The economic cost of weeds in pastures systems.

Randall Jones[A] and Jack Sinden[B]

[A]Senior Research Scientist (Economics), NSW Department of Primary Industries and Cooperative Research Centre for Australian Weed Management, Orange, NSW 2800.

[B]Associate Professor, University of New England and Cooperative Research Centre for Australian Weed Management, Armidale, NSW 2351.

Abstract

Weeds are an important issue to Australian farmers and consumers of agricultural products. The total annual cost of weeds to livestock industries based on pasture systems is $2404 million, which on average represents a 15% reduction in the gross value of production of livestock commodities. Integrated weed management is an important strategy for managing weeds in the long-term. Appropriate options for pasture based systems include herbicides, fertilisers and grazing management tactics. It is shown in this paper that there are significant economic benefits from adopting a flexible management approach to weeds compared to a standard continuous stocking rate management approach.

Introduction

Weeds are one of the major economic problems facing Australian agriculture, costing annually between $3500 and $4500 million (Sinden *et al.* 2004). The farm-level impacts of weeds can vary significantly depending upon the pasture type, the livestock system, weed species, and environmental conditions. In the case of grazing systems the impact of weeds are primarily experienced as an opportunity cost rather than direct costs of control (eg herbicides). The opportunity cost is mostly derived from a reduction in stocking rates compared to the potential rate of livestock production that could occur in the absence of weeds.

The purpose of this paper is to present some estimates of the economic impact of weeds in pasture based production systems and to introduce some concepts that can reduce these costs in the long-term. Integrated weed management is a term often used to promote better weed management and usually consists of a package of weed control options. In pasture based systems these would include herbicides, fertilisers and grazing management tactics. Economic analysis demonstrates that there are long-term benefits from adopting a pasture management approach that maintains a reasonable level of perennial grass composition and minimising the composition of annual grass and broadleaf weeds.

The economic impact of weeds

Industry impacts

Weeds in pasture systems impose a number of costs, mostly through direct financial costs and opportunity costs. Financial costs are the direct money costs of control, and examples include herbicides and their application costs, fuel, labour and other material costs incurred in weed control. Opportunity costs are income that is foregone due to the competitive effects of weeds in the production system. In cropping systems this is generally reflected in reduced crop yields, while in pasture systems it is more likely to be through reduced stock carrying capacities. The lower stocking rates result in income foregone compared to a weed-free situation, and the income foregone is referred to as the opportunity cost. As weed densities increase in pasture systems, not only is there a reduction in the biomass of desirable species, but there is also a negative change in the species composition of a pasture which can have long term implications on farm returns.

At an industry level the economic impact of weeds is best measured using economic welfare techniques. Economic welfare is the well-being of the whole community, and is measured as the sum of producers' surplus and consumers' surplus. Producers' surplus is measured at an industry level and is the difference between revenue derived from producing a commodity and the costs of production. Consumers' surplus is the difference between the amount that consumers would be willing to pay and the amount they have to pay for a particular good or service.

The impact of weeds upon pasture systems is given in Table 1, with the mean annual cost to the Australian livestock industries being $2404 million. This was comprised of losses of $1709 million to producers and $607 million to consumers of livestock products. The loss to consumers arises because prices of food are higher and the available quantities of agricultural output are lower than they otherwise would have been. Producers lose due to the reduced production that occurs because of weeds, which is not compensated for by any (slightly) higher prices received because of the reduced market supply. Of the total loss in economic welfare due to weeds in Australian pasture systems, consumers accounted for 25% and producers accounted for 75% of the total loss.

The contribution to the total loss due to weeds was $650 million by the dairy industry, $588 million by the wool industry, $283 million by the sheep meat industry, and $883 million by the beef industry. The estimated economic loss due to weeds in each industry was compared to the 2003–04 gross value of production for each industry (ABARE 2004), with the results plotted in Figure 1. This indicates that the dairy industry experiences the greatest proportional loss due to weeds (19%), followed by the wool industry (17%), the beef industry (11%) and the sheep meat industry (11%). These results indicate that weeds are one of the more significant economic issues to Australian pasture systems.

Paddock level economic impacts: a case-study

Despite the national cost estimate, there is considerable variability in the economic impact of weeds in pasture systems at a paddock or farm level. This impact will depend upon the type of pasture (i.e. species present), the livestock enterprise, weed type, and seasonal conditions.

A grazing systems model to estimate changes in economic returns, measured by a farm enterprise gross margin was used for various perennial pasture types and weed composition levels. The case study area is the Central Tablelands of NSW, the livestock type is a self replacing merino ewe enterprise,

Table 1 Annual economic losses due to weeds in Australia's pasture based industries ($ million).

Industry	Loss to consumers	Loss to producers	Economic loss
Dairy	178	472	650
Wool	230	358	588
Sheep meat	141	143	283
Beef	59	824	883
Total	607	1797	2404

and the weed type is a mix of annual grass species (eg *Vulpia* spp., *Hordeum leporinum*) and broadleaf weeds (eg *Echium* spp.). Two perennial pasture types were considered: an introduced perennial grass mix (phalaris, cocksfoot and subclover), and a native perennial grass mix (*Microlaena*, *Austrodanthonia* and *Bothriochloa*) with some subclover.

The weed composition was varied from zero to 100% of the pasture sward, and the optimal stocking rate (head/ha) and gross margin per hectare (GM/ha) were estimated at each composition. This analysis is largely a measure of the opportunity costs of weeds at a paddock level, as direct financial control options such as herbicides were not considered.

For introduced perennial pasture systems there is a steady decline in returns from around $270/ha to $50/ha as weed composition increases (Figure 2). The loss in economic returns is also expressed as a proportion of the maximum returns than can be obtained from the pasture system (Figure 3), which indicates that there is a loss of about 80% at the

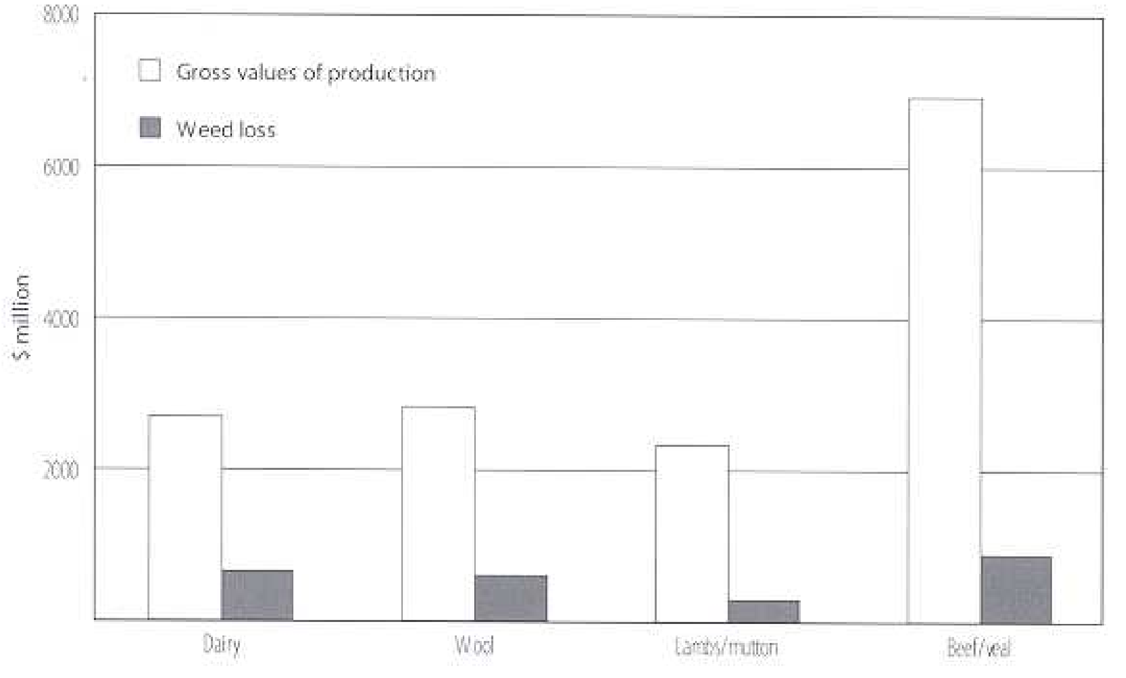

Figure 1 The total gross value of production (2003-04) and weed losses for Australia's pasture based industries ($ million).

maximum weed composition. The pattern of loss due to weeds is slightly different in the case of a native perennial pasture system. There is an increase in gross margin as weeds increase from zero to 20% weed composition, and gross margin declines thereafter as weed composition increases. As weed composition approaches the maximum, the difference in gross margin between the introduced and native perennial systems is diminished. The results illustrated in Figure 3 indicate that the maximum returns from a native pasture coincide with a weed composition of around 15%, and that for any given weed composition the proportional loss is less with the native perennial system than with the introduced perennial system. Similar patterns of weed loss are expected with different livestock systems and regional areas, although the magnitude of the losses will differ to those presented here.

Options for reducing weed impact

Although it has been determined that weeds impose significant costs upon individual pasture systems and Australian livestock industries, it is relevant to ask what can be done to ameliorate these costs. Producers are largely most interested in what options are available for reducing weed impact and maximising returns from pasture systems. Integrated weed management (IWM) has been proposed as a technique for managing weeds over the long term. IWM can be thought of as a sustainable management system that combines all appropriate weed control options, and does not rely on any single option (eg herbicides) for controlling weeds (Sindel 2000). In pasture systems IWM may combine options such as herbicides, fertilisers and grazing management tactics to promote desirable species at the expense of undesirable species, or weeds.

Examples of economic evaluations of weed management in grazing systems are for improved vulpia management in south-eastern Australia (Vere *et al.* 2002) and the benefits of tactical grazing rests to improve the composition of perennial species (Jones and Dowling 2005; Jones *et al.* 2006). Annual grass weeds, in particular *Vulpia* spp., are a significant factor of reduced agricultural output in south-eastern Australian livestock systems, estimated at being up to $27 million per annum for the wool industry. Research into improved vulpia management technologies by NSW Department of Primary Industries and the Cooperative Research Centre for Australian Weed Management has the potential to result in high returns to producers and consumers. Management options include strategic grazing rests over summer, fertiliser, herbicides and resowing of pasture. An economic evaluation of a 10% reduction

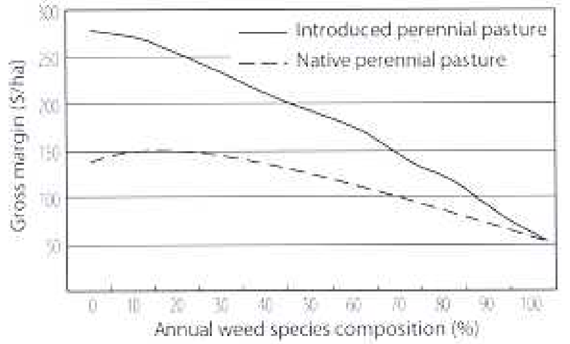

Figure 2 The impact upon gross margin of two pasture systems of an increase in the composition of annual weed species..

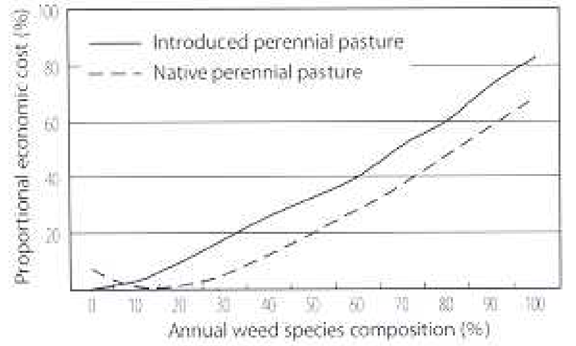

Figure 3 The cost of weeds for two pasture systems represented as a proportional reduction in gross margin due to an increase in the composition of annual weed species.

in vulpia infestations from current levels resulted in a net benefit to the industry over 15 years of $255 million, and a benefit-cost ratio of 85:1.

The economic benefits of an IWM strategy involving fertiliser application and summer tactical grazing rests to promote perennial species composition and reduce annual grass and broadleaf weeds was identified for a site on the Central Tablelands of NSW. A grazing simulation model (Jones *et al.* 2006) was solved for a 20-year period for a range of continuous grazing stocking rates and tactical rest scenarios. The case study livestock system was a merino wether enterprise and stocking rates ranged from 5 to 12.5 wethers/ha, and the pasture type was a sown introduced perennial grass system (phalaris, cocksfoot and subclover) with an initial perennial grass composition of 80%. If perennial grass composition fell below a threshold of 50%, then a tactical summer rest could be employed. The analysis also tracked soil fertility and imposed a phosphorous fertiliser application at a rate of 125 kg/ha when fertility declined below a threshold of 10 soil P (Bray).

The net present values (NPV) over the 20-year period were estimated for a range of scenarios (Table 2). For the continuous stocking rate option the maximum NPV of $732/ha was associated with a stocking rate of 7.5 wethers/ha, and as stocking rate increased from

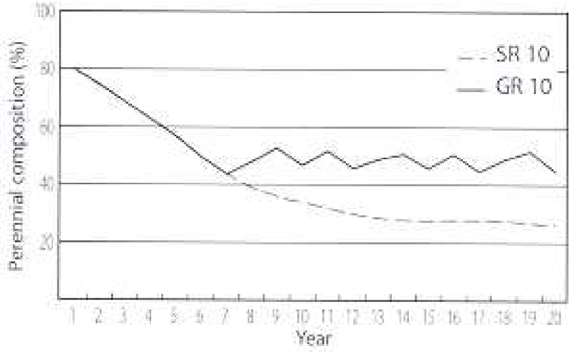

Figure 4 Perennial grass composition over a 20-year simulation for a continuous grazing system at 10 ewes/ha (SR10) and grazing system involving a stocking rate of 10 ewes/ha and a tactical summer rest when perennial composition falls below 50% (GR10)..

this level there was a considerable decline in NPV. At the lower stocking rates (5 and 7.5 wethers/ha), there was no economic benefit from adopting a tactical summer rest. The grazing rest strategy provides significant benefits at the higher stocking rate strategies with a NPV of $1238/ha derived for a 12.5 wether/ha stocking rate with a summer rest imposed when perennial grass composition declined below 50%. This represents a 70% improvement in the NPV over the 20-year period compared to the best return that could be obtained from a continuous stocking rate strategy. The perennial grass composition for two scenarios, continuous stocking at 10 wethers/ha (SR10) and the same stocking rate with a grazing rest (GR10) option, was calculated over the 20-years. This illustrates how the periodic use of a grazing rest can maintain perennial grass at a composition of around 50%, whereas perennial grass declines further under the continuous grazing strategy.

Summary

The economic costs of weeds in pasture systems at an industry and paddock level were presented. This suggests that weeds are a serious economic issue to Australian livestock industries. Consequently, options that ameliorate the impact of weeds can return substantial economic benefits to producers and industry. Integrated weed management is one such option, particularly where it includes grazing management tactics to shift species composition from undesirable annual grass and broadleaf weed species to more desirable native and introduced perennial grasses. In this paper a case-study analysis indicated that an IWM strategy that included a tactical summer rest could improve economic returns by 70% over a 20-year period compared to a continuous stocking rate strategy.

Table 2 Economic returns over a 20-year simulation period (net present value) for a continuous stocking system and a system with a summer rest when perennial grass composition falls below 50% ($/ha).

Stocking rate	Continuous stocking	With summer rest
5 ewes/ha	341	316
7.5 ewes/ha	732	664
10 ewes/ha	482	989
12.5 ewes/ha	180	1238

Acknowledgements

We would like to acknowledge the financial assistance and support of the CRC for Australian Weed Management for funding part of this research. We would also like to thank our colleagues Cheryl Kalish and Garry Griffith for providing guidance and assistance for this research.

References

ABARE (2004). Australian Commodity Statistics 2004. ABARE Project 1059. Australian Government, Canberra.

Jones, R. and Dowling, P. (2005). Sustainability and economics of temperate perennial grazing systems. *Agriculture, Ecosystems and Environment* **106**, 359–376.

Jones, R., Dowling, P., Michalk, D. and King, W. (2006). Sustainable grazing systems for the Central Tablelands of New South Wales. 5. A bio-economic framework for assessing the long-term economic benefits of grazing management tactics and implications for sustainability. *Australian Journal of Experimental Agriculture* **46**, 495–502.

Sindel, B.M. (2000). The history of integrated weed management. *In* 'Australian Weed Management Systems'. (ed B.M. Sindel). R.G. and F.J. Richardson, Melbourne.

Sinden, J., Jones, R., Hester, S., Odom, D., Kalisch, S., James, R. and Cacho, O. (2004). The economic impact of weeds in Australia. Technical Series 8, CRC for Australian Weed Management, Adelaide.

Sinden, J., Jones, R., Hester, S., Odom, D., Kalisch, S., James, R., Cacho, O. and Griffith, G. (2005). The economic impact of weeds in Australia. *Plant Protection Quarterly* **20**, 25–32.

Vere, D.T., Jones, R.E. and Griffith, G.R. (2003). Economic benefits of public investment in weed management: the case of vulpia in south-eastern Australia's temperate pasture areas. *Australian Journal of Agricultural and Resource Economics* **47**, 519–539.