

**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.

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 known 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 A2.1.1 to Table A2.1.3, 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 A2.1.4, below.

Table A2.1.1 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
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 A2.1.2 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 A2.1.3 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
Variiegated thistle (cabbage thistle)	0.97
Black thistle (spear or Scotch thistle)	0.96
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 A2.1.4 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 A2.1.5.

Table A2.1.5 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 A2.1.5 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 A2.1.6 below. Three attitude statements that were poorly correlated with the three attitudinal dimensions have been omitted.

Table A2.1.5 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 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 A2.1.6:

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 A2.1.6 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 of 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 A2.1.6 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 A2.1.7).

Table A2.1.7 Possible Likert scales identified using factor analysis.

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 A2.1.7 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 Table A2.2.1 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 A2.2.1 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
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 A2.3.1 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
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.

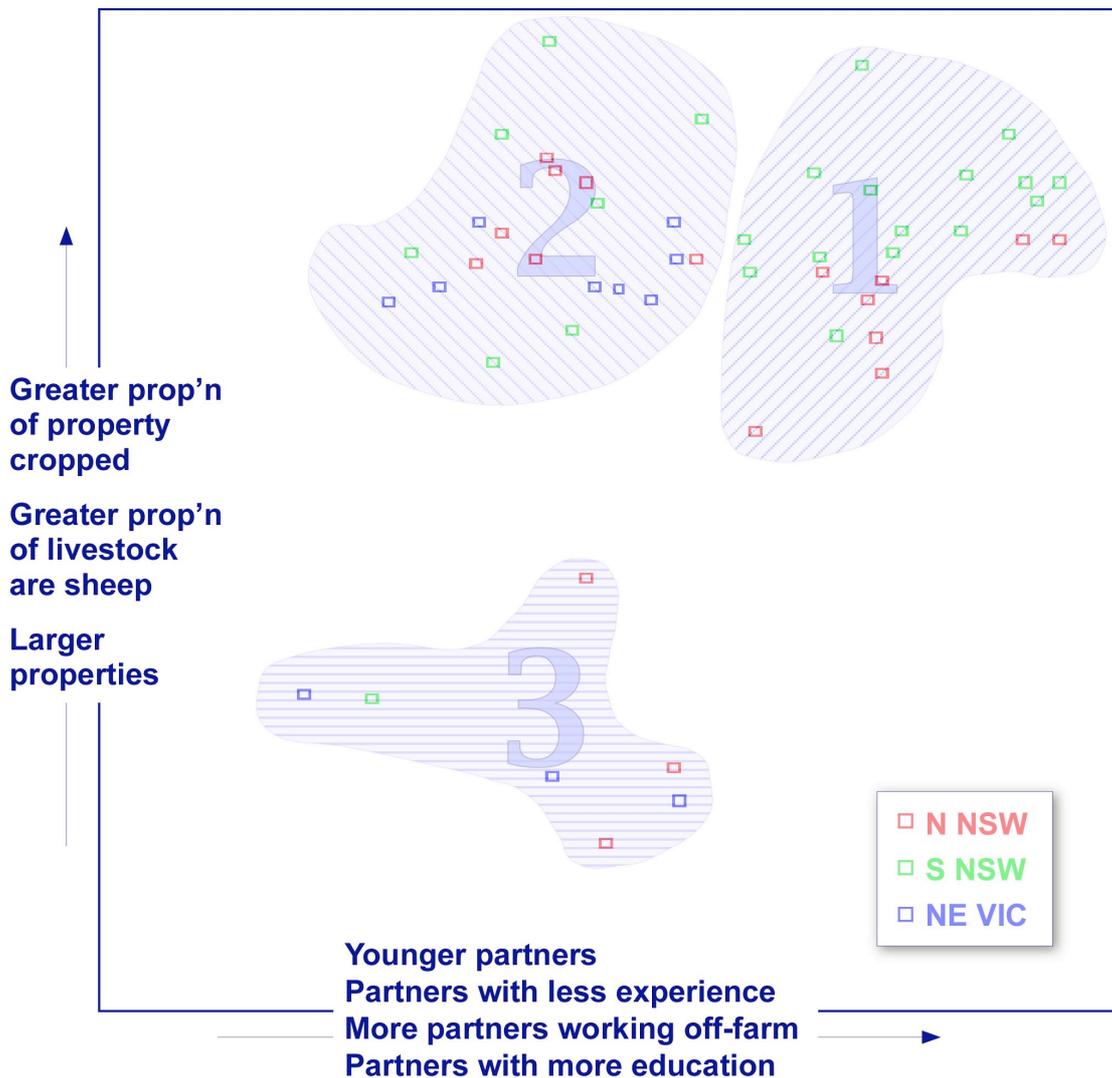
This person also regarded the key element of a weed control program as:

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 A2.3.1. 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 A2.3.1, 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 A2.3.1.

Figure A2.3.1 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 A2.4.1), with group 1 farmers having lower levels of weeds and a higher level of management effort.

Table A2.4.1 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 A2.5.1). 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 A2.5.1 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 A2.5.2 to Table A2.5.9 below.

Table A2.5.2 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 A2.5.3 Differences in views about tactical grazing pressure.

Weed control group	Tactical grazing pressure (%)		
	Worth doing	Not worth doing	Not familiar
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 A2.5.4 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 A2.5.5 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 A2.5.6 Differences in views about cultivation, rotational cropping and pasture re-establishment.

Weed control group	Cultivation, rotational cropping, pasture re-establishment (%)		
	Worth doing	Not worth doing	Not 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 A2.5.7 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 A2.5.8 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 A2.5.9 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
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 A2.5.10).

Table A2.5.10 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 A2.5.11).

Table A2.5.11 Differences in the complexity of practices used.

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.

A2.5.3.1 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 A2.5.12).

Table A2.5.12 Geographic distribution of weed control groups.

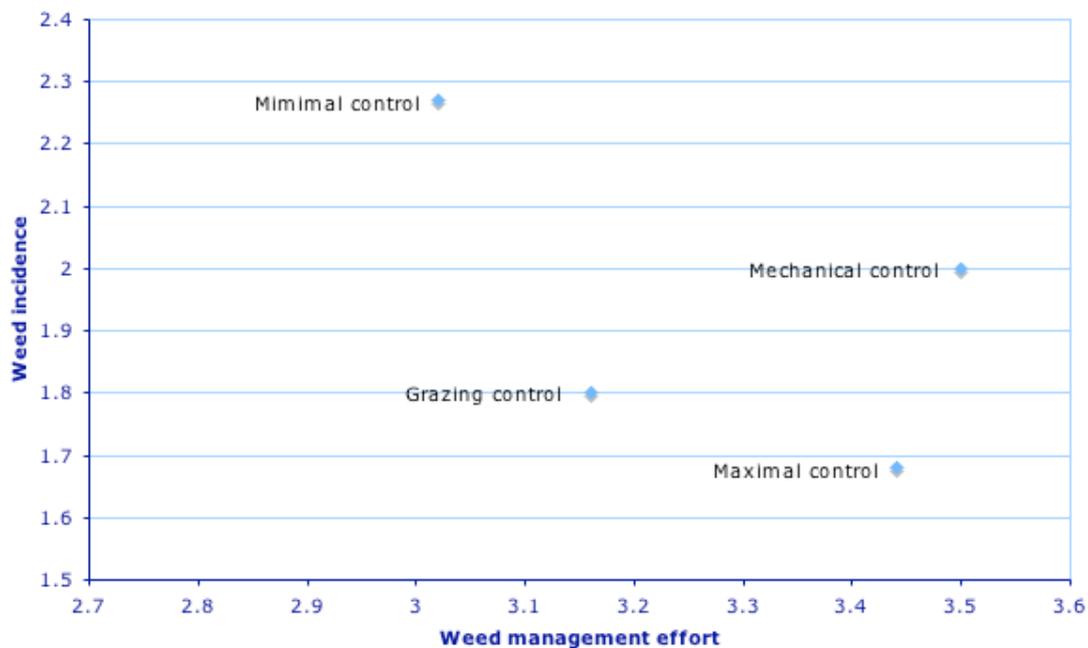
Weed control group	Region		
	Northern New South Wales	Southern New South Wales	North eastern Victoria
Minimal control	56.0	32.0	12.0
Mechanical control	69.2	7.7	23.1
Grazing control	13.0	56.5	30.4
Maximal control	15.4	61.5	23.1

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 A2.3, 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 A2.5.1).

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 A2.5.1 Differences across weed control groups in weed incidence and level of management effort as rated by weeds officers accompanying the farm visits.



A2.5.3.2 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 A2.1 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 A2.6.1).

Table A2.6.1 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 A2.6.2).

Table A2.6.2 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 A2.6.3). Difficulties with terrain and herbicide resistance are the main problems where technological innovations may lead to improved weed control.

Table A2.6.3 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 A2.6.3, 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 A2.6.1), 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 ($p=0.008$), 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 A2.6.4). 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 A2.6.4 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 A2.6.5).

Figure A2.6.1 Location of properties regarded by their owners as difficult for weed control, with respect to the demographic and farm characteristic dimensions.

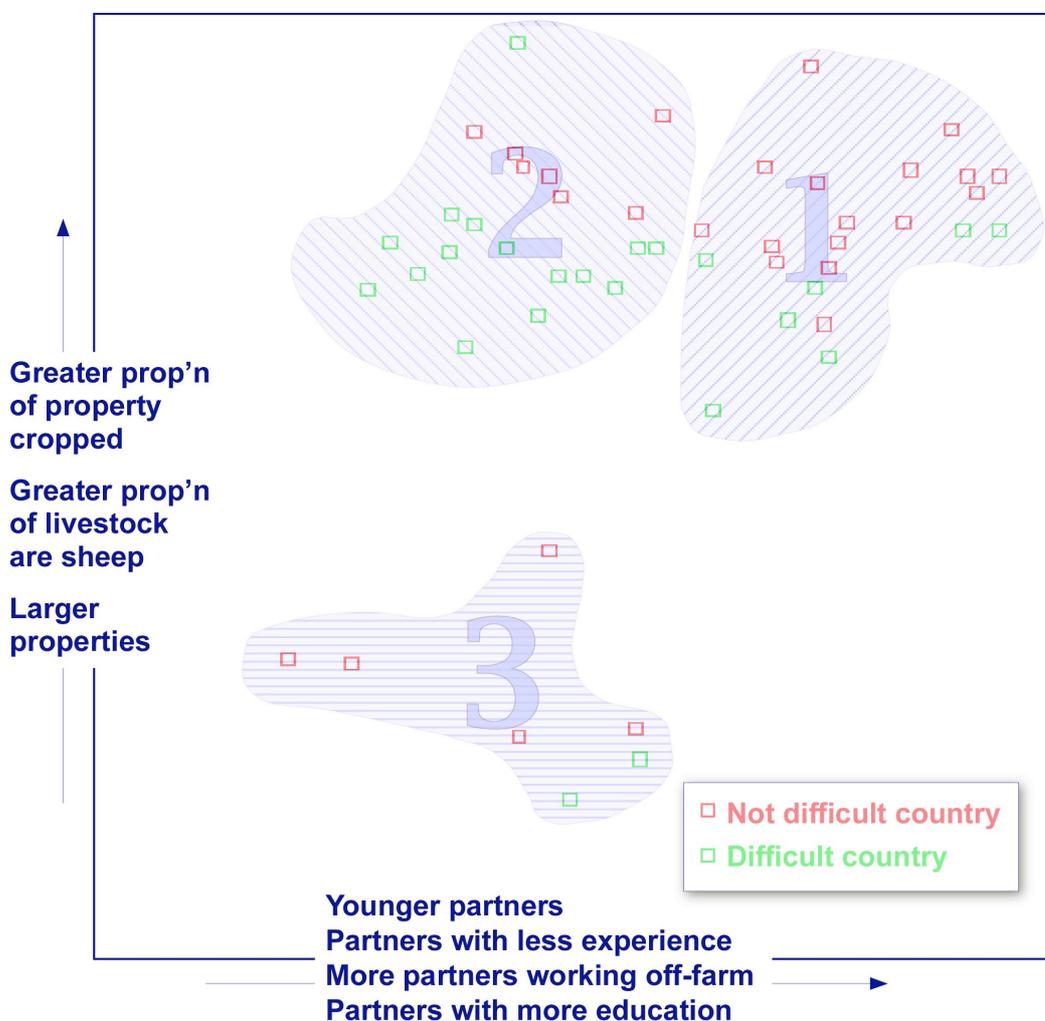


Table A2.6.5 Differences between weed control groups in the proportion who disliked using chemicals.

Weed control group	Don't like using chemicals (%)	
	Not ticked	Ticked
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 A2.6.6 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 A2.6.6 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
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 A2.6.1).

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 A2.1. 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 A2.6.7 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 A2.6.7 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 A2.6.8 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 A2.6.8 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 A2.6.9),
- younger, better-educated producers on cropping properties were more likely to consult with others about weed problems (Table A2.6.10), and
- younger, better educated producers on cropping properties were more likely to be aware that new weed control methods are becoming available (Table A2.6.11).

Interestingly, it is this latter group who have a more diffident attitude to the benefits of new weed control methods (Table A2.6.12), perhaps reflecting greater awareness of the complexities of weed management and the absence of ‘magic bullet’ solutions.

Table A2.6.9 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 A2.6.10 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 A2.6.11 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 A2.6.12 Differences across the demographic and farm groups in views about the benefits of new weed control methods compared to the cost of trialing.

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 A2.6.13).

Table A2.6.13 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 A2.6.14),
- place a very high priority on weed control compared to other farm management tasks (Table A2.6.15),
- not believe that weed control can be put off in difficult times, to be caught up with later (Table A2.6.16), and
- believe that the benefits of new weed control methods outweigh the costs of trialing them (Table A2.6.17).

Table A2.6.14 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 A2.6.15 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
Neutral	2.21	2.88
Disagree	2.18	3.00

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

Table A2.6.16 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 A2.6.17 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 A2.6.18.

Table A2.6.18 Usefulness to respondents of information sources.

Source of information	Proportion of respondents (%)		
	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 A2.6.19 and Table A2.6.20).

Table A2.6.19 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 A2.6.20 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, $p=0.079$

A2.6.10.2 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 A2.6.21 to Table A2.6.24).

Table A2.6.21 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 A2.6.22 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 A2.6.23 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 A2.6.24 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.

A2.6.11 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 A2.6.25). On the other hand, the electronic media – radio, TV and Internet – are regarded as not useful by large proportions of respondents.

Table A2.6.25 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
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

A2.6.11.1 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 A2.6.26). 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 A2.6.27).

Table A2.6.26 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 A2.6.27 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
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, $p=0.047$

A2.6.11.2 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 A2.6.28 and Table A2.6.29). On the other hand, books and fact sheets from government departments were very favourably regarded by those in the mechanical control group.

Table A2.6.28 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 A2.6.29 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 A2.6.30).

Table A2.6.30 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 A2.6.31 to Table A2.6.36, 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 A2.6.31 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 A2.6.32 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 A2.6.33 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 A2.6.34 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.

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 A2.6.35 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 A2.6.36 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 A2.6.37 and Table A2.6.38. 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 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 A2.6.37 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 from respondent's grazing enterprise	Little or no 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 A2.6.38 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 Low management effort associated with:	Group 2 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.

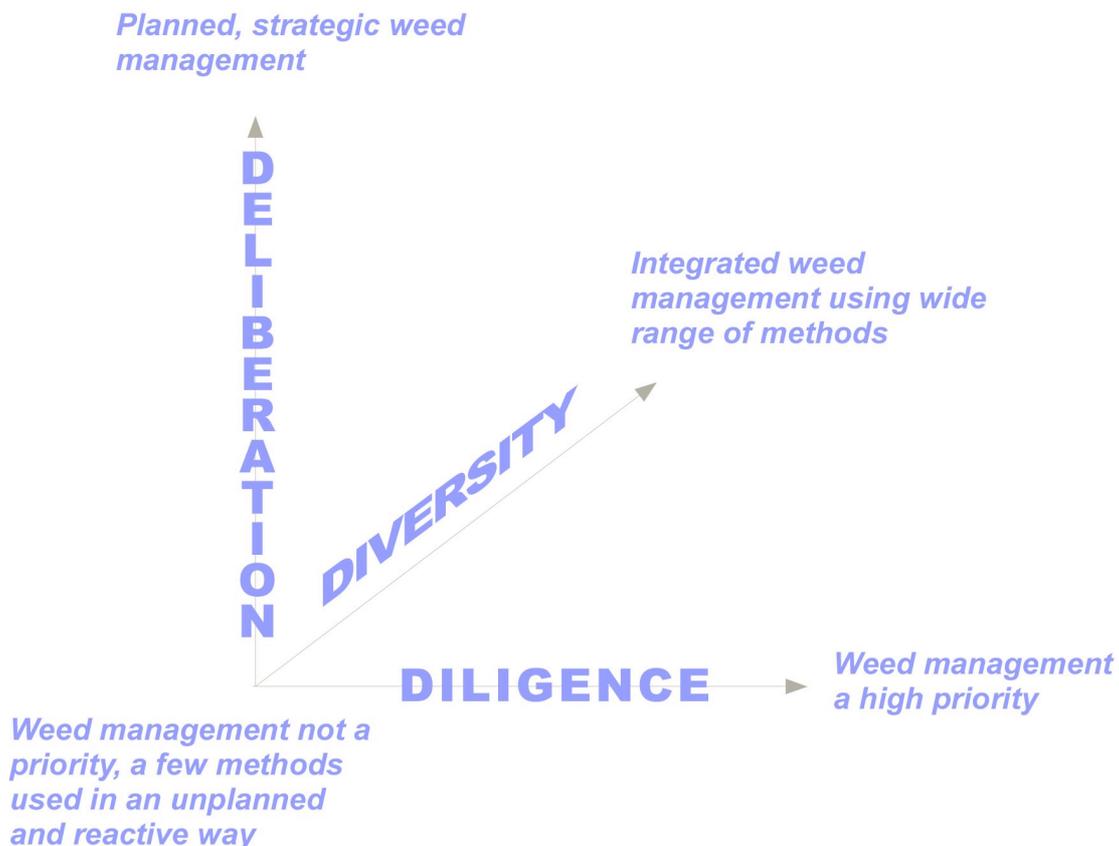
Diligence is adhering to routine practices, using them in a timely fashion and maintaining weed control as a high priority among all the other tasks competing for the farmer's time and attention.

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 A2.7.1) 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.

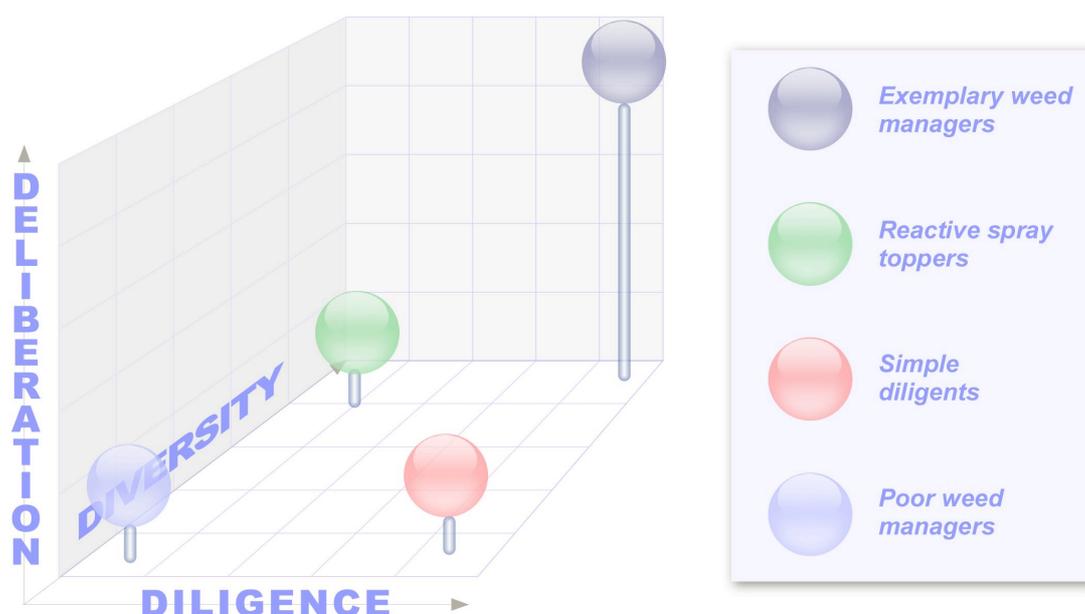
Figure A2.7.1 The 3 Ds of weed management



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 A2.7.2). 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 A2.7.2 Different types of weed managers in 3 'Ds' space



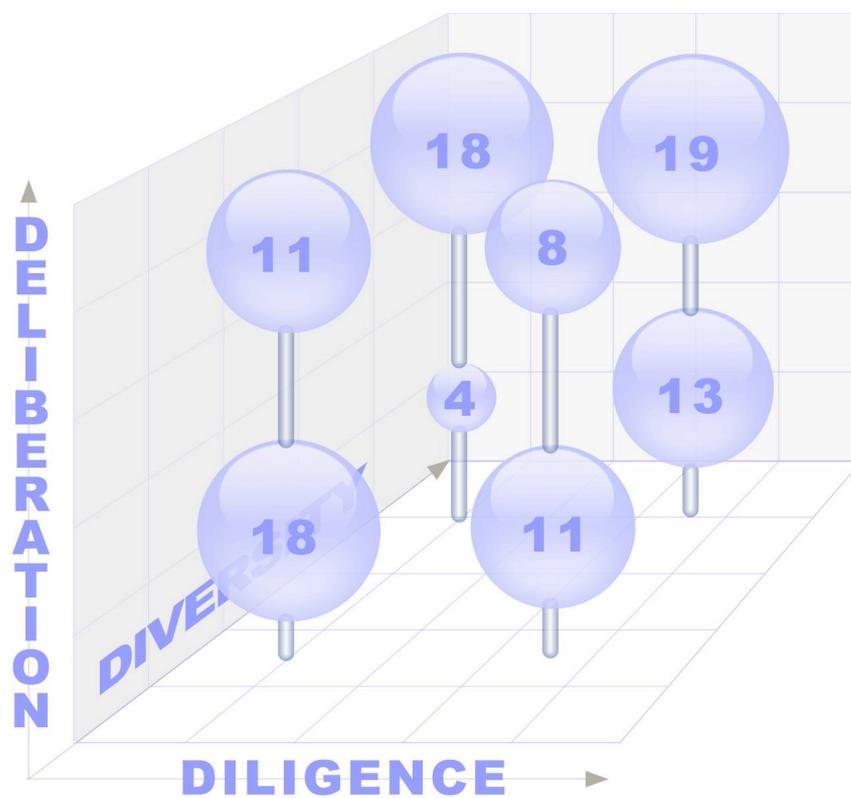
The top, right, rear is where the exemplary weed managers are located, those who diligently use a wide range of weed control methods in a planned, strategic way. The maximal group of the four weed control groups described in the analysis of the mail-back survey, would be located in this region of Figure A2.7.2. 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 A2.7.2 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 A2.7.2). 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 A2.7.2).

The responses to a number of questions in the mail-back survey were used as proxies for the three dimensions in Figure A2.7.2, to gain an indication of what proportion of respondents were located in the various parts of Figure A2.7.2. Diligence was approximated with the first attitudinal factor: Weed control – a habitual routine (Table A2.1.6). Diversity was approximated by the number of weed control methods the respondent considered well worth doing (Table A2.5.1). Deliberation was approximated with the complexity of practices used (Table A2.5.11).

The proportion of respondents in each of the eight octants defined by the medians is shown in Figure A2.7.3. 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 A2.7.3 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 A2.7.3 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 A2.7.1 lists the all the barriers

and motivations that have been encountered in the face-to-face interviews with farmers, and key informant interviews.

Table A2.7.1 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 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		
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		✓
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		
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 A2.7.2 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.

A2.7.2.4 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.
- 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



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	
			Easy	Difficult
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"/>

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 (injury, illness etc)	<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 (please describe)	<input type="checkbox"/>

2

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?

	Big reduction	Some reduction	Little or no reduction
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 (please specify)	<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 (please specify)	_____		_____
Total area of property(ies)	_____		_____

3

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"/>					
Age: please tick if person is over 55	<input type="checkbox"/>					
Please tick each person who is a partner in the farm business	<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"/>					

4

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 (Please write number of years)	_____	_____	_____	_____	_____	_____
Part or all of a university or ag college degree in agriculture	<input type="checkbox"/>					
TAFE course(s)	<input type="checkbox"/>					
High school agriculture course	<input type="checkbox"/>					
Field days, discussion groups etc	<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"/>				
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"/>				
Of all the jobs on a farm, weed control is probably the most important.	<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"/>				
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"/>				
In my view, you are better off looking after your stock, than worrying too much about weeds.	<input type="checkbox"/>				

continued on next page

5

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"/>				
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"/>				
Weed control is one of those things you have to keep on top of all the time.	<input type="checkbox"/>				
Weed control is one part of running a property that hasn't changed much over the years.	<input type="checkbox"/>				
Fortunately, weed control is something you can put off in difficult times, and catch up on later.	<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"/>				
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"/>				
Generally, the benefits of new weed control methods outweigh the costs in trying them out.	<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

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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.uneng.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.

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

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.

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