

Strategic research, development and extension to address weed problems confronting Australian livestock industries

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Summary Weeds are a significant issue for Australian livestock industries but financial resources are limited so research, development and extension (RD&E) needs must be prioritised. This paper summarises the results of an analysis of RD&E since 2003 on weeds that adversely affect livestock industries. We identified weed species as either emerging or already prominent in different geographical areas and livestock management systems. We devised RD&E priorities across species using a decision tree, though its application is necessarily based on imperfect knowledge of key variables. We also identified RD&E issues that are not species-specific. Many of the species that are problematic for livestock enterprises are shared with other sectors; others are the subject of inter-sectoral contentions. These jurisdictional and institutional issues should be addressed. The complexity of the challenge to setting priorities is such that there can be no single ‘correct solution’ to the question of which species should be given priority; it is possible to over-invest in prioritisation.

Keywords Grazing, livestock, priorities.

INTRODUCTION

Like all Australian primary industries, livestock industries and enterprises are subject to the direct and indirect effects of a wide variety of weed problems. They expend considerable amounts of money addressing these weed problems. However, the resources available for either on-ground management, or research and development designed to provide more effective or more efficient control measures, are limited. This points inevitably to the need for prioritisation. We reviewed the current situation regarding research, development and extension (RD&E) relating to weeds of Australian livestock industries. Our aim was to identify defensible, species-specific and generic RD&E priorities. In this paper we provide a brief synopsis of the results and discuss the issues that must be considered in making investment decisions in weed RD&E for livestock industries.

MATERIALS AND METHODS

In 2003, Meat and Livestock Australia (MLA) released a review of national RD&E priorities relevant to weeds of livestock industries (Grice 2003). Our review assessed progress since then. We examined the literature and widely distributed a discussion paper that provided a synopsis and assessment of this material. Following further analysis of the literature and consideration of feedback on the discussion paper we reported our findings to MLA in January 2014.

The literature reviewed included the previous MLA-sponsored report (Grice 2003) and strategy documents prepared for the 32 Weeds of National Significance (WoNS) (Thorp and Lynch 2000, Anon. 2013). We also examined relevant publications from the CRC for Australian Weed Management (Weeds CRC) (2001–2008), the five Australian Weeds Conferences since 2003, journal papers identified using the Web of Science database, relevant PhD and MSc theses, and reports of projects conducted under a range of Australian government initiatives (e.g. Defeating the Weed Menace program, the Australian Weeds Research Centre and the National Weeds and Productivity Research Program) and others funded by MLA.

We applied the following set of definitions:

- Weed – a species that is problematic for some sector(s) whether or not it is problematic for livestock industries.
- Grazing-relevant weed - a ‘weed’ that has positive or negative impacts on livestock industries.
- Prominent weed – a species that is having negative impacts on livestock industries.
- Emerging weed – a species that is not currently having major impacts on livestock industries but which has the potential to do so.
- Priority weed – a priority species for investment by stakeholders in livestock industries.

A list of prominent weeds was derived from results of 17 reviews, surveys and prioritisation exercises conducted for various jurisdictions since 2002. A list of emerging weeds was compiled from sources that included Grice (2003), the National Alert List for Environmental Weeds, publications of the former

Weeds CRC, post-2003 literature and feedback on the discussion paper.

Priority weeds were determined by applying a simple decision tree that required assessments of each species' distribution and abundance, current and potential impacts, the availability of effective control measures, and the prospect of improved control measures being developed (Figure 1).

RESULTS

Grice (2003) listed 142 'weeds of significance to Australian grazing industries' of which 64 were identified as being 'of greatest significance' and 24 were listed as emerging weeds (Grice 2003). These were not mutually exclusive categories.

Our analysis in 2013 identified 71 prominent weeds of which 20 were assigned higher priority for RD&E and 51 were assigned lower priority (Table 1). A preliminary list of 73 taxa that are potentially emerging weeds of livestock industries was reduced to 18 species, five of them being given higher priority, one medium priority and the remainder lower priority (Table 1).

Forty-one species were common to the 2003 'most significant' and 2013 'prominent' weed categories and only ten of the 2013 'prominent' weeds had not been listed in 2003. Twelve out of 18 of the 2013 'emerging' weeds had not been listed at all in 2003. Our report also included 17 recommendations relating to RD&E needs over the next ten years.

DISCUSSION

The 2003 lists of 'most significant' and 'emerging' weeds of grazing industries were compiled from state or regional reports prepared specifically for the exercise, usually by a single individual (Grice 2003). Our 2013 effort attempted a more systematic approach involving a review of literature, more strict definitions and specific selection criteria (Grice *et al.* 2014). It yielded 71 prominent weeds and 18 emerging weeds (Table 1).

The plant species identified in 2013 as most prominent or most likely to emerge as weeds of livestock industries differ greatly between climatic zones. Of the 71 prominent weeds, 16 are found mainly north of the Tropic of Capricorn, 18 to the south and 37 species are widespread. Two-thirds (12) of the emerging weeds are mainly tropical in their distributions.

Some species that were categorised as prominent or emerging weeds of livestock industries are also weeds of other commercial sectors; many are environmental weeds. For example, wild radish (*Raphanus raphanistrum* L.) and fescues (*Vulpia* spp.) are cropping weeds in southern Australia; rubber vine (*Cryptostegia grandiflora* R.Br.), lantana (*Lantana camara* L.) and giant sensitive plant (*Mimosa pigra* L.) are important environmental weeds. Livestock industries are associated with a number of contentious species, most notably species that are valued as forage plants but that are problematic for the environment.

Is weed abundant and widespread?							
Yes				No			
If the weed is not controlled, does it have high impact?				If the weed is not controlled, does it have high impact?			
No		Yes		Yes		No	
Low priority	Are cost-effective control measures available?			Are cost-effective control measures available?			No
	No		Yes	Yes	No		
Can effective control measures be developed within 10 years?		Are control measures well and widely applied?		Is there a high likelihood of further spread and high impact?			
Yes		No	No	Yes	No		
Can effective control measures be developed within 10 years?		Can effective control measures be developed within 10 years?		Can effective control measures be developed within 10 years?		Can effective control measures be developed within 10 years?	
High priority	Low priority	High priority	Low priority	Yes	No	Yes	No
				High priority	Low priority	Medium priority	Low priority

Figure 1. Schematic of decision tree used to prioritise weed species.

Table 1. Summary of sources of information and results derived for prominent and emerging weeds.

Information source	Changes	Outcome	Output
Prominent weeds			
Up to top 10 spp. from each of 13 regional sources	–	66 taxa	Discussion paper
Up to top 10 spp. from each of 4 additional data sources	+7 spp.	73 taxa	Grazing-relevant weeds
Feedback on discussion paper	–16 spp. +14 spp.	71 taxa	Prominent weeds
Processed through decision tree	–	Higher priority 20 spp. Lower priority 51 spp.	Prominent weeds priorities
Emerging weeds			
Grice (2003) Other publications	–	73 taxa	Preliminary list of emerging weeds
Removed native, aquatic and valuable pasture spp.	–21 spp.	52 taxa	Removed spp.
Applied selection criteria for emerging weeds	–34 spp.	18 spp.	Emerging weeds
Processed through decision tree	–	Higher priority 5 spp. Medium priority 1 spp. Lower priority 12 spp.	Emerging weeds priorities

Many do not meet our criteria for being prominent or emerging weeds of livestock industries, an example being buffel grass (*Cenchrus ciliaris* L.). However, one sown pasture species, gamba grass (*Andropogon gayanus* Kunth) was listed as a prominent weed of livestock industries, along with several other high-biomass grasses that are not valued as pasture plants (e.g. Coolatai grass *Hyparrhenia hirta* Stapf., thatch grass *H. rufa* (Nees) Stapf, and *Themeda quadrivalvis* (L.) Kuntze).

Decisions about investment in weed RD&E or on-ground weed management present an important challenge. Many factors might justifiably be considered in making investment decisions.

First, it is important to consider the impacts that a species has or could have. We identified impact criteria that we considered useful for determining which species should be given priority, but detailed, quantitative information for many is not available. For many species there have not been detailed studies of biology and ecology in the Australian livestock industry environment. Further, there has been little work to quantify the economic impacts of weeds on livestock enterprises and industries. Decisions about priorities must often be made in the absence of comprehensive information.

Second, one needs to consider the likely consequences of particular investments based on the

prospects of finding tenable solutions to particular weed problems. These consequences are difficult to predict. For example, it is difficult to confidently predict whether it will be possible to find host-specific biological control agents for a particular weed or the effectiveness of any agents that are released (Morin *et al.* 2013). For both impact criteria and predictions of the consequences of particular investments for individual species, we relied more on ‘expert opinion’ than upon hard data.

Third, it is important to consider how RD&E investments might be distributed geographically. Neither the productive capacity of livestock industries nor the weeds that impinge on that productive capacity are homogeneously distributed across Australia. Investment decisions might consider where, geographically, the greatest industry-level impacts are likely to be (tackle the biggest problems), the greatest industry-level gains might be made (pursue the greatest returns on investment), as well as sources of the resources to be applied to the RD&E (distribute resources in proportion to their geographic origins).

Fourth, there is inevitably some subjectivity in the decision-making process. Stakeholders hold divergent views and interpret the available information in different ways. This is compounded when there are issues over which there may be conflicting interests with other sectors, as is the case with pasture

species that are potentially environmental or cropping weeds.

Species might be given priority because:

- (i) they are currently widespread and so have an impact across a large area;
- (ii) they are restricted in distribution relative to their potential with the assumption that the species might be contained and its impacts limited accordingly;
- (iii) they have a high impact where they occur locally even though they are not currently widespread relative to their potential distribution;
- (iv) they are prospective weeds of livestock industries even though they are not currently having an impact;
- (v) there are no cost-effective control measures currently available;
- (vi) the currently available control measures are ineffective;
- (vii) the currently available control measures are not being applied;
- (viii) there is a high prospect of cost-effective management measures and strategies being developed and applied; and
- (ix) their biology and ecology are poorly known.

The nine broad reasons that might influence priorities do not all drive consistently to the same set of priorities. Prioritisation involves a trade-off that rationalises across the influence of these different driving forces. For example, priority could be given to large problems simply because there is currently no effective solution, or to lesser problems because it is judged that a solution is within reach given a realistic level of investment. The complexity of the prioritisation issue is such that there can be no single 'correct solution' to the question of which species should be given priority, suggesting that it is possible to overinvest in prioritisation processes.

Finally, RD&E priorities should be considered in the light of recent declining trends in capacity and outputs. While RD&E outputs on grazing-relevant weeds have declined in recent years, the decline is not

out of proportion to the general decline in weed outputs overall. Some non-species specific priority areas for RD&E for livestock industries are to:

- (i) test and demonstrate the benefits of weed management at an enterprise level, including economic studies;
- (ii) develop systems approaches to weed issues;
- (iii) encourage biological control programs for priority species for which there are good prospects of success; and
- (iv) develop predictions of the potential distributions of weeds under both current and future climates and devise adaptation responses.

ACKNOWLEDGMENTS

This work was funded as Project B.WEE.0132 by Meat and Livestock Australia. We thank the large number of individuals who contributed to the project through feedback on the discussion paper and discussions with the project team.

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