

final report

Project Code: WEED. 121/B.WEE.0121

Prepared by: Annamieke van der Meulen, Ian Reeve and
Brian Sindel
University of New England

Date published: November 2006

PUBLISHED BY
Meat and Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

The Sociology of Weed Management Insights for Extension and Communication based on a Survey of Graziers

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

This publication is published by Meat & Livestock Australia Limited ABN 39 081 678 364 (MLA). Care is taken to ensure the accuracy of the information contained in this publication. However MLA cannot accept responsibility for the accuracy or completeness of the information or opinions contained in the publication. You should make your own enquiries before making decisions concerning your interests. Reproduction in whole or in part of this publication is prohibited without prior written consent of MLA.

Abstract

Weeds are a significant source of lost income to livestock producers. Management practices that provide long-term solutions to weeds have been developed, but could be more widely used. This project aimed to improve understanding of the factors behind inadequate weed control on grazing properties, and to develop extension strategies to overcome these factors.

It was found that there are many motivations and barriers that influence the effectiveness of weed management. Weed life cycle events are an important motivation to take action, particularly among the better weed managers. Poorer weed managers are more likely to be motivated to control weeds by increasing weed levels or invasiveness. Lack of time, money and labour are problems reported by many graziers, particularly by the poorer weed managers.

This report provides guiding principles to follow in designing weeds extension strategies, as well as some simple tactics for particular grazier segments. It is recommended that a national leadership level program be developed to improve weed management in the grazing industry, with extension strategies based on the findings of this report. Given the magnitude of the costs of weeds to the industry, it is expected that such a program will substantially benefit Australian livestock industries.

This report is a summary. The full report that describes research methods and detailed findings can be accessed via the R&D database within the MLA website (www.mla.com.au)

WEED.120: The Sociology of Weed Management; Motivating, Building Capacity and Educating Graziers who fail to control weeds. ISBN 9781741911237

The related project WEED.124 New Approaches to Weed Management Extension in Southern Australia referred to in this document can also be found at the above location. ISBN 9781741911244

Executive Summary

Background

The current estimated cost of weeds in livestock grazing systems is in the order of \$1billion to \$1.87billion per annum. Management practices that provide long-term solutions to weeds have been developed, but could be more widely used.

Aims and objectives

The aim of the project was to conduct social research to understand factors important in graziers' decisions about weed control. Specific objectives were to:

- establish the broad scope of potential reasons why graziers do not adopt improved management practices,
- identify motivations and barriers to effective weed management,
- develop tactics to overcome barriers and capitalise on motivations,
- collaborate with researchers from a complementary project to develop guiding principles for weed extension strategies, and
- communicate results to, and obtain feedback from weeds extension, regulation, and research staff.

Methods

The project commenced with a review of the written literature, supplemented by consultation with stakeholder organizations, including catchment management authorities, weed advisory boards, and local councils. On-farm interviews (122) were conducted, and written questionnaires (94) were returned by mail. On farm interviews were carried out in the company of a weeds authority officer who assisted with rating the property in terms of weed levels and management effort. Telephone interviews (815) were conducted by a market research firm, based on a system of drawing telephone numbers randomly from postcodes in the southern cereal and higher rainfall zones. Only respondents with more than 500 sheep and/or 60 cattle were included in the survey. Validation of the survey findings was obtained through a discussion group with New England Weeds Authority, via email to weed control and extension officers across southern Australia, and at a workshop for weed researchers.

Project findings

The literature review showed that the reasons graziers do not adopt improved weed management practices could potentially be assigned into several distinct groups, including institutional factors, weed specific factors, the characteristics of weed management practices, and the characteristics of weed managers and their farms.

It was found that motivations to undertake weed control are wide ranging, reflecting knowledge and skills, attitudes towards weed control, and innovation behaviour.

- Among the more effective weed managers, weed life cycle events are a motivation for action.
- On mixed farming and grazing properties, fitting weed control in with farm operations is an important motivation for action, but the demands of mixed farming may lead to a lower priority being placed on weed control.

- The time of year is an important motivation among those who are only using a few weed control practices.
- Concerns about weed levels getting worse, or weeds being invasive, are a motivation for action among the poorer weed managers.
- Concerns about weed impact on production or product quality motivates some graziers to take action.
- Pressure from weed authorities was rarely reported as a motivation to take action.

There were also a number of barriers reported.

- The most frequently reported problems were lack of resources (e.g. time, money, or labour) and these are more likely to be reported by the poorer weed managers.
- Infestation from neighbouring properties was more likely to be reported by better weed managers.
- Difficult country and dislike of chemicals were reported as problems by significant numbers of graziers.
- Lack of information was **not** regarded a problem.

There are a number of simple extension tactics that may be useful in overcoming barriers and capitalising on motivations.

- Promote control techniques that overcome frequently reported barriers. For example, combinations of biological control, grazing and competitive pastures can reduce resource inputs and reliance on herbicide, thereby meeting the needs of those graziers who are reluctant to use chemical methods and perhaps ultimately lowering the risk of weed resistance.
- Encourage group-based approaches to tackling local weed issues and overcoming disputes between neighbours.
- Provide tools (e.g. weed calendars) that are useful for graziers who are motivated by time of year and weed life cycle events.
- Use local media to raise awareness of new weeds and the potential pathways for weed spread.
- Provide information on the production impacts of weeds, including, where possible, economic data.
- Simple hints about weed control opportunities that are generated by other farm operations.

The development of weeds extension strategies will need to follow a series of steps.

- Strategic analysis is needed to identify, for a particular weed in a particular region, what is leading to ineffective weed management, and to determine the institutional requirements to support extension programs to address the problem.
- The development of communication content requires an organising theme for the content, the identification of segments and adoption paths, and the content appropriate to these segments and paths. It is suggested that the three dimensions, or “3Ds” of effective weed management can serve as an organising theme. The 3Ds of weed management are:

- Deliberation (planned, strategic and integrated weed control),
- Diversity (of methods), and
- Diligence (in application of methods).

A segmentation approach was identified using the 3Ds, comprising poorer weed managers, “simple diligents” who are effective in controlling common broadleaf weeds through the diligent application of a few simple techniques, and better weed managers who are competent in a range of weed control techniques and able to identify a broader range of weeds. The focus of extension content for each segment was also identified.

- Communication content has to be matched with appropriate extension methods. Project findings include:
 - effective extension requires social interaction between graziers and professionals, either in one-to-one or groups situations,
 - extension via the internet would meet the needs of only a small proportion of graziers,
 - printed fact sheets, while not considered as useful as extension methods involving social interaction, are nevertheless valuable for raising awareness, and
 - one- to-one extension was found to be particularly valued among managers of mixed farms, who are more likely to be using consultant agronomists who will be an important channel for the extension of weed information.

Conclusions and recommendations

This report provides guiding principles to follow in designing weeds extension strategies, as well as some simple tactics for particular grazier segments. It is recommended that a national level leadership program be developed to improve weed management in the grazing industry, with extension strategies based on the findings of this report. Given the magnitude of the costs of weeds to the industry, it is expected that such a program will substantially benefit Australian livestock industries.

Contents

1	Background.....	7
2	Project Objectives	7
2.1	Purpose.....	7
2.2	Objectives	7
3	Methodology	8
3.1	Literature review.....	8
3.2	Farm visits (Nth and Sth NSW, and SE VIC)	8
3.3	Telephone survey (NSW, VIC, TAS, SA and WA).....	8
3.4	Validation and Communication.....	8
4	Results and Discussion	8
4.1	Reasons for Not Adopting Improved Weed Control Practices...8	
4.2	Motivations and Barriers to Effective Weed Management.....9	
4.2.1	Motivations	9
4.2.2	Barriers.....	9
4.3	Tactics to overcome barriers and capitalise on motivations ...10	
4.3.1	Overcoming barriers.....	10
4.3.2	Capitalising on motivations.....	10
4.4	Extension Principles for Weed Management	10
4.4.1	Strategic analysis	11
4.4.2	Communication content.....	13
4.4.3	Extension principles	14
4.5	Communication and Feedback	14
5	Conclusions and Recommendations.....	14
6	Bibliography.....	16
7	Acknowledgements	16

1 Background

Weeds are a significant source of lost income to livestock producers and the industry generally, with costs including product contamination, livestock injury and poisoning, impeding vehicle and stock movement, and competition with desirable pasture species leading to reduced productivity.

Sinden *et al.* (2004) estimated that:

Livestock Industries

- Spend \$315 - \$345 million per annum,
- Lose \$1,870 million per annum.

Cropping Industries

- Spend \$1,033 - \$1,121 million per annum,
- Lose \$346 million per annum.

Management practices that sustain and revive the pasture resource and provide long-term solutions to weeds have been developed. However, adoption of these practices has not been widespread, and only a relatively small proportion of landholders achieve effective weed control.

2 Project Objectives

2.1 Purpose

To conduct social research to understand factors important in graziers' decisions about weed control.

2.2 Objectives

- Establish the broad scope of potential reasons why graziers do not adopt improved management practices.
- Identify motivations and barriers to effective weed management.
- Develop tactics to overcome barriers and capitalise on motivations.
- Collaborate with researchers from a complementary project to develop guiding principles for weed extension strategies.
- Communicate results to, and obtain feedback from weeds extension, regulation, and research staff.

3 Methodology

3.1 Literature review

Information was distilled from the literature produced by industry groups, government and non-government agencies, research organisations, and from scientific journals and conference proceedings. Review of the written literature was supplemented by consultation with stakeholder organizations, including catchment management authorities, weed advisory boards, and local councils.

3.2 Farm visits (Nth and Sth NSW, and SE VIC)

On-farm interviews (122) were conducted with graziers in perennial pasture zones of southern Australia, and 94 interview participants also returned a written survey. On farm interviews were carried out in the company of a weeds authority officer who assisted with rating the property in terms of weed levels and management effort, based on an 8 point scale.

3.3 Telephone survey (NSW, VIC, TAS, SA and WA)

Telephone interviews (815) were carried out by a market research firm, using a system of drawing telephone numbers randomly from postcodes in the southern cereal and higher rainfall zones. Only respondents with more than 500 sheep and/or 60 cattle were included in the telephone survey.

3.4 Validation and Communication

Validation and interpretation of the survey findings was obtained through:

- a discussion group with New England Weeds Authority,
- email to weed control and extension officers across southern Australia, and
- a workshop for weed researchers.

These activities also enabled the preliminary findings to be communicated to a wide audience of weed research and extension professionals. The project findings have also been presented at two conferences.

4 Results and Discussion

4.1 Reasons for Not Adopting Improved Weed Control Practices

The first objective of the project: *establish the broad scope of potential reasons why graziers do not adopt improved management practices*, was addressed through the literature review. On the basis of the existing literature, it was concluded that the reasons graziers do not adopt improved weed management practices could potentially fall into several distinct groups.

Institutional factors, e.g. difficulty in identifying who should pay for weed management, problems with the enforcement of weed legislation, and lack of processes for resolving conflicts of interest.

Weed specific factors, e.g. sleeper weeds and slow development of weed problems.

Characteristics of weed management practices, e.g. complexity, trialability, compatibility with farm system, observability of results.

Characteristics of weed managers and their farms, e.g. averseness to risk, physical ability, personal priorities, ability to identify weeds, knowledge of weed life cycles and control practices, time and financial pressure, enterprise type, and physical characteristics of farm.

The literature also drew attention to the fact that adoption takes a number of steps; from recognising there is a problem, through information seeking, weighing up alternatives, small trials and refinement to suit a particular production system. Factors that impede or facilitate adoption of improved weed management practices can occur at any point in the process.

4.2 Motivations and Barriers to Effective Weed Management

The second objective of the project: *identify motivations and barriers to effective weed management*, was addressed through the on-farm interviews, mail-back survey and telephone survey.

4.2.1 Motivations

It was found that motivations to undertake weed control are wide ranging, reflecting knowledge and skills, attitudes towards weed control, and innovation behaviour.

- Among the more effective weed managers, weed life cycle events are a motivation for action.
- On mixed farming and grazing properties, fitting weed control in with farm operations (e.g. seeding) as the opportunity arises is an important motivation for action, but the demands of mixed farming may lead to a lower priority being placed on weed control.
- The time of year is an important motivation among those who are only using a few weed control practices.
- Concerns about weed levels getting worse, or weeds being invasive are a motivation for action among the poorer weed managers.
- Concerns about weed impact on production or product quality motivates some graziers to take action.
- Pressure from weed authorities was rarely reported as a motivation to take action.

4.2.2 Barriers

- Most commonly reported barriers were: lack of resources, e.g. time, money, or labour, and these are more likely to be reported by the poorer weed managers.
- Infestation from neighbouring properties was more likely to be reported by better weed managers.
- Difficult country and dislike of chemicals are reported as problems by significant numbers of graziers.
- Lack of information was **not** regarded a problem.

4.3 Tactics to overcome barriers and capitalise on motivations

The third objective of the project: *develop tactics to overcome barriers and capitalise on motivations*, was achieved through analysis of the data gathered from the on-farm interviews, mail-back survey and telephone survey.

4.3.1 Overcoming barriers

- Promote methods that overcome resource constraints, e.g. did you know that: X technique can save you time and money, or that Y technique can help control weeds on slopes too steep to use cultivation or spray equipment, or that Z is a good way to reduce reliance on chemicals control methods and reduce risk of herbicide resistance, or that preventing weed spread through quarantine and other measures can help in avoiding costly control later?
- Area wide management approaches whereby neighbouring landholders collectively tackle weed issues, potentially involving a mediator to overcome disputes between neighbours.

4.3.2 Capitalising on motivations

- Calendars of weed control activities directed to those who work to a fixed calendar of farm activities.
- Use local media (radio, PRIME television network, newspapers etc.) to raise awareness about new weed threats, and the potential for certain weather events to increase weed levels and/or risk of invasion (e.g. drought conditions resulting in bare ground, spread of weeds through transportation of fodder and livestock, etc.).
- Provide information on the production impacts of weeds, including, where possible, economic data to show productivity losses per hectare of weed once a certain density is reached.
- Simple hints about weed control opportunities that are generated by other farm operations (“Did you know that when you are doing X you could be doing Y to control weeds with little extra cost or effort?”).

4.4 Extension Principles for Weed Management

The fourth objective of the project: *collaboration with complementary project to develop extension principles for weed management*, was achieved through analysis of the data gathered from the on-farm interviews, mail-back survey and telephone survey, together with a joint workshop and discussion with the researchers undertaking the complementary project Weed 124.

Weed 124 has recommended that a three-pronged approach to improve the management of weeds in high rainfall grazing systems:

- *reform* national communication strategies related to weeds management, according to social marketing principles and practice,
- *shape* the decisions of relevant funding agencies and policy makers toward collaboration around a common goal, and

- *integrate* the efforts of service providers and resource managers at the regional and district level through capacity building initiatives.

The development of weeds extension strategies, whether part of a national reform of weeds communications strategies, or of regional integration and capacity building, will need to follow a series of steps:

- strategic analysis to identify what is leading to ineffective weed management, and determine the institutional requirements to support extension programs to address the problems,
- development of communication content (organising theme, identification of segments and adoption paths and the content appropriate to these), and
- selection of appropriate extension methods.

These steps and associated key principles are described in the following sections.

4.4.1 Strategic analysis

There are a number of important strategic considerations that should shape approaches to improving weed management in the higher rainfall grazing regions. These considerations are equally important at the regional level.

Extension problem definition

*Who believes the weed is a problem?
Producers, agricultural professionals or both?*

This is critical in shaping an extension strategy. If producers do not think the weed is a problem, the reasons for this have to be well understood. The findings from this project suggest that there are a number of grass weeds that are not well known to producers and which research and extension professionals believe may be reducing production.

Why is the weed currently a problem? Is it lack of control methods, or are the available control methods ineffective, or are the methods effective but poorly used, or are the methods effective but not being used at all?

This is also critical in shaping extension strategy. Lacking or ineffective control methods point to the need for research before extension can be proceeded with. Poorly used methods means extension has to focus on refining existing skills, whereas methods not being used at all points to the need for a broader extension program to raise awareness and overcome any adoption barriers.

Weed-specific considerations

The findings from the problem definition questions above will differ according to the type of weed. Weeds fall into four general groups with respect to graziers' levels of awareness and knowledge.

1. <i>Common broadleaf species such as blackberry and gorse (in states where it occurs) are almost universally regarded as ubiquitous, a weed and easy to identify.</i>	There is no need for extension resources to improve identification skills.
2. <i>Grasses, such as barley grass, almost universally regarded as ubiquitous and easy to identify, but with opinion divided as to whether it is a weed or not.</i>	Again, there is no need for extension resources to improve identification skills. However, if the weed is causing losses to production or product quality, despite being useful as feed at certain times of year, then extension needs to raise awareness about these losses.
3. <i>Grasses, such as serrated tussock, are almost universally regarded as a weed, but with substantial numbers of graziers who believe it is not in their district and who are unsure whether it is easy or difficult to identify.</i>	Extension needs to raise awareness of the distribution of the weed, and provide resources to improve identification skills.
4. <i>Grasses, such as Chilean needle grass and African lovegrass, where substantial numbers of graziers are unsure whether it is in their district, unsure whether it is a weed and unsure whether it is easy or difficult to identify.</i>	These types of weeds require a full awareness raising program, alerting graziers that the weed is a threat to their livelihoods, that it is potentially present in their region, and providing resources to improve identification skills.

Institutional considerations

<i>Upon whom do the costs of not controlling the weed fall? Does weed control require collective action to be successful? Are those who will benefit from weed control the same as those who have to bear the costs of achieving control?</i>	This is fundamental to specifying the make-up of what have been termed "communities of practice" ¹ in Weed 124, as well as the balance between public and private contributions to research and extension.
<i>Does the production system affected by the weed generate returns sufficient to invest in weed control? Will the value of increased production cover the cost of weed control? If controlling the weed is not economically rational for the individual, will it spread and generate further private and public costs, such that</i>	This determines whether weed control can reasonably be expected to be a matter of private adoption, or whether collective action and possible public subsidy is required.

¹ A "community of practice" can be loosely defined as a group of people who share a common interest, interact regularly, and work collectively in pursuit of this interest.

collective control is rational, even if it is not rational for the individual?

4.4.2 Communication content

Organising theme for communication

Communication with graziers and extension professionals needs to be organised around a central theme which helps extension professionals identify their clients' needs, and helps graziers evaluate their own situation.

It is suggested that the Three Dimensions, or "3Ds" of effective weed management can serve as an organising theme. The 3Ds of weed management are:

- Deliberation (planned, strategic and integrated weed control),
- Diversity (of methods), and
- Diligence (in application of methods).

Segmentation and adoption paths

Consistent with the findings of Weed 124, communication resources should meet the needs of the main grazer segments with respect to their current weed management practices and which path(s) they need to take to improve their weed management further. The main segments and their needs are listed below.

Poor weed managers, characterised by a lack of deliberation, diversity and diligence in their weed management, need to be encouraged to use one or two straightforward weed control methods diligently. They may believe they are prevented from improving weed control by factors such as lack of time, money and labour, or believe their efforts will be wasted because of the vagaries of the weather. There are a number of communication tactics for this group.

- Lower their thresholds for action with visual communications about weed density along the lines that "If [a particular weed] looks like this [picture 1] on your place, then you are going to have to spend more money than you need to. By acting when it looks like this [picture 2], it'll cost you a lot less".
- 'A stitch in time saves nine' or 'one year's seed, seven years weed' is widely accepted among primary producers. This idea can be used in extension messages about buying clean feed and using confined feeding areas during drought, and adopting on-farm quarantine measures such as vehicle washdown areas, or buying certified seed in fodder cropping or mixed farming situations.
- Emphasise opportunities for weed control that arise in unusual seasonal conditions by publicity/awareness raising events when these seasonal windows occur. For example, when a rain event follows a long dry period and weeds have germinated, it is important to identify and control weeds using an appropriate method or mix of methods (e.g. crash grazing, spray topping, cultivation etc.) well before seed set.

'Simple diligents', who are achieving good weed control of the main declared and broadleaf weeds through the diligent application of a small number of straightforward chemical and mechanical methods, but may still be losing production to lesser known weeds. It is possible that rising chemical prices, the appearance of new weeds, or physical frailties associated with aging could result in some

members of this group slipping back into the poorer weed management group. The extension focus for maintaining and improving the effectiveness of this group should be upon developing skills in the identification of the lesser known grass weeds, alerting them when new weed problems emerge, and increasing their awareness of the advantages of newer weed control methods.

Better weed managers are more likely to be involved in mixed farming enterprises, to be younger and to have off-farm work commitments. To assist this group to continue as effective weed managers, extension and communication should focus on providing detailed information about emerging weed threats, alternatives to herbicides that may assist to reduce resistance problems, and time-saving control practices. Farmers in this group are also more likely to use internet resources.

4.4.3 Extension principles

The effective extension of weed information and more general capacity building is the subject of detailed investigation in Weed 124. Findings of this project consistent with the findings of Weed 124 are that:

- effective extension requires social interaction between graziers and professionals, either in one-to-one or groups situations,
- extension via the internet would meet the needs of only a small proportion of graziers, and
- printed fact sheets, while not considered as useful as extension methods involving social interaction, were nevertheless valuable for raising awareness.

One-to-one extension was found to be particularly valued among managers of mixed farms. This group is more likely to use consultant agronomists. The trust and credibility afforded to consultant agronomists makes them an important channel for the extension of weed information.

A further consistency between the two projects, with respect to segmentation and adoption paths, is the recommendation that multiple methods of message delivery are required to meet the needs of graziers in various segments and at different points on adoption paths.

4.5 Communication and Feedback

The fifth objective of the project: *communicate results to, and obtain feedback from weeds extension, regulation, and research staff*, was achieved via the activities described in section 3.4, above.

The experience gained from the communication and consultation activities has reinforced the view that effective weeds extension strategies must be matched to the particular type of weed. The strategic problem definition approach outlined in section 4.4.1 above, is essential in achieving this and, in many cases, will need to be supported by agronomic expertise.

5 Conclusions and Recommendations

The project has demonstrated that there is a wide range of reasons that graziers do not control weeds, or undertake ineffective weed control. The project has provided the foundation for the design of weed extension strategies, both at a national leadership level and at a regional or district level. It is the former level that is applicable to any future national leadership level program to

improve weed management in the grazing industry. The following sections set out the recommendations that follow from this project. The recommendations from Weed 124 are also briefly referred to at appropriate points.

- 1 **It is recommended that a national leadership level program be developed to improve weed management in the grazing industry.** Both this project and Weed 124 have confirmed the need for such a program and have provided much of the foundation needed for its design.
- 2 **It is recommended that the weed extension design principles developed in this project be used in the design of this program.**
- 3 **It is recommended that the design of the program proceed through most of the steps listed below.** The listing of steps assumes that the three-pronged approach recommended in Weed 124 (reform, shape and integrate) will underpin the design of the program.
 - Identify the target weeds for the program (develop a list of economically significant weeds occurring in perennial pasture zones of southern Australia).
 - Carry out the extension problem definition described in section 4.4.1. Problem definition can make use of the regional tables in the report of the telephone survey that show the proportion of graziers who believe various weeds are in their district, whether or not they regard them as weeds, and whether they believe they are easy or difficult to identify. Consultation with agronomic expertise for particular weeds may be required. At the completion of this step, it should be possible to say, for each weed and each region, whether extension needs to focus on awareness raising, identification resources, demonstration of production losses, adoption of newly developed practices, or improving the effectiveness of existing practices, or whether research is required before extension can be embarked upon.
 - Work through the institutional considerations in section 4.4.1. For particular weeds and regions, the local knowledge of weeds authorities may be needed to obtain a reasonable picture of how the costs and benefits of weed control are distributed. It will also be important to ascertain what actions are already being taken by other agencies and look for synergies between their efforts and what the national program might contribute. In doing this, those administering the national program will need to make their own assessment as to whether or not these agencies might need assistance in improving the effectiveness of their extension effort. The outputs from this step will assist in identifying relevant funding agencies, policy makers, and regional weeds extension agencies to involve in collaboration around a common goal as recommended in the Weed 124 report, as well as the nature of the collaboration.
 - Formalise the involvement of the partners identified in the previous step.
 - With the collaboration of any partners, further develop the extension strategy appropriate to the extension focus from the problem identification step above. This step can use the findings on communication content and extension methods in sections 4.4.2 and 4.4.3 above, together with the findings on extension methods from the Weed 124 report. A series of illustrative examples are listed below.
 - If the focus is on awareness raising for a new weed threat, development of printed and internet resources may be appropriate, something which may be part of the national reform of communication as recommended in the Weed 124 report.
 - If the focus is on weed identification resources, this also might be done as part of the national reform of communication products. On the other hand, if identification

resources are already available at the regional level, the national program might consider supporting more effective dissemination of these resources through local field days or workshops.

- If the focus is on raising awareness of the production losses, collaboration with regional researchers with field trials and production data may be appropriate, with a view to organising a field day or demonstration based at the fieldsite.
- If the focus is on improving the effectiveness of practices graziers are already using, this may require collaboration with regional extension staff and agronomic consultants to develop key messages on how to improve use of these practices. The findings on motivations in the report on the telephone survey will be useful in developing these messages.
- If, in working through the institutional considerations, the national program finds that regional extension programs could be improved, the relevant sections in this report and that from Weed 124 could be compiled into a manual for the design of weed extension strategies and supplied to regional weed extension agencies, possibly with accompanying training workshops. Workshops that brought extension staff and other stakeholders together across a region would also perform, or assist with, the regional integration and capacity building approach recommended in the Weed 124 report.

4 It is recommended that weed related extension programs take note of the value of trusted intermediaries in reaching those graziers who have a low level of engagement with natural resource management issues. The Weed 124 report emphasises the critical importance of the credibility of extension agents. As the recommended steps listed above will inevitably involve extension agents, it is important that these be people who are trusted by graziers and have a high level of credibility.

6 Bibliography

Sinden, J., Jones, R., Hester, S., Odom, D., Kalisch, C., James, R. and Cacho, O. (2004). *The economic impact of weeds in Australia*. Technical Series Paper No. 8. CRC for Australian Weed Management, Adelaide.

7 Acknowledgements

The work described in this report was funded by Meat and Livestock Australia (MLA). Various other groups provided assistance, but in particular, we acknowledge the valuable feedback and involvement in the surveys by weed research and regulatory staff from the Department of Sustainability and Environment and the Department of Primary Industries in Victoria, and the Wagga Wagga and Tamworth City Councils, the Lockhart, Tumut and Gundagai Shire Councils, and the New England Weeds Authority in New South Wales. We also thank the many livestock producers who participated in our surveys.



finalreport

FEEDBASE AND PASTURES

Project code: WEED.121/B.WEE.0121
Prepared by: Annamieke van der Meulen,
Ian Reeve and Brian Sindel
University of New England
Armidale NSW
Date published: September 2006
ISBN: 9781741911237

PUBLISHED BY
Meat & Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

The Sociology of Weed Management

Motivating, Building Capacity and Educating Grazers who fail to control weeds

Abstract

Weeds are a costly problem in livestock grazing systems. Weed management practices that provide long-term solutions to weed problems have been developed. However, adoption of these practices has not been widespread, and only a relatively small proportion of landholders achieve effective weed control. The challenge is to communicate information to, and motivate, the large proportion of landholders that are not controlling weeds effectively. An understanding of the social dimension of weed control is necessary to bring about change.

The purpose of this project was to conduct social research to understand the decision making process of weed managers across the southern Australian sheep and cattle grazing industries, identify motivations for action, barriers to the adoption of better weed management and develop strategies for overcoming these barriers and capitalising on the motivations.

The project commenced with a literature review to establish the range of factors that influence weed management on grazing properties. This was used to develop an interview schedule for on-farm face-to-face interviews. A total of 122 interviews were conducted in northern and southern NSW and north-eastern Victoria. Farm visits were in the company of weeds authority staff, who provided estimates of weed levels and management effort. Interviewees were provided with a questionnaire to mail back at their convenience. After analysis of the face-to-face interviews and the mail-back survey a telephone survey of a random sample of producers in the southern sheep-wheat and higher rainfall grazing regions was carried out. A total of 815 completed interviews were obtained. The project methodology also included a number of validation phases, including the circulation of findings to weeds authority staff, a workshop with weeds authority staff at Armidale and a workshop with weeds research and extension staff in Sydney. After incorporation of input from weeds authority and weeds research and extension staff, and analysis of the findings from the farm visits and two surveys, a number of principles for the design of weed extension strategies have been developed. These are based on the motivations and barriers identified in the research and provide a sound basis for effective weeds extension strategies

Principle 1: *There is a wide range of motivations for controlling weeds, and extension strategies have to be tailored to a particular weed, a particular agricultural production system, and a particular social and institutional setting.*

Principle 2: *The greater the diversity of control methods, the greater the possibility producers will find a way of controlling the weed that suits their situation.*

Principle 3: *Effective weed management involves deliberation, diversity and diligence and encouraging each of these requires a different extension approach.*

Contents

Section	Page
1	Background.....8
1.1	Objectives.....8
2	Methodology 10
2.1	Literature review 10
2.2	Field visits..... 10
2.3	Telephone survey..... 11
2.4	Communication of results..... 12
2.4.1	Discussion group with New England Weed Authority..... 12
2.4.2	Circulation of results via email..... 12
2.4.3	Journal article and conference proceedings..... 12
2.4.4	Workshop..... 12
2.5	Evaluation resources..... 13
3	Discussion of Project Findings 13
3.1	Introduction 13
3.2	The magnitude of the problem..... 13
3.3	Policy context..... 14
3.4	Adoption paths and segments..... 16
3.5	Motivations and barriers..... 18
3.6	Extension strategies 28
4	Appendices 35
A1.1	Overview..... 35
A1.2	Introduction..... 35
A1.3	Weeds in Pasture Systems..... 37
A1.3.1	The cost of pasture weeds..... 37
A1.4	Pasture Weed Management..... 38
A1.4.1	Current state of pasture weed management..... 39
A1.4.2	The social dimension of pasture weed management..... 39
A1.4.3	Land Stewardship..... 39
A1.4.4	Processes Influencing Adoption of Weed Management Strategies 40

<i>A1.4.4.1 Decision making processes</i>	40
<i>A1.4.4.2 Qualities of innovations</i>	41
A1.5 Risk and uncertainty	43
A1.5.1 Uncertainty and learning	43
A1.5.2 Risk and risk attitudes	44
A1.6 Heterogeneity in farming	44
A1.6.1 Market segmentation	44
A1.6.2 Farming styles research	46
A1.7 What is a weed to a grazier?	46
A1.8 Environmental factors	46
A1. 9 Conclusions and Recommendations	47
A2.1 Performance of awareness and attitudinal measures	50
A2.1.1 Weed awareness	50
A2.1.2 Differences between weeds	50
A2.1.3 A minimum weed set	51
A2.1.4 Attitudinal dimensions	53
A2.2 Tactics for Identifying Non-Adopters	57
A2.3 Demographic and Farm Characteristics	59
A2.4 Weed Incidence and Management Levels	63
A2.5 Methods of Weed Control	63
A2.5.1 Opinions across all respondents	63
A2.5.2 Differences between the demographic and farm groups	64
A2.5.3 Integration of weed control methods	65
A.2.5.4 Other characteristics of weed control groups	70
2.5.5 A minimum set of weed control methods	71
A2.6 Perceptions and Attitudes	71
A2.6.1 Reasons Plants Cause Problems	71

A2.6.2 Influences on the Choice of Weed Control Methods	72
A2.6.3 Difficulties with Weed Control	73
A2.6.4 Motivations for Changing Weed Management	76
A2.6.5 Reasons for Not Changing Weed Management	76
A2.6.6 Key to Good Weed Management	77
A2.6.7 Views about How Much Weeds Reduce Returns	77
A2.6.8 Weed Awareness	78
A2.6.9 Attitudes	80
<i>A2.6.9.1 Differences across demographic and farm groups</i>	80
<i>A2.6.9.2 Differences across weed control groups</i>	82
<i>A2.6.9.3 Relationship between attitudes and weed incidence and management effort</i>	83
A2.6.10 Views about Information Sources	84
<i>A2.6.10.1 Differences between weed control groups</i>	85
A2.6.11 Relationship between usefulness of information sources and weed incidence....	86
A6.11.1 Views about Communication of Information	87
A6.11.2 Differences between demographic and farm groups	88
A6.11.3 Differences between weed control groups	89
A2.6.11.3 Relationship between usefulness of ways of communicating information and weed incidence and management effort	90
A2.6.12 Different Relationships Within the Demographic and Farm Groups	93
A2.7 Discussion of Findings	96
A2.7.1 The 3 ‘Ds’ of Effective Weed Management	96
A2.7.2 Improving Weed Management – Adoption Paths in 3 ‘Ds’ Space .	100
A2.7.2.1 Poorer weed managers.....	105
A2.7.2.2 The ‘simple diligents’	107
A2.7.2.3 Assisting better managers to become better still	108
A2.7.2.3 Other implications for extension.....	108
A2.8 Supporting documentation	110
A2.8.1 Letter to weed authority staff	110
A2.8.2 Letter to livestock producers	111
A2.8.3 Mail survey for southern NSW	113
A2.8.4 Farm visit interview questions	121
A2.8.5 Email to weeds extension and regulatory officers	121

A2.8.6 Summary circulated to weeds extension and regulatory staff	123
A3.1 Telephone Survey Objectives	129
A3.2 Telephone Survey Details.....	129
A3.2.1 Method.....	129
A3.2.2 Nature of the sample	129
A3.2.2.1 Demographics.....	129
A3.2.2.2 Farm characteristics.....	131
A3.2.3 Telephone Survey Findings	132
A3.2.3.1 Weed awareness and identification	132
A3.3.2 Attitudes to weed control.....	132
A3.3.3 Motivations for weed control.....	132
A3.3.3.1 Types of motivations	132
A3.3.3.2 Factors related to fitting in with other farming operations.....	134
A3.3.3.3 Factors relating to weed life cycle	136
A3.3.3.4 <i>Factors relating to weed levels</i>	137
A3.3.3.5 <i>Factors relating to time of year</i>	138
A3.3.4 Motivation differences between croppers and graziers	138
A3.3.5 Motivation differences between those with high and low predicted weed incidence.....	139
A3.3.6 Barriers to effective weed control.....	139
A3.3.6.1 <i>Types of difficulties</i>	139
A3.3.6.2 <i>Difficulties amenable to management</i>	141
A3.3.6.3 Difficulties beyond management control	142
A3.3.7 Differences in barriers nominated by cropper and graziers	143
A3.3.8 Differences in barriers between those with high and low predicted weed incidence.....	143
A3.4 Self-Reported Weed Levels	144
A3.5 Discussion	145
A3.5.1 Identifying non-adopters.....	145
A3.5.2 Motivations.....	145
A3.5.3 Barriers.....	147
A3.5.4 Implications for extension	147

A3.5.4.1 Relationship between motivations and the 3Ds of weed management147

A3.5.4.2 Motivation, adoption paths and extension message content..... 149

A3.5.4.3 Other extension and communication considerations 150

A3.6 References151

A3.7 Detailed regional frequency tables151

A3.7.1 Demographic Data.....151

A3.7.2 Agricultural Education154

Farm Data.....157

A3.7.4 Regional Weeds.....159

A3.7.4.1 Northern NSW 159

A3.7.4.2 Southern NSW..... 160

A3.7.4.3 North eastern Victoria 161

A3.7.4.4 Central and Western Victoria 162

A3.3.7.4.5 South Australia 163

A3.7.4.6 Western Australia 164

A3.7.4.7 Tasmania 165

A3.7.5 Weed Levels.....166

A3.7.5.1 Reasons for high weed levels 167

A3.7.5.2 Reasons for low weed levels 168

A3.7.5.3 When weed control becomes a priority..... 170

3.7.6 Weed Control Methods171

A3.7.7 Difficulties encountered in weed control.....173

A3.7.8 Sources of information180

A3.7.8.1 People..... 180

A3.7.8.2 Written sources..... 186

A3.7.8.3 Other sources 189

A3.8 Supporting Documentation190

A3.8.1 Telephone interview schedule.....190

A4.1 Background.....197

A4.2 Overview of event.....198

A5.1 Australian Sources.....200
A5.2 International.....202
**A5.2 Paper submitted to the Australian Journal of
Experimental.....210**

1 Background

Weeds are a costly problem in livestock grazing systems. Weeds compete directly with more desirable pasture species for light, water and nutrients, lowering livestock productivity and reducing profit margins because of the costs of control. Management practices that sustain and revive the pasture resource and provide long-term solutions to weeds have been developed. However, adoption of these practices has not been widespread, and only a relatively small proportion of landholders achieve effective weed control. The challenge is to communicate information to, and motivate, the large proportion of landholders that are not controlling weeds effectively.

An understanding of the social dimension of weed control is necessary to influence change. Farmers and farms are not homogenous, but vary in many ways, including size of enterprise, propensity to adopt new ideas, soil types and fertility, vegetation cover, topography, climate, and weeds present. Farmers will differ in their opinions about the desirability of a plant, so that 'one grazier's weed is another grazier's feed'. Understanding how these kinds of factors influence weed management is crucial to promoting improved management of weeds across grazing industries.

1.1 Objectives

The purpose of this project was to conduct social research to understand the decision making process of weed managers across the southern Australian sheep and cattle grazing industries, identify motivations for action, barriers to the adoption of better weed management and develop strategies for overcoming these barriers and capitalising on the motivations.

Specific objectives of this research were to:

1. Establish the broad scope of potential reasons why graziers do not adopt improved management practices, with particular reference to existing proven management practices,

The Sociology of Weed Management

2. Identify producers' motivations and perceived disincentives for effective weed management,
3. Work collaboratively with researchers from a complementary project to develop and recommend strategies, tactics, processes (and associated evaluation methods) for motivating effective weed management,
4. Communicate results to weed regulatory, extension, and research professionals, including those working on MLA approved projects,
5. Complete, and have approved by MLA, a final report comprising the results of objectives 1 to 4.

2 Methodology

2.1 Literature review

A literature review formed the first phase of this project. The principal aims of this literature review were to:

1. Establish the range of factors that influence weed management on grazing properties,
2. Bring sociological insights to understanding the decision making process of farmers when considering adoption of agricultural innovations.
3. Enable refinement of survey questions and interpretation of the resulting data, such that the principal motivations and barriers to effective weed management on grazing properties can be identified,
4. Assist in developing a set of recommendations to identify opportunities and provide direction for further weed management extension activities.

Information was distilled from the literature produced by industry groups, government and non-government agencies, research organisations, and from scientific journals and conference proceedings. Review of the written literature was supplemented by consultation with stakeholder organizations, including catchment management authorities, weed advisory boards, local councils. The complete literature review is presented in Appendix 1.

2.2 Field visits

The data for this study were derived from personal interviews with livestock producers in temperate pasture systems (average annual rainfall >500 mm) of New South Wales and Victoria. A questionnaire was left with the interviewees for completion and return at their convenience. A literature review, together with discussions with weeds regulatory and extension staff, informed the development these survey tools. A total of 122 interviews were conducted in north-east (31) southern New South Wales (58) and in south-east Victoria (33).

The majority of interviews (88) were conducted on the property of the participating livestock producer. In New South Wales another 34 interviews were conducted off-farm with livestock producers participating in the Lockhart Drum Muster (31) and a small number (3) that took place at a location specified by the interviewee, usually at local government headquarters.

Property owners were first contacted by the local weeds authority officer, to arrange permission for the IRF researcher to accompany them onto the participants' property, and to arrange a suitable time for an interview to occur. An advantage of this approach was a

personal introduction to landholders by a locally known and trusted individual. This was important in gaining access to landholders who would not normally respond to less personal mail and telephone survey, so reducing non-response bias (Armstrong and Overton 1977). Another advantage was that, for each property visited, weed incidence and weed management effort was rated on an eight-point-scale, aided by the weed officers' local weed expertise and knowledge of management history. These ratings assisted in profiling graziers with respect to their effectiveness in controlling weeds.

The interviews were conducted with primary weed managers (i.e. individuals with primary or shared responsibility for weed control decisions). Participants were asked to name plants locally problematic to grazing, and describe the reasons why these plants were a problem. Interviewees were also asked what they considered important when choosing methods of weed control, and what they regarded as the key element in a good weed control program.

The mail questionnaire returned by interviewees gathered data on: weed awareness, views about how much weeds were reducing returns, use and opinions of various weed control strategies, difficulties encountered with weed control, farmer demographics and farm characteristics, attitudes towards weed control, and perceptions of the usefulness of various sources for information relating to grazing weeds. The full report, including the detailed results of the field survey and supporting documentation, is presented in Appendix 2.

2.3 Telephone survey

Australian Bureau of Statistics (ABS) Agricultural Census data was used to prepare a list of the local government areas in New South Wales, Victoria, South Australia, Tasmania and Western Australia which contained 90 per cent of the total number of cereal-sheep and cattle establishments in those States. The list was adjusted to ensure that only local government areas in the southern cereal and higher rainfall zones were included. GIS software was used to obtain a list of postcode areas covering these local government areas. Telephone interviews were carried out by a market research firm, Taverner Research of Sydney, drawing telephone numbers randomly from within these postcodes. Only respondents with more than 500 sheep and/or 60 cattle were included in the survey. Sampling was stratified by State to provide the best possible confidence intervals on estimates of proportions for each State, while maintaining a total sample size of 800. With a sample of 48 in Tasmania and samples of 188 in each of the remaining States, it was possible to obtain confidence intervals on estimates of proportions around ± 10 per cent (calculated with the finite population correction) in each of the State. Unless otherwise noted, the figures in tables in this report are weighted to the actual distribution of establishments across States. A total of 815 interviews were obtained. The full report, including a detailed results of the telephone survey and supporting documentation, is presented in Appendix 3.

2.4 Communication of results

2.4.1 Discussion group with New England Weed Authority

Once the data from the field visits had been analysed, a discussion group was held at IRF on December 1, 2005, to present the main results (see Appendix 2) to the staff of New England Weeds Authority – an organisation active in both an extension and regulatory capacity. These officers had been involved in the project from the earliest stage, providing important insight into the weed control situation on grazing properties. The majority of these staff had also accompanied Ms van der Meulen on the field visits carried out in the New England Region.

This discussion group served as an important check point, with the feedback from these officers being noted and used in future stages of the project. The group also provided validation that the results of the field survey accurately depicted the weed control situation on grazing properties. Such verification was necessary to the development of the telephone questionnaire, so that the questions were designed on sound principles. Further, it provided IRF with an opportunity to communicate results to the staff of New England Weeds for use in planning and evaluating their own activities.

2.4.2 Circulation of results via email

To further validate the results of the field visit data, and especially to ensure that the results were equally applicable across all parts of the perennial grazing regions of southern Australia, a summary of the results was circulated (via email) to weed control and extension officers in Southern NSW, Victoria, South Australia and Western Australia. These officers were first telephoned to introduce the project and obtain their cooperation in providing feedback on the report.

A copy of the email and associated summary is presented in Appendix 2. This email was sent on March 3 2006, with responses generally received within 2 weeks of this date. Most officers responded by email, although some provided feedback via telephone. Responses were generally affirmative, with no significant issues arising that contradicted the results.

2.4.3 Journal article and conference proceedings

In order to communicate the results to a wider audience of weed professionals, the main findings of the research were consolidated into two conference papers. These papers are provided in Appendix 6.

Dr Reeve presented the paper 'Insights into motivations and barriers for weed control in temperate grazing systems of southern Australia' at the Facilitating Adoption of No-tillage and Conservation Farming Practices Conference, at the Sustainable Farming Training Centre at Tamworth on March 29, 2006.

Ms van der Meulen is to present the paper 'Insights into motivations and barriers for weed control in grazing districts of southern Australia' at the 15th Australian Weeds Conference in Adelaide on September 25, 2006.

2.4.4 Workshop

On 18 July 2006, MLA hosted a workshop in North Sydney involving the Weed 120 and Weed 124 Project teams (IRF and Rural Enablers, respectively) and professionals working

in weeds research and extension. This workshop was organized by IRF, for the purpose of providing research and extension staff with a brief introduction to the issues they need to consider in the design, delivery, and evaluation of weed communication strategies. Weeds research and extension agents involved in this workshop represented Weeds Australia, the University of Sydney, and the Department of Primary Industries in Queensland, New South Wales, and Victoria. These individuals were identified by MLA as working in areas relevant to the two Projects.

After presentation and discussion of the findings from the two Projects, participants were assigned into two groups to discuss one of two topics relevant to the projects being carried out by the workshop participants. The two topics were:

1. Assisting woolgrowers to use an integrated approach in the management of serrated tussock in native pasture systems with poorer soil and difficult terrain.
2. Working with extension staff and woolgrowers to control Prairie Ground Cherry and Silver Leaf Nightshade in disturbed environments, involving bio-economic modelling and other tools.

In each group, members of the Weed 120 and Weed 124 Project teams were present to facilitate and guide discussion. Each group were to identify challenges and strategies specific to their topic, drawing on the findings of the Weed 120 and Weed 124 Projects. The results are presented in Appendix 4, which is the summary report for this workshop.

2.5 Evaluation resources

A small collection of evaluation resources was compiled with a view to providing weed research and extension staff with the tools they will need to evaluate the impact of their weeds extension programs. The evaluation resources are provided in Appendix 5.

3 Discussion of Project Findings

3.1 Introduction

This section draws together the findings of the various phases of the project, as well as providing a number of observations about broader extension issues that have become apparent in the course of undertaking the project. In the latter case, and where appropriate, reference is made to the findings of the parallel project to this one, Weed 124.

3.2 The magnitude of the problem

Weeds are recognised as a major threat to both agricultural and native vegetation systems in Australia (Nugent et al. 1999). The naturalised flora of Australia consists of about 2700 species believed to be non-native. Those posing a problem for agricultural systems number 1266 species, 35% of which represent a major problem. Sixteen of these species are currently subject to nationally or state-coordinated eradication programs throughout

their known range because of their impacts on agricultural ecosystems (Groves et al. 2003).

Many of the factors contributing to the on-going problems with weeds in Australia are well recognised (ARMCANZ 1999). They include:

- the gradual development of weed problems,
- the phenomenon of sleeper weeds,
- the tendency of weeds to colonise disturbed areas,
- persistent failure to recognise the scope of weed problems,
- mixed private and public benefits to weed control and the difficulty in identifying who should pay for weed management,
- treating the symptom rather than the cause,
- problems with weed legislation,
- over-reliance on chemical control,
- unduly high expectations of biological control, and
- the lack of a process for resolving conflicts of interest where weeds may be a benefit to some but a cost to others.

As a consequence, weed levels on many farms are higher than they need be, and there would be both private and public benefits in reducing weed levels. Weeds in pasture systems are estimated to cost landholders and the community between \$1 billion and \$1.87 billion per year (Burton and Dowling 2004; Sinden et al. 2004).

3.3 Policy context

The potential public, industry and private benefits in reducing weed levels is the central justification for public policy directed at improved weed management. The benefits from improved weed control include:

- increased production (private benefit),
- maintaining product quality and market access (private and industry benefit),
- eventual decrease in weed control costs across the industry (private and industry benefit),
- eventual decrease in weed control costs on public land (public benefit),
- reduction in threats to biodiversity in public reserves (public benefit).

The costs of achieving the benefits listed above can be borne privately or publicly or both. As in other areas of agricultural and natural resource management policy, the appropriate policy approach is determined by the balance of public and private costs and benefits, and

The Sociology of Weed Management

by whether or not coordinated action is required to obtain the benefits. Some examples of this are:

- if a weed is non-invasive and no threat to the industry or the environment, i.e. costs and benefits are entirely private, then control may be left individual decision making,
- however, if in the above situation there is a loss of production, and there is a government agency with a mandate to increase agricultural production, then public funding may be used for research and extension to improve control of the weed,
- if failure to control a weed results in product quality or market access problems that disadvantage the whole industry, then industry-wide research, extension and compliance monitoring may be funded privately (industry levies on individuals), possibly augmented by matching public funds,
- if failure to control a severely invasive weed imposes costs on other landholders, regardless of which commodities they produce, compliance may be obtained through extension and regulation with a legislative basis, with the costs of monitoring and prosecution publicly funded, possibly with some recovery of costs through imposition of fines,
- if failure to control a weed does not affect agricultural productivity but threatens to degrade biodiversity on public reserves, then control may be encouraged by publicly funded education and extension activities.

In general, the more severe the spillover effects from one property to another (i.e. the more readily the weed spreads) and the more severe the costs to production and product quality, the more likely there is to be public investment in weed control and the more likely there is to be some form of compliance monitoring and penalties for non-compliance.

However, for many weed species, the threat to production (or the political appreciation of the threat to production) and the spillover effects have not become sufficiently large to warrant major public investment in regulatory approaches to obtain compliance. Consequently, there is a large number of weed species where the policy approach is one of moderate to minimal public investment in education and extension to encourage voluntary adoption of control practices, with the costs of adoption being largely borne privately.

This policy approach has been widely used in agriculture and natural resource management for a considerable period of time and has evolved many variants. There has also been much research into this form of extension, both in Australia and internationally. This research has been located in various schools of thought or paradigms in the social sciences.

Consequently, there are a wide range of extension approaches which vary according to the source of public funding (Commonwealth, State or local government), the extent of industry contribution, the extent of individual contribution and the rationale underpinning the approach. The latter rationales are located in such areas as:

- economics – adoption as private rational calculation and extension as a response to market failure,
- constructionist sociology – adoption as assimilation of new practices into how farming is seen by the individual and extension as a dialogue between professional and farmer perceptions of agricultural production,
- social and behaviourist psychology – adoption as a behaviour explained by personality and attitudinal traits, and extension as communicating information to specific groups of farmers defined by these traits,
- realist sociology and hard systems – the Wageningen school where adoption and extension are conceptualised as components of an Agricultural Knowledge and Information System,
- social ecology and soft systems – adoption as an iterative process of observation, reflection and action and extension as facilitation and capacity building, and
- education – adoption as learning and extension as teaching.

While the more enthusiastic proponents of a particular rationale might wish to claim its universal applicability, a pragmatic and less partisan assessment would conclude that different rationales are suited to developing weeds extension strategies in different situations. For example, an economic rationale would apply to a region where farming was profitable and farmers were young, well-informed and information-hungry. If the market had failed to provide information on simple practices to combat a particular weed, then all that is needed is some public investment to make the information available and farmers rationally pursuing their self interest will do the rest.

On the other hand, an educational or social ecological rationale might apply to a region where farming was less profitable, returns to weed control were lower and the methods of control complex and demanding.

Further discussion of the rationales for extension strategy design and the social institutions by which strategies are implemented lies outside the scope of this project, although discussion of these issues is to be found in the Weed 124 project report.

3.4 Adoption paths and segments

Regardless of the extension approach and the social and institutional context within which extension programs are implemented, there will be always a requirement that farmers become aware of new practices, assess the applicability to their situation and possibly trial and adopt the practices. It is this aspect that is the central focus of this project.

It is generally accepted that the practice of farming requires constant adjustment to the production system and enterprise mix in response to input and commodity prices, emerging natural resource management issues, new technologies and changing personal goals and family circumstances. In addition, the adoption of a particular practice is often

dependent upon other practices already having been adopted. From this perspective, the sequence of adoption of new practices and the discarding of old ones can be seen as an adoption path leading from one way of farming towards some other way, with various practices adopted and discarded along the way. Of course, any one farm will be on a number of paths simultaneously, e.g. reducing sheep flock size and increasing cattle numbers in response to commodity prices, moving from cattle breeding towards steer fattening in response to declining physical capacity with age, moving from pasture re-sowing to grazing management in response to rising costs of pasture establishment.

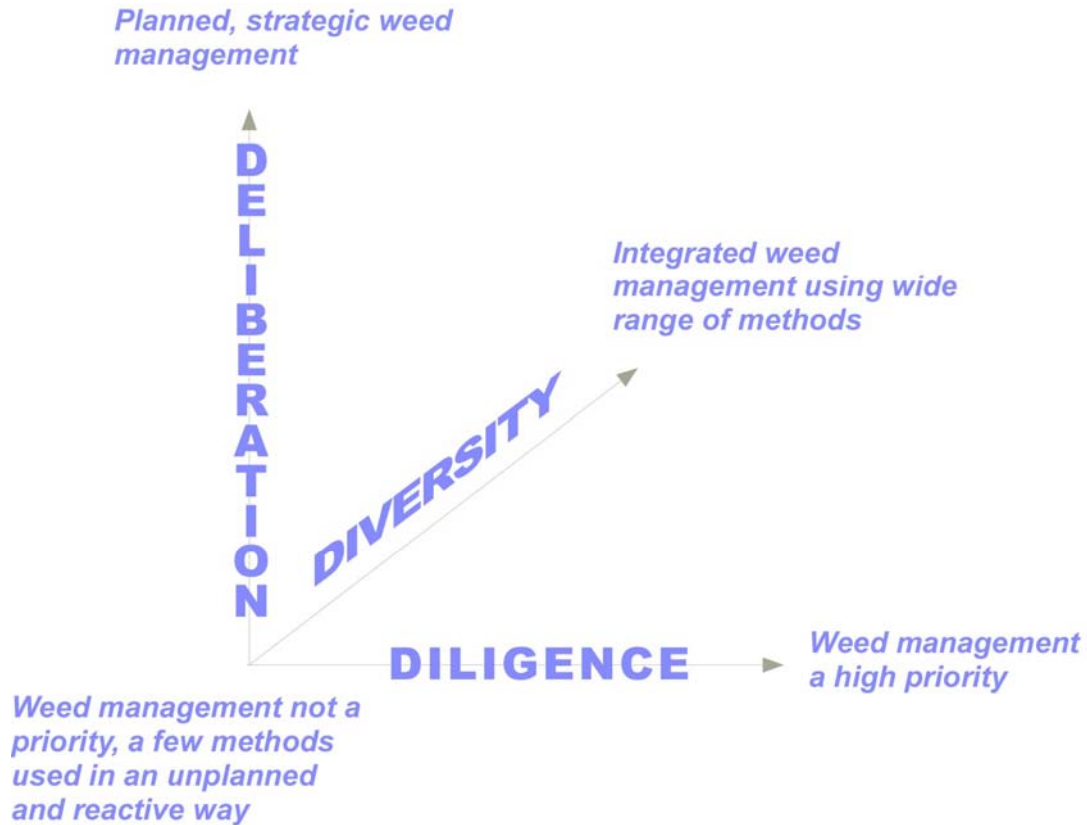
For a particular set of adoption paths, the population of farms will be located at different points along the paths. The farms at a particular point will tend to be similar in terms of their production systems, practices in use and practices which can potentially be adopted. The position of a farm on an adoption path may also reflect the personal goals, family situation, risk preferences and farming style of the farm business partners. It is these groupings of farms that are of interest in segmentation and social marketing approaches to extension (see Appendix A1.6.1 of this report and section A1 of the Weed 124 Project report).

The adoption path with which this project is concerned is that from ineffective or non-existent weed control towards effective weed control. The on-farm interviews, interviews with weeds officers and telephone interviews with farmers suggested that there are three key factors involved in improving weed control. These have been labelled as the 3Ds of effective weed control:

- Deliberation (planned, strategic and integrated weed control),
- Diversity (of methods), and
- Diligence (in application of methods).

While it is obvious that an improvement in any of the three factors will lead to better weed control, the findings from the mail-back survey support the view that there is not a simple linear adoption path from the unplanned, reactive, and ad hoc application of a few simple weed control methods to the planned, strategic, integrated and diligent application of a diversity of methods. The nature of the possible adoption paths and the segmentation of farms relative to these paths can be conveniently summarised in a three-dimensional space (Figure 3.1).

Figure 3.1 The 3Ds of effective weed management define a 3D space.



The data from the mail-back survey suggested that farms were not distributed uniformly in this three-dimensional space (Figure 3.2). The fact that relatively few farms lie in the lower, left, back part of Figure 3.2 is consistent with the realities of weed management, i.e. the use of a range of weed control methods results in some of the methods being the more complex ones, which require a certain amount of planning in their use. So it is unlikely that very many farmers will be using the more complex methods in an unplanned, reactive way.

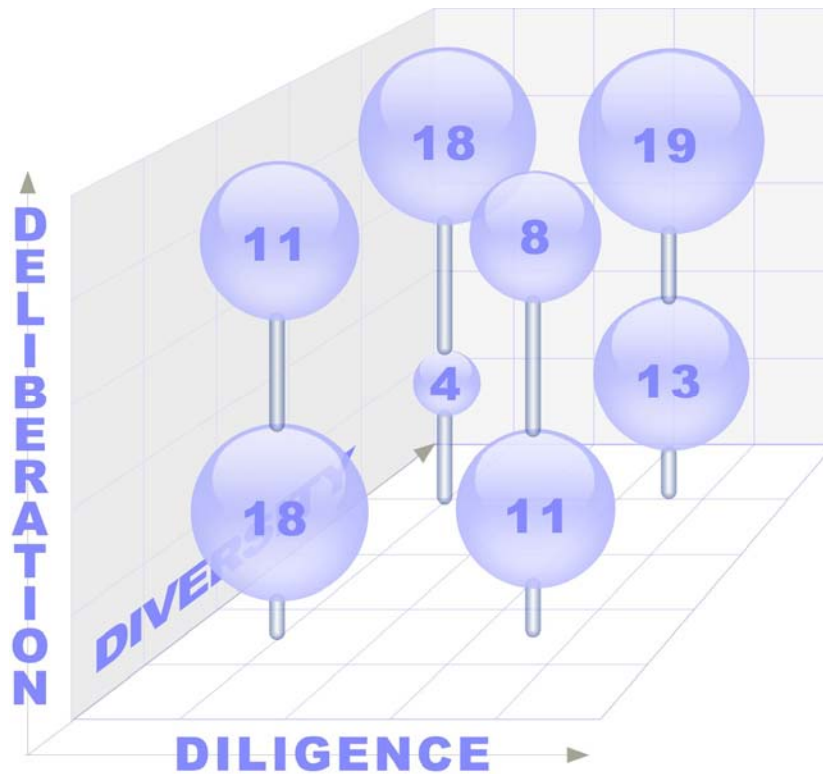
3.5 Motivations and barriers

Before proceeding to a fuller discussion of adoption paths towards improved weed management and the implications for weeds extension strategies, it is necessary to introduce the other area of emphasis in this project – motivations and barriers.

It is generally accepted that adoption of a new farming practice involves a number of steps. An example of the sequence of steps in adoption is shown in

Figure 3.3. Further examples are given in section A1 of the Weed 124 Project report.

Figure 3.2 Distribution of respondents to the mail-back survey in the space defined by the three dimensions of Diligence, Diversity and Deliberation. The numbers on the spheres are the proportion of respondents in that region of the three dimensional space.



Many of the models of the adoption decision process assume initial steps relating to awareness, problem recognition, and acceptance that the problem is amenable to management action. However, for many weeds, the problem is already recognised and management action is being taken, but with unsatisfactory results. Many of the properties visited for the on-farm interviews had weed levels regarded by the accompanying weeds officers as somewhat or very unsatisfactory, yet in all cases the managers were undertaking weed control practices.

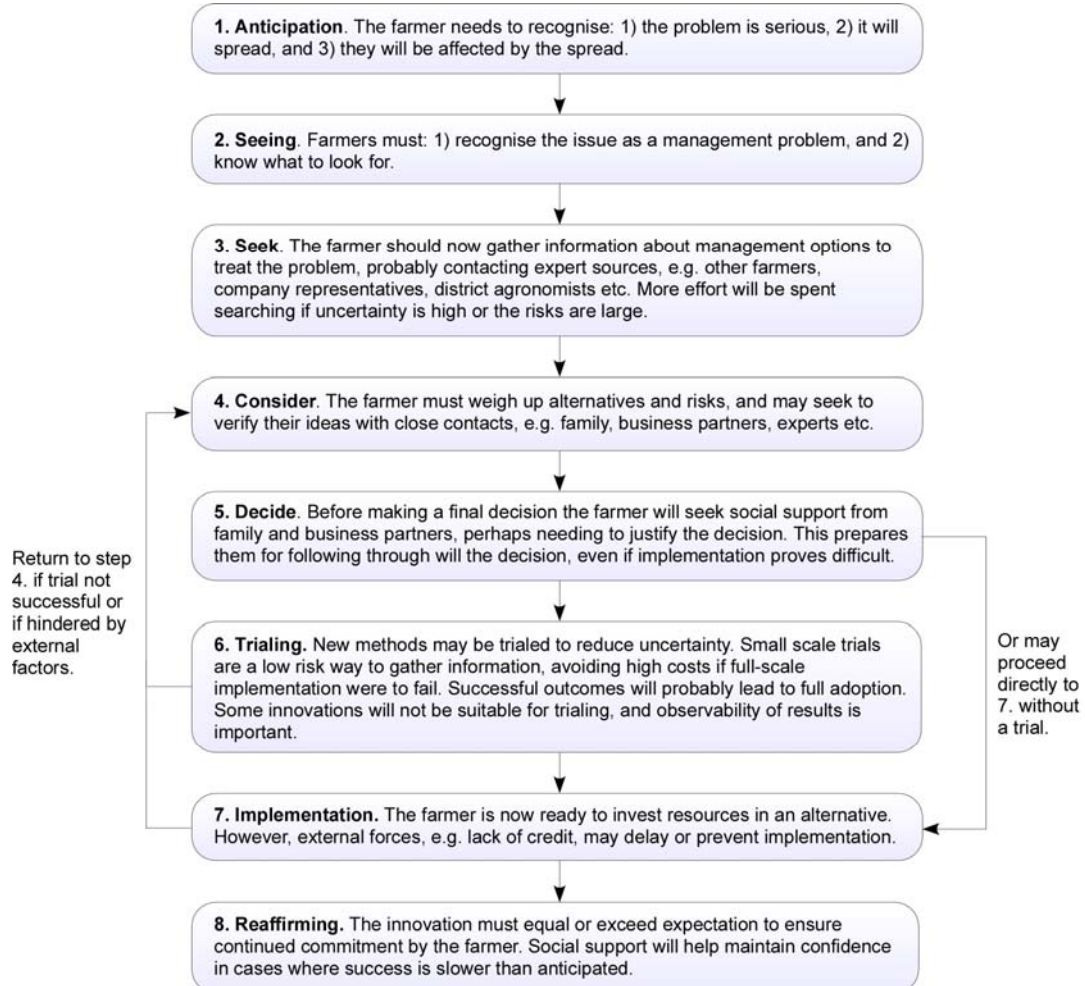
The telephone survey asked farmers about whether particular weeds were in their district, were regarded as a weed and were easy or difficult to identify. The results from these questions are reported in Appendix 3.7. It can be seen there are distinct differences between weeds, with:

- some common broadleaf species such as blackberry and gorse being almost universally regarded as ubiquitous, a weed and easy to identify,
- grasses, such as barley grass, being almost universally regarded as ubiquitous and easy to identify, but with opinion divided as to whether it was a weed or not,
- grasses, such as tussock grass, being almost universally regarded as a weed, but with substantial numbers of respondents who believed it was not in their district and substantial numbers who were unsure whether it was easy or hard to identify, and

- grasses, such as Chilean needle grass and African love grass, where substantial numbers are unsure whether it is in their district, unsure whether it is a weed and unsure whether it is easy or hard to identify.

Figure 3.3 Eight stages of decision-making in the adoption process (after Barr and Cary, 2000).

The Sociology of Weed Management



These differences highlight the need for weed extension strategies to be tailored very specifically to individual weeds. There is strong evidence from the telephone survey that there is a need to raise awareness of the existence of some of the lesser known grass weeds and of their impacts on production, whereas there is no need for investment in awareness raising for weeds such as gorse and blackberry.

If farmers are already using weed control practices, but without achieving satisfactory levels of control, then it is important to have an understanding of what is motivating their current control efforts and what they regard as difficulties that work against increased effort or effectiveness.

In the telephone survey, data on motivation was obtained from the responses to the question:

...when you are thinking about the jobs you have to get done in the coming few days or weeks, what reasons will cause you to put weed control in a particular paddock or place on your property at the top of the list?

It was found that there were a wide range of motivations reported. Grouping these into 11 main categories, it was found that motivations relating to weed life cycle, fitting in with other farming operations, times of year and high weed levels were mentioned by between 20 and 40 per cent of interviewees. It is worth noting that the motivation that is often the basis of extension communication – awareness of the impacts on productivity – was mentioned by only 16 per cent of interviewees. However, in the mail-back survey, when asked specifically about the reduction of returns by weeds, over 90 per cent of respondents indicated that reduced pasture production or costs of controlling weeds resulted in a big reduction, or some reduction in returns. This suggests that, although many producers are well aware that weeds are costing them money, it is not necessarily this aspect that motivates day-to-day decisions about weed control.

Interviewees could supply more than one motivation and there were 63 different combinations of motivations given, the most popular of which – the single motivation of fitting in with other farming operations – was given by only 14 per cent of interviewees.

In addition to motivations relating to the priority placed on weed control in farm operations, the on-farm face-to-face interviews asked what had motivated producers to change their weed control methods. The most frequently mentioned reason was a worsening weed situation (30 per cent), followed by a desire to increase production (15 per cent).

Further evidence for the diversity of motivations was obtained in the on-farm interviews and interviews with key informants. Table A2.7.1 in Appendix 2 provides an extensive list of motivations ordered according to the stages in

Figure 3.3, above.

The barriers that interviewees believed they faced in controlling weed fell into two groups: those that are feasibly within management control, such as lack of time, money or labour; and those that are beyond management control, such as drought, neighbours with weeds, or weeds on adjoining public land. Lack of time and lack of money were the most frequently mentioned (two thirds of interviewees). Neighbours with weeds, lack of labour and drought were mentioned by between two thirds and half of the interviewees.

Weed levels on farms represent a balance struck by managers between the barriers and difficulties they face, and how hard and how effectively they are prepared to work to overcome these barriers (

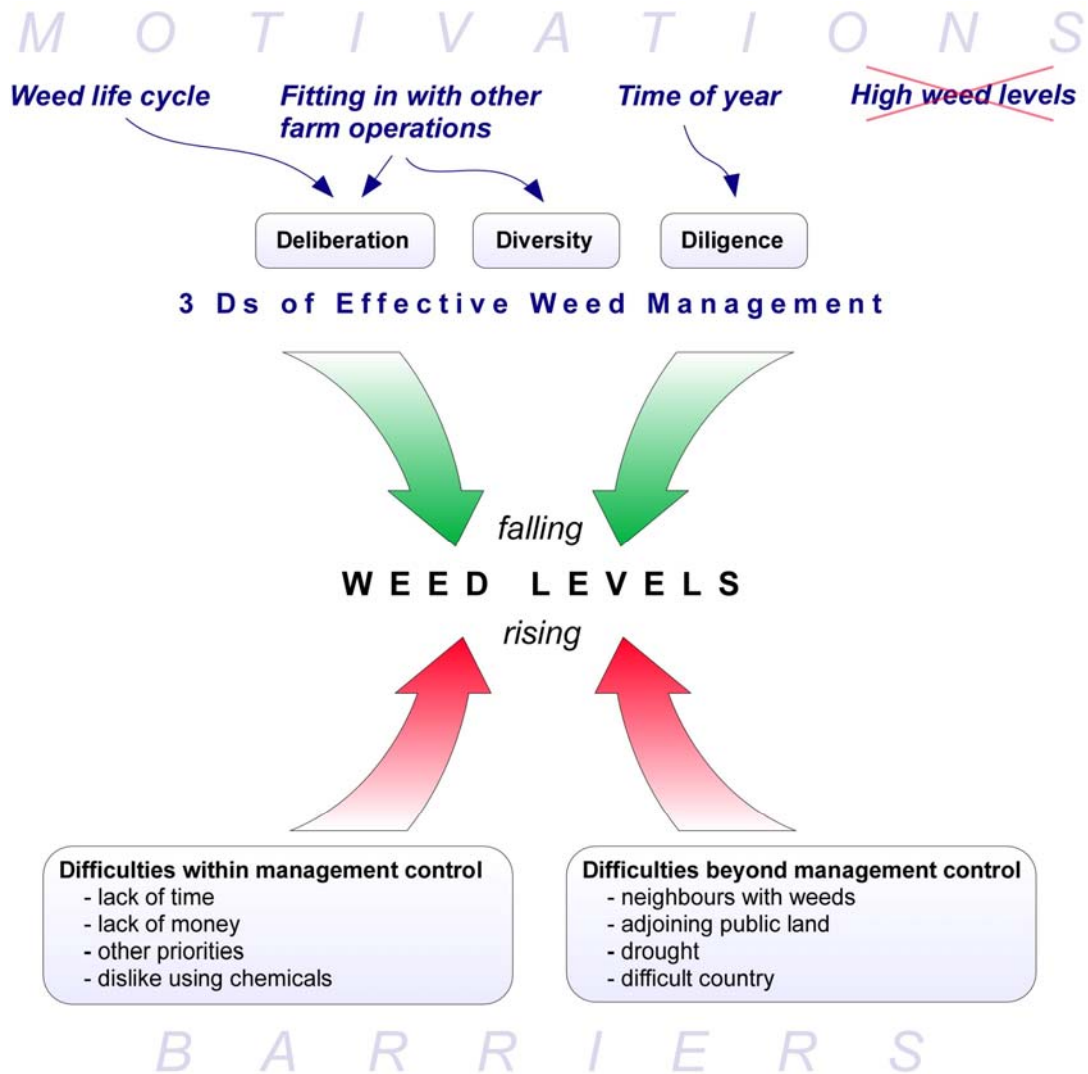
Figure 3.4). The effectiveness of weed control efforts is a function of the 3Ds described in the previous section, and the motivations that influence day-to-day weed control decisions.

The data from the telephone interviews suggested that those who gave a single motivation relating to weed life cycle appear to be the better weed managers who place a higher priority on weed control. Fitting weed control in with other farm operations was associated more with sheep-wheat production than with beef cattle production, and it appears that the need to fit weed control in with other operations may result in lower priority being placed on weed control. Poorer weed management also appears to be associated with weed levels and time of year as motivations for weed control. Clearly, waiting until weed levels are high before acting is inconsistent with the 3Ds for effective weed management (as indicated by the red cross in

Figure 3.4). The association between time of year as a motivation for weed control and poorer weed management may reflect a tendency for some producers to undertake particular weed control operations routinely at a particular time of year, without paying too much attention to the life cycle stage of the weed or other factors important in the weed control decision. However, as suggested in

Figure 3.4, weed control undertaken at particular times of year, with due consideration of other factors can improve the diligence of weed management efforts.

Figure 3.4 Schematic of the relationship between motivations, barriers and the 3Ds of effective weed management.



The findings from the telephone interviews also indicate that it is the poorer weed managers who believe they are prevented from improving weed control by factors such as lack of time, money and labour – factors that may well be within their own management control. This suggests that there will be situations where improving the standard of weed management will require first that overall farm management and profitability are raised to higher standards. In comparison, the better weed managers appear to be more troubled by spillover effects from adjoining properties.

3.6 Extension strategies

The Sociology of Weed Management

The findings of Weed 120 (this project) and Weed 124 (the Rural Enablers' project) both point to the critical importance of tailoring extension strategies to the weed problem on hand. This careful design of the fit between the problem and solution involves consideration of:

1. the nature of the weed and its behaviour in the agricultural production system,
2. the technical options for control,
3. the nature of weed management that is currently occurring or not occurring,
4. the reasons for ineffective weed management,
5. the capacity of farm businesses to support improved or changed weed management,
6. the distribution of costs and benefits of improved or changed weed management, and
7. the most appropriate and effective way to bring about these improvements or changes, given the incentives and disincentives for action resulting from distribution of costs and benefits.

As discussed in the Weed 124 report, various people could find they have a responsibility to undertake extension strategy design taking account of the points listed above, e.g. a national MLA/AWI funded coordinator, or a local group taking on a particular weed problem and building capacity in their locality.

The design of extension implementation, point 7 above, is dealt with in comprehensive detail in the Weed 124 report.

From the experience with this project, some observations can also be made with respect to point 6 above, however the findings from this project relate mainly to points 1 - 5 above. The following sections set out the main findings as a series of check questions and principles to be followed in developing weed extension strategies. It is assumed that assessments at a national or regional level have already been carried out to identify which weed or weeds will be the focus of extension effort.

Principle 1: Extension strategies have to be tailored to a particular weed, a particular agricultural production system, and a particular social and institutional setting.

The telephone survey showed there were marked differences in levels of awareness and knowledge about different weeds, while the workshop with researchers showed how the extension strategy to be used was critically dependent of the nature of the weed, the production system and the capacities of managers.

Check question 1: What are the key characteristics of the weed?

Knowledge of the weed life cycle, means of spread, conditions favouring or constraining reproduction and spread, and future potential are essential.

Check question 2: How do the weed and the production system interact?

This nature of this interaction determines how the production system might have to be modified, what new practices might be needed (which assumes these are known), and what old practices might need to be dropped.

Principle 2: *The greater the diversity of control methods, the greater the possibility producers will find a way of controlling the weed that suits their situation.*

It is important in the early stages of developing an extension strategy for a particular weed to have information on all the possible ways of controlling it. Building an extension strategy on a single control method is likely to leave the weed poorly controlled on properties where the method is not suited to the production system or the producer's farming style.

Check question 3: *Upon whom do the costs of not controlling the weed fall? Does weed control require collective action to be successful? Are those who will benefit from weed control the same as those who have to bear the costs of achieving control?*

The answers to these questions are fundamental to specifying the institutional setting within which an extension program might sit. Parameters to be considered in defining the institutional setting include:

- the relative public and private contribution to research and extension,
- the level of involvement of industry organisations,
- the level of involvement of representatives of public environmental interests, such as environmental NGOs or government agencies with environmental responsibilities, and
- the balance between self-regulation and external monitoring and sanctions.

Further details are provided in section 3.3 and the Weed 124 report.

Check question 4: *Does the production system affected by the weed generate returns sufficient to invest in weed control? Will the value of increased production cover the cost of weed control? If controlling the weed is not economically rational for the individual, will it spread and generate further private and public costs, such that collective control is rational, even if it is not rational for the individual?*

The answers to these questions determine whether weed control can reasonably be expected to be a matter of private adoption, or whether collective action and possible public subsidy is required. Further details are provided in section 3.3.

Check question 5: *Who believes the weed is a problem? Producers, agricultural professionals or both?*

The answer to this question is critical in shaping extension strategy. If producers do not think the weed is a problem, the reasons for this have to be well understood. The findings from this project suggest that there are a number of grass weeds that are not well known to producers and which research and extension professionals believe may be reducing production. If there are practices available to control such weeds, then the first step of an extension program has to involve raising awareness and demonstrating the losses to production.

Producers may think the weed is a problem, but control is not economically rational, as mentioned in the previous check question.

Check question 6: *Why is the weed currently a problem? Is it lack of control methods, or are the available control methods ineffective, or are the methods effective but poorly used, or are the methods effective but not being used at all?*

The answer to this question is also critical in shaping extension strategy. Lacking or ineffective control methods point to the need for research before extension can be proceeded with. Poorly used methods means extension has to focus on refining existing skills, whereas methods not being used at all points to the need for a broader extension program.

Check question 7: *If methods known to be effective are not being well used, why are they not resulting in effective weed control?*

The findings from this project suggest that, where well proven effective methods of weed control exist, ineffective weed control is likely to be due to a lack of diligence in use, reliance on one or two (often herbicide-based) methods, or unplanned, reactive weed control, or some combination of the three. The design of extension strategies to improve the effectiveness of weed control requires knowledge of the contribution of each of these factors to the problem.

Principle 3: *Each of the 3Ds of effective weed management requires its own extension approach.*

Increasing diligence in application of methods with which the producer is already familiar and can use competently, requires a knowledge of what motivates producers to use the particular method for a particular weed in a timely fashion. This project suggests four motivations are fairly common among producers: those related to weed life cycle, those related to fitting in with other farm operations, those related to time of year and those related to weed levels. However, there are many more motivations and combinations of motivations and those applicable to a particular weed and method of control will need to be identified.

There are a number of simple extension messages which can remind producers to control weeds in a timely fashion:

- calendars of weed control activities directed to those who work to a fixed calendar of farm activities,
- warnings on local radio or in local newspapers about early germination, flowering or seed set directed to those who time their activities around weed life cycles,
- warnings on local radio or in local newspapers about particular weeds being present in greater densities than is immediately apparent, and
- simple hints about weed control opportunities that are generated by other farm operations (“Did you know that when you are doing X you could be doing Y to control weeds with little extra cost or effort?”)

Increasing the diversity of methods used for weed control requires the adoption of new weed control methods. Consequently, issues of trust and credibility of information and preferred ways of learning about new practices become important. The report for Weed 124 discusses the issue of trust and credibility in section A1 and A2. This project, consistent with the findings from Weed 124, has found that 'people sources', such as one-to-one advice, field days, workshops and discussion groups are preferred by producers to written or electronic sources. For this reason, extension approaches that build trust and credibility and use preferred modes of communication will be important for increasing the diversity of methods used in weed control.

The way in which trust and credibility are built will depend upon the institutional setting for the extension program. For example, for traditional extension by a government department, trust and credibility is built upon at least several years personal interaction with extension staff and a track record of delivering effective and successful changes to agricultural practices. For extension through an industry program, trust and credibility builds from industry organisations' track record in promoting and defending the interests of producers. For extension through a regulatory agency, trust and credibility is built from the agency's track record in being fair, flexible, helpful and empathetic in carrying out its regulatory mandate.

Increasing deliberation in weed control (i.e. planned, strategic, integrated methods), is likely to require an educational approach working through producer groups. This is because a planned, strategic and integrated approach to weed control requires learning about the ecology and life cycle of the weed in some detail, something which cannot be done effectively by the simple provision of information or at field days. In the last decade, there have been a number of successful group-based extension programs with a strong educational basis (e.g. BestWool, Wool for Wealth, TopCrop, TripleP, Grazing for Profit, ProGraze) and the design of educational, group-based programs for improving weed management skills should build on the experience with these programs.

Principal 4: Producers fall into different groups according to the level of deliberation, diversity and diligence into their weed management. Different groups need to follow different adoption paths.

The Weed 124 project report (section A1) and Appendix 1 in this report reviews some of the literature that argues for segmentation and social marketing approaches in agricultural extension. The on-farm interviews and the mail-back survey in this project support the view that there are different groups of producers with respect to how they are managing weeds and what their needs might be in improving their weed management. The nature of groups will vary from weed to weed and region to region, but there are at least two groups that will be reasonably universal, and around which extension strategies can be planned.

The first group of producers is those whose weed management is not at all effective. Their management is likely to be unplanned, reactive, based on very few methods of weed control and carried out in an ad hoc fashion. The findings from this project suggest that the best course of action to improve weed management by this group is to improve the diligence with which they tackle weed control. Weed levels are a trigger for action in this group and many may be waiting until levels are too high before taking action. In addition, many may feel that their best efforts will come to nought because of the vagaries of the

weather. This is a potent justification for neglecting weed control, especially among external locus of control personality types. There are a number of ways simple extension messages can help overcome some of these barriers to diligence in weed control.

Firstly, thresholds for action may be able to be lowered with visual communications about weed density along the lines that “If [a particular weed] looks like this [picture 1] on your place, then you are spending more money than you need to. The time to act is when it looks like this [picture 2], and it’ll cost you a lot less”

Secondly, the commonsense idea that ‘a stitch in time saves nine’ or ‘one year’s seed, seven years weed’ is widely accepted among primary producers. There are a number of areas where this idea can form the basis of extension messages. These include buying clean feed and confined feeding areas during drought, on-farm quarantine measures such as vehicle washdown areas, and use of certified seed in cropping.

Thirdly, extension messages that emphasise opportunities for weed control that arise in unusual seasonal conditions can be publicised when these conditions occur.

Lastly, extension messages can emphasise that, while livestock production and cropping is never simple, producers can make their weed control simpler by establishing a routine with a few straightforward methods and following it diligently.

While regulatory approaches might be considered as a means of increasing diligence, the findings from this project suggest these can only be a measure of last resort to deal with persistent and flagrant negligence to control seriously invasive weed species.

The second, fairly universal group of producers is those who are achieving reasonable to good weed control of the main declared and broadleaf weeds through the diligent application of a small number of methods. However, they may still be losing production to lesser known weeds. It is possible that rising chemical prices, the appearance of new weeds or increasing age could result in some members of this group slipping back into the poorer weed management group. The focus for maintaining and improving the effectiveness of weed management in this group should be upon developing skills in the identification of the lesser known grass weeds, alerting them when new weed problems emerge and increasing their awareness of the advantages of newer weed control methods.

There are also other segmentations of producers that will be suitable for tailoring extension strategies. For example, the mail-back survey data showed that producers could be divided into four groups according to the weed control practices they used: a group using relatively few practices, a group using mainly mechanical methods, a group using mainly grazing management methods and a group using most methods.

Check question 8: *Is lack of time and money the real reason that producers are not controlling weeds effectively?*

Lack of time and money is likely to be volunteered by many producers as the reason they are having trouble controlling weeds. This could mean three things:

- lack of time and money is the consequence of spending available time and money on other priorities believed to be more important than weed control,

The Sociology of Weed Management

- the production system is not being managed in the most time-effective and profitable way, resulting in insufficient time and money available for weed control, or
- even with the best management possible, the production system will not provide the returns needed to invest in weed control.

The last of the three points above is dealt with under check question 4. The second point above implies that weed management extension will have to be carried out in parallel with, or after, extension and education to improve management of the production system. In relation to the first point above, other priorities may or may not be more important than weed control. If priorities relate to personal goals, then the only approach is probably one of the educational, group-based extension approaches that encourages reflection on personal goals. The Weed 124 report provides information on a number of group techniques that could be adapted to this purpose.

Principle 5: Gaining reasonably precise estimates of weed levels by telephone interview is not practicable.

Evaluation of the impacts of weed extension programs require measures of what has been achieved. Consistent with the concept of Bennett's Hierarchy, the ultimate measure of impact, changes in weed levels, is the most difficult to measure. Apart from the influence of seasonal conditions on weed levels, it has been shown in this project that it is very difficult to obtain reasonable estimates of weed levels by telephone interview. However, it has also been shown that good estimates can be obtained from weeds authority staff who are familiar with weed levels in the district and the properties they visit. Consequently, the involvement of weeds authorities can assist with evaluation of extension programs, as well as with developing broad communities of practice in building local capacity.

4 Appendices

Appendix 1 Literature Review

A1.1 Overview

This literature review is the first phase of the project. The principal aims of this literature review are to:

1. Establish the range of factors that influence weed management on grazing properties;
2. Bring sociological insights to understanding the decision making process of farmers when considering adoption of agricultural innovations;
3. Enable refinement of survey questions and interpretation of the resulting data, such that the principal motivations and barriers to effective weed management on grazing properties can be identified;
4. Assist in developing a set of recommendations to identify opportunities and provide direction for further weed management extension activities.

A1.2 Introduction

Weeds are recognised as a major threat to both agricultural and native vegetation systems in Australia (Nugent et al. 1999). The naturalised flora of Australia consists of about 2700 species believed to be non-native. Of this total, 798 are considered a major problem in natural ecosystems. Those posing a problem for agricultural systems number 1266

species, 35% of which represent a major problem. Sixteen of these species are currently subject to nationally or state-coordinated eradication programs throughout their known range because of their perceived impacts on agricultural ecosystems (Groves et al. 2003). A common definition of a weed is simply a plant growing where it is not wanted. A species may be labelled a weed because of its geographical origin, because of its impact on a particular land use, or because of more encompassing effects on ecosystem structure and function (Grice and Brown 1996). Typical characteristics of weeds that make them unwanted include: contamination of agricultural produce; livestock poisoning; restriction to livestock movement and access to pastures; and because they occupy space and resources that could be utilised by more beneficial species (Grice 2003).

Weeds are an important economic problem in agricultural systems. Weeds have a direct impact by affecting the productivity of crops and pastures, resulting in a reduction in on farm income. The economic impacts of weeds are not confined to an individual farm. There may also be industry-wide impacts if weeds affect the supply and market price of a commodity. Externalities are prevalent where uncontrolled weed populations on an individual farm spread to neighbouring farms, imposing additional costs (Jones 2000).

Shortcomings of existing approaches to weed management in Australia have been highlighted by the National Weeds Strategy (ARMCANZ 1999). Reasons for these shortcomings identified in the strategy include:

- **Slow development of weed problems.** People do not identify a strange solitary plant or small group of similar plants as potential weeds. By the time realisation is achieved, the problem is costly and difficult to address.
- **Sleeper weeds.** Plants that appear benign for many years may suddenly spread rapidly after disturbance or after a change in conditions (e.g. land use).
- **Weeds invasion and disturbance are closely linked.** Most of the significant weeds are plants that are able to colonise disturbed areas. It is important to be aware of the danger of invasion following a disturbance event and to minimise opportunity for weed invasion.
- **Failure to recognise the scope of the weed problem.** Many people only consider a weed to be important if it affects them personally.
- **Difficulty in identifying who should pay for weed management.** Government has increasingly applied the 'beneficiary pays' principle for assigning the costs of weed control. Failure to identify the true beneficiary has led to inequities in assigning these costs. For example, farmers must pay to control noxious weeds that may not cause them personal economic harm, simply to prevent its spread into other areas. In such cases the true beneficiary may be the whole community in that region.
- **Treating the symptom rather than the cause.** Weeds are often a symptom of degradation caused by mismanagement. Failure to treat the problem rather than

the symptom will mean that direct weed control will require numerous applications and only achieve short-term success.

- **Problems with weed legislation.** Difficulties inherent in adhering to or enforcing the legislation that aims to improve weed control include: slowness of enforcement proceedings against landholders, giving the weed time to spread; reluctance by landholders to report new infestations of noxious weeds for fear that they will be compelled to personally bear the costs of control measures that have no immediate benefit to them; and insufficient government personnel to implement weed legislation effectively.
- **Over-reliance on chemical control.** The effectiveness and simplicity of herbicide control has also mitigated against the development of alternative approaches to weed control. Adoption of alternative strategies is now a matter of necessity due to the long-term disadvantages of herbicide control (e.g. resistance, human health, environment etc.).
- **Over-expectation of biological control.** A failure on the part of landholders to realise biological control is just one component of an integrated weed management program can result in reduced input into alternative methods for control if a biological agent is readily available.
- **No process for resolving conflicts of interest.** Stakeholders may hold different opinions on weed issues, such as responsibility for weed control and differences of opinion regarding the relative economic, social and biological values of particular plant species.

A1.3 Weeds in Pasture Systems

The temperate perennial pasture zone of southern Australia, which is the focus of this research, covers an estimated 26 million hectares, and produces nearly half of southern Australia's sheep and cattle products. This region has a temperate climate and higher rainfall, which fosters the growth of perennial species. Pastures in this region have typically been sown with mixtures comprising perennial grasses and legumes. However, other species usually establish themselves within a few years, and most pastures in the higher rainfall zones are typically complex mixtures of sown, volunteer exotic, and native plant species. A significant part of the total biomass is often species that are considered weeds for at least part of their lifecycle (Kemp et al. 1999).

A1.3.1 The cost of pasture weeds

Over half of Australia's land area is used for grazing livestock on plant communities typically referred to as grasslands or pastures (Dowling et al. 2000). Weeds in pasture systems are estimated to cost landholders and the community between \$1 and \$1.87 billion per year (Burton and Dowling 2004; Sinden et al. 2004). Weeds are not only a cause of pasture degradation but may also be a symptom of pasture decline. They

compete directly with more desirable pasture species for light, water and nutrients, lowering livestock productivity and reducing profit margins because of the costs of control. Weeds also harbour pests such as rabbits and foxes, and can act as hosts for plant diseases that can devastate crops growing nearby (Taylor and Sindel 2000).

Campbell (1997) divides significant pasture weeds into the following non-exclusive groups, according to their deleterious effects on livestock production.

Poisonous weeds. Weeds in this category cause death, ill-health, photosensitisation, bloat and allergies, resulting in significant losses in livestock production. Their greatest impact on production, however, occurs as a result of non-utilisation of affected pastures and non-achievement of breeding potential. Paterson's curse (*Echium plantagineum*) is an example of a weed in this category, being poisonous to livestock when consumed in large quantities, resulting in reduced livestock performance and even death.

Competitive weeds. Weeds in this category deprive pastures of water, nutrients and light. Invasion occurs primarily through their ability to establish, vigorous growth, and massive seed production. Annual grasses, such as *Vulpia* (*Vulpia* spp.) are typical of weeds in this category, and have become serious weeds of perennial grass pastures in temperate areas of Australia.

Unpalatable and/or unproductive weeds. Weeds in this category are unpalatable to livestock, and so tend to be avoided, enabling them to develop and multiply unhindered. They reduce the quantity of high quality pasture available, lowering the carrying capacity of land and resulting in production losses. Serrated tussock (*Nassella trichotoma*) is an example of a weed in this category.

Injurious and/or restrictive weeds. These weeds may possess structures that injure humans, working animals and livestock, and may form barriers that exclude people and livestock and harbour native and pest animals. Thistles, e.g. Saffron thistle (*Carthamus lanatus*), and burrs, e.g. Bathurst burr (*Xanthium spinosum*) are among the types of weeds represented in this category.

Weeds that depreciate the quality of livestock products. Weeds in this category reduce the price for meat and livestock products through contamination of the external fibre (e.g. from Bathurst burr), and damage to pelts (e.g. from the awned seeds of annual grasses), while others, such as Parthenium weed (*Parthenium hysterophorus*), produce taints in meat and milk products.

A1.4 Pasture Weed Management

Maintaining and improving the feed supply for livestock is the underlying objective of pasture weed management (Taylor and Sindel 2000). Recommendations for pasture weed management strategies are undergoing a transition. The use of herbicides and regular resowing of pastures has been effective in the past, but their use is now restricted by the growing realisation of the unfavourable economic, herbicide resistance, environmental, and human health issues associated with these practices. The emphasis of pasture weed management is now on the integration of weed management methods that aim to control pasture weeds in the long term by establishing and maintaining useful and well-adapted pasture species in a healthy and vigorous condition (Dowling et al. 2000).

A1.4.1 Current state of pasture weed management

Management practices that sustain and revive the pasture resource and provide long-term solutions to weeds have been developed (Burton and Dowling 2004). However, adoption of these practices has not been widespread, and only a relatively small proportion of landholders achieve effective weed control. Research indicates that awareness of the weed problem is high and landholders recognise the need for action. Lees and Reeve (1994) conducted an extensive mail survey of over 2000 producers as part of the Temperate Pasture Sustainability Key Program (TPSK). Meat and Livestock Australia initiated this project for the purpose of developing principles for manipulating pasture composition so as to improve the productivity and sustainability of grazing systems. The producer survey showed that producers listed stocking rate, weeds and grazing management as the most important factors affecting pasture quality and persistence. Further, in all but one region, producers ranked weed management as the highest priority issue in need of research. While the survey did not elicit producers' reasons for their ranking of issues in need of research, this high priority may indicate that weed control is regarded as a burdensome task which producers would prefer not to have to undertake.

A1.4.2 The social dimension of pasture weed management

The social dimension is increasingly being recognised as being vital to sound weed management practices (Grice 2003). Sindel (1996) surveyed graziers in northern NSW to investigate grazier attitudes towards weeds, research and education. Issues identified by this survey were: the spread of weeds from properties where weeds were permitted to grow unchecked; and the need for legal constraints to ensure control of noxious weeds was carried out by all landowners in an area. Some respondents to this survey mentioned worsening weed problems as being due to their inability to afford the time and financial costs involved in managing them. Such limiting factors were particularly significant where farms were left unattended for long periods, or were managed by older farmers (Sindel 1996).

A1.4.3 Land Stewardship

It is obvious that not all farmers are as effective as others at controlling weeds. This issue is highlighted in a paper by Rush (1996), who offers a practitioners' perspective of weed management based on his experience managing a mixed sheep and cattle grazing enterprise in North Central Victoria. Rush identifies a highly developed 'weed ethic' among the 'best farmers' in his region, who were diligent in controlling serious weeds. He pointed out that this diligence was not shared by all the farmers in his district, who had widely differing views towards weed control.

The concept of a land stewardship 'ethic' has been widely discussed in the sustainable land management literature. It is held that adherence to a land stewardship ethic would result in land users accepting a moral responsibility to manage the land as stewards on behalf of future generations. The land stewardship ethic has been used as a policy rationale in a number of the natural resource management strategies and programs of the late 1980s and early 1990s, including Landcare. However, confidence in the concept has

been eroded by developments of the late 1990's. Despite the empirical evidence of widespread beliefs among landholders that are concordant with a land stewardship ethic, the 1996 State of the Environment report demonstrated that serious land and river degradation problems continued unabated. Confidence in the concept was further eroded by the failure of research to find much empirical evidence that landholders who expressed attitudes consistent with a land stewardship ethic were more likely to have adopted a range of sustainable practices (Reeve et al. 2005).

It is possible that the apparent widespread acceptance of a land stewardship ethic amongst landholders may reflect widely held notions of 'good farm management'. A farmer's idea of good management is essentially value driven, and is therefore a personal issue, reflecting an individual's goals and priorities. Economic considerations may be paramount for some farmers, while others may be more influenced by social factors (Kilpatrick et al. 1999). According to Vanclay (2002), local context also has a strong influence on a farmers' idea of good farm management. He suggests that an individual's concept of good management conforms to locally approved practices, or 'social norms'. It is therefore important to recognize that the desire to be a 'good manager' will not, in all cases, compel farmers to control weeds. The priority given to weed control will, like any other component of farm management, vary between farmers.

A1.4.4 Processes Influencing Adoption of Weed Management Strategies

Good management is never simply an application of good science (Freudenberger and Freudenberger 1994). Agricultural ecosystems are extremely complex and involve interrelated economic, ecological and social components (Ridley 2004). The conversion of research findings to change of practice on farm is a major challenge facing agricultural extension (Keeble et al. 2004). Practice change is often slow, and efforts to promote adoption of new agricultural practices will face a number of challenges. Few studies have specifically examined the processes relating to adoption of weed management strategies in grazing systems. However, there is a wealth of literature relating to the extension of agricultural innovations, and to a lesser extent, of sustainable land management practices.

Adoption is not a simple matter of developing and then promoting an innovation, expecting awareness to result in implementation. Adoption is primarily a process of dynamic learning and refinement of decision making over time (Pannell and Zilberman 2000). There is a technical basis for adoption, whereby the qualities of an innovation will itself influence its rate of adoption. There is also a social basis for decision making about farm innovation or change. Finally, farmers are a diverse group of individuals, and this will be reflected in their approach towards innovation and change in farm management practices.

A1.4.4.1 Decision making processes

Barr and Cary (2000) have undertaken an extensive review of the adoption literature with relation to sustainable agricultural practices. As weeds are a land degradation issue and their control is an important component of sustainable management, the review by Barr and Cary provides many insights relevant to adoption of weed control practices. Based on the findings of various researchers, Barr and Cary have identified eight stages of decision-

making as being important in the adoption process. These eight stages are represented in Figure A3.4.1, below.

A number of conditions have been identified as necessary to achieve adoption of an agricultural innovation. The farmer must firstly be aware that an innovation exists and is potentially of practical relevance to them. Reaching this point of awareness is a trigger which prompts the farmer to take note of an innovation and begin to collect information about it in order to decide whether or not to go the next step of trialing the innovation. Secondly, the farmer must perceive that the innovation is worth trialing. This will typically involve small-scale trials, gradually resulting in full adoption or disadoption as the farmer gains knowledge and confidence in its performance. The farmer must also perceive that the innovation promotes their objectives. A farmer's objective will be influenced to varying degrees by personal factors, social pressures and community expectations. However, research suggests that economic factors, that is, whether an innovation is profitable, will have the most impact on an adoption decision (Pannell and Marsh 1998).

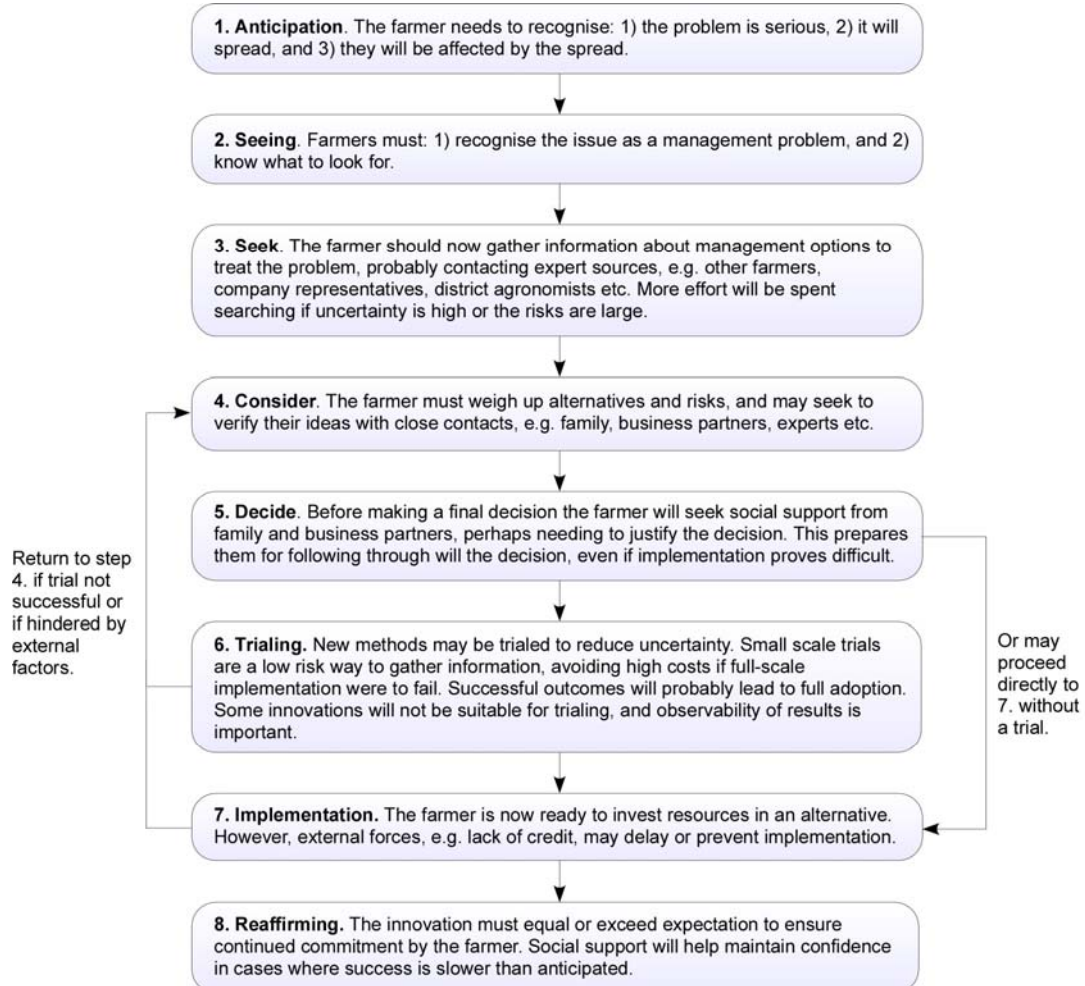
A1.4.4.2 Qualities of innovations

There are qualities of innovations that may increase or decrease their adoption potential. Adoption is unlikely if management strategies are not in the best interests of individual farmers. Some key considerations (following Frank and Chamala 1992; Vanclay 1992; Bullen and Woods 1999) that affect the adoption of new farming technologies are as follows.

- i. Complexity. Adoption probability reduces with increasing complexity.
- ii. Divisibility. Partial adoption is viewed as a form of trial adoption. Techniques that cannot be easily divided into manageable parts require farmers' total commitment to the new innovation before implementation, and so are less likely to be adopted.
- iii. Compatibility. Farmers are more likely to adopt innovations that are suited to their farm and personal objectives.

Figure A3.0.1 Eight stages of decision-making in the adoption process (after Barr and Cary, 2000).

The Sociology of Weed Management



- iv. **Economics.** The more likely the economic benefit, the more probable an innovation will be adopted.
- v. **Expense.** Much innovation requires considerable capital outlay, which many farmers may be unable to afford.
- vi. **Knowledge requirements.** Innovations with high additional learning needs are less likely to be adopted.
- vii. **Risk and uncertainty.** Most farmers are averse towards risk and uncertainty, so more risky strategies are unlikely to be adopted.
- viii. **Conflicting information.** Farmers receive information from numerous sources, which often contradict each other. This increases uncertainty and lowers the probability of adoption.

- ix. Perception. If farmers are aware that they are personally affected by land degradation, they are more likely to adopt appropriate management techniques.
- x. Social context. Social networks of farmers have a crucial role in providing information about an innovation, and also provide social support for adoption or non-adoption of an activity.
- xi. Flexibility. Farmers prefer land management practices to be flexible, allowing them to change in response to market and climate conditions.

The characteristics of technologies that have been readily adopted have been widely studied and identified. Vanclay and Lawrence (2002) observed that the more readily adopted technologies were generally: commensurate with other farm activities; clearly profitable; did not require a substantial capital or intellectual outlay; involved little risk; did not require a major change to farm management; were simple; could be adopted in parts; were widely and uniformly supported by extension agencies, other farmers and farm literature; and did not reduce farmers flexibility.

A1.5 Risk and uncertainty

It is obvious from the information presented above that uncertainty and risk are integral to the decision making process. Uncertainty results from imperfect information, while risk in this context relates to the uncertain consequences of adopting an innovation, such as the loss of capital if the innovation does not produce any benefits (Vanclay 2002).

A1.5.1 Uncertainty and learning

Uncertainty leaves room for misunderstanding and misperceptions about the innovation. In some cases, there may be an option value from not adopting (Pannell 1999). In other words, a farmer who is not sure about the benefits of an innovation may choose not to adopt it, so that resources which would be tied up in the innovation will instead be available for other future purposes. In other cases, the existence of uncertainty will foster a desire for information to inform the decision about whether to consider adopting a new innovation. Formal training, one-on-one learning from experts, media sources, extension services, personal experience, and trialing are among the major sources of information used by farmers. Information and learning sources valued by farmers will vary depending on the characteristics of the individual, including education (Kilpatrick et al 1999; Reeve and Black 1998).

Few studies have examined adoption and awareness of weed management practices or what can be done to increase the rate of change. It is therefore difficult to identify particular learning or communications processes that will improve the uptake of new weed management practices, or to assess the capacity of scientific and technical information to meet farmers' needs. It has been suggested that identifying how farmers learn about weed management practices is key to designing effective extension strategies to overcome uncertainty and increase adoption (Marra et al. 2003).

A1.5.2 Risk and risk attitudes

A management decision that is risky, but potentially profitable, may be desirable to individuals more willing to take risks, but not to others who are less willing. Differences in willingness to take risks can be conceptualised in terms of 'risk attitudes', and can generally be divided into three types: risk averse, risk preferring and risk neutral. Risk averse individuals will generally be more cautious people who prefer less risky sources of income or investment. They are likely to sacrifice some level of expected return rather than risk the possibility of a loss. Risk preferring individuals are characterized as being more adventurous, likely to select the alternative with some probability of a better outcome and more willing to accept high probabilities of a poor outcome. Risk neutral individuals are intermediate between risk averse and risk preferring individuals. This type of person will select the highest expected outcome regardless of the probabilities associated with potential gains or losses. They will primarily be concerned with achieving a sustainable outcome over time. Risk attitudes are not rigid, but likely to change over time with increased experience, goals and financial resources, and similar factors (Kaan 1999).

Research by Musser et al. (2002) with farmers in the Eastern Cornbelt of the U.S.A. examined risk attitudes of farmers, professional farm managers and agricultural lenders using agricultural choice dilemmas. It was found that differences in risk attitudes can lead individuals in similar circumstances to make different decisions, and that differences in risk preferences are a factor in adoption of alternative management options. They also suggested that risk attitudes of all individuals involved in farm decision making, including business partners, investors, and family members, will influence the decision making process.

A1.6 Heterogeneity in farming

Farmers are not homogenous. Farmers vary in innumerable ways, including: wealth; size of enterprise; age; stage of life; propensity to adopt new ideas; chemical preferences (e.g. organic farmers); attitudes towards risk and approaches to learning (Vanclay 2004). Diversity in farmer attitudes towards risk and uncertainty can be approached on the basis of segmentation analysis.

A1.6.1 Market segmentation

Segmentation research attempts to explain observed variations in farmer behaviour and values using a variety of techniques that range from qualitative to quantitative. Segmentation studies often provide useful insights into the way individuals assess agricultural technology and extension messages. The rationale for this approach is that understanding the producers in each segment will be helpful in refining communications and delivery of extension programs, and for assessing the effectiveness of policies and programs designed for the industry overall (Angus Reid Group 1998).

Barr and Cary (2000) group farmers into seven 'market segments', based on review of eight segmentation studies examining farmers' sowing and management of perennial pasture in south east Australia. Text Box 1 shows the market segments identified in this review.

TEXT BOX 1: Market Segments for Pasture Management (Source: Barr and Cary, 2000).

The Committed: In all the studies used, this group usually represented less than 15 per cent of the population. Members of this group had a high proportion of their farm sown to exotic perennial pastures, and their pastures were regularly top dressed and grazed rotationally or strategically. Members of this group were driven by production and profit and had a good understanding of their production system. These producers placed a high value on information, and awareness of farm innovation generally lead to attitude change and then behaviour change.

The Pasture Part Timers: This group comprised up to 15 per cent of the farm population surveyed. They had a smaller proportion of their farm under perennial pasture, often regularly top-dressed their pastures and practiced rotational grazing. Farmers in this group were motivated by the desire to increase productivity and income, but were constrained by commitment to another business or work interest.

The Crop Focused: These producers were found only in the mixed cropping zone. They saw pastures as a means to improve soil fertility for the next crop and sometimes as a means to maintain sheep until they were required to graze stubble. They often had a negative view towards grasses, particularly perennial pastures, with lucerne tending to be the preferred fodder crop.

Belt Tighteners: This was the largest group identified by the various studies, representing between 30 per cent and 40 per cent of farmers. This group generally claimed to have large areas sown to improved perennial pasture, and usually practiced set stocking. Members believed that conservative grazing strategies would be more profitable than innovation in the long run. These farmers were identified as risk averse, with a decision making style that flowed from awareness to action (trialing) to attitude change. The results of trials are slow to appear in a grazing system, and O'Keefe (1993) argued that this helps explain the low innovativeness of grazing industries in comparison with cropping industries.

Sceptics: Members of this group comprised between 10 per cent and 20 per cent of the sample. They distrusted the advantages described for pasture improvement. Many in this group believed strongly in the importance of low stocking rates. They often had large properties and this may have enabled them to produce a living despite low stocking rates.

Comfortable: This group represented the second largest group, making up 20 per cent to 40 per cent of the population. Many in this group claimed to have significant areas of perennial pastures, but did not see the need for re-sowing, top-dressing, or a change from set stocking. These farmers were typically older, and often grazed beef cattle because of their lower management needs. They were not interested in increasing their workload or accepting additional risks, as they had sufficient income for the foreseeable future and recognized their children as unlikely to succeed them in the farm business.

Retreatists: Mainly found around major population centers, this group was mostly composed of rural residential dwellers or absentee hobby farmers. Pasture was chiefly judged on an aesthetic basis, and group members had little time to undertake significant management tasks. Many of the studies reviewed did not include this group, as its members generally failed to qualify as farmers according to ABS criteria.

A1.6.2 Farming styles research

Another approach to understanding diversity in farmer practice may be found in the rural sociological theory 'farming styles' developed by Prof. Jan Douwe van der Ploeg at Wageningen Agricultural University in The Netherlands. The theory is based upon the view that farming is a social process, with cultural, economic, political and farm management components. Application of this concept involves recognising consistencies in the social goals of farmers, so that individuals can be categorised into appropriate 'styles'. The proposed benefits are better targeted extension and, ultimately, a change in agricultural research priorities so that they better reflect the needs of farmers (Howden et al. 1998). Although farming styles research is still in its infancy, it seems there could be a strong interaction between farming styles and innovation characteristics (Barr and Cary 2000).

A1.7 What is a weed to a grazier?

Weeds are defined by people's perceptions of their desirability. Recognition of context and perception is critical when formulating a definition of a grazing weed. Research by Kersten (1996) with graziers of western N.S.W. highlighted the differences in criteria used by researchers to those used by graziers when evaluating plant species. Graziers focused on the value of plants for their stock, valuing such characteristics as palatability, availability, provision of shade and usefulness as windbreaks. Researchers, on the other hand, evaluated native grasses on their ability to survive, perenniality and seed production, independent of their value as stock feed. The desirability of plants will vary throughout the year. For example, some grasses, such as Barley grass (*Hordeum* spp.) are palatable and nutritious and considered useful until they produce spiky seeds that cripple lambs, blind sheep and contaminate wool. The form of animal production will also impact which plants are considered weeds. For example, 'good sheep country' may become 'good cattle country' when infestations of Bathurst burr (*Xanthium* spp.) reach levels where wool contamination is an issue. Appreciating these differences in perception and context is essential when investigating differences in management approaches towards weed control (Webber 1996).

A1.8 Environmental factors

Although this review is focused on understanding the sociological factors influencing weed management, it is worth noting that farms, like farmers, are heterogeneous. There is no single management practice that is suitable across all farming regions, all farms within a region, or even all areas within a farm. For example, farms will vary greatly in factors such as size, soil types and fertility, vegetation cover, topography, available labour, financial resources, climate, and weeds present. The suitability of a technique to the physical characteristics of the farm will need to be considered in any management decisions. Consequently, farmers' responses to a new innovation will depend, not just on the characteristics of farm managers, but on the physical characteristics of the farms they manage (Pannell 1998).

A1. 9 Conclusions and Recommendations

The temperate perennial pasture zone of southern Australia produces nearly half of southern Australia's sheep and cattle products. Weeds in pasture systems represent considerable costs to landholders and the community. Management practices that sustain and revive the pasture resource and provide long-term solutions to weeds have been developed, but adoption of these practices has been slow and only a relatively small proportion of landholders control weeds effectively.

An understanding of landholders' decision processes is necessary to influence change. The adoption of an agricultural practice is not merely a technical process whereby a farmer will simply decide to adopt a better practice once they are made aware of it. Rather, it is an ongoing process wherein farmers constantly re-evaluate adoption decisions. Risk, uncertainty and learning are important considerations in understanding adoption behaviour. High levels of uncertainty can negatively influence rates of adoption of an agricultural practice, and providing information to reduce uncertainty is a key consideration for weed orientated extension.

Innovations also vary in terms of risk and the amount of learning they involve, and this will influence adoption rates. The qualities of some innovations will appeal more to some farmers than others, depending on the physical and social context of the farm and the management goals (motivations) of the farmer. The results of segmentation studies involving graziers in south east Australia have demonstrated the usefulness of grouping farmers according to attitudes towards management and change. The use of such grouping techniques may be useful in identifying motivations, or triggers, that are likely to prompt different groups of graziers to adopt better weed management practices. Such information would be expected to reveal opportunities for targeted weeds extension activities that are effective in inducing real change in weed management practices.

Appendix 2: Report on Farm Visits and Mail-Back Survey

Summary

The analysis of the face-to-face interviews with farmers, discussions with weeds officers during farm visits, and the mail-back questionnaire has shown that:

- a reasonable measure of weed awareness can be obtained from questions about just eight weeds,
- a reasonable measure of the diligence with which farmers carry out weed control and the priority they place on weed control can be obtained from just six attitude statements,
- using the answers to just five questions, it is possible to correctly predict in 82 per cent of cases whether a respondent is among the worst half of respondents with respect to the levels of weed infestation as rated by weeds officers,
- effectiveness of weed control is related to farmer demography and farm characteristics, with higher levels of weed infestation occurring among older farmers with lower levels of education, who do not work off-farm, have relatively more cattle and less cropping,
- there appear to be four groups with respect to the mix of weed control methods: those using few methods (some, but not all of whom, have the highest levels of weed infestation), those using mainly mechanical methods, those using mainly grazing-related methods, and those using most methods (and having the lowest levels of weed infestation), and
- farmers can be placed in one of these four groups using their response to whether or not they are spray grazing, slashing, or using quarantine measures.

The Sociology of Weed Management

- A number of motivations that are demonstrably related to better weed control have been identified:
- awareness of the effects of weeds on livestock and the value of livestock products,
- awareness of the invasive and competitive nature of particular weeds, including those new to the district,
- advice from agricultural consultants, retailers and fertiliser and chemical company representatives (an important factor in the generally better weed control among those who are cropping),
- awareness that local well-regarded producers are successfully using a weed control method,

Many of those using grazing-related weed control measures (which take longer to show improvements in the weed situation) regard persistence as important.

A number of barriers demonstrably related to poor weed control have been identified:

- inability to identify particular grass weeds,
- time and monetary constraints,
- areas on the property where topography makes access and control difficult,
- weeds that have, or appear to have some feed value at sometimes of the year, but which lower the productivity of pasture on the whole,

Field days and fact sheets and booklets from government departments are widely held in high regard as a means of communication of weed information, particularly among the better weed managers, reflecting an active approach to information. Radio, TV and newspapers are held in less regard, but are more likely to be viewed favourably by the poorer weed managers, reflecting their passive approach to information. The electronic and print media have an important role to play in elevating the priority placed on weed control among the poorer managers, as well as in alerting those, who are effectively controlling weeds with a few methods diligently applied, about new weed problems.

The opportunities and challenges for weeds extension can be analysed in the context of the 'three Ds' of effective weed management: Diligence, a Diversity of methods, and Deliberation (a planned and proactive approach weed control). Poorer weed managers tend to use a few methods of control in a casual and reactive way. Strategic and integrated weed management requires competence with a range of weed control

methods, and there is little point in encouraging the poorer weed managers to adopt additional methods if they do not use these diligently. For this reason, it is suggested that the focus for improving weed management among poorer weed managers should be upon more diligent use of a few well chosen methods.

There is an identifiable group of farmers who are achieving reasonable to good weed control of the main declared and broadleaf weeds through the diligent application of a small number of methods. While currently not a problem, it is possible that rising chemical prices, the appearance of new weeds or increasing age could result in some members of this group slipping back into the poorer weed management group. It is suggested that the focus for maintaining and improving the effectiveness of weed management in this group should be upon developing skills in the identification of the lesser know grass weeds, alerting them when new weed problems emerge and increasing their awareness of the advantages of newer weed control methods.

For those who are achieving good to exemplary weed control, there is still the potential for technical innovation to bring further improvements, such as through solutions to herbicide resistance problems and methods of control that are more effective in the use of the farmer's time.

A2.1 Performance of awareness and attitudinal measures

A2.1.1 Weed awareness

Question 1 of the mail-back survey was intended to gauge the level of awareness of weeds by asking: whether each of a list of weeds was present in the district, whether each was regarded as a weed, and how easy or difficult each was to identify. These questions were considered to be the only way to gain some measure of weed awareness in a concise and non-threatening way in a mail questionnaire. For some weeds, the two choices, present/absent, weed/not a weed, and easy/difficult to identify can be unambiguously assigned as correct or incorrect. For other weeds, both presence and absence in the respondent's district are reasonable answers, as is both regarding or not regarding a plant as a weed. Also, for some weeds, regarding it as easy to identify or regarding it as difficult to identify are both reasonable answers. With any scoring system based on proportion of correct answers, respondents will get the same awareness score, regardless of which way they answer, for the weeds where presence/absence, weed/not a weed and easy/difficult to identify are equally reasonable answers. Consequently these weeds do not contribute any explanatory power to the overall weed awareness score for each respondent. For this reason, and in view of the need to keep the interview schedule for the telephone survey of producers as concise and cost-effective as possible, the weeds for which there is some ambiguity about their presence in a region, their status as weeds and their ease of identification, will be omitted from the weed awareness question in survey.

A2.1.2 Differences between weeds

In addition to weed awareness scores for respondents calculated across weeds in their region, it was possible to obtain weed awareness scores for individual weeds, calculated

across all respondents in a region. The results obtained in each of the three regions, based only on those weeds for which it was possible to unambiguously assign answers as correct or incorrect, are shown in Table A2.0.1 to Table A2.0.3, below. These show that there is a consistent difference between the well-known 'prickly' and/or declared weeds and the grass weeds. The levels of awareness of the former were generally higher than for the grass weeds. This difference was also referred to by some producers and land management professionals interviewed in the course of the farm visits. One producer stated that:

The older ones [weeds] we know them ourselves...but the new ones... African lovegrass and those, I still can't identify them...blowed if I know. It looks like everything else. I don't think we've got any. I hope we don't...but Paterson's curse and things like that, it's got a nice purple flower, it's easy, everyone can pick it but [I have difficulty] when it comes to some of these other ones [grass weeds] which will make a big economic impact when they are the predominate pasture species.

Another producer, when asked if he considered thistles to be his main weed problem, replied that:

I class them [thistles] as a weed whereas I have probably got some other grasses you could class as weeds... My properties pretty weed free as far as noxious weeds go

A Catchment Management Officer observed that:

African lovegrass is probably the main new one for us. Just helping cockies to identify it is a bit of a challenge because it is a hard one to id[entify].

'Decoy' weeds from outside the region were generally correctly identified as not occurring in the region.

A2.1.3 A minimum weed set

The mail-back questionnaire included 17 to 18 different weeds in each region and a total of 30 different weeds across the three regions. As these numbers are too large to include in a telephone interview, the correlations between scores on individual weeds and the overall weed awareness score were examined with a view to identifying a smaller set of weeds that would provide a reasonable measure of weed awareness. It was found that the score across three weeds provided the best balance between maximising the correlation with the score across all weeds, and minimising the number of weeds included. The correlations between the three-weed scores and all-weed scores in each of the three regions are shown in Table A2.0.4, below.

Table A2.0.1 Mean awareness scores for individual weeds in the northern NSW region.

Weed	Mean awareness score across respondents
Bellyache bush (decoy weed)	1.00
Caltrop	1.00
Sickle pod (decoy weed)	1.00
Bathurst burr	0.93
Saffron thistle	0.93

The Sociology of Weed Management

Black thistle (spear or Scotch thistle)	0.90
Blackberry	0.90
Sweet briar	0.78
Nodding thistle	0.77
Paterson's curse	0.73
St John's wort	0.72
Blackthorn	0.60
Vulpia (rats-tail fescue)	0.57
Chilean needle grass	0.54
Serrated tussock	0.44
African lovegrass	0.43

Table A2.0.2 Mean awareness scores for individual weeds in the southern NSW region.

Weed	Mean awareness score across respondents
Bathurst burr	0.98
Cape weed	0.96
Paterson's curse	0.95
Saffron thistle	0.92
Bellyache bush (decoy weed)	0.91
Sickle pod (decoy weed)	0.91
Barley grass	0.91
Scotch or Illyrian thistle	0.90
St John's wort	0.86
Vulpia or silver grass	0.85
Blackberry	0.76
Caltrop or cat head	0.76
Black or spear thistle	0.71
Serrated tussock	0.67
Sweet briar or briar rose	0.54
Sorrel	0.52

Table A2.0.3 Mean awareness scores for individual weeds in the north eastern Victoria region.

Weed	Mean awareness score across respondents
Giant Parramatta grass (decoy weed)	1.00
Rush, pin rush or toad rush	1.00
Sickle pod (decoy weed)	1.00
Onopordum thistle (Scotch, cotton or blue thistle)	1.00
Variegated thistle (cabbage thistle)	0.97
Black thistle (spear or Scotch thistle)	0.96

The Sociology of Weed Management

Blackberry	0.94
Paterson's curse	0.94
Cape weed	0.92
Sweet briar or briar rose	0.90
Barley grass	0.89
Bracken fern	0.88
Bellyache bush (decoy weed)	0.83
Yorkshire fog or fog grass	0.75
Vulpia (silver grass or rat's tail fescue)	0.65
Bent grass or brown top bent grass	0.55
Gorse	0.38

Table A2.0.4 Correlations between three-weed awareness scores and all-weed scores.

Region	Minimum set of three weeds	Correlation (Spearman's rho) with score across all weeds
Northern NSW	African Love Grass Chilean Needle Grass Blackberry	0.83
Southern NSW	Serrated Tussock Saffron Thistle St John's Wort	0.76
North eastern Victoria	Yorkshire Fog Sweet Briar Blackberry	0.73

A2.1.4 Attitudinal dimensions

A set of attitude statements was included in the mail-back questionnaire for use in constructing a number of Likert scales relating to aspects of weed management, such as the priority afforded to weed management compared to other farm tasks, interest in innovation in weed management, propensity to discuss weed issues with other people, awareness of change in species regarded as weeds, awareness that recommended control methods change and orientation to preventative and reactive weed management strategies. The Likert scales and constituent attitude statements are listed in Table A2.0.5. Table A2.0.5 also shows the value of Cronbach's alpha for each Likert scale. This measure of scale reliability shows the extent to which responses are consistent within a scale. Values higher than 0.5 for a two item scale and 0.6 for a four item scale are generally taken as indicating a satisfactory degree of consistency, i.e. the set of attitude statements are tapping a single attitudinal dimension. The values shown in Table A2.0.5 show that the Likert scales performed poorly, indicating that producers did not respond as anticipated. While it is usual in attitudinal research for the first version of Likert scales to have some unsatisfactory alphas, which can be improved by careful rewording of attitude statement, the findings above suggest there are attitudinal dimensions other than those embodied in the names of the scales that are structuring responses. This is consistent

with the experience from the on-farm face-to-face interviews, where several questions had to be re-worded as producers interpreted questions differently to what had been expected in designing the interview schedule.

It is possible, using factor analysis (principal components), to identify attitudinal dimensions within a set of attitude statements. This analysis found that 48 per cent of the variation in the responses to the 14 attitude statements could be captured with the three strongest attitudinal dimensions. The correlations between attitude statements and the three attitudinal dimensions are shown in Table A2.0.6 below. Three attitude statements that were poorly correlated with the three attitudinal dimensions have been omitted.

Table A2.0.5 Likert scale, constituent attitude statements and Cronbach's alpha for each scale.

Likert scale	Constituent attitude statements	Alpha
Weed Priority	In my view, you are better off looking after your stock, than worrying too much about weeds. Fortunately, weed control is something you can put off in difficult times, and catch up on later. Of all the jobs on a farm, weed control is probably the most important. (R) Weed control is one of those things you have to keep on top off all the time. (R)	0.43
Weed Innovativeness	With weed control, it's better to stick to what you know works well, rather than experimenting with new methods. Generally, the benefits of new weed control methods outweigh the costs involved in trying them. (R)	-0.22
Propensity to Talk about Weeds	With weed problems, it's best to get in and fix them yourself, rather than talking to others about what to do. If you've got a problem with a weed, the best thing you can do is ask your friends or neighbours what they are doing with it. (R)	-0.86
Awareness that Weeds Change	In this district, it's just the same few weeds that are a problem - you don't have to worry about new weeds appearing. If you see a plant on your place you haven't seen before, it's well worth finding out what it is. (R)	0.45
Awareness that Control Methods Change	Weed control is one part of running a grazing property that hasn't changed much over the years. Even though it takes a bit of time, it's well worth looking out for new recommended ways to control weeds. (R)	-0.02
Prevention vs Cure	Generally, it's not worth trying to work out why weeds are appearing in a pasture - spraying and chipping will keep them under control. With most weeds around here, it's possible to change your grazing management so they don't get a chance to spread. (R)	-0.46

Note: statements denoted (R) are reverse coded to calculate respondent scores on the Likert scales.

The Sociology of Weed Management

The attitudinal dimensions can be interpreted by considering the outlook of a person who agreed with all the statements correlated with the dimensions. For example, the first attitudinal dimension can be illustrated with the following statement from an imaginary producer who agrees with the first four statements in Table A2.0.6:

Weed control hasn't changed much over the years. I just stick to what I know works well and get in and do the spraying and chipping. There's no point in trying new methods, or asking others what they're doing, or trying to figure out why weeds are appearing in the pasture.

This attitudinal dimension can be illustrated by the words of one of the farmers interviewed on-farm when asked about what he looked for when choosing methods of weed control:

Well the cheapest and the best, which is spraying. It is the only way to control them here.

Table A2.0.6 Correlations between attitude statements and the three attitudinal dimensions.

Attitude statement	Correlations with dimensions		
	1	2	3
With weed control, it's better to stick to what you know works well, rather than trying new methods.	.820	.204	
Weed control is one part of running a property that hasn't changed much over the years.	.788	-.105	.184
With weed problems, it's best to get in and fix them yourself, rather than talking to others about what to do.	.594		.350
Generally, it's not worth trying to work out why weeds are appearing in a pasture - spraying and chipping will keep them under control.	.572	.395	.116
If you see a plant on your place you haven't seen before, it's well worth finding out what it is.	.196	-.811	.109
In my view, you are better off looking after your stock, than worrying too much about weeds.	.269	.644	
In this district, it's just the same few weeds that are a problem - you don't have to worry about new weeds appearing.	.361	.638	
Fortunately, weed control is something you can put off in difficult times, and catch up on later.	.132	.518	.515
Weed control is one of those things you have to keep on top off all the time.	.505	-.507	.105
Generally, the benefits of new weed control methods outweigh the costs in trying them out.			.752
If you've got a problem with a weed, the best thing you can do is ask your friends or neighbours what they are doing with it.	.144	-.197	.669

Correlation less than 0.100 omitted

This person saw the key factor in controlling weeds as:

Spray at the right time, before they get too established. You know when they are there. You know when they are going to come, like now, after rain.

When asked if he had used the same methods of weed control for a long time, he responded:

Oh basically yeah, the only way to beat 'em is spray 'em.

He also said that there had been no changes in weed control in the past five years. This outlook on weed control was also shown by a number of older graziers with properties on hilly terrain. As one grazier said:

... that is the key to it all, your management. You got to be weed conscious in your management. You got to go round and check all the time. If you got a patch of weeds you go back regularly and you check it.

Asked whether there were enough effective control techniques, his response was:

Oh yeah there is. All I need is a motorbike with a spray tank because I do the blackberries every year. If you do them every year then you don't have a lot to worry about.

The three attitudinal dimensions in Table A2.0.6 can be interpreted as:

- dimension 1: "Weed control - a habitual routine",
- dimension 2: "Weeds - nothing to worry about",
- dimension 3: "Weed control - worth finding out about new methods".

To identify minimum sets of attitude statements to form Likert scales for these three dimensions for use in the producer telephone survey, Cronbach's alpha was calculated for scales of 2, and where possible, 3, 4 and 5 constituent attitude statements. It was found that satisfactory Likert scales could be constructed for the first two attitudinal dimensions, but not for the third dimension (

Table A2.0.7).

Table A2.0.7 Possible Likert scales identified using factor analysis.

The Sociology of Weed Management

Likert scale	Constituent attitude statement	Alpha
Weed control - a habitual routine	With weed control, it's better to stick to what you know works well, rather than trying new methods. Weed control is one part of running a property that hasn't changed much over the years.	0.73
Weeds - nothing to worry about	If you see a plant on your place you haven't seen before, it's well worth finding out what it is. In my view, you are better off looking after your stock, than worrying too much about weeds. (R) In this district, it's just the same few weeds that are a problem - you don't have to worry about new weeds appearing. (R)	0.63
Weed control - worth finding out about new methods	Generally, the benefits of new weed control methods outweigh the costs in trying them out. If you've got a problem with a weed, the best thing you can do is ask your friends or neighbours what they are doing with it.	0.39

These findings indicate that it should be possible in the producer telephone survey to obtain reliable measures of the first two attitudinal dimensions from the responses to five attitude statements. One or both of the two statements comprising the third attitudinal dimensions may be included and used singly in the analysis, rather than as part of a Likert scale.

Responses to the seven attitude statements in

Table A2.0.7 were generally well distributed across the agreement/disagreement categories, with the exception of "If you see a plant on your place ..." which had relatively few respondents indicating they disagreed or strongly disagreed. Consideration will be given to adjusting the wording of this statement to improve the distribution of responses (highly skewed distributions have little explanatory power).

A2.2 Tactics for Identifying Non-Adopters

It is difficult to establish the level of weed infestation on a property by simply asking its owner in a telephone interview. However, the data from the mail-back survey, together with the ratings of weed incidence provided by the weeds officers assisting with the farm visits, make it possible to identify a small set of questions (not about weed incidence) which would provide a good measure of weed incidence.

Exploratory logistic regression was used to find the best combination of questions from the mail-back survey to predict whether or not a respondent was in the lower or upper half of the distribution of weed incidence ratings. The answers to the questions listed in

The Sociology of Weed Management

Table A2.0.1 below, if used in the logistic regression model, will correctly identify whether a respondent is in the high or the low weed incidence group in 82 per cent of cases.

Table A2.0.1 Questions to identify whether respondents are in the high or low weed incidence group.

Questions	Response indicating high likelihood of being in the worst half of respondents with respect to weed levels.
<i>Weed awareness scores for the following weeds</i>	
Sweet Briar	High awareness
Vulpia	Low awareness
<i>Whether familiar with the following practices and whether they are worth doing</i>	
Spray grazing	Not familiar
Slashing	Well worth doing
Holding yards and other forms of quarantine	Not familiar
<i>Whether respondent agrees with the following statements:</i>	
Of all the jobs on a farm, weed control is probably the most important.	Disagree
With weed problems, it's best to get in and fix them yourself, rather than talking to others about what to do.	Agree
<i>Whether the respondent indicates that the following makes controlling weeds difficult on their property:</i>	
Don't like using chemicals	Ticked
<i>The usefulness of the following sources of information and forms of communication:</i>	
Expert producers in the region	Not useful

The Sociology of Weed Management

Farmer and industry newsletters and magazines	Not useful
Leaflets and booklets from retailers, merchandisers and stock and station agents	Not useful
Radio	Useful

The questions above will be core questions to be retained for the telephone survey of producers. This does not rule out some questions that ask circumspectly about weed levels on the interviewee's property, e.g.

Would you say that the weed levels on your property are [A] higher than what you would prefer them to be, or [B] at a level where it wouldn't be worthwhile trying to reduce them any further?

[If A] *And with the weed levels you've got, are they [C] a bit higher than levels in the district, [D] about the same, or [E] lower?*

[If C or D] *And which weeds are particular problems for you?*

[If E] *So what weeds are causing problems on other places in the district?*

And how have you been able to avoid problems with these weeds?

[If B] *And what's the main reason that it's not worthwhile reducing them any further?*

A2.3 Demographic and Farm Characteristics

This section of the analysis deals with those aspects of producer and farm characteristics that are unlikely to be amenable to change through communication or extension efforts. An understanding of these demographic and farm physical aspects is, however, needed so that communication and extension efforts recognise, and take account of, the constraints upon adoption of improved weed management practices.

To provide an overview of the nature of the variation in these characteristics, factor analysis (principal components) was used to identify demographic and farm dimensions. It was found that two dimensions could be extracted that captured 54 per cent of the variation in the demographic and farm characteristic variables used in the analysis.

Table A2.0.1 Correlations between demographic and farm characteristics and the two demographic and farm dimensions.

Demographic and farm characteristics	Correlations with dimensions	
	Demographic dimension	Farm dimension
Proportion of farm partners over 55 years of age	-0.800	-0.137
Mean years of experience of farm partners	-0.734	-0.339
Proportion of farm partners working off-farm	0.722	-0.231
Mean level of education of farm partners	0.462	0.423

The Sociology of Weed Management

Proportion of farm area under cropping		0.838
Proportion of livestock that are sheep	0.111	0.667
Total area of property		0.612

Correlation less than 0.100 omitted

As might be expected, there is a demographic dimension (related to age, experience, working off-farm and level of education) and a farm dimension (related to farm size and enterprises). The two dimensions are not completely independent, in that while mean level of education falls with increasing age and experience, and fewer partners working off-farm, mean level of education also increases with the amount of cropping, the amount of sheep compared to cattle and the size of the property.

These relationships reflect well-known trends in agricultural demography, such as lower levels of education among older farmers, and a tendency for graziers to reduce sheep numbers and increase cattle numbers as they get older, and to move to smaller properties. These trends have implications for the adoption of improved weed management practices. For example, older farmers who have moved onto smaller properties and are only running cattle (and possibly have more hilly properties with parts difficult to access with spray equipment) may have very limited options for improving their weed management. The lack of options may be exacerbated by physical handicaps occurring with increased age. This was reflected in the responses to the mail-back questionnaire. Among those who nominated medical problems as something that makes weed control difficult for them, the mean proportion of farm business partners over 55 years of age was 100 per cent, compared to 49 per cent among those who did not nominate medical problems as a difficulty ($p=0.06$).

On the other hand, younger, better educated farmers who are cropping and running sheep and cattle on better quality agricultural land will have many more options for improving weed control. One young farmer, who had been educated at tertiary level, stated when asked what he regarded as the key element of a good weed control program:

*...utilising a number of tools and timing.
...we don't just use chemicals, we use a range of cropping, slashing, hay and silage.*

He also remarked that he believed there were plenty of options for weed control.

However, younger well-educated farmers can get off farm-work more easily and they may lack the time to trial and adopt these options. As one young farmer who, along with three other partners in the farm business, worked off-farm, stated when asked if he was happy with the currently available options for weed control:

Oh yeah, it is just time, getting around to doing it... if we had more time we would do a lot better job...it's just time.

This person also regarded the key element of a weed control program as:

Probably just getting on top of it in time.

Using the variables comprising the demographic and farm dimension, each respondent can be assigned a score on each of the two dimensions in Table A2.0.1. For example,

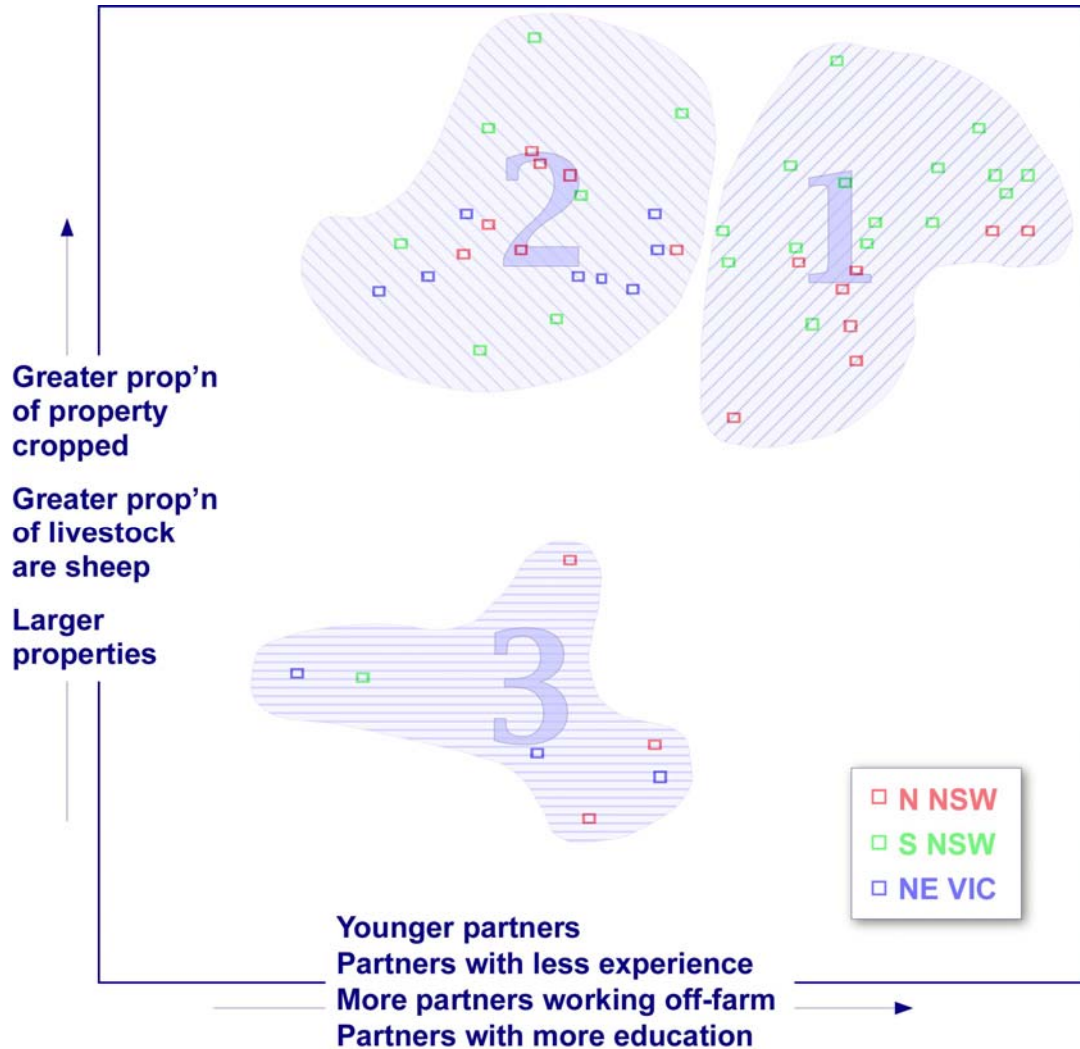
respondents with a high score on the demographic dimension will tend to be younger, have less years experience, be more likely to be working off-farm and have a higher level of education. Respondents can be plotted in the space of the two dimensions, as shown in

Figure A2.0.1, below. It can be seen from the figure that there is some tendency for respondents to fall into groups.

This was confirmed with cluster analysis (partitioning around medoids), which suggested that a three cluster solution best represented the grouping of the respondents (highest silhouette coefficient for two to eight cluster solutions of 0.55). The three clusters are shown by the blue shaded areas in

Figure A2.0.1.

Figure A2.0.1 Respondents to the mail-back survey plotted in the space of the demographic and farm dimensions.



It can be seen from the figure that there are two relatively large groups of respondents (groups 1 and 2) who have larger properties, greater areas of cropping and relatively less cattle. Group 2 has older farmers with more experience, lower levels of education and who are less likely to be working off-farm. There are approximately equal proportions of these farmers from northern New South Wales, southern New South Wales and north-eastern Victoria.

Group 1 has younger farmers with less experience, higher levels of education and who are more likely to be working off-farm. This group is dominated by farmers from southern New South Wales, together with some from northern New South Wales.

Group 3 has relatively fewer farmers, mainly from northern New South Wales and north-eastern Victoria, who are generally older, have more experience, lower levels of education

and who are less likely to be working off-farm. Their properties are smaller and they are less likely to be cropping and have relatively more cattle.

These three groups could be used for the design of communication and extension strategies, however, it is likely that when the producer telephone survey data is analysed, a more finely detailed segmentation will be able to be obtained.

A2.4 Weed Incidence and Management Levels

The incidence of weeds and the level of management effort on each property were rated on an eight point scale (1 corresponding to a negligible or very low level of weed infestation or management effort and 8 corresponding to a very high level of weed infestation or management effort) by the weeds officer assisting with the farm visits. There was a significant difference in the level of weed management effort between the three groups, and a consistent, but marginally significant pattern for the rated incidence of weeds (Table A2.0.1), with group 1 farmers having lower levels of weeds and a higher level of management effort.

Table A2.0.1 Ratings of weed incidence and level of management effort for the three demographic and farm groups.

Demographic and farm group (see fig A2.1)	Mean of weeds officers' ratings	
	Level of management effort	Incidence of weeds
Group 1	7.26	3.06
Group 2	6.46	3.66
Group 3	6.72	4.28

(Management effort: anova, $p=0.028$, weed incidence: anova, $p=0.132$)

A2.5 Methods of Weed Control

The aim of any extension program to improve weed management is to encourage changes in the methods of weed control being used. This section provides an analysis of the methods of weed control in use by those surveyed, and the relationships between these and a range of possible motivations and disincentives for improved weed management.

A2.5.1 Opinions across all respondents

There were substantial differences in the popularity of, and familiarity with, the various methods of weed control. Boom spraying and selective use of herbicides were almost universally regarded as well worth doing, while around a third of respondents regarded both slashing and burning as not worth doing (Table A2.0.1). Almost three-quarters of respondents were not familiar with the use of granular and pelletised herbicides.

A2.5.2 Differences between the demographic and farm groups

There was a significant difference ($p = 0.016$) across the three demographic and farm groups in the pattern of opinions about spray topping or winter cleaning. Almost three quarters of group 3 respondents were not familiar with the methods, whereas around 60 per cent of group 1 and group 2 respondents believed it was well worth doing. However groups 1 and 2 differed in the proportions who believed it was not worth doing, with 26 per cent of group 1 respondents indicating it was not worth doing, compared to 5 per cent of group 2 respondents. Spray grazing showed a similar but less pronounced pattern of opinion across the three groups.

Table A2.0.1 Views about methods of weed control.

Weed control method	Proportion of respondents (%)		
	Well worth doing	Not worth doing	Not familiar with it
Boom spraying	94.3	3.4	2.3
Selective use of herbicide (spot spraying, weed wipers etc)	93.2	0.0	6.8
Maintain ground cover	71.6	2.3	26.1
Chipping and hand weeding	70.5	19.3	10.2
Cultivation, rotational cropping and pasture re-establishment	65.9	10.2	23.9
Spray grazing (using low doses of herbicides to make weeds more palatable to stock)	56.3	10.3	33.3
Tactical grazing pressure (e.g. crash grazing)	53.4	10.2	36.4
Spray topping or winter cleaning	52.3	12.5	35.2
Holding yards and other forms of quarantine to stop weed importation and spread	46.6	13.6	39.8
Slashing	43.2	35.2	21.6
Biological control	42.0	8.0	50.0
Burning	36.4	34.1	29.5
Pelletised or granular herbicides	23.9	2.3	73.9

This pattern appears to reflect both an enterprise and demographic effect. Sheep producers and croppers seem to be more aware of the existence of spray grazing and spray topping methods, and younger, better educated farmers have possibly tried the methods at an earlier stage than their older counterparts, providing younger farmers with the chance to form a definite opinion that the method is not worth doing in their situation.

A2.5.3 Integration of weed control methods

Success in weed control depends on the extent to which an appropriate set of methods are used in an integrated fashion. It was found that respondents could be divided into four groups (based on monothetic divisive clustering), according to the weed control methods they used. Whether or not respondents use spray grazing separates them into the two maximally different groups with respect to the remaining methods of weed control. The group not using spray grazing is then separated into two maximally different subgroups depending on whether slashing is, or is not, used as a weed control method. The group that uses spray grazing is separated into two maximally different subgroups depending on whether members of this group use weed quarantine measures such as holding yards. While the divisive clustering technique shows further possible subdivisions, these are not used in further analysis to ensure sufficiently large numbers of respondents in the groups to be analysed.

With the divisions described above, the four groups are:

- neither spray grazing nor slashing (29 per cent of respondents),
- not spray grazing, but using slashing (15 per cent of respondents)
- spray grazing, but not using quarantine practices (26 per cent of respondents), and
- both spray grazing and using quarantine practices (30 per cent of respondents).

The further characteristics of these four groups with respect to other weed control practices are summarised in Table A2.0.2 to Table A2.0.9 below.

Table A2.0.2 Differences in views about pelletised or granular herbicides.

Weed control group	Pelletised or granular herbicides (%)		
	Worth doing	Not worth doing	Not familiar
Neither spray grazing nor slashing	12.0	0.0	88.0
Not spray grazing, but using slashing	23.1	0.0	76.9
Spray grazing, but not quarantine	26.1	4.3	69.6
Both spray grazing and quarantine	33.3	3.7	63.0

Table A2.0.3 Differences in views about tactical grazing pressure.

Weed control group	Tactical grazing pressure (%)		
	Worth doing	Not worth doing	Not familiar

The Sociology of Weed Management

Neither spray grazing nor slashing	28.0	24.0	48.0
Not spray grazing, but using slashing	38.5	7.7	53.8
Spray grazing, but not quarantine	52.2	4.3	43.5
Both spray grazing and quarantine	85.2	3.7	11.1

Table A2.0.4 Differences in views about spray topping or winter cleaning.

Weed control group	Spray topping or winter cleaning (%)		
	Worth doing	Not worth doing	Not familiar
Neither spray grazing nor slashing	28.0	24.0	48.0
Not spray grazing, but using slashing	23.1	15.4	61.5
Spray grazing, but not quarantine	60.9	13.0	26.1
Both spray grazing and quarantine	81.5	0.0	18.5

Table A2.0.5 Differences in views about spray grazing.

Weed control group	Spray grazing (%)		
	Worth doing	Not worth doing	Not familiar
Neither spray grazing nor slashing	0.0	28.0	72.0
Not spray grazing, but using slashing	0.0	15.4	84.6
Spray grazing, but not quarantine	100.0	0.0	0.0
Both spray grazing and quarantine	100.0	0.0	0.0

Table A2.0.6 Differences in views about cultivation, rotational cropping and pasture re-establishment.

Weed control group	Cultivation, rotational cropping, pasture re-establishment (%)		
	Worth	Not worth	Not

The Sociology of Weed Management

	doing	doing	familiar
Neither spray grazing nor slashing	44.0	8.0	48.0
Not spray grazing, but using slashing	69.2	7.7	23.1
Spray grazing, but not quarantine	60.9	17.4	21.7
Both spray grazing and quarantine	88.9	7.4	3.7

Table A2.0.7 Differences in views about slashing.

Weed control group	Slashing (%)		
	Worth doing	Not worth doing	Not familiar
Neither spray grazing nor slashing	0.0	60.0	40.0
Not spray grazing, but using slashing	100.0	0.0	0.0
Spray grazing, but not quarantine	39.1	39.1	21.7
Both spray grazing and quarantine	59.3	25.9	14.8

Table A2.0.8 Differences in views about burning.

Weed control group	Burning (%)		
	Worth doing	Not worth doing	Not familiar
Neither spray grazing nor slashing	4.0	52.0	44.0
Not spray grazing, but using slashing	46.2	23.1	30.8
Spray grazing, but not quarantine	34.8	34.8	30.4
Both spray grazing and quarantine	63.0	22.2	14.8

Table A2.0.9 Differences in views about holding yards and quarantine.

Weed control group	Holding yards and quarantine (%)		
	Worth doing	Not worth doing	Not familiar
Neither spray grazing nor slashing	28.0	20.0	52.0

The Sociology of Weed Management

Not spray grazing, but using slashing	53.8	0.0	46.2
Spray grazing, but not quarantine	0.0	30.4	69.6
Both spray grazing and quarantine	100.0	0.0	0.0

There is a significant difference between the mean number of weed control methods within each group (

Table A2.0.10).

Table A2.0.10 Differences in the mean number of weed control methods used.

Weed control group	Mean number of weed control methods
Neither spray grazing nor slashing	4.96
Not spray grazing, but using slashing	7.23
Spray grazing, but not quarantine	7.17
Both spray grazing and quarantine	10.22

Anova, $p < 0.005$

If the various weed control methods are rated on a scale of 1 to 3, where 1 is a simple, straightforward method and 3 is a complex method requiring specific skills, and 2 is methods intermediate between the previous extremes, then a weed control complexity rating can be calculated for each respondent. There is a significant difference between the four groups with respect to the mean weed control complexity rating (

Table A2.0.11).

Table A2.0.11 Differences in the complexity of practices used.

The Sociology of Weed Management

Weed control group	Mean weed control complexity rating
Neither spray grazing nor slashing	1.47
Not spray grazing, but using slashing	1.48
Spray grazing, but not quarantine	1.73
Both spray grazing and quarantine	1.69

Note that the mean weed control complexity rating for the fourth group is slightly lower than that for the third group. This is an inevitable consequence of the fourth group using a wider range of methods, which necessarily include a number of simpler methods.

There was no significant difference between the groups with respect to:

- selective use of herbicide,
- boom spraying,
- maintaining ground cover,
- biological control, and
- chipping and hand weeding.

The pattern of differences between the four groups suggest that producers in the first group (neither spray grazing nor slashing) generally use fewer and simpler weed control methods and are not familiar with a number of weed control methods, while those in the fourth group (both spray grazing and quarantine) use a wide range of control methods, including the more complex methods, and are generally familiar with most methods.

The pattern of differences also suggests that the second and third groups, which are intermediate in the number of weed control methods used, can be distinguished by a tendency to favour mechanical control methods (burning, slashing, cultivation, holding yards) or grazing-based methods (tactical grazing pressure, spray topping, spray grazing). The second group favours the mechanical methods while the third group favours grazing based methods.

For the purposes of the results presented below, these four groups are referred to as:

- minimal control,
- mechanical control,
- grazing control, and
- maximal control.

A.2.5.4 Other characteristics of weed control groups

There are a number of significant associations between group membership and responses to other questions that cast further light on the nature of these groups.

The four groups are not evenly distributed across the three regions in which the face-to-face interviews and mail-back survey were undertaken. The minimal and mechanical control groups are most strongly represented in northern New South Wales, while the grazing and maximal control groups have greater proportions of members in southern New South Wales (Table A2.0.12).

Table A2.0.12 Geographic distribution of weed control groups.

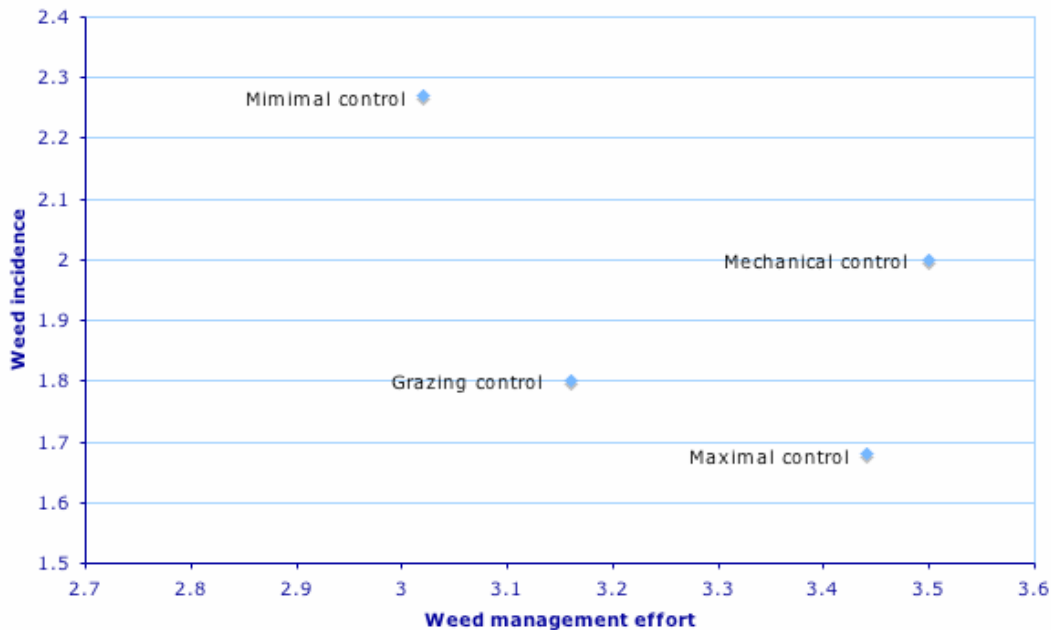
Weed control group	Region		
	Northern New South Wales	Southern New South Wales	North eastern Victoria
Minimal control	56.0	32.0	12.0
Mechanical control	69.2	7.7	23.1
Grazing control	13.0	56.5	30.4
Maximal control	15.4	61.5	23.1

The mean proportion of property area under cropping is much higher for the grazing and maximal control groups (15 and 20 per cent respectively), than for the minimal and mechanical control groups (1 and 3 per cent respectively). The greater range of weed control options considered worth using among those with cropping enterprises is consistent with the statements obtained from those with cropping enterprises interviewed on-farm (see, for example, section 0, above).

There is a significant difference between the four groups with respect to the management effort ($p=0.089$) and weed incidence ($p=0.068$) ratings supplied by the weeds officers who accompanied the farm visits (Figure A2.0.1).

Interestingly, the mechanical control group rates slightly higher than the maximal control group on weed management effort, but also has a higher level of weed infestation. This might reflect the higher visibility of mechanical control to visiting weeds officers. Another possibility is the interplay of topographic factors, with a large number of producers in the mechanical control group being located in rougher, more hilly regions. Weed control is more difficult in these areas and more effort would be needed to control weeds, a factor well understood by visiting weeds officers. Further, rough terrain limits the variety of methods available for controlling weeds. For example, a boom spray may not be safely used on very uneven, rough terrain. By comparison, the grazing control group appears to be achieving a level of weed infestation only slightly worse than that achieved by the maximal control group, but with much less effort.

Figure A2.0.1 Differences across weed control groups in weed incidence and level of management effort as rated by weeds officers accompanying the farm visits.



2.5.5 A minimum set of weed control methods

The weed control groups described above can be defined with information on just three weed control practices: spray grazing, slashing and quarantine. With nearly all respondents regarding boom spraying and spot spraying with herbicides as well worth doing, these two methods will have little explanatory value in any analysis to understand the relationships between weed control on the one hand, and attitudes and beliefs about weeds and weed control on the other. These findings will assist in reducing the number of weed control methods included in the producer telephone survey.

A2.6 Perceptions and Attitudes

The performance of the weed awareness and attitudinal questions has been discussed in section 0 of this appendix. This section deals with the relationships between weed awareness and attitudes on the one hand and, on the other, demographic and farm characteristics, weed incidence, weed management effort and weed control.

A2.6.1 Reasons Plants Cause Problems

In the on-farm face-to-face interviews, producers were asked about what plants (not necessarily just those declared as noxious weeds) caused them the most problems, and what it was about these plants that made them a problem. Those who gave answers

relating to the health of livestock and the value of livestock products had significantly lower levels of weed infestation, as rated by the weeds officers assisting with the farm visits (

Table A2.0.1).

Table A2.0.1 Difference in weed incidence between those giving and not giving animal health or value of livestock products as a reason plants cause problems for graziers.

Animal health or value of livestock products given as a reason plants cause problems.	Mean rating on weed incidence
Yes	1.79
No	2.06

Anova, weed incidence: p=0.083

Those who saw the invasive or competitive nature of plants as a problem were also more likely to have lower levels of weed infestation (Table A2.0.2).

Table A2.0.2 Differences in weed incidence between those giving and not giving invasive or competitive nature as a reason plants cause problems for graziers.

Invasive or competitive nature of plants given as a reason plants cause problems.	Mean rating on weed incidence
Yes	1.75
No	2.22

Anova, weed incidence: p=0.002

Among the reasons given that plants cause problems for graziers, there were no significant relationships with weed incidence or management effort for reasons related to productivity and profitability.

A2.6.2 Influences on the Choice of Weed Control Methods

In the face-to-face on-farm interviews, farmers were asked about the things they considered in choosing methods of weed control. Aspects relating to their experience and outside sources of advice such as agronomists were most frequently mentioned (61 per cent of those interviewed), followed by aspects relating to time and monetary constraints (49 per cent of those interviewed) and aspects relating to the weed, its location and size of infestation (45 per cent of those interviewed).

However, among the one half of interviewees with lower levels of weed infestation as rated by the weeds officers, 71 per cent of those interviewed mentioned aspects relating to their experience and sources of advice, compared to 53 per cent among those in the one half of interviewees with higher levels of weed infestation. While this difference suggests that

those using outside advice are more likely to be controlling weeds effectively, the magnitude of the difference has probably been reduced by an opposite effect, viz. those with high levels of weeds are more likely to have attracted the attention of weeds authorities and have received advice on control.

Among the one half of interviewees with lower levels of weed infestation, only 29 per cent of those interviewed mentioned time and monetary constraints, compared to 64 per cent among those in the one half of interviewees with higher levels of weed infestation. This marked difference would suggest that failure to control weeds is frequently due to a lack of time or money or both.

A2.6.3 Difficulties with Weed Control

The responses to the question in the mail-back survey about any difficulties respondents faced in controlling weeds suggest that the barriers to better weed control are more managerial than technological (Table A2.0.3). Difficulties with terrain and herbicide resistance are the main problems where technological innovations may lead to improved weed control.

Table A2.0.3 Incidence of difficulties with weed control reported by respondents.

Difficulty	Proportion of respondents (%)
Lack of time	67.4
Drought	66.3
Lack of money	61.6
Difficult country	50.0
Weeds spread from neighbours	45.9
Labour shortage	40.7
Herbicide resistance	19.8
I don't like using chemicals	14.0
Lack of information	12.8
Control methods don't work well	10.5
Other priorities are more important	5.8
Medical problems	4.7
Live off-farm and rarely have time to control weeds	1.2

For three of the difficulties listed in Table A2.0.3, there were significant differences between the three demographic and farm groups. Lack of money was given by all respondents in group 3, compared to 61 per cent in group 1 and 48 per cent in group 2 ($p=0.049$). This is consistent with group 3 being smaller properties and group 2 having older farmers.

Difficult country was given by 67 per cent of respondents in group 2, compared to around 30 per cent of respondents in groups 1 and 3 ($p=0.035$). The incidence of properties regarded by their owners as difficult for weed control showed a marked grouping of such properties (

Figure A2.0.1), due for their prevalence among mixed farming properties that were neither solely sheep-wheat, nor largely cattle operations.

Among the three demographic and farm groups, the problem of weeds spreading from neighbours was identified by all respondents in group 3, compared to around 37 per cent of producers in groups 1 and 2 ($t(p=0.008)$), suggesting that this problem may be more prevalent among properties with no cropping.

For two of the difficulties listed in the table above, there were significant differences between the weed control groups. Herbicide resistance was more likely to be nominated by members of the maximal control group as a problem that makes weed control difficult for them (

Table A2.0.4). This is consistent with the greater numbers of this group located in the southern New South Wales sheep-wheat zone, where herbicide is used intensively, leading to the emergence of herbicide resistant weeds.

Table A2.0.4 Differences between weed control groups in the proportion who regarded herbicide resistance as a problem in weed control.

Weed control group	Herbicide resistance (%)	
	Not ticked	Ticked
Minimal control	88.0	12.0
Mechanical control	84.6	15.4
Grazing control	90.9	9.1
Maximal control	58.3	41.7

Anova, $p=0.019$

Dislike of using chemicals is nominated as a weed control difficulty by a just over a third of the minimal control group, compared to relatively few in the other groups (Table A2.0.5).

Figure A2.0.1 Location of properties regarded by their owners as difficult for weed control, with respect to the demographic and farm characteristic dimensions.

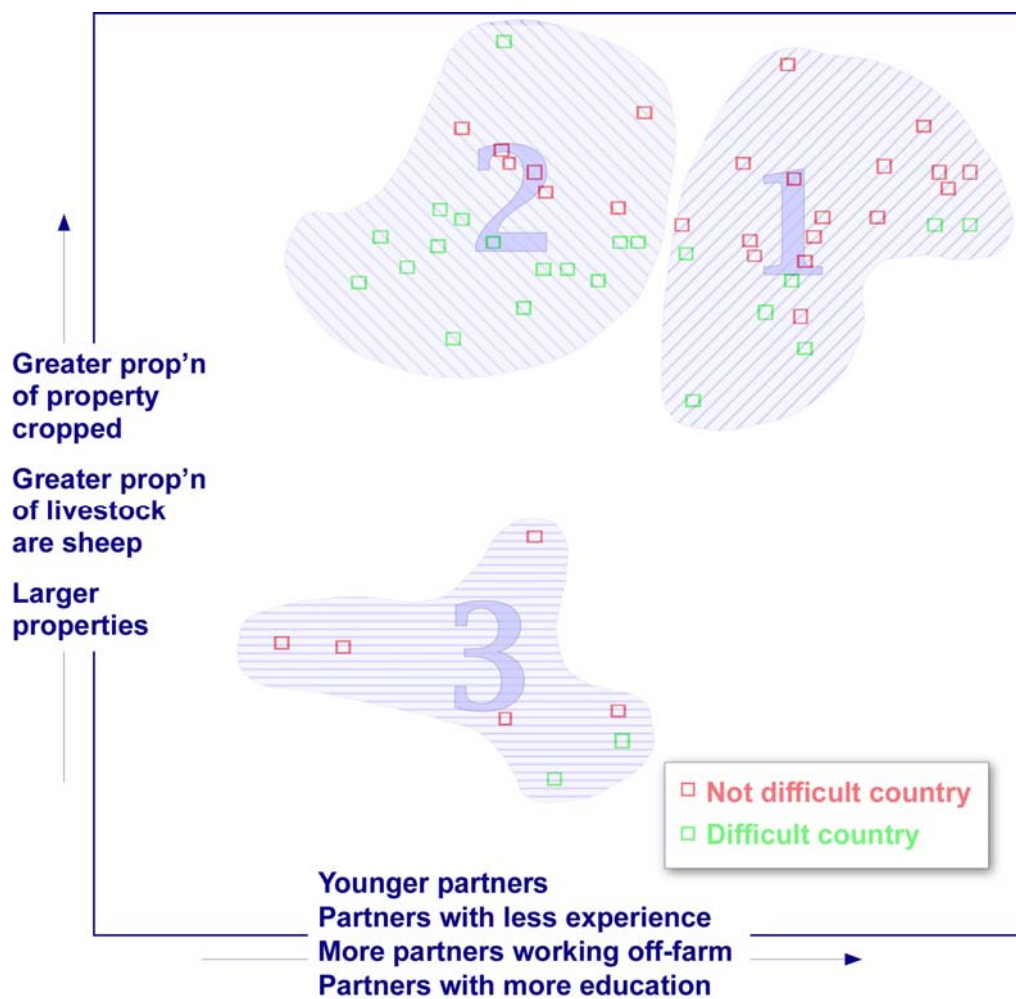


Table A2.0.5 Differences between weed control groups in the proportion who disliked using chemicals.

Weed control group	Don't like using chemicals (%)	
	Not ticked	Ticked

The Sociology of Weed Management

Minimal control	64.0	36.0
Mechanical control	92.3	7.7
Grazing control	100.0	0.0
Maximal control	91.7	8.3

Anova, p=0.002

Weed incidence and weed management effort, as rated by the weeds officers assisting with the farm visits, were related to three of the difficulties. Those who nominated 'Lack of money' as a difficulty they faced had a significantly higher mean rating for weed incidence ($p=0.054$) than did those who did not nominate this difficulty. This was also the case for those who nominated 'Don't like using chemicals', compared to those who did not ($p=0.056$). On the other hand, those who nominated 'Herbicide resistance' as a difficulty they faced had a significantly lower weed incidence rating ($p=0.045$) than those who did not nominate this difficulty. Consistent with this, those with herbicide resistance problems had a significantly higher rating for weed management effort ($p=0.040$), compared to those who did not have this problem.

A2.6.4 Motivations for Changing Weed Management

Farmers were asked in the face-to-face interviews whether they had changed their weed management in the last five years, and if so, the reason for doing so. Those who had changed their weed management had significantly higher levels of weed management effort as rated by the weeds officers assisting with the farm visits ($p=0.015$). The most frequently mentioned new practices mentioned by those changing methods were aerial spraying (15 per cent of changes mentioned) and pasture improvement (15 per cent), followed by general increases in management activity (12 per cent), and biological control methods (7 per cent). A number of chemical and non-chemical methods each comprised less than 5 per cent of the changes mentioned.

The most frequently mentioned motivation for changing weed management was a worsening weed situation (30 per cent of motivations mentioned), followed by a desire to increase production (15 per cent) and as an outcome of successful trials (8 per cent). The first motivation shows that, by itself, recent changes in weed management are not necessarily an indication of good weed management and a question on this in the telephone survey would not be satisfactory as a proxy for standard of weed management. A range of motivations each comprised 5 per cent or less of the motivations mentioned. These included motivations related to increased awareness, where respondents mentioned field days, Grazing for Profit courses, Landline, success by other producers and advice from professionals. Taken together, these awareness-related motivations comprised 20 per cent of motivations mentioned.

A2.6.5 Reasons for Not Changing Weed Management

Among those who had not changed their weed management in the last five years, the most popular reason for not changing was that their current methods were working and there was no need to change (30 per cent of reasons mentioned). However, the level of

weed infestation among those who believed there was no need to change, as rated by the weeds officers, was not significantly lower than those who had changed their management. Thus it is possible that at least some of those who had not changed their weed control methods in the past five years were achieving adequate levels of control. Again, this suggests that change in weed management, by itself, is not a satisfactory proxy for standard of weed management. A range of reasons for not changing weed management each comprised eight percent or less of the reasons mentioned

A2.6.6 Key to Good Weed Management

In the face-to-face interviews, farmers were asked what they regarded as the key element in a good weed control program. The most popular response was aspects relating to the timing and effectiveness of spray application (50 per cent of interviewees), followed by aspects relating to diligence and care (39 per cent of interviewees).

Among those in the one half of interviewees with lower levels of weed infestation as rated by the weeds officers, 57 per cent mentioned diligence and care, compared to 39 per cent among the one half of interviewees with higher levels of weed infestation.

Among those in the one half of interviewees with lower levels of weed infestation, 41 per cent mentioned aspects relating to timing and effectiveness of spray application, compared to 58 per cent among the one half of interviewees with higher levels of weed infestation. These differences suggest that diligence and care do contribute to better weed control, and that some farmers may be experiencing poor control due to when and how they carry out spray applications.

A2.6.7 Views about How Much Weeds Reduce Returns

The mail-back survey asked how much it was believed that weeds were reducing returns from grazing enterprises in the district. It can be seen from Table A2.0.6 that loss of pasture production and cost of weed control are seen as causing substantial reductions in returns. Consistent with the differences in farm characteristics between groups 1, 2 and 3, all group 3 respondents believed that there was little or no reduction in returns in their district due to reduction in the value of fleeces and skins.

Table A2.0.6 Views about how much weeds reduce returns from grazing enterprises.

Cause of reduction to returns from grazing enterprises	Proportion of respondents (%)		
	Big reduction	Some reduction	Little or no reduction
Loss in pasture production	38.8	54.1	7.1
Cost of controlling weeds	37.6	57.6	4.7
Reduction in value of fleece and skins	16.5	42.4	41.2
Injury to stock	2.4	21.2	76.5
Meat and milk taint	1.2	10.6	88.2

The Sociology of Weed Management

Poisoning of stock	0.0	21.2	78.8
--------------------	-----	------	------

These findings suggest that there is widespread awareness of the costs of weed control and the loss in pasture production caused by weeds. However, it is important to note that awareness of these costs does not necessarily lead to farmers improving their weed management. There were no significant differences in perceptions of reductions in returns among the weed control groups – in other words, those who were doing relatively little to control weeds appeared to be just as aware of the costs of weeds to their grazing enterprises as those who were using a wide range of control practices. Consistent with this, there were no significant relationships between views about the reductions in returns and level of weed infestation or management effort as rated by the weeds officers who assisted with the farm visits. This is also consistent with the responses to the face-to-face interviews when producers were asked what it was about plants that caused them problems (section 0).

The perceived costs of improved weed management will be weighed up against the perceived costs of other options, such as doing nothing. As one farmer observed:

I think that farms need to be profitable before anything happens, so [if you are making little profit] you can't be doing any la-di-da stuff. If you look at the very visible economic incentive to control the weeds it is probably far cheaper to buy the paddock next door [where there are less weeds].

If the rate of spread of a weed is relatively slow, the point in the future at which returns are seriously reduced may be well beyond the planning horizon of an older farmer. It should be noted that the responses to the question about reductions in returns to grazing enterprises are mediated through respondents' views about what constitutes a weed. The comment below illustrates this variation in graziers' perceptions of a weed:

How do you define a weed though? I mean barley grass is actually quite a good thing in the autumn because they are the first green feed, but in the spring they are a weed with the grass seeds coming out and they get in your sheep and cause wool contamination ... I mean it is the same with Paterson's curse and Capeweed and things like that.

There may be cases where the weeds a respondent is familiar with do not cause substantial production losses, while there may still be substantial losses in production occurring, due to plants not considered as weeds. Obviously, any communication and extension efforts focusing on production losses should be very specific about what plants cause the losses, and make sure that graziers are able to recognise these plants in their pastures.

A2.6.8 Weed Awareness

The performance of the weed awareness questions has been discussed in section 0. This section deals with the relationship between weed awareness and weed control. Firstly, it can be noted that there are no significant differences across the weed control groups or the demographic and farm groups with respect to overall weed awareness measured in the way described in the first section of this appendix.

However, this does not necessarily mean that awareness of weeds has no effect on farmers' willingness to control them. Rather, the lack of a significant relationship for an awareness measure averaged across all weeds is due to different relationships for individual weeds which cancel out when the individual weed measures are averaged. This is best illustrated by the correlations between awareness measures for individual weeds and the weed incidence as rated by the weeds officers assisting with the farm visits. It might, at first thought, be assumed that weed awareness should be negatively correlated with weed incidence, i.e. those with high levels of awareness should have low levels of weed infestation. However,

Table A2.0.7 shows that this is the case only for the grass weed *Vulpia*, whereas the measured weed awareness for Bathurst burr, blackberry and sweet briar is positively correlated with weed incidence.

Table A2.0.7 Correlation between the weed awareness measure for individual weeds and weed incidence as rated by weeds officers assisting the farm visits.

Weed	Correlation with weed incidence
Bathurst burr	+0.265*
Blackberry	+0.288**
Sweet briar	+0.310**
<i>Vulpia</i>	-0.266*

*Spearman's rho: * denotes a significant correlation at $p < 0.05$; ** denotes a significant correlation at $p < 0.01$*

This pattern of correlations suggests that those with serious infestations of universally recognised weeds such as Bathurst burr, blackberry and sweet briar are well aware that they have the weed, that it is regarded as a weed, and they can readily identify it. In areas where these weeds are less common and/or well controlled, respondents may indicate that the weed is not present in their district, resulting in a lower weed awareness score.

However, for a less well known grass weed like *Vulpia*, those who have serious infestations of the universally recognised broad leaf weeds, possibly through poor management, may not be aware of the existence of *Vulpia*, they may not recognise it as a weed, and may not be able to identify it.

This pattern of correlations may also reflect the tendency of weeds officers to focus on declared weeds in making their assessments as to the weed incidence of the properties visited.

The differences in weed awareness for individual weeds across the four weed control groups are consistent with the findings above. As Table A2.0.8 shows, the highest awareness scores are for the minimal control group, and the lowest scores for the maximal control group.

These findings highlight the need for care in proposing communication activities focusing on raising awareness about well-known broadleaf weeds as a means of improving weed control. There is likely to be a significant number of graziers with higher than desirable levels of infestation of well-known broadleaf weeds, upon whom such activities would have little impact.

Table A2.0.8 Differences across the weed control groups in weed awareness measures.

Weed control group	Mean weed awareness score	
	Blackberry	Sweet briar
Minimal control	0.942	0.696
Mechanical control	0.667	0.456
Grazing control	0.725	0.652
Maximal control	0.569	0.306

Blackberry: anova, p=0.025, sweet briar: anova, p=0.022

A2.6.9 Attitudes

A2.6.9.1 Differences across demographic and farm groups

There were significant differences in the responses to four of the attitude statements, suggesting that:

- producers with mainly grazing operations were more likely to be aware of the possibility of controlling weed with grazing management (Table A2.0.9),
- younger, better-educated producers on cropping properties were more likely to consult with others about weed problems (Table A2.0.10), and
- younger, better educated producers on cropping properties were more likely to be aware that new weed control methods are becoming available (
- Table A2.0.11).

Interestingly, it is this latter group who have a more diffident attitude to the benefits of new weed control methods (Table A2.0.12), perhaps reflecting greater awareness of the complexities of weed management and the absence of 'magic bullet' solutions.

The Sociology of Weed Management

Table A2.0.9 Differences across the demographic and farm groups in views about weed management and grazing management.

Demographic and farm group	With most weeds around here, it's possible to change your grazing management so they don't get a chance to spread.		
	Agree	Neutral	Disagree
Group 1	34.8	8.7	56.5
Group 2	38.1	33.3	28.6
Group 3	57.1	0.0	42.9

χ^2 test, $p=0.099$

Table A2.0.10 Differences across the demographic and farm groups in views about consulting with others on weed problems.

Demographic and farm group	With weed problems, it's best to get in and fix them yourself, rather than talking to others about what to do.		
	Agree	Neutral	Disagree
Group 1	21.7	8.7	69.6
Group 2	81.0	4.8	14.3
Group 3	57.1	14.3	28.6

χ^2 test, $p=0.004$

Table A2.0.11 Differences across the demographic and farm groups in views about change in weed management.

Demographic and farm group	Weed control is one part of running a property that hasn't changed much over the years.		
	Agree	Neutral	Disagree
Group 1	30.4	8.7	60.9
Group 2	61.9	19.0	19.0
Group 3	57.1	0.0	42.9

χ^2 test, $p=0.057$

Table A2.0.12 Differences across the demographic and farm groups in views about the benefits of new weed control methods compared to the cost of trialling.

Demographic and farm group	Generally, the benefits of new weed control methods outweigh the costs in trying them out.		
	Agree	Neutral	Disagree
Group 1	17.4	39.1	43.5
Group 2	42.9	42.9	14.3
Group 3	71.4	28.6	0.0

χ^2 test, $p=0.019$

A2.6.9.2 Differences across weed control groups

Attitudinally, the maximal and mechanical control groups are more likely to put a high priority on weed control, while well over a third of the minimal control group do not see weed control as the most important farm task (Table A2.0.13).

Table A2.0.13 Differences across the weed control groups in views about the priority of weed control compared to other farm tasks.

Weed control group	Of all the jobs on a farm, weed control is probably the most important. (%)		
	Agree	Neutral	Disagree
Minimal control	41.7	20.8	37.5
Mechanical control	75.0	0.0	25.0
Grazing control	65.2	26.1	8.7
Maximal control	69.2	7.7	23.1

Among the impacts of weeds nominated as a reason for control by respondents in the face-to-face on-farm interviews, impact on pasture productivity was more likely to be mentioned by those in the minimal control group and in the grazing control group. In the case of the minimal control group, this may be a consequence of weeds being allowed to spread until the point where production was obviously being affected. On the other hand, the impact of competitive and invasive weeds was more likely to be mentioned by those in the mechanical control group. The minimal control group had a markedly lower proportion who were concerned about impacts on animal health and the value of animal products.

When asked in the face-to-face interviews about what influenced their choice of weed control methods, those in the minimal control group were more likely to mention aspects relating to time and financial considerations, while those in the mechanical control group were more likely to mention aspects relating to farmer experience and outside advice, often from visiting weeds officers rather than as the result of their own investigative effort.

The latter is consistent with responses to the face-to-face interview question about who identified weeds on interviewees' properties. After themselves and other landholders (mentioned by all interviewees), government department staff were the next most

frequently mentioned identification source by the mechanical control group. In the latter case, identification assistance was obtained occasionally when an unfamiliar plant was ‘chipped out’ and sent or taken to, for example, the local department of agriculture office, for identification. The next most frequently mentioned identification source for the maximal control group was, on the other hand, agronomists and farm consultants.

In relation to the most crucial element in good weed control, members of the grazing control group were markedly more likely than those in other groups to nominate aspects of persistence and diligence.

A2.6.9.3 Relationship between attitudes and weed incidence and management effort

There are a number of attitude statements, the responses to which are related to weed incidence and management effort as rated by the weeds officers assisting with the farm visits. Those with lower levels of weed infestation and higher levels of management effort tend to:

- be aware that new weeds can appear in their district (Table A2.0.14),
- place a very high priority on weed control compared to other farm management tasks (Table A2.0.15),
- not believe that weed control can be put off in difficult times, to be caught up with later (Table A2.0.16), and
- believe that the benefits of new weed control methods outweigh the costs of trialing them (Table A2.0.17).

Table A2.0.14 Differences in weed incidence and management effort among those who agree or disagree with the statement below.

In this district, it’s just the same few weeds that are a problem – you don’t have to worry about new weeds appearing.	Mean rating on weed incidence	Mean rating on management effort
Agree	2.13	3.06
Disagree	1.77	3.38

Anova, weed incidence: p=0.062; management effort: p=0.037

Table A2.0.15 Differences in weed incidence and management effort among those who agree or disagree with the statement below.

Of all the jobs on a farm, weed control is probably the most important.	Mean rating on weed incidence	Mean rating on management effort
Agree	1.72	3.42

The Sociology of Weed Management

Neutral	2.21	2.88
Disagree	2.18	3.00

Anova, weed incidence: $p=0.045$; management effort: $p=0.008$

Table A2.0.16 Differences in weed incidence and management effort among those who agree or disagree with the statement below.

Fortunately, weed control is something you can put off in difficult times, and catch up later.	Mean rating on management effort
Agree	2.83
Neutral	3.63
Disagree	3.31

Anova, management effort: $p=0.037$

Table A2.0.17 Differences in weed incidence and management effort among those who agree or disagree with the statement below.

Generally, the benefits of new weed control methods outweigh the costs in trying them out.	Mean rating on weed incidence
Agree	1.57
Neutral	2.08
Disagree	2.03

Anova, weed incidence: $p=0.040$

A2.6.10 Views about Information Sources

The usefulness to respondents of a range of information sources is shown in

Table A2.0.18.

Table A2.0.18 Usefulness to respondents of information sources.

Source of information	Proportion of respondents (%)
------------------------------	--------------------------------------

The Sociology of Weed Management

	Very useful	Some use	Not useful
Other family members	27.3	45.5	27.3
Neighbouring producers	30.5	62.2	7.3
Expert producers in region	46.8	40.5	12.7
Farmer organisations	21.3	57.5	21.3
Local council	23.1	39.7	37.2
Spray contractors	33.3	56.0	10.7
Weeds authorities	51.2	36.6	12.2
Government departments	55.4	41.0	3.6
Agricultural consultants	40.0	40.0	20.0
Chemical and fertiliser company advisors	36.6	43.9	19.5
Retailers, stock and station agents	35.3	52.9	11.8

There were no significant differences in views about the usefulness of the above information sources across the demographic and farm groups, suggesting that the relative high rating of government departments, weeds authorities and expert producers, and lower rating of local government is fairly universal among producers.

A2.6.10.1 Differences between weed control groups

There were a number of significant differences between the weed control groups in the reported usefulness of various sources of information. A greater proportion of producers who were using a wide range of weed control practices rated expert producers, agricultural consultants and chemical and fertiliser company advisors as very useful (Table A2.0.19 and Table A2.0.20).

Table A2.0.19 Differences across weed control groups in respondents ratings of the usefulness of expert producers in their region.

Weed control group	Expert producers in region (%)		
	Very useful	Some use	Not useful
Minimal control	41.7	29.2	29.2
Mechanical control	54.5	36.4	9.1
Grazing control	31.6	63.2	5.3
Maximal control	61.5	34.6	3.8

χ^2 test, $p=0.042$

Table A2.0.20 Differences across weed control groups in respondents' ratings of the usefulness of chemical and fertiliser company advisors.

Weed control group	Chemical and fertiliser company advisors (%)		
	Very useful	Some use	Not useful
Minimal control	17.4	47.8	34.8
Mechanical control	33.3	50.0	16.7
Grazing control	38.1	38.1	23.8
Maximal control	53.8	42.3	3.8

χ^2 test, $p=0.079$

A2.6.11 Relationship between usefulness of information sources and weed incidence

Weed incidence as rated by the weeds officers assisting with the farm visits was also related to views about the usefulness of various information sources. Compared to those with higher levels of weed infestation, those with a lower incidence of weeds on their properties tended to have a higher opinion of expert producers, local councils, chemical and fertiliser company advisors and retailers and stock and station agents as useful sources of information (Table A2.0.21 to Table A2.0.24).

Table A2.0.21 Differences in weed incidence across groups defined by rating of the usefulness of expert producers in the region as an information source.

Expert producers in region as sources of information about weeds.	Mean rating on weed incidence
Very useful	1.63
Some use	2.08
Not useful	2.56

Anova, weed incidence: $p=0.006$

Table A2.0.22 Differences in weed incidence across groups defined by rating of the usefulness of the local council as an information source.

Local councils as sources of information about weeds.	Mean rating on weed incidence
Very useful	1.50
Some use	2.13
Not useful	1.94

Anova, weed incidence: $p=0.047$

Table A2.0.23 Differences in weed incidence across groups defined by rating of the usefulness of chemical and fertiliser company advisors as an information source.

Chemical or fertiliser company advisors as sources of information about weeds.	Mean rating on weed incidence
Very useful	1.61
Some use	1.97
Not useful	2.33

Anova, weed incidence: $p=0.019$

Table A2.0.24 Differences in weed incidence across groups defined by rating of the usefulness of chemical and fertiliser company advisors as an information source.

Retailers and stock and station agents as sources of information about weeds.	Mean rating on weed incidence
Very useful	1.50
Some use	1.99
Not useful	2.56

Anova, weed incidence: $p=0.002$

It is worth noting that all these information sources that are regarded as useful by the better weed managers are local in nature.

A6.11.1 Views about Communication of Information

Across all respondents, fact-sheets and booklets from government departments and field days and workshops stand out as ways of communicating information about weeds that are widely regarded as very useful (Table A2.0.25). On the other hand, the electronic media – radio, TV and Internet – are regarded as not useful by large proportions of respondents.

Table A2.0.25 Usefulness to respondents of ways of communicating information.

Communication of information	Proportion of respondents (%)		
	Very useful	Some use	Not useful
Books	36.7	54.4	8.9

The Sociology of Weed Management

Daily or local newspapers	15.0	51.2	33.8
Weekly rural newspapers	29.3	53.7	17.1
Farmer and industry newsletters and magazines	37.5	55.0	7.5
Fact-sheets and booklets from government departments	61.3	31.3	7.5
Field days and workshops	67.5	25.0	7.5
Leaflets and booklets from retailers, merchandisers and stock and station agents	30.4	57.0	12.7
Radio	12.5	40.0	47.5
TV	7.5	36.3	56.3
Internet	14.1	34.4	51.6

A6.11.2 Differences between demographic and farm groups

There were two significant differences in views about communication of information across the demographic and farm groups. Younger, better-educated farmers with larger cropping properties were more likely to regard farmer and industry newsletters as very useful ways of communicating information (Table A2.0.26). Older, less well educated farmers on smaller properties with relatively more cattle were more likely to regard TV as a very useful way of communicating information (Table A2.0.27).

Table A2.0.26 Differences across the demographic and farm groups in views about the usefulness of farmer and industry newsletters as a way of communicating information about weeds.

Demographic and farm group	Farmer and industry newsletters		
	Very useful	Some use	Not useful
Group 1	50.0	36.4	13.6
Group 2	26.3	73.7	0.0
Group 3	16.7	83.3	0.0

χ^2 test, $p=0.061$

Table A2.0.27 Differences across the demographic and farm groups in views about the usefulness of TV as a way of communicating information about weeds.

Demographic and farm group	TV		
	Very useful	Some use	Not useful

The Sociology of Weed Management

Group 1	4.8	19.0	76.2
Group 2	0.0	60.0	40.0
Group 3	14.3	28.6	57.1

χ^2 test, $p=0.047$

A6.11.3 Differences between weed control groups

There were significant differences between the weed control groups in views about the usefulness of various ways of communicating information about weeds. Books, fact sheets from government departments and the internet were regarded less favourably by the minimal control group as a means of communicating information, although fact sheets from government departments were regarded as not useful by a relatively small proportion of respondents in the minimal control group (Table A2.0.28 and Table A2.0.29). On the other hand, books and fact sheets from government departments were very favourably regarded by those in the mechanical control group.

Table A2.0.28 Differences across weed control groups in respondents' ratings of the usefulness of books as a way of communicating information.

Weed control group	Books (%)		
	Very useful	Some use	Not useful
Minimal control	18.2	63.6	18.2
Mechanical control	58.3	33.3	8.3
Grazing control	40.0	50.0	10.0
Maximal control	44.0	56.0	0.0

χ^2 test, $p=0.072$

Table A2.0.29 Differences across weed control groups in respondents' ratings of the usefulness of fact sheets from government departments as a way of communicating information.

Weed control group	Fact sheets from government departments (%)		
	Very useful	Some use	Not useful
Minimal control	39.1	52.2	8.7
Mechanical control	81.8	18.2	0.0
Grazing control	70.0	15.0	15.0
Maximal control	61.5	34.6	3.8

χ^2 test, $p=0.086$

A relatively large proportion of the minimal control group regard the Internet as not useful to them for weed information (Table A2.0.30).

Table A2.0.30 Differences across weed control groups in respondents' ratings of the usefulness of the Internet as a way of communicating information.

Weed control group	Internet (%)		
	Very useful	Some use	Not useful
Minimal control	0.0	22.2	77.8
Mechanical control	20.0	20.0	60.0
Grazing control	17.6	29.4	52.9
Maximal control	21.1	63.2	15.8

χ^2 test, $p=0.015$

A2.6.11.3 Relationship between usefulness of ways of communicating information and weed incidence and management effort

Views about a number of ways of communicating information were quite strongly related to weed incidence as rated by the weeds officers assisting with the farm visits and, to a lesser extent, to the level of weed management effort rated in the same way.

For each of the ways of communicating information in Table A2.0.31 to Table A2.0.36, below, those who indicated the forms of communication were very useful, had significantly lower levels of weed infestation. Those who regarded as very useful, farmer and industry newsletters, and leaflets and brochures from retailers, merchandisers and stock and station agents, also had significantly higher levels of weed management effort.

Table A2.0.31 Differences in weed incidence across groups defined by rating of the usefulness of books as a way of communicating information.

Books as a way of communicating information about weeds.	Mean rating on weed incidence
Very useful	1.56

Some use	2.10
Not useful	2.29

Anova, weed incidence: $p=0.016$

Table A2.0.32 Differences in weed incidence across groups defined by rating of the usefulness of daily or local newspapers as a way of communicating information.

Daily or local newspapers as a way of communicating information about weeds.	Mean rating on weed incidence
Very useful	1.40
Some use	1.90
Not useful	2.17

Anova, weed incidence: $p=0.050$

Table A2.0.33 Differences in weed incidence across groups defined by rating of the usefulness of weekly rural newspapers as a way of communicating information.

Weekly rural newspapers as a way of communicating information about weeds.	Mean rating on weed incidence
Very useful	1.55
Some use	1.92
Not useful	2.18

Anova, weed incidence: $p=0.071$

Table A2.0.34 Differences in weed incidence across groups defined by rating of the usefulness of farmer and industry newsletters and magazines as a way of communicating information.

The Sociology of Weed Management

Farmer and industry newsletters and magazines as a way of communicating information about weeds.	Mean rating on weed incidence	Mean rating on management effort
Very useful	1.52	3.48
Some use	2.17	3.16
Not useful	2.00	2.75

Anova, weed incidence: $p=0.006$; management effort: $p=0.026$

Table A2.0.35 Differences in weed incidence across groups defined by rating of the usefulness of leaflets and booklets from retailers, merchandisers and stock and station agents as a way of communicating information.

Leaflets and booklets from retailers, merchandisers and stock and station agents as a way of communicating information about weeds.	Mean rating on weed incidence	Mean rating on management effort
Very useful	1.55	3.58
Some use	1.98	3.12
Not useful	2.45	3.15

Anova, weed incidence: $p=0.016$; management effort: $p=0.038$

Table A2.0.36 Differences in weed incidence across groups defined by rating of the usefulness of radio as a way of communicating information.

Radio as a way of communicating information about weeds.	Mean rating on weed incidence
Very useful	1.56
Some use	1.67
Not useful	2.19

Anova, weed incidence: $p=0.018$

A2.6.12 Different Relationships Within the Demographic and Farm Groups

The preceding sections have examined the significant relationships *between* groupings of producers. These groupings were, for example, the weed control groups which separate producers according to the quantity, mix and complexity of the weed control methods they use, or the demographic and farm characteristic groups, which separate producers according to age, education, working off-farm, property size, relative proportions of sheep and cattle, and amount of cropping.

There are some relationships, however, while not significant *between* the demographic and farm groups, are significant *within* the groups. This often occurs where relationships within groups are in opposite directions, such that they cancel out when examined across the whole sample, rather than group by group. These types of relationships can be very important for understanding the different motivations and disincentives for effective weed control that operate within different farming and socio-demographic contexts.

While there were three demographic and farm groups identified, group 3 was not large enough to permit an examination of within-group relationships. The following section describes the differences in the predictors of weed incidence and weed management effort in group 1 (younger, better educated farmers on properties with relatively fewer cattle and more cropping, and who are more likely to be working off-farm), and group 2 (older, less educated farmers on properties with relatively fewer cattle and more cropping, and who are less likely to be working off-farm).

Firstly, it can be noted that respondents' views about the usefulness of various sources of information dominate the predictors of weed incidence and management effort. While this gives support for the importance of information provision in weed management extension, the relationship need not be strictly causal, i.e. provision of information leads to adoption of improved weed management practices. The same availability of information may be very useful to person who is strongly motivated to change practices, and not useful to another who has no intention, or need, to change.

It is these differences in motivation that are likely to lie behind the pattern of differences in Table A2.0.37 and Table A2.0.38. Older, less educated farmers who are nonetheless good weed managers may have established a routine for weed control (possibly based on straightforward boom spraying and spot spraying) which, due to the diligence of the individual, is very effective, even if it is not taking advantages of recent advances in weed management. Such farmers may have little use for information about better weed management, either from printed sources, their spray contractor or from other producers. This state of affairs may continue until there is a significant increase in chemical prices or fall in commodity prices, or a new weed problem arises. In the latter case, news stories in rural newspapers about new weed problems may be sufficient to alert them to the need for action. If older farmers who are controlling weeds effectively have relatively little debt to service, it may be some time before changes in prices are sufficient to provide a motivation for information seeking and changed practices.

On the other hand, there will be older, less educated farmers who are not managing weeds effectively who are under some pressure to improve their weed management

The Sociology of Weed Management

practices, either through the actions of weeds authorities or because of loss of production. These farmers may not have reached the stage of active information seeking, but nonetheless be assimilating knowledge while they go about their usual activities, such as picking up leaflets from the local retailer or merchandiser, asking more questions of their spray contractor, or asking questions of their colleagues on sale day. Shortage of labour may be a barrier to such farmers wishing to improve their weed management.

Turning to the good weed managers among the younger, better educated farmers who may also be working off-farm, these farmers appear to be active information users, i.e. low weed incidence and high weed management effort are associated with effective use of information sources that require purposeful action on their part, such as searching the internet, seeking the opinions of expert producers or neighbours, attending field days and reading books.

If active information seeking involves time and money, then younger farmers who are working off-farm and servicing higher debt levels may have difficulty investing either time or money in both information seeking and weed management, with the consequence that weed problems escalate.

From the sample size available to this component of the project, it is not possible to demonstrate conclusively the influence of all the factors discussed above. Further, where factors relate to personal matters of financial situation, health and family organisation, it is not possible to be too inquisitive in face-to-face interviews. However, the findings do demonstrate the important point that not only do attitudes to use of information impact on weed management, but the reverse is equally possible, with the state of weed management on a property impacting on the owner's attitude to information use.

Table A2.0.37 Differences between respondents in group 1 (younger, better educated farmers on properties with relatively fewer cattle and more cropping, and who are more likely to be working off-farm), and group 2 (older, less educated farmers on properties with relatively fewer cattle and more cropping, and who are less likely to be working off-farm), with respect to predictors of high levels of weed infestation as rated by the weeds officers who assisted with the farm visits. Where there is no predictive relationship, this is indicated by –. All relationships significant at $p < 0.1$ are listed.

	Group 1 High weed incidence associated with:	Group 2 High weed incidence associated with
With weed problems, it's best to get in and fix them yourself, rather than talking to others about what to do	Agree	–
In my view, you are better off looking after your stock, than worrying too much about weeds	–	Disagree
Herbicide resistance makes controlling weeds difficult on respondent's property	Not ticked	–
How much poisoning of stock reduces returns	Little or no	–

The Sociology of Weed Management

from respondent's grazing enterprise	reduction	
Proportion of partners attending field days, discussion groups etc.	–	Higher
Usefulness of expert producers in region as a source of information	Not useful	–
Usefulness of agricultural consultants as a source of information	Some use or not useful	–
Usefulness of chemical and fertiliser company advisors as a source of information	Not useful	–
Books as a source of information	Some use or not useful	–
Leaflets from retailers, stock and station agents etc as a source of information	Some use or not useful	Very useful or some use
The internet as a source of information	Not useful	–
Weekly rural newspapers as a source of information	–	Some use or not useful
Fact sheets from government departments as a source of information	–	Very useful or some use

Table A2.0.38 Differences between respondents in group 1 (younger, better educated farmers on properties with relatively fewer cattle and more cropping, and who are more likely to be working off-farm), and group 2 (older, less educated farmers on properties with relatively fewer cattle and more cropping, and who are less likely to be working off-farm), with respect to predictors of low levels of weed management effort as rated by the weeds officers who assisted with the farm visits. Where there is no predictive relationship, this is indicated by –. All relationships significant at $p < 0.1$ are listed.

	Group 1	Group 2
	Low management effort associated with:	Low management effort associated with
With weed problems, it's best to get in and fix them yourself, rather than talking to others about what to do	Agree	Agree
If you've got a problem with a weed, the best thing you can do is ask your friends or neighbours what they are doing with it.	–	Agree
Labour shortage makes controlling weeds difficult on respondent's property	–	Ticked
Usefulness of neighbouring producers as a source of information	Some use or not useful	–
Usefulness of expert producers in region as a source of information	Some use or not useful	Very useful or some use
Usefulness of farmer organisations as a source of information	Not useful	–

Usefulness of spray contractors as a source of information	Some use or not useful	Very useful or some use
Books as a source of information	Some use or not useful	–
Fact sheets from government departments as a source of information	Not useful	–
Field days and workshops as a source of information	Some use or not useful	–
Leaflets from retailers, stock and station agents etc as a source of information	Some use or not useful	Very useful or some use
Weekly rural newspapers as a source of information	–	Some use or not useful

A2.7 Discussion of Findings

A2.7.1 The 3 ‘Ds’ of Effective Weed Management

From the analysis of the face-to-face interviews, the mail-back survey and from discussions with key informants, it would appear that there are three critical factors that lead to effective weed management. These are the three “Ds” of Diligence, Diversity and Deliberation.

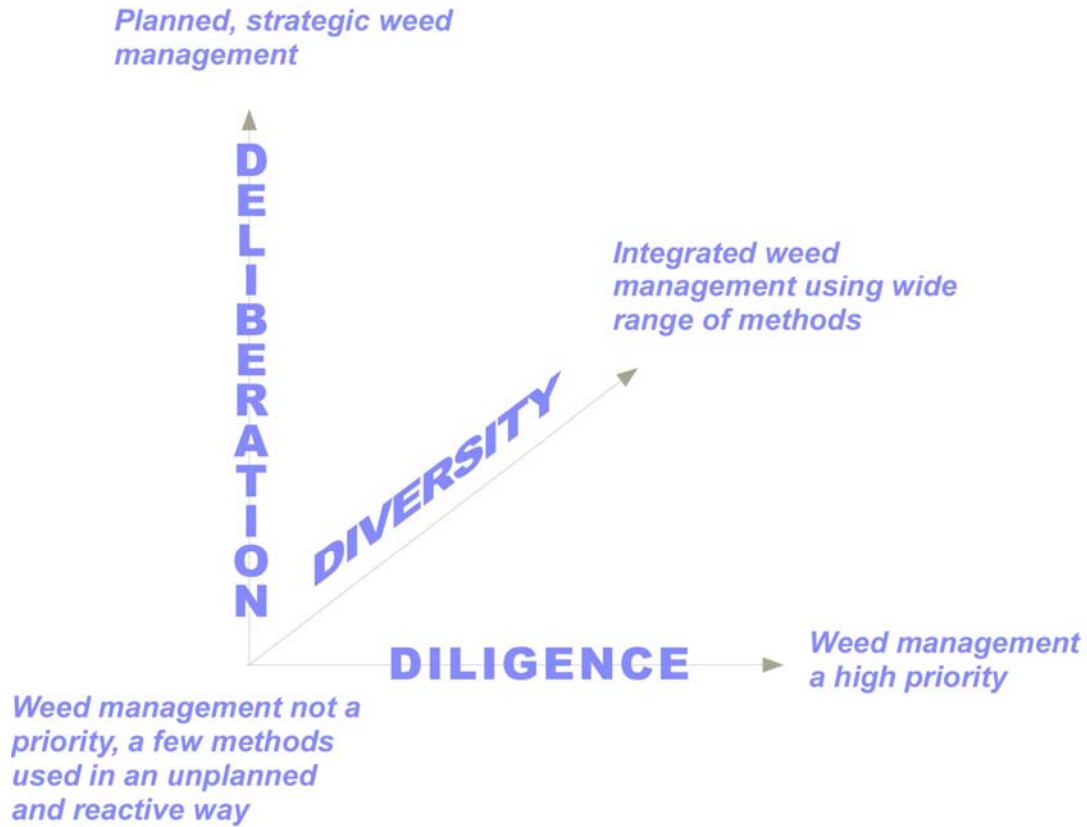
Diligence is adhering to routine practices, using them in a timely fashion and maintaining weed control as a high priority among all the other tasks competing for the farmer’s time and attention.

Diversity is the number of weed control practices used, and how multiple methods are used together to obtain better and more cost effective control.

Deliberation is the planning of weed control, and undertaking it in a strategic fashion that takes advantage of knowledge of the life cycles of weeds and desirable pasture species. An absence of deliberation is manifested by unplanned, reactive weed control, often reduced in effectiveness due to being undertaken at an inopportune time. Such an approach will, at best, provide only short-term weed relief from weeds, and at worst, waste time and money. In some cases useful pasture plants will be killed through ad-hoc application of concentrated chemical, leaving space for weeds to occupy and dominate. In other cases, herbicide may be applied at insufficient dosage rates, or in weather that is not favourable for spraying, with the result that weeds will not be killed.

These three “Ds” define a useful three dimensional space (Figure A2.0.1) within which can be placed the styles of weed management and the effectiveness of weed control encountered in the farm visits and alluded to by key informants.

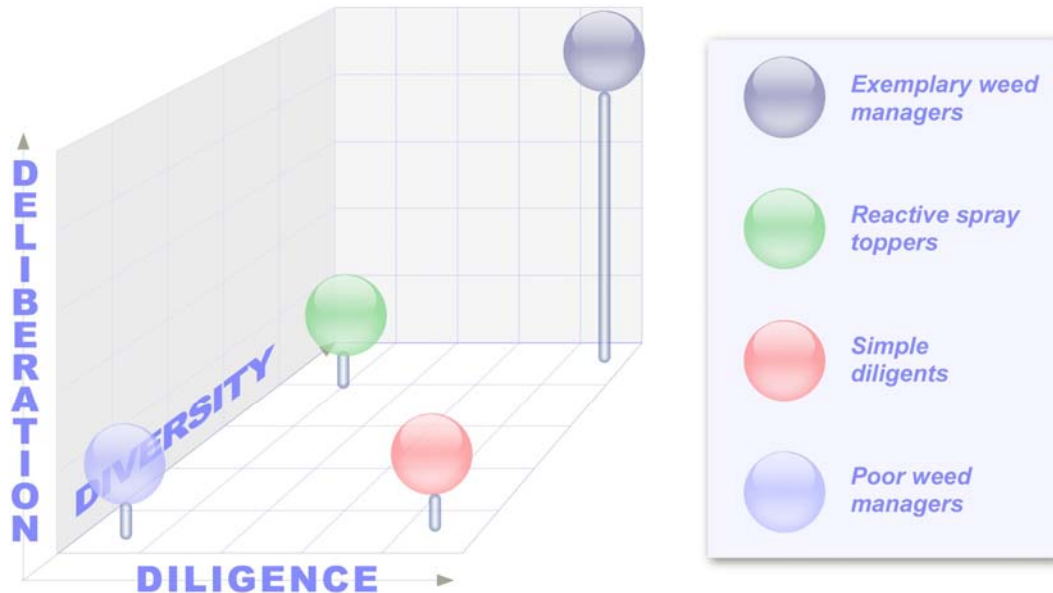
Figure A2.0.1 The 3 Ds of weed management



The bottom, left, front is where the poor weed managers are located – those who place a low priority on weed control, using a few methods in an unplanned and reactive way (

Figure A2.0.2). These are the producers who fell in the minimal group of the four weed control groups described in the analysis of the mail-back survey. This group had the highest weed incidence and lowest management effort, as rated by the weeds officers assisting with the farm visits.

Figure A2.0.2 Different types of weed managers in 3 'Ds' space



The top, right, rear is where the exemplary weed managers are located, those who diligently use a wide range of weed control methods in a planned, strategic way. The maximal group of the four weed control groups described in the analysis of the mail-back survey, would be located in this region of

Figure A2.0.2. It was this group that had the lowest incidence of weeds as rated by the weeds officers, and a high rating on management effort.

It is important to note that weed levels do not necessarily decline in a simple linear fashion from the bottom, left, front of figure

Figure A2.0.2 to the top, right, rear. For example, some producers achieve good weed control using a few simple methods that are diligently, or almost obsessively, applied (the 'simple diligents' in

Figure A2.0.2). Information from key informants suggests that some producers who are using a wide range of weed control methods, may be using some methods in an unplanned, reactive way, such as when spray topping is used as a last resort to sterilise the seeds of inadequately controlled weeds that are on the point of dispersing seed (the 'reactive spray toppers' in

Figure A2.0.2).

The responses to a number of questions in the mail-back survey were used as proxies for the three dimensions in

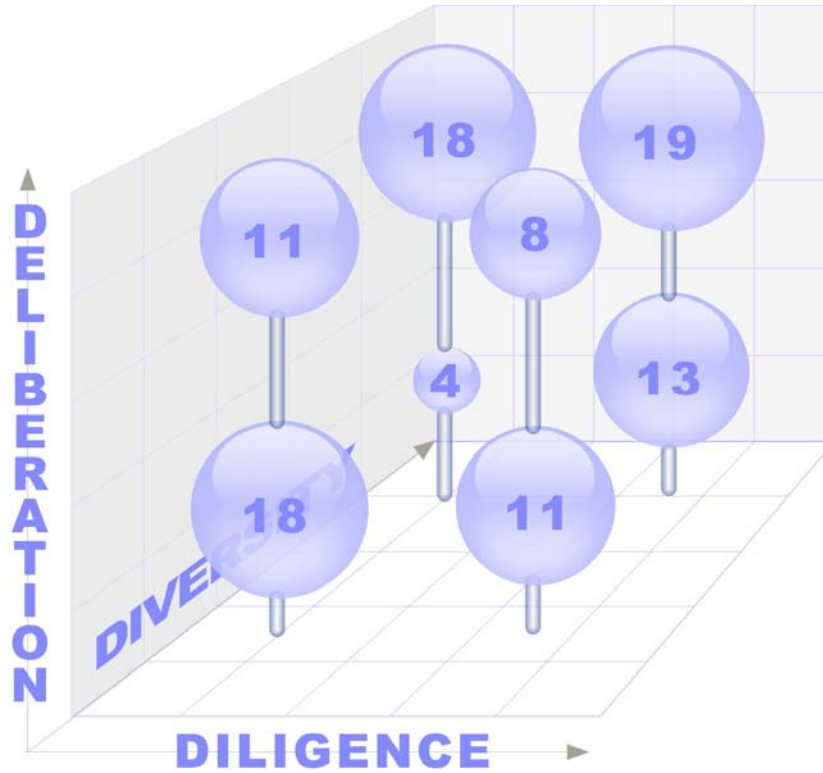
Figure A2.0.2, to gain an indication of what proportion of respondents were located in the various parts of

Figure A2.0.2. Diligence was approximated with the first attitudinal factor: Weed control – a habitual routine (Table A2.0.6). Diversity was approximated by the number of weed control methods the respondent considered well worth doing (Table A2.0.1). Deliberation was approximated with the complexity of practices used (

Table A2.0.11).

The proportion of respondents in each of the eight octants defined by the medians is shown in Figure A2.0.3. It can be seen from this figure that there are relatively more respondents in the top, rear and front, bottom, left areas of the space depicted in the figure. To the extent that the proxies from the questionnaire can be taken as gauging the dimensions in the figure, the following interpretation can be proposed. Those at the top, rear of the figure are the exemplary weed managers together with those who are using less diligently a range of methods in a planned way. Those at the front, bottom, left of the figure are the poor weed managers who are using relatively few methods with little diligence and in an unplanned reactive way.

Figure A2.0.3 Distribution of respondents to the mail-back survey in the space defined by the three dimensions of Diligence, Diversity and Deliberation. The numbers on the spheres are the proportion of respondents in that region of the three dimensional space.



The relatively few respondents in the lower, rear, left of the space in the figure is consistent with the realities of weed management, i.e. the use of a range of weed control methods results in some of the methods being the more complex ones, which require a certain amount of planning in their use. So it is unlikely that very many will be using the more complex methods in an unplanned, reactive way.

A2.7.2 Improving Weed Management – Adoption Paths in 3 ‘Ds’ Space

Improvements in weed management will almost always involve moving along an adoption path from one point in the space depicted in Figure A2.0.3 to another point. Adoption paths involve different sets of barriers and motivations, depending on where they are located and who is travelling the path.

Table A2.0.1 lists the all the barriers and motivations that have been encountered in the face-to-face interviews with farmers, and key informant interviews.

The Sociology of Weed Management

Table A2.0.1 Barriers to, and motivations for, improved weed management encountered in face-to-face interviews with farmers, and key informant interviews. They have been grouped according to the stages identified by Barr and Cary (2000), as depicted in figure A1.1.

	Identified in face to face interview	Identified by key informant
Anticipation		
Others in district taking action	✓	✓
I care what others think of me	✓	✓
I care what others think of my property	✓	✓
Property is regularly traversed by manager or hired labour	✓	
Property regularly inspected by weeds officers		✓
Ability to identify weeds	✓	
Pasture focused rather than stock focused orientation to management	✓	
“Stitch in time saves nine” attitude	✓	✓
I don't like having weeds on my property	✓	✓
It's on my better country	✓	✓
It consistently reoccurs	✓	
Control new weeds before they get away	✓	✓
I have to be on guard against weeds spreading from public lands and neighbours' properties	✓	✓
Money spent now saves money spent/lost in future	✓	
Noxious weed: I will be fined if I don't control it	✓	✓
I don't care whether others think I am a good farmer	✓	
If others aren't controlling it I don't worry about it	✓	
Low level infestations aren't a concern	✓	
Occasional weeds are not worth controlling	✓	✓
It has always been there but has not spread	✓	✓
Some weeds are something you have to live with	✓	✓

The Sociology of Weed Management

The situation is beyond control	✓	✓
What is the point, weeds always come back	✓	
I am more stock focused than pasture focused	✓	✓
Crop focused: weeds in grazing areas don't matter	✓	✓
Weeds in less productive areas not a priority	✓	✓
Weeds are something you manage when you have time	✓	✓
Absentee landholder		✓
Unless it is noxious I won't know it is a problem	✓	✓
I may not be able to identify it		✓
Seeing		
It's out-competing desirable pasture species	✓	
Weeds lower productivity	✓	✓
Weed reduces the quality of hay	✓	
Property value will be reduced	✓	✓
Weed causes vegetable fault in wool	✓	✓
Weed injures stock and restricts their movement	✓	✓
Weed makes stock sick and reduce animal performance	✓	✓
Weed makes handling stock and wool painful	✓	✓
Weed is spreading	✓	✓
Farm productivity is low on priority list	✓	✓
Some weeds are useful (e.g. soil fertility and thistles)	✓	
Some weeds are only a problem at certain times of the year and good feed at others	✓	✓
Some farmers are not aware of how much weeds reduce productivity	✓	✓
Stock eat it	✓	✓
It is good feed in dry times when nothing else grows	✓	✓
Seeking		

The Sociology of Weed Management

Always looking for improved methods	✓	✓
If your weed management program doesn't work well change it	✓	
Find out what peers are using	✓	✓
Information is readily available from council and Landcare brochures etc	✓	✓
Ask extension officer/weeds authority	✓	
Ask agronomist	✓	
Field days	✓	
Landline program	✓	
If others aren't using it, I don't	✓	
I don't have the time to look for new methods or attend field days etc	✓	✓
It is best to stick to what is tried and true	✓	✓
Chemicals are really the only option	✓	✓
I can't do anything, my country is too difficult	✓	✓
I can't do anything because of the native vegetation act	✓	
Not really interested in trying anything new	✓	✓
Seasons have been too dry the last 5 years to do much about weed control	✓	
I don't know what options are available (not an active information seeker)		✓
Consider		
Willing to take a risk		✓
Practice has low risk of human health problems	✓	✓
Low risk of environmental damage	✓	✓
It is simple	✓	
Others are achieving success with it	✓	✓
Contractors still available in district to carry out the practice	✓	
Can be trialed on a small scale		✓
Information is consistent and non-conflicting		✓

The Sociology of Weed Management

Information is not consistent and conflicting	✓	✓
Too much additional learning required		✓
Chemicals risk human and environmental health	✓	✓
I am interested in biological control but uncertain how to manage it (e.g. can you still spray?)	✓	✓
I am interested in grazing strategies but would like more information about using them	✓	
I am not physically capable of undertaking the practice	✓	✓
Contractors in my area are scarce or too busy	✓	
Decide		
It is affordable	✓	✓
It has worked well for me in the past	✓	✓
Practice fits into calendar of regular farm tasks	✓	✓
Compatible with existing equipment and practices	✓	✓
It suits my country	✓	✓
It suits me personally	✓	✓
Physically able to undertake practice	✓	✓
Others have not had success with it	✓	✓
Not interested in taking on additional cost and risk		✓
Too costly	✓	
It involves too much effort	✓	✓
It doesn't suit my country	✓	✓
Past experiences have not been good	✓	✓
Doesn't fit in well with other farm practices	✓	
I don't have the right equipment	✓	
Weeds are beyond control	✓	✓
I don't have the time	✓	✓
Trialing and implementation		

The Sociology of Weed Management

Tried it and it worked	✓	
Effects are readily and quickly observable	✓	
Have not encountered any significant problems with practice	✓	
I am able to afford it	✓	
I tried it but was disappointed with results	✓	✓
There was no observable improvement	✓	
I was intending to change but the seasons have been too poor	✓	
Reaffirming		
Experience with the practice has been good	✓	
It has improved my productivity	✓	✓
My methods work for me. Consistency and persistence is important	✓	✓
Costs have not increased	✓	
Results have been slower than I expected I don't think it really works	✓	✓

Adoption paths will also have differing communication and extension requirements. The analysis in the preceding sections provided a description of how various barriers and motivations were related to weed incidence and management effort. It also identified aspects that are not open to change through extension, but are fixed realities of the heterogeneous farming sector which extension has to accommodate. The remaining sections discuss the possible adoption paths which might be encouraged, and some of the main motivations and barriers associated with them.

A2.7.2.1 Poorer weed managers

It should be first noted that there will be poorer weed managers in situations where it is simply not economically feasible, in terms of private costs and benefits, to overcome weed problems that have got out of hand. If the increased returns from weed control are not sufficient to cover the repayments on the loans necessary to invest in weed control, then weed control is not economically rational from the individual viewpoint. This situation is most likely to be encountered on properties that are marginally or sub-viable and with large areas of relatively unproductive country where it is difficult to control weeds.

However, there may be public benefits to weed control in these situations, which then provides a rationale for public investment in weed control on private property. The policy approach will obviously be very different for properties where weed control is only rational on public good grounds, compared to properties where weed control is economically feasible in terms of private costs and benefits. The motivations for, and barriers to,

participation by landholders in public good weed control programs lies outside the scope of this project.

In the case of weed control for private benefit, an adoption path for the poorer weed managers can include, at least in theory, any combination of increased diligence, increased range of methods and increased planning. In practice, a more planned, strategic approach to weed management will generally require as a prerequisite that the weed manager is competent in the use of a range of weed control methods. In addition, the adoption of more planned, strategic approaches probably requires more than simple provision of information. It will require educational approaches such as have been used with Wool 4 Wealth, ProGraze and Grazing for Profit programs.

This then leaves increased diligence and increased range of methods as adoption paths for the poorer weed managers. However, there is little point in adopting a wider range of control methods, unless they are applied diligently. This would suggest that improving diligence in weed control should be the primary focus for the poorer weed managers. This project has so far identified a number of reasons contributing to lack of diligence in controlling weeds.

Firstly, weed control has traditionally received little attention in grazing industries. This has not been the case in cropping districts, where weeds have long been recognised as a threat to farm profitability the subject of research and extension. Agronomic extension has, until recently, focused on pasture improvement and stock health as a means of improving the productivity of grazing enterprises. Consequently, weeds are often regarded as 'something you can manage when you have time'. Noxious, or declared weeds, are the obvious exception, as they bear financial penalties and must therefore be considered as affecting farm profits. With universally recognised declared broadleaf weeds such as blackberries, raising awareness of their existence will not lead to weed control. There is likely to be a significant number of graziers with higher than desirable levels of infestation of well-known broadleaf weeds, upon whom such activities would have little impact. In these situation, increased fines for failure to control may be the only option to motivate action, despite the inherent disadvantages of the regulatory approach.

Plants that are not listed as noxious, but which potentially reduce income, are often not recognised as being important to control, except when their impacts are obvious, such as stock injury or poisoning. This lack of recognition particularly applies to grass weeds that reduce productivity on the whole, but which provide, or appear to provide, feed at particular times of the year. Raising awareness about less well-known grass weeds will be likely to increase the effort spent controlling these weeds on properties where some priority is placed on weed control. The key aspects are improving the ability to recognise these grasses in pastures and the existence of good economic data that demonstrates unequivocally their impact on productivity. However, there will still be some graziers who place little priority on weed control, upon whom such activities would have little impact.

Lack of time is another factor reducing diligence, and is somewhat related to priorities. This is particularly the case with graziers who have full or part-time jobs which necessitate long hours away from the farm. Any time that is available for farm work is spent on tasks that are perceived as being more urgent, such as feeding stock or controlling internal

parasites. For graziers in this situation, emphasis on time-effective methods of control may lead to better weed control.

Seasons are another important factor, particularly dry seasons. There is a tendency for graziers to regard weeds as useful for stock feed in dry times, as they are 'the only thing that hang on'. Limited finances, typically constrained in dry years, add to the temptation to defer weed control until a time when the finances are available. There is also a tendency to regard some weeds as a temporary or seasonal problem, only affecting production at certain times or the year, or only appearing some years and not others. The result is that weeds are only controlled occasionally, if at all, rather than as an integral part of routine farm operations. When weed control is carried out it is often ad-hoc and poorly implemented, with the result that pasture is damaged or at least that weeds are not reduced, which can discourage further efforts. While it could be suggested that weed control be given more emphasis in extension programs dealing with drought management, the past experience with the adoption of better ways of dealing with climatic variability gives little hope that weed control would fare any better.

Finally, there are those graziers who are not interested in improving profitability, being content to earn a marginal income from their property. This is particularly the case with older farmers approaching retirement, but with no heir to the property and therefore little incentive to improve farm profitability. Those in this situation may place more priority on weed control if they were made aware of the reduction in the value of their property due to the presence of weeds.

A2.7.2.2 The 'simple diligents'

This group occupies the lower, right, front of

Figure A2.0.2 and often achieve a reasonable level of weed control through diligent use of a limited number of more traditional approaches, such as spot spraying, boom spraying, and 'chipping them out'. These graziers compensate for 'imagination' with persistence. They are often motivated by a sense of 'pride in property' and are also concerned about the productivity of their pastures. However, they may tend to focus on declared weeds and may not be aware of plants that are causing production losses on their property, particularly grass weeds. They may therefore be losing income through the impact of plants that they do not recognise as 'weeds'. With these individuals it is likely that awareness will lead to action. That is, that once these graziers are aware that a plant is reducing farm productivity, they will include it in their regular weed control operations. These graziers are less likely to respond to information on new weed control practices, since their existing methods, in combination with diligence, have so far proved effective. It is worth noting that these producers are largely reliant on application of herbicides, and that they spend a large proportion of their time and energy controlling weeds. It is likely that factors such as increased costs of herbicides, the development of herbicide resistance, reduction in availability of labour, the appearance of new weeds, and the influence of aging may reduce their ability to control weeds, resulting in them joining the poorer weed managers.

A2.7.2.3 Assisting better managers to become better still

Other graziers may achieve a high level of weed control though using a greater diversity of weed control methods in a more integrated fashion. Such diversity of approach is typical of graziers in cropping systems with planned pasture rotations, where farmers are profit-driven and weeds are considered a source of lost income. The diversity of such mixed enterprises will lend itself to diversity in approaches to weed management. Unlike 'diligent graziers', increasing awareness of the types of plants that may reduce profits may not always result in greater emphasis on controlling these weeds. This is particularly the case in cropping systems with regular phases of sown pasture. Weeds in a sown pasture situation can be broadly defined as 'anything except that which was sown'. Application of herbicides to reduce the incidence of weeds is routine, and herbicide resistance is an emerging concern. It is likely that information on alternatives to chemical use, as well as information about ways to reduce the risk of resistance developing, is likely to benefit weed control in these situations. In the case of many younger farmers, off-farm work reduces the amount of time they have available for controlling weeds. The key in these situations may be to provide information on weed control options that require relatively little time and effort. Increasing ease-of-access to information about weed control, and hence saving the amount of time and effort spent looking for it, is also likely to assist with weed control in these situations.

A2.7.2.3 Other implications for extension

There are also a number of more specific implications for weed extension that can be drawn from the analysis.

- Communication and extension efforts focusing on production losses should be very specific about what plants cause the losses, and make sure that graziers are able to recognise these plants in their pastures.
- Although graziers are aware of the importance of pasture cover in reducing weed incidence, many are not familiar with the use of granular and pelletised herbicides which can improve the health and competitiveness of useful pasture plants.
- Difficulties with terrain and herbicide resistance are the main problems where technological innovations may lead to improved weed control.
- Dislike of using chemicals may hinder weed control on some properties, suggesting more effort in research and extension of alternatives to herbicide application.
- Awareness of the costs of weeds does not necessarily lead to farmers improving their weed management. When the vaguely sensed costs of productivity loss at some time in the future are weighed against the very specific and immediate costs of chemical purchase, doing nothing is an attractive option. Quantification of productivity loss in realistic farm situations is essential to influence those for whom economic considerations are uppermost in weed control decisions.

The Sociology of Weed Management

- Information sources that are regarded as useful by the better weed managers are local in nature.
- Fact-sheets and booklets from government departments and field days and workshops stand out as ways of communicating information about weeds that are widely regarded as very useful.
- The electronic media – radio, TV and Internet – are regarded as not useful by large proportions of respondents. However, it is worth pointing out that the Internet is a rich source of information about weeds and their management, and is often used by younger graziers. It is also likely to become increasingly important in the future as older graziers retire and the younger generation take over.

A2.8 Supporting documentation

A2.8.1 Letter to weed authority staff



About the project

It is estimated that Australia's grazing industries lose \$1.87 billion every year due to weeds. With the cost-price squeeze that all primary producers face, they are under increasing pressure to control pasture weeds as cheaply and effectively as possible. Generally, from the point of view of weed control, there are three groups of primary producers:

- those who are using existing information sources and controlling weeds effectively,
- those who are not making the most of the information available and not doing as much as they should to control weeds, and
- those who do little or nothing and for whom regulatory approaches are required.

The middle group, above, is a relatively large one, and this project aims to get a better understanding of what producers in this group require to help them lift the standard of their weed control.

Who is involved

This project is funded by Meat and Livestock Australia. The project is being carried out by Agronomy and Soil Science, and the Institute for Rural Futures, at the University of New England. We are also working with a number of weeds authorities in NSW and Victoria.

Why we are contacting weeds authorities

As the people working closely with producers in weed control, weeds authority staff have a great deal of knowledge and experience about what motivates producers to keep on top of weed problems, and what might be discouraging some producers from doing as much as they should be.

In the course of the project, we will be talking with primary producers, mainly those with pastures and livestock, about their weed control - what they are doing, their views about it, and any problems they may be having.

We would appreciate the opportunity to compare our findings from this with the experience of weeds authority staff. This will ensure that we have drawn the correct conclusions from what we have learnt from primary producers.



How much time will it take

We are contacting weeds authorities in the higher rainfall temperate grazing regions of Australia. We would like to speak with weeds authority staff who have first hand experience in working with livestock producers to help them control weeds on their properties.

The telephone interview will be conversational rather than formal and should take 15-30 minutes, depending upon how much of their experience and ideas people want to share with us.

How is your privacy protected

Your participation in this project is entirely voluntary and if you choose to take part, you may withdraw at any time. The information you provide is treated in strictest confidence. Only the geographic region from which the information came is recorded. Individuals' names, or the names of weeds authorities are not recorded. The information from weeds authorities will be kept in secure storage at the Institute for Rural Futures and only the project staff listed below will have access to it. As the information that we collect will be very helpful in future studies, the information will be kept indefinitely.

In writing the project findings, no individual will be identified and the information we gather will only be presented as summaries that combine the answers of large numbers of weeds authority staff.

Contact details

If you would like to know more about the project, or receive a summary of the project findings, please contact one of the project staff below.

Brian Sindel, Agronomy and Soil Science
02 6773 3747 bsindel@une.edu.au
Ian Reeve, Institute for Rural Futures
02 6773 5145 ireeve@une.edu.au
Annie van der Meulen
Institute for Rural Futures
02 6773 5146 avander2@une.edu.au

This project has been approved by the Human Research Ethics Committee of the University of New England (Approval No. HE05/175, Valid to 9/8/2006).
Should you have any complaints concerning the manner in which this research is conducted, please contact the Research Ethics Officer at the following address:
Research Services
University of New England, Armidale, NSW 2351.
Telephone: (02) 6773 3449
Facsimile (02) 6773 3543
Email: Ethics@pobox.une.edu.au

A2.8.2 Letter to livestock producers



About the project

Australia's grazing industries lose \$1.87 billion every year due to weeds. In today's difficult conditions, not everyone has a lot of time to put into weed control. This project is helping make sure that all landholders have the information they need to control weeds as cheaply and effectively as possible. Everyone benefits if we get on top of weeds.

Who is involved

This project is funded by Meat and Livestock Australia. The project is being carried out by Agronomy and Soil Science, and the Institute for Rural Futures, at the University of New England. We are also working with a number of weeds authorities in NSW and Victoria.

How you can help

We are going out with the staff of weeds authorities as they go on their property visits to landholders in the southern New England and South West Slopes areas of NSW. We are asking landholders a few questions about problems they are having controlling weeds and what might be done to help make it easier for them.

We also need to ask a few questions about your farm situation to make sure we have spoken to a wide range of landholders. To save taking up your time during the day, we've put these questions on a short paper questionnaire which you can send back in the reply paid envelope at your own convenience.



If you would like to receive information from this project, please fill in the details below.

Name:

Postal Address:

.....

A2.8.3 Mail survey for southern NSW



*A Research Project to Help Land Holders Reduce
Production Losses from Weeds in Pastures*



The Sociology of Weed Management

WEEDS

Depending on your situation, some plants may or may not be regarded as a weed. Also, it is not always easy to tell the difference between weeds and other plants.

1 For the plants listed below, please tick the boxes to show which ones occur in your district, which ones you regard as a weed, and how easy they are to recognise.

	Plant occurs in my district	Regard this as a weed	How easy to recognise	
			<i>Easy</i>	<i>Difficult</i>
Bathurst burr	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Barley grass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bellyache bush	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Blackberry	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Black or spear thistle	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Caltrop or cat head	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cape weed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Chilean needle grass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Paterson's curse	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Saffron thistle	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Scotch or Illyrian thistle	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Serrated tussock	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sickle pod	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sorrel	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
St John's wort	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sweet briar or briar rose	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Vulpia or silver grass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other weed (please describe)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

The Sociology of Weed Management

Graziers use a range of methods to control pasture weeds. Of course, not all methods are worth doing in all situations.

2 For each weed control method below, please tick a box to show whether, in your experience, it is worth doing.

Weed control method	Well worth doing	Not worth doing	Not familiar with it
Selective use of herbicide (spot spraying, weed wipers etc)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Boom spraying	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Pelletised or granular herbicides	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Maintain ground cover	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Biological control	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tactical grazing pressure (e.g. crash grazing)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Spray topping or winter cleaning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Spray grazing (using low doses of herbicides to make weeds more palatable to stock)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cultivation, rotational cropping, and pasture re-establishment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Slashing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Chipping and hand-weeding	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Burning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Holding yards and other forms of quarantine to stop weed importation and spread	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Controlling weeds is just one of the many things that graziers have to deal with, and it's often hard to keep up with weed control.

3 Is there anything that makes controlling weeds difficult on your property? (Please tick all those that apply).

Lack of time	<input type="checkbox"/>	Medical problems (<i>injury, illness etc</i>)	<input type="checkbox"/>
Lack of money	<input type="checkbox"/>	Control methods don't work well	<input type="checkbox"/>
Lack of information	<input type="checkbox"/>	Weeds spread from neighbours	<input type="checkbox"/>
Labour shortage	<input type="checkbox"/>	I don't like using chemicals	<input type="checkbox"/>
Difficult country (rocky, steep etc.)	<input type="checkbox"/>	Live off-farm and rarely have time to control weeds	<input type="checkbox"/>
Drought	<input type="checkbox"/>	Other priorities more important	<input type="checkbox"/>
Herbicide resistance	<input type="checkbox"/>	Other (<i>please describe</i>)	<input type="checkbox"/>

The Sociology of Weed Management

Weeds can be a big cost for graziers for different reasons.

4 In your opinion, how much are returns from grazing enterprises in your district being reduced by the factors below?

	<i>Big reduction</i>	<i>Some reduction</i>	<i>Little or no reduction</i>
Cost of controlling weeds	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Loss in pasture production	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Poisoning of stock	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Reduction in value of fleece and skins	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Injury to stock	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Meat and milk taint	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other (<i>please specify</i>) _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

YOUR FARM

To make sure we have information from most types of farms, we need a few brief details about your farm.

1 In the last few years, about what proportion of your total net income was derived from agricultural production?

Less than 15% 15% to 50% 51% to 85% More than 85%

2 In the table below, please show the approximate area of land you farm or graze livestock on. (Your answer can be in either acres or hectares).

	Hectares	OR	Acres
Freehold in your name or that of your partnership or company	_____		_____
Crown leasehold in your name or that of your partnership or company	_____		_____
Land that you have the use of under agistment or share farming arrangements	_____		_____
Some other form of tenure (<i>please specify</i>) _____	_____		_____
Total area of property(ies)	_____		_____

The Sociology of Weed Management

3 What forms of commercial agricultural production are you involved in?
(Please tick one or more boxes).

					Tick if a stud
Beef cattle	<input type="checkbox"/>	-	Number of cattle	_____	<input type="checkbox"/>
Sheep for wool	<input type="checkbox"/>	-	Number of sheep	_____	<input type="checkbox"/>
Sheep for meat	<input type="checkbox"/>	-	Number of sheep	_____	<input type="checkbox"/>
Crops	<input type="checkbox"/>	-	Area cropped	_____ ha _____ ac	
Other (please specify) _____					

YOUR HOUSEHOLD

A few details about your household will help us make sure that all types of households are represented. As mentioned before, your response is completely confidential and anonymous.

1 For each person that lives in your household, please fill in the details for that person in a separate column below. If there are more than six people, please include the six oldest people. The first column is for your details.

	You	Person 2	Person 3	Person 4	Person 5	Person 6
Male or female? (Please circle)	M/F	M/F	M/F	M/F	M/F	M/F
Age: please tick if person is under 35	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Age: please tick if person is over 55	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Please tick each person who is a partner in the farm business	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In the last 12 months, did this person work off-farm either full-time (F) or part-time (P)? (Please circle)	F/P	F/P	F/P	F/P	F/P	F/P
Please tick if off-farm work is in agriculture (e.g. shearing, stock and station agent, contract harvesting)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

The Sociology of Weed Management

2 What sorts of experience in agriculture do household members have? (Please tick any that apply, ensuring that each person is in the same column as they were in the previous question).

	You	Person 2	Person 3	Person 4	Person 5	Person 6
Practical experience owning, managing or working on a grazing property <i>(Please write number of years)</i>	_____	_____	_____	_____	_____	_____
Part or all of a university or sq college degree in agriculture	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
TAFE course(s)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
High school agriculture course	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Field days, discussion groups etc	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

OPINIONS ABOUT WEED CONTROL

In our discussions with producers in the last few years, we have been given various opinions on what's important in weed control. Listed below are some of the things producers said.

1 If you have an opinion on any of the statements below, please tick the appropriate box. Otherwise, please tick the 'neutral or not sure' box.

	Strongly agree	Mostly agree	Neutral or not sure	Mostly disagree	Strongly disagree
If you've got a problem with a weed, the best thing you can do is ask your friends or neighbours what they are doing with it.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In this district, it's just the same few weeds that are a problem - you don't have to worry about new weeds appearing.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Of all the jobs on a farm, weed control is probably the most important.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
With weed control, it's better to stick to what you know works well, rather than trying new methods.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
With most weeds around here, it's possible to change your grazing management so they don't get a chance to spread.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my view, you are better off looking after your stock, than worrying too much about weeds.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

continued on next page

The Sociology of Weed Management

continued from previous page

	Strongly agree	Mostly agree	Neutral or not sure	Mostly disagree	Strongly disagree
Even though it takes a bit of time, it's well worth looking out for new recommended ways to control weeds	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
With weed problems, it's best to get in and fix them yourself, rather than talking to others about what to do.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Weed control is one of those things you have to keep on top of all the time.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Weed control is one part of running a property that hasn't changed much over the years.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fortunately, weed control is something you can put off in difficult times, and catch up on later.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
If you see a plant on your place you haven't seen before, it's well worth finding out what it is.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Generally, it's not worth trying to work out why weeds are appearing in a pasture - spraying and chipping will keep them under control.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Generally, the benefits of new weed control methods outweigh the costs in trying them out.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

INFORMATION

1 If you have a problem controlling weeds, how useful do you find the following sources of information?

Information source	Very useful	Some use	Not useful
Other family members	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Neighbouring producers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Producers recognised as experts in your region	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Farmer organisations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Local council	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Spray contractors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Weeds authorities or county councils	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

continued on next page

The Sociology of Weed Management

Information source	Very useful	Some use	Not useful
Government department (agriculture, soil conservation)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Agricultural consultants	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Advisers employed by fertiliser or chemical companies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Retailers, merchandisers or stock and station agents	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other (Please specify).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2 How useful do you find the following sources of published information about weed control?

Information source	Very useful	Some use	Not useful
Books	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Daily or local newspapers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Weekly rural newspapers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Farmer and industry newsletters and magazines	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fact-sheets and booklets from government departments (agriculture, soil conservation)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Field days and workshops	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Leaflets and booklets from retailers, merchandisers, and stock and station agents	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Radio	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
TV	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Internet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other (Please describe).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3 If you have any other information you would like to add, or general comments, please use the space below.



THANK YOU FOR YOUR HELP WITH THIS PROJECT

This project has been approved by the Human Research Ethics Committee of the University of New England (Approval No. HE05/175, Valid to 9/8/2006). Should you have any complaints concerning the manner in which this research is conducted, please contact the Research Ethics Officer at the following address: Research Services, University of New England, Armidale, NSW 2351.
Telephone: (02) 6773 3449 Facsimile (02) 6773 3543 Email: Ethics@pobox.une.edu.au

A2.8.4 Farm visit interview questions

1. What kinds of plants cause the most problems for you (not just noxious weeds)?
2. What is it about these plants that make them a problem?
3. When does it become important to control weeds?
4. How do you choose a method of weed control?
5. Who generally identifies weeds on your place? If you can't identify something, who do you ask?
6. From your experience, what would you say is the most important thing for achieving good weed control?
7. What methods of weed control do you use? Have you adopted any new methods of controlling weeds in the last 5 years or so? If yes, what changes have you made and what motivated the change? If no, why do you stick to this approach?
8. Would you say there are a wide variety of effective techniques available for controlling weeds?
9. Are there any areas of further research or extension that would help farmers with weed control?
10. Have you had any biological control sites established on your place?

A2.8.5 Email to weeds extension and regulatory officers

Dear (name)

Attached is the summary I mentioned to you on the phone. It would be great if you could look over it and let me know whether it lines up with your impression of the weed control situation on grazing properties in your district. There are a few points that we would particularly like your feedback on:

1. the reasons people do or do not control weeds (as described under the headings 'motivations' and 'barriers' respectively).
2. the preferences for different methods of weed control (as described under the heading 'weed control groups').
3. the section entitled 'Opportunities and challenges for weed extension', especially if you have any ideas for the way that extension should be focused to help the three groups we identified to do a better job controlling weeds.

The Sociology of Weed Management

I will call you next week to discuss this with you. If there is anything that is unclear, or you would like more detail about, please let me know. Thanks again for your assistance with this.

Best regards
Annie van der Meulen

A2.8.6 Summary circulated to weeds extension and regulatory staff

Summary of Research Findings

Motivations and Barriers in the Adoption of Weed Control Practices

3/3/2006



Weeds in Grazing Industries

Weeds in pasture systems are estimated to cost landholders and the community between \$1 and \$1.87 billion per year. Weeds compete directly with more desirable pasture species for light, water and nutrients, lowering livestock productivity and reducing profit margins because of the costs of control. Management practices that sustain and revive the pasture resource and provide long-term solutions to weeds have been developed. However, adoption of these practices has not been widespread, and only a relatively small proportion of landholders achieve effective weed control. The challenge is to communicate information to, and motivate, the large proportion of landholders that are not controlling weeds effectively.

An understanding of the social dimension of weed control is necessary to influence change. Farmers and farms are not homogenous, but vary in innumerable ways, including size of enterprise, propensity to adopt new ideas, soil types and fertility, vegetation cover, topography, climate, and weeds present. Farmers will differ in their opinions about the desirability of a plant, so that 'one grazier's weed is another grazier's feed'. Understanding how these kinds of factors influence weed management is crucial to promoting improved management of weeds across grazing industries.

Project Background

The purpose of this project is to conduct social research into the decision making process of weed managers across the Australian sheep and cattle grazing industries. Principal objectives of this research are to:

1. Establish the broad scope of potential reasons why graziers attempt or do not attempt to control weeds on their land using existing proven management practices.
2. Identify and characterise the barriers to adoption.
3. Develop strategies to overcome these barriers, together with evaluation methods

that can be used by those implementing the strategies.

The project has been commissioned by Meat and Livestock Australia, and is being carried out by staff of the Institute for Rural Futures and the Department of Agronomy and Soil Science at the University of New England. A survey of graziers across various districts of New South Wales and Victoria included face-to-face interviews and a mail-back questionnaire. Most interviews were conducted on-farm, and the properties that were visited were rated for weed incidence and weed management effort. The results have been analysed, and are summarised below.

Future stages of the project will extend the research to other parts of the sheep-wheat and high rainfall grazing regions and develop recommendations for the design and implementation of communication strategies to improve weed management practices on grazing properties. These will be presented to a MLA workshop later in the year, with subsequent publication of the project report and detailed evaluation resources and costings appropriate to the evaluation of communication strategies and tactics.

Summary of Results to Date

The analysis of the information resulting from face-to-face interviews with farmers, discussions with weeds officers during farm visits, and the mail-back questionnaire has revealed a number of general trends:

- there is a consistent difference between the well-known 'prickly' and/or declared weeds and the grass weeds, with generally higher levels of awareness of the former than for the latter,
- effectiveness of weed control is related to farmer demography and farm characteristics, with higher levels of weed infestation occurring among older farmers with lower levels of education, who do not work off-farm, have relatively more cattle and less cropping.

Weed control groups

There were substantial differences in the popularity of, and familiarity with, the various methods of weed control:

- boom spraying and selective use of herbicides were almost universally well regarded,
- slashing and burning were not generally well regarded,
- sheep producers and croppers seem to be more aware of the existence of spray grazing and spray topping methods than graziers with no sheep or cropping,
- those with a higher mean proportion of their property under cropping tended to practice a greater variety of weed control methods,
- many of those using grazing-related weed control measures (which take longer to show improvements in the weed situation) regard persistence as important, and
- a large proportion of graziers do not recognise that granular and pelletised fertilisers can help control weeds by promoting growth of competitive pasture species.

There appears to be four groups of weed controllers with respect to the mix of weed control methods they use: those using few methods, those using mainly mechanical methods, those using mainly grazing-related methods, and those using most methods (and having the lowest levels of weed infestation).

Motivations and barriers

A number of motivations have been identified that are demonstrably related to better weed control:

- awareness of the effects of weeds on livestock and the value of livestock products,
- awareness of the invasive and competitive nature of particular weeds, including those new to the district,

- advice from agricultural consultants, retailers and fertiliser and chemical company representatives (an important factor in the generally better weed control among those who are cropping), and
- awareness that locally well-regarded producers are successfully using a weed control method.

A number of barriers have been identified that are demonstrably related to poor weed control:

- inability to identify particular grass weeds,
- time and monetary constraints,
- areas on the property where topography makes access and control difficult, and
- weeds that have, or appear to have some feed value at sometimes of the year, but which lower the productivity of pasture on the whole.

Sources of information about weeds

Field days, fact sheets and booklets from government departments are widely held in high regard as a means of communication of weed information. This is particularly the case among the better weed managers, probably reflecting an active approach to gathering information. Radio, TV and newspapers are held in less regard generally, but are more likely to be viewed favourably by the poorer weed managers, perhaps reflecting their passive approach to information. The Internet was not regarded well by the graziers practicing minimal weed control, or only using mechanical methods. Those using grazing tactics, and those employing a wider variety of different methods, tended to regard the Internet more favourably, and it was often used by younger graziers. The electronic and print media have an important role to play in elevating the priority placed on weed control among the poorer managers, and also for alerting those diligently using a limited variety of methods, about new weed problems.

Opportunities and challenges for weeds extension

The opportunities and challenges for weeds extension can be described as the 'three Ds' of effective weed management: Diligence, a Diversity of methods, and Deliberation (a planned and proactive approach weed control). Poorer weed managers tend to use a few methods of control in a casual and reactive way. Strategic and integrated weed management requires competence with a range of weed control methods, and there is little point in encouraging the poorer weed managers to adopt additional methods if they do not use these diligently. For this reason, it is suggested that the focus for improving weed management among poorer weed managers should be upon more diligent use of a few well-chosen methods.

There is an identifiable group of farmers, the 'diligent', who are achieving reasonable to good weed control of the main declared and broadleaf weeds through the diligent application of a small

number of methods. While currently not a problem, it is possible that rising chemical prices, the appearance of new weeds or increasing age could result in some members of this group slipping back into the poorer weed management group. It is suggested that the focus for maintaining and improving the effectiveness of weed management in this group should be upon developing skills in the identification of, and recognition of the loss of income caused by, some of the lesser know grass weeds. They should also be alerted when new weed problems emerge and be made more aware of the advantages of newer weed control methods.

For those who are achieving good to exemplary weed control, there is still the potential for technical innovation to bring further improvements, such as through solutions to herbicide resistance problems and methods of control that make more effective use of the farmer's time.

Contact Details

Research Organisation

Institute for Rural Futures
University of New England, Armidale, NSW 2351

Contact

Annemieke van der Meulen
02 6773 5146
avander2@une.edu.au



Funding organisation: Meat & Livestock Australia Limited
Street Address Level 1, 165 Walker Street North Sydney NSW 2060
Postal Address Locked Bag 991 North Sydney NSW 2059

Appendix 3 Report on the Telephone Survey

SUMMARY

Telephone Survey Findings

A telephone survey was undertaken of producers in the sheep-wheat and beef cattle raising zones of southern Australia. A sample of 800 completed interviews was obtained from the local government areas in these zones are responsible for 90 per cent of the cereal, sheep and cattle production in southern Australia. The survey contained questions relating to weed awareness, weed control methods, motivations and difficulties with, weed control and a number of standard questions on demographics and farm characteristics.

The analysis of the survey data focussed on the motivations and difficulties reported by interviewees. The data on motivation was obtained from the responses to the question:

...when you are thinking about the jobs you have to get done in the coming few days or weeks, what reasons will cause you to put weed control in a particular paddock or place on your property at the top of the list?

It was found that there were a wide range of motivations reported. Grouping these into 11 main categories, it was found that motivations relating to weed life cycle, fitting in with other farming operations, times of year and high weed levels were mentioned by between 20 and 40 per cent of interviewees. However, interviewees could supply more than one motivation and there were 63 different combinations of motivations given, the most popular of which – the single motivation of fitting in with other farming operations – was given by only 14 per cent of interviewees.

Despite the apparent diversity of motivations, there is some indication as to how motivations might be related to other factors. Fitting weed control in with other farm operations appears to be associated more with sheep-wheat production than with beef cattle production, and the need to fit weed control in with other operations may result in lower priority being placed on weed control. Poorer weed management also appears to be associated with weed levels and time of year as motivations for weed control. On the other hand, those who gave a single motivation relating to weed life cycle appear to be the better weed managers who place a higher priority on weed control.

The barriers that interviewees believed they faced in controlling weed fell into two groups: those that are feasibly within management control, such as lack of time, money or labour; and those that are beyond management control, such as drought, neighbours with weeds, or weeds on adjoining public land. Lack of time and lack of money were the most

frequently mentioned (two thirds of interviewees). Neighbours with weeds, lack of labour and drought were mentioned by between two thirds and half of the interviewees.

There is a good deal of evidence in the findings from the telephone interviews that it is the poorer weed managers who believe they are prevented from improving weed control by factors such as lack of time, money and labour – factors that may well be within their own management control. On the other hand, the better weed managers appear to be more troubled by spillover effects from adjoining properties.

Implications for weed management extension strategies

The findings of the telephone survey are broadly consistent with the findings from a previous phase of the research – a face-to-face on-farm and mail-back survey in northern NSW, southern NSW and north eastern Victoria. The findings are also consistent with a number of the findings from a parallel project undertaken by Rural Enablers.

Weed levels on farms represent a balance struck by managers between the barriers and difficulties they face, and how hard and how effectively they are prepared to work to overcome these barriers. The previous phase of research identified three key factors in effective weed management: deliberation (planned, strategic and integrated weed control), diversity (of methods) and diligence (in application of methods). It was also found that there were a number of types of weed managers depending on the extent to which they used deliberation, diligence and a diversity of methods in their weed management.

The motivations and barriers identified in the telephone survey are relevant to different stages on the range of adoption paths that producers might take as they improve their weed management. For example, for the poorest weed managers, the path to better weed management might be via the 'simple diligent' stage – the adoption and diligent application of a few straightforward herbicide-based control methods to some of the more serious and easily recognised broadleaf weeds. This step on the adoption path could be encouraged in extension communication by emphasising that, while livestock production and cropping is never simple, producers can make their weed control simpler by establishing a routine with a few straightforward methods and following it diligently.

The association between better weed management and motivations relating to weed life cycle suggests that information resources on the life cycle and ecology of individual weeds will be important for those producers seeking to move beyond simple routine weed control to more deliberative approaches.

The report also discusses a number of more general extension implications that arise out of the findings of the telephone survey. Of particular importance, and consistent with the findings from the Rural Enablers parallel project, it is very clear that there is a strong preference among producers considering adoption of weed control methods for 'people sources' such as agricultural consultants (particularly among croppers) and field days and workshops. The level of preference for written sources is lower, although fact sheets, weekly newspapers and industry newsletters are regarded as useful by around 90 per cent of producers. This suggests that in the overall scheme of extension programs, the motivation for action may have to come from trusted and credible 'people sources',

backed up by readily available, appropriately pitched, written resources that can be drawn upon once a producer is involved in changing their weed control methods. The report provides regional breakdowns on all the questions in the telephone survey. These tables will be of value to regional weeds extension staff planning extension programs.

A3.1 Telephone Survey Objectives

To supplement the on-farm interviews and mail-back questionnaire with a more detailed and geographically broader understanding of the motivations for, and barriers to, the adoption of effective weed management practices.

To supplement the findings from the on-farm interviews and mail-back questionnaire with figures that can be more validly generalised than those from the small sample of farms visited.

To trial a method of identifying non-adopters in a telephone survey.

A3.2 Telephone Survey Details

A3.2.1 Method

ABS Agricultural Census data was used to prepare a list of the local government areas in New South Wales, Victoria, South Australia, Tasmania and Western Australia which contained 90 per cent of the total number of cereal-sheep and cattle establishments in those States. The list was adjusted to ensure that only local government areas in the southern cereal and higher rainfall zones were included. GIS software was used to obtain a list of postcode areas covering these local government areas. Telephone interviews were carried out by a market research firm, Taverner Research of Sydney, drawing telephone numbers randomly from within these postcodes. Only respondents with more than 500 sheep and/or 60 cattle were included in the survey. The interview schedule is provided in section 0. Sampling was stratified by State to provide the best possible confidence intervals on estimates of proportions for each State, while maintaining a total sample size of 800. With a sample of 48 in Tasmania and samples of 188 in each of the remaining States, it was possible to obtain confidence intervals on estimates of proportions around ± 10 per cent (calculated with the finite population correction) in each of the States. Unless otherwise noted, the figures in tables in this report are weighted to the actual distribution of establishments across States.

A3.2.2 Nature of the sample

The following tables provide some basic demographics and farm characteristics for the sample.

A3.2.2.1 Demographics

Table A3.0.1 Proportion of business partners in each of three age groups.

Region	Proportion in age group (%)		
	Less than 35 years	Between 35 and 55 years	Over 55 years

The Sociology of Weed Management

Nthn NSW	16	61	22
Sthn NSW	10	66	24
Nth eastern Vic	5	80	16
Central and Western Vic	12	66	22
Tas	12	71	16
SA	14	71	15
WA	11	73	16
All regions	12	68	20

Table A3.0.2 Proportion of interviewees with formal learning experience at a university or college, TAFE or high school.

Region	Proportion with formal learning in category (%)		
	Uni or College	TAFE	High school
Nthn NSW	18	32	67
Sthn NSW	23	34	65
Nth eastern Vic	17	27	88
Central and western Vic	19	36	77
Tas	26	23	80
SA	10	42	65
WA	21	16	75
All regions	18	31	71

Table A3.0.3 Proportion of interviewees with informal learning experience through growing up on a farm, working in a farming partnership with their parents, or regularly attending field days.

Region	Proportion of interviewees (%)		
	Grew up on farm	Partnership with parents	Regularly attends field days
Nthn NSW	87	74	72
Sthn NSW	88	68	74
Nth eastern Vic	85	67	66

The Sociology of Weed Management

Central and western Vic	89	75	76
Tas	94	82	75
SA	90	82	76
WA	88	81	82
All regions	88	75	75

A3.2.2.2 Farm characteristics

Table A3.0.4 Proportion of interviewees with beef, sheep and cropping enterprises.

Region	Proportion of interviewees (%)		
	Beef	Sheep	Cropping
Nthn NSW	95	68	53
Sthn NSW	75	85	79
Nth eastern Vic	86	40	46
Central and Western Vic	71	70	66
Tas	86	76	71
SA	60	82	66
WA	43	92	90
All regions	72	76	69

Table A3.0.5 Size distribution of properties

Region	Proportion of properties in each size category (%)						
	500 to 1,000 ha	2,500 to 5,000 ha	2,500 to 5,000 ha	5,000 to 10,000 ha	10,000 to 25,000 ha	25,000 to 50,000 ha	50,000 to 100,000 ha
Nthn NSW	37	40	15	8	1	0	0
Sthn NSW	45	34	7	5	6	2	0

Nth eastern Vic	87	11	2	0	0	0	0
Central and Western Vic	58	27	8	4	2	1	0
Tas	48	23	14	2	12	2	0
SA	47	32	8	6	3	2	1
WA	21	46	20	12	2	0	0
All regions	44	34	11	7	3	1	0

A3.2.3 Telephone Survey Findings

A3.2.3.1 Weed awareness and identification

Consistent with the findings of the farm visits and mail-back survey, producers are generally aware of the common broadleaf weeds and confident that they can identify them. However, the levels of awareness and confidence are much lower for grass weeds. The proportions of interviewees aware of the existence of various weed species and their confidence in identifying these weeds are shown for each region in section 0.

A3.3.2 Attitudes to weed control

The attitude statements used in the mail-back survey were used in the telephone survey, with refinements to some statements, the omission of others and the addition of several new statements. The results of factor analysis (principal components) on these statements was largely consistent with the findings from the mail-back survey. It was found that 43 per cent of the variation in the responses to the 12 attitude statements could be captured with the three strongest attitudinal dimensions. The correlations between attitude statements and the three attitudinal dimensions are shown in Table A3.0.1.

The three dimensions can be summarised as:

- dimension 1: “Weeds – nothing to worry about”,
- dimension 2: “Weed control – a habitual routine”, and
- dimension 3: “Weed control – worth trying new methods”.

A3.3.3 Motivations for weed control

A3.3.3.1 Types of motivations

A wide range of motivations were mentioned by interviewees when asked:

The Sociology of Weed Management

...when you are thinking about the jobs you have to get done in the coming few days or weeks, what reasons will cause you to put weed control in a particular paddock or place on your property at the top of the list?

The responses were grouped into 11 main categories (Table A3.0.2).

Table A3.0.1 Correlations between individual attitude statements and the three attitudinal dimensions

Attitude statement	Correlations with dimensions		
	1	2	3
In my view, you are better off looking after your stock, than worrying too much about weeds.	.689	.261	
Fortunately, weed control is something you can put off in difficult times, and catch up on later.	.631	.223	
Of all the jobs on the farm, weed control is probably one of the most important	- .589		.207
Weed control is more a matter of economics than having a weed-free property you can be proud of.	.580	- .114	.253
The satisfaction of having no weeds on your property makes up for the time and money you have to spend on weed control.	- .533	.368	.231
With weed problems, it's best to get in and fix them yourself, rather than talking to others about what to do.		.726	
With weed control, it's better to stick to what you know works well, rather than trying new methods.		.613	- .104
Weed control is one part of running a property that hasn't changed much over the years.		.573	
In this district, it's just the same few weeds that are the problem – you don't have to worry about new weeds appearing.	.184	.540	.105
With most weeds around here, it's possible to change your grazing management so they don't get a chance to take hold.	.235		.664
If you see a plant on your place you haven't seen before, you should get it identified straight away.	- .203	- .131	.662
Generally, the benefits of new weed control methods outweigh the costs in trying them out.	- .225	.299	.337

Correlation 3 less than 0.100 omitted

Interviewees could give more than one motivation (the average number given across all interviewees was 1.6), however it was found that there were no strong correlations among particular motivations for those who gave more than one motivation. In addition, there was no tendency for interviewees to fall into a small number of distinct groups defined by particular combinations of motivations.

Table A3.0.2 Frequency of responses to the question about what would cause interviewees to place weed control at the top of their list of jobs.

The Sociology of Weed Management

Motivation	Proportion of interviewees (%)
Related to weed life cycle (e.g. before flowering or seeding)	39
Fitting in with other farming operations (e.g. stock movement)	34
Certain times of year (e.g. early in spring)	29
High weed levels	24
If a weed is competitive or invasive	18
Weather-related (e.g. after rain)	17
When productivity is impacted	16
When product quality is impacted	5
When chemicals are cheap	3
When aesthetics are impacted	1
When there is pressure from weed authorities	0

Percentages add to more than 100 because interviewees could nominate more than one motivation. Zero values indicate proportions less than 0.5 per cent.

The first seven categories in Table A3.0.2, above, comprised 95 per cent of the responses given. The combinations of one or more of the seven categories given in responses were ranked in order of most frequent to least frequent combination. In all, 63 different combinations of categories were represented in the responses given by interviewees. The top ranking combination, in terms of how frequently it was given by interviewees, was given by 14 per cent of interviewees. The 13 highest ranking combinations accounted for the responses of just under 75 per cent of interviewees. At the other end of the ranking, there were 14 combinations of categories each given by just one interviewee. The frequencies for the 13 highest ranking combinations are shown in Table A3.0.3.

For the more common combinations of motivations, it is possible to determine whether there are statistically significant relationships between the combination of motivations and the responses to other questions. The following sections describe these relationships (all relationships are significant at the 0.05 level or better, as shown by a chi-squared test, Fisher's exact test or analysis of variance). Only the first four combinations of motivations in Table A3.0.3 are described, as the numbers of interviewees in each combination of motivations below the first four were too small for drawing generalisable inferences.

A3.3.3.2 Factors related to fitting in with other farming operations

Interviewees in Western Australia were more likely to give a single motivation related to fitting in with other farming operations (18 per cent compared to the national average of 11 per cent), while those in north eastern Victoria were least likely to give this motivation (3 per cent). Among Western Australian interviewees, those who gave a single motivation related to fitting in with other farming operations were more likely to regard Brome Grass as easy to identify (97 per cent compared to 82 per cent among other West Australian interviewees).

Table A3.0.3 Most common combinations of motivations in responses to the question about what would cause interviewees to place weed control at the top of their list of jobs.

The Sociology of Weed Management

Combination of motivation categories	Proportion of interviewees (%)
One motivation only: fitting in with other farming operations	14
One motivation only: weed life cycle	13
One motivation only: high weed levels	10
One motivation only: certain times of year	7
One motivation only: whether the weed is competitive or invasive	5
Two motivations: certain times of year and weed life cycle	5
One motivation only: weather-related	5
One motivation only: when productivity is impacted	5
Two motivations: weed life cycle and high weed levels	3
Two motivations: certain times of year and fitting in with other farming operations	2
Two motivations: weather-related and fitting in with other farming operations	2
Two motivations: high weed levels and whether weed is competitive or invasive	2
Two motivations: weed life cycle and fitting in with other farm operations	2

Nationally, those who gave a single motivation related to fitting in with other farming operations were:

- more likely to regard better ground cover for weed control as not worth doing (10 per cent compared to 4 per cent among other interviewees),
- more likely to regard holding yards and other quarantine measures as not worth doing (40 per cent compared to 22 per cent among other interviewees),
- more likely to regard using fertiliser to outcompete weeds as not worth doing (28 per cent compared to 17 per cent among other interviewees),
- more likely to nominate herbicide resistance as a difficulty they faced with weed control (38 per cent compared to 21 per cent among other interviewees),
- less likely to run beef cattle (55 per cent compared to 69 per cent among other interviewees),
- less likely to agree or strongly agree with the statement that: *The satisfaction of having no weeds on your property makes up for the time and money you have to spend on weed control* (67 per cent compared to 76 per cent among other interviewees),

- less likely to agree or strongly agree with the statement that: *Weed control is one part of running a property that hasn't changed much over the years* (33 per cent compared to 43 per cent among other interviewees),
- less likely to agree or strongly agree with the statement that: *Of all the jobs on the farm, weed control is probably one of the most important* (52 per cent compared to 63 per cent among other interviewees),
- more likely to regard agricultural consultants as very useful sources of information (62 per cent compared to 48 per cent among other interviewees), and
- less likely to give *Vigilance and diligence* as the key to keeping weed levels low (22 per cent compared to 54 per cent among other interviewees).

Those who gave a single motivation related to fitting in with other farming operations also had a higher mean score on the first attitudinal dimension (*Weeds – nothing to worry about*), denoting a lower priority placed on weed control.

A3.3.3.3 Factors relating to weed life cycle

Interviewees in southern NSW were most likely to give a single motivation related to weed life cycle (14 per cent), while those in central and western Victoria and in Tasmania were least likely to give this motivation (4 per cent in each case). Among South Australian interviewees, those who gave a single motivation relating to weed life cycle were more likely to regard Paterson's Curse as a weed (100 per cent compared to 84 per cent among other South Australian interviewees). Among central and western Victorian interviewees, those who gave a single motivation relating to weed life cycle were less likely to regard *Vulpia* as easy to identify (25 per cent compared to 81 per cent among other central and western Victorian interviewees).

Nationally, interviewees who gave a single motivation relating to weed life cycle were:

- more likely to nominate drought as a difficulty they faced in weed control (60 per cent compared to 47 per cent among other interviewees),
- more likely to nominate a shared boundary with public land as a difficulty they faced in weed control (56 per cent compared to 33 per cent among other interviewees),
- more likely to say that their weed levels were higher than they would like but lower than in their district (39 per cent compared to 25 per cent among other interviewees),
- more likely to agree or strongly agree with the statement that: *Generally, the benefits of new weed control methods outweigh the costs in trying them out* (65 per cent compared to 49 per cent for other interviewees),

- less likely to agree or strongly agree with the statement that: *Fortunately weed control is something you can put off in difficult times and catch up on later* (10 per cent compared to 20 per cent among other interviewees),
- less likely to agree or strongly agree with the statement that: *In my view, you are better off looking after your stock than worrying too much about weeds* (13 per cent compared to 24 per cent among other interviewees),
- more likely to disagree or strongly disagree with the statement that: *Weed control is more a matter of economics than having a weed-free property you can be proud of* (43 per cent compared to 31 per cent among other interviewees), and
- more likely to regard visits from the local weeds officer as a very useful source of information (38 per cent compared to 27 per cent among other interviewees).

Those who gave a single motivation relating to weed life cycle also had a smaller mean number of sheep (3003 compared to 5008 for other interviewees). Consistent with this, they also had a lower mean percentage of income from wool (13 per cent compared to 18 per cent for other interviewees) and a higher mean percentage of income from crop sales (25 per cent compared to 18 per cent for other interviewees).

Those who gave a single motivation relating to weed life cycle had a lower mean number of persons in their household (2.6 compared to 2.9 for other interviewees). While the relationship with age was not significant, the differences in proportions in various age groups for those who gave a single motivation relating to weed life cycle would suggest that the smaller household size is more likely to be due to children having left home than to young couples with no children.

Those who gave a single motivation related to weed life cycle also had a lower mean score on the first attitudinal dimension (*Weeds – nothing to worry about*), denoting a higher priority placed on weed control.

A3.3.3.4 Factors relating to weed levels

There were no significant differences across regions in the proportion of interviewees who gave a single motivation related to weed levels. Those who did give this motivation were:

- more likely to be unfamiliar with spray grazing (26 per cent compared to 14 per cent among other interviewees),
- less likely to disagree or strongly disagree with the statement that: *In my view you are better off looking after your stock than worrying too much about weeds* (46 per cent compared to 60 per cent among other interviewees),

- more likely to agree or strongly agree with the statement that: *With weed control, it's better to stick to what you know works well, rather than trying new methods* (52 per cent compared to 36 per cent among other interviewees),
- less likely to regard advisers employed by fertiliser or chemical companies as a very useful source of information (11 per cent compared to 24 per cent among other interviewees), and
- less likely to regard retailers, merchandisers and stock and station agents as a very useful sources of information (14 per cent compared to 29 per cent among other interviewees).

Those who gave a single motivation relating to weed levels had a higher mean score on the second attitudinal dimension (*Weed control – a habitual routine*), suggesting a greater tendency to see weed control as a necessary routine rather than strategic management.

A3.3.3.5 Factors relating to time of year

There were no significant differences across regions in the proportions of interviewees giving a single motivation relating to time of year. However, in southern NSW, interviewees who gave this motivation were less likely to regard Serrated Tussock as a weed (67 per cent compared to 100 per cent among other interviewees).

Interviewees who gave a single motivation relating to time of year were:

- less likely to agree with the statement that: *Weed control is one part of running a property that hasn't changed much over the years* (26 per cent compared to 42 per cent among other interviewees),
- more likely to regard daily or local newspapers as not useful sources of information (56 per cent compared to 41 per cent among other interviewees),
- more likely to regard leaflets and booklets from retailers as not useful sources on information (33 per cent compared to 16 per cent among other interviewees), and
- more likely to be in the minimal control group as defined by use of weed control practices (28 per cent compared to 12 per cent among other interviewees).

Those who gave a single motivation relating to time of year had a higher mean number of people in the household (3.4 compared to 2.9 for other interviewees).

A3.3.4 Motivation differences between croppers and graziers

The motivations given by interviewees who had no cropping and interviewees who had crops and livestock were compared. Interviewees who had livestock only and no cropping were:

- more likely to give motivations relating to weather (17 per cent compared to 11 per cent among those with crops and livestock), and
- less likely to give motivations relating to fitting in with other farm operations (21 per cent compared to 29 per cent among those with crops and livestock).

A3.3.5 Motivation differences between those with high and low predicted weed incidence

As described in section A2.2 in the report on the farm visits and mail-back survey, it was possible to use the data from the mail-back survey, together with the ratings of weed incidence provided by the weeds officers assisting with the farm visits, to identify a small set of questions (not about weed incidence) which provided good predictive measure of weed incidence.

Table A2.2.1 in the report on the farm visits and mail-back survey listed a set of questions, the answers to which would correctly predict whether or not a respondent was in the lower or upper half of the distribution of weed incidence ratings in 82 per cent of cases.

By applying the predictive equation developed from the mail-back survey data and weeds officer ratings to the same set of questions in the telephone survey, it was possible to predict whether or not telephone interviewees might lie in the lower or upper half of the unknown distribution of weed incidence levels on their properties.

Comparison of the motivations of the half of interviewees with higher predicted weed incidence and the half with lower predicted weed incidence revealed that those with higher predicted weed incidence levels were less likely to give motivations related to weed life cycle (22 per cent compared to 31 per cent among the half of interviewees with lower predicted weed incidence).

A3.3.6 Barriers to effective weed control

A3.3.6.1 *Types of difficulties*

The items about difficulties with weed control used in the mail-back survey were used in the telephone survey, with the addition of several new items. The frequencies with which these difficulties were reported are shown in Table A3.0.4.

Using factor analysis (principal components) on these items found that 44 per cent of the variation in the responses to the 14 items could be captured with the four dimensions. The correlations between items and the four dimensions are shown in Table A3.0.5.

The groups of items indicated by the bolded correlations and row shading in Table A3.0.5 suggest that barriers may fall into four different types. The first, represented by dimension 1, is a group of barriers which are theoretically amenable to management control (perhaps with the exception of *Difficult country*), even if the items represent fairly severe difficulties. The second type, represented by dimension 2, is a group of barriers that are mostly beyond the management control of the individual. These are genuine barriers or a

The Sociology of Weed Management

rationalisation for lack of weed control by an external locus of control personality. The remaining factors are more difficult to interpret and represent a residue of difficulty items that are generally unrelated and more reflective of the choice of items in the survey, rather than inherent attitudinal dimensions.

Table A3.0.4 Proportions of interviewees reporting various difficulties with weed control.

Difficulty with weed control	Proportion of interviewees (%)
Lack of time	67
Lack of money	66
Neighbours with weeds	60
Lack of labour	59
Drought	55
Other priorities	51
Difficult country	46
Dislike using chemicals	40
Methods don't work well	35
Shared boundary with public land	35
Herbicide resistance	21
Medical problems	16
Lack of information	13
Live off-farm	7
When there is pressure from weed authorities	0

Percentages add to more than 100 because interviewees could nominate more than one difficulty.

Table A3.0.5 Correlations between individual difficulty items and the four difficulty dimensions.

Difficulty item	Correlations with dimensions			
	1	2	3	4
Lack of time.	.773			
Lack of labour	.674	.224		
Other priorities	.638	-.101		.203
Lack of money	.528	.115	.195	
Difficult country	.355	.315		-.310
Shared boundary with public land		.587	-.261	
Medical problems		.580	.379	
Neighbours with weeds		.528	.173	
Drought	.290	.510		
Live off-farm		.144	.704	-.264
Herbicide resistance			.594	.397

The Sociology of Weed Management

Dislike using chemicals	.292	.430	.152
Methods don't work well	.153	.124	.642
Lack of information		.163	.634

Correlation³ less than 0.100 omitted

For convenience of reference in the following section the first two dimensions are described as:

- dimension 1: difficulties amenable to management, and
- dimension 2: difficulties beyond management control.

A3.3.6.2 Difficulties amenable to management

There were higher mean scores on *Difficulties amenable to management* across interviewees in southern NSW and in Tasmania and lower mean scores across interviewees in north eastern Victoria.

More generally, higher mean scores on *Difficulties amenable to management* were associated with:

- not being familiar with maintaining groundcover as a method of weed control,
- self-reported weed levels being higher than the interviewee would like and higher than in the district,
- regularly attending field days,
- having done agriculture courses at high school,
- having done TAFE courses in agriculture,
- disagreeing with the statement that: *The satisfaction of having no weeds on your property makes up for the time and money you have to spend on weed control,*
- agreeing with the statement that: *Weed control is more a matter of economics than having a weed-free property you can be proud of,*
- agreeing with the statement that: *Fortunately weed control is something you can put off in difficult times and catch up later,*
- disagreeing with the statement that: *With weed problems, it's best to get in and fix them yourself, rather than talking to others about what to do,*
- disagreeing with the statement that: *With weed control, it's better to stick to what you know works well, rather than trying new methods,*

- having a higher score on the attitudinal dimension: *Weeds - nothing to worry about*,
- having a lower score on the attitudinal dimension: *Weed control - a habitual routine*,
- regarding field days as useful sources of information, and
- regarding weekly rural newspapers as very useful sources of information,

A3.3.6.3 Difficulties beyond management control

There were higher mean scores on *Difficulties beyond management control* across interviewees in north eastern Victoria and lower mean scores across interviewees in Western Australia.

More generally, higher mean scores on *Difficulties beyond management control* were associated with:

- regarding quarantine measures as worth doing,
- self-reported weed levels being higher than the interviewee would like but lower than in the district,
- running beef cattle and not having any crops,
- having a higher proportion of income from cattle sales,
- not having worked in partnership with parents,
- agreeing with the statement that: *The satisfaction of having no weeds on your property makes up for the time and money you have to spend on weed control*,
- disagreeing with the statement that: *In my view, you are better off looking after your stock than worrying too much about weeds*,
- agreeing with the statement that: *Of all the jobs on a farm, weed control is probably one of the most important*,
- having a lower score on the attitudinal dimension: *Weeds - nothing to worry about*, and
- being in the group who gave a single motivation related to weed life cycle as causing them to place weed control at the top of their farm jobs.

A3.3.7 Differences in barriers nominated by cropper and graziers

The difficulties encountered in weed control nominated by those with no cropping and those with both crops and livestock were compared. Interviewees with livestock only and no cropping were:

- more likely to nominate lack of information (20 per cent compared to 10 per cent among those with both crops and livestock),
- less likely to nominate herbicide resistance (13 per cent compared to 27 per cent among those with both crops and livestock),
- more likely to nominate medical problems (19 per cent compared to 12 per cent among those with both crops and livestock), and
- more likely to nominate dislike of using chemicals (46 per cent compared to 39 per cent among those with both crops and livestock).

A3.3.8 Differences in barriers between those with high and low predicted weed incidence

Comparison of the difficulties nominated by the half of interviewees with higher predicted weed incidence and the half with lower predicted weed incidence found a number of differences. Interviewees in the half with higher predicted weed incidence were:

- more likely to nominate lack of time as a difficulty they faced in weed control (70 per cent compared to 62 per cent among interviewees in the half with lower predicted weed incidence)
- more likely to nominate lack of money as a difficulty (59 per cent compared to 49 per cent among interviewees in the half with lower predicted weed incidence),
- more likely to nominate lack of labour as a difficulty (69 per cent compared to 60 per cent among interviewees in the half with lower predicted weed incidence),
- more likely to nominate medical problems as a difficulty (17 per cent compared to 11 per cent among interviewees in the half with lower predicted weed incidence),
- more likely to nominate as a difficulty they face in weed control that control methods do not work well (40 per cent compared to 30 per cent among interviewees in the half with lower predicted weed incidence), and

- more likely to nominate other priorities as a difficulty (59 per cent compared to 48 per cent among interviewees in the half with lower predicted weed incidence),

A3.4 Self-Reported Weed Levels

Self-reported weed levels and how the levels compared with levels in the district are shown in Table A3.0.1.

Table A3.0.1 *Self-reported weed levels*

Self-reported weed level	Proportion of interviewees (%)
Weeds at a level that it is not worth reducing them further	32
Weed levels higher than preferred but lower than the district	26
Weed levels higher than preferred and same as the district	35
Weed levels higher than preferred and higher than the district	7

It is difficult to establish the level of weed infestation on a property by simply asking its owner in a telephone interview. As described in section 0, the predictive equation developed from the mail-back survey data and weeds officer ratings could be applied to the same set of questions in the telephone survey, and so predict whether or not telephone interviewees might lie in the lower or upper half of the unknown distribution of weed incidence levels on their properties.

This was then compared with telephone interviewees self-reported weed levels (whether weed levels were higher than they preferred, or were at a level such that it was not worth reducing them further). The relationship between predicted and self-reported weed levels is shown in Table A3.0.2.

Table A3.0.2 *Relationship between predicted weed incidence and self-reported weed levels.*

Self-reported weed levels	Proportion of interviewees (%)	
	Predicted to be in the lower half of the weed incidence distribution	Predicted to be in the upper half of the weed incidence distribution
Not worth reducing them further	32	32
Higher than preferred	68	68

Table A3.0.2 shows that the proportions of interviewees reporting their weed levels to be higher than preferred is the same for each of the two groups defined by predicted weed incidence. In other words, there is no relationship between what people report their weed levels to be and what their actual levels might be as predicted from a range of other question which proved to have good predictive power in the mail-back survey.

There was also no relationship between predicted weed incidence and self-reported weed levels when the analysis was restricted to just those interviewees in the same regions as where the farm visits and mail-back survey were carried out. This supports the view that the lack of relationship is due more to how interviewees report their weed levels than to a failure of the predictive equation derived from the mail-back survey to generalise to a broader population.

A3.5 Discussion

As described in 0, the telephone survey aimed to provide broader geographical coverage than the farm visits and mail-back survey, examine the motivations and barriers in weed control and trial a method of identifying non-adopters in a telephone survey.

A3.5.1 Identifying non-adopters

With regard to the latter aim, it appears that there may be little relationship between actual and self-reported weed levels. The evaluation of the ultimate impact of weed extension programs requires the use of some measure of weed levels and it is clear from this study that self-reported levels in phone interviews will be a very imprecise measure. However, as the report on the farm visits and mail-back survey describes, a simple eight point scale used by weeds officers familiar with weed levels in the region had strong and readily interpreted relationships with respondents views on weed control and their weed control practices. The local knowledge of weeds authority staff is therefore a valuable resource for the evaluation of weeds extension programs. As weeds authorities adopt the use of geographical information systems, an additional resource for evaluation will become available, subject of course to the privacy guidelines under which the authorities operate.

The predictive equation developed from the mail-back survey data appears to have some potential as a means of predicting the incidence of weeds on properties through telephone interviews. However, it is likely to lose predictive power over time as the circumstances that influence weed incidence on properties change from those that pertained at the time of the farm visits. It is also likely, for similar reasons, to be inaccurate if applied to small numbers of properties in a specific region.

A3.5.2 Motivations

The telephone survey has confirmed that there are a number of attitudinal dispositions towards weeds that will have an influence on the levels of knowledge and skill possessed by producers, and upon the particular motivations that might result in decisions to control weeds at a point in time. Firstly, weed control has to be afforded an overall level of priority among all the tasks that compete for the producer's time and attention. If weeds and weed control are not seen as important, then it is likely less effort will be made to keep informed about control methods and new weed threats. In addition, weed control decisions are more likely to be reactive than planned, and motivated by whatever might elevate weed control to temporary priority, such as observing that is weed is going to seed, or routinely undertaking control measures at a particular time of year.

Secondly, an attitudinal disposition to simplify the inherent complexity of farm management by following routines is also likely to reduce the amount of interest in new or improved weed control methods, particularly if it is believed that the routines being followed are achieving effective control. For those who have weed control routines, the motivations that trigger particular control decisions are more likely to be related to times of year or fitting in with other farm management routines.

Thirdly, consistent with the seminal work of Rogers (1962), a disposition to innovativeness may lead a producer to seeking information on new weed control methods, trialing these methods, and increasing their knowledge and skills in the use of these methods. In such a case, the availability of information on new methods may, of itself, provide sufficient motivation.

The set of attitude statements used in the telephone survey was constrained by the interview time available and was by no means exhaustive of all the possible attitudinal orientations towards weeds and weed control. Other attitudinal dispositions encountered in the farm visits include pride in the appearance of one's property, a tendency to observe closely, and reflect upon, what is happening in crops and pastures and a tendency to give weight to future consequences (often expressed as one year seed, seven years weed). Each of these dispositions can be associated with particular motivations.

For example, when particular species of weeds become highly visible in the farm landscape, this may motivate control activity among those who have pride in the appearance of their farm. For the person with an intense interest in pasture composition, small changes in composition that would be invisible to others may be sufficient to motivate changes to grazing pressure for weed control purposes. For the person who gives weight to future consequences and is confident in their ability to obtain desired outcomes on their property in the future, a weed at the flowering stage may motivate control activities, while another person with a fatalistic view that their efforts will be in vain may not attempt any weed control.

This suggests that there will be a wide range of possible motivations for embarking upon weed control at a particular time and place. The telephone survey findings were consistent with this expectation – even taking just the seven most frequently given categories out of the 11 categories into which motivations were grouped, there were 63 different combinations of the seven motivations given by interviewees. The most commonly given combination of motivations – a single motivation related to fitting in with other farm operations – was given by only 14 per cent of interviewees.

Despite the apparent diversity of motivations, there is some indication from the telephone interview data of how motivations might be related to other factors. Fitting weed control in with other farm operations appears to be associated more with sheep-wheat production than with beef cattle production, and the need to fit weed control in with other operations may result in lower priority being placed on weed control. Poorer weed management also appears to be associated with weed levels and time of year as motivations for weed control.

On the other hand, those who gave a single motivation relating to weed life cycle appear to be the better weed managers who place a higher priority on weed control.

A3.5.3 Barriers

The barriers that interviewees believed they faced in controlling weed fell into two groups: those that are feasibly within management control, such as lack of time, money or labour; and those that are beyond management control, such as drought, neighbours with weeds, or weeds on adjoining public land. Lack of time and lack of money were the most frequently mentioned (two thirds of interviewees). Neighbours with weeds, lack of labour and drought were mentioned by between two thirds and half of the interviewees.

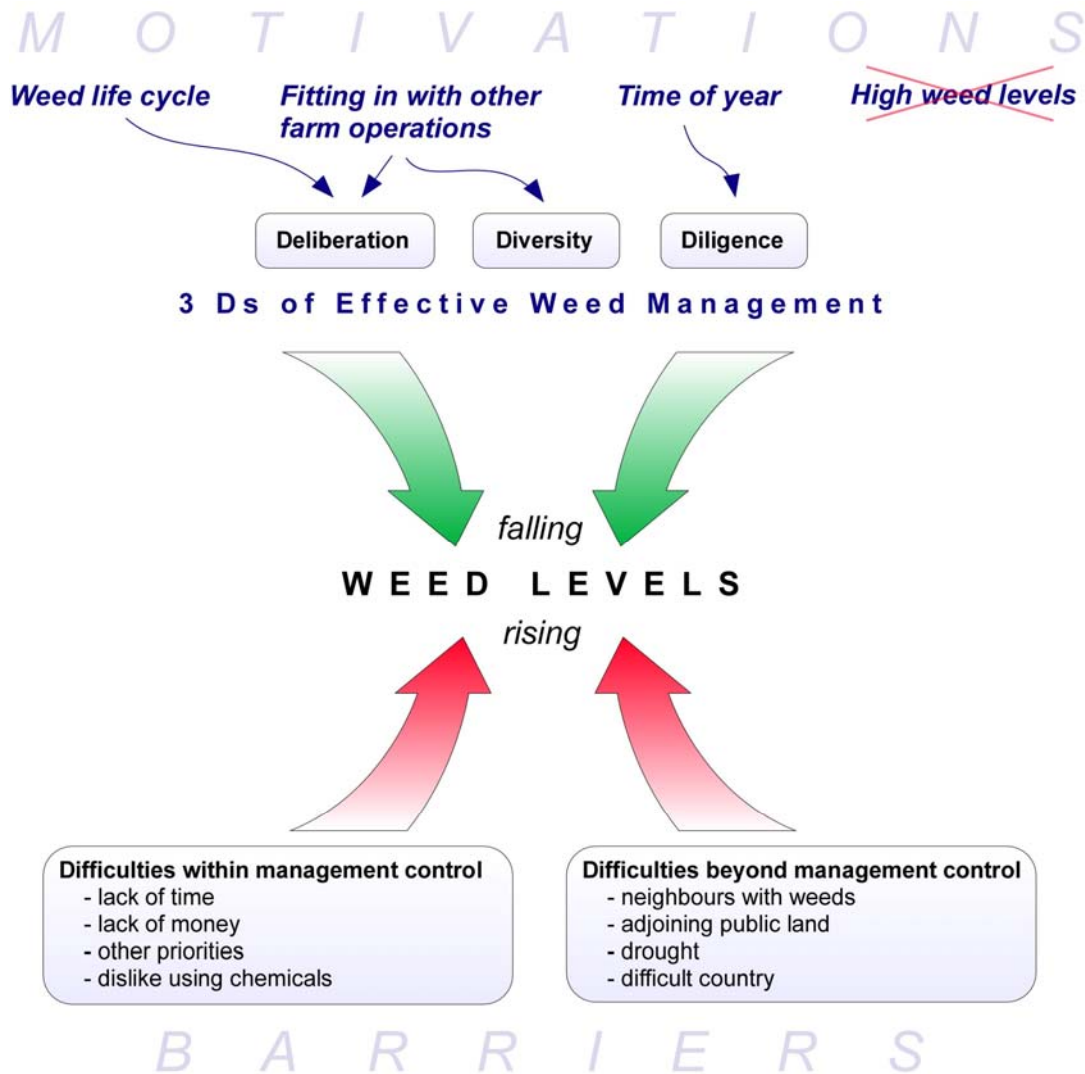
There is a good deal of evidence in the findings from the telephone interviews that it is the poorer weed managers who believe they are prevented from improving weed control by factors such as lack of time, money and labour – factors that may well be within their own management control. On the other hand, the better weed managers appear to be more troubled by spillover effects from adjoining properties.

A3.5.4 Implications for extension

A3.5.4.1 Relationship between motivations and the 3Ds of weed management

These findings are broadly consistent with, and complement, the findings from the farm visits and mail-back survey. The weed levels on farms represent a balance struck by managers between the barriers and difficulties they face (lower part of Figure A3.0.1), and how hard and how effectively they are prepared to work to overcome these barriers (upper part of Figure A3.0.1). For example, the manager of a sub-viable property with mostly steep inaccessible terrain and re-infestation from neighbouring land will have to work much harder to control weeds effectively than the manager of a profitable property on good agricultural land that can all be accessed easily by tractor or quad-bike.

Figure A3.0.1 Schematic of the relationship between motivations, barriers and the 3Ds of effective weed management.



However, for a given property with whatever inherent difficulties might be associated with it, the level of weeds will be determined by skills of the manager. As discussed in the report on the farm visits and mail-back survey, three key aspects of effective weed management are deliberation (planned, strategic and integrated weed control), diversity (of methods) and diligence (in application of methods). Whether or not weed management is undertaken with deliberation, diligence and a diversity of methods depends on the extent to which the manager is motivated to do this.

The findings from the telephone survey suggest that motivations are many and varied, such that weed management extension efforts that seek to tap into these motivations will need to be similarly diverse. At a minimum, there are four main groups of motivations that could be utilised in weed management extension: those relating to weed life cycle, to fitting in with other farm operations, to time of year and to level of infestation. Weed life cycle

related motivations appear to be important among the better managers and a knowledge of weed life cycles is obviously necessary for a planned, strategic and integrated approach to weed management (Figure A3.0.1).

Fitting in with other farm operations is also necessary for this deliberative approach (Figure A3.0.1). Such an approach can make use of the opportunities for weed control offered by farm operations that are being undertaken for purposes other than weed control, and so be part of good weed management. However, the findings from the telephone survey suggest that this motivation may also occur among the poorer managers who place a lower priority on weed control, such that weed control is *only* undertaken when it fits in with other operations.

Motivations relating to time of year are characteristic of a group of weed managers identified in the farm visits and mail-back survey. This group, termed 'simple diligents' achieve good levels of weed control through the diligent and vigilant application of a few straightforward weed control methods such as boom spraying, spot spraying and hand chipping. The routinisation of weed control is, in part, a means of simplifying the inherent complexity of farm management and linking weed control activities to a time of year assists in this.

Motivations relating to high weed levels were also reported by a number of interviewees. As the red cross in Figure A3.0.1 indicates, weed control based on acting only when weed levels become severe does not contribute to effective weed management. This reactive approach is characteristic of some of the poorer weed managers. However, there are situations where successful and cost-effective weed control might be based upon taking action when weed incidence reaches certain thresholds that are well before the severe infestation stage.

A3.5.4.2 Motivation, adoption paths and extension message content

The report on the farm visits and mail-back survey suggested that there were a number of types of weed managers depending on the extent to which they used deliberation, diligence and a diversity of methods in their weed management. It was argued that, for the poorest weed managers, the path to better weed management might be via the 'simple diligent' stage – the adoption and diligent application of a few straightforward herbicide-based control methods to some of the more serious and easily recognised broadleaf weeds. This step on the adoption path could be encouraged in extension communication by emphasising that, while livestock production and cropping is never simple, the farmer and grazier can make their weed control simpler by establishing a routine and following it diligently. Appropriate routines need to be region specific and developed in collaboration with weed and pasture agronomists. The production and dissemination of regional calendars of weed control activities would assist those moving from ineffective reactive weed management to a routine, and provide timely reminders for those following weed control routines.

A necessary part of extension communication for the 'simple diligents' is to publicise via local radio and newspapers when unseasonal conditions necessitate departures from the routine followed in most years. As discussed in the report on the farm visits and mail-back

survey, those who are diligently following fixed routines and are achieving good weed control may also need to be alerted to emerging issues, such as new weed threats or particular weeds becoming resistant to herbicides.

It was suggested in the report on the farm visits and mail-back survey that there may be potential in extension efforts to encourage in the 'simple diligent' group to include grass weeds in their routines. As the telephone survey has confirmed the generally lower levels of awareness about grass weeds, such an approach would need to be supported with credible research that showed the loss of production due to grass weeds, and tools to aid in the identification of grass weeds and assessment of their incidence in pastures.

There is a substantial difference in the management of grazing-only properties and those with both crops and livestock. The latter have an inherent diversity which lends itself to the use multiple weed control methods in an integrated fashion. However, as noted above, the many tasks competing for the farmer's attention and the need for timeliness in cropping operations can result in weed control in pastures taking a low priority. For those in this situation, extension communication that emphasises the weed control opportunities generated by other farm operations may be of value. In addition, as those with mixed crop and livestock enterprises can be younger and possibly working off-farm, any information about more time-effective weed control methods is likely to receive consideration by those in this group.

A3.5.4.3 Other extension and communication considerations

There are a number of other considerations arising from the findings from the telephone survey which are applicable to all producers, regardless of where they might be situated on the adoption paths for poor to effective weed management.

Firstly, the telephone survey has confirmed that substantial proportions of producers regard a lack of time and money as a difficulty they face in weed management. This means that emphasis on the time and money saving aspects of weed control methods is likely to gain the attention of a large number of producers.

Secondly, all primary production is subject to the high variability of the Australian climate. The belief that one's best efforts will come to nought because of the vagaries of the weather is a potent justification for neglecting weed control, especially among external locus of control personality types. The challenge for weeds research and extension is to discover and publicise the opportunities for weed control that emerge as a consequence of seasonal fluctuations.

Thirdly, the commonsense idea that 'a stitch in time saves nine' or 'one year's seed, seven years weed' is widely accepted among primary producers. There are a number of areas where this idea can form the basis of extension messages. These include buying clean feed and confined feeding areas during drought, on-farm quarantine measures such as vehicle washdown areas, and use of certified seed in cropping. Of course, it is implicit in this approach that the relatively small costs of the 'stitch' and the extensive benefits of the 'nine saved stitches' are promoted in a credible way.

Lastly, and consistent with the findings both from the report on the farm visits and mail-back survey and the Rural Enablers project, it is very clear that there is a strong preference among producers considering adoption of weed control methods for 'people sources' such as agricultural consultants (particularly among croppers) and field days and workshops. The level of preference for written sources is lower, although fact sheets, weekly newspapers and industry newsletters are regarded as very useful or of some use by around 90 per cent of producers. This suggests that in the overall scheme of extension programs, the motivation for action may have to come from trusted and credible 'people sources', backed up by written resources that can be drawn upon once a producer is involved in changing their weed control methods.

A3.6 References

Rogers EM 1962. *Diffusion of Innovations*. Free Press, New York.

A3.7 Detailed regional frequency tables

The tables below provide detailed breakdowns by region of the responses to each question in the telephone interview.

A3.7.1 Demographic Data

Table A3.0.1 Size of farm households.

Region	Proportion of farm households (%)					
	1 member	2 members	3 members	4 members	5 members	6 or more members
Nthn NSW	16.7	41.7	16.7	13.5	3.1	8.3
Sthn NSW	15.5	42.3	15.5	18.6	7.2	1.1
Nth eastern Vic	12.7	46.8	14.9	16	8.5	1.1
Central and Western Vic	11.2	37.7	18.4	17.4	7.1	8.2
Tas	7.7	24.6	30.8	16.9	7.7	12.3
SA	7.9	41.1	22.1	15.8	7.9	5.3
WA	7.4	45.3	13.2	21.6	6.3	6.3
All regions	12.4	42.4	16.6	17.2	6.3	5.1

Table A3.0.2 Number of farm household members who are also business partners.

Region	Proportion of farm households (%)			
	1 member	2 members	3 members	4 or more members

The Sociology of Weed Management

Nthn NSW	24.0	60.4	9.4	6.3
Sthn NSW	24.7	62.9	7.2	5.2
Nth eastern Vic	21.3	67.1	6.4	5.3
Central and Western Vic	22.4	60.2	9.2	8.2
Tas	20.0	69.2	4.6	6.2
SA	18.4	68.4	8.9	4.2
WA	17.4	62.6	14.2	5.8
All regions	21.7	63.2	9.4	5.7

Table A3.0.3 Number of farm business partners aged less than 35 years.

Region	Proportion of farm households (%)			
	1 member	2 members	3 members	4 or more members
Nthn NSW	52.2	43.4	0.0	4.3
Sthn NSW	61.1	38.9	0.0	0.0
Nth eastern Vic	71.2	28.8	0.0	0.0
Central and Western Vic	56.4	39.2	0.0	4.4
Tas	61.5	30.8	7.7	0.0
SA	61.9	33.3	4.7	0.0
WA	61.5	28.2	10.2	0.0
All regions	58.7	36.9	2.7	1.7

The Sociology of Weed Management

Table A3.0.4 Number of farm business partners aged between 35 and 55 years.

Region	Proportion of farm households (%)			
	1 member	2 members	3 members	4 or more members
Nthn NSW	11.9	76.3	6.8	5.1
Sthn NSW	12.5	84.4	3.1	0.0
Nth eastern Vic	8.0	81.3	6.6	4.0
Central and Western Vic	17.2	78.1	0.0	4.7
Tas	14.9	83.0	2.1	0.0
SA	13.3	81.5	2.9	2.2
WA	12.3	79.0	8.0	0.7
All regions	12.4	80.2	4.9	2.4

Table A3.0.5 Number of farm business partners aged greater than 55 years.

Region	Proportion of farms (%)			
	1 member	2 members	3 members	4 or more members
Nthn NSW	70.4	25.9	3.7	0.0
Sthn NSW	66.7	33.3	0.0	0.0
Nth eastern Vic	82.2	11.9	5.9	0.0
Central and Western Vic	56.7	39.9	3.4	0.0
Tas	75.0	25.0	0.0	0.0
SA	59.0	35.9	0.0	5.1
WA	52.2	43.2	4.6	0.0
All regions	64.2	32.7	2.5	0.6

The Sociology of Weed Management

Table A3.0.6 Number of farm households with members employed off-farm.

Region	Proportion of farm households (%)			
	1 member	2 members	3 members	4 or more members
Nthn NSW	85.0	10.0	5.0	0.0
Sthn NSW	80.0	20.0	0.0	0.0
Nth eastern Vic	82.5	17.5	0.0	0.0
Central and Western Vic	72.8	27.2	0.0	0.0
Tas	77.3	18.2	4.5	0.0
SA	76.4	22.3	0.0	1.3
WA	81.7	18.3	0.0	0.0
All regions	80.4	18.1	1.2	0.2

A3.7.2 Agricultural Education

Table A3.0.7 Whether participant has completed a university of agricultural college degree.

Region	Proportion in each region (%)	
	Yes	No
Nthn NSW	17.7	82.3
Sthn NSW	22.7	77.3
Nth eastern Vic	17.0	83.0
Central and Western Vic	19.4	80.6
Tas	26.2	73.8
SA	10.0	90.0
WA	20.5	79.5
All regions	18.4	81.6

Table A3.0.8 Whether participant has completed a TAFE course in agriculture.

Region	Proportion in each region (%)	
	Yes	No
Nthn NSW	32.3	67.7
Sthn NSW	34.0	66.0
Nth eastern Vic	26.6	73.4
Central and Western Vic	35.7	64.3
Tas	22.7	77.3
SA	41.6	58.4
WA	15.8	84.2
All regions	30.8	69.2

Table A3.0.9 Whether participant has completed a high school unit in agriculture.

Region	Proportion in each region (%)	
	Yes	No
Nthn NSW	33.3	66.7
Sthn NSW	35.1	64.9
Nth eastern Vic	11.7	88.3
Central and Western Vic	23.5	76.5
Tas	20.0	80.0
SA	35.3	64.7
WA	25.2	74.8
All regions	29.5	70.5

Table A3.0.10 Whether participant grew up on a farm.

Region	Proportion of respondents (%)	
	Yes	No
Nthn NSW	86.5	13.5
Sthn NSW	87.6	12.4
Nth eastern Vic	85.1	14.9
Central and Western Vic	88.8	11.2
Tas	93.8	6.2
SA	90.0	10.0
WA	88.4	11.6
All regions	87.8	12.2

Table A3.0.11 Whether participant has worked in a farm partnership with his or her parents.

Region	Proportion in each region (%)	
	Yes	No
Nthn NSW	74.0	26.0
Sthn NSW	68.0	32.0
Nth eastern Vic	67.0	33.0
Central and Western Vic	74.5	25.5
Tas	81.5	18.5
SA	82.1	17.9
WA	81.6	18.4
All regions	74.6	25.4

Table A3.0.12 Whether participant regularly attends field days.

Region	Proportion in each region (%)	
	Yes	No
Nthn NSW	71.9	28.1
Sthn NSW	74.2	25.8
Nth eastern Vic	66.0	34.0
Central and Western Vic	75.5	24.5
Tas	75.4	24.6
SA	75.8	24.2
WA	82.1	17.9
All regions	74.7	25.3

Farm Data

Table A3.0.13 Land tenure arrangements.

Region	Proportion of property (%)	
	Freehold title (%)	Leasehold title (%)
Nthn NSW	77.1	22.9
Sthn NSW	79.4	20.6
Nth eastern Vic	83.0	17.0
Central and Western Vic	77.6	22.4
Tas	89.4	10.6
SA	75.3	24.7
WA	84.2	15.8
All regions	79.3	20.7

Table A3.0.14 Whether respondents run beef cattle.

Region	Proportion of respondents (%)	
	Yes	No
Nthn NSW	94.8	5.2
Sthn NSW	75.3	24.7
Nth eastern Vic	86.2	13.8
Central and Western Vic	71.4	28.6
Tas	86.2	13.8
SA	59.5	40.5
WA	42.6	57.4
All regions	72.1	27.9

Table A3.0.15 Whether respondents run sheep.

Region	Proportion of respondents (%)	
	Yes	No
Nthn NSW	67.7	32.3
Sthn NSW	84.5	15.5
Nth eastern Vic	40.4	59.6
Central and Western Vic	70.4	29.6
Tas	75.4	24.6
SA	81.6	18.4
WA	91.6	8.4
All regions	76.0	24.0

Table A3.0.16 Whether respondents grow crops.

Region	Proportion of respondents (%)	
	Yes	No
Nthn NSW	53.1	46.9
Sthn NSW	79.4	20.6
Nth eastern Vic	45.7	54.3
Central and Western Vic	66.3	33.7
Tas	71.2	28.8
SA	65.8	34.2
WA	90.0	10.0
All regions	68.8	31.2

A3.7.4 Regional Weeds

A3.7.4.1 Northern NSW

Table A3.0.17 Whether blackberry (*Rubus spp.*) is: in the region; considered a weed; and easy to identify.

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	59.4	39.6	1.0
Do you regard it as a weed?	88.6	8.3	3.1
Is it easy to identify?	94.8	1.0	4.2

Table A3.0.18 Whether African lovegrass (*Eragrostis curvula*) is: in the region; considered a weed; and if it is easy to identify.

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	39.6	44.8	15.6
Do you regard it as a weed?	56.3	10.4	33.3

The Sociology of Weed Management

Is it easy to identify?	39.6	19.8	40.6
-------------------------	------	------	------

Table A3.0.19 Whether Chilean needle grass (Nassella neesiana) is: in the region; considered a weed; and easy to identify.

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	17.7	60.4	21.9
Do you regard it as a weed?	52.1	4.2	43.7
Is it easy to identify?	20.8	20.8	58.3

A3.7.4.2 Southern NSW

Table A3.0.20 Whether Serrated tussock (Nassella trichotoma) is: in the region; considered a weed; and easy to identify.

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	29.9	64.9	5.2
Do you regard it as a weed?	90.7	1.0	8.2
Is it easy to identify?	47.7	17.5	35.1

Table A3.0.21 Whether Saffron thistle (Carthamus lanatus) is: in the region; considered a weed; and easy to identify.

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	95.9	4.1	0.0
Do you regard it as a weed?	97.9	2.1	0.0
Is it easy to identify?	97.9	2.1	0.0

*Table A3.0.22 Whether St John's wort (*Hypericum perforatum*) is: in the region; considered a weed; and easy to identify.*

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	63.9	35.1	1.0
Do you regard it as a weed?	94.8	1.0	4.1
Is it easy to identify?	79.4	8.2	12.4

A3.7.4.3 North eastern Victoria

Table A3.0.23 Whether Blackberry is: in the region; considered a weed; and easy to identify.

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	72.2	26.6	2.1
Do you regard it as a weed?	97.2	2.1	0.0
Is it easy to identify?	98.9	1.1	0.0

*Table A3.0.24 Whether Sweet briar (*Rosa rubiginosa*) is: in the region; considered a weed; and easy to identify.*

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	59.6	34.0	6.4
Do you regard it as a weed?	71.2	11.7	17.0
Is it easy to identify?	71.3	4.2	24.5

Table A3.0.25 Whether Yorkshire fog (*Holcus lanatus*) is: in the region; considered a weed; and easy to identify.

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	56.4	37.2	6.4
Do you regard it as a weed?	39.4	31.9	28.7
Is it easy to identify?	61.7	7.4	30.9

A3.7.4.4 Central and Western Victoria

Table A3.0.26 Whether Cape weed (*Arctotheca calendula*) is: in the region; considered a weed; and easy to identify.

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	99.0	1.0	0.0
Do you regard it as a weed?	89.9	6.1	4.0
Is it easy to identify?	97.9	1.0	1.0

Table A3.0.27 Whether Vulpia (*Vulpia spp.*) is: in the region; considered a weed; and easy to identify.

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	59.2	31.6	9.2
Do you regard it as a weed?	66.3	9.2	24.5
Is it easy to identify?	52.0	15.3	32.7

T

Table A3.0.28 Whether Yorkshire fog is: in the region; considered a weed; and easy to identify.

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	69.4	28.6	2.1
Do you regard it as a weed?	60.2	18.4	21.4
Is it easy to identify?	75.5	2.1	22.4

A3.3.7.4.5 South Australia

Table A3.0.29 Whether Paterson's curse (Echuim spp.) is: in the region; considered a weed; and easy to identify.

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	82.1	16.9	1.0
Do you regard it as a weed?	84.2	13.7	2.1
Is it easy to identify?	97.4	0.0	2.6

Table A3.0.30 Whether Vulpia is: in the region; considered a weed; and easy to identify.

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	75.3	21.0	3.7
Do you regard it as a weed?	81.0	5.3	13.7
Is it easy to identify?	74.7	10.5	14.7

Table A3.0.31 Whether Yorkshire fog is: in the region; considered a weed; and easy to identify.

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	32.1	48.9	19.0
Do you regard it as a weed?	24.2	21.6	54.2
Is it easy to identify?	37.4	2.6	60.0

A3.7.4.6 Western Australia

Table A3.0.32 Whether Cape weed is: in the region; considered a weed; and easy to identify.

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	98.9	1.1	0.0
Do you regard it as a weed?	64.7	32.6	2.6
Is it easy to identify?	98.4	1.6	0.0

Table A3.0.33 Whether Barley grass (*Hordeum leporinum*) is: in the region; considered a weed; and easy to identify.

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	97.4	1.6	1.1

The Sociology of Weed Management

Do you regard it as a weed?	75.8	18.4	5.8
Is it easy to identify?	93.2	5.3	1.6

Table A3.0.34 Whether Brome grass (Bromus spp). is: in the region; considered a weed; and easy to identify.

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	82.1	14.7	3.2
Do you regard it as a weed?	75.3	14.7	10.0
Is it easy to identify?	73.2	13.7	13.2

A3.7.4.7 Tasmania

Table A3.0.35 Whether Gorse (Ulex europaeus) is: in the region; considered a weed; and easy to identify.

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	87.7	12.3	0.0
Do you regard it as a weed?	98.5	1.5	0.0
Is it easy to identify?	100.0	0.0	0.0

Table A3.0.36 Whether Barley grass is: in the region; considered a weed; and easy to identify.

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	92.3	6.2	1.5

The Sociology of Weed Management

Do you regard it as a weed?	72.7	22.7	4.5
Is it easy to identify?	98.8	0.0	1.5

Table A3.0.37 Whether Brown top bent (Agrostis capillaris): in the region; considered a weed; and easy to identify.

	Proportion of respondents in each category (%)		
	Yes	No	Unsure
Is it in the region?	69.2	18.5	12.3
Do you regard it as a weed?	53.0	24.2	22.7
Is it easy to identify?	77.3	6.1	16.7

A3.7.5 Weed Levels

Table A3.0.38 Farmers' opinion of the weed level on their property.

Region	Proportion of respondents (%)	
	Weed level is higher than preferred	Not worth reducing weed level any further
Nthn NSW	66.7	33.3
Sthn NSW	71.1	28.9
Nth eastern Vic	62.8	37.2
Central and Western Vic	66.3	33.7
Tas	77.3	22.7
SA	67.4	32.6
WA	69.0	31.0
All regions	67.9	32.1

Table A3.0.39 Farmers' opinion of the weed level on their property compared to that of the surrounding district.

Region	Proportion of respondents (%)		
	A bit higher	About the same	Lower
Nthn NSW	7.8	45.3	46.9
Sthn NSW	11.6	52.2	36.2
Nth eastern Vic	5.1	44.1	50.8
Central and Western Vic	13.9	52.3	33.8
Tas	8.0	50.0	42.0
SA	10.9	47.7	41.4
WA	8.4	64.9	26.7
All regions	9.7	51.6	38.7

A3.7.5.1 Reasons for high weed levels

Table A3.0.40 Farmers' reasons for having high weed levels.

Region	Proportion of respondents stating reason (%)				
	Natural phenomena (e.g. drought)	Nature of the farm enterprise (e.g. sheep spread weeds)	Chemical issues (e.g. long holding period)	Other people (e.g. neighbours have weeds)	Own management (e.g. weeds are not a high priority)

The Sociology of Weed Management

Nthn NSW	0.0	50.0	0.0	50.0	25.0
Sthn NSW	57.1	42.9	14.3	14.3	42.9
Nth eastern Vic	66.7	100.0	0.0	0.0	0.0
Central and Western Vic	50.0	62.5	12.5	0.0	12.5
TAS	33.3	66.7	33.3	33.1	33.3
SA	21.4	57.1	0.0	28.6	0.0
WA	33.3	33.3	8.3	16.7	8.3
All regions	36.3	50.2	7.4	20.7	19.5

A3.7.5.2 Reasons for low weed levels

Table A3.0.41 Farmers' opinions on factors important to maintaining low levels of weeds.

Reason	Proportion of respondents stating reason (%)							
	Nthn NSW	Sthn NSW	Nth eastern VIC	Central and Wstn Vic	TAS	SA	WA	All Regions
Advice and learning	6.7	4.2	0.0	0.0	0.0	0.0	2.8	3.2
Vigilance	56.7	45.8	74.1	45.0	68.8	57.7	36.1	52.5
Timing	16.7	29.2	18.5	20.0	12.5	21.2	22.2	21.4
Pasture management	23.3	16.7	11.1	25.0	6.3	5.8	2.8	14.9
Grazing management	20.0	12.5	7.4	15.0	12.5	19.2	36.1	18.6
Using chemical control methods	30.0	45.8	29.6	20.0	25.0	28.8	30.6	32.7
Biological control	16.7	25.0	14.8	5.0	31.3	11.5	22.2	17.5
An integrated approach	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.4
Hygiene practices	0.0	0.0	0.0	0.0	0.0	1.9	2.8	0.7
Financial commitment	3.3	0.0	3.7	0.0	0.0	7.7	8.3	3.7

The Sociology of Weed Management

Pride in property	0.0	0.0	0.0		25	1.9	0.0	0.4
Particular attention to problem weed	3.3	12.5	0.0	15.0	6.3	5.8	5.6	6.7

The Sociology of Weed Management

A3.7.5.3 When weed control becomes a priority

Table A3.0.42 Factors that motivate farmers to make weed control a high priority.

Reason	Proportion of respondents stating each reason (%)							
	Nth NSW	Sthn NSW	Nth eastern VIC	Central and Wstn Vic	TAS	SA	WA	All regions
Weeds don't need to be a priority	7.1	3.5	4.7	1.1	0.0	4.7	5.6	4.8
Always a priority	9.5	9.3	15.3	5.7	6.5	7.1	5.6	8.5
Certain times of year	21.4	20.9	28.2	27.3	41.3	23.7	20.9	22.8
At vulnerable stage of weeds life cycle	28.6	38.4	43.5	26.1	26.1	29.6	20.3	30.6
When there are a lot of weeds	14.3	24.4	27.1	36.4	30.4	20.7	19.2	22.0
If a weed is competitive or invasive	11.9	16.3	23.5	21.6	21.7	13.6	19.8	16.8
When other farming operations allow	28.6	19.8	17.6	27.3	32.6	26.6	41.2	27.5
When chemicals are cheap	3.6	1.2	3.5	2.3	4.3	3	0.6	2.2
When product quality is impacted	7.1	3.5	0.0	1.1	0.0	5.3	5.1	4.3
When productivity is impacted	8.3	8.1	5.9	22.7	10.9	11.8	15.8	11.4
When aesthetics are impacted	1.2	0.0	2.4	3.4	4.3	1.2	1.7	1.3
When there is pressure from weed authorities	0.0	0.0	0.0	1.1	2.2	0.6	0.6	0.3

3.7.6 Weed Control Methods

Table A3.0.43 Farmers' opinion of the importance of improving ground cover in order to control weeds.

Region	Proportion of respondents (%)		
	Well worth doing	Not worth doing	Not familiar
Nthn NSW	94.8	3.1	2.1
Sthn NSW	89.7	6.2	4.1
Nth eastern Vic	93.6	3.2	3.2
Central and Western Vic	90.7	4.1	5.2
Tas	93.7	0.0	6.3
SA	92.3	3.8	3.8
WA	89.8	6.4	3.8
All regions	91.8	4.7	3.6

Table A3.0.44 Farmers' opinion of the usefulness of spray grazing as a method of weed control.

Region	Proportion of respondents (%)		
	Well worth doing	Not worth doing	Not familiar
Nthn NSW	49.5	17.2	33.3
Sthn NSW	63.9	20.6	15.5
Nth eastern Vic	57.0	17.2	25.8
Central and Western Vic	73.2	9.3	17.5
Tas	66.2	10.8	23.1
SA	82.0	10.1	7.9
WA	87.8	8.0	4.2
All regions	68.0	14.4	17.5

The Sociology of Weed Management

Table A3.0.45 Farmers' opinion of the usefulness of slashing as a method of weed control.

Region	Proportion of respondents (%)		
	Well worth doing	Not worth doing	Not familiar
Nthn NSW	53.8	37.6	8.6
Sthn NSW	56.8	36.8	6.3
Nth eastern Vic	50.0	45.6	4.4
Central and Western Vic	52.1	38.5	9.4
Tas	54.7	39.1	6.3
SA	59.1	33.9	7.0
WA	40.4	45.2	14.4
All regions	52.3	39.1	8.6

Table A3.0.46 Farmers' opinion of the usefulness of holding yards and other quarantine techniques.

Region	Proportion of respondents (%)		
	Well worth doing	Not worth doing	Not familiar
Nthn NSW	57.9	22.1	20.0
Sthn NSW	44.6	31.5	23.9
Nth eastern Vic	60.7	9.6	29.8
Central and Western Vic	39.2	22.7	38.1
Tas	43.8	26.6	29.7
SA	55.5	20.3	24.2
WA	42.2	31.9	25.9
All regions	49.9	24.7	25.4

Table A3.0.47 Farmers' opinion of using fertiliser to help useful plants to outcompete weeds.

Region	Proportion of respondents (%)		
	Well worth doing	Not worth doing	Not familiar
Nthn NSW	72.1	18.3	9.7
Sthn NSW	69.5	22.1	8.4
Nth eastern Vic	84.0	9.6	6.4
Central and Western Vic	86.6	8.3	5.1
Tas	77.8	11.1	11.1
SA	63.0	23.7	13.3
WA	71.4	21.1	7.6
All regions	72.5	18.7	8.8

A3.7.7 Difficulties encountered in weed control

Table A3.0.48 Whether a lack of time is a factor hindering weed control.

Region	Proportion of respondents (%)	
	Yes	No
Nthn NSW	62.5	37.5
Sthn NSW	78.4	21.6
Nth eastern Vic	58.7	41.3
Central and Western Vic	64.3	35.7
Tas	75.4	24.6
SA	68.8	31.2
WA	60.5	39.5
All regions	66.7	33.3

The Sociology of Weed Management

Table A3.0.49 Whether a lack of money is a factor hindering weed control.

Region	Proportion of respondents (%)	
	Yes	No
Nthn NSW	63.5	36.5
Sthn NSW	75.3	24.7
Nth eastern Vic	50.0	50.0
Central and Western Vic	53.1	46.9
Tas	67.2	32.8
SA	71.6	28.4
WA	65.6	34.4
All regions	65.7	34.3

Table A3.0.50 Whether a lack of information is a factor hindering weed control.

Region	Proportion of respondents (%)	
	Yes	No
Nthn NSW	14.7	85.3
Sthn NSW	12.5	87.5
Nth eastern Vic	11.7	88.3
Central and Western Vic	11.2	88.8
Tas	14.5	85.5
SA	13.3	86.7
WA	13.7	86.3
All regions	13.2	86.8

The Sociology of Weed Management

Table A3.0.51 Whether a lack of labour is a factor hindering weed control.

Region	Proportion of respondents (%)	
	Yes	No
Nthn NSW	63.5	36.5
Sthn NSW	74.2	25.8
Nth eastern Vic	48.9	51.1
Central and Western Vic	50.5	49.5
Tas	59.1	40.9
SA	55.3	44.7
WA	44.7	55.3
All regions	58.7	41.3

Table A3.0.52 Whether difficult country (e.g. rocky, hilly, treed etc.) is a factor hindering weed control.

Region	Proportion of respondents (%)	
	Yes	No
Nthn NSW	42.7	57.3
Sthn NSW	55.8	44.2
Nth eastern Vic	52.7	47.3
Central and Western Vic	43.9	56.1
Tas	59.1	40.9
SA	41.6	58.4
WA	36.5	63.5
All regions	45.5	54.5

The Sociology of Weed Management

Table A3.0.53 Whether drought conditions are a factor hindering weed control.

Region	Proportion of respondents (%)	
	Yes	No
Nthn NSW	71.4	28.6
Sthn NSW	78.9	21.1
Nth eastern Vic	53.2	46.8
Central and Western Vic	47.3	52.7
Tas	49.2	50.8
SA	35.7	64.3
WA	30.7	69.3
All regions	56.0	44.0

Table A3.0.54 Whether herbicide resistance makes weed control difficult for farmers.

Region	Proportion of respondents (%)	
	Yes	No
Nthn NSW	12.8	87.2
Sthn NSW	21.5	78.5
Nth eastern Vic	7.6	92.4
Central and Western Vic	17.7	82.3
Tas	12.7	87.3
SA	25.3	74.7
WA	38.8	61.2
All regions	21.6	78.4

The Sociology of Weed Management

Table A3.0.55 Whether medical problems are a factor hindering weed control.

Region	Proportion of respondents (%)	
	Yes	No
Nthn NSW	14.7	85.3
Sthn NSW	29.9	70.1
Nth eastern Vic	18.3	81.7
Central and Western Vic	12.3	87.7
Tas	20.0	80.0
SA	10.1	89.9
WA	6.4	93.6
All regions	16.2	83.8

Table A3.0.56 Whether ineffective weed control methods are a factor hindering weed control.

Region	Proportion of respondents (%)	
	Yes	No
Nthn NSW	34.4	65.6
Sthn NSW	39.3	60.7
Nth eastern Vic	27.8	72.2
Central and Western Vic	26.8	73.2
Tas	36.9	63.1
SA	42.1	57.9
WA	38.7	61.3
All regions	36.2	63.8

The Sociology of Weed Management

Table A3.0.57 Whether weed spread from neighbours is a factor hindering weed control.

Region	Proportion of respondents (%)	
	Yes	No
Nthn NSW	63.5	36.5
Sthn NSW	59.8	40.2
Nth eastern Vic	71.3	28.7
Central and Western Vic	53.6	46.4
Tas	50.0	50.0
SA	62.2	37.8
WA	49.5	50.5
All regions	59.6	40.4

Table A3.0.58 Whether dislike of chemical control methods is a factor hindering weed control.

Region	Proportion of respondents (%)	
	Yes	No
Nthn NSW	38.9	61.1
Sthn NSW	39.2	60.8
Nth eastern Vic	32.6	67.4
Central and Western Vic	41.8	58.2
Tas	53.3	46.7
SA	42.2	57.8
WA	43.0	57.0
All regions	40.0	60.0

Table A3.0.59 Whether living off-farm is a factor hindering weed control.

Region	Proportion of respondents (%)	
	Yes	No
Nthn NSW	7.3	92.7
Sthn NSW	8.3	91.7
Nth eastern Vic	7.4	92.6
Central and Western Vic	2.1	97.9
Tas	8.2	91.8
SA	9.6	90.4
WA	5.9	94.1
All regions	7.1	92.9

Table A3.0.60 Whether other priorities reduce the effort farmers can put into weed control.

Region	Proportion of respondents (%)	
	Yes	No
Nthn NSW	43.0	57.0
Sthn NSW	60.8	39.2
Nth eastern Vic	48.4	51.6
Central and Western Vic	59.8	40.2
Tas	72.6	27.4
SA	52.4	47.6
WA	47.8	52.2
All regions	51.9	48.1

The Sociology of Weed Management

Table A3.0.61 Whether sharing a boundary with public land is a factor hindering weed control.

Region	Proportion of respondents (%)	
	Yes	No
Nthn NSW	29.5	70.5
Sthn NSW	38.1	61.9
Nth eastern Vic	51.1	48.9
Central and Western Vic	29.6	70.4
Tas	36.9	63.1
SA	35.8	64.2
WA	28.6	71.4
All regions	34.4	65.6

A3.7.8 Sources of information

A3.7.8.1 People

Table A3.0.62 Whether family members are a useful source of information on weed control.

Region	Proportion of respondents (%)		
	Very useful	Of some use	Not useful
Nthn NSW	27.2	46.8	26.1
Sthn NSW	40.4	35.1	24.5
Nth eastern Vic	19.6	45.7	34.8
Central and Western Vic	17.5	41.2	41.2
Tas	25.4	42.9	31.7
SA	26.3	52.2	21.5
WA	30.3	49.2	20.5
All regions	29.1	44.6	26.3

The Sociology of Weed Management

Table A3.0.63 Whether neighbouring producers are a useful source of information on weed control.

Region	Proportion of respondents (%)		
	Very useful	Of some use	Not useful
Nthn NSW	27.1	51.0	21.9
Sthn NSW	34.4	42.7	22.9
Nth eastern Vic	22.6	61.3	16.1
Central and Western Vic	19.6	66.0	14.4
Tas	13.8	66.2	20.0
SA	26.1	56.9	17.0
WA	33.7	55.1	11.2
All regions	28.7	53.1	18.2

Table A3.0.64 Whether well-regarded local producers are a useful source of information on weed control.

Region	Proportion of respondents (%)		
	Very useful	Of some use	Not useful
Nthn NSW	50.6	31.8	17.6
Sthn NSW	52.7	33.3	14.0
Nth eastern Vic	34.1	55.7	10.2
Central and Western Vic	29.5	55.8	14.7
Tas	31.7	55.0	13.3
SA	35.0	56.1	8.9
WA	36.4	53.4	10.2
All regions	42.4	44.6	13.0

The Sociology of Weed Management

Table A3.0.65 Whether staff of the local shire or town council are a useful source of information on weed control.

Region	Proportion of respondents (%)		
	Very useful	Of some use	Not useful
Nthn NSW	15.1	36.6	48.4
Sthn NSW	11.6	28.4	60.0
Nth eastern Vic	2.3	19.1	78.6
Central and Western Vic	3.4	18.9	77.7
Tas	1.6	14.8	83.6
SA	23.1	35.3	41.6
WA	5.6	19.1	75.3
All regions	11.3	27.9	60.8

Table A3.0.66 Whether visits from the local weeds officer are a useful source of information on weed control.

Region	Proportion of respondents (%)		
	Very useful	Of some use	Not useful
Nthn NSW	46.2	31.2	22.5
Sthn NSW	34.9	40.7	24.4
Nth eastern Vic	13.7	38.3	47.9
Central and Western Vic	21.7	33.3	45.0
Tas	20.5	30.8	48.7
SA	31.5	42.8	25.8
WA	21.6	41.2	37.3
All regions	31.8	38.1	30.2

The Sociology of Weed Management

Table A3.0.67 Whether staff of government departments (such as agriculture or soil conservation) are a useful source of information on weed control.

Region	Proportion of respondents (%)		
	Very useful	Of some use	Not useful
Nthn NSW	36.7	44.5	18.9
Sthn NSW	47.8	29.4	22.8
Nth eastern Vic	18.9	57.8	23.3
Central and Western Vic	25.0	47.8	27.2
Tas	25.0	51.6	23.4
SA	24.0	52.6	23.4
WA	39.8	45.7	14.5
All regions	35.2	43.9	20.9

Table A3.0.68 Whether agricultural consultants are a useful source of information on weed control.

Region	Proportion of respondents (%)		
	Very useful	Of some use	Not useful
Nthn NSW	47.1	36.8	16.1
Sthn NSW	58.9	28.9	12.2
Nth eastern Vic	30.9	38.3	30.9
Central and Western Vic	44.4	43.3	12.2
Tas	41.7	46.7	11.7
SA	46.9	34.3	18.9
WA	60.7	32.0	7.3
All regions	50.8	34.4	14.8

The Sociology of Weed Management

Table A3.0.69 Whether advisors employed by fertiliser or chemical companies are a useful source of information on weed control.

Region	Proportion of respondents (%)		
	Very useful	Of some use	Not useful
Nthn NSW	27.2	48.9	23.9
Sthn NSW	32.6	49.5	17.9
Nth eastern Vic	14.3	59.3	26.4
Central and Western Vic	18.6	59.8	21.6
Tas	26.2	61.5	12.3
SA	19.6	57.5	22.9
WA	24.6	50.3	25.1
All regions	24.8	52.7	22.5

Table A3.0.70 Whether retailers, merchandisers or stock and station agents are a useful source of information on weed control.

Region	Proportion of respondents (%)		
	Very useful	Of some use	Not useful
Nthn NSW	34.4	49.0	16.7
Sthn NSW	34.4	51.0	14.6
Nth eastern Vic	17.4	63.0	19.6
Central and Western Vic	29.9	59.8	10.3
Tas	22.7	66.7	10.6
SA	27.0	55.5	17.5
WA	27.4	56.3	16.3
All regions	29.9	54.2	15.9

The Sociology of Weed Management

Table A3.0.71 Whether farmer discussion groups are a useful source of information on weed control.

Region	Proportion of respondents (%)		
	Very useful	Of some use	Not useful
Nthn NSW	39.5	41.9	18.6
Sthn NSW	55.9	33.3	10.7
Nth eastern Vic	33.3	52.2	14.4
Central and Western Vic	42.1	50.5	7.4
Tas	33.3	58.7	7.9
SA	45.0	45.5	9.5
WA	51.9	42.6	5.5
All regions	46.3	42.4	11.3

Table A3.0.72 Whether field days and workshops are a useful source of information on weed control.

Region	Proportion of respondents (%)		
	Very useful	Of some use	Not useful
Nthn NSW	50.6	37.6	11.9
Sthn NSW	61.1	31.4	7.6
Nth eastern Vic	30.1	56.1	13.9
Central and Western Vic	39.8	55.0	5.2
Tas	35.6	59.0	5.5
SA	39.7	50.2	10.2
WA	48.5	45.4	6.1
All regions	48.0	42.9	9.1

The Sociology of Weed Management

A3.7.8.2 Written sources

Table A3.0.73 Whether weed books are a useful source of information on weed control.

Region	Proportion of respondents (%)		
	Very useful	Of some use	Not useful
Nthn NSW	26.6	54.3	19.2
Sthn NSW	47.4	39.2	13.4
Nth eastern Vic	17.4	56.5	26.1
Central and Western Vic	28.4	54.7	16.9
Tas	29.2	66.2	4.6
SA	20.0	61.1	18.9
WA	34.0	47.9	18.1
All regions	31.3	50.8	17.9

Table A3.0.74 Whether daily or local newspapers are a useful source of information on weed control.

Region	Proportion of respondents (%)		
	Very useful	Of some use	Not useful
Nthn NSW	20.2	44.7	35.1
Sthn NSW	24.7	38.1	37.1
Nth eastern Vic	9.6	52.1	38.3
Central and Western Vic	9.3	51.6	39.2
Tas	10.8	41.5	47.7
SA	14.0	40.5	45.4
WA	15.0	39.0	46.0
All regions	17.3	42.8	39.9

The Sociology of Weed Management

Table A3.0.75 Whether weekly rural newspapers are a useful source of information on weed control.

Region	Proportion of respondents (%)		
	Very useful	Of some use	Not useful
Nthn NSW	35.4	54.2	10.4
Sthn NSW	44.3	45.4	10.3
Nth eastern Vic	26.1	58.7	15.2
Central and Western Vic	29.9	63.9	6.2
Tas	40.9	54.5	4.5
SA	29.1	60.8	10.1
WA	41.0	48.4	10.5
All regions	36.3	53.4	10.4

Table A3.0.76 Whether farmer and industry newsletters are a useful source of information on weed control.

Region	Proportion of respondents (%)		
	Very useful	Of some use	Not useful
Nthn NSW	34.0	57.5	8.5
Sthn NSW	45.4	44.3	10.3
Nth eastern Vic	25.8	61.3	12.9
Central and Western Vic	30.6	66.3	3.1
Tas	28.8	66.7	4.5
SA	26.5	60.8	12.7
WA	40.0	53.2	6.8
All regions	35.6	55.3	9.1

The Sociology of Weed Management

Table A3.0.77 Whether fact sheets and booklets from government departments are a useful source of information on weed control.

Region	Proportion of respondents (%)		
	Very useful	Of some use	Not useful
Nthn NSW	43.0	47.3	9.7
Sthn NSW	45.3	46.3	8.4
Nth eastern Vic	20.5	58.1	21.5
Central and Western Vic	28.0	60.2	11.8
Tas	38.1	49.2	12.7
SA	31.9	55.7	12.4
WA	40.9	50.0	9.2
All regions	37.9	51.0	11.0

Table A3.0.78 Whether leaflets and booklets from agricultural retailers are a useful source of information on weed control.

Region	Proportion of respondents (%)		
	Very useful	Of some use	Not useful
Nthn NSW	27.7	53.2	19.2
Sthn NSW	34.8	47.4	17.9
Nth eastern Vic	11.7	66.0	22.3
Central and Western Vic	22.9	61.5	15.6
Tas	16.9	75.4	7.7
SA	18.1	64.3	17.6
WA	21.6	64.2	14.2
All regions	24.8	57.6	17.6

A3.7.8.3 Other sources

Table A3.0.79 Whether radio is a useful source of information on weed control.

Region	Proportion of respondents (%)		
	Very useful	Of some use	Not useful
Nthn NSW	18.3	39.8	41.9
Sthn NSW	24.0	43.8	32.3
Nth eastern Vic	11.1	40.0	48.9
Central and Western Vic	6.4	40.4	53.2
Tas	12.7	44.4	42.9
SA	13.3	43.1	43.6
WA	25.4	53.5	21.2
All regions	18.4	43.9	37.7

Table A3.0.80 Whether television is a useful source of information on weed control.

Region	Proportion of respondents (%)		
	Very useful	Of some use	Not useful
Nthn NSW	18.8	37.5	43.7
Sthn NSW	12.4	40.2	47.4
Nth eastern Vic	9.6	37.2	53.2
Central and Western Vic	7.2	35.1	57.7
Tas	10.8	26.2	63.1
SA	7.1	37.1	55.7
WA	10.4	32.8	56.8
All regions	12.0	36.9	51.1

Table A3.0.81 Whether the Internet is a useful source of information on weed control.

Region	Proportion of respondents (%)		
	Very useful	Of some use	Not useful
Nthn NSW	20.5	32.9	46.6
Sthn NSW	24.7	34.2	41.1
Nth eastern Vic	17.2	35.9	46.8
Central and Western Vic	17.1	36.6	46.3
Tas	17.0	52.8	30.2
SA	17.7	39.0	43.3
WA	17.4	48.4	34.2
All regions	19.8	37.9	42.3

A3.8 Supporting Documentation

A3.8.1 Telephone interview schedule

Format conventions:

Numbers and capital letters in bold are markers for indicating question sequences that are contingent upon answers to a preceding question

Text in square brackets is instructions for call management, for interviewer and/or for the entry of the schedule into the CATI software.

[1] Good My name is from and we're conducting a survey for the University of New England at Armidale, New South Wales.

[2] Before I continue, I just need to know whether or not you are on a grazing property with more than 500 sheep or 60 cattle.

[if doesn't have more livestock than the threshold, thank and terminate]

[if over the threshold, continue]

[if some other meat producer, e.g. goats, and they have more than 500, assure them that their views will be welcome and continue]

[3] The University has been asked by Meat and Livestock Australia to find out ways they could help meat producers to keep on top of weed problems and reduce the losses to production from weeds in pastures.

The Sociology of Weed Management

[4] Would it be possible to speak to a person in your household who has a major role in the running and decision-making on your property?

[if current interviewee has major role, continue at **5**, below]

[if person with major role is not available, arrange call back]

[if another person has major role and is available, continue at **6**, below]

[5] Would you be willing to answer some questions about any weed problems you might be having and what might be done to help reduce production losses from weeds in pastures? The questions take about 15 minutes, your answers are kept completely anonymous, that is we don't keep any information about who provided the answers. For training purposes, the interview may be monitored by my supervisor. If at the end of the interview you would like more information about the project, we can email or post it to you. Are you happy to start the interview now?

[if agreed, continue at **7**, below]

[if refused, thank and terminate]

[6] [Repeat **1**, **3** and **5**, above, then continue at **7**, below]

[7] Thanks for agreeing to take part.

The first question is about plants that cause problems for producers.

I'll read out a list of plants and can you please tell me for each one:

- firstly, does it occur in your region, [yes, no - record if not sure but don't volunteer]
- secondly, do you yourself regard it as a weed, [yes, no - record if not sure but don't volunteer]
- thirdly, whether it is easy or difficult to recognise. [yes, no - record if not sure but don't volunteer]

[choose weed list corresponding to location of interviewee - see end of schedule]

[may need to prompt with first one or two weeds, e.g. Saffron thistle... Does it occur in your district? And do you yourself regard it as a weed? And would you say it is easy or difficult to identify.]

[rotate order of weeds]

Producers use a range of practices to control pasture weeds. Of course, not all practices are worth doing in all situations. I'll read out a list of weed control methods. Could you please tell me for each one whether, in your experience, it is well worth doing, not worth doing or is something you are not familiar with using.[rotate order]

- Using fertiliser specifically to get pastures to out-compete weeds.
- Getting better ground cover with healthy native pastures or sown improved pastures
- Holding yards and other forms of quarantine to stop weed importation and spread
- Spray grazing, that is, using low doses of herbicides to make weeds more palatable to stock
- Slashing

The Sociology of Weed Management

Controlling weeds is just one of the many things that producers have to deal with, and it's often hard to keep up with weed control. Do any of the following make controlling weeds difficult on your property? [yes, no] [rotate order]

- Lack of time
- Lack of money
- Lack of information about weed control
- Lack of labour to help with weed control
- Difficult country, such as steep or rocky country
- Drought
- Herbicide resistance problems
- Medical problems such as injury or illness
- Control methods don't work well
- Dislike of using chemicals
- Live off-farm and rarely have time to control weeds
- Shared boundary with a national park, vacant crown land, forestry reserve or other type of reserve
- Neighbouring producers with weed problems
- Other priorities

Everyone accepts that weed levels over time on a property vary a fair bit, depending on the seasons and the demands of other jobs that have to be done. At the moment, would you say that the weed levels on your property are

[A] higher than what you would prefer them to be, or

[B] at a level where it wouldn't be worthwhile trying to reduce them any further?

[If A] And in comparison to the general level of weeds on surrounding properties in your district, are the levels of weeds on your place

[C] a bit higher,

[D] about the same, or

[E] lower?

[If C] And is there any particular reason for this? [record response verbatim]

[If E] What is the key to keeping low levels of weeds on your place? [record response verbatim]

[If B] And what's the main reason that it's not worthwhile reducing them any further? [record response verbatim]

The reasons people control weeds can vary from one property to the next, depending on the particular situation and people's preferences. In your situation, when you are thinking about the jobs you have to get done in the coming few days or weeks, what reasons will cause you to put weed control in a particular paddock or place on your property at the top of the list? [record response verbatim].

The Sociology of Weed Management

To make sure we have information from most types of farms, we need a few brief details about your farm.

What is the total area of your property?

[record number and whether answer is in acres or hectares]

And is this all freehold or is some or all of it under lease, agistment or share farming arrangements?

[if not all freehold, record aggregate area under lease, agistment and/or share farming]

Do you run any beef cattle?

[if yes] How many head would you run in an average year?

Do you run any sheep?

[if yes] How many head would you run in an average year?

Do you grow any crops?

[if yes] And on average, about what area is cropped?

A few details about your household will help us make sure that all types of households are represented. As mentioned before, your response is completely confidential and anonymous.

First of all, I'll read out a list of possible income sources and can you tell me for each one approximately what percentage of your farm's total net income comes from that source?
[rotate order]

- Cattle sales
- Wool sales
- Sheep sales, for example, culls or lambs
- Crop sales, including hay sales
- Off-farm income

[don't check for summing to 100]

And how many people live in your household?

And how many of these are adults involved in farm decision making and receive income from the business. [response=N]

And how many [use "are either" for N=2] of the [N] partners are under 35 years old?

And how many are over 55?

In the last 12 months, did any [use "either" for N=2] of the [N] partners work off-farm either full-time or part time?

[if no go to next question]

The Sociology of Weed Management

[if yes] And how many worked off farm?

Now I'll read out a list of different ways in which people gain their experience in running farming and grazing properties. For each one can you tell me whether you have this type of experience or not. [don't rotate order]

- Growing up on a farm
- Working in partnership with parents
- Regularly attending field days or group meetings related to agriculture
- High school course in agriculture
- TAFE course relating to agriculture
- University or ag college degree in agriculture

Thanks for those household details. We're just about finished now.

In our discussions with producers, we have been given various opinions on what's important in weed control. I'll read out some of the things we've been told by producers. For each one, can you please tell me whether you agree or disagree, or if it's something you don't have a firm opinion about. [don't rotate order]

The satisfaction of having no weeds on your property makes up for the time and money you have to spend on weed control.

In this district, it's just the same few weeds that are a problem – you don't have to worry about new weeds appearing.

Generally, the benefits of new weed control methods outweigh the costs in trying them out. With most weeds around here, it's possible to change your grazing management so they don't get a chance to take hold.

Weed control is one part of running a property that hasn't changed much over the years.

If you see a plant on your place you haven't seen before, you should get it identified straight away.

Fortunately weed control is something you can put off in difficult times and catch up later.

In my view, you are better off looking after your stock than worrying too much about weeds.

Weed control is more a matter of economics than having a weed-free property you can be proud of.

With weed problems, it's best to get in and fix them yourself, rather than talking to others about what to do.

With weed control, it's better to stick to what you know works well, rather than trying new methods.

Of all the jobs on a farm, weed control is probably one of the most important.

Finally two questions about weed information.

The Sociology of Weed Management

I'll read out a list of various sources of information about weeds and weed control. For each can you please tell me whether you regard it as very useful, of some use, or not useful. [rotate order]

- Other family members
- Neighbouring producers
- Producers recognised as experts in your region
- Farmer discussion groups
- Field days and workshops
- Staff of the local shire or town council
- Visits from the local weeds officer
- Staff of government departments such as agriculture or soil conservation
- Agricultural consultants, for example private agronomists
- Advisers employed by fertiliser or chemical companies
- Retailers, merchandisers or stock and station agents

Now last of all, I'll read out some sources of published information about weed control? For each can you please tell me once again whether you regard it as very useful, of some use, or not useful. [rotate order]

- Books
- Daily or local newspapers
- Weekly rural newspapers
- Farmer and industry newsletters and magazines
- Fact-sheets and booklets from government departments (agriculture, soil conservation)
- Field days and workshops
- Leaflets and booklets from retailers, merchandisers, and stock and station agents
- Radio
- TV
- Internet

That's the last question. Thank you very much for your help with this. If there are any weed control issues that we haven't covered that you'd like to tell us about, I can arrange for a person from the University of New England to call you.

If you would like to receive a summary of the findings from this project, you can leave your postal or email address with me, and it will be sent to you later this year.

REGIONAL WEED LISTS

Northern NSW

Blackberry

African Love Grass

Chilean Needle Grass

Southern NSW

Serrated Tussock
Saffron Thistle
St John's Wort

North eastern Victoria

Blackberry
Sweet Briar
Yorkshire Fog, also known as Fog Grass

Central and western Victoria

Capeweed
Silver Grass, also known as Vulpia or Rat's Tail Fescue
Yorkshire Fog, also known as Fog Grass

South Australia - postcodes

Paterson's Curse, also known as Salvation Jane
Silver Grass, also known as Vulpia or Rat's Tail Fescue
Yorkshire Fog, also known as Fog Grass

Western Australia

Capeweed
Barley Grass
Brome Grass, also known as Soft Brome or Rip Gut Brome

Tasmania

Gorse
Barley Grass
Browntop Grass, also known as Browntop Bent Grass

Appendix 4: Workshop with Research and Extension Staff

A4.1 Background

On 18 July 2006, MLA hosted a workshop in North Sydney involving the WEEDS 120 Project teams (IRF and Rural Enablers) and professionals working in weeds research and extension. The purpose of this workshop was to provide research and extension staff with a brief introduction to the issues they need to consider in the design, delivery, and evaluation of weed communication strategies, based on the key messages from the Project. Expected outcomes of this workshop were:

- increased familiarity of weed researchers and extension agents with the work being done by the WEED 120 team,
- improved capacity of these agents to use messages from WEED 120 in the design, planning, delivery and evaluation of research and extension activities,
- increased understanding of the WEED 120 team with the challenges and opportunities for different weed types and livestock grazing situations, and
- input to assist the WEED 120 team in refining key messages to assist in the design, implementation and evaluation of communication/extension strategies.

Weeds research and extension agents involved in this workshop represented Weeds Australia, the University of Sydney, and the Department of Primary Industries in Queensland, New South Wales,

and Victoria. The participants were identified by MLA as being suitable for this workshop based on the relevance of their work to the Project aims. Participants were invited by email invitation, with travel and other meeting costs being covered by MLA.

A4.2 Overview of event

During the morning session, the MLA Project team provided an introduction to their work and described the results-to-date. Following this, there was an opportunity for invited researchers and extension staff to comment on the work being done by IRF and Rural Enablers, and to describe their work and the challenges they faced.

In the afternoon, participants were split into two groups to discuss topics relevant to the projects being carried out by the workshop participants. The two topics were:

- 1) Assisting woolgrowers to use an integrated approach in the management of serrated tussock in native pasture systems with poorer soil and difficult terrain.
- 2) Working with extension staff and woolgrowers to control Prairie Ground Cherry and Silver Leaf Nightshade in disturbed environments, involving bio-economic modelling and other tools.

In each group, members of the Weed 120 Project team were present to facilitate and guide discussion. Each group were to identify challenges and strategies specific to their topic, using the key messages from Weed 120.

A4.3 Summary of challenges and strategies

Challenges identified included:

Serrated tussock

- conflict between neighbouring landholders,
- large farms without large income and/or sufficient labour (e.g. I can't afford to control weeds),
- lack of openness towards new ideas, i.e. preference for 'tried and true' methods,
- heterogeneity of farms and farmers – how do you meet the needs of everyone?

Prairie Ground Cherry and Silver Leaf Nightshade

- multiple flushes of germination and 10 year seed viability,
- managing producer expectations of biological controls,
- integration of weed control with production system, and
- the need for a zero tolerance approach.

Strategies identified were:

Serrated tussock

- identify a mediator to resolve dispute and to mentor development – ideally this person would have credibility with locals - preferably with a grazing background in the local area,
- provide opportunities for group discussion between neighbouring landholders, preferably with a mediator present to facilitate discussion and assist in conflict resolution and negotiation,
- mentor extension agents to facilitate their development and foster targeted extension,
- reduce large scale problems into a set of smaller tasks/management units,
- show the cost of NOT controlling weeds and compare this with the cost of a well formulated control plan, both in terms of short-term and long-term costs,
- raise awareness of the range of available control methods (weed specific), and
- prepare, or assist landowners and extension staff to prepare, control strategies specific to the enterprise, and region (terrain, weather, soil type, vegetation type etc.), and which meet 'felt needs' or goals.

Prairie Ground Cherry and Silver Leaf Nightshade

- establish a consultative committee for the project,
- use media in late Spring when identification is easier to alert producers to the differences between species,
- develop an Agnote on identification of the species at early growth stages,
- liaise across States where the weeds occur to develop standard information sources, and
- work with farmers to critique and validate control strategies.

Overall, reactions towards the information resulting from the Weed 120 Project were positive. Participants expressed satisfaction at the workshop outcomes, feeling that the day had been of benefit to their work, and expressed interest in receiving further information from the Project. The opportunity to work with researchers with specific weed control projects highlighted the need for extension strategies to be tailored to specific weeds.

Appendix 5: Evaluation Resources

A5.1 Australian Sources

Research Evaluation and Policy Project, Research School of Social Sciences, the Australian National University. <http://repp.anu.edu.au/>

REPP is Australia's leading centre for the systematic evaluation and mapping of research across all fields of scholarship. A particular focus is research on the advanced quantitative analysis of scientific performance and the organisational structure of Australia's research landscape. Other activities include conducting regular bibliometric analyses of publicly-funded scientific publications, exploring novel qualitative and quantitative approaches to research assessment and generating 'metrics' or

indicators sensitive to the research and dissemination practices of a variety of fields. REPP also investigate the sociology of science, such as the way researchers respond to external forces (e.g. methods of funding allocation). REPP Discussion Papers are scholarly papers that report research in progress. They can be downloaded free of charge (PDF). One such paper is: Research Evaluation and Policy Project. (March 2005). Quantitative indicators for research assessment – a literature review. Literature Review for ARC Linkage Project: The Strategic Assessment of Research Performance Indicators. REPP Discussion Paper 05/1. Research School of Social Sciences, ANU, Canberra.

This literature review was undertaken as part of an Australian Research Council (ARC) project, “Strategic Assessment of Research Performance Indicators”, which was funded to examine quantitative performance indicators used in the evaluation of research. The overall aim of the project is to establish a knowledge base on performance measures, containing a comprehensive coverage of indicators and an assessment of their validity, fairness, transparency and impact on research, and the cost of implementation. This review seeks to summarise the ‘state of the art’ by giving an overview of quantitative indicators that are currently in use, or have been proposed, and locating any assessments of the measures that have already been undertaken. In this way, any gaps in our knowledge of quantitative indicators that need to be addressed in further research can be identified. This paper is available at: <http://repp.anu.edu.au/Literature%20Review3.pdf>

The Rural Industries Research and Development Corporation (RIRDC) <http://www.rirdc.gov.au/>
RIRDC work closely with Australian rural industries on the organisation and funding of their R&D needs. RIRDC provides free research reports. A paper that is particularly relevant to evaluation of agricultural extension is:

Dart, J., Petheram, R.J. and Straw, W. (1998). Review of Evaluation in Agricultural Extension. Institute of Land and Food Resources, Vic.

This report discusses the discipline of program evaluation and then reviews five main forms of evaluation and illustrates them with case studies drawn from agricultural extension in Australia. It is available at:

<http://www.rirdc.gov.au/reports/HCC/VCA-3A.pdf#search=%22extension%20evaluation%20%22>

Land and Water Australia <http://www.lwa.gov.au>

Land and Water Australia website provides a number of publications and tools relevant to researchers and extension agents. The following documents are particularly useful for researchers interested in communicating research outcomes:

Communication planning checklist (December 2004). Series 1 Number 06/99. ISSN 1320-4734

This checklist assists researchers to understand the steps in developing a communication plan for their research project. It can also help researchers to draft their own communication plans when professional communication assistance is not available. The checklist takes you step by step through the process of devising a communication plan.

Media release guide. (December 2004). Series 1 Number 07/99. ISSN 1320-4734.

This guideline will assist researchers understand the process of writing a media release. It can also help researchers to draft their own media releases when professional communication assistance is not available.

Natural Resources Communication Workbook. (September 1994). Occasional Paper 14/94.

This workbook is targeted generally at anyone who is interested in improving their communication

with clients about natural resource issues. People who may find this workbook relevant include: researchers, resource managers, policy developers, resource users, community or rural groups, and communication professionals. Some of the concepts and planning tools may be familiar to professional communicators, however the total process of “risk communication” planning should provide a novel approach.

These documents are available at:

http://www.lwa.gov.au/Publications_and_Tools/Researcher_Guidelines/index.aspx

The Regional Institute <http://www.regional.org.au>

The Regional Institute provides a one stop shop for professional associations and not-for-profit groups wanting affordable solutions for running their organisation efficiently and growing their member or subscriber base. It also offers a number of free publications, including conference proceedings, journals and reports. For an example relevant to evaluation of extension services, see: Christiansen, I., Pyke, B., Gibb, D. and McIntyre, G. (2003). Ever improving: Evaluation and outcomes in the National Cotton Extension Network. Proceedings of the Asia Pacific Network International Conference.

This paper can be downloaded at:

<http://www.regional.org.au/au/apen/2003/3/131christianseni.htm>

A5.2 International

Evaluation: The International Journal of Theory, Research and Practice <http://evi.sagepub.com>.

Edited from a European base, *Evaluation* is an international journal which promotes exchange between European, North American, Asian and Australasian voices within the evaluation community. It encourages dialogue between different evaluation traditions such as program evaluation, technology assessment, auditing, value-added studies, policy evaluation and quality assessment. Evaluation is available electronically on SAGE Journals Online.

A useful article is:

McDonald, B., Rogers, P. and Kefford, B. (2003). Teaching People to Fish? Building the Evaluation Capability of Public Sector Organisations. *Evaluation* 9: 9 - 29.

This paper can be downloaded at: <http://evi.sagepub.com/cgi/reprint/9/1/9.pdf>

University of Wisconsin – Cooperative Evaluation <http://www.uwex.edu>

The Cooperative Extension campus is a community-based faculty providing resources and training for use in implementing and evaluating educational programs. The Program Development and Evaluation Unit (PDE) is especially concerned with evaluation. PDE offers a number of free-to-download evaluation resources, which are available at:

<http://www.uwex.edu/ces/pdande/evaluation/index.html>

Cooperative Extension and Outreach <http://www.extension.psu.edu>

Cooperative Extension and Outreach is part of the College of Agricultural Sciences at Penn State University. It offers educational programs and resources on agriculture, horticulture, and environmental issues among many other topics. Through the Program Evaluation directorate, the centre provides information on implementing program evaluations for project improvement, comparison of delivery methods, responding to stakeholders, etc. The information is based on methodological research and theory, and on twenty years of experience evaluating extension programs. These resources are available at:

<http://www.extension.psu.edu/evaluation/>

The Kentucky Cooperative Extension Service <http://www.ca.uky.edu>

The Kentucky Cooperative Extension Service is a comprehensive outreach and engagement program at the University of Kentucky. The service began in 1914 when county, state and federal governments agreed that they could work collaboratively to provide all citizens with access to the wealth of knowledge generated by public universities. Today that partnership includes county governments, a national network of land-grant universities, and the US Department of Agriculture. Their web site is a treasure trove of information about research based education. Useful reference documents for program development and evaluation can be obtained at:

<http://www.ca.uky.edu/agpsd/soregion.htm>

Ohio State University Extension <http://www.ag.ohio-state.edu>

Ohio State University Extension interprets knowledge and research developed by the Ohio Agricultural Research and Development Center, Ohio State and other land-grant universities, so that it is useful and practical to community members. Program evaluation and measurement resources are available at:

<http://www.ag.ohio-state.edu/~brick/dcc1pg.htm>

The Centre for Evaluative Studies (CES) <http://www.canr.msu.edu>

The Centre for Evaluative Studies (CES) is located within the College of Agriculture & Natural Resources Department of Education and Communication Systems at Michigan State University. The centre draws on the expertise and experience of faculty, staff and graduate students, and provides technical assistance and training in four major areas of evaluation:

- Conduct evaluation studies,
- Train individuals and groups in evaluation methodology,
- Provide consultation to individuals and organisations involved with evaluation,
- Provide a forum for an on-going dialogue related to issues of evaluation.

For a detailed list of program evaluation resources produced by CES, visit:

<http://www.canr.msu.edu/evaluate/AllTextMaterial/ProgEvaRes.html>

The Free Management Library <http://www.mapnp.org/library>

The Free Management Library is a complete, highly integrated library for nonprofit and for profit organisations. The Basic Guide to Program Evaluation provides extensive guidance toward planning and implementing an evaluation process, featuring many kinds of evaluations that can be applied to programs (e.g. goals-based, process-based, outcomes-based, etc.). For more information visit:

http://www.mapnp.org/library/evaluatn/fnl_eval.htm

Horizon Research, Inc. (HRI) <http://www.horizon-research.com>

HRI is a private research firm specializing in work related to science and mathematics education. The firm has expertise encompassing a range of areas, including evaluation of science and mathematics education initiatives. A useful reference available from the HRI website is:

Bond, S.L., Boyd, S.E. and Rapp, K.A. (1997). Taking Stock: A Practical Guide to Evaluating Your Own Programs.

This guide is written for community-based organisations interested in improving programs. With a focus on internal evaluation, the guide is a useful program staff to design and carry out a program

evaluation. It is available as a free download (PDF) at:
http://www.horizon-research.com/reports/1997/taking_stock.php

A6.1 Paper to be presented at the 15th Annual Australian Weeds Conference

Insights into motivations and barriers for weed control in grazing districts of southern Australia

A. W. van der Meulen¹, I. J. Reeve¹ and B. M. Sindel²

¹Institute for Rural Futures, University of New England, Armidale, New South Wales 2351, Australia.

²CRC for Australian Weed Management Systems, University of New England, Armidale, New South Wales 2351, Australia.

Summary Weeds in pasture systems are a major factor reducing productivity of grazing enterprises. While a broad range of weed management products and practices have been developed, their adoption has not been widespread across the grazing industry. Weed control, like any other aspect of land management, is influenced by a complex interplay of social, economic, and biophysical factors. Social research can offer valuable insights into graziers' decisions concerning weed control, and may help to identify opportunities to improve weed management practices on grazing properties.

Keywords Weed control, grazing, pasture, social research, extension, decision-making, motivations, barriers.

INTRODUCTION

The temperate perennial pasture zone of southern Australia covers an estimated 26 million hectares, and produces nearly half of southern Australia's sheep and cattle products. Pastures in this zone are typically complex mixtures of species, sown, volunteer exotic, and native plant species. Species that are considered weeds for at least part of their lifecycle will usually represent a significant part of the total biomass (Kemp *et al.* 1999).

Weeds compete directly with more desirable pasture species, lowering livestock productivity and reducing profit margins because of the costs of control (Taylor and Sindel 2000). Management practices that sustain and revive the pasture resource and provide long-term solutions to weeds have been developed (Burton and Dowling 2004). However, the conversion of research findings into change of practice on farm is a major challenge facing agricultural extension (Keeble *et al.* 2004), and this certainly appears true for weed management.

Few studies have specifically examined the processes relating to adoption of weed management strategies in grazing systems. Graziers are a diverse group of individuals, and their differences will be reflected in their perception of weeds and their approach towards adopting new weed innovations. Social research may be useful in identifying motivations, or triggers, that are likely to prompt graziers to adopt better weed management practices.

This project was commissioned by Meat and Livestock Australia, and is being carried out by staff of the Institute for Rural Futures and the School of Rural Science and Agriculture at the University of New England. The objectives of this research are to:

1. understand weed management decision-making in the southern Australian sheep and cattle grazing industries; and
2. identify motivations for, and barriers to, better weed management.

MATERIALS AND METHODS

A literature review was completed to establish the broad scope of issues underlying weed control in grazing industries. This literature, together with discussions with weeds regulatory staff in the New England region of northern New South Wales, informed the development of a written questionnaire and a set of face-to-face interview questions.

Grazing properties were visited in the New England Tablelands and the Southern Slopes of New South Wales, and in the South East of Victoria. Face-to-face interviews were conducted with the property owner (or manager) about their approach to managing weeds. Participants were left with a mail-back survey, covering weed control methods, basic farm attributes, attitudes, information preferences and demographics. For each property visited an assessment of weed incidence and management effort was made by an accompanying weed authority officer, using a simple eight point rating system.

The data resulting from interviews and mail surveys were analysed using an extension-orientated approach. That is, the analysis distinguished between those characteristics of graziers and their properties that are not amenable to modification through extension efforts, and those that are amenable to modification. For example, the ages of graziers cannot be changed, but can be taken into account in the design of extension strategies. By contrast, knowledge may be amenable to change through extension, leading to changes in weed management practices.

In consideration of the small sample size, and since the focus of the analysis was on explanatory

relationships, a slightly relaxed threshold for statistical significance of 0.10 rather than 0.05 in analyses of variance or chi-squared tests was considered appropriate. The information resulting from this analysis has been verified through focus group, email and telephone discussion with weed regulatory and extension staff located in New South Wales, Victoria, Tasmania, South Australia, and Western Australia.

RESULTS

Methods of weed control There were substantial differences in the popularity of, and familiarity with, the various methods of weed control. Boom spraying and selective use of herbicides were almost universally well regarded, while slashing and burning were not generally well regarded. Awareness of spray grazing and spray topping methods was higher among graziers with some sheep and cropping than among those with no sheep or cropping. Graziers with a higher mean proportion of their property under cropping tended to use the greatest range of approaches. Almost three-quarters of respondents did not use granular and pelletised herbicides. Producers appear to fall into four groups with respect to the mix of weed control methods they use: those using few methods, those using mainly mechanical methods, those using mainly grazing-related methods, and those using most methods (and having the lowest incidence of weeds).

Motivations A number of motivations for better weed control were identified. Those who gave answers relating to the health of livestock and the value of livestock products had significantly lower levels of weed infestation, as rated by the weeds officers assisting with the farm visits. Those who saw the invasive or competitive nature of plants as a problem were also more likely to have lower levels of weed infestation. Weed incidence as rated by the weeds officers assisting with the farm visits was also related to views about the usefulness of various information sources. Compared to those with higher levels of weed infestation, those with a lower incidence of weeds on their properties tended to have a higher opinion of expert producers, local councils, chemical and fertiliser company advisors and retailers and stock and station agents as useful sources of information.

Barriers A number of barriers were identified that are demonstrably related to poor weed control. These included the inability to identify particular grass weeds, time and monetary constraints, difficult terrain, and differences in perception of 'weeds'. There was a consistent difference in awareness of the well-known broadleaf weeds and that of grassy weeds (e.g. *Vulpia spp.*), with generally higher levels of awareness for the former group.

Farm and farmer characteristics Effectiveness with controlling weeds was related to farmer demography and farm characteristics, with higher levels of weed infestation occurring among older farmers with lower levels of education, who do not work off-farm, have relatively more cattle and less cropping.

The 'three Ds' From the face-to-face interviews and the results described above, it appeared that there are three critical factors leading to effective weed management. These are: Diligence, a Diversity of methods, and Deliberation (a planned and proactive approach to weed control). Diligence was examined using a score obtained on a series of attitude statements related to diligence. Diversity was determined on the bases of the number of weed control methods reported. Deliberation was analysed by rating weed control methods on a scale of one to three for complexity and planning. These three "Ds" define a useful three dimensional space (Figure 1) within which can be placed the styles of weed management and the effectiveness of weed control encountered in the farm visits and alluded to by key informants.

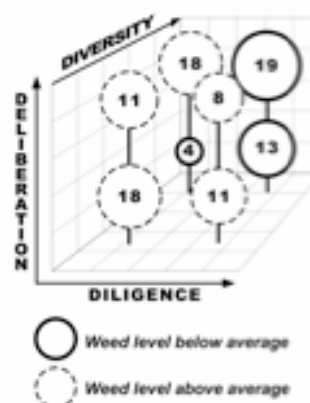


Figure 1. Proportions (%) of respondents in each of the eight octants defined by the median scores on each dimension.

Sources of information Field days, fact sheets and booklets from government departments were held in high regard by graziers as sources of weed information, particularly among better weed managers. Radio, TV and newspapers were generally less well regarded, but were more favourably viewed by the less effective weed managers. The Internet was not generally well regarded, but was perceived more favourably by those using grazing tactics and those employing a wider variety of different methods, and was used most by younger graziers.

DISCUSSION

Methods of weed control Difficulties with terrain and herbicide resistance are the main problems where technological innovations may lead to improved weed control. Dislike of using chemicals may hinder weed control on some properties, suggesting more effort is required in research and extension of alternatives to herbicide application.

Cost of weeds Communication and extension efforts focusing on production losses should be very specific about what plants cause the losses, and make sure that graziers are able to recognise these plants in their pastures. Awareness of the costs of weeds does not necessarily lead to farmers improving their weed management. When the vaguely sensed costs of future productivity loss is weighed against the very specific and immediate costs of chemical purchase, doing nothing is an attractive option. Quantification of productivity loss in realistic farm situations is essential to influence those for whom economic considerations are uppermost in weed control decisions.

Information sources Information sources that are regarded as useful by the better weed managers are local in nature. Fact-sheets and booklets from government departments and field days and workshops stand out as ways of communicating information about weeds that are widely regarded as very useful. The electronic media – radio, TV and Internet – are regarded as not useful by large proportions of respondents. However, it is worth pointing out that the Internet is a rich source of information about weeds and their management, and is often used by younger graziers. It is also likely to become increasingly important in the future as older graziers retire and the younger generation take over.

The three D's There appear to be three critical factors that lead to effective weed management on grazing properties. Diligence is adhering to routine practices, using them in a timely fashion and treating weeds as a high priority among all the other tasks competing for the farmer's time and attention. Diversity is the number of weed control practices used, with multiple methods being used together to obtain better and more cost effective control. Deliberation is the planning of weed control, and undertaking it in a strategic fashion using knowledge of weed life cycles and knowledge of desirable (and less desirable) pasture species. These 'three Ds' provide a useful summary of opportunities and challenges for weed communication and extension strategies.

There is an identifiable group of farmers, the 'diligent', who are achieving reasonable to good weed control of declared and broadleaf weeds through diligently applying a small number of traditional approaches, such as spot spraying, boom spraying, and 'chipping them out'. These graziers compensate for 'imagination' with persistence. They are often motivated by a sense of 'pride in property' and are also concerned about the productivity of their pastures. However, they may tend to focus on declared weeds and may not be aware of certain less well-known plants that are causing production losses. They may therefore be losing income through the impact of plants that they do not recognise as 'weeds', particularly grassy weeds. With these individuals it is likely that awareness will lead to action. That is, that once these graziers are aware that a plant is reducing farm productivity, they will include it in their regular weed control operations. These graziers are not likely to respond to information on new weed control practices, since their existing methods, in combination with diligence, have so far proved effective. It is worth noting that these producers are largely reliant on application of herbicides, and that they spend a large proportion of their time and energy controlling weeds. It is likely that factors such as increased costs of herbicides, the development of herbicide resistance, reduction in availability of labour, the appearance of new weeds, and the influence of aging may reduce their ability to control weeds effectively.

Other graziers may achieve a high level of weed control though using a greater diversity of weed control methods in a more integrated fashion. This 'diverse' approach is typical of graziers in cropping systems with planned pasture rotations, where farmers are profit-driven and weeds are considered a source of lost income. The diversity of such mixed enterprises will lend itself to use of a broader range

of tools to manage weeds. Wide scale application of herbicides is routine, and herbicide resistance is the major challenge faced by this group. Another factor, particularly relevant to many younger farmers in this group, is that off-farm work reduces the amount of time they have available for controlling weeds.

Turning effectiveness to excellence As herbicide resistance is an issue for both the 'diligent' and the 'diverse' weed controllers, it is suggested that reduced reliance on chemical control methods is important to maintaining and improving weed control. Information on alternatives to chemical methods, and training about how to use these methods in an integrated fashion, should be a key focus for both these groups. In the case of younger graziers in cropping situations, increasing ease-of-access to information about weed control, and hence saving the amount of time and effort spent looking for it, is also likely to assist with weed control. For 'diligent' weed managers, it is suggested weed extension efforts should raise awareness about the loss of income caused by some of the lesser-known weeds, particularly grassy weeds, as well as skills in identifying and controlling these weeds.

Improving effectiveness of the ineffective This study found that the least effective weed managers tend to use a few methods of control in a casual and reactive way. An adoption path for this group can, at least in theory, include any combination of increased diligence, increased diversity and increased 'deliberation'. In practice, a more planned, strategic approach to weed management will generally require the weed manager to be competent in the use of a range of weed control methods. In addition, it will require more than simple provision of information, and will probably involve educational approaches, such as have been used with Wool 4 Wealth, ProGraze and Grazing for Profit programs. This then leaves increased diligence and increased range of methods as the most effective adoption paths for the less effective weed managers. However, there is little point in adopting a wider range of control methods, unless they are applied diligently. This would suggest that improving diligence in weed control should be the primary focus for the less effective weed managers.

ACKNOWLEDGMENTS

The work described in this paper was funded by Meat and Livestock Australia (MLA) – Project number WEED.120. Cameron Allen and Bob Hannam, both of MLA, have provided useful feedback on the various stages of this research.

Weed research and regulatory staff from several states of Australia have provided much valued assistance to this research. The contribution of graziers participating in this research is also greatly appreciated.

REFERENCES

- Burton, J. and Dowling, P. (2004). Pasture management for weed control: a graziers' guide to controlling annual weeds in southern Australian improved pastures (NSW Agriculture and the Cooperative Research Centre for Australian Weed Management, Orange).
- Keeble, B., Robertson, D. and Johnson, F. (2004). A qualitative approach to improve the effectiveness of products of research findings for users: a case study of the Analytical Irrigation Model. *Australian Journal of Experimental Agriculture* 44, 207-212.
- Kemp, D.R., King, W., Michalk, D.L. and Alemseged, Y. (1999). Weed proofing pastures: how can we go about it? In 'Weed Management into the 21st Century: Do we know where we are going?' Proceedings of the 12th Australian Weeds Conference, eds A.C. Bishop, M. Boersma and C.D. Barnes, Hobart, 12-16 September 1999, pp. 71-75. (The Tasmanian Weed Society).
- Taylor, U. and Sindel, B. (2000). 'The pasture weed management kit: A guide to managing weeds in Southern Australian perennial pastures' (Cooperative Research Centre for Weed Management Systems. (University of Adelaide, Glen Osmond).

A5.2 Paper submitted to the Australian Journal of Experimental

Insights into motivations and barriers for weed control in temperate grazing systems of southern Australia

A. W. van der Meulen^A, I. J. Reeve^A and B. M. Sindel^B

^AInstitute for Rural Futures, University of New England, Armidale, New South Wales 2351, Australia.

^BSchool of Rural Science and Agriculture, University of New England, Armidale, New South Wales 2351, Australia.

Suggested short title: Influencing weed control in southern Australia

Abstract. Opportunities and challenges important to effective weed management in southern grazing systems were explored using personal interviews and mail survey of livestock producers in New South Wales and Victoria. Ninety grazing properties were visited and rated for weed incidence and management effort. One hundred and twenty-two graziers were interviewed, and ninety-four completed questionnaires returned. Respondents were grouped into three categories based on farmer demographics and farm characteristics. These groups varied significantly in the range of control methods used, weed management effort, difficulties encountered with weed control, and attitudes towards weed control. Respondents were also grouped into four groups with respect to weed control methods: minimal control, mechanical control, grazing control, and maximal control. Control groups differed significantly in terms of the number and complexity of methods used, difficulties encountered with weed control, levels of weed awareness, and the value placed on various sources of information about weed control. In comparison with less effective weed controllers, more effective weed controllers had higher awareness of grass weeds, were conscious of the invasive or competitive nature of weeds, considered weed control a high priority, and were open to new control methods. Managers of properties with lower weed incidence placed a high value on information and used a wide range of information sources. Three factors were identified as critical to effective weed management: Diligence, Diversity and Deliberation. The opportunities and challenges for weed extension can be analysed in the context of these three factors.

Introduction

Pasture weeds impose considerable annual costs on Australian livestock producers and the livestock industries. Costs to livestock production include contamination of livestock products, livestock injury and poisoning, and competition with newly sown and regenerating pastures, thereby lowering the carrying capacity of land and resulting in production losses (Campbell 1997). Sinden *et al.* (2004) estimated that the Livestock Industries spend between \$315 and \$345 million on control of weeds while suffering production losses of \$1,870 million. In contrast, the Cropping Industries spend between \$1,033 and \$1,121 million on control while suffering losses of \$346 million. The disparity between production losses and control costs in beef-sheep industry, which stands out in stark contrast to the grain industry, prompts the question: why aren't livestock producers doing more about weed control?

Pasture weeds are a major problem in temperate pasture systems in southern Australia. Surveys of pastures in this zone have shown that naturalised pastures are less productive than they were, while sown pastures fail to maintain their initial levels of production. Important perennial grasses have decreased in abundance, while the incidence of weeds, and annual grasses in particular, is higher relative to earlier periods (Kemp and Dowling 1991; Kemp and Dowling 2000). Weed invasion has been identified as a major factor in pasture decline, and livestock producers perceive weeds to be a major problem reducing pasture quality and persistence (Reeve and Lees 1994).

The use of herbicides and regular resowing of pastures has been effective in controlling weeds in the past. Their use is now restricted by the emergence of herbicide resistance, and growing realisation of the unfavourable economic, environmental, and human health issues associated with these practices. The current emphasis of pasture weed management is on the integration of a range of weed management methods (Dowling *et al.* 2000). Management practices that sustain and revive the pasture resource and provide long-term solutions to weeds have been developed (Burton and Dowling 2004). However, adoption of these management practices has not been widespread across the livestock industry, with the result that success with weed control is relatively limited.

Numerous studies have examined the processes relating to adoption of agricultural innovations. Adoption is not a simple matter of developing and then promoting an innovation, expecting awareness to result in implementation. Rather, adoption is primarily a process of dynamic learning and refinement of decision making over time. There is a technical basis for adoption, whereby the qualities of an innovation will itself influence its rate of adoption (Pannell and Zilberman 2000). There is also a social basis for farmers' decision making about farm innovation or change (Pannell and Marsh 1998). Farmers vary in innumerable ways, including: wealth, type and size of enterprise, age, stage of life, propensity to adopt new ideas, chemical preferences (e.g. organic farmers), attitudes towards risk and approaches to learning (Vanclay 2004).

Studies of factors influencing adoption of weed control practices in cropping systems have been conducted (Llewellyn *et al.* 2005). Comparatively few studies have examined adoption of weed control strategies in pasture systems, and fewer still have explored graziers' perceptions of the value of weed control methods or attitudes towards

weed control generally. Sindel (1996) surveyed graziers in northern NSW to investigate graziers' attitudes towards weed control. Respondents mentioned lack of time and heavy financial costs as factors in worsening weed situations. Such limiting factors were particularly significant where farms were left unattended for long periods, or were managed by older farmers.

Surveys identifying major factors influencing graziers' decisions with relation to weed control are likely to be valuable in identifying opportunities for better-targeted extension strategies. It is possible that investment directed towards such strategies will have the greatest influence on weed management practices in livestock grazing systems.

This paper reports the results from the first stage of a project commissioned by Meat and Livestock Australia to improve the understanding of the influences on the level of weed control on grazing properties, and so assist in identifying incentives and barriers to weed control and opportunities for better-targeted pasture weed extension. The first stage of the project, as described in this paper, involved face-to-face interviews and mail survey of sheep and beef graziers in temperate pasture regions of New South Wales and Victoria. The results of this stage inform the next stage of the project, which is currently in progress. This next stage involves a telephone survey of graziers across high rainfall zones of southern Australia. The combined results of both stages will inform the development of extension strategies (and associated evaluation mechanisms) to promote best weed management to producers in temperate pasture systems in southern Australia.

Methods

Survey of livestock producers

The data for this study were derived from personal interviews and a fully specified written questionnaire of livestock producers in temperate pasture systems (average annual rainfall >500 mm) of New South Wales and Victoria. A literature review, together with discussions with weeds regulatory and extension staff, informed the development of these survey tools. A total of 122 interviews was conducted in northern (31) and southern New South Wales (58) and in south-east Victoria (33). Properties in northern NSW were largely livestock orientated, with some sown (improved) pasture but little cropping. The same was true for the properties surveyed in south-east Victoria, although properties in this region were not as steep and had larger areas of sown pasture. Southern

NSW, by comparison, was flatter and many enterprises were mixed livestock and cropping, and livestock were mostly grazed on sown pasture and fodder crops. The majority of interviews (88) were conducted on the property of the participating livestock producer. In NSW another 34 interviews were conducted off-farm with livestock producers participating in the Lockhart Drum Muster (31) and a small number (3) that took place at a location specified by the interviewee, usually at local government offices.

In recognition of the strong need for professional intermediaries between extension and science (Coutts *et al.* 2001), every attempt was made to establish strong links between project staff and weeds extension providers. Property owners were first contacted by the local noxious weeds officer, to arrange permission for the researcher to accompany them onto the participant's property, and to arrange a suitable time for an interview to occur. An advantage of this approach was a personal introduction to landholders by a locally known and trusted individual. This was important in gaining access to landholders who would not normally respond to less personal mail and telephone survey, so reducing non-response bias (Armstrong and Overton 1977). Another advantage was that, for each property visited, weed incidence and weed management effort was rated on an eight-point scale, aided by the weed officers' local weed expertise and knowledge of management history. These ratings assisted in profiling graziers with respect to their effectiveness in controlling weeds.

The interviews were conducted with primary weed managers (i.e. individuals with primary or shared responsibility for weed control decisions). Participants were asked to name plants locally problematic to grazing, and describe the reasons why these plants were a problem. Interviewees were also asked what they considered important when choosing methods of weed control, and what they regarded as the key element in a good weed control program. At the end of each interview, participants were given a written questionnaire to be completed in their own time and then returned by mail. The mail questionnaire gathered data on: weed awareness, views about how much weeds were reducing returns, use and opinions of various weed control strategies, difficulties encountered with weed control, farmer demographics and farm characteristics, attitudes towards weed control, and perceptions of the usefulness of various sources for information relating to grazing weeds.

Techniques used in statistical analysis

Data resulting from interviews and mail questionnaires were analysed using SPSS (SPSS Inc 2001) and R (R Development Core Team 2004). Categorising farmers into groups, or 'market segments' (Barr and Cary 2000), is helpful in refining communications and targeting of extension programs, and for assessing the effectiveness of policies and programs designed for the industry overall (Angus Reid Group (ARG) 1998). Respondents were assigned to groups with respect to demographic, farm and attitudinal characteristics, and methods of weed control. The grouping technique used was cluster analysis (partitioning around medoids). Where necessary, factor analysis (principal components analysis) was used for dimensional reduction. The differences among groups with respect to other information obtained in the mail-back survey were examined using several techniques appropriate to the small sample and uneven group sizes. For continuous variables, the hypothesis of equality of means across the groups was tested using analysis of variance. Due to the unequal group sizes, Welch's variance-weighted analysis of variance was used. Equality of variance was tested with Levene's test and where this indicated a departure from equality of variance significant at the 0.05 level, Dunnett's T3 statistic was used to test equality of means in post-hoc pairwise comparisons. Where Levene's test was not significant, Tukey's Honestly Significant Difference was used for post-hoc pairwise comparisons (Hochberg and Tamhane 1987; Klockars and Sax 1986). For nominal or ordinal variables, the hypothesis of independence of factors was tested with the chi-squared statistic. When the proportion of cells in a contingency table with expected frequencies less than five was more than 20%, the p value of the chi-squared statistic was obtained by Monte Carlo simulation with 10,000 replicates. Associations between ordinal variables were expressed in terms of Spearman's rho.

Measuring attitudinal dimensions

A set of attitude statements relating to various aspects of weed control was included in the mail back survey. These were used in constructing Likert scales. For each statement, respondents were asked to indicate the extent to which they agreed or disagreed with that statement (5=strongly agree, 4=mostly agree, 3=neutral or not sure, 2=mostly disagree, 1=strongly disagree). Cronbach's alpha was used to calculate the reliability of each scale (values higher than 0.5 are considered reliable for a two item scale, and 0.6 for a four item scale). Factor analysis (principal

components) was used to identify attitudinal dimensions within a set of attitude statements. Attitude statements that were poorly correlated with the attitudinal dimensions were omitted from the analysis.

Measuring demographic and farm dimensions

Demographic and farm physical characteristics may constrain decisions relating to weed control. Such constraints will need to be considered in the development of extension strategies. To provide an overview of the nature of the variation in demographic and farm characteristics, factor analysis was again used to identify demographic and farm dimensions. The respondent scores on the resulting dimensions were analysed using cluster analysis (partitioning around medoids) to identify groups of farmers sharing similar demographic and farm characteristics.

Methods of weed control

Monothetic divisive clustering (a method appropriate for binary data) was used to divide respondents into weed control groups according to methods of weed control they used. The various weed control methods were rated on a scale of 1 to 3 (where 1 is relatively simple, 3 is a complex method requiring specific skills, and 2 is intermediate between the two extremes). This system enabled a weed control complexity rating to be calculated for each respondent.

Measuring weed awareness

The mail-back survey contained a list of 17 to 18 weeds for each region, a total of 30 different weeds across the three regions. Producers were asked for each weed in the list: whether it was present in the district, whether it was regarded as a weed, and how easy or difficult it was to identify. Using a scoring system based on proportion of correct answers, it was possible to calculate weed awareness scores for respondents across weeds in their region. It was also possible to obtain awareness scores for individual weeds, calculated across all respondents in a region. For some of the weeds listed in the survey it was not possible to unambiguously assign answers as correct or incorrect. These weeds were excluded in developing awareness scores.

Perceptions and attitudes

Relationships were explored between weed awareness and attitudes on the one hand, and, on the other, demographic and farm characteristics,

weed incidence, weed management effort, weed control, and views about the usefulness of farmer and industry newsletters as means of communicating information about weeds. A variety of statistical tools were used to test these relationships, including ANOVA, Spearman's rho, and the chi squared test.

Identifying extension groups

Respondents were divided into groups according to whether their score on each of three dimensions was above or below the median. These dimensions were: diligence, measured using scores on attitude statements, diversity, measured by the number of weed control methods respondents considered worth doing in their situation, and deliberation, measured using the complexity of methods used by respondents.

Results

For economy of presentation, only significant relationships ($P < 0.05$) have been presented.

Factors in effective weed management

Interview data showed that producers who were concerned with controlling invasive or competitive weeds had significantly lower levels of weed infestation ($p = 0.002$), than those who did not mention this concern. Weed incidence was also significantly lower ($p = 0.045$) on properties where respondents were encountering herbicide resistance than on properties where this was not a problem. Consistent with this was a significantly higher rating for weed management effort ($p = 0.045$) on properties where herbicide resistance was an issue.

Correlation patterns (Table 1) between weed awareness measures for individual weeds and weed incidence suggested that respondents with serious infestations of easily recognized weeds (e.g. blackberry, *Rubus* spp.) were more aware of these weeds. The reverse was true for less well-known weeds, such as *Vulpia*. Managers of properties with high infestations of common broad-leaved weeds were not aware of lesser known species, such as *Vulpia*. Examples of these correlation patterns are shown in Table 1.

Table 1. Correlation between the weed awareness score for *Rubus spp.* and *Vulpia spp.* and weed incidence.

Weed	Correlation with weed incidence
<i>Rubus spp.</i> (blackberry)	+0.265**
<i>Vulpia spp.</i> (silver grass)	-0.266*
<i>Spearman's rho:</i>	
* denotes a significant correlation at $P < 0.05$;	
** denotes a significant correlation at $P < 0.01$	

There was a significant relationship between lower weed incidence and two of the attitude statements. Respondents who placed a very high priority on weed control amongst other farm tasks had significantly lower weed incidence ($p=0.045$). Incidence was also lower on properties of respondents who were favourably inclined to trialing new methods ($p=0.040$). Weed incidence was also lower on properties where the owners placed a high value on local sources of information about weeds, such as locally well-regarded producers ($p=0.006$), local council ($p=0.047$), chemical or fertilizer company advisors ($p=0.019$), and retailers and stock and station agents ($p=0.002$). It is worth noting that effective weed controllers valued a wide range of information sources, particularly those that were local in nature.

Demographic and farm dimensions

Principal components analysis identified two dimensions that captured 54% of the variation among the demographic and farm characteristic variables. There was a demographic dimension (related to age, experience, working off-farm and level of tertiary education), and a farm dimension (related to farm size and type of enterprise). Within the demographic dimension, lower levels of education were associated with increased age and experience, and fewer partners working off-farm. Within the farm dimension, farm size, sheep as a proportion of total livestock and area cropped tended to be positively correlated. The two dimensions were not fully independent, with mean level of education increasing with the amount of cropping, with sheep as a proportion of total livestock, and with the size of the property.

Cluster analysis on the respondents' scores on these two dimensions showed there was some grouping of respondents, best represented by a three cluster solution. Group 1 was dominated by farmers from southern NSW, and were younger, less experienced farmers with higher levels of

education and higher incidence of off-farm work. Respondents in Group 2 were older, more experienced farmers, with lower levels of education, and less involvement in off-farm work. There were approximately equal proportions of Group 2 farmers in each of the three zones. Group 3 was the smallest, and consisted of older more experienced farmers with lower levels of education and less incidence of off-farm work. Farmers in this group differed from Group 2 farmers in that they were mostly from smaller cattle properties in northern NSW and south-eastern Victoria.

These groups differed significantly in the level of weed management effort ($p=0.028$), with Group 1 expending the most effort (7.26), followed by Group 3 (6.72) and lastly by Group 2 (6.46). These groups also varied significantly in the range of control methods used, difficulties encountered with weed control, and attitudes towards weed control.

As an example, the groups varied significantly in the pattern of opinions about spray topping (or winter cleaning). Almost 70% of Group 3 members were not familiar with spray topping. It was well regarded by 60% of respondents in Groups 1 and 2, although these groups differed in proportions of those who did not believe it was worth doing, with 26% in Group 1 compared with 5% in Group 2. Spray grazing showed a similar but less pronounced pattern of opinion across the three groups.

The three groups differed significantly with respect to three weed control difficulties (factors limiting effective weed control). These were lack of money, difficult country, and weed spread from neighbours. Lack of money was given by all respondents in Group 3, compared with 61% in Group 1 and 48% in Group 2 ($p=0.049$). Difficult country was given by 67% of respondents in Group 2, compared with 30% of respondents in Groups 1 and 3 ($p=0.035$). The problem of weeds spreading from neighbours was identified by all Group 3 respondents, compared with 37% in Groups 1 and 2 ($p=0.008$).

Chi-squared tests revealed that the 3 groups varied significantly ($c^2=0.004$) in their views about consulting with others about weed problems. Group 1 felt strongly that it was important to consult others (70%). Groups 2 and 3 reacted in the opposite way, with 81% of Group 2, and 57% of Group 3 not regarding consultation with others to be important. The groups also varied significantly ($c^2=0.019$) in their views about the benefits of new weed control methods compared with the cost of trialing. Trialing was preferred by older farmers, with 43% of Group 2 and 71.4% of Group 3 agreeing it was worthwhile to trial new methods. A smaller proportion of Group 1 (17.4%) were favourably disposed to trialing new methods.

Weed control groups

Monothetic divisive cluster analysis was used to divide respondents into four groups using their responses on whether or not they were spray grazing, slashing or using quarantine measures. The four groups were: neither spray grazing nor slashing (29% of respondents), not spray grazing but slashing (15%), spray grazing but not using quarantine measures (26%), and using both spray grazing and quarantine practices (30%). After examining their patterns of use of all weed control methods listed in the questionnaire, these were referred to as the minimal, mechanical, grazing, and maximal control groups respectively. The four groups were not evenly distributed across the three regions surveyed. The minimal and mechanical control group were most strongly represented in northern NSW, while the grazing and maximal control groups have greater proportions in southern NSW. The mean proportion of property area under cropping was much higher for the grazing and maximal control groups (15% and 20% respectively) than for the minimal and mechanical control groups (1% and 3% respectively). There was a significant difference ($p < 0.0005$) between the number of weed control methods used within each group. This number was highest for the maximum control group with a mean of 10.2, followed by the grazing control group (7.2), the mechanical group (7.1) and the minimal control group (4.9). Those with cropping enterprises used the greatest number of weed control strategies. They were also significantly different with respect to the mean control complexity rating, although in this case the grazing control group was highest with a mean complexity rating of 1.7, then the maximal control group (1.6), the mechanical control group (1.4) and the minimal control group (1.4).

For two of the difficulties encountered with weed control, there were two significant differences between the weed control groups: herbicide resistance ($p = 0.019$) and dislike of using chemicals ($p = 0.002$). In the maximal control group, 41.7% of respondents ticked herbicide resistance, compared with 15.4% in the mechanical control group, 12% in the minimal control group, and 9.1% in the grazing control group. Dislike of using chemicals was nominated by 36% in the minimal control group, compared with 7.7%, 0% and 8.3% in the mechanical, grazing, and maximal control groups respectively.

The weed control groups were significantly different in terms of weed awareness measures for easily recognised broadleaved weeds reflecting, at least in part, the geographic distribution of the weed control groups and

the weeds. The minimal group had the highest score, and the maximal group the lowest score. Some examples are shown in Table 2.

Table 2. Differences across the weed control groups in weed awareness measures.

Weed Control Group	Mean weed awareness score	
	Blackberry	Sweet briar
Minimal control	0.942	0.696
Mechanical control	0.667	0.456
Grazing control	0.725	0.652
Maximal control	0.569	0.306
<i>blackberry: Anova, p=0.025, sweet briar: Anova, p=0.022</i>		

The four groups differed significantly in their rating of usefulness of expert producers as a source of information about weeds (c^2 test $p=0.042$). The maximal control group rated them the most highly, with 61.5% of respondents considering them very useful, 34.6% some use, and 3.8% no use. The other significant difference was the perceived value of the Internet (c^2 test, $p=0.015$). The maximal group again rated it the most highly, with 21.1% of respondents considering it very useful, 63.2% some use, and 15.8 not useful, compared with the minimal control group, proportions of which were 0%, 22.2% and 77.8% respectively.

Critical success factors

From the analysis of the interviews and mail back questionnaire, three critical factors were identified as important to effective weed management. We refer to these as the three "D's": Diligence, Diversity, and Deliberation. *Diligence* is adhering to routine practices, using them in a timely fashion and maintaining weed control as a high priority among all the other tasks competing for the farmer's time and attention. *Diversity* is the number of weed control practices used, and how multiple methods are used together to obtain better and more cost effective control. *Deliberation* is the planning of weed control, and undertaking it in a strategic fashion that takes advantage of knowledge of the life cycles of weeds and desirable pasture species. As these factors did not become evident until after the interviews and mail survey were carried out, there

were no variables available to the analysis specifically designed to gauge respondents' situation relative to these factors. However, it was possible to derive three proxy variables representing the factors using the questions available in the mail back survey. Diligence was approximated with the mean score on a group of attitude statements. Diversity was approximated by the number of weed control methods the respondent considered well worth doing. Deliberation was approximated with the complexity of practices used.

Respondents were divided into eight groups according to whether their score on each of the three proxy variables was above or below the median. These groups can be plotted in the three dimensional space defined by the three factors (Figure 1, Table 3).

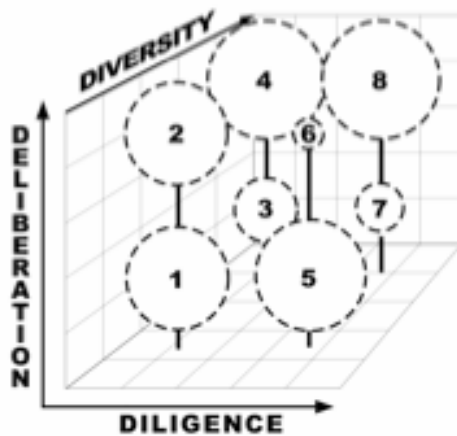


Figure 1. Distribution of respondents across the eight octants defined by the median scores on each dimension of diversity, deliberation and diligence. Size of circle is proportional to the number of respondents in each group.

Table 3. Proportion of respondents falling in each of the eight groups defined by the median scores on each of the three dimensions.

	Prop'n of respondents in group (%)	Position of mean score on dimension relative to median			Mean score	
		Diligence	Diversity	Deliberation	Weed incidence	Effort
Group 1	15.1	below	below	below	2.3	3.1
Group 2	15.1	below	below	above	2.2(1)	2.7(3)
Group 3	9.3	below	above	below	1.1(1,2)	3.8(2)
Group 4	17.4	below	above	above	2.2	3.1
Group 5	16.3	above	below	below	2.1(2)	3.2
Group 6	2.3	above	below	above	1.5	3.8
Group 7	7.0	above	above	below	1.8	3.3
Group 8	17.4	above	above	above	1.6	3.6
Total	100					
Average for all groups					1.5	3.2
Test significance					Anova, p=0.012	Anova, p=0.014
N		86	86	86	79	79

**The numbers in brackets identify pairs of mean values with post-hoc pairwise comparisons significant at the 0.05 level (e.g. Groups 2 and 3 differ significantly from each other in terms of weed incidence (Group 2 = 2.2, Group 3 = 1.1) and in terms of weed management effort (Group 2 = 2.7, Group 3 = 3.8)).*

***The sample size in the right most two columns is lower than that in the other columns, due to ratings by weeds authority staff not being available for a small number of properties.*

Using information on mean weed incidence and management effort ratings provided by weeds authority staff accompanying the farm visits (Table 3), some general trends can be observed in the way group members are positioned in Figure 1. Less effective weed managers (i.e. those with higher weed incidence and lower management effort) tend to be positioned in the bottom, left, and front of Figure 1. These are those who place a low priority on weed control, using a few methods in an unplanned and reactive way. The top, rear of Figure 1 is where better weed managers are located – those who diligently use a wide range of weed control methods in a planned, strategic way. The obvious exceptions to these generalizations are Groups 3 and 4. As evidenced by these exceptions, weed levels do not necessarily decline in a simple linear fashion from the bottom, left, front of Figure 1 to the top, right, and rear. Group 6, for example, achieve reasonably high levels of weed control (weed incidence = 1.5) using relatively few methods.

The eight groups varied significantly with respect to the mean proportion of property area under crops (Anova p<0.0005), and to proportion experiencing herbicide resistance (Anova p=0.020). Groups 3

(36.9%), 8 (20.6%) and 4 (16.4%) had the highest mean proportion of property under crops. These groups were also those with the highest proportion of members encountering herbicide resistance, with Group 3 having the highest proportion of respondents encountering resistance (62.5%), then Group 8 (33.3%), and finally Group 4 (20%). The eight groups also differed significantly in the proportion of respondents that rated two information sources as very useful: daily and local newspapers (χ^2 , $p=0.021$) and the Internet (chi-squared, $p=0.029$). Newspapers were most valued by Groups 5 (50%) and 3 (25%), while Groups 7 and 8 were equal (33.3%) in the proportion of respondents rating the Internet as very useful.

Discussion

The three "Ds" define a useful three dimensional space (Figure 1) within which can be placed the styles of weed management and the effectiveness of weed control encountered in the farm visits and alluded to by key informants. Improvements in weed management will involve moving along an adoption path from one point in the space depicted in Figure 1 to another point. Adoption paths involve different sets of barriers and motivations, depending on where they are located and who is travelling the path. Adoption paths will also have differing communication and extension requirements. The preceding analysis provided a description of how various barriers and motivations were related to weed incidence and management effort. It also identified aspects that are not open to change through extension, such as rugged terrain, but are fixed realities of the heterogeneous farming sector which extension has to accommodate. The discussion now turns to the possible adoption paths which might be encouraged, and some of the main motivations and barriers associated with them.

Lack of finances available for weed control is a limiting factor in weed control. It should be first noted that there are situations in which it is not economically feasible, in terms of private costs and benefits, to overcome weed problems that have got out of hand. Such may be the case on smaller beef properties in the high rainfall zone, where producers have not been able to make the productivity gains necessary to maintain their real incomes (ABARE 2004). There may be public benefits to weed control in these situations, which then provide a policy rationale for public investment in weed control on private property. The policy approach will obviously be very different for properties where weed control is only rational on public good grounds, compared to properties

where weed control is economically feasible in terms of private costs and benefits. The motivations for, and barriers to, participation by landholders in public good weed control programs lay outside the scope of this project.

In the case of weed control for private benefit, an adoption path for the less effective weed managers can include, at least in theory, any combination of increased diligence, increased range of methods (diversity) and increased planning (deliberation). In practice, a more deliberative approach to weed management will generally require the strategic integration of a range of weed control methods. To be successful, such an approach requires that the user is competent in the use of a diverse range of methods. Being able to use a diverse range of methods in a strategic, integrated fashion, is complex and involves high learning requirements. Complexity and high additional learning requirements have been identified as factors likely to constrain adoption (Bullen and Woods 1999; Frank and Chamala 1992; Vanclay 1992), and may therefore limit movement along the deliberation and diversity dimensions. This would suggest that improving diligence using a few methods of weed control should be the primary focus for the less effective weed managers. This project has so far identified a number of reasons contributing to lack of diligence in controlling weeds.

Firstly, weeds are defined by people's perceptions of their desirability. Noxious or declared weeds carry a financial penalty for failure to control, and are therefore obviously undesirable. Such is the case with well-known broadleaf weeds, such as blackberry. Nonetheless, it appears likely that there is a significant number of graziers with higher than desirable levels of infestation of well-known broadleaf weeds, such as blackberry. As awareness of these weeds is typically high in these situations, further awareness raising activities are likely to have limited impact. Increased fines for failure to control may be one option to motivate action, though there are inherent disadvantages of the regulatory approach.

The situation is more complex with plants that, although reducing productivity, are not declared weeds. This is especially true for grass weeds, such as *Vulpia* spp. It appears that there is little recognition of these plants as 'weeds', except where their competitive and invasive nature is recognised. Raising awareness about the economic costs of less well-known grass weeds may increase the effort spent controlling these weeds. Economic evaluations of pasture weeds will, however, be hampered by the complexity of plant-animal relationships, and by the lack

of consensus on the 'weediness' of certain plants, particularly those with seasonal grazing value (Vere *et al.* 2002). Communication and extension efforts focusing on production losses should be very specific about what plants cause the losses, and make sure that graziers are able to recognise these plants in their pastures.

The low priority status of weed control among other farm tasks is another factor reducing diligence. Efforts are focused towards tasks that are perceived as being more urgent, such as feeding stock or controlling internal parasites. Economic evaluations of the impacts of these weeds on productivity are likely to raise the priority placed on weed control. Awareness of the costs of weeds may not necessarily lead to farmers improving their weed management. When the vaguely sensed costs of future productivity loss are weighed against the very specific and immediate costs of chemical purchase, doing nothing is an attractive option. Quantification of productivity loss in realistic farm situations is essential to influence those for whom economic considerations are uppermost in weed control decisions. However, there are those graziers who are not interested in improving profitability. For example, older farmers approaching retirement are unlikely to risk learning and applying new production practices, especially if there are additional costs involved (Drost *et al.* 1996). Farmers approaching retirement may place more priority on weed control if they were made aware of the reduction in the sale value of their property due to the presence of weeds.

A proportion of graziers will often achieve a reasonable level of weed control through diligent use of a limited number of more traditional approaches, such as spot spraying, boom spraying, and 'chipping them out'. These graziers compensate for 'imagination' with persistence, placing a high priority on weed control. However, there is a tendency to focus on declared weeds, and they may not be aware of plants that are causing production losses on their property, particularly grass weeds. With these individuals it is likely that once these graziers are aware that a plant is reducing farm productivity, they will include it in their regular weed control operations. Since the methods used by these graziers, in combination with diligence, have so far proved effective, they see little need for adopting new methods of weed control. The effectiveness of their preferred methods is reduced in difficult country, where access is restricted by rugged terrain or dense vegetation, and control methods are limited to the costly aerial application of herbicides and biological control, where that is available. Persistent spot and boom spraying with herbicides has the potential for herbicide resistance to develop. Strategies

to prevent the development of resistance, and methods suited to controlling weeds in rugged country at low cost, are likely to capture the interest of these graziers, and may provide useful 'angles' for weed extension activities. Further, as these graziers place a high value on trialing as a means of establishing the credibility of new practices, extension activities should, where possible, encourage small-scale trialing of new techniques. These graziers tend to prefer local sources of information about weeds, such as fact sheets from local council and chemical companies. They are often older and do not regard the Internet as being very useful. The Internet is not recommended as a means of communicating information to this group.

Other graziers may achieve a high level of weed control though using a greater diversity of weed control methods in a more integrated fashion. Such diversity of approach is typical of graziers in cropping systems with planned pasture rotations, where farmers are profit-driven and weeds are well-recognized as a source of lost income. The diversity of such mixed enterprises will lend itself to diversity in approaches to weed management, and as the topography of these properties is typically relatively flat, the manager is less constrained in their choice of weed control methods. Application of herbicides to reduce the incidence of weeds is routine, and herbicide resistance is a factor reducing effectiveness in weed control. To be successful in improving the ability of these producers to control weeds, extension strategies should go beyond the routine application of herbicide to include a range of weed control strategies, including non-chemical methods (Pannell 2002). These producers typically place a high value on information, and particularly value consultation with local agricultural advisors. These communication strategies are recommended for extending weed information to this group.

Acknowledgements

The work described in this paper was funded by Meat and Livestock Australia (MLA) – Project number WEED.120. Cameron Allan and Robert Hannam, both of MLA, have provided useful feedback on the various stages of this research. Weed research and regulatory staff from several states of Australia have provided much valued assistance to this research. The contribution of graziers participating in this research is also greatly appreciated.

References

- ABARE (2004) Australian beef industry productivity [Online]. Available at <http://abarepublications.com/product.asp?prodid=12845> (verified 3 April 2006)
- Angus Reid Group (ARG) (1998) Adapting to change and managing risk: a profile of Canadian farmer attitudes and behaviour [Online]. Available at: http://www.agr.gc.ca/spb/rad-dra/publications/adapt/adapt_e.php (verified 30 May)
- Armstrong JS, Overton TS (1977) Estimating non-response bias in mail surveys. *Journal of Marketing Research* **14**, 396–402.
- Barr N, Cary J (2000) Influencing improved natural resource management on farms. Report to the Natural Resource Management Taskforce Reference Group. Department of Agriculture, Fisheries and Forestry, Canberra.
- Bullen K, Woods EJ (1999) Do farmers adopt new management strategies developed by researchers? Do researchers communicate their results effectively? In 'Proceedings of the 12th Australian Weeds'. (Eds AC Bishop, M Boersma, CD Barnes) pp. 71-75. (Tasmanian Weeds Society: Hobart)
- Burton J, Dowling PM (2004) 'Pasture management for weed control: a graziers' guide to controlling annual weeds in southern Australian improved pastures.' (NSW Agriculture and the Cooperative Research Centre for Australian Weed Management)
- Campbell M (1997) Pasture weeds. In 'Pasture production and management'. (Eds JVS Lovett, JM Scott) pp. 254–268. (Inkata Press: Melbourne)
- Coutts J, Douglas J, Campbell A (2001) Cooperation, collaboration and common sense: Towards a national extension framework for Australia. In 'Proceedings of APEN (Australasia Pacific Extension Network) 2001 International Conference (University of South Queensland: Toowoomba)
- Dowling PM, Michalk DL, Sindel BM (2000) Weed management in pasture systems. In 'Australian weed management systems'. (Ed. BM Sindel) 307–326. (RG and FJ Richardson: Melbourne)
- Drost DT, Long G, Wilson D, Miller B, Campbell W (1996). Barriers to adopting sustainable agricultural practices. *Journal of Extension* **34** (6), 1–6.
- Frank B, Chamala S (1992) Effectiveness of extension strategies. In 'Agriculture, environment and society'. (Eds G Lawrence, F Vanclay and B Furze) pp. 122–140. (McMillan Press: Melbourne)

- Hochberg Y, Tamhane AC (1987) 'Multiple comparison procedures.' (John Wiley & Sons, Inc: NY)
- Kemp DR, Dowling PM (1991) Species distribution within improved pastures over central NSW in relation to rainfall and altitude. *Australian Journal of Experimental Research* **42**, 647–659.
- Kemp DR, Dowling PM (2000) Towards sustainable temperate perennial pastures. *Australian Journal of Experimental Agriculture* **40**, 125–132.
- Klockars AJ, Sax G (1986) 'Multiple comparisons.' (Sage Publications: Thousand Oaks, California)
- Llewellyn RS, Pannell DJ, Lidner RK, Powles SB (2005) Targeting key perceptions when planning and evaluating extension. *Australian Journal of Experimental Agriculture* **45**, 1627–1633.
- Pannell D (2002) The human dimensions of integrated weed management. In 'Proceedings of the 13th Australian Weeds Conference'. Perth. (Eds HS Jacob, J Dodd, JH Moore) pp. 8–15. (Shannon Books: Melbourne)
- Pannell DJ, Marsh SP (1998) Agricultural extension policy in Australia: the good, the bad and the misguided. [Online]. In 'Papers on Agricultural Extension and Adoption and Diffusion of Innovations in Agriculture'. Available at <http://www.crcsalinity.com/newsletter/seaNews/dpap982a.htm> (verified 7 December 2005)
- Pannell DJ, Zilberman D (2000) Economic and sociological factors affecting growers' decision making on herbicide resistance. [Online]. In 'Sustainability and Economics in Agriculture, GRDC Project 251'. Available at <http://www.general.uwa.edu.au/u/dpannell/dpap0007.htm> (verified 6 December 2005)
- R Development Core Team (2005) 'R: A language and environment for statistical computing'. (R Foundation for Statistical Computing, Vienna, Austria)
- Reeve IJ, Lees JW (1994) Temperate pasture sustainability key program: Producer survey. Report to the Meat Research Corporation (M. 414). The Rural Development Centre, University of New England, Armidale.
- Sindel BM (1996) Grazier attitudes to weeds, research and education in northern New South Wales. In 'Proceedings of the 11th Australian Weeds Conference'. (Ed. RCH Shepherd) pp. 247–252. (Weeds Science Society of Victoria, Inc: Frankston)

Sinden J, Jones R, Hester S, Odom D, Kalish C, Hames R, Cacho O (2004) The economic impact of weeds in Australia, Technical Series Paper No. 8. CRC for Australian Weed Management, Adelaide.

SPSS Inc (2001) 'SPSS 11.0 Syntax Reference Guide.' (Prentice Hall: NY)

Vanclay F (1992) The social context of farmers' adoption of environmentally sound farming practices. In 'Agriculture, environment and society'. (Eds G Lawrence, F Vanclay, B Frank) pp. 94–121. (McMillan Press: Melbourne)

Vanclay F (2004) Social principles for agricultural extension to assist in the promotion of natural resource management. *Australian Journal of Experimental Agriculture* **44**, 213–222.

Vere DT, Jones RE, Dowling PM, Kemp DR (2002) Economic impact of *Vulpia* in temperate pasture systems in south eastern Australia. *Australian Journal of Experimental Agriculture* **42**, 465–472.