Profitability and financial feasibility of strategies to increase native vegetation in Victorian hill country

By

Jim Crosthwaite [1 5], Jim Moll [2], Josh Dorrough [1 3] and Bill Malcolm [4]

[1] Department of Sustainability and Environment, Victoria
[2] Goulburn-Broken Catchment Management Authority
[3] Outposted to CSIRO Sustainable Ecosystems
[4] University of Melbourne
[5] Corresponding author: jim.crosthwaite@dse.vic.gov.au, 03-9637-8457

The views expressed in this paper are those of the authors, and do not necessarily reflect those of their employers.

Paper presented to the Annual Conference of the Australian Agricultural and Resource Economics Society, Manly, February 2006.

Key words
Farm businesses, native vegetation, strategies, profitability, financial feasibility, investment

Abstract

The capacity of farmers to adapt their businesses and adopt management practices that improve environmental outcomes varies greatly from case to case. Factors influencing this include the state of the farm business and its resources, the extent of the environmental problems, condition of native vegetation (and existing provision of ecosystem services), availability of labour, current financial position, and age of farmer, and family goals.

In this paper, results are reported from a study based on 17 sheep-beef farms in Victorian hill country. Information about vegetation, agronomic potential and farm business situation was collected, and the effect on the farm business of adopting four management strategies that could potentially improve farm environmental outcomes was tested. It is shown that reorganizational strategies are available that are economically, financially and environmentally sound. Implications for environmental policy are discussed.

Introduction

Almost all land used for agricultural purposes across south-eastern Australia have been significantly modified in the last 200 years of European occupation. While generating significant wealth for Australia, agricultural activity has resulted in the widespread and well-documented changes to flora and fauna, soils, and hydrology. There is now a recognition that many agricultural lands are not as productive as they previously were, that degradation of these lands is responsible for major off-site environmental problems, and that the extent of past land clearing means that important biodiversity assets are under threat (Mansergh et al. In press). In short, these lands are not presently capable of producing many of the ecosystem services that society now demands. As a result, various strategies and plans call for large-scale increases in vegetation cover across the landscape.

Such changes would involve considerable reallocation of resources . However, the issue isn’t so much of changing the status quo. In some of these landscapes, the rate of new investment is quite high. There are several concurrent trends

- investing in highly productive pastures
- investing in plantations
- investing in new activities that are relatively land-intensive, such as vineyards and olives
- investing in non-commercial ‘lifestyle’ properties and associated infrastructure

This picture of a high level of investment is balanced by the static situation on many wool-producing properties that are managed by elderly farmers, who are no longer managing in anticipation of an heir taking over the farm (Barr et al., 2005). However, most of these farms will be on the market within 20 or so years, and the investment cycle will be renewed.

Given that capital investment is periodically renewed by private land owners, and new investments occur to replace depreciating assets, can the direction of investment be influenced?

The starting point is to recognise that farmers and other landholders are *the* decision-makers. Whatever regulations, incentives or information programs that governments initiate, it is how landholders respond to *all* market signals that matters. Much then depends on the knowledge, interests and capacity of landholders, both those there now and those who might occupy the land in future.

In this paper, the focus is on identifying and analysing the attractiveness to farmers of several options for private investment that might also meet public goals in the Victorian hill country. Establishing the extent to which farmers are likely to take up such options is not the issue here, rather the focus is on whether or not they pass the test of being good investments on economic and financial criteria. We are also not concerned with ranking investments according to these criteria. The question to answer is whether there are sound reorganizational strategies for hill country farms that are compatible with promoting environmental objectives – and vice-versa.

In empirical research conducted in north-east Victoria, Farmar-Bowers (2004) has identified that there are five core drivers of the long-term actions of farmers. These revolve around meeting the nine 'fundamental human needs' we all have as people (Max-Neef 1991). The drivers include ensuring succession of responsibility, enjoying farming, overcoming isolation, learning about farming and educating children. Earning sufficient income is a second-order driver, clearly essential if higher-order needs are to be met.

The focus in this paper is on the economic dimension of decision-making. Suffice to say that while farmers and other landholders may occasionally make some major decisions based on short-term criteria, such as shifts in price or occurrence of drought, they are generally making major decisions, some more consciously than others, based on their long-term interests. This suggests that a major consideration in environmental policy should be how can government help ensure that investments that deliver environmental goals are not only profitable but are also consistent with the 20 year vision of the farmer (Crosthwaite & Malcolm 2000). The focus for policy should thus be on the triggers or 'circuit-breakers' that are required to bring about a shift in resource allocation (Crosthwaite 1997, Young et al 1996).

It is crucial to ask what resource allocations can potentially deliver the ecosystem services that are required, and what effect that they will have on profitability. Neo-classical economic theory spells out that there is an optimal allocation for any given set of resources. Hence, an allocation that delivers ecosystem services may or may not be the best for the particular farm, or in aggregate for all the farms in a given landscape. However, Kalecki (1937) challenged the 'traditional' view and argued that in fact there can be several optimal allocations. Agricultural economists have also identified flat payoff functions in agriculture, which means there is potentially more than one optimal farm plan (Pannell 2004).

In this paper, we draw on a rich dataset to inform this discussion. The dataset includes information from 17 farms about the vegetation (Dorrough and Moxham, 2005; Dorrough et al., 2005; Dorrough et al., 2006), state of the pastures and agronomic potential (assessed by an agronomist), and current economic position. Analysis of this data has informed the identification of four strategies that can potentially deliver, each alone or in combination, the environmental gains required at a landscape level without adversely affecting profitability. Results of implementing these strategies on a representative farm have been previously reported (Moll et al. 2005).

The analysis required is necessarily different to one in which the goal is solely to optimise profitability subject only to the effect on cash flow and risk. Meeting environmental goals is now an additional constraint for each of the four strategies. Hence, the purpose of the analysis is to identify if there are profitable solutions that achieve both business and environmental goals.

In this paper the results of applying the four investment strategies to the 17 farms are reported. It is a rich set of data that allows a new form of comparison or benchmarking based on results of investment analysis. Rather than drawing comparisons between farms based on their current performance, comparisons are drawn on the basis of what might be in a number of alternative futures for these businesses.

The purpose of the paper is to

- test whether economically, financially and environmentally sound reorganizational strategies exist for hill country grazing farms in some parts of Victoria, and
- consider the implications for future investment in farming systems and for agri-environmental policy

The paper is structured as follows.

- The background section covers the regional context for the research, selection of case study farms, the current situation on the farms regarding the environment, development of the four management strategies, and the environmental outcomes if they are adopted.

- The method section of the paper outlines how the economic and financial analysis was conducted.
- The results are then presented, followed by a discussion.
- Appendices contain assumptions for the economic and financial analysis.

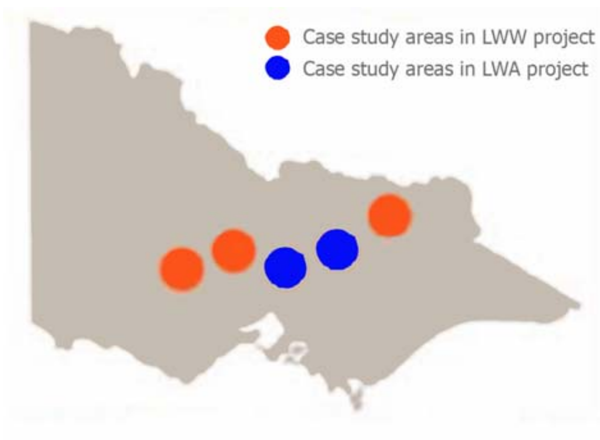
Background

Regional context

The research reported in this paper was conducted in five localities in Victoria (Figure 1), stretching from the Ararat Hills to the east of Gariwerd (the Grampians), through Maryborough, Broadford and Violet Town to Springhurst near Wangaratta. Research in three localities was funded under the Land Water & Wool (LWW) program and two under a program of Land & Water Australia (LWA) – see Acknowledgements for more details.

Sheep grazing is the primary land use, with some cattle and cropping.

Figure 1 Study area in central and north-eastern Victoria.



The area contains land systems ranging from broad alluvial plains, originally dominated by open grassy woodlands, to slopes and hills of sedimentary and granitic origin which once supported extensive dry eucalypt forests and woodlands. Quaternary basalt flows also intersect some of the southern plains and slopes and these were typically sparsely treed (Dorrough and Moxham, 2005). Now as little as 3% tree cover persists in areas managed for livestock production (Dorrough and Moxham, 2005).

Annual rainfall varies from 530 mm yr^{-1} in the west to 670 mm yr^{-1} with approximately 60% of rain falling between May and October (www.bom.gov.au). The study area ranges from 150 to 600 metres above sea level.

Case study farm selection and data collection

Results in this paper are based on studies of seventeen farms in the region described above. Case study methodology was used to select the farms. The farm business was identified as the main unit of analysis, with the production system, the paddock and the site of conservation interest being important sub-units. The objective in designing the study around the selected farm businesses was to be able to generalise to theory, rather than to generalise to a population as part of a statistical analysis (Eisenhardt 1989, Yin 1989, Crosthwaite & Malcolm 1997).

Fourteen of the farms were selected on the basis that agricultural production was the prime source of income for the farm family, and hence commercial realities were a major influence on decision-making. Another three farms were selected where off-farm income dominated and while farm income was expected to cover overhead costs, it was not relied upon to generate income. An effort was made to select some farms where, based on financial criteria, environmental management decisions could be implemented relatively easily, and to select others where this would be difficult (Moll et al. 2003).

Pasture assessments by a consultant agronomist and soil tests produced considerable information about the current state of pastures. This was combined with information obtained from the farmers about grazing systems and stocking rates for each paddock to develop estimates of production potential across each farm. Vegetation assessments across each property generated rich data sets about the condition and composition of vegetation. Spatially explicit estimates of current and potential production and current vegetation cover have enabled modelling to rank priority areas for production and conservation on each farm.

Farmers also provided information on assets, income and expenditure and this was used to develop profit and loss statements, gross margin and cash flow budgets.

Native vegetation and current production

Key findings from the ecological and agronomic research conducted as part of this project relevant to developing the proposed strategies are that:

- Each property is now managing about 5% of the farm primarily for reasons that are consistent with maintaining biodiversity values (Dorrough et al., submitted). These areas include fenced out creeks and revegetated areas.
- There are small areas of significant conservation value on each property, although their condition is generally less than for similar areas on nearby public land. Habitat hectare scores (Parkes et al 2003) were typically around 20 for native pasture areas, and around 40 for remnant bush areas (Dorrough et al., 2005).
- Most farms have a much greater area of native pasture, and within that area a higher proportion of native grasses compared to exotics, than the farmers generally believe they have. Native pasture makes up to 40% of the area on many of the case study farms - particularly farms with high proportions of hill country (Dorrough et al., 2004). Sown grasses have often disappeared or are rare, and have been replaced by recolonising native grasses (eg. *Microleana stipoides*, *Austrodanthonia* spp and *Austrostipa* spp.), but more typically naturalised annual grasses, such as rats tail fescues (*Vulpia* spp.), barley grasses (*Critesion* spp.) and bromes (*Bromus* spp), and broad-leaved weeds (eg. capeweed, *Arctotheca calendula* and flatweed, *Hypochaeris radicata*) (Dorrough and Moxham, unpublished data).
- Most farmers are managing their pastures well below potential. Leaving aside the issue of pasture composition (see above point), production can often be increased by correcting soil nutrient deficiencies, especially phosphorous, and soil pH.
- Analysis of data of vegetation cover, soil types and management history indicate high potential to achieve natural regeneration of trees across much of the hills and slopes. However, this potential is disappearing at an exponential rate because of the loss of paddock trees that act as a seed source (Dorrough & Moxham 2005).
- While few native plant species persist when grazing intensities are high and phosphorus fertilisers have been added, the cover and diversity of native plant species is high when soil phosphorus is low and grazing is strategically managed (Nie et al., 2005, Dorrough et al., 2006).

Development of four management strategies

Four strategies that could potentially improve both the condition and extent of native vegetation and profits on wool properties were chosen for further analysis, out of the many possible combinations available to the wool grower. The four strategies and their goals are outlined in Table 1, along with details about how parts of the farm are to be managed.

The four strategies were identified because they met the following criteria and they were consistent with the findings of this and other research. Each strategy had to satisfy the following criteria:

- Increases the cover and/or extent of native vegetation, in identified priority native vegetation areas
- Potentially increases the overall condition of native vegetation on-farm, though not necessarily within 15 years

The strategies also focused to varying degrees on dealing with other management and production issues:

- Match stocking rate to carrying capacity
- Remedy overgrazing of hill country and waterways
- Reduce fertiliser application in priority native vegetation areas

In evaluating the strategies against these criteria, information was drawn from the data collected on-farm, that is from the financial evaluation, agronomic assessments and vegetation surveys for each case study farm. Other research was also used, notably the Broadford long-term grazing experiment (DPI, 2003), shelter belt research (Rod Bird, 1991) and deferred grazing trials that are part of the Sustainable Farming Systems for Steep Hills project (DPI nd., Nie et al 2005, Zollinger et al 2005).

Table 1 Management option by goals and area allocated

		Area managed		
	Goals	For wool/beef production only	Jointly for biodiversity and wool/beef production	For biodiversity only
Option				
1. Targeted vegetation management & Correcting nutrient deficiencies	1. Increase carrying capacity on most of farm 2. Improve condition of priority vegetation	**85%** Most of farm	**0%** None	**15%** Watercourses, remnant bush, hill tops, rare/endangered vegetation
2. Targeted vegetation management & Intensive rotational grazing	1. Increase carrying capacity on most of farm 2. Improve condition of priority vegetation	**85%** Most of farm	**0%** None	**15%** Watercourses, remnant bush, hill tops, rare/endangered vegetation
3. Deferred grazing of hill country	1. Increase carrying capacity on hill areas 2. Improve the condition of native pastures on hills 3. Maintain existing conservation areas	**42%** Parts of the farm not classified as hill country (average over 17 farms)	**52%** Hill country (average over 17 farms)	**6%** Very small areas (average over 17 farms)
4. Establishing shelter trees	1. Increase wool profits through shelter benefits 2. Expand area of native vegetation, and maintain condition	**85%** Most of the farm is benefited from tree shelter	**9%** Benefits to native vegetation are limited to the additional 9% under trees	**6%** Small areas, however condition improved with the addition of adjacent natural regen. areas (average over 17 farms)

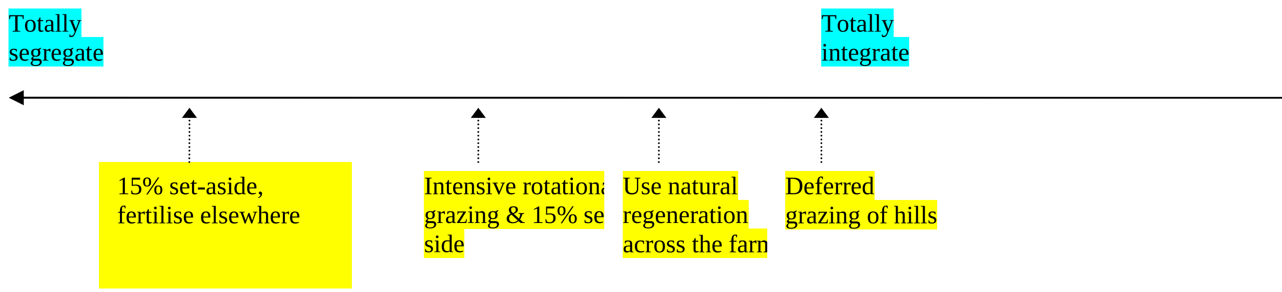
Environmental results if the strategies are adopted

The potential gain for biodiversity from adopting these strategies was assessed through simple spatial models of changes in vegetation condition over time. The approach taken was to develop a simple patch based deterministic model of vegetation change and average changes in vegetation condition for each discrete patch across entire farms. The model is based on determining a habitat hectare score for each patch (Parkes et al 2003) and predicting changes based on our current knowledge of responses of native vegetation to management. Predictions are thus highly uncertain.[1] Nevertheless, the approach provides a simple method for examining various land management options. Improvements in vegetation condition score that would result from implementing the four strategies across the 17 farms are being determined (Dorrough et al, in prep).

There are radical differences in what the future farm would look like if each of the four strategies was pursued separately. In considering management of native vegetation on farms, we can envisage a continuum with 'segregate' on one end and 'totally integrate into farming operations' on the other (Figure 2). Dorrough et al (submitted) use empirical data to make a case that the best environmental outcomes will result from approaches that integrate conservation into the farm management system, rather than treating it as something separate in isolated parts of the farm.

The Correcting Nutrient Deficiencies strategy is closest to the 'lock it up' end of the spectrum because it provides for 15% of the farm to be managed primarily for biodiversity while allowing for intensive management on the rest of the farm. However, because the remainder of the farm is intensively managed, maintenance of native vegetation outside of the conservation area is unlikely and off-site impacts of nutrient additions are possible. The deferred grazing strategy sits towards the other end of the continuum, because it involves what is perhaps a more 'ecologically friendly' form of farming across the hills, which usually constitute large parts of the property. The natural regeneration strategy is also a form of integration but across only a small proportion of the farm. In this case only small improvements in the extent and condition of native vegetation are expected because the shelter areas are open to grazing and livestock camping impacts and an exotic annual plant understorey is most likely. Intensive rotational grazing is less easy to locate on the continuum; only 15% of the farm is managed for biodiversity, and there is insufficient research to be sure of the biodiversity consequences on the rest of the farm (Dorrough et al., 2004; Kirkpatrick et al., 2005). The pasture rest periods that are integral to this approach could result in environmental gains on the rest of the farm.

Figure 2 Continuum for how conservation management is tackled on the farm



Trade-offs are likely on some farms with loss of some biodiversity assets occurring under some of the strategies. The Correcting Nutrient Deficiencies strategy is of particular interest. If fertiliser is applied to the slopes on some farms, which is where potential returns to fertiliser use have been judged by an agronomist to be among the highest on some properties, there could be loss of native grasses and the potential for natural regeneration of trees. This particular tradeoff is explored further in Dorrough et al. (submitted), while alternative ways of using fertiliser on native pasture are outlined by Langford et al (2004).

Methods for the economic and financial analysis

[1] It should also be noted that this approach does not take into account spatial dependencies (ie. the size and location of remnant patches will influence rates of improvement/decline in condition)

This paper report
nothing' situation
partial budgets w
profitability. Retu
development pha
budgets were use
cash flow budgets
debt as two meas
single measures c

Assumptions for
follows. A 15 yea
financial analysis

An operator's allo

the repayments can become onerous. The length of time before the strategy breaks even is also a concern. The importance of cash flow for decisions will also depend on how risk averse the farmer is.

Table 2 Expected

	Strategy
	Economic
Farm	ROMC at SS
	%
1	57
2	18
3	32
4	36
5	52
6	-2

The results for an
criteria. First, the
than the opportun
the farm plan is .a

- Expecte
  opportu
- The inve
  is accept

Profitability

Expected return o
strategies on mos
expected to earn

Fifteen of the 17
farmer and enviro
discount rate (Fig

For two farms (6
NPV at a 10% dis
profitable strategi
2,7,8,11,13,16) ha

There is variation
for likely landsca
strategy of Correc
Grazing strategy
Grazing is likely

attractive. While farmers require a viable farm business that can generate productivity increases of 1 – 2 % a year just to stay abreast of the declining terms of trade for agriculture, most farmers also recognise that in the long-term farm viability depends on farm systems being physically and economically sustainable. Farm land capital is after all the major asset or store of wealth for most farmers.

Using economic and financial criteria, all of the strategies that have been investigated have a place on grazing properties and a combination of strategies could work in many cases. With the exception of Shelter, each strategy was expected to be profitable on some farms. De-stocking for a considerable length of time was the major reason for the Shelter strategy being a poor investment. More likely natural regeneration would be staged over many years, gradually increasing the total area supporting regenerating trees. This would be possible using electric fencing on small parts of the property that are lightly stocked. This option warrants a closer look.

No one strategy is better than the others across all farms. Each strategy was found to be unprofitable on some farms. Overall, the strategies of Correcting Nutrient Deficiencies and Deferred Grazing performed the best, if implemented on the right farm. These two strategies require the least adaptation from current farming operations, and can be done at relatively low extra cost in many cases.

The variation in results also suggests that farming in these landscapes may not go solely down the path of intensification, through fertiliser use and associated set-aside. However, neither will the path of integrating conservation into the production system, through changing grazing system dominate the landscape. A combination of strategies could work in many cases, but the results of the analyses presented in this paper do not tell us what farmers who learn about these findings will do. To the extent that farmers adopt these strategies, there is likely to be considerable variation in where, how and why they do so.

Further work is required to firstly monitor the farm business and environmental outcomes as farmers initiate these strategies. Most importantly we still have little information on which to assess the relative ecological outcomes of each strategy. Secondly, the techniques underpinning some of the strategies need to be investigated; for instance is supplementary feeding necessary for Deferred Grazing, and can stock be reintroduced more quickly in the Shelter strategy. Thirdly, the research on which this paper is based could be repeated in other landscapes.

Implications for environmental policy

This paper began with a discussion of the large landscape-scale changes required, and identified in various government strategies and plans, if environmental sustainability was to be achieved. It argued that understanding the investment cycle and opportunities to influence that cycle was a useful starting point.

Strategies have been identified that are compatible with farmer economic goals and can potentially achieve public policy goals, without necessarily requiring public funds for them to be profitable and affordable to the majority of farmers in the hills of central and north-east Victoria. This compatibility with the interests of farmers relates to the fact that all the strategies are based on increased, rather than decreased, levels of farm-level productivity – something that is critical in the long-run if commercially-run grazing properties are to be viable.

Government now typically intervenes to achieve biodiversity outcomes largely on a site-by-site basis, without considering the possible success of strategies at the whole farm level. Given the findings presented here, there is a case for a modified approach.

The first role of government might be to inform farmers in these locations, their advisers and financiers, and others in agribusiness that such opportunities are available. This information would necessarily emphasise that there are several available opportunities, and that careful case by case consideration will determine which strategies are good investments for the particular property. Some principles and methods to analyse the question and to help determine applicability might be communicated. Extra information advising on how to minimise the environmental effects of fertiliser use will also be required, given that the fertiliser-based strategy, which involves managing 15% of the farm primarily for biodiversity, is a better investment in more cases than either of the grazing strategies.

The second role of government might be to pursue initiatives that lead to greater uptake of the opportunities by farmers. For this role, the question becomes what policy will trigger change required to achieve sought after outcomes. It does not have to reflect a cost-share ideal. This would first require identifying what proportion of farmers are likely to adopt these opportunities, and at what rate. It would also require careful evaluation of the possible initiatives. Auction based programs like Bush Tender (Stoneham et al., 2003) will have a role – what the fit is between such programs and whole farm based approaches requires investigation (Crosthwaite 2003).

In summary, we have shown that economically, financially and environmentally sound reorganizational strategies exist for hill country grazing farms in parts of Victoria. The availability of such strategies can potentially contribute to the direction of future investment in farming systems. Farmers and their financiers will determine the overall pattern of investments. We have pointed to ways in which agri-environmental policy might influence this pattern.

Acknowledgments

This research was supported by funding through the Land Water & Wool Native Vegetation and Biodiversity Sub-program (a joint initiative of Australian Wool Innovations and Land & Water Australia) and also the Native Vegetation R&D Program of Land & Water Australia.
Special thanks to all landholders involved, and staff of the Department of Sustainability and Environment, Department of Primary Industries and Catchment Management Authorities who have helped out in one way or another. Particular thanks to project team members Andrew Straker and Claire Moxham.

References

Barr, N., K. et al. (2005). Australia's farmers: past, present and future. Canberra, Land & Water Australia.

Bird, Rod. (1991) Tree and Shelter Effects on Agricultural Production in Southern Australia, Agricultural Science Vol 4 No 5.

Crosthwaite, J., (2003) "Whole farm considerations in the design of management agreements". A paper to the Australian Agricultural and Resource Economics 47th Annual Conference, Fremantle, 11-14 February, 2003.

Crosthwaite, J. (1997) Native grassland: at what cost? A paper to the 41st Annual Conference of the Australian Agriculture and Resource Economics Society, Gold Coast 22-24 January 1997.

Crosthwaite, J. & Malcolm, B. (2000). *Looking to the farm business: Approaches to managing native grassland in south-eastern Australia*, National Research and Development Program on Rehabilitation, Management and Conservation of Remnant Vegetation Research Report 5/2000, Land and Water Resources Research and Development Corporation, Canberra.

Crosthwaite, J., MacLeod, N. and Malcolm, B. (1997) 'Case studies: theory and practice in natural resource management' in Vanclay F and Mesiti L (eds) *Sustainability and Social Research*. Wagga Wagga: Centre for Rural Social Research, Charles Sturt University.

Dorrough, J., Moxham, C., 2005. Eucalypt establishment in agricultural landscapes and implications for landscape-scale restoration. *Biological Conservation* 123, 55-66.

Dorrough, J., Moll, J., Crosthwaite, J., submitted. Can intensification of temperate Australian livestock production systems save land for native biodiversity? *Agriculture Ecosystems & Environment*.

Dorrough, J., Moxham, C., Crosthwaite, J., Moll, J., 2005. Vegetation management in wool production landscapes, Unpublished Report, Land Water & Wool Native Vegetation and Biodiversity Sub-program, Land and Water Australia Native Vegetation R&D program, Victorian Department of Sustainability and Environment, Melbourne,

Dorrough, J., Moxham, C., Turner, V., Sutter, G., 2006. Soil phosphorus and tree cover modify the effects of livestock grazing on plant species richness in Australian grassy woodland. *Biological Conservation* in press.

Dorrough, J., Yen, A.L., Turner, V., Clark, S., Crosthwaite, J., Hirth, J.R., 2004. Livestock grazing management and biodiversity conservation in Australian temperate grassy landscapes. *Australian Journal of Agricultural Research* 55, 279-295.

DPI 2003, Grazing Management for Productive Hill Country Pastures. The Broadford Grazing Experiment 1998 – 2002. Department of Primary Industries)

DPI nd Farming Systems for Steep Hills. Department of Primary Industries (brochure).

Eisenhardt, K.M. 1989. 'Building Theories from Case Study Research', *Academy of Management Review* 14:532-550.

Farmar-Bowers, Q. (2004). 'Personal drivers – interviews.' Background Report 5: J. Crosthwaite, J. Callaghan, Q. Farmar-Bowers, C. Hollier and A. Straker (eds). Land Use Changes, their Drivers and Impact on Native Biodiversity – Driver Research Phase 1: Overview Report. Department of Sustainability and Environment, Melbourne. (CD ROM)

Kalecki, M. (1937) 'The Principle of Increasing Risk,' *Economica*, N.S. Vol. 4, No.16.

Kirkpatrick, J.B., Gilfedder, L., Bridle, K., Zacharek, A., 2005. The positive and negative conservation impacts of sheep grazing and other disturbances on the vascular plant species and vegetation of lowland subhumid Tasmania. *Ecological Management and Restoration* 6, 51-60.

Langford, C.M, Simpson, P.C., Garden, D.L., Eddy, D.A., Keys, M.J., Rehwinkel, R. and Johnston, W.H. (2004) *Managing native pastures for agriculture and conservation*. NSW Department of Primary Industries.

Malcolm, L. R., Makeham, J. P., and Wright, V. (2005) *The Farming Game*. Cambridge University Press: Cambridge.

Mansergh, I. et al. (in press) Victoria's living Natural Capital - decline and replenishment 1800 - 2050 (Part 1), *The Victorian Naturalist*, Vol. 123 (1).

Max-Neef, M.A. (1991), *Human scale development*, The Apex Press, New York.

Moll, J., Dorrough, J.,Crosthwaite, J. and Straker, A. (2005) Improving native biodiversity management on wool properties in central Victoria – investment analysis of four strategies. A paper presented to a Resource Economics Workshop 'Identifying production and environmental trade-offs at the farm level'. Organised by the AGSIP project AG13 in partnership with the Australian Agricultural and Resource Economics Society. 28 October 2005, Rockhampton.

Moll, J., Crosthwaite, J. and Dorrough, J. (2003) Better Management of Wool Businesses and Native Biodiversity. *Connections*. Spring 2003. (www.agric.uwa.edu.au/ARE/AARES/News/Con_Spg_2003.htm).

Nie, Z., Quigley, P., Zollinger, R., 2005. Impacts of strategic grazing on density and ground cover of naturalised hill pasture. Proceedings of the XX International Grassland Congress. Dublin, Ireland.

Parkes, D., Newell, G., & Cheal, D. (2003) Assessing the quality of native vegetation - the habitat hectares approach. *Ecological Management and Restoration*, Supplement February, S29-S38.

Pannell, D.J. (2004). Flat-earth economics: The far-reaching consequences of flat payoff functions in economic decision making. Unpublished paper presented at 48th Annual Conference of the Australian Agricultural and Resource Economics Society, Melbourne, 11-13 February 2004. http://www.general.uwa.edu.au/u/dpannell/dp0402.htm

Stoneham, G., Chaudhri, V., Ha, A., Strappazzon, L., 2003. Auctions for conservation contracts: an empirical examination of Victoria's Bush Tender trial. *Australian Journal of Agricultural and Resource Economics* 47, 477-500.

Yin R.K. 1989. *Case study research: Design and methods*. Newbury Park Ca: Sage Publications.

Zollinger, R., Nie, Z. and McCaskill, M. (2005) The impact of strategic grazing practice on groundcover and landscape function of hilltops in steep hill country (poster), *Grassland Conservation and Production – Both sides of the fence*. Fourth National Native Grasses Conference. 11–13 October, Burra, SA.

Young, M. D., N. Gunningham, J. Elix, J. Lambert, B. Howard, P. Grabosky, and E. McCrone (1996) *Reimbursing the Future : An Evaluation of Incentives for the Conservation of Biodiversity*. Biodiversity Series. Department of Environment, Sport and Territories: Canberra

Appendix 1

The following tab
enterprise used in
the analysis.

Table 3. Averag

INCOME
Sales
Wool (gross)
Total
COSTS

Appendix 2: Assumptions used in financial analysis

General Economics

- a 15 year cash flow budget is used, with discount rate of 10%, reflecting 0% inflation over this period
- extra gross margin (GM) is calculated by multiplying change in stocking rate and area, by GM/DSE
- if the potential increase in stocking rate is more than 200 DSE within a year, stock are bought in at $40 /DSE to utilise extra pasture growth
- the salvage value is calculated as a proportion of any extra capital expenditure on, fencing, trees and watering points
- extra profits are calculated **before tax**
- there are no net increases in labour and overhead costs required for undertaking each management option.

Options 1 & 2 Correcting Nutrients & Intensive rotation

- changes in stocking rate as a result of applying various management strategies were calculated by multiplying paddock area by stocking rate
- area managed for native vegetation is 15% of the total farm area. The areas of native vegetation conservation per paddock were calculated from the prioritisation model used in the project (Dorrough 2005).
- fence length required for native vegetation areas was estimated to be the same as that calculated for natural regeneration areas,
- fencing used is classified as "light merino" @ $2500/km inc labour
- areas fenced for native vegetation are valued as fodder reserves after year 5, and valued 1 year in every 4 as a valuable source of drought feed
- there are no $ valued net shelter benefits in these two options, only in the *shelter trees* option
- under *intensive rotation*, no extra fencing (over and above new fencing that is required for "cells") is required for native vegetation areas, unlike fertiliser option which requires extra fencing for biod areas'

Correcting soil nutrients

Fertiliser program developed to achieve Olsen P >12 over 10 years and correct lime and other nutrient deficiencies.

Example as follows (depending on current soil test results)

Maint P	maintenance applications of phosphorus at 8 kg P/ha
Cap P	capital dressings of phosphorus at 25 kg P/ha
Cap K	capital dressings of potassium at 30 kg potassium/ha
Lime	broadcast lime at 2.5 t/ha.

- stocking rates under fertiliser strategy are estimated from the report by the agronomist (Jim Shovelton) engaged by the project.
- current stocking rates are operating at maximum utilisation of pastures on all paddocks
- the fertiliser program targets the whole property, including hill country
- fertiliser is not applied to paddocks with vegetation condition above score of 20--and no increase in SR is assumed
- the cost of the suggested fertiliser program is based on the average current fertiliser budget for each property, and is therefore calculated on each case study farm.

Intensive rotational grazing

- results from Broadford grazing trial are used in the context of "extra stocking rates achieved from various treatments, compared to the set stocked treatment"
- fencing & water required for intensive rotational grazing is costed at $60/ha (from practical experience)
- Increase in carrying capacity is 35% over 4 years on low P areas, 37% on high P areas.
- GM per DSE for various treatments was estimated using farm figures and estimated stocking rates for different P levels
- P levels are ranked either h or l--depending on most recent soil test results
- likely increases in carrying capacity were estimated for both the low P and high P parts of each farm, using the results from the Broadford grazing trials.

Deferred grazing

- deferred grazing does not result in whole farm destocking—no stock are sold
- stock are removed from 25% of the total hill areas for 4 months each year, and supplementary fed @ $8.40/DSE/4 mths
- land-class fencing is carried out on hill areas of the property, using electric fencing at a cost of $1,550 /km.
- a 25% increase in carrying capacity is achieved over 5 years, due to better pasture growth and utilisation on hill country

Shelter

- It is assumed that 15% of the total farm area is established to trees using natural regeneration
- there is an initial destocking over first 5 years, then stock levels back to "normal"
- lamb mortality is reduced by up to 5% under tree shelter, beginning proportionally after 5 years after planting, with full effect at year 14
- there is no net fodder benefit in integrated native vegetation areas--as they are fully grazed after year 5 anyway
- mortality of shorn sheep is reduced by up to 0.5% under tree shelter, beginning proportionally after 5 years after planting, with full effect at year 14
- There is an increase of 10% in gross margin due to combined extra pasture growth and savings in feed intake under tree shelter, beginning proportionally after 5 years after planting, with full effect at year 14.
- Feed savings and pasture growth benefits are assumed to occur on double the area with trees established (not the whole farm)
- there is no loss in overall stocking rate after the initial 5 years of establishment is over
- shelter area fencing is calculated from boundaries of priority areas, using logical fencing (straight lines)
- shelter option uses electric fencing @ $1550/km, which is pulled down and used elsewhere once trees are established after year 5.
- electric fencing used for establishing shelter is valued as a benefit when it is pulled down after 5 years around trees--valued at 75% of purchase price in year