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Sustainable grazing systems: Economic and financial implications of adopting different grazing systems in north-east Victoria

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Abstract. Data from experimental sites at Maindample and Ruffy was extrapolated to a 100 ha paddock on a commercial property. Incorporated into the analyses were risk assessments to allow for sowing failures due to adverse seasonal conditions and price variability for meat and wool during the life of the pasture. Where graziers carried out pasture improvement, the results indicated that changing from Control (low input pastures stocked at a low intensity) to High-input (high stocking rates and fertilizer addition) rather than Medium-input pasture was the more profitable option. In changing to High-input pasture using data from Maindample, a cattle activity using nominal discount rates of 10% per annum required success rates in pasture establishment of ≥ 80% for profitability. For Ruffy cattle, using the same discount rate, the change was profitable for success rates in pasture establishment of ≥ 70%, but lamb and wool activities were only profitable for success rates in pasture establishment of ≥ 90%. Over both sites, Ruffy cattle was the only activity for the change to be profitable for nominal discount rates of 15% per annum, but success rates for pasture establishment would also have to be ≥ 90%. Financial analyses performed on these increases in profitability confirmed that they were feasible because the pay-back periods for deficits incurred during the development and management of the improved pasture were less than the 13 year life of the investments. However, using a contractor to improve the pastures was not feasible because the deficits could not be repaid within the period of the investment. These results support the current low adoption of perennial pastures and have significant implications for catchment management bodies in Victoria and New South Wales where heavy reliance is placed on perennial pastures to improve catchment outcomes.

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Introduction

Relatively few papers have been published on the economics of pasture improvement. Scott *et al.* (2000) used benefit-cost analyses to develop an interactive spreadsheet model for assessing the profitability of improving and managing improved pastures over a period of 15 years. Examples of the use of the model were provided for the profitability of native compared to improved pastures on the North West Slopes of New South Wales. The model was also applied to a grazing study of phalaris pasture within the Temperate Pasture Sustainability Key Program (Lodge and Orchard 2000).

Barlow *et al.* (2003) developed a spreadsheet model to analyse profitable and sustainable grazing systems over a period of 10 years that was to be applied to 6 National Experimental (NE) Sites of the Sustainable Grazing Systems (SGS) Program within the high rainfall zone (HRZ, >600 mm/year) of southern Australia. The north-east Victoria component of the SGS program was 1 of 6 NE sites (Andrew and Lodge 2003). However, the benefit-cost analysis for assessing changes in profitability has not been applied to this site (Barlow and Ellis 2005 *pers. comm*). Indeed, Barlow *et al.* (2003) have recognized that the results of their economic analyses should only be regarded as 'indicative' because they did not include the cost of livestock capital nor the implications of taxation on the economic benefits of the investments in different pasture management systems.

To overcome those omissions, this paper reports the results of benefit-cost analyses for the north-eastern Victoria site of the SGS program to determine the economics of the different pasture management systems represented there. Further, because pasture improvement can be very risky, in carrying out the analyses, special consideration was given to two types of risks that graziers face when sowing pastures namely; (1) sowing failure or lack of persistence due to adverse seasonal conditions; (2) risk associated with price variability for livestock products during the life of the pasture. Following the economic analyses, financial analyses were carried out to determine the characteristics of the resulting cumulative net cash flows (CNCF) for the different pasture systems. Those characteristics may often be more significant than increases in profitability in determining whether graziers will adopt improved management procedures to increase the productivity and sustainability of their pastures.

The results of this paper are particularly relevant to graziers and their advisors because it is the continuing increases in the efficiency of pasture management systems through the application of improved production strategies that will offset the decline in the terms of trade that have been affecting agriculture over the long term.

Materials and methods

Sites and treatments

A brief description of sites and treatments is given, with full details found in Ridley *et al.* (2003). The two Sites were located on farms in north-eastern Victoria - Maindample (36° 59'S; 145° 59'E) and Ruffy (37° 00'S; 145° 27'E) with three unreplicated treatments per site within existing paddocks in natural sub-catchments. Treatments are referred to as Control, Medium and High. The soil at Maindample was of sedimentary origin whilst at Ruffy the soil was lighter, less duplex and of granitic origin (Isbell 1996).

The Control treatment at both sites was unsown pasture consisting of annual species and some native grasses, especially at Ruffy. At Maindample the Medium and High treatments were sown to *Phalaris aquatica* L. (phalaris cv. Australian). Phosphate (P) fertilizer was applied at rates of 5.5, 11 and 22 kg P/ha.year from 1997-2000. Topdressed lime was applied (2.5 t/ha) to the Medium in 1996 and 1999 and to the High treatment in 1992 and 1999.

At Ruffy the High and Medium treatments were sown to *Dactylis glomerata* L. (cocksfoot cv. Porto) and *Trifolium subterraneum* L. (subterranean clover) in 1989. Phosphate was applied at rates of 4.5, 9 and 27 kg P/ha.year respectively from 1997-2000. Lime was topdressed at 2 t/ha in 1992 on the High.

Description of livestock activities and stocking rates

The livestock activities on the two sites were cattle or sheep (prime lambs or wool). The cattle activity was one commonly carried out in the study area and involved self-replacing herds with progeny being sold at 18 months. Females were sold as store pregnant heifers, and steers were sold at liveweights of less than 450 kg for further growing out and finishing in a feed-lot. The sheep activities comprised prime lambs produced at Maindample and a self-replacing Merino flock for wool production at Ruffy.

Stocking rates on the Control and P treatments have been outlined previously (Ridley *et al.* 2003), and these were used in the economic and financial analyses where data from the trial sites were extrapolated to a paddock size of 100 hectares on a commercial farm in the HRZ of north-east Victoria.

Economic analyses

Benefit-cost analyses where results were expressed as net present values (NPV's) for the investment options were used to assess the after-tax profitability of sowing pastures, and using higher levels of inputs for their management, compared with maintaining unimproved pastures with only a basic level of inputs. This method of analysis is relevant for assessing the relative net benefits of investment programs that involve capital budgeting over the medium to long term (Van Horne 1977, Zerbe and Dively 1994, Sinden and Thampapillai 1995). Data used in the budgets were obtained from the graziers at the Maindample and Ruffy sites, with modifications where appropriate. For example, the grazier at Maindample repeatedly obtained lambing percentages ≥ 160 per cent for crossbred ewes. That figure was changed to 115 percent, which most graziers would consider a more likely level of performance in flocks producing prime lambs. Medium or High-input pastures and their management were analysed relative to continuing the existing (unimproved) pasture of the Control.

A critical factor for a decision-maker in deciding to change from Control to higher input pastures is the difference in NPV between the alternatives. The difference for one hectare of change might be quite small leading to only minute changes in wealth. But as the number of hectares increases, so too does the absolute size of the change in NPV, and hence the amount that is added to the wealth of the business. Consequently, the incentive for a grazier to make the change is much greater.

It is important to note that the purpose of the comparisons between NPV's for the Control and higher input pastures was not to compare the performance of one type of livestock with another. Rather, the comparison was to determine changes in NPV's for the Control versus the higher input pasture for cattle, crossbred sheep for prime lambs, or merinos for wool. In other words, the performances of cattle, or merino sheep, or crossbred sheep on the Control or higher input pastures were deliberately not compared between each other.

Financial analysis

After the economic analyses, financial analyses were conducted to determine the change in cumulative net cash flow (CNCF) in switching from Control pastures to Medium or High-input pastures. Important characteristics are the level of deficit in CNCF, the time at which the peak deficit occurs during the life of the investment, and the time taken to liquidate the deficit and generate cash surpluses. Financial analyses are critical to making decisions about the benefits of alternative investments. For example, an investment may pass the initial test of being expected to return equal or greater returns than discount rates, but if the financial analysis reveals an unacceptably high deficit in CNCF or pay-back periods that are too long, the investment should not be countenanced.

Assumptions used for the economic analyses

- *Land and overhead costs.* It was assumed that land was already owned so its capital value did not appear as an initial input of capital expenditure, and overhead costs for the farm business were assumed to remain constant as output increased for the higher input treatments.
- *Dollar terms and interest rates.* All dollar and interest rates were expressed in nominal terms.
- *Inflation.* Inflation was assumed as a nominal rate of 4% per annum and affected all prices received and costs paid.
- *Capital sowing costs.* Land preparation and sowing costs were included at two different levels; 1) for producers using their own equipment, and 2) where a contractor was used. For producers establishing pastures themselves, costs were assumed to be $275/ha and $245/ha for High and Medium-input pastures at Maindample and Ruffy respectively. Costs included the variable costs for machinery plus the cost of seed and fertilizer and the cost of lime. Where a contractor was used, the costs for pasture improvement were increased to $450/ha and $425/ha for High and Medium-input pastures at Maindample and Ruffy respectively.
- *Length of life of sown pastures.* All sown pastures were assumed to last for 13 years.
- *Stocking rates.* Assumed stocking rates (DSE/ha), shown in Table 1 were based on the actual stocking rates at the Maindample and Ruffy sites. Following Scott *et al.* (2000) and Barlow *et al.* (2003), stocking rates rise before reaching a steady maximum for a number of years then decline to a level where the investment analysis finishes and the project is repeated for another period. It was also assumed that the paddocks could maintain the same stocking rate for cattle as for the lamb and wool activities. Cattle were not introduced until the second year because of the risk of causing damage from pugging the newly sown pastures.

Table 1. Stocking rates (DSE/ha) for the livestock activities based on the higher input sites at Maindample and Ruffy.

Livestock activity	Location	Years						
		1	2	3 to 9	10	11	12	13
		DSE/ha	DSE/ha	DSE/ha	DSE/ha	DSE/ha	DSE/ha	DSE/ha
High input pasture								
Cattle	Maindample	0	14	18	17	16	15	14
Cattle	Ruffy	0	15	20	18	16	15	14
Lambs	Maindample	7	14	18	17	16	15	14
Wool	Ruffy	7	15	20	18	16	15	14
Medium-input pasture								
Cattle	Maindample	0	10	14	13	12	11	10
Cattle	Ruffy	0	12	15	14	13	12	11
Lambs	Maindample	7	10	14	13	12	11	10
Wool	Ruffy	7	12	15	14	13	12	11
Control pasture								
All activities	Maindample and Ruffy	10	10	10	10	10	10	10

- *Lime application.* The cost of lime was $54/t spread.
- *Residual lime value.* It is essential that unused values for inputs added during the period of the investment are accounted for as salvage values at the close of the period (Barnard and Nix 1972, Makeham and Malcolm 1993). A pasture life of 13 years was assumed and the value of lime remaining in the soil at the end of the period was calculated. The amount of lime was that not used in neutralising the acidifying effect of nitrate leaching, increases in soil organic matter and product removal (Ridley *et al.* 1990, Slattery *et al.* 1991). The value of lime remaining after 13 years was calculated for the cattle activities as $50/ha for Maindample High and $47/ha for Ruffy High. For the sheep activities, the value for prime lambs at Maindample High was $48/ha and $50/ha for wool at Ruffy High. Because the stocking rates and thus product removal were lower, the residual values of lime for Medium inputs were higher. Medium-input cattle at Mansfield and Ruffy were $57/ha and $56/ha respectively, whilst prime lamb at Maindample was $56/ha with wool at Ruffy being $60/ha. In benefit-cost analyses, if the salvage value of lime was ignored, the NPV and annuities for the project would appear to be lower than is the case when the value is included as a residual asset remaining at the end of the period of the analysis (Trapnell and Malcolm 2004).
- *Livestock accounting.* All analyses that deal with livestock must contain a stream of livestock schedules covering the total period of the investments (Makeham and Malcolm 1993), which ensures that in all years, the sources of stock - opening numbers, births and purchases, equal the uses of the stock - sales, deaths and closing numbers. Commensurate with this requirement, the benefit-cost analyses in this paper all commenced with livestock trading schedules that reconciled numbers and values for each year. In particular, the value of livestock for the various activities at the end of the period was included as salvage values in order to calculate the correct value for the NPV's (or annuities) over time.

- *Animal production.* For cattle over an area of 100 ha using stocking rates from the Maindample High treatment of 18 DSE/ha for years 3 to 9 inclusive when the pasture was fully developed, 80 calves were born from 89 cows, that is, a calving rate of 90%. Of those calves born, after allowing for deaths, sales comprised 38 steers, 20 pregnancy tested in calf (PTIC) heifers, and 6 non-pregnant heifers with the remaining 14 heifers being kept to maintain the number of breeding cows in the herd. For the 100 ha area based on stocking rates at Ruffy High of 20 DSE/ha, the equivalent figures were 88 calves born from 98 cows, and after accounting for deaths, sales comprised 41 steers, 41 PTIC heifers, and 6 empty heifers with 16 pregnant heifers being retained to maintain the number of breeding cows. For Maindample Medium, at a stocking rate of 14 DSE/ha from years 3 to 9 inclusive, 60 calves were born from 67 cows. After allowing for deaths, sales were 29 steers, 14 PTIC heifers, 4 non-pregnant heifers with 10 heifers being retained for breeding. Using stocking rate figures from Ruffy Medium of 15 DSE/ha in years 3 to 9 inclusive, for the 100 ha area, 66 calves were born from 73 cows. From the calves that did not die, sales were 31 steers, 19 PTIC heifers, 5 empty heifers and 11 joined the breeding herd. The equivalent stock numbers for Maindample and Ruffy Control were 43 calves born from 48 cows. After allowing for deaths, sales were 21 steers, 10 PTIC heifers, and 3 non-pregnant heifers with the remaining 8 heifers being kept to maintain the number of breeding cows.

  Wool weight for first cross Border Leicester-Merino ewes was assumed to be 4.2 kg/ewe. Wool weights for the Merino flock were assumed to be 5.5 kg for ewes, 9.0 kg for rams, 4.8 kg for 17 month old ewes and wethers and 1.0 kg for lambs. Total wool sales for Ruffy High and Medium for years 3 to 9 inclusive were 7 920 kg and 5 932 kg respectively. Total wool sales for Ruffy Control were 4 082 kg. Prime lambs sold from Maindample were assumed to be 110% of ewes joined. In years 3 to 9 inclusive, for Maindample High, 891 lambs were sold from 810 ewes and for Maindample Medium, 688 lambs were sold from 627 ewes. For the Control, 475 lambs were sold from 432 ewes.
- *Supplementary feed.* Increasing stocking rates increases risk in production. However, graziers can overcome increased risk from greater intensification by increasing the amount of supplementary feed provided to stock (Malcolm *et al.* 1996). Accordingly, graziers at the Maindample and Ruffy sites increased the amount of supplementary feed provided to stock as the stocking rates increased from the Control to the Medium and High-input treatments. For extrapolation of the amounts of supplementary feed supplied to the livestock at the two sites to an area of 100 ha, the following inputs of supplementary feed on the basis of amount per female breeder were provided to the cattle and sheep activities. For cattle, the amounts of hay fed on the Control, Medium and High-input pastures were 0.5, 0.6 and 0.7 t/cow at a cost of $145/t. The cost of supplementary feed for the prime lamb activity based on data from Maindample was $2.20, $4.50 and $8.50/ewe for the Control, Medium and High-input pastures respectively. Merino ewes were fed at a cost of $3.50 for the Control pasture, $6.20 for Medium pasture and $11.20 for the High-input pasture.
- *Expected prices for sales.* Expected prices are shown in Table 2. Expected prices are the sum of the probability weighted occurrence of various prices being received over time (Boehlje and Eidman 1984, Makeham and Malcolm 1993). They are the most likely values fine-tuned by the chances of other less likely outcomes occurring and are more informative than most likely prices based on historical averages. That is because averages are about the past whereas expected values allow more explicitly for new developments that may affect future events. Livestock prices were increased by 30% and wool prices by

25% for the ‘high price’ scenarios in the economic analyses and reduced by 30% and 25% for the ‘low price’ scenarios.

Table 2. Expected prices for products and prices for the high and low price scenarios

Item	Expected price		High price		Low price	
	Cents/kg	$/head	Cents/kg	$/head	Cents/kg	$/head
SteersA	190B	817	247B	1 062	133B	572
Heifers PTICC	195B	780	254B	1 054	137B	546
Heifers emptyC	175B	700	228B	910	123B	490
LambsD	318E	67	420E	87	220E	47
Crossbred wool	360F		450F		270F	
Merino wool	560G		700G		420G	

[A] Steers sold to a feedlot at an average liveweight of 430 kg

[B] Cents/kg liveweight

[C] Heifers sold at an average liveweight of 400 kg

[D] Lambs sold at 18-20 kg carcass weights, fat score 3, with a skin value of $7.00

[E] Cents/kg dressed weight

[F] Greasy wool price for a 28 micron fleece including fleece wool with a yield of 73% and oddments

[G] Greasy wool price for a 21 micron fleece including fleece wool with a yield of 70% and oddments

- *Allowing for risk.* Two types of risk are common for pasture improvement: (1) Sowing failures or lack of persistence due to adverse seasonal conditions: (2) risk associated with price variability for meat and wool during the life of the pasture. The first source of risk was handled by defining scenarios that relate to chances of the newly sown pasture being successful. The scenarios were that (i) re-sowing would succeed 9 years in 10, (90%), (ii) 8 years in 10 (80%) or (iii) 7 years in 10 (70%). These different events were handled by multiplying the cost of pasture establishment in the first year of the investment by the probability of failure, that is, 10%, 20% or 30%, to estimate the expected cost of failure. This was used as a contingency cost in each of the latter 12 years. (For more on this, see Gigerenzer 2002). Risks associated with price variability were accounted for by considering two pricing scenarios that involve a mixture of expected prices (E), high prices (H) and low prices (L). The first pricing scenario denoted EHL was EEHHEELLEEHHE over the 13 year period of the investment. The second pricing scenario denoted ELH was EELLEEHHEELLE over 13 years. The two types of variation in prices are considered as alternative propositions with equal probability of occurring for the various economic analyses in this paper. Because they have equal probability of occurring, the NPV’s/ha would have to be greater for the higher input pastures than for the Control for both pricing scenarios to indicate that a change would be warranted.
- *Livestock capital.* Values for livestock capital at current expected prices were assumed as $60/DSE for the breeding unit comprising cows, replacement heifers and bulls for the cattle activities, $37/DSE for first cross Border Leicester-Merino ewes and Dorset rams for the prime lamb activity, and $22/DSE for Merino ewes, replacement ewe weaners and Merino rams for the wool activity. These increased to respective capital values of

$77/DSE, $47/DSE, and $30/DSE for cattle, prime lambs and wool for the 'high price' scenario but reduced to $42/DSE, $26/DSE and $13/DSE for the 'low price' scenario.

- *Fertiliser for pasture maintenance.* It was assumed that in years 2, 3, 4, 5, 8, 9, 10, 12, and 13, P was provided to the High and Medium input treatments and the Control at respective rates of 22, 11, and 5.5 kg P/ha. In years 6 and 11, potassium (K) was provided to High and Medium pastures as 2:1 P:K mixed fertiliser at respective rates of 380 and 220 kg product/ha. Molybdenum (Mo) was provided as a Mo:P mixture as 0.05% Mo for the High-input pastures, 0.025% Mo for the Medium input pastures and 0.015% Mo for the Control in year 7. Fertiliser costs (January 2005 values from Button Bulk Fertilizers, Benalla) were $206/t for P, $275/t for 2:1 P:K and $230/t for fertiliser with 0.05% Mo, $225 for 0.025% Mo, and $223/t for 0.015% Mo. Contract spreading costs were assumed to be $26/t.
- *Extra labour.* Extra labour required was assumed as an increased cost of 50 cents per additional DSE run on High and Medium input pastures compared to the stocking rate on the Control. The extra cost was included to cover extra casual labour that would be required to assist the owner-operator with tasks to do with livestock management such as drenching, vaccination, marking and so forth.
- *Tax.* The average marginal rate of taxation was assumed as 25%. That is, 25 cents per taxable dollar earned after allowing for tax relevant deductible expenses.

Assumptions used for the financial analyses

- In the financial analyses, it was assumed that the business had zero cash at the start of the period.
- *Interest.* All capital for pasture improvement and associated costs was assumed to be borrowed. The rate of interest paid was assumed as 10% per annum before tax or 7.5% per annum after tax. Interest paid each year was based on the cumulative deficit carried forward plus any annual deficit for that year. The annual deficit was approximated as an overdraft accumulated over the course of the year but spread evenly throughout it. The calculation was handled by multiplying the total annual deficit by the full annual rate of 10% per annum then averaging it throughout the year by multiplying the full interest cost by 0.55 (Makeham and Malcolm 1993). Note that interest payable on the tax component of a cumulative deficit in one year would be paid in the year following the levying of tax. Interest could be earned on annual and cumulative balances at nominal rates of 5% less than the nominal rate for borrowed funds. That is, the assumption was made that bank's margin between borrowing and lending rates was 5% nominal per annum.
- *Length of loan.* Because moving from the Control to higher input pastures will become a normal process in the future management of the property, it was assumed that the length of the loan to carry out the process for the first paddock analysed in this paper will equal the assumed life of the pasture before it needs to be re-sown. That is, the pay-back period in the financial analyses must be no greater than13 years.

Sensitivity analyses

Two sensitivity analyses were carried out. The first was to gauge the effect on NPV (profitability) of changing average marginal rates of taxation in the economic analyses. That effect would also flow through to affecting cumulative net cash flow in the financial analyses. The second was to determine the nature of changes in cumulative net cash flow, particularly the pay-back period, that would arise from changing the rate of interest charged on borrowed funds (or received on cash surpluses) in the financial analyses.

Results

Economic analyses

An example of the economic analysis for running a beef cattle activity using data from the Ruffy site is shown in Appendix 1.

In Table 3, NPV's/ha are shown at various discount rates for cattle and sheep activities grazed on pastures where management was based on data from the Control and High-input sites for the two pricing scenarios of EHL and ELH where pasture improvement was performed by graziers. In Table 4, the same information is shown for pastures where the Control is compared with Medium- input pasture.

Table 3. NPV's per ha at various discount rates for Control and High input pastures for livestock activities on a 100 ha area of a property for the two pricing scenario's. Pasture improvement carried out by a grazier

Activity	Location	Success rate for pasture improvement	Discount rate 10%		15%		20%	
			Control	High input	Control	High input	Control	High input
		%	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha
EHL pricing scenario								
Cattle	Maindample	90	1 240	1 410	800	770	520	390
		80	1 240	1 330	800	720	520	340
		70	1 240	1 260	800	660	520	300
Cattle	Ruffy	90	1 240	1 520	800	860	520	450
		80	1 240	1 450	800	800	520	410
		70	1 240	1 380	800	740	520	360
Lambs	Maindample	90	1 220	1 300	880	850	650	571
		80	1 220	1 230	880	800	650	526
		70	1 220	1 150	880	740	650	481
Wool	Ruffy	90	1 100	1 250	790	850	580	590
		80	1 100	1 170	790	790	580	540
		70	1 100	1 100	790	730	580	500
ELH pricing scenario								
Cattle	Maindample	90	1 080	1 220	670	620	420	260
		80	1 080	1 140	670	570	420	220
		70	1 080	1 070	670	510	420	180
Cattle	Ruffy	90	1 080	1 340	670	710	420	320
		80	1 080	1 260	670	650	420	280
		70	1 080	1 190	670	590	420	230
Lambs	Maindample	90	1 120	1 200	800	770	590	500
		80	1 120	1 120	800	710	590	460
		70	1 120	1 040	800	660	590	410
Wool	Ruffy	90	960	1 010	680	650	490	420
		80	960	940	680	600	490	380
		70	960	860	680	540	490	330

Table 4. NPV's per ha at various discount rates for Control and Medium input pastures for livestock activities on a 100 ha area of a property for the two pricing scenario's. Pasture improvement carried out by a grazier

Activity	Location	Success rate for pasture improvement	Discount rate 10%		15%		20%	
			Control	Mediuminput	Control	Mediuminput	Control	Mediuminput
		%	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha
EHL pricing scenario								
Cattle	Maindample	90	1 240	1 210	800	710	520	410
		80	1 240	1 150	800	670	520	370
		70	1 240	1 090	800	620	520	340
Cattle	Ruffy	90	1 240	1 320	800	770	520	440
		80	1 240	1 260	800	730	520	400
		70	1 240	1 200	800	680	520	370
Lambs	Maindample	90	1 220	1 200	880	810	650	570
		80	1 220	1 140	880	770	650	530
		70	1 220	1 070	880	720	650	490
Wool	Ruffy	90	1 100	1 010	790	650	580	420
		80	1 100	950	790	600	580	380
		70	1 100	890	790	560	580	340
ELH pricing scenario								
Cattle	Maindample	90	1 080	1 080	670	620	420	330
		80	1 080	1 020	670	570	420	300
		70	1 080	960	670	530	420	260
Cattle	Ruffy	90	1 080	1 180	670	670	420	360
		80	1 080	1 120	670	630	420	320
		70	1 080	1 060	670	580	420	288
Lambs	Maindample	90	1 120	1 080	800	720	590	490
		80	1 120	1 020	800	680	590	460
		70	1 120	960	800	630	590	420
Wool	Ruffy	90	960	830	680	500	490	290
		80	960	770	680	450	490	250
		70	960	710	680	410	490	220

In Table 3, because the two pricing scenarios have equal probabilities of occurring, profitable levels of production will be indicated where the NPV/ha for the High-input treatment is greater than that of the Control for both pricing scenarios. For a nominal discount interest rate of 10%, that occurs for Maindample cattle for success rates in pasture establishment of 80% and 90%. That means, moving from Control to High-input pastures would lead to higher levels of profitability of greater than a 10% return on capital invested in pasture establishment and the extra capital invested in increasing the stocking rate. However, the return would be less than 15% because for a discount rate of 15% per annum, the NPV for High-input pastures was less than that of the Control. For Ruffy cattle, and at both pricing scenarios, higher NPV's and hence higher profitability occurred for all success rates for pasture improvement for a discount interest rate of 10%. Further, for a discount interest rate of 15%, the NPV for High-input pasture was greater than for the Control, but only for a success rate in pasture establishment of 90%. With lambs at Maindample and wool at Ruffy, higher NPV's for High-input pasture at both pricing scenarios only occurred for a discount interest rate of 10% per annum with success rates for pasture improvement of 90%.

Table 4 shows that in moving from Control to Medium-input pastures, because the increase in stocking rates were less, for a discount rate of 10% per annum, the only activity where the NPV for the Medium-input pasture was greater than for the Control for both pricing scenarios was Ruffy cattle for success rates in pasture establishment of 80% and 90%. However, the increases in NPV's, and hence increases in profitability, were less than for High-input compared to Control shown in Table 3.

Change in wealth for the farm business

Table 5 indicates the change in wealth for the farm business over a period of 26 years (two cycles of pasture improvement) as changes in NPV and annuity for changing from Control to High-input pastures for pricing scenarios of EHL and ELH respectively. The annuity, sometimes referred to as the annualised net present value (ANPV), is where the NPV for a project that is calculated over the whole life of the investment, is converted to an annual amount that is also expressed in present day values.

Table 5. Change in wealth for the farm business over a period of 26 years expressed as change in NPV and annuity[1] for the Control compared to High input pastures for various paddock areas at nominal discount interest rates of 10 and 15% per annum for the two pricing scenarios.

Activity	Location	Success rate in pasture improvement	Area (ha)															
			50				100				200				400			
			10%		15%		10%		15%		10%		15%		10%		15%	
			NPV	Annuity	NPV	Annuity	NPV	Annuity	NPV	Annuity	NPV	Annuity	NPV	Annuity	NPV	Annuity	NPV	Annuity
			$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$
EHL price scenario																		
Cattle	Maindample	90	10,962	1,197	-1,744	-269	21,924	2,393	-3,488	-537	43,849	4,786	-6,975	-1,075	87,697	9,573	-13,950	-2,149
		80	5,803	634	-4,650	-716	11,607	1,267	-9,300	-1,433	23,214	2,534	-18,600	-2,866	46,428	5,068	-37,201	-5,732
		70	1,290	141	-8,138	-1,254	2,579	282	-16,275	-2,508	5,159	563	-32,551	-5,015	10,317	1,126	-65,102	-10,030
Cattle	Ruffy	90	18,055	1,971	3,488	537	36,111	3,942	6,975	1,075	72,221	7,884	13,950	2,149	144,442	15,767	27,901	4,299
		80	13,541	1,478	0	0	27,083	2,956	0	0	54,166	5,913	0	0	108,332	11,825	0	0
		70	9,028	985	-3,488	-537	18,055	1,971	-6,975	-1,075	36,111	3,942	-13,950	-2,149	72,221	7,884	-27,901	-4,299
Lamb	Maindample	90	5,159	563	-1,744	-269	10,317	1,126	-3,488	-537	20,635	2,252	-6,975	-1,075	41,269	4,505	-13,950	-2,149
		80	645	70	-4,650	-716	1,290	141	-9,300	-1,433	2,579	282	-18,600	-2,866	5,159	563	-37,201	-5,732
		70	-4,514	-493	-8,138	-1,254	-9,028	-985	-16,275	-2,508	-18,055	-1,971	-32,551	-5,015	-36,111	-3,942	-65,102	-10,030
Wool	Ruffy	90	9,672	1,056	3,488	537	19,345	2,112	6,975	1,075	38,690	4,223	13,950	2,149	77,380	8,447	27,901	4,299
		80	4,514	493	0	0	9,028	985	0	0	18,055	1,971	0	0	36,111	3,942	0	0
		70	0	0	-3,488	-537	0	0	-6,975	-1,075	0	0	-13,950	-2,149	0	0	-27,901	-4,299
ELH price scenario																		
Cattle	Maindample	90	9,028	985	-2,906	-448	18,055	1,971	-5,813	-896	36,111	3,942	-11,625	-1,791	72,221	7,884	-23,251	-3,582
		80	3,869	422	-5,813	-896	7,738	845	-11,625	-1,791	15,476	1,689	-23,251	-3,582	30,952	3,379	-46,501	-7,164
		70	-645	-70	-9,300	-1,433	-1,290	-141	-18,600	-2,866	-2,579	-282	-37,201	-5,732	-5,159	-563	-74,402	-11,463
Cattle	Ruffy	90	16,766	1,830	2,325	358	33,531	3,660	4,650	716	67,063	7,320	9,300	1,433	134,125	14,641	18,600	2,866
		80	11,607	1,267	-1,163	-179	23,214	2,534	-2,325	-358	46,428	5,068	-4,650	-716	92,856	10,136	-9,300	-1,433
		70	7,093	774	-4,650	-716	14,186	1,549	-9,300	-1,433	28,373	3,097	-18,600	-2,866	56,745	6,194	-37,201	-5,732
Lamb	Maindample	90	5,159	563	-1,744	-269	10,317	1,126	-3,488	-537	20,635	2,252	-6,975	-1,075	41,269	4,505	-13,950	-2,149
		80	0	0	-5,231	-806	0	0	-10,463	-1,612	0	0	-20,926	-3,224	0	0	-41,851	-6,448
		70	-5,159	-563	-8,138	-1,254	-10,317	-1,126	-16,275	-2,508	-20,635	-2,252	-32,551	-5,015	-41,269	-4,505	-65,102	-10,030
Wool	Ruffy	90	3,224	352	-1,744	-269	6,448	704	-3,488	-537	12,897	1,408	-6,975	-1,075	25,793	2,816	-13,950	-2,149
		80	-1,290	-141	-4,650	-716	-2,579	-282	-9,300	-1,433	-5,159	-563	-18,600	-2,866	-10,317	-1,126	-37,201	-5,732
		70	-6,448	-704	-8,138	-1,254	-12,897	-1,408	-16,275	-2,508	-25,793	-2,816	-32,551	-5,015	-51,587	-5,631	-65,102	-10,030

The way to read Table 5 is for the various paddock sizes, look down the table for an annual discount rate of 10% per annum, that is, a return to extra capital invested in moving from Control to High-input pasture of at least 10% per annum, and observe the instances where the increase in NPV and annuity are greater than zero. Because the pricing scenarios have an equal probability of occurring, it is the lower increases for the pricing scenario of ELH that are relevant. Those instances occur for Maindample cattle for success rates in pasture establishment of 80% and 90%, for Ruffy cattle, for all success rates in pasture establishment, and for lamb at Maindample and wool at Ruffy for success rates in pasture establishment of 90%. By repeating the process for a discount rate of 15% per annum, the only activity to have an increase in NPV and annuity of greater than zero is Cattle at Ruffy for a 90% success rate in pasture establishment.

Financial analyses

An example of a financial analysis for a beef cattle activity run on pastures based on data from the Ruffy experimental site comparing the Control with High-input is shown in Appendix 1.

Peak deficits, year of peak deficits and pay-back periods of the cumulative net cash flows (CNCF) for changing from Control pastures to High-input pastures for EHL and ELH pricing scenarios are shown in Table 6.

Table 6. Peak deficits per ha, year of peak deficits and pay-back periods for changing from the Control to High input pastures for cattle and sheep activities based on data from the Maindample and Ruffy experimental sites for the two pricing scenarios

Activity	Location	Success rate in pasture establishment	Peak deficit per ha.	Year of peak deficit	Pay-back period
		%	$/ha	Year	Years
EHL pricing scenario					
Cattle	Maindample	90	920	3	11
		80	940	3	12
		70	970	3	> 13
Cattle	Ruffy	90	950	3	9
		80	970	3	10
		70	1 000	3	11
Lambs	Maindample	90	420	2	11
		80	440	2	> 13
		70	470	2	> 13
Wool	Ruffy	90	310	2	8
		80	320	2	9
		70	340	2	> 13
ELH pricing scenario					
Cattle	Maindample	90	960	4	12
		80	1 000	4	12
		70	1 040	4	> 13
Cattle	Ruffy	90	990	4	9
		80	1 020	4	10
		70	1 070	4	12
Lambs	Maindample	90	440	3	12
		80	480	4	> 13
		70	540	6	>13
Wool	Ruffy	90	380	4	8
		80	420	4	>13
		70	470	6	>13

In Table 6, the most important characteristic for the change in cumulative net cash flows (CNCF's) is the pay-back period. Observing the pay-back period for both pricing scenarios, in particular, ELH, shows that infeasible changes are evident for cattle at Maindample for success rates in pasture establishment of 70%, and for lambs and wool for success rates in pasture establishment of 70% and 80% because all exceed the 13 year life of the pasture. Also, infeasible changes were evident for moving from a Control to a Medium-input pasture (data not tabulated) because pay-back periods were greater than the 13 year life of the pasture for all discount rates and all success rates in pasture establishment.

Contractor carries out pasture improvement

Here, there were only two instances where the NPV for higher input pastures exceeded the NPV for the Control for both pricing scenarios. They were for Maindample cattle and Ruffy cattle for High-input pastures compared to the Control (data not presented in a table). The results showed that for a discount interest rate of 10% per annum, a success rate for pasture establishment of 90%, and a pricing scenario of EHL, Maindample cattle had an NPV/ha of $1 260 for High-input pastures compared to $1 240 for the Control. For Ruffy cattle, the NPV/ha was $1 370 for High- input pasture compared to $1 240 for the Control. In both cases, however, the financial analyses revealed that having a contractor carry out pasture improvement was not feasible because pay-back periods were greater than the 13 year life of the pasture.

Sensitivity analyses

Effect of increasing taxation. Increasing the taxation rate by 50% from 25 cents to 37.5 cents in the dollar for all of the cattle and sheep activities caused the NPV's for the Control to decrease by 20%. The decrease was less for the High-input pastures at 17%. Consequently, increasing the taxation rate led to larger changes in NPV's, that is, higher levels of profitability from making the change. For success rates in pasture establishment of 90%, the increase in NPV was $10/ha. The increase was $20/ha for success rates of 80% and the increase for success of 70% was $30/ha. For the EHL pricing scenario, the decline in addition to wealth for the various activities was only 4% over a period of 26 years, whilst the decline for the ELH pricing scenario was 8%. The financial analyses for all the grazing activities showed that with an increase in the taxation rate, the peak deficit increased slightly for differences in CNCF between Control and High-input pastures, but the pay-back periods did not change.

Effect of changing the interest rate in the financial analysis. The only place that interest rate entered the economic analysis was through the calculation of the amount of tax payable. Changing the interest rate paid on borrowed funds or received on cash surpluses in the financial analyses had a negligible effect on NPV's. Reducing it from 10% to 8% on borrowed funds caused the NPV's to increase slightly whilst increasing it to 12% caused a similar small reduction. The differences between the Control and High-input systems remained about the same. In the financial analyses, reducing the interest rate caused the peak deficit to be lower by 2% to 4% and increasing the interest rate increased it by about the same amount. Pay-back periods were also relatively unaffected with the greatest change being only one year for the lamb activity for a 90% success rate with pasture establishment and a pricing scenario of EHL when the interest rate was increased from 10% to 12%. A one year increase in pay-back period also occurred for the ELH pricing scenario causing it to extend from 12 years to greater than 13 years.

Discussion

Economic analyses

The risks associated with price variability for the economic analyses carried out over the 13 year period of investment in this paper were pricing scenarios of EHL and ELH. As was explained previously, either of those scenarios have an equal probability of occurring, therefore, NPV's/ha would have to be greater for the higher input pastures than for the Control for both pricing scenarios to indicate that a change would be warranted.

In all cases, the NPV's for the High-input pastures were greater than those of the Medium-input pastures. The reason for the poorer performance of the Medium-input pastures was that despite the lower initial capital cost of establishing the improved pasture and the reduced investment in increasing stocking rates for the various cattle and sheep activities, the lower stable state carrying capacity was not sufficiently high enough to generate profits that were equivalent to levels achieved for changing from Control to High-input pasture. But, at this stage the next form of risk intervenes being the success rate in pasture establishment. Consequently, for Maindample cattle, if a grazier expected to achieve success rates in pasture establishment with a probability rating of at least 80%, they could achieve after tax returns to the extra capital invested of greater than 10% but less than 15% from changing from Control to High-input pastures. The same would be true for Ruffy cattle if expected probabilities for success in pasture establishment were 70% or 80%. But if the expectation for success in pasture establishment was 90%, the after tax returns to extra capital invested would be slightly higher than 15% per annum. Graziers who produce prime lambs from crossbred ewes or Merino wool would have to have expectations for success in pasture establishment of at least 90% to receive after tax returns of 10% per annum to the extra capital invested in changing from Control to High-input pastures.

Financial analyses

The financial analyses carried out for the above economic analyses showed they were all feasible because their pay-back periods were all less than 13 years.

Change in wealth of the farm business

Viewed from the increases in wealth that could be achieved by moving from Control to High-input pastures, Table 5 shows that scaling up the area of pasture improvement that was carried out over a period of 26 years would only provide modest increases in wealth. The exception could be Ruffy cattle for carrying out the change for 400 hectares. However, relatively few properties in the high rainfall zone of north-eastern Victoria would be large enough for graziers to consider carrying out 400 ha's of change. Unless substantial increases occurred in the size of properties over the next decade, there would be insufficient scope to permit the expansion. However, as is common in many high rainfall regions in south-eastern Australia, ageing farmer populations, high land price, an increasing reliance on off-farm income, small farm size and transition to 'amenity', rather than agricultural landscapes will tend to preclude farm expansion (Barr 2005).

Contractor carries out pasture improvement

Economic analyses revealed that employing a contractor to carry out land preparation and sowing operations rather than the grazier carrying out the tasks would lead to lower levels of profitability for the whole farm business. As well as lower levels of profitability, the financial analyses indicated that employing a contractor meant that the peak deficit in CNCF arising from pasture improvement was increased and could not be repaid during the 13 year life of the pasture. Graziers who are faced with the situation of having to undertake pasture improvement on a regular basis would probably be advised to purchase their own set of equipment and allocate some of their allowance for property labour and management to carrying out the tasks themselves.

Sensitivity analyses

Effect of increasing taxation. Results suggest that an increase in the taxation rate by 50% from 25 cents to 37.5 cents in the dollar for all of the cattle and sheep activities caused the NPV's for the Control to decrease by 20%. The decrease was less for the High-input pastures at 17%. The reason that the NPV's for the High-input pastures declined less than the reduction in NPV's for the Control pastures was that taxation relief was gained from initial capital expenditure in carrying out the pasture improvement program. That is, because the pasture improvement program was part of a larger farm business, the cost of pasture improvement was written off against net taxable income for the rest of the farm so there was a reduction in tax paid. Since that benefit occurred at the beginning of the discounting period, it had a greater effect on increasing NPV's than did the lowering effect of increases in taxation payable on increased income as the stocking rates increased. Although increasing the taxation rate led to larger increases in NPV's between the Control and High-input pastures, the increases were not large enough to alter the conclusions for the results of the economic and financial analyses stated above. Additionally, the slightly higher differences in NPV's for the Control vis à vis the High-input pastures led to only small and relatively insignificant changes occurring in wealth generated for the farm business.

Effect of changing the interest rate in the financial analysis. Changing the interest rate on borrowed funds in the financial analyses had little effect on varying the NPV's of the Control or the higher input pastures. As was stated previously, interest rates only have an effect on the economic analyses through their effect on taxation, and varying them upwards from 10% to 12% or downwards to 8% had almost no effect on levels of profitability as a result of changing from Control to higher input pastures. Increasing or decreasing interest rates in the financial analysis changed the peak deficits in CNCF slightly. In analysing the difference in the CNCF as a result of moving from the Control to higher input pastures, increasing the interest rate to 12% caused an increase in peak deficit/ha of between 2% and 4% whilst reducing it to 10% led to the same levels of reduction. Such changes would not have been significant enough to influence decisions about carrying out the switch in systems for managing pastures. Pay-back periods were also relatively unaffected except in the case of the lamb activity for a success rate in the establishment of pasture of 90% when for the ELH scenario it increased from 12 years to greater than 13 years. That latter change was very serious because it would have led a grazier to reject the change. The conclusion for the lamb activity was that the stocking rate for the High-input pasture, based on the Maindample site, was too low at 18 DSE /ha for the steady state stocking rate to cope with increases in nominal interest rates on borrowed funds from 10% to 12% per annum. The only way to overcome that difficulty would be to increase the stocking rate for lambs from 18 DSE/ha to 20 DSE/ha which was the stocking rate for the wool activity. If that had have been the case then the pay-back period would have been reduced to 8 years for both of the pricing scenarios.

Conclusions

For sowing of perennial pastures to be profitable, landholders must have the skills to sow pastures themselves and to substantially increase stocking rates, fertiliser and lime inputs. Such increases must inevitably be accompanied by strong skills in both grazing and business management. Given the demographic trends, only a minority of landholders in this and similar regions of the high rainfall zone of south-eastern Australia are likely to have the commercial drivers and skills to embark upon perennial pasture establishment and management. This has significant environmental implications for catchment management bodies and governments who are still relying heavily on perennial pastures to achieve better environmental outcomes.

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Appendix 1. Example economic and financial analyses for a cattle activity grazed on 100 ha using High input data from the Ruffy experimental site for an EHL pricing scenario using a nominal discounting rate of 10% per annum

Item		Year												
		1	2	3	4	5	6	7	8	9	10	11	12	13
		$	$	$	$	$	$	$	$	$	$	$	$	$
Economic analysis														
Income:	Cattle sales	0	38,658	87,268	96,857	82,153	85,439	62,200	64,688	102,128	102,025	114,349	112,213	85,126
	Salvage value of lime													7,885
	Salvage value of livestock													128,322
	Salvage value of pasture													9,217
Costs:	Variable costs for cattle activity	0	4,131	7,932	8,837	7,967	8,285	7,017	7,298	9,894	9,111	10,068	9,869	8,178
	Supplementary feed	0	7,819	11,498	11,099	11,807	12,280	12,771	13,282	13,624	12,553	11,777	11,425	11,099
	Extra casual labour		270	562	585	608	633	658	684	712	592	462	400	333
	Livestock replacements				4,060	2,904	3,021	2,199	2,287	7,731	0	3,442	3,134	2,323
	Livestock acquisition	0	98,539	23,400										
	Lime cost	13,500												
	Pasture establishment	13,839												
	Pasture maintenance fertiliser		6,273	6,524	6,785	7,057	14,473	8,192	7,938	8,255	8,585	17,608	9,286	9,657
	General pasture maintenance		1,082	1,125	1,170	1,217	1,265	1,316	1,369	1,423	1,480	1,539	1,601	1,665
	Risk allowance for failure of improved pasture to establish for an estimated probability of 10%		1,497	1,557	1,619	1,684	1,751	1,821	1,894	1,970	2,048	2,130	2,216	2,304
Net cash flow before tax		-27,339	-80,954	34,669	62,702	48,909	43,732	28,226	29,936	58,520	67,655	67,322	74,282	194,991
Tax payable		-7,211	5,847	12,213	13,783	10,385	9,871	6,859	7,560	13,469	13,681	16,594	19,016	14,870
Net cash flow after tax		-20,128	-86,801	22,456	48,919	38,524	33,861	21,367	22,377	45,051	53,974	50,728	55,266	180,121
NPV		$152,166												
Financial analysis														
Cumulative net cash flow after tax		-20,128	-108,432	-92,592	-54,224	-24,290	4,635	24,282	47,580	94,714	152,781	210,309	275,405	323,151
Interest		-1,504	-6,616	-10,551	-8,590	-4,936	-1,720	922	2,083	4,092	6,801	9,830	13,050	19,785
Cumulative net cash flow (CNCF) after tax and interest		-21,632	-115,048	-103,143	-62,814	-29,226	2,915	25,204	49,664	98,807	159,582	220,140	288,455	342,936
Less CNCF after tax and interest for Control pasture		-46,374	-32,001	-7,878	16,933	38,559	61,835	77,712	94,886	121,897	151,106	193,013	237,923	277,005
Change in CNCF		24,742	-83,047	-95,265	-79,747	-67,785	-58,920	-52,509	-45,222	-23,091	8,476	27,127	50,533	65,932