Survey of the impact and control of fireweed (*Senecio madagascariensis* Poir.) in New South Wales

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Summary

A questionnaire about the control of fireweed (*Senecio madagascariensis*) and its impact on agriculture was mailed to 780 dairy farmers and beef cattle graziers in coastal areas of New South Wales during the spring of 1985. The survey had, as one of its main aims, the provision of information on which to base future decisions regarding fireweed research. A 74% response was obtained, indicating a successful survey technique and a real concern by farmers about this weed.

The median response was that properties have 'moderate' amounts of fireweed and that it is a 'minor/moderate' problem, mostly because it was perceived as competing with crops or pastures. For the dairy industry in N.S.W., control costs some 100 000 man hours and $250 000 annually. Grazing with sheep or goats, herbicides and competitive pastures were found to be the most effective methods of control, with kikuyu (*Pennisetum clandestinum*) being considered the best competitor.

Introduction

Fireweed (*Senecio madagascariensis* Poir.), a yellow-flowering composite long thought to be a native of Australia, was discovered in 1980 to be an introduced species that originates in south-eastern Africa and Madagascar (Michael 1981). Previously incriminated in the poisoning of grazing animals (Green 1953), recent reports (Walker and Kirkland 1981; Kirkland *et al.* 1982) have confirmed its toxicity to cattle. These findings, followed in 1983 by an explosion of fireweed throughout many parts of coastal New South Wales after a long drought, and the continued spread of the weed into new areas, particularly along the south coast, have led to renewed interest in its ecology and the development of acceptable control methods. A review of the existing literature on fireweed was made by Sindel (1986) and, while that review shows ecological work being done in Argentina, where fireweed also occurs, few published accounts exist of its impact on agriculture or its control.

A survey was therefore undertaken during the spring of 1985 of the fireweed problem in New South Wales. Its object was to provide information on which to base future decisions regarding the fireweed research program. The questionnaire was distributed by mail to dairy farmers and graziers in coastal areas of New South Wales. It sought information on the occurrence of the weed, its spread, the nature of the problem, its relationship to different agronomic practices and pasture situations, and the methods of control presently being employed.

Materials and methods

Prior to the mailing of the questionnaire a draft version was tested with 12 farmers on a face-to-face basis in order to identify difficult and ambiguous questions (Freebairn 1967). While the general principles of questionnaire design are adequately outlined by Karmel and Polasek (1970), specific techniques used in this survey to give a high response were:

1. The questionnaire, a single yellow sheet of multiple-choice questions, was accompanied by a letter of explanation and a reply-paid envelope.
2. A press release regarding the survey was circulated through the 'University News', the fortnightly publication of the University of Sydney, to 'The Land' newspaper and over 40 regional newspapers for printing 2 weeks prior to mailing the questionnaire.

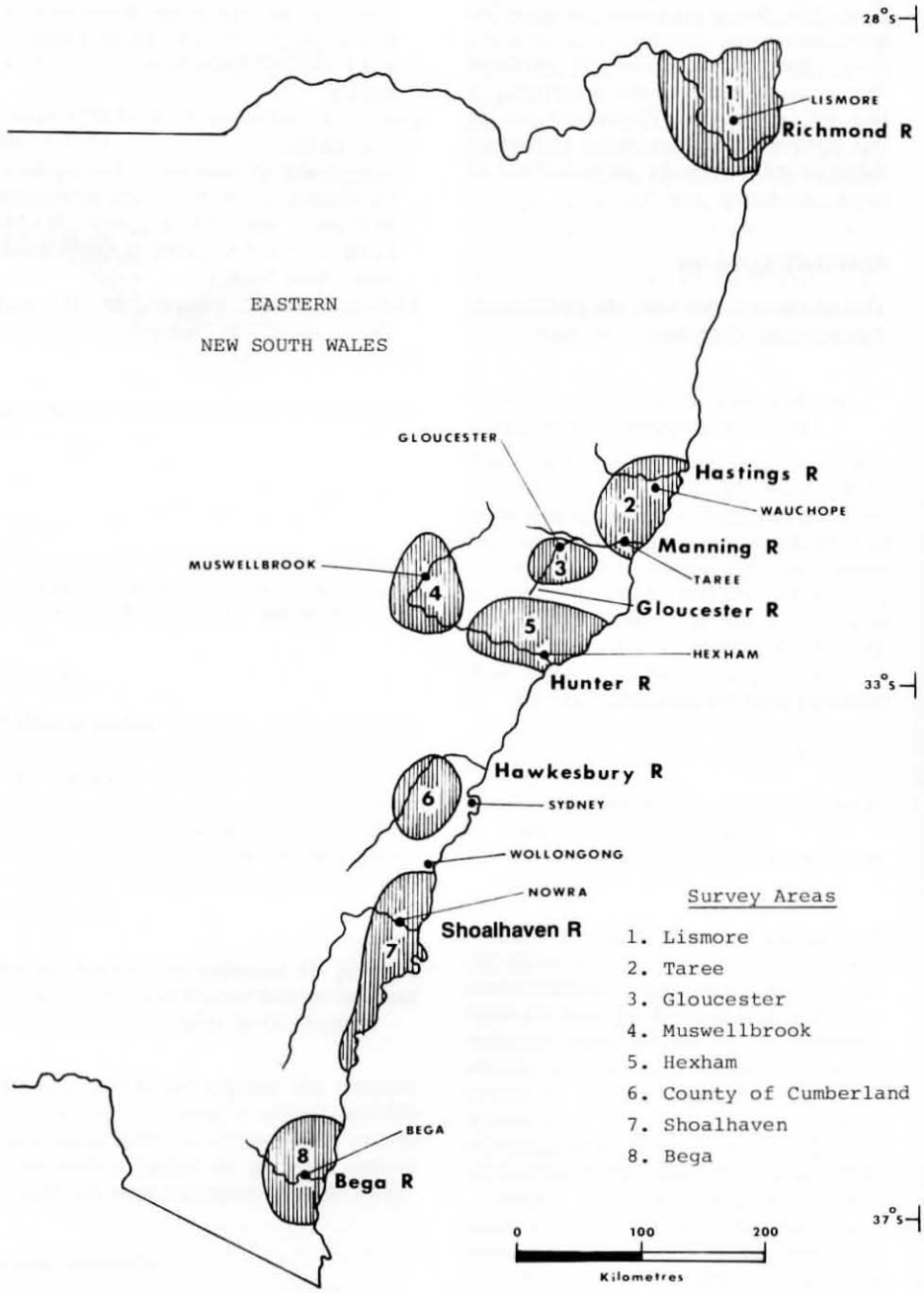

Figure 1 Areas sampled in the fireweed survey.

3. A follow-up reminder mailing which included another questionnaire, reply-paid envelope and letter of explanation was sent 4 weeks after the first mailing to all farmers who had not yet replied.
4. Letters which were returned not having been received by farmers to whom they were sent, were destroyed and replacement questionnaires mailed to other randomly selected farmers in their particular areas. Thus the original 2.7% dead letter response was effectively reduced to zero.
5. The survey was conducted at a time when fireweed was flowering and obvious to respondents. It is important in a survey of this kind that the weed be a well-known plant easily recognized by farmers.

Since fireweed predominantly infests coastal pastures of New South Wales, the sample, totalling 780 farmers, was stratified over eight areas, all east of the Great Dividing Range from Lismore in the north to Bega in the south. These eight areas corresponded to the areas served by particular dairy cooperatives and are all regions in which fireweed was expected to occur (see Watson *et al.* 1984 Figure 2).

Sixty dairy farmers were randomly selected from each of the areas from lists supplied by the various dairy cooperatives. In addition to these 480 dairy farmers, 60 graziers (almost exclusively running beef cattle) were randomly selected from each of the five northern areas (a total of 300) from telephone directories and lists supplied by District Agronomists. This stratification (see Figure 1) not only provided a sample representative of coastal pastures but also allowed for a comparison between each of the eight areas (amongst dairy farmers) and a comparison between the situation on dairy farms and other grazing properties in the five areas where fireweed has been established for the longest period of time.

Data from returned questionnaires were coded where necessary and analysed using the SPSS-X computer package.

Results and discussion

A 56% response was obtained from the first mailing and this was increased to 74% after the second mailing. Rates greater than 60% were achieved for all regions with two as high as 87%. Both the large initial response and total response compare very favourably with that obtained in other agricultural mail surveys (Dillon and Jarrett 1964; Auld 1971), and would seem to indicate a successful technique and a real concern by farmers about this weed.

The total number of respondents was 581, of which 373 (64%) cited their main farm enterprise as dairying, 201 (35%) beef cattle, and 7 (1%) something other than these.

The possibility of a non-response bias is the most important limitation in mail surveys of this type (Auld 1971). However, Freebairn (1967) showed that, in general, differences between respondents and non-respondents are attributable to chance alone if returns are relatively high. The large response rate obtained in this study therefore allows for confidence in its results.

Occurrence

Fireweed was present on 522 (90%) of respondents' properties and of those, 51 or less than 10% considered it under control. All respondents in the Lismore, Taree, Gloucester and Hexham areas had fireweed with the greatest amounts occurring in the latter three. Infestation in the County of Cumberland was similar to Lismore. As yet, fireweed is not common in Bega or Muswellbrook and rarely occurs in large quantities in the Shoalhaven (see Table 1).

Only three respondents, all from the Bega area, professed difficulty in recognizing fireweed. *Senecio madagascariensis* can sometimes be confused with representatives of the similar native *Senecio lautus* complex, but because the latter occurs in isolated pockets and does not behave in a weedy manner, it was assumed that what farmers identified as fireweed was *S. madagascariensis*. A full description of *S. madagascariensis* including characteristics used to distinguish it from *S. lautus* is given elsewhere (Sindel 1986).

Spread

Of the respondents with fireweed, 29% observed its arrival on their properties within the last 5 years and 58% within the last 10 years. This suggests that the weed is spreading rapidly and the number of farms infested in New South Wales has doubled since the mid 1970s.

Table 1 Occurrence of fireweed
Values are expressed as percentages of total replies

		Survey areas[A]							
Occurrence	**Overall survey (%)**	**Lismore (%)**	**Taree (%)**	**Gloucester (%)**	**Muswellbrook (%)**	**Hexham (%)**	**County of Cumberland (%)**	**Shoalhaven (%)**	**Bega (%)**
Absent	10	–	–	–	29	–	4	14	65
Small amounts	30	29	18	24	56	21	35	43	25
Moderate amounts	40	46	48	59	9	50	42	20	2
Large amounts	11	10	17	15	–	19	13	4	–
Under control	9	15	17	2	6	10	6	19	8

[A]Results for individual areas are for dairy farms only.

Table 2 Duration of fireweed presence
Values are expressed as percentages of respondents with fireweed

		Survey areas[A]							
Duration present (years)	**Overall survey (%)**	**Lismore (%)**	**Taree (%)**	**Gloucester (%)**	**Muswellbrook (%)**	**Hexham (%)**	**County of Cumberland (%)**	**Shoalhaven (%)**	**Bega (%)**
Less than 5	29	29	14	–	63	4	62	89	94
5 to 10	29	29	50	27	8	13	36	11	6
10 to 20	28	25	36	49	25	28	2	–	–
20 to 30	10	7	–	22	–	38	–	–	–
More than 30	4	10	–	2	4	17	–	–	–

[A]Results for individual areas are for dairy farms only.

Table 2 confirms that, from an original infestation in the Lower Hunter River Valley, fireweed was introduced to the far north coast in about 1940 (Green 1953). The Gloucester River Valley has been the other major locality with a comparatively long history of fireweed. Fireweed has spread to the Shoalhaven and Bega areas primarily in the last 5 years and has become abundant in the County of Cumberland in the last 10 years. Although declared a noxious weed in certain shires of New South Wales from 1946 to 1971 (Martin and Colman 1977), legal requirements for control of fireweed have now been discontinued.

Methods of spread were not studied in this survey but history of farm ownership and the presence of fireweed in hay or silage are potential causes of infestations. Achenes or 'seeds' are easily blown by wind.

Size of the problem

In addition to knowing something of its prevalence and spread, farmers were asked for their opinion on the size of the fireweed problem. Table 3 shows the response.

The extent of the problem varies between localities and, of particular note, is the large number who consider it a major problem in the Shoalhaven area where, for the most part, fireweed occurs only in small amounts. Of special concern is the potential for infestations to increase in the area. Notably, fireweed was not thought to be a major problem by any respondents from the Muswellbrook area despite its occurrence there for up to 20 years. This may be significant in terms of the potential distribution of fireweed in Australia and the threat it poses, if any, to agriculture away from the coast.

A reasonably strong correlation existed between the occurrence of fireweed and how farmers perceived the problem. For a small occurrence of fireweed, 37% said it was no problem and 54% a minor problem; for a moderate occurrence 37% said minor and 50% moderate; and for a large occurrence, 46% said moderate and 51% a major problem.

Fireweed was considered less of a problem on respondents' properties in the first few years following its arrival and then substantially less after being present for 30 years or more than in the intervening period.

Why fireweed is a problem

The main reasons why fireweed was seen as a problem by farmers are listed in Table 4. Other reasons specifically added by two or more respondents were that it: removes moisture from the soil, is time-consuming to control, has the ability to spread quickly, reduces stocking rates, has the potential for infestation to increase and to poison stock, and is impossible to eradicate.

Poisoning and poor growth of stock Although fireweed-infested pastures look bad to many farmers, more importantly, 4% of respondents believed it had been or is currently causing poisoning of stock and 4% poor growth of stock, the latter being worst in the Taree area. This result is confirmed by the small but constant number of animals affected by fireweed poisoning coming into the veterinary stations in coastal New South Wales (Walker, personal communication).

Fireweed is toxic owing to the presence of a pyrrolizidine alkaloid believed to be senecionine (Culvenor unpublished data, cited by Bull *et al.* 1968; McBarron 1976). Cattle will inadvertently graze the weed in its younger stages and, when other feed is not available, can be forced to eat it despite its unpalatability.

Presence in hay or silage Notably, 24% of respondents found fireweed in pasture or crops used for hay or silage. This situation is potentially dangerous because fireweed remains poisonous when dry (Walker and Kirkland 1981) and stock may not be

Table 3 Size of the fireweed problem as perceived by farmers
Values are expressed as percentages of respondents with fireweed

Size of problem	Overall survey (%)	Survey areas[A] Lismore (%)	Taree (%)	Gloucester (%)	Muswellbrook (%)	Hexham (%)	County of Cumberland (%)	Shoalhaven (%)	Bega (%)
No problem	19	19	8	2	58	19	10	26	52
Minor problem	36	48	33	46	28	27	41	34	29
Moderate problem	33	19	41	43	14	48	37	19	5
Major problem	12	14	18	9	–	6	12	21	14

[A]Results for individual areas are for dairy farms only.

Table 4 Reasons why farmers consider fireweed a problem
Values are expressed as percentages of total replies

Reasons for problem	Overall survey (%)	Survey areas[A] Lismore (%)	Taree (%)	Gloucester (%)	Muswellbrook (%)	Hexham (%)	County of Cumberland (%)	Shoalhaven (%)	Bega (%)
Looks bad	45	57	63	67	19	52	52	31	4
Poisons stock	4	2	4	4	–	6	6	8	–
Causes poor growth of stock	4	7	10	4	–	2	4	2	–
Competes with crops or pasture	57	52	73	70	19	69	67	41	15
Prevents stock grazing amongst it	30	24	40	43	6	46	33	18	4
In crops or pasture used for hay or silage	24	12	40	30	17	29	46	43	4

[A]Results for individual areas are for dairy farms only.

able to select against it as well as they do in the field. Poisoning is thus more likely to occur. Because cultivation, more often than not, stimulates germination of fireweed (Sindel 1986), land used for fodder crops can easily become infested.

Reduction in productivity Additionally, 57% of respondents indicated that fireweed reduced crop or pasture productivity and 30% noted that the available grazing area was restricted. This is not surprising considering that densities in pastures range from 0 to 5000 plants m^{-2}. Competition with crops or pastures and the associated reduction in their productivity is most significant around Taree, Gloucester, Hexham and in the County of Cumberland because of their heavy infestations.

Since fireweed varies greatly in abundance from season to season, farmers were asked to estimate the reduction in pasture or crop productivity both for 'normal' and 'bad' fireweed years. The result is shown in Table 5. While only 19% of respondents to this question felt that crop or pasture productivity was reduced by more than 10% in a 'normal' year, 41% believed such reductions occurred in a 'bad' fireweed year.

Table 5 Reduction in pasture or crop productivity caused by fireweed in 'normal' and 'bad' fireweed years
Values expressed as percentages of respondents with fireweed

Reduction in productivity	'Normal' year (%)	'Bad' year (%)
None	37	26
0–10%	44	33
10–20%	15	28
20–50%	4	12
More than 50%	–	1

Table 6 Situations favouring the growth of fireweed

Situations favouring growth	No. of respondents	Percentage[A]
Previously cultivated land	197	38
Previously burnt land	65	12
Native pasture	166	32
Improved/fertilized pasture	187	36
Heavily grazed pasture	178	34
Soil of low fertility	120	23
Soil of high fertility	83	16
Bare ground	130	24

[A]As a proportion of respondents with fireweed

Situations favouring growth

No one situation on the farms favoured the growth of fireweed over others. Given the wide range mentioned by respondents and that 31% said 'no particular situation' favours its growth, the conclusion that fireweed is an opportunistic weed with the ability to invade and colonize a great variety of habitats (Fernández and Verona 1984) is most appropriate. It was, however, found predominantly in the situations listed in Table 6. Of the respondents who made additional comments to this question, 10 (24%) emphasized that drought, or the breaking of it, also favours the growth of fireweed. A similar observation was that fireweed is worst following a dry summer.

Worst weed?

Of all respondents, 248 (43%) believed fireweed to be their worst weed. For Lismore, the result was 36%, Taree 77%, Gloucester 54%, Muswellbrook 8%, Hexham 46%, County of Cumberland 48%, Shoalhaven 51% and Bega 6%. Lantana (*Lantana camara*), the second most important weed, was said to be worst by only 8% of respondents. Other weeds of considerable importance were blackberry (*Rubus* sp.), Crofton weed (*Ageratina adenophora*), spear thistle (*Cirsium vulgare*), Paterson's curse (*Echium plantagineum*), Noogoora burr (*Xanthium occidentale*), spiny emex (*Emex australis*) and bracken (*Pteridium esculentum*). Thistles, tussocks and rushes in general were also given high ranking. For each area the four most commonly cited weeds, excluding fireweed, are listed in Table 7.

Although some bias towards ranking fireweed highly may occur in a survey specifically directed to fireweed, it is, nevertheless, evident that it is considered the most important weed of pastures in all areas surveyed, except for Muswellbrook and Bega. The occurrence of problem weeds will, of course, vary between individual properties.

Comparison with dairying

A comparison of the survey results between dairy farms and other grazing properties in the Lismore, Taree, Gloucester, Muswellbrook and Hexham areas revealed a similar response rate—75% and 69% respectively, and no significant difference in the occurrence of fireweed nor the magnitude of the fireweed problem as perceived by respondents. Twice as many dairy farmers as other graziers, however, considered fireweed to be under control. This may well result from the greater intensity of management and the use of competitive pastures on dairy farms.

Fireweed was considered a problem by both groups of respondents for the same reasons, but its presence in pastures used for hay and silage production caused greater concern among dairy farmers than among other graziers (27% compared with 15% of all respondents respectively).

Of the situations said to encourage the growth of fireweed, native pastures and soils of low fertility were more common on dairy farms. The opposite situations such as improved and fertilized pastures and soils of high fertility, as well as cultivated land and heavily grazed pastures, were more stressed by respondents on other grazing properties. Thus, it appears that on intensively farmed dairies, where good pastures are grown, less competitive native pastures and low-fertility soils are more suitable for the growth of fireweed. On the more undulating and less intensive grazing properties, which predominantly have native pastures, soil disturbance and an increase in fertility levels, with perhaps no significant increase in competition from pastures, causes fireweed to thrive. The claim that 'fireweed grows in the hills' was made by a number of respondents who were almost exclusively dairy farmers. An observation shedding light on this subject is that 'on more fertile flats of our farm the individual fireweed plants grow into strong robust plants but the pest is much more prolific in the areas of low fertility soils and natural pastures'.

Control

Over 80% of respondents with fireweed attempt one or more forms of control, the lowest proportion being in the Muswellbrook area (73%) and the highest in the Shoalhaven (100%). Dairy farmers undertake control more often than other graziers. In terms of number of respondents and the amount of time and money spent, control was found to intensify as the fireweed problem increased. Farmers who had experienced poisoning or poor growth of their stock also placed greater emphasis on control strategies. The techniques used in control, their frequency and the relative success of each are given in Table 8.

Hand weeding The success achieved by hand weeding was variable with a some-

Table 7 Main weeds other than fireweed, ranked in order of importance

Grazing properties				
Lismore	**Taree**	**Gloucester**	**Muswellbrook**	**Hexham**
1. Crofton weed	1. Lantana	1. Lantana	1. Saffron thistle	1. Thistles
2. Lantana	2. Rushes	2. Blackberry	2. Bathurst burr	2. Spear thistle
3. Noogoora burr	3. Thistles	3. Crofton weed	3. Variegated thistle	3. Lantana
4. Thistles	4. Bracken	4. Bracken	4. Paterson's curse	4. Paterson's curse
Dairy farms				
Lismore	**Taree**	**Gloucester**	**Muswellbrook**	**Hexham**
1. Crofton weed	1. Thistles	1. Paterson's curse	1. Star thistle	1. Spiny emex
2. Noogoora burr	2. Lantana	2. Blackberry	2. Bathurst burr	2. Thistles
3. Ragweed	3. Rushes	3. Lantana	3. Spiny emex	3. Lantana
4. Lantana	4. Blackberry	4. Thistles	4. Variegated thistle	4. Paterson's curse
County of Cumberland	**Shoalhaven**	**Bega**		
1. Spear thistle	1. Blackberry	1. Blackberry		
2. Thistles	2. Thistles	2. Paterson's curse		
3. Paterson's curse	3. Tussocks	3. Tussocks		
4. Dock	4. Lantana	4. Thistles		

Table 8 Use and success of fireweed control methods

	Level of use		Level of success[B]								
	Overall survey		Overall survey			Dairy farmers[C]			Other graziers[C]		
Control method	**No. of respondents**	**Percentage[A]**	**Low (%)**	**Moderate (%)**	**High (%)**	**Low (%)**	**Moderate (%)**	**High (%)**	**Low (%)**	**Moderate (%)**	**High (%)**
Hand weeding	309	74	37	29	34	36	25	39	56	29	15
Slashing	287	68	41	46	13	36	47	17	48	44	8
Cultivation	79	19	33	54	13	32	53	15	42	50	8
Herbicides	49	12	22	37	41	13	27	60	22	57	21
Grazing with sheep or goats	19	5	11	22	67	25	50	25	7	14	79
Promoting competitive pasture	147	35	21	37	42	13	40	47	26	45	29

[A]As a proportion of respondents who attempt control.
[B]Values are percentages of respondents who attempt control by that method.
[C]Results are for survey areas 1 to 5 only.

what equal number of respondents indicating high, moderate and low levels. This is despite its being the most frequently used form of control. One respondent who was able to keep fireweed within manageable proportions indicated the need to allocate up to 20% of labour time for this purpose.

Hand weeding was attempted by a greater percentage of respondents who either had a small amount of fireweed on their land or who perceived it to be a major problem. Understandably hand weeding was more successful where the infestation was small. Thus hand weeding was very common in areas such as Muswellbrook, Shoalhaven and Bega but considerably less so at Hexham and Gloucester. Notably, the method is more effective on dairy farms. If the earlier comment about fireweed plants being larger but fewer on fertile river flats is generally correct, then this may partly explain why it is easier on dairy farms to pull fireweed by hand. Of those who consider fireweed under control, 80% use this as one of their methods.

Slashing and cultivation Although slashing to control fireweed is more common than cultivation, neither was thought by many respondents to be highly successful. Moderate success was achieved by means of either method, with dairy farms recording better results than other grazing properties.

Both slashing and cultivation were more commonly used where fireweed was more abundant and where farmers considered it a bigger problem. While slashing was utilized on 45% of properties where fireweed was said to be controlled, only 10% practised cultivation.

Herbicides Herbicides were assessed as giving good control, again with most success on dairy farms, but are not applied very extensively and predominantly only when the problem is seen as major. Their most frequent use is in the Lismore, Muswellbrook, County of Cumberland and Shoalhaven regions. Of those respondents who had fireweed under control, 16% used herbicides.

Grazing sheep or goats Grazing with sheep or goats produced very good results but only a small proportion of graziers in the Lismore, Taree and Hexham areas have yet utilized their potential. Their use primarily away from dairy farms reflects the type of management they require (Watson *et al.* 1984; Sindel 1986). Because sheep and goats, unlike cattle and horses, readily eat fireweed and are much less susceptible to pyrrolizidine alkaloid poisoning (Bull 1955), they provide a level of control worthy of serious consideration. Tukidale sheep were suggested as being very effective under coastal conditions.

Competitive pastures The promotion of competitive pasture was considered to be as effective in control as herbicides, and is used more widely. This result is encouraging since competitive pastures offer long-term control. The other methods already discussed, if used singly, offer only a short-term solution and provide opportunities for reinvasion. Herbicides, however, certainly have a place as aids in pasture establishment and maintenance.

Farmers endeavoured to promote competitive pastures as fireweed became more abundant and as their awareness of the problem increased. This was particularly so in the Gloucester and Hexham areas. Of those who consider fireweed under control, 35% employ this method.

The higher success achieved with slashing, herbicides and competitive pastures on dairy farms can be linked primarily to the better soil and environmental conditions. These allow for greater competition against fireweed from the pasture species after application of the control strategy.

It has been reckoned that the best weapons against pasture weeds are often the pasture species themselves as components of a vigorous competitive pasture. Different species or cultivars appropriately managed may fulfil this purpose in different areas. Respondents were asked to indicate from their experience which pastures appeared to control fireweed.

Pastures for control

Pasture species able to control fireweed in the different survey areas are shown in Table 9. Kikuyu (*Pennisetum clandestinum*) was found by 60% of respondents with fireweed to be the best species followed by ryegrass (*Lolium* sp.) (17%) and white clover (*Trifolium repens*) (14%). However, a number of pasture species were each found by a significant group of farmers to be useful in control. The relative importance of these varied between areas and situations; e.g. phalaris (*Phalaris aquatica*) was effective in the County of Cumberland and Rhodes grass (*Chloris gayana*) on grazing properties.

Of particular note are the results for Gloucester and Hexham. Farmers in both areas have experienced the growth of fireweed on their properties for many years (see Table 2), and now almost all affirm that one or more pasture species offer effective control. A high percentage of respondents in the Muswellbrook, Shoalhaven and Bega areas, all relatively new areas of infestation, suggested that no pasture controls fireweed.

Economics of control

Farmers attempting fireweed control spend an estimated average of 56 hours and $152 per year, ranging from 16 h and $34 at Muswellbrook to 84 h and $187 per year at Taree. Over all respondents, this is equivalent to an average of 40 h and $110. For the dairy industry alone in New South Wales, a conservative estimate of some 100 000 man hours and $250 000 are being spent on fireweed control annually.

Farmers grazing sheep or goats spent the least amount of time on control, followed by those who used hand weeding, while the other methods involved more or less the same amount of time. Herbicides and the promotion of competitive pastures were the most costly techniques, followed by slashing and cultivation and then hand weeding. Grazing with sheep and goats was least expensive.

All respondents who originally considered fireweed to be under control had to work to achieve that situation, with some 30% spending over 100 man hours and 56% over $200 per year.

General comments from respondents

Many of the 288 respondents (50%) who made additional comments at the end of the questionnaire expressed concern at the increasing threat posed to them by fireweed, even though some, as yet, have only a few plants on their properties. A smaller number believed that it was not a problem.

Public land and neighbours' properties, where fireweed is allowed to grow with no attempt at restraint, were often cited as factors preventing successful control on a particular individual's farm. These places act as 'seed banks' for reinfestation.

Of foremost concern in the minds of many farmers was the large amount of time required to control fireweed and the overall difficulty encountered in such an endeavour. It is primarily for this reason that fireweed is no longer declared a noxious plant. While some respondents suggested biological methods of control were required, others encouraged further research on the weed.

Conclusions

Having had to cope with fireweed since its introduction to Australia some 70 years ago, dairy farmers and graziers were able through this survey to provide valuable insights into its impact on agriculture and its control. They believe it to be the major weed of improved and unimproved pastures in many areas of coastal New South Wales. Not only does it reduce pasture productivity and the available grazing area but can also cause poisoning and poor growth of stock when grazed or ingested in contaminated hay and silage. Moreover, fireweed continues to spread and seems yet to reach its full potential in Australia. The survey provided some helpful information concerning the imposed cost of fireweed on the farming community with some hundreds of thousands of man hours and dollars being spent on control annually. Because farmers were unable to give sufficiently precise data on the reductions of pasture productivity caused by fireweed, experiments designed to determine such losses should be undertaken. Relating the significance of this weed to other well-known weeds was a useful comparison, and served to highlight the relative importance of each in the areas surveyed.

It is apparent that soil fertility alone is not the all-embracing answer to the fireweed problem, but that the solution must involve other factors also. Further work is

Table 9 Pasture species found to best control fireweed
Values are percentages of respondents with fireweed

Pastures controlling fireweed	Overall survey (%)	Survey areas[A] Lismore (%)	Taree (%)	Gloucester (%)	Muswellbrook (%)	Hexham (%)	County of Cumberland (%)	Shoalhaven (%)	Bega (%)
None	25	37	23	2	50	2	18	43	53
Phalaris	3	–	2	2	–	2	10	–	–
Ryegrass	17	20	29	37	4	19	26	18	–
White clover	14	10	19	24	–	27	26	14	–
Subterranean clover	8	–	6	17	–	21	22	5	–
Kikuyu	60	59	65	91	21	77	54	39	18
Paspalum	11	12	10	15	4	10	16	2	–
Rhodes grass	3	–	4	–	–	2	–	–	–
Setaria	3	15	4	–	–	–	–	–	–

[A]Results for individual areas are for dairy farms only.

required to elucidate this relationship. Respondents seemed aware of the limited usefulness of herbicides and, while the value of competitive pastures has already been noted (Sindel 1986), the results of this survey give confidence in pursuing this line of investigation, particularly in areas where fireweed has appeared most recently. As is the case for other weeds of pastures, an ecological approach towards fireweed control is required, based on the establishment and management of improved pasture or the manipulation of existing pasture species.

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