoption. A key advance on the findings of this study would be to combine information on motivations with regional and farm profiling to gain a more holistic picture of adoption and influences on it. This would involve incorporating information on adoption and motivations from the DPC survey with the geography of adoption (which regions are practices suited to and where 'should' these practices be adopted), as well as farm financial information. Nave et al. (2013) combined information on farm profile, individual motives, social commitments and farm inputs to better understand adoption of sustainable wheat farming practices. Based on their assumption that low-input farming was more sustainable than high input, they found farmers with low–medium inputs who attended extension activities were more likely to show environmental awareness than those with high inputs that did not attend extension activities. Whilst this European study is not directly comparable with Australian circumstances, a similar in-depth study that uses data available through the ABARES farm surveys, as well as land capability mapping, would provide further insight into the complexity of adoption of sustainable land management practices in Australia, and highlight where further effort in encouraging adoption is best placed.

Ongoing quantitative data collection

There are a number of quantitative measures that should be retained in future surveys of farm managers to provide a basis for comparing survey results over time, including:

- adoption of sustainable land management practices
- group and network involvement
- recognition of, involvement in and outcomes from Australian Government programs
- involvement in extension activities
- support seeking—who farmers are going to for support for land management decisions
- barriers to sustainable farm practices
- associated farm financial information (farm survey data).

Appendix 1 Annotated bibliography

BAUMGART-GETZ, A., PROKOPY, L. S. & FLORESS, K. (2012) Why farmers adopt best management practice in the United States: A meta-analysis of the adoption literature. *Journal of Environmental Management*, 96, 17–25.

Focus

Meta-analysis of theoretical underpinning of the adoption of innovations with regard to the uptake of best management practices (BMP) amongst American farmers.

Theory

The study took an empirical approach and considered the influence of 31 social factors on best practice adoption assessed over 25 years in 46 separate studies. The social factors were categorised in terms of three major themes:

- capacity
- attitude
- environmental awareness.

Key findings

The study identifies access to and quality of information; financial capacity; and being connected to agency or local networks of farmer groups as having the greatest impact on adoption.

It also identifies farm size, age and extension training as having an influence on adoption. Farmers' willingness to take risks is insignificant, as is adoption payments—both of these findings were unexpected. Familiarity with program goals and knowledge of impacts of on-farm actions on the environment were positive significant predictors of adoption.

Limitations

The study is a meta-analysis and the authors point out that a key limitation is categorisation validity: that the social factors may be classified differently across different studies. The survey questions asked in the original studies may vary slightly. Therefore, there is a risk of comparing 'apples and oranges'.

Relevance to research and policy

This study confirms the importance of social factors in adoption, which are similar to findings from the analysis of the DPC stage2 survey results. The authors suggest that policy makers can use these findings to develop a two-pronged approach to the adoption of practices: firstly, have an implementation focus targeting farmers most likely to adopt; secondly, continue to increase individual capacity and awareness by using networks to inform other farmers about the benefits of adoption.

VITALE, J. D., GODSEY, C., EDWARDS, J. & TAYLOR, R. (2011) The adoption of conservation tillage practices in Oklahoma: Findings from a producer survey. *Journal of Soil and Water Conservation*, 66, 250–264.

Focus

Quantitative assessment of current adoption status of conservation tillage and econometric analysis to explain observed use of conservation tillage.

Theory

None identified.

Key findings

The study identifies operator age, perceived knowledge of conservation tillage, erosion control, insect pressure, livestock grazing, farm size and crop rotation as having a significant effect on explaining tillage choice.

Other factors suggested to improve adoption rates include improving knowledge and awareness; and provision of information through extension and outreach using traditional methods such as field days and workshops as well as new media (online videos, web based).

Larger off-farm income share earnings are associated with use of reduced tillage (RT) and conventional tillage (CT) but not conservation tillage (CST). The authors think this is because RT requires less labour effort and time, and therefore farmers see RT as a means to increase their off-farm employment.

Limitations

None identified.

Relevance to research and policy

This study highlights the multiple benefits of adoption, such as ameliorating erosion issues, improving the economic 'bottom line', saving energy and improving environmental stewardship. This concurs with the finding in the DPC study that reducing workload is a key motivator for the uptake of certain practices.

GEDIKOGLU, H. & MCCANN, L. M. J. (2012) Adoption of win-win, environment-orientated, and profit-orientated practices among livestock farmers. *Journal of Soil and Water Conservation*, 67, 218–227.

Focus

Econometric analysis of win-win, environment orientated and profit orientated farm practices. Dependent variables were four innovations (use of roundup ready soybeans, manure testing, manure spreading and setback of manure applications from water courses). Independent variables included socio-economic characteristics (age, education and off-farm income); farm characteristics (farm sales, location, number of livestock and type of livestock); farmer perceptions of the practice and attitudes about the environment.

Theory

None identified.

Key findings

Observations about social and economic characteristics that influenced practice uptake were:

- Farmers with less high school education were less likely to adopt roundup ready and maintain setbacks than those with a high school education
- Farmers with no off-farm income were more likely to adopt roundup ready soybean
- High off-farm income may indicate farming is not a primary occupation and therefore may reduce adoption
- Farmers with the lowest farm sales were less likely to adopt three of the four innovations
- Farmers that agreed that a practice increases profitability were more likely to adopt each practice compared to those that did not agree that the practice was profitable
- General attitudes about water quality or the environment were not important by themselves in the adoption of environment-orientated practice (this contradicted the research hypothesis).

The study highlighted that education programs that promote the win-win nature of practices will tend to promote adoption of sustainable practices. Those that focus on environmental benefits alone are unlikely to be sufficient to increase adoption.

Limitations

None identified.

Relevance to research and policy

These study findings highlight multiple benefits as influencing adoption and this also supports the findings from the DPC stage 2 survey. However, the role of multiple benefits in adoption requires further investigation.

The authors of the study propose that these results will help policy makers know whether different policies are needed to promote environment (only)-orientated technologies.

REIMER, A. P., WEINKRAUF, D. K. & PROKOPY, L. S. (2012) The influence of perceptions of practice characteristics: An examination of agricultural best management practice adoption in two Indiana watersheds. *Journal of Rural Studies*, 28, 118–128.

Focus

Qualitative study of the specific attributes of a BMP that influence acceptability to farmers and ultimately adoption. Farmers' use of conservation practices and the reasons behind their adoption. Interviewees undertake mainly row cropping of corn and soybeans on their farms. The four conservation practices were two management practices (cover crops and conservation tillage) and two structural practices (grassed waterways and filter strips)

Theory

Theory of Planned Behaviour, Reason Action Approach.

Key findings

The study identifies high level of relative advantage (reduced inputs, time-saving, on-farm benefits—e.g. soil and financial—and environmental benefits); compatibility with farm system and needs of producers; and observability as the most important factors in increasing adoption of conservation practices. Perceived risk and complexity associated with conservation tillage was an important barrier. Increasing adoption should focus on the on-farm, financial and environmental benefits; and the compatibility of conservation practices with current farm systems.

Limitations

None identified.

Relevance to research and policy

Gives insights into the reasons why farmers think that practices provide them with a relative advantage, compatibility or observability on their farms. But only looks at part of the picture explaining adoption—i.e. attitudes towards the characteristics of the practice. The study does not explicitly consider how important these are relative to other reasons (i.e. non-practice related characteristics) for adoption.

LEVISTON, Z., PRICE, J. C. & BATES, L. E. (2011) Key influences on the adoption of improved land management practice in rural Australia: The role of attitudes, values and situation. *Rural Society*, 20, 142–159.

Focus

Qualitative and quantitative analysis of the importance of farmers' values and attributes in their decision to adopt sustainable land management practices.

Theory

None identified.

Key findings

The qualitative component of the study investigated four key areas of interest in regard to social-psychological attributes and values that may predict the adoption of land management practices; these were 1) local land management practices, 2) barriers and pressures experienced, 3) catchment and community issues, and 4) social networks and sources of land management information. Farm manager responses to these four key areas of interest identified six themes; these were farm success and 'good' land management; reduced financial resources; increased regulation and paperwork; high land values, property size and community structure; limited time, social interaction and community cohesion; and stress, depression and feeling out of control.

The quantitative study identified having a professional property plan; feeling in control of one's own circumstances; trusting and being influenced by peers and informed groups; concern for the natural environment; and reduced concern for environmental problems impacting self or family as key socio-psychological attributes that contribute to the likelihood of adopting sustainable management practices.

Limitations

None identified.

Relevance to research and policy

This study highlights the importance of considering the diverse values and motivations that landholders have in the design and delivery of incentive programs especially during extended drought periods.

SUTHERLAND, L.-A., BURTON, R. J. F., INGRAMC, J., BLACKSTOCK, K., SLEE, B. & GOTTS, N. (2012) Triggering change: Towards a conceptualisation of major change processes in farm decision-making. *Journal of Environmental Management*, 104, 142–151.

Focus

Presents a conceptualisation of major change in farming system practices. Focuses on drivers of major change, including ‘trigger events’ for major change and ‘path dependency’ describing factors that constrain major changes to farming practices.

Draws on 48 qualitative interviews with organic and conventional farmers in two English case study areas (organic farming ‘hotspot areas’) in the English midlands and southern England. Production systems included livestock (beef and sheep for meat), dairy and cereal.

Theory

Inductively develops a theory called the ‘triggering change’ cycle to explain the process by which farmers decide to actively consider a major practice change after a period of incremental minor changes. The cycle involves five components in the following order:

- 1) Path dependency
- 2) Trigger event
- 3) Active assessment
- 4) Implementation
- 5) Consolidation (and back to 1).

Key findings

The authors note that the conceptualisation is an idealised process and triggers are unpredictable. Examples given of major changes to farm systems included the conversion to an organic production system, a succession crisis, injury/death, or financial difficulties. They find that:

- change processes often occur over a period of years
- change is iterative and occurs at multiple points
- change requires the acquisition of new knowledge through experimentation and social interaction, and this differs from Rogers’ one-off conceptualisation of adoption of an innovation.

Limitations

Possible over-representation of organic farms, and findings are illustrative rather than comprehensive.

Relevance to research and policy

The authors note several policy implications for this conceptualisation of change:

- there are distinct periods of time when farmers can be influenced to change to specific directions: straight after a ‘trigger event’, e.g. disease outbreak, and major policy reform

- during path dependency periods, farmers can benefit from knowing where information can be obtained (though major decisions to change are less likely)
- resources could be provided to farms likely to experience a 'trigger event' (e.g. market fluctuation or succession change)
- sufficient financial and other resources must be made available for change to occur since it requires an investment
- could take opportunities for applying incentives (e.g. information and financial resources) during times when farms are experiencing multiple triggers
- consider giving transition support over a period of years (while new knowledge is developed and shared and farm incomes might be lowered).

LASHGARARA, F. (2011) Identification of factors on adoption of sustainable agriculture among wheat farmers of Lorestan Province, Iran. *Advances in Environmental Biology*, 5, 967–972.

Focus

Quantitative assessment of factors that potentially influence the adoption of sustainable agricultural practices among wheat farmers in the Lorestan province in Iran. Population of 862 wheat farmers, with random stratified sampling method used to select 140 individuals.

Theory

Draws on Rogers' theory of adoption of innovations to determine variables to investigate.

Key findings

The study identifies farming-economic factors; characteristics of innovation; individuals' characteristics (e.g. knowledge and attitudes of farmers); use of communication channels (e.g. use of mass media); better access to markets; and educational participation (including participation in extension classes) as the main factors influencing the adoption of sustainable management practices.

Limitations

None identified.

Relevance to research and policy

Finds similar factors to be positively associated with adoption as were found in the DPC 2012 survey findings, for example membership of social networks. Author does not really analyse the role of perceptions of the applicability of the practice to the farm context or environmental condition of the farm in adoption.

PRAGER, K. & POSTHUMUS, H. (2010) Socio-economic factors influencing farmers' adoption of soil conservation practices in Europe. New York, Nova Science Publishers Inc.

Focus

Review and synthesis of existing studies on the role of socio-economic factors that influence farmer adoption of soil conservation practices, with a particular focus on the European situation. Comparative qualitative case studies across Europe based on the results of the project Sustainable Agriculture and Soil Conservation 2007–2008. Aim was to understand how policy measures can contribute to encouraging farmers to adopt.

Theory

Based on the review of literature the authors hypothesise that any adoption decision is based on the combined influence and interplay of environmental/technical, personal, economic and institutional factors.

In order to explain which factor comes into play at which stage, how it interrelates with other factors, and what its relative importance is, the authors draw on three theories of adoption:

- economic constraint paradigm
- innovation-diffusion paradigm
- adopter perception paradigm.

The authors propose a multi-criteria conceptual model of acceptance levels of the innovation, preconditions of the adoption process and reasons for non-adoption.

Primarily based on the three theories of adoption paradigms and Lucke's (1995) three-step model of cognitive, normative and action-orientated (conative) acceptance.

Key findings

Literature review

Factors influencing adoption included expectation of a positive effect on soil fertility and higher yields (relative advantage); contribution to environmental quality; decreased costs (machinery, fuel and labour); government incentives and subsidies; mandatory policies; raising awareness and extension; identification of a problem or opportunity; cultural background; existence of innovation systems.

Case studies

Belgium—influencing factors: awareness of practice, awareness of environmental and economic benefits, economic feasibility, provision of technical assistance and demonstration sites, and flexibility in implementation.

Germany—influencing factors; sufficient compensation of incurred costs, economic advantage; profitability (risk, effectiveness and time/effort); awareness of soil degradation and available technologies (through field days, seminars, demonstration farms).

Bulgaria—influencing factors: mainly barriers such as property rights

Czech Republic—influencing factors: financial (incentives or penalties for non-compliance), main barrier property rights.

Greece—price and policy dominate; practice must be technically feasible. Lack of awareness of environmental degradation and unclear benefits are barriers. Rigid mental models where farmers believe environmental problems outside of their farm are the responsibility of the government.

Conclusions

No evidence that either economic or social factors are superior in explaining adoption. Rather adoption decisions are based on a mix of personal, socio-cultural, economic, institutional and environmental variables.

The authors report three distinct adoption pathways for soil conservation:

- 1) farm managers' own initiative**
- 2) farm manager participates in agri-environmental scheme/program and receives incentive payment**
- 3) farm manager complies with legislative requirement.**

Each pathway has its own drivers but in each case the farm manager will weigh up the costs and benefits, which may be beyond direct costs and benefits and include reputation, social norms, satisfaction, learning costs and uncertainty on impact. Furthermore costs and benefits are influenced by environmental and economic context, institutional structures, and personal characteristics; therefore will differ between farm managers and farms.

Limitations

None identified.

Relevance to research and policy

Confirms that a multiplicity of motivational factors influence a farm manager's decision to adopt soil conservation practices; these are similar to the findings of the DPC study. Highlights context specific factors that will influence adoption, citing that these are not universal. The heterogeneity of farm managers and farming enterprises, and the environment in which they operate, needs to be considered in efforts to promote adoption.

KNOWLER, D. & BRADSHAW, B. (2007) Farmer's adoption of conservation agriculture: A review and synthesis of recent studies. *Food Policy*, 32, 25–48.

Focus

Meta-analysis of 23 published studies on conservation agriculture to identify those independent variables that regularly explain adoption around the world.

Theory

None identified.

Key findings

Across the 23 studies the independent variables found to significantly affect farmers' adoption of conservation agriculture were categorised as farmer and farm household characteristics; farm biophysical characteristics; farm financial/management characteristics; and exogenous factors.

However, the meta-analysis revealed only two independent variables that were consistently significant and in the same direction (positive or negative); these were 'awareness of environmental threat' and 'high productivity soils'.

The authors conclude that a universal set of variables that predict the adoption of conservation agriculture practices does not exist.

Limitations

Main limitations with this study result from contextual differences in the 23 studies analysed in the synthesis. The lack of convergence around key independent variables is a concern. This is most likely due to differences in the 23 study locations, statistical methods applied and the technologies investigated across studies. Moreover studies that focus on understanding the independent variables that may predict adoption do not explain why farm managers adopt and therefore provide little utility to policy makers.

Relevance to research and policy

The study advocates a targeted policy approach to promoting conservation agriculture, where policy mechanisms must suit the context of the farm manager and their farm. The authors suggest policy makers should identify the costs and benefits of adoption (environmental and economic); increase awareness of the benefits; provide education and technical assistance; and consider the provision of incentives or the application of regulation and taxes to ensure compliance. Furthermore the authors make special note of the importance of social capital and the potential for policy makers to invest in improving it. They cite government support for social capital as an element in the success of Landcare in Australia. Lastly they believe in leveraging off social norms within the farming fraternity through targeted campaigns.

LLEWELLYN, R. (2011) Identifying and targeting adoption drivers. In PANNELL, D. & VANCLAY, F. (Eds) Changing land management: Adoption of new practices by rural landholders. Collingwood, CSIRO publishing.

Focus

Explores the role of information and learning in adoption decision making with the view to providing a pathway for more effective extension planning and delivery.

Theory

None identified.

Key findings

Information and learning are key to the adoption process. Promoting the relative advantage of adoption in information and learning is important. Where potential adopters hold different perceptions from those held by comparable users of an innovation there is potential for learning. Access to local sources of information is likely to reduce uncertainty regarding relevance and applicability of information and improve its validity, especially information produced by the local use of the innovation or through local on-farm trials. It is beneficial to avoid using information on factors that cannot be influenced or are not influential in the adoption decision.

Limitations

None identified.

Relevance to research and policy

Information and learning are important levers that policy makers can utilise to influence the adoption of sustainable land management practices.

PANNELL, D. J., MARSHALL, G. R., BARR, N., CURTIS, A., VANCLAY, F. & WILKINSON, R. (2006) Understanding and promoting adoption of conservation practices by rural landholders. *Australian Journal of Experimental Agriculture* 46, pp. 1407–1424.

Focus

Review of research on the adoption of rural innovations from a cross-disciplinary perspective. Areas of focus influencing adoption include the process of learning and experience; social, cultural and personal influences; and attributes of practice that affect adoption innovations.

Theory

No single theory is used as a basis but they do draw on a wide range of literature which may have a theoretical basis such as Rodgers' *Diffusion of innovations*.

Key findings

Process of learning and experience

This influence is broken down into a number of stages: awareness of the problem or opportunity; non-trial evaluation; trial evaluation; adoption; review and modification; and non-adoption or disadoption.

Social, cultural and personal influences

Explores the role of the 'family' in decision making, differentiating between routine decisions and those that are more complex based on who is involved in the decision-making process. The process of decision making also involves an information-seeking stage where the farmer considers the creditability and relevance. The evaluation stage involves assessment of information against the goals, values, beliefs and objectives of the landholder and their family. The role of the landholder's personality is considered; here the trait of locus of control, degree of risk aversion, and introversion/extroversion are considered important in the style of decision making used by landholders. Looks at the role of links between landholders and others (networks). Factors that can influence adoption include strength and quality of landholder networks; physical proximity to other adopters; distance of property from information sources; history of relationship between landholders and innovation advocates; ethnic and cultural divisions within landholder population; and extension, promotion and marketing campaigns by government. Other demographic and situational variables that are deemed important because they influence a landholder's goals and aspirations include financial viability and capital, access to and reliance on off-farm income; property size; age; level of landholder education; and reason for holding land.

Attributes of practice that affect adoption innovations

Relative advantage and trialability of the innovation are considered as cornerstones to the process of adoption.

Limitations

None identified.

Relevance to research and policy

Policy makers should consider the factors influencing adoption presented in this study.

RICHARDS, C. & LAWRENCE, G. (2009) Adaptation and change in Queensland's rangelands: Cell grazing as an emerging ideology of pastoral-ecology. *Land Use Policy*, 26, 630–639.

Focus

Qualitative study, interviews with 49 graziers representing 25 grazing properties in Queensland, Australia. This paper examines the social, economic and cultural conditions that act as facilitators for those in the Australian grazing industry to adopt conservation practices such as cell grazing. Challenges the productivist model of agriculture in that it is not sustainable or does not fulfil the production criteria stipulated by consumers seeking 'clean and green' foods.

Theory

None identified.

Key findings

Ecological and lifestyle factors are key motivations in the adoption of cell grazing. Personal characteristics of adopters in the study include individual flexibility and adaptability, not adhering to social norms, and willingness to challenge tradition within the family and community. All cell graziers interviewed had attended 'Grazing for profit' training.

Study participants differed from conventional graziers in terms of:

- viewing their approach to grazing as holistic where lifestyle, production, economics and environmental protection are interrelated components of sustainability
- animal welfare and cattle management through daily interaction with livestock
- business philosophy; greater entrepreneurialism to support lifestyle preferences; re-thinking of identity through diversification of business, including off-farm income and greater collaboration with other cell graziers.
- importance of positive on-farm ecological outcomes.

Limitations

None identified

Relevance to research and policy

Highlights the influence of environmental and lifestyle goals opposed to productivity as drivers of practice change. Potential adopters can face a number of challenges (socio-cultural) that influence their decision making which may not seem rational even though adoption may be recognised as beneficial. Training focused on holistic management (financial and environmental) may increase adoption. Local networks develop social capital, which positively influences not only adoption but also continued improvement and changes in philosophical position on alternative grazing systems.

Appendix 2 Case study: Experiences in adopting conservation agriculture

Introduction

The following presents findings from a qualitative study into motivating factors associated with adoption of no-till and other conservation farming practices in the broadacre industry.

The study explored these issues through interviews conducted as part of a study undertaken by Conservation Agriculture Alliance of Australia and New Zealand (CAAANZ) in 2012 with 31 farm managers involved with conservation agriculture (CA) located in the northern grain region of New South Wales and Queensland; the central, southern and western areas of New South Wales; South Australia; Western Australia; and the Wimmera region of Victoria.

The study involved purposive sampling of farmers involved with conservation agriculture and, as such, this sample is not representative of the wider Australian broadacre industry. Farm managers interviewed were active members of CA and no-tillage farming associations belonging to CAAANZ (the full list of farming associations is in the acknowledgment section). These farmer-driven grower groups support the adoption of sustainable and profitable broadacre no-till cropping systems and conservation farming in general, by sharing grower experiences, coordinating and conducting innovative research and supporting the development of tillage equipment.

The interviews were conducted during field days organised by farming associations in different states by two researchers on behalf of CAAANZ, in conjunction with the University of Queensland. The participants were selected at field days by asking for volunteers to do an interview with university students. This was facilitated by CAAANZ officers. The project was supported by the Sustainable Resource Management Division of the former Department of Agriculture, Fisheries and Forestry.

The objective of the CAAANZ study was to obtain qualitative data on the value of extension activities, such as field days, to farm managers in making various changes in farm practices. Interview participants were asked about their personal and farm characteristics, specific conservation farming practices they had adopted on their farms and previous practices. They were also asked to indicate the role of support providers in motivating sustainable farm practices; the reasons for continuing the adopted practices, including key benefits of innovations; and the extent to which challenges faced by their businesses affected ongoing innovation processes.

ABARES analysed the interview material to explore motivations and factors that were important in the adoption process. Because the CAAANZ research was focused largely on the influence of support groups on CA adoption, there were a number of issues of relevance to the DPC study. For example, the participants were not asked directly which factors influenced their original decisions to adopt CA, about any perceived benefits or about the relative importance of motivations for adopting sustainable farming practices. However, in their responses to individual questions they made references to financial, personal and environmental motivations, thus allowing some conclusions to be reached for comparison with results from the DPC 2010 and 2012 surveys.

The paper comprises four parts. The first part discusses conservation practices adopted by participants in the study. The second part examines key influences on innovation adoption, including environmental, personal and economic motivations, key benefits of innovations, and the role of support groups. The third part explores the effect of constraints on ongoing innovation decisions and factors in overcoming difficulties. The fourth part concludes with a

summary of findings of the study and highlights the complex nature of interactions between motivating factors which affect farm managers' innovative efforts.

Conservation farming practices adopted by participants in the study

All farm managers who participated in the study had moved from conventional farming to conservation farming but they were at various stages of implementing sustainable land management practices on their farms. Some had been practising and trialling various forms of no-tillage (narrow/knifepoint seeding with less than full cut-out) and zero-tillage (disc seeding) farming systems over 20 years, while a number were in the process of converting to a no-till system.

Despite a commitment to CA, not all farm managers introduced the three practices regarded by farmers in Australia as the main principles of CA: no-till, stubble retention and crop rotation. While all adopted no-till practices, and all but one farmer had introduced full stubble retention and crop rotation, only a small number had introduced cover cropping. While most participants acknowledged that cover cropping is 'a great idea for the right system', those who had not introduced the practice cited insufficient rainfall or lack of funds as the key reasons.

Some also indicated that they still occasionally used practices associated with traditional farming, such as strategic cultivation to get resistant weeds under control, or resorting to burning if absolutely necessary. Combining cropping with livestock was also a relatively common practice. Others were adapting crops to the quality of soil and climatic conditions.

Most farmers combined their conservation farming with complementary technology, such as precision agriculture (PA) and control traffic farming (CTF). With regard to PA most growers used auto steer, GPS and farm mapping. Some did not use all features, for example variable rate fertiliser.

Overall, the most commonly stated reasons for non-adoption or gradual adoption of CTF were financial and/or related to the nature of the farming environment. The barriers relating to biophysical characteristics of the farm included the topography of the land being unsuited to CTF (e.g. characterised by steep slopes), the small size of paddocks, and weed issues.

Factors associated with adoption of land management practices

The analysis of interview material compared motivations with the framework of motivations developed from the DPC survey analysis (outlined in the main report). The intention was to enable a comparison between the findings from the report and those of the CAAANZ study.

The motivations for adoption suggested in the main report included:

- environmental benefits (related to improving environmental performance, such as soil quality)
- financial benefits (related to directly increasing income)
- personal motivations (related to improving non-financial personal and social outcomes such as obligation to others—for example providing for future generations)
- availability of support (related to the influence of support providers).

Evidence to support these motivational areas in interview material is discussed below.

Environmental benefits

Results from this study suggest that land quality and environmental pressures such as drought strongly influenced adoption of practices, with most growers indicating that improving soil condition was a key motive. One grower enunciated his objective as: 'Soil to me is the key to the whole system. I wanted to change the system to improve the soil. You do not want to see your soil move at all, blown away.'

Among the key reasons given for adopting no-till practices were reducing the consequences of land degradation caused to soil by traditional farming, improving soil quality and health, reducing soil loss through wind and water erosion and reducing water run-off.

For the majority of farm managers participating in the CAAANZ study, positive environmental outcomes were also the main driver for continuing with the adopted practices. One of the participants expressed the view: 'Soil is the most important—changes in soil keep me going. Seeing the soil reminds me of what has been achieved. The soil has been drastically transformed. I will stick with the system due to the changes that have been seen.'

The main environmental improvements reported by almost all participants included reducing soil loss due to wind and water erosion, physical improvements of soil structure and quality, moisture retention and reduced salinity. CA also alleviated other problems, such as compaction issues and weed problems.

A number of participants commented on the improvement of soil health, reporting that 'paddocks are alive not dead, they are soft, with plenty of biomass on top'. They also noted the reappearance of worms.

Personal motivations and benefits

Personal motivations, such as desire to protect natural resources or recognition by neighbours and community, were also indicated as an important influence on the adoption of CA farming practices by many farm managers.

A number of participants articulated environmental stewardship objectives in such comments as, 'You want to do the best things for your land'.

Creating sustainable farming systems was positive for farm managers' sense of pride. CA bestowed social acceptance on farming by removing the stigma of unsustainable land management. Another participant added that 'the reason I stayed was because of changes possible. We are looking after our country. The country is in much better condition.'

Many participants stated that conservation practices provided them 'with new tools to better suit the Australian environment' and were convinced that they would not be able to continue farming without CA practices and their environmental benefits.

Particularly motivating for many participants was seeing 'the benefit of CA when looking at neighbouring properties which operate [traditional] cultivation and that they are a long way behind'.

Social benefits and time effectiveness

Many participants stated that they would continue with adopted practices as they were time effective and contributed positively to their personal goals such as sustaining a good lifestyle for their families and leaving the place in a better condition for their children.

According to most respondents, the transition to new farming methods has made the job easier and considerably improved time effectiveness. These time savings and an increase of free time provided time to consider other aspects of the business and resulted in better lifestyle and improved social and family life as 'weekends are free to go to the football and spend time with family and friends'.

Economic motivations and benefits

Statements highlighting environmental and personal motivations as important influences on the adoption of CA practices demonstrated that some farmers considered the environment as a value in itself and/or were driven by non-financial motivations.

Other participants were motivated by seeing evidence that CA 'made sense' in economic terms. One farm manager stated, 'No-till makes the most money, which is the main driver.'

Almost all participants stated that adoption of new practices resulted in financial benefits compared with previous practices. The improved financial profitability was due to increasing returns from enhanced production stability and increased or more reliable yields, increased soil fertility, incorporation of new areas into production, and lower production costs. Cost savings came from reduction in fuel, water and fertiliser consumption and farm labour costs. Cost savings also related to more efficient machinery and technology and less machinery wear. One participant noted that: 'I trebled the area of production without employing more staff.'

Some participants noted the long-term cost efficiency of CA, commenting that 'although more money is spent (initially), there is a long-term cost benefit'. One added, 'Profits aren't as big, but they are more regular now. A lot of money is going out but with good returns.'

Role of support in influencing adoption: Impact of grower group activities

A number of participants acknowledged a key role of support providers, ranging from grower groups and private consultants to neighbours and family members, in their transition from conventional to no-till farming.

Among support providers almost all participants in the study identified farming groups and field days as important factors in their uptake of CA practices. Field days supported adoption of the whole spectrum of new conservation-related practices, ranging from adopting no-till, moving from crop rotations, introducing new crops, buying new machinery, introducing CTF and PA and better use of fertilisers to stubble and weed management.

Several participants stated that it was the support provided by farming groups that led them to make changes in their farm practices. They used expressions such as 'as a result of field days' or 'due to involvement with field days' to describe the impact of grower group activities on making changes to their production systems.

There were many aspects of field days that influenced adoption of new practices. Field days were seen as an opportunity for getting together and sharing information with like-minded people across the industry: growers, agronomists, guest speakers, and researchers. Farm managers considered sharing information as the 'most important' way of getting valuable, specific information about why 'some practices work only in certain circumstances'. Many stated that 'the best way to learn is from your peers' and that talking about failures is just as important as talking about other farmers' successes, as it enables one 'to avoid making the same mistakes'.

Some participants liked meeting people from different areas and witnessing practices and strategies used in different states. Others preferred meeting local people with similar farm types.

The potential impact of field days on adoption was encapsulated in this response from a farm manager: 'the main thing which changed my mind was a speaker at the conference who got rid of his old stock and was doing quite successfully. That was a wakeup call; there was the biggest influence on how I changed my thinking.'

Several participants noted that particularly useful in encouraging adoption of new farming systems were trials and demonstrations of new technologies and crop varieties. Interviewed farmers were especially 'impressed' by the variety of trials, displays of farmer modified machines showing 'how to set up machinery and convert your combines' and witnessing CTF working on field days. One participant said that they learnt how to use chemicals more efficiently from a chemical spraying demonstration.

This combination of getting knowledge by listening to speakers and seeing new practices in action gave many farmers the confidence 'to go home and try new products and strategies on their own farms'. One grower said, 'I have not invented anything on the farm, but I brought ideas back from field days and adopted them on the farm.'

The impact of field days on the fast uptake (e.g. a couple of months later) of innovations was confirmed by an agronomist/grower who also participated in the CAAANZ study. He noted that networking and getting together during field days gives growers, who are under pressure to become more efficient and be better stewards, confidence to try new things.

In addition to field days, a number of participants mentioned other sources of support and advice. These included their families who were supportive of change, paid consultants who provided advice regarding farming practices, and other information providers. Grower groups' publications were considered very informative amongst their members. Other participants were prompted to adopt by the positive experiences of neighbouring properties which were implementing new practices and becoming more profitable. One participant commented: 'If they can do it, why can't I?'

A number of participants commented that state agricultural departments did not have adequate staff and no longer had adequate contact with growers.

Interconnections between motivations

Many participants indicated that there were multiple reasons for the uptake of no-till practices and that environmental and financial motivations were often conflated. For example, a number of participants indicated that the continuation of old practices was simply not an option, as it would have threatened the very existence of the farm. They saw the improvement in soil quality and health and reduction of soil erosion through the move to CA as a means to achieve their economic goals.

A number of farm managers identified an interrelationship between financial and environmental benefits in such comments as 'our farm is benefiting in relation to our soils getting healthier and healthier, our bank balance is benefitting', and said that 'adoption of CA gave them confidence that their farming systems can be both environmentally and economically sound'. One noted, 'You can see you are on the road to nowhere watching your country blow away. Gradual loss of returns stimulated the need to do something.' He added that he wanted 'to improve my business but equally important, to stop blowing the soil away'.

One farm manager commented, 'As time goes, you get to know your soils and you learn about your soils, you see that the healthier your soils are, the more money you can make. So this is a win-win situation. We love this aspect: we are doing something not only for the farm, we are doing more for ourselves.'

The main constraints of no-till adoption

As discussed above, participants in this study were generally very satisfied with the results of their new farming practices and did not give any indication of an intention to abandon the new system. Conservation farming methods were seen as offering many potential benefits, including greater profitability, sustainability, reduced environmental impact on their farms and social benefits. However, a number of participants in this study reported that these benefits might take time to fully materialise, as CA represented a fundamental change in the agricultural production system and the transition to CA posed many difficulties.

Finding the right approach

Barriers included difficulties with applying innovations to suit individual circumstances and managing new challenges and risks, such as herbicide and pesticide resistance, soil compaction or emergence of snails.

Some participants expressed their disquiet over the lack of progress through comments such as: '[There are] still question marks as to whether continuous cropping is the right thing for us. We are definitely not in a position to say that we are now way better off than back in the 1990s. We might not have the system quite right. Some issues keep cropping up, for example herbicide

resistance and soil compaction.’ Others noted the need to conduct more research and trials due to the lack of improvement in soil health despite adoption of new cropping practices.

Complexity of CA

Dealing with the complexity of CA was another barrier to adoption. CA is a complex system relying not on a single technology but on a range of technologies. There can be a variety of choices in the methods of implementation. It is also a knowledge intensive system which is significantly different from conventional tillage agriculture, which requires a fundamental change in every aspect of farming.

Participants’ comments on the need for constant improvements of farm practices included the statements: ‘I need to change almost everything’, ‘New methods now are completely different’ and ‘The farming system has changed, is in constant change. You wouldn’t know it was the same farm from 15 years ago.’

The complexity of CA systems also meant that adoption of farming innovations required a certain level of technical knowledge and developing new skills through implementing the changes. As one of participants explained:

CA is the logical next step in the business. New ideas come along and new technology is introduced, which in turn may develop the ideas a farmer already has in his head. This is an ongoing process and not a radical change in my thinking. My main difficulty is getting enough data to understand why some areas do not yield as much as they should be. Interpreting that data as to what drives this yield is an ongoing battle for me.

Another participant noted that ‘a lot more thinking and research is involved to do it right’ because everything is connected and it has to be carried out correctly compared to the traditional method: ‘the easy way, can’t go wrong’. He added, ‘Things have to be constantly monitored and seen through.’

Financial barriers

Finally, most respondents identified lack of funds, or concerns about high initial outlays not matched by rewards, as the key factors limiting their ability to adopt new practices. A number of participants observed that the financial benefits may take time to fully materialise as it ‘takes two years to change soil’ and benefits require original investments in machinery such as CTF and use of harvest stubble spreaders.

In particular, high financial outlays were associated with the introduction of expensive complementary technology and equipment for PA and CTF. As indicated earlier, most respondents who had not practised PA or CTF indicated that they would have introduced these techniques if they could afford better technology and new machinery.

Factors in overcoming difficulties

In spite of the constraints affecting CA adoption and difficulties in finding the right approach to new farming methods, there was no evidence that any of the participants were considering reverting to conventional farming. In fact the complexity of managing the system itself and the need for constant improvements of practices on the farm were considered as a worthwhile challenge having a positive impact on their way of thinking, resulting in more confidence to persist with the new system.

This new way of thinking entailed an interest in developing new managerial skills and acquiring technical knowledge and acted as an important motivating factor in addressing challenges and constraints posed by the innovation process.

Responses indicating the impact of involvement in CA on broadening horizons and attitudes included statements such as 'CA makes farmers question themselves and look at the farming system as a whole system' and 'CA opened their minds to try new things and not to fear changes'. One participant stated that he enjoyed 'working with like-minded people, interactions with other farmers, challenging my thoughts, pushing those boundaries'.

Another commented on the impact of CA on his sense of self-efficacy, saying that he got 'really involved' after overcoming initial difficulties. One of the farm managers noted, 'The reason I stayed—because of changes possible. A high percentage of techniques we have tried have worked, therefore giving us more confidence all the time, confidence that we are doing a good job.'

Conclusion

This qualitative study of farm managers involved with CA identified financial, environmental and personal motivations, as well as the role of farming support associations, as important influences on the adoption of no-till and other conservation farming practices.

While qualitative studies have limited scope to examine the relative importance attached by participants to individual motivations and the interconnections between the motivations, this study demonstrates that very rarely was the decision to adopt motivated by a single factor, whether environmental pressures, economic necessity or support group. The results show that, while financial or environmental benefits such as drought were important catalysts of change, they interacted with a range of other motivations to influence adoption of farming practices.

Results also indicated that the availability of support from grower groups and farmer organisations in some cases played an important role before the decision to adopt had been made. These groups continued to influence farm managers' innovative efforts and the strong sense of self-efficacy in subsequent stages of the innovation process by contributing to the dissemination of new technologies and knowledge to farm businesses and by providing the opportunity for 'benchmarking against other progressive farmers'.

The lack of funds was the main factor limiting farmers' ability to change their management practices, followed by difficulties in finding the right methods to apply innovations to suit individual circumstances and the emergence of new challenges and risks.

Appendix 3 DPC stage 1 workshops summary

Introduction

This section presents the summary of findings from a qualitative study which involved four consultative workshops conducted as part of the first stage of the Drivers of Practice Change project. The objective of the workshops was to gather information about factors influencing the adoption of sustainable land management practices, in particular to identify the key drivers of practice change in land management.

Workshops were designed to identify motivations for the uptake of sustainable land management practices from the perspective of practitioners and experts. To obtain local knowledge and experience, the workshops included landholders, farmer groups, industry representatives, extension practitioners and researchers, policy staff and practice change consultants.

In recognition of regional level variation in farm practice, workshops were held in the four regions representing Australia's major climatic zones, including eastern temperate (South Australian temperate as a case study), western temperate, tropical and semi-tropical (Queensland coastal catchments as a case study) and the arid and semi-arid zone.

The design of the workshops was developed on the basis of preliminary investigation, which involved a review of literature on practice change and a desktop review of social and economic information relevant to adoption of land management practices for each of the four climatic regions, including relevant surveys.

The outcomes of the workshops were used in the development of the national survey of landholders that aimed to provide further quantitative evidence of key influences on practice uptake for the DPC project.

The outcomes of the workshops—key findings

The workshops identified major factors influencing natural resource management practice uptake and developed main lines of enquiry useful in the development of a survey focusing on understanding motivations for each management practice. These include:

- Overarching influences on practice change
 - Policy and regulatory environment
 - Climate variability / drought / change events
 - R&D investment
 - Resource availability
- Drivers of practice change
 - Financial
 - Groups and networks
 - Information / sources of information

- Incentives, disincentives, subsidies and external pressures
- Personal motivations, beliefs and attitudes
- Market
- Enabling activities
 - Extension
 - Training and education
 - Communication
 - One-on-one support
 - Integrated and holistic approaches
 - Monitoring and evaluation
 - Coordination and collaboration
- Barriers to practice change
 - Extension barriers
 - Information/knowledge barriers
 - Risk related barriers
 - Economic/profitability barriers
 - Reporting and monitoring barriers
 - Funding accessibility issues
 - Institutional barriers
- Capacity and characteristics of farmers influencing adoption

These drivers, enablers and impediments to the uptake of practice change are discussed in the following sections.

Overarching influences

Workshop participants acknowledged that uptake of soil and land cover management practice is directly or indirectly influenced by four overarching impacts:

- the policy and regulatory environment
- environmental pressures such as climate and other system ‘shocks’ or changes
- research and development (R&D)
- resource availability.

Policy environment

The policy and regulatory environment was seen to have an indirect influence on the adoption of sustainable farm practices. Participants observed that adoption of innovations might be affected by the way policies are developed and communicated, and that community and industry involvement in policy development can encourage adoption.

The main issues relating to the influence of the policy environment on practice change, which could be further explored through a survey, included the effect of overarching policies (e.g. climate change policy driving soil conservation); effects of regulation on adoption of sustainable farm practices; the current knowledge and awareness of land managers about soil conservation regulations; how regulations and policies impact on the way extension providers do business, including provision of advice; and the degree to which extension provider advice aligns with government policy.

Climate variability / drought / environmental pressures

Throughout all the workshops, participants noted that environmental pressures or specific climatic events were very strong factors driving adoption. It was noted that shocks to the system such as drought events, pest or disease outbreaks and other climatic events (e.g. floods and cyclones) could accelerate change.

Participants recommended pursuing the following issues related to the influence of climate and other environmental ‘shocks’ on practice uptake: the impact of climate and drought events on adoption; and the impact of climate variability on uptake of land management practices.

Research and development

Declining R&D funding was raised as an important overarching influence. There were also concerns that funding is disproportionate to needs across different industries. Funding the gap between R&D investments and adoption of innovations was also seen as an important influence on practice change. Participants recommended that a survey further explore the impact of availability of R&D funding on land managers’ decision making and adoption.

Resource availability trends

Resource use efficiency, resource scarcity and future trends such as peak oil and peak food were noted as important contextual influences for practice change. Participants suggested the following lines of enquiry related to these issues: impacts of declining resource availability on

business viability; and the effect of views on future resource scarcity/availability on soil and land conservation.

Drivers of practice change

For the purpose of this project drivers of practice change were defined as factors that directly or indirectly encourage or facilitate adoption of sustainable farm practices. Of particular interest to this project were drivers that could potentially be used in policy or program interventions.

The workshops identified six key drivers of practice change:

- farm finances, profitability and income
- groups and networks
- information sources and provision
- incentives and external pressures
- personal motivations
- market drivers.

Financial drivers for practice change

The current financial performance of farmers was brought up at all four workshops as an important driver and, for more poorly performing farms, a barrier to practice change. Participants commented that farmers in many parts of the country operate at very low returns with a range of factors such as increased costs, poor climatic conditions and rising land values contributing to poor financial performance in recent years. These difficulties highlighted the need to work with farmers' financial goals in mind.

During consultations workshop participants identified following financial factors as drivers/motivations of practice change:

- perceived financial benefits related directly to increasing income as costs were getting higher and margins smaller
- remaining financially viable
- keeping their farm or maintaining natural farm assets (i.e. farm value)
- perceived relative advantage of adopting new practices (i.e. belief that the cost of maintaining current practices is higher than that of adopting new practices)
- potential for increased financial returns, particularly because of the low margins in farming
- potential for improved long-term financial security and capital growth.
- 'turn a profit'—improved financial profitability due to increased returns combined with desire to protect the environment
- business drivers—wanting to be the first to adopt innovation for economic outcomes

- dealing with adverse industry economic conditions
- perceived improvement in managing risk and perceptions of risks
- moderating impacts of adverse changes in commodity and input prices, for example reducing herbicide and other input costs
- necessity to reduce costs of erosion to individual farms and the community.

Factors that were seen as potential financial barriers to changes to management practices included:

- high establishment costs—high up-front costs
- the adjustment costs associated with adoption
- costs of changes to infrastructure required for improving sustainability
- uncertainty about potential advantages
- high transportation costs
- costs of NRM practices - higher in the rangelands.

Groups and networks as drivers for practice change

The importance of groups and networks in supporting practice change was evident at all workshops. A variety of different groups and networks was suggested as influencing practice change. These ranged from specific interest groups (e.g. the state no-till associations such as WANTFA and SANTFA) to local agricultural research and development groups to the more informal neighbourhood groups. Other groups which were likely to engage in sustainable farm practices were those with a more commercial focus, such as production groups set up by farm consultants.

Generally it was proposed that there was little value in considering these production groups as separate to Landcare groups for the purposes of exploring the role of groups in supporting sustainable farm practice adoption.

Participants noted that groups were not suitable for all circumstances; however, they played an important role in information sharing and building confidence. They also potentially contributed to three major areas of the land managers' areas of interest: land management, business and financial management and social networking.

In addition, participants identified a number of benefits of groups as potential drivers of practice change:

- groups offer shared learning and support
- groups and networks bring people together
- people learn more from each other than other sources of information ('tribe' effect)
- groups reduce perceived risks by sharing knowledge on successes and failures

- groups enable local research and testing of technology
- groups provide practices to emulate / to aim for.

There were some issues raised about the less positive aspects of groups, including that people may be restricted to moving at the pace of the group, and issues around sharing knowledge in potentially commercially competitive environments.

Information drivers for practice change

Participants at all workshops identified information and information sources as potential drivers of practice change. Participants listed as useful the following information providers and sources of information: regional NRM groups' consultants, industry communication (e.g. newsletters), local trialling, demonstrations, regional bodies and a number of new technologies, including the use of podcasts, teleconferences and online databases. Consultants were seen as valuable because of their conservative and experience based approach, although their risk averse approach was also criticised.

Many issues were raised about appropriate methods and models of extension and support including the need for local adaptation of information and local trialling at applicable scales, such as farm-sized demonstrations (rather than just paddock scale) and on-farm demonstrations. Participants commented that some forms of information may be more efficient in encouraging practice adoption; for example they highlighted the need for information and advice to be:

- tailored to the audience, for example retail, NRM, consultants, and land managers
- adapted to different learning styles and local needs
- relevant, high quality, credible and independent (without a barrow to push, e.g. coming from fertiliser companies)
- matched with landholders' interests
- timely—to ensure it comes when morale is high
- useful to communicate the benefit/cost of approaches.

Significant information barriers to practice change that workshop participants considered were:

- the lack of information on a range of factors including unreliability in climatic predictions and lack of baseline information to inform stocking rates
- the provision of sectoral or industry based advice which restricts integration at farm scale
- lack of coordination amongst information sources
- risk aversity of some consultants.

Incentives, disincentives, rewards and recognition as drivers for practice change

Another group of drivers of practice change discussed at the workshops related to incentives, disincentives and external pressures that may influence behaviour through reward or penalty. Existing and potential incentives or forms of recognition of best practice mentioned by workshop participants included:

- fiscal and economic incentives which translate into a financial reward, direct or indirect:
 - property or rights based incentives such as financial reward in exchange for commitment to stewardship activities
 - tax deductions and/or rebates/credits and interest rate relief
 - subsidies and co-funding arrangements
 - reduced interest rates for good management from Rabobank
- regulatory incentives, for example Chemcert compliance
- ecological services and rewards—market based instruments, for example a potential carbon market
- tax system incentives for machinery
- recognition of effort (e.g. signs at gates recognising sustainable land management)
- market based instruments for environmental stewardship.

The dangers of perverse incentives, for example drought assistance, which could encourage inappropriate behaviour or reward poor land management were noted.

Workshop participants suggested that some forms of incentives may be more effective in encouraging practice adoption; for example they highlighted the need for market testing of any incentive program, management of both negative and positive messages associated with incentives, and explanation of variation in incentive rates between areas or between projects. They mentioned that incentives must be simple to implement and efforts should be made to minimise the costs of transaction, enforcement and participation.

Personal motivations as drivers of practice change

Personal motivations were identified at all workshops as key drivers of practice change. It was observed that personal motivations are central to practice change, as without an individual's desire for sustainable practice innovation adoption will not happen.

There was a major focus on environmental stewardship and lifestyle motivations as potential drivers of practice change. This included environmental stewardship motivations to manage the environment for current and future generations and not wanting to degrade the land. This also related to motivations of being accepted by the community as proactive or good citizens. It was also noted that having children returning to the farm could motivate adoption of sustainable practices.

Differences between what influences strongly commercially focused land managers and more lifestyle focused farmers were also noted. Lifestyle motivations could result in both positive and

negative influences on sustainable farm practice adoption; for example lifestyle farmers may not have the same need to 'push' the country.

Workshop discussions also highlighted the need to find a balance between competing priorities; for example participants noted that there was increasing pressure for a commercial approach to farming but that a balance between lifestyle and economic survival was required. Conversely, achieving a comfortable level of financial security could allow more focus on sustainability issues.

The following lines of enquiry were recommended to explore the link between personal motivations and practice uptake:

- To what degree do personal motivations influence management practices?
- To what degree do historical factors (e.g. family, or previous government policy) influence land management practices?
- What is the interaction between profit and lifestyle, both negative and positive impacts on practice change?
- Are there differences in adoption between 'lifestyle' farmers and mainstream farmers?
- How do the different lifestyle motivations influence adoption of both sustainable and unsustainable land management practices?

Market access drivers for practice change

Market access was observed as a potential driver of sustainable farm practice particularly for horticulture, with broadacre industries generally yet to observe the influences or advantages of environmental or organic market access.

A number of opportunities were noted including specialised and niche marketing of organic or 'sustainable' products and the options for tapping into new markets such as environmental stewardship or potential carbon markets.

While the desire by consumers for purchasing 'clean and green' agricultural produce is regarded as a potential driver of practice change in the developed countries, workshop participants were generally hesitant to characterise it as a driver for practice change in Australia.

Enabling activities—workshop outcomes

For the purpose of this project enablers were defined as factors, which are distinguished from the 'drivers' as they are more about the way business is done to use or promote the drivers identified. Workshops identified five enabling activities: planning, communication, holistic and systems approaches, monitoring and evaluation, and coordination and collaboration.

Barriers to adoption

The following barriers to practice adoption were identified by participants from all the workshops:

- Extension barriers
- Information/knowledge barriers

- Risk related barriers
- Economic/profitability barriers
- Reporting and monitoring barriers
- Institutional barriers.

Appendix 4 Methods—inferential statistics

Inferential tests applied

Inferential statistical analyses were performed on the survey results to investigate specific questions that were raised. For all analyses the data were weighted, which allows for the calculation of population estimates. On average, the sample weights equal the number-raised weight, N/n , where N is the population and n is the sample size at the weighting level. Additionally, the weights that are allocated sum to the 'known' population, and the weighted sum from the sample for a set of 'benchmark' variables will equal the 'known' population totals. These 'known' populations and totals are generally provided by the ABS, and are derived from the Agricultural Census or Agricultural Survey.

Due to the nature of the data causation is difficult to establish, although the tests highlight some important relationships between adoption of sustainable farm management practices and other variables.

One-way analysis of variance

To determine if there were any differences between farm managers who had adopted farm management practices (adopters), those who had considered adopting farm management practices (considerers), and those who had not adopted (non-adopters) on various characteristics, separate one-way analysis of variance (ANOVA) were performed to ascertain any statistically significant differences between the groups. The groups were compared on the following characteristics:

- Difference between total cash receipts and total cash costs of their business (farm cash income)
- Rate of return excluding capital appreciation
- Gross off-farm income earned by owner manager and spouse
- Area cropped (cropping management practices only)
- Farm size
- Age of owner manager
- Education level
- The proportion of the group that had participated in extension programs (e.g. trials)
- The proportion of the group that had participated in a government program (e.g. Farm Ready)
- The proportion of the group that belonged to a land management group (e.g. Landcare).

For this analysis, the level of education that a farm manager had was converted into a numerical variable with a maximum score of five; therefore higher numbers indicate higher levels of

education. In addition, the variables which indicated whether a farm manager had participated in extension or in a government program or was a member of a group were dummy-coded into numerical variables where 1 indicated participation and 0 indicated no participation; a higher mean indicates a higher level of overall participation by that group.

Separate one-way ANOVAs were performed for each characteristic for each of the management practices (e.g. periods of fallow in crop rotation); thus in total each management practice had nine ANOVAs conducted (10 for the three cropping management practices), leading to an overall total of 16 ANOVAs. Due to the increased risk of making a Type 1 error—mistakenly ruling that there is a statistically significant difference when there is not one—by running multiple tests the alpha for each test was adjusted using a Bonferroni correction. This meant that for each practice the original alpha of 0.05 was divided by the number of ANOVAs that were being performed to compare the characteristics to produce a new alpha (e.g. $0.05/10 = 0.005$). The final alpha that was used was 0.005 for all ANOVAs comparing characteristics of the different cropping management practices and 0.006 for all other ANOVAs used to compare all of the other management practices. If the one-way ANOVA established that there was a difference between the three groups on one of the characteristics the post hoc Games-Howell test was performed to determine between which groups this difference was.

All test assumptions were met except for the assumption of normality and the assumption of homogeneity of variance. As the sample size was large (i.e. more than 30 participants in each group) ANOVA is robust to violations of normality. To counter the violation of the assumption of homogeneity of variance the Welch correction was performed and the post hoc test used was the Games-Howell. As multiple ANOVAs were conducted, there was a risk that multivariate outliers could skew the data and impact upon the analysis. For this reason, multivariate outliers with Mahalanobis distances of over 22.458 (or 24.332 for cropping management practices) were excluded from the analysis (Tabachnick and Fidell 2007). For each management practice multivariate outliers accounted for less than 7 per cent of all the data.

Independent samples t-test

For the practice 'management of WoNS' the survey grouped farm managers who had either adopted or considered adopting weed management together as one group, meaning that comparisons can only be made between adopters/considerers and non-adopters. For this reason independent sample *t*-test comparisons were performed to find any differences between these two groups. The characteristics compared are the same as those used in the one-way ANOVAs above. In total nine independent sample *t*-tests were performed and the alpha for each was 0.006 (after a Bonferroni adjustment).

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