The GRASSLAND SOCIETY of NSW Inc.

21st Annual Conference

Waging War on Weeds

Battle Plans and Winning Strategies

25th-27th July 2006

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The GRASSLAND SOCIETY of NSW Inc.

Proceedings of the 21st Annual Conference
of The Grassland Society of NSW Inc.

Edited by
Belinda Hackney, Kristy Bailes, John Piltz and Helen Burns

Waging War on Weeds

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The GRASSLAND SOCIETY of NSW Inc.

A unique blend of people with a common interest in developing our most important resource–our grasslands.

The Grassland Society of NSW Inc. was formed in March 1985. The society now has over 600 members most of whom are farmers and graziers. The balance is made up of agricultural scientists, farm advisers, consultants, and executives or representatives of organisations concerned with fertilisers, seeds, chemicals and machinery.

The aims of the Society are to provide opportunities for members to meet in conference, at field days, or socially, to exchange information, ideas and experiences relating to grasslands.

Other aims of the Society are to advance the investigation of problems affecting grasslands husbandry and to encourage the adoption into practice of results of research and practical experience. The Society holds an annual conference, publishes a quarterly newsletter, holds field days, and has established regional branches throughout the State.

Membership is open to any person or company interested in grassland management and the aims of the Society. Ordinary (including family or farm units), student and corporate memberships are available.

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Preface

A very warm welcome to all members attending this, the 21st Annual Conference of The Grassland Society of NSW Inc.

An equally warm welcome to those who are not members of this Society. I encourage you to join us and enjoy the many benefits of membership. Application forms are available from the registration desk or can be printed from our internet site: www.grasslandnsw.com.au

This is not the first conference of The Grassland Society of NSW Inc. to take place at Wagga Wagga. Since our formation in 1985 at Orange, there have been several very successful conferences held in this city. This conference promises to be of a similarly high standard and is designed to provide all delegates with the opportunity to hear, discuss and see cutting edge agricultural technology in a relaxed environment.

Plant and animal production depends heavily on new and developing technology as well as sound agricultural science. The Grassland Society is a forum to bring together producers, agronomists, agribusiness firms, animal scientists and teachers of agriculture to review and exchange high quality information of relevance to grassland farming. The objective is the promotion of animal and plant production systems that embrace improved efficiencies and environmental responsibility. Pastures; native and introduced, are the powerhouse of agriculture in all it's forms across Australia. They provide for the grazing animal and microbial activity under the ground. In turn, pastures depend on good soil health to sustain production and suppress invasion by unproductive species.

This conference examines the vital subject of weeds as they confront producers, technologists and the environment, within the overall theme of *Waging war on Weeds*.

The organizing committee has put much time and effort into selecting expert speakers to cover relevant topics of interest that will bring delegates up to date with all aspects of weed management. The conference convener, Belinda Hackney and her team are to be congratulated and thanked for putting together such a stimulating program of formal sessions and paddock tours.

I would like to acknowledge our many sponsors from the corporate and government agency world who regularly support the Society. Conferences of this nature do not happen without the substantial assistance of our sponsors. I encourage all conference delegates to visit the well prepared commercial displays and exhibits. They are full of current information on new pasture varieties, fertilizer products, herbicides and management strategies to assist producers and their advisers. Please take time to talk with representatives of the trade exhibits. They are a valuable source of information and are always happy to discuss product developments with conference delegates.

Finally, I thank all those who are here to enjoy and learn from this conference. The Grassland Society is keen to maintain the high standards and tradition of previous years. We willingly accept suggestions to improve future activities. Please feel free to let any member of the committee know your thoughts in this regard. After all, the Society is only as effective as it's membership and depends on individual members for it's continued existence.

Best wishes for a most enjoyable conference.

Mick Duncan

Executive President

Invited Papers 1

Day 1 Tuesday 25th July

Day 2 Wednesday 26th July

Day 3 Thursday 27th July

The GRASSLAND SOCIETY of NSW Inc.
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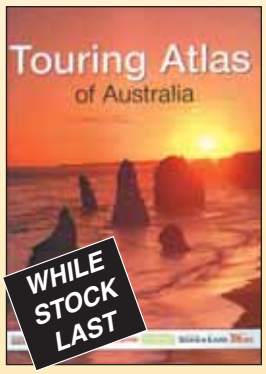

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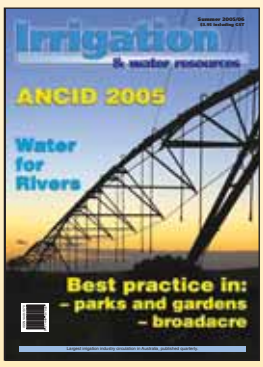

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Farming - 'a great means of wealth creation, but who's managing it'.

Peter Jacobs
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13/452 Flinders Street, Melbourne, Vic 3000

Abstract

This paper identifies that modern farm businesses have three key aspects to consider in order to optimise business and farm capital performance. These three aspects comprise the need to continue to farm more efficiently, the need to increase farm scale and the need to consider investment outside the farm sector. Few farmers actively manage off-farm investment programs despite these having a capacity to enhance wealth creation and provide other tangible benefits to the farm sector.

Introduction

The Australian agribusiness sector is often depicted in negative terms particularly by the media given the variety of events which make good copy including droughts, floods, insect and pest attacks and the inevitable commodity price cycle downturns. For those in society removed from direct contact with agriculture, many could be forgiven for considering farm communities as an economic wasteland and a sector requiring ever increasing financial support at the hands of the taxpayer.

However from our perspective as agribusiness bankers we witness something very different because we see very few farm business failures, substantial levels of reinvestment by farmers back into their business to improve efficiency and wealth creation by asset accumulation often over generations. These positives have created new investment by the leading financial institutions into their agribusiness offerings resulting in improved understanding of farm financial cycles, increased flexibility and sophistication in farm lending packages and access to loans often at premium borrowing levels.

Clearly there is a disconnect between the public view of agriculture and the reality of agriculture from a business view point.

The challenge for the farmer is to firmly decide which camp they wish to be in; the cultural practice of farming as a life style where profit and conditions always seem to be against you, or the business of farming as a pathway to sustained wealth creation.

For those that decide they are in the business of farming and as such are committed to optimise the business performance of the operation, farming provides significant wealth creation opportunities but in order to capture these opportunities farmers need to actively concentrate on both the physical process of farming as well as managing the farm capital.

Key aspects of business performance

There are three key aspects that farmers should consider focusing on in order to derive optimum business performance.

These aspects comprise the need for farmers to:

- Farm better – to maximize operational efficiency and enhance economic returns and generate cashflow.
- Get more farm – benefits of economies of scale, ability to stay commercially relevant.
- Use the asset rich farm balance sheet to invest in other sectors – to diversify the asset and income base away from the farm, improve retirement and succession plan aspects and gain increased wealth and consistency in income returns whilst still farming.

In general, farmers have traditionally undertaken the first two aspects reasonably well. However the concept of using the farm assets to invest into other sectors is an area that not many have undertaken, despite the fact that farmers have significant capacity to invest into other sectors and that strong evidence exists to suggest that many positive benefits could be gained by farmers in doing so. The latent capacity is readily apparent when the neighbour's farm comes onto the market!

Farm better

Operational efficiency is vital in order for farmers to remain financially sustainable given the long term adverse trend in Australian farm sector terms of trade. Put simply this means every year, each dollar grossed from the farm will deliver less surplus given costs are increasing faster than returns. The only way to

combat this trend in order to stay financially viable is to manage for increased operational efficiency either by increasing outputs off the same level of inputs or maintaining the same level of outputs but in doing so lower input costs (Figure 1).

Clearly concentration on aspects such as weed cost and controls plays an important part in farming better and as such your attendance at the Grasslands Society – Waging War on Weeds conference is a key indication that you are all in the business of farming in a professional manner.

Numerous studies and analysis of statistical data on the Australian farm sector have revealed that management plays an important part in achieving enhanced economic returns which ultimately contributes to increased wealth for farmers.

Segment analysis of the economic performance of farm management invariably reveals that the top performing segment out performs the average of the study group by often factors as high as 100%.

Enhanced economic performance leads to increased capacity to grow the business due to increased surplus cash being available to reinvest or being directed to debt service expenses enabling unused leveraged capital expenditure back into the farm business.

If I wear my land valuer hat for a moment, it is interesting to note that highly efficient and profitable farms may not have this benefit reflected fully in the value of the assets given most Australian farms do not involve analysis of trading figures as part of the asset sale process. Well presented farms would in most cases be likely to sell at upper valuation range levels however this is not always the case given the various factors that drive property values.

However poor management can have an adverse effect on capital values despite the current strong rural property markets. This is evidenced via a recent valuation which I have reviewed involving a property where pasture management had been poor. In essence the valuation of this property given the farm's lower carrying capacity has incurred a 30% discount compared to the potential value of the property if well managed.

The clear message under the heading of 'farm better' is that operational efficiency is important to farm economic wealth and can be managed for improved performance. It is likely to impact on future economic fortunes within farming and in particular cases can have a major impact on farm capital wealth.

Get more farm

The 'get big or get out' message has long prevailed in the agribusiness sector and culturally the sector is predisposed to growing the business via further farm land acquisition. ABARE statistics have revealed that record levels of farm land transactions have been in occurring in Australia since 2000 with consequent strong land value appreciation occurring.

Whilst a constant debate exists over the issue of what constitutes on economic farm size, considerable research exist to suggest that farm size is a critical factor to overall farm economic performance. An important component of economy of scale is the capacity to potentially lower a farm operations fixed cost ratio. Any lowering in cost ratio's potentially assists the farm business stay in front of its declining terms of trade resulting in enhanced economic performance.

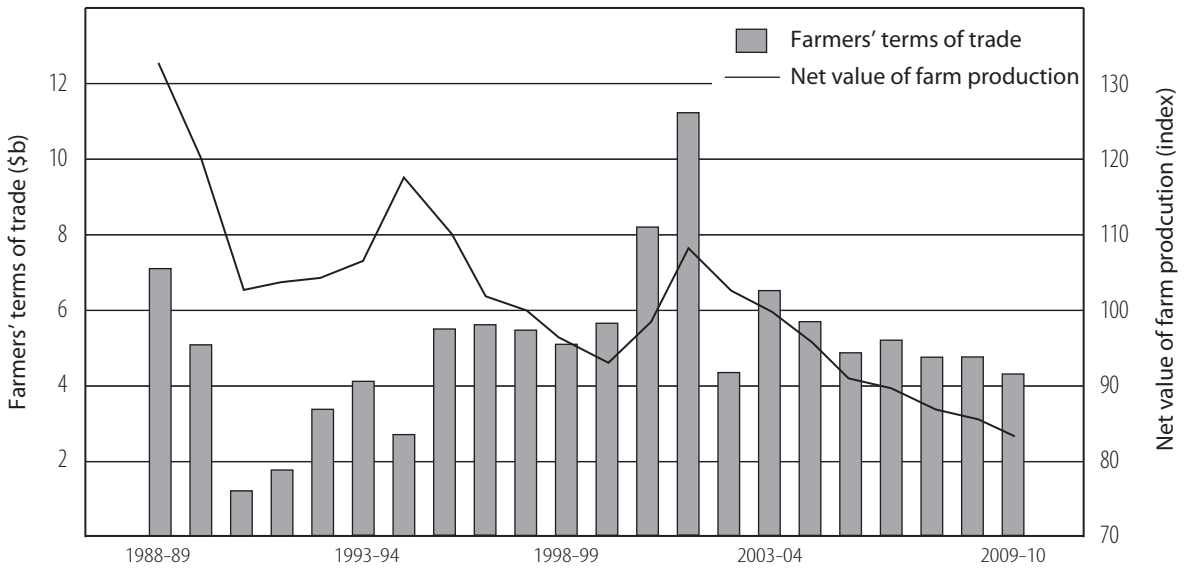

Figure 1 The value of Australian farm production and terms of trade expressed in 2004/05 dollars from 1988 and projected forecast to 2010. Source: Australian Commodities, Volume 12 No. 1 March quarter 2005. ABARE.

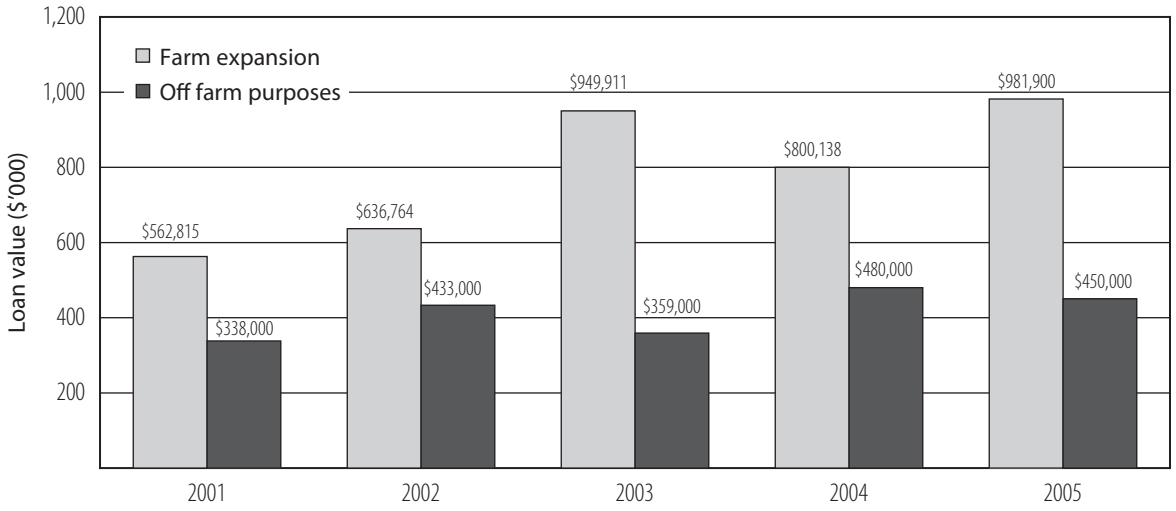

Figure 2 Average value of ANZ loan approvals for farm expansion and off-farm purposes 2001-2005. Source: ANZ Internal Data (Risk Online).

Other benefits of scale include the potential for more efficient use of often high cost technology such as irrigation systems, farm plant (eg tractors and harvesting equipment), increased 'upside' potential for elevated earnings to occur when the combination of yield and price turn favourable. Further benefits of a larger scale can comprise production and geographical diversification and a larger capital base to derive capital appreciation over the longer term.

The difficulty for farmers in regard to farm expansion activity is that the opportunity to expand often comes unplanned as it is invariably driven by the sudden opportunity of a neighbouring farm being placed on the market. Frequently it will occur at an inopportune time for the potential acquiring farmer, presents itself during a high land value period (farmers tend to sit out poor periods and sell in the next upside or improved valuation period) and of course can never be tailored in regard to size to match the perfect expansion fit for the acquiring farm business.

As such, farm expansion can prove a difficult course to manage and may present new risks. Farm expansion now also often demands larger debt exposure due to the higher land values and these farmers must become more informed about debt and capital management.

The amounts involved in financing expansion have increased significantly. ANZ lending data reveals that the average size loan approval for farm expansion purposes has nearly doubled in the last three years increasing from $560,000 in 2002 to $980,000 in 2005. This significant increase in debt requirement means that farmers most likely need to hone their financial literacy and farm capital management skills in order to manage this new level of capital effectively.

However now that very high land values exist, the decision to expand is now less clear, both on economic return analysis and more importantly financial capacity to fund the purchase. Farm income levels have not lifted anywhere near the increase in land values and in many parts of Australia, returns in excess of 2% from farming are proving difficult to achieve. As such, the farm cashflow position has tightened for farmers debt funding or contemplating debt funded farm expansion and demands significant consideration (Figure 2).

Another aspect in regard to farm expansion is the issue associated with competition. Part of the equation leading to high land values involves competition among farmers for the land. ANZ has experienced numerous auctions of farm land where more than one of its farm customers have gained approval to purchase the same parcel of land – clearly only one can emerge as the successful purchaser. New forms of competition are arising for farm land including demand for land from 'hill changers', urban encroachment, managed investment schemes, investment syndicates and superannuation funds. For many in agriculture there is a sense of being 'land locked' due to local values and competition rendering further farm expansion unlikely.

For many farmers, the need to expand has also come in to question due to family succession issues. Statistics are revealing that the passing of the farm to the next generation has reduced dramatically since the 1970s as less young people elect to resume the traditional farm family path of intergenerational farm transfer.

Therefore despite farm expansion being a key attribute to on-going farm business success for many it is now not an option likely to be pursued prompting the question as to what other aspects do farmers need to consider in order to continue to remain in front of the farm cost price squeeze.

Use the farm to invest in other sectors

Farmers can potentially derive increased revenues and wealth creation from their farm businesses if they viewed their farm businesses in two parts, one being the management of the farm itself in terms of production and operational efficiency with the other being the management of the farm capital via utilising the equity built up in the farm and its subsequent income to leverage into investments away from the farm designed to provide diversified income and further capital gains.

Farmers have a significant financial capacity to make investments into other sectors outside the farm yet very few do so despite evidence suggesting that investments in off-farm can provide favourable returns (particularly when compared to the farm) over long term.

Despite these opportunities, very few farmers undertake off-farm investments with ANZ lending figure revealing that loan approvals for off –farm investment purposes comprise less than 5 % of approvals for farm expansion purposes (Figure 3).

The aspect of lack of off-farm investment appears to strongly reflect cultural or traditional capital management practices rather than any specific financial or economic reason and requires questioning and consideration in a modern farm business. Although the old adage of not investing in anything you do not understand is still relevant, farmers, if committed to farm capital optimisation can improve their understanding of markets and investment and have ready access to advice in this area. Evidence has emerged to demonstrate that whilst farm land is a good store of wealth and has recently experienced

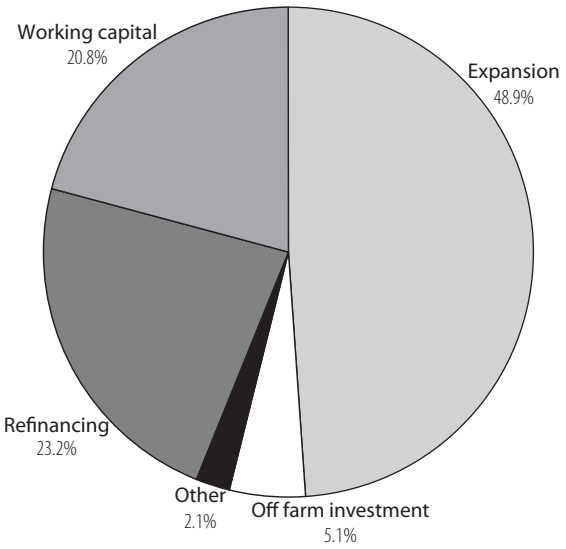

Figure 3 Purpose of lending by ANZ to Australian farmers (average 2002-2005).
Source: ANZ Internal Data (Risk Online).

significant increases in values, it lags other investment mediums in regard to returns and thus farmers should consider investment diversification into these sectors to optimise total returns to their businesses (Figure 4).

Conclusion

In concluding, farming in Australia in the new millennium remains an attractive business sector particularly for those willing to manage their farms on key business principles including focus on capital management aspects of the farm. The later is becoming increasingly important given the capital cost of farming and the value of assets required to farm. Three key aspects where farm management should continue to concentrate comprise increasing

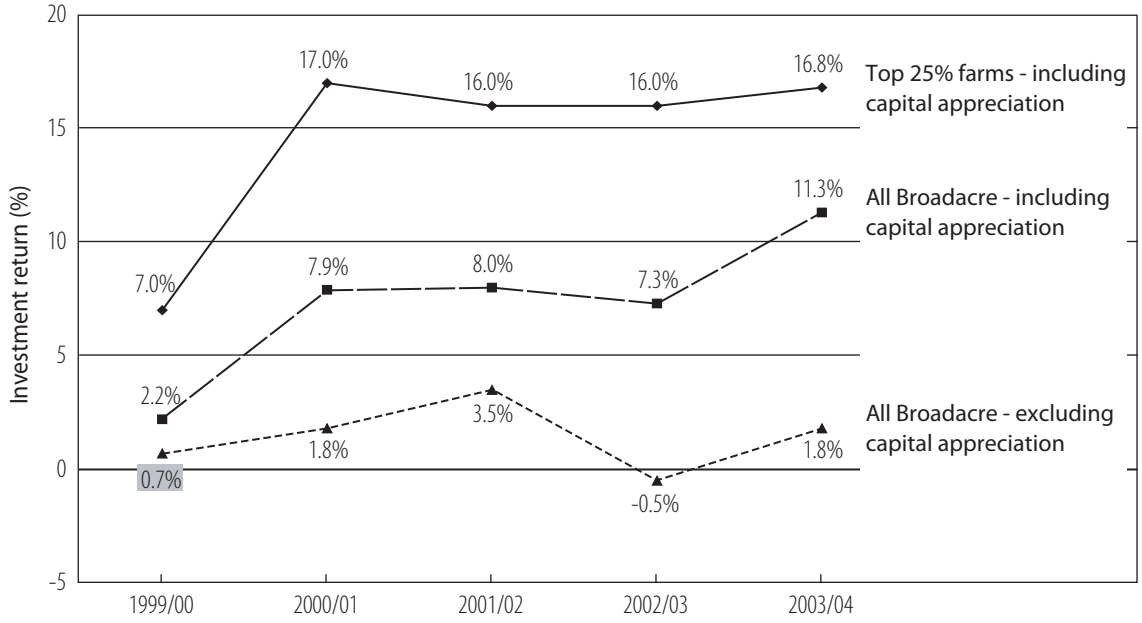

Figure 4 Investment returns. Source: ABARE data extract.

farm efficiency on-farm, farm expansion planning and execution and importantly consideration of off-farm investment opportunities. The later has not formed a key part of traditional farm management practices yet strong evidence exists in both financial and economic terms that this practice could bring significant new opportunities to traditional farm businesses in the form of farm risk management and income and asset diversification.

Simply put the modern day Farmer must learn to 'farm the farm' and also to 'farm the farm capital'.

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The economic cost of weeds in pastures systems.

Randall Jones[A] and Jack Sinden[B]

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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.

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

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, 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

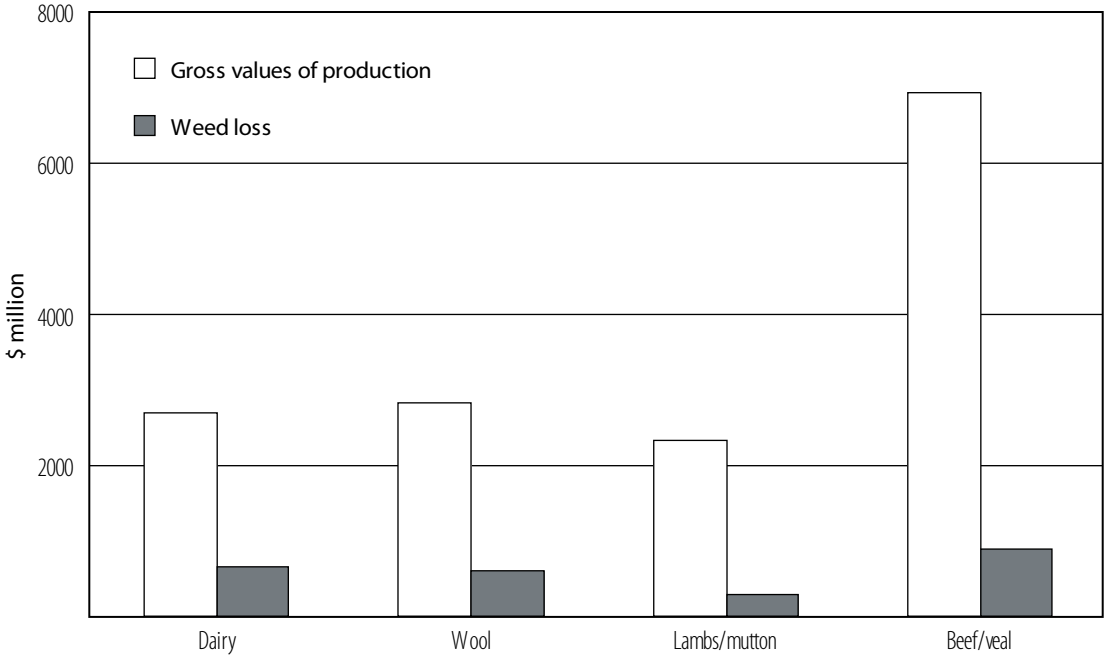

Figure 1 The total gross value of production (2003-04) and weed losses for Australia's pasture based industries ($ million).

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

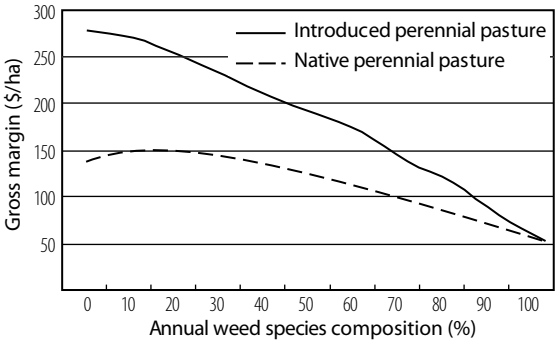

Figure 2 The impact upon gross margin of two pasture systems of an increase in the composition of annual weed species..

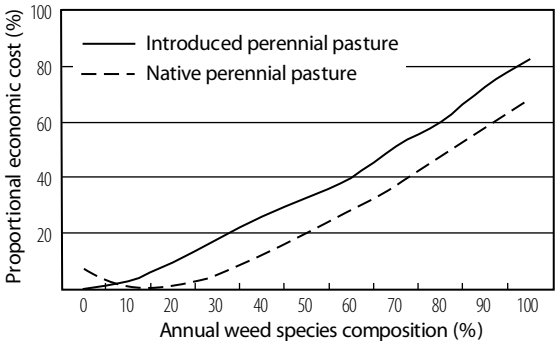

Figure 3 The cost of weeds for two pasture systems represented as a proportional reduction in gross margin due to an increase in the composition of annual weed species.

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

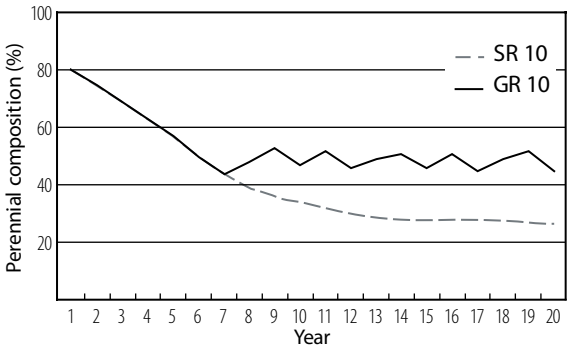

Figure 4 Perennial grass composition over a 20-year simulation for a continuous grazing system at 10 ewes/ha (SR10) and grazing system involving a stocking rate of 10 ewes/ha and a tactical summer rest when perennial composition falls below 50% (GR10)..

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

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Weed introductions: what has been learned from the past that can help stop future weed problems?

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Abstract

Australia has long history of exotic plant introduction, but the last 200-300 years has seen a dramatic rise in exotic species naturalisation. Of the estimated 27, 000 introduced plant species, approximately 3,480 are considered weeds, and 954 of these are weeds of agriculture. Several relatively recent efforts have been made to prevent the introduction of further high-impact weeds, and these are discussed at the Border and Post-Border level, and from an industry perspective. Suggestions for areas of improvement are made, and candidates for future weed species are identified.

Introduction

The introduction of exotic plant species to Australia has occurred for many thousands of years. However, the number of species introduced greatly increased with European discovery and settlement in the 1700s. For example in South Australia, over 900 species have naturalised in less than 200 years, compared to an estimated 60 species in the several million years prior (Kloot 1991). The last 200–300 years has seen mass global movement of plant species (Low 2002), the impact of which we are yet to fully witness and understand.

Australia currently has an estimated 27,000 introduced plant species, of which 3480 are considered weeds (Virtue *et al.* 2004). If there were no weeds in agricultural systems, producers and consumers would be an estimated $4 billion dollars per annum richer (Sinden *et al.* 2004).

Origin of Australian agricultural weeds

Of the 954 known agricultural weeds, 26 have originated from the food crops sector, 159 from the pastures sector, 660 from the gardening sector, and 84 from accidental introduction, usually as contaminants of grain, fodder, ballast, packing or livestock (Virtue *et al.* 2004).

Many serious agricultural weeds were introduced from all around the world into Australia in the 1800s or early 1900s (Table 1). Early European explorers and settlers brought with them an enormous selection of plant species, purposely or inadvertently, the impact of which we are still realising two centuries later. Botanists were recording weed species in the Sydney area as early as 1802–1804, and *Marrubium vulgare* (horehound) and *Arctotheca calendula* (capeweed) were dominating landscapes in Tasmania and South Australia in the 1850s and 1860s (Low 1999).

In more recent times, agricultural weed species have continued to enter Australia as contaminants of agricultural products, and purposely for ornamental or medicinal uses. Many species introduced as potential pastures have also become weeds, mainly as environmental rather than agricultural weeds. *Eragrostis curvula*, which is now a declared species in Tasmania, South Australia and New South Wales, was introduced as a potential pasture species and soil stabiliser. The palatable variety 'Consul' is a valuable pasture species in some areas, and is used successfully to control spiny burrgrass (*Cenchrus incertus* and *C. longispinus*) (Bennett and Virtue 2004), however the other unpalatable lines are serious agricultural and environmental weeds.

Learning from past mistakes

The cost of weeds to the Australian economy and environment was recently quantified (Sinden *et al.* 2004) but has been known to be significant for many decades. Awareness of invasive species has also increased globally, and Australia is now much more cautious regarding plant introductions. This is reflected in relatively recent policy changes described below.

Border control

An Australian Quarantine Act has been in place since 1908, which empowered the Australian Quarantine and Inspection Service (AQIS) to regulate the importation of all plant material into Australia. Prior to 1997, the importation of a plant species was permitted provided the species was

Table 1 Weed species common in NSW pastures (mostly from Dellow *et al*. 2002). Country of origin, year of introduction to Australia and purpose for introduction reference from Groves *et al.* (1995), Panetta *et al.* (1998), Muyt (2001), Cocks (1976).

Species	Common name	Country of origin	Year introduced	Purpose for introduction
Bromus diandrus	Annual brome grass Great Brome	Eurasia - Mediterranean	1875	Most likely contaminant of ballast, seeds, forages, livestock
Carduus nutans ssp. *nutans*	Nodding thistle	Europe, Asia, North Africa, Siberia	1950	Seed contaminant
Carthamus lanatus	Saffron thistle	Mediterranean, Western Asia	Probably 1860s	Possibly medicinal, contaminant of fodder or seed
Echium plantagineum	Paterson's curse Salvation Jane	Western Mediterranean (Spain, Portugal, Morocco)	1850s 1917	Ornamental Seed contaminant
Eragrostis curvula	African lovegrass	South Africa	Unknown	Pasture and soil stabilisation
Hordeum spp.	Barley grass	Europe, Western Asia, North Africa	Prior to 1848	Unknown, possibly in fodder or livestock
Hypericum perforatum	St John's wort	Eurasia, North Africa	1904 1957	Ornamental Medicinal
Hypochaeris radicata	Catsear, flatweed, false dandelion	Europe	Likely pre-1866	Most likely ballast contaminant
Nasella trichotoma	Serrated tussock	Peru, Chile, Uruguay, Argentina	Early 1900s	Most likely agricultural contaminant
Rubus fruticosus	European blackberry	Europe	Early 1800s	Garden (fruit), hedgerows
Vulpia bromoides *Vulpia myuros*	Squirrel tail, Rat's tail fescue Silver grass	Western Mediterranean, SW and central Europe	1886	Possible ornamental, contaminant of ballast, forage, livestock

not on the 'Prohibited List', a list of known weed species. Recognising that significant new weed species were still entering Australia, a new approach was developed, and a 'Permitted List' approach was adopted by AQIS in 1997.

This approach is a three-tiered screening process (Walton 2001).

Tier 1 is the identification of the species, referring to lists of prohibited and permitted species, and determination of its Australian distribution. If the species is on the permitted list, it is allowed entry to Australia, and does not proceed through the second and third tiers. If the species is widely distributed in Australia and not under official control (i.e. not a declared species in any State), it is also permitted. International trade agreements forbid the exclusion of any species from Australia if it is already present and not a quarantine pest. It is for this reason that certain (undeclared) weed species found in Australia can still be imported.

A grain import contaminant list is also consulted, which describes weed seeds for which AQIS have a nil tolerance in grain shipments.

If the species of interest not appear on any of the above lists, it proceeds to Tier 2 of the screening process, which is a weed risk analysis (Walton *et al*. 1999). This is a pre-entry analysis to determine the risk of the species becoming a weed in Australia. The weed risk analysis consists of 49 questions concerning the history, biogeography, biological and ecological attributes of the species. The answers generate a score which corresponds to an outcome of high or low weed risk, or of a 'further evaluate' assessment where the weed risk is still not certain. If a minimum number of questions are not answered, the outcome is also 'further evaluate'. Species deemed as low weed risk are added to the Permitted List, and importation into Australia is allowed. Species of high weed risk are not permitted entry to Australia. Species in the further evaluate category undergo Tier 3 of the screening process.

Tier 3 of the screening process enables more information on a species to be collected to better estimate the potential weed risk to Australia. This may be through a wider literature search, quarantine glasshouse trials, or field trials overseas to collect more data. Currently, there are no formal protocols

for assessing Tier 3 species; therefore these species are, by default, prohibited entry to Australia. A recent review of the Border screening process recommended that Tier 3 protocols be developed as originally envisaged in 1997.

Post-border

Post-border, the level of assessment on whether species should be permitted entry to individual States or Territories varies between jurisdictions. Western Australia and Tasmania use the Australian Border system to determine the weed risk to their States. As a consequence, there are several species that are permitted in Australia, but are not permitted entry into Western Australia and/or Tasmania. Some states, such as Victoria and South Australia, implement a prioritising weed risk assessment process where weeds are ranked in terms of priority for control or eradication, however this does not stop the movement of non-declared species into or around the State. Fortunately, a national protocol for post-border weed risk management has been developed, and will be published soon by Standards Australia (Virtue *et al*. in press). This will assist States/Territories in developing weed risk assessment processes that are consistent with other states, and provide some protection from potentially invasive species from within Australia.

A changing culture

Industries involved in exotic plant importation are becoming increasingly aware of the weed risk issues surrounding new plants, thanks to efforts from individuals and organisations such as the Cooperative Research Centre (CRC) for Australian Weed Management. Historically, scientists and horticulturalists could import species quite freely to test for potential uses in pastures, crops and the gardening sector. However, it is now viewed that these groups have a duty of care not to import species that will become serious pests. The CRC for Plant-Based Management of Dryland Salinity is incorporating weed risk analyses into their research programs to ensure that species of high weed risk are not promoted in the wider community. Trial site hygiene will be improved so that abandoned trials sites, such as those investigated by Emms and Virtue (2005), will no longer contain persistent species that can escape from former trial plots. The nursery and garden industry is also beginning to improve its awareness of weed risk and take steps to minimise sale of weedy garden plants.

Many useful and valued pasture species are serious weeds of the environment, just as many highly prized garden plants are serious pests of agriculture. Put simply, a weed is a plant that is unwanted in a particular time and place, and therefore there will always be debate about what is a weed species and what isn't. Conflicts of interest will remain, but strategies can be employed to minimise impacts, such as developing Codes of Practice (eg the Code proposed by the (now disbanded) Northern Australian Pasture Plant Evaluation Committee for evaluation and release of pasture plants) (Anon. 2005). Bennett and Virtue (2004) suggested conflicts between weedy economic plants in Australia could be resolved by:

i) having a standard assessment for weed risk, utility and feasibility of management;

ii) developing, implementing and monitoring weed risk management guidelines; and

iii) improving our understanding of the attributes of high impact weeds.

Room for improvement

Although we have learnt a lot from the legacy of invasive species that our early European explorers and settlers left us, there is still much we can do to prevent new weeds from appearing and impacting on agriculture and the environment in the next 200 years. We may now have in place an effective means of screening exotic plants at the Australian border, but the true test of this system will take many decades. Many future weeds will come from movement of both native and exotic species beyond their natural or naturalised range (both intra and inter-state). There are many examples already, of Australian native species becoming weeds within Australia, such as several *Acacia* and *Pittosporum* species growing beyond their natural distributions (Groves 2001; Low 2001). 'Sleeper' weeds that are currently limited in their distribution and impact due to a restricted genetic base, limited suitable habitat, limited opportunities for recruitment, low intrinsic population growth rate, absence of mutualists, or an incorrect perception of their invasiveness (Grice and Ainsworth 2003) may overcome these barriers and become more prominent. The effects of impending climate change on the distribution and impact of weed species is an area of increasing research, but it would be expected that certain species will increase their range of naturalisation, and others may not adapt to the changing environment.

The globalisation of commodity trading brings with it inherent risks of importing undesirable plant species. Contamination of grains, fodder or livestock has been a common route of importation of Australian agricultural weeds (Table 1), so it is vitally important that appropriate precautions are taken. AQIS continue to be vigilant in their screening, but it is also

important for the consumer or grower to be on the look out for any unusual plant species emerging.

Conclusion

Australia leads the world in taking a pro-active approach to assessing new plant species for weed risk. We hope that no new high-impact weeds will be introduced to Australia, but any predictive assessment system has its limitations because it is impossible to account for every ecological scenario and environmental condition. Post-border, we can be pro-active in preventing new weeds from emerging by:

i) being cautious in introducing new plant species to an area, whether native or exotic.
The most cost-effective form of weed control is to avoid introducing the plant in the first place.

ii) being vigilant.
Early detection is essential for eradication and control. The feasibility of eradication declines rapidly with increasing area of weed infestation (Panetta and Timmins 2004).

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