PROFITABILITY AND RISK EVALUATION OF NOVEL PERENNIAL PASTURE SYSTEMS FOR LIVESTOCK PRODUCERS IN THE HIGH RAINFALL ZONE: INITIAL ANALYSIS AND RESULTS

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Abstract

Increased awareness by farmers, scientists and farm advisors of the potential to increase the role of perennial pastures in livestock grazing systems has lead to the development and evaluation of new perennial pasture systems for livestock production in the high rainfall zone of south west Victoria. Increased stock carrying capacity per hectare compared to current common practice has been reported. Thorough and convincing whole farm management analysis of the merit of investing in these new perennial pasture systems is required. This evaluation must account for the likely increases in carrying capacity, expected return on extra capital invested, finance implications, effects on the farm balance sheet and other whole farm implications of the change over time including risk. In this work changes to a current-practice, regional representative farm were modelled over time. The approach was to use partial development budgets with a whole of farm perspective to calculate the possible net present values, internal rate of returns and nominal net cash flows of two perennial pasture investment options under a range of stocking rate conditions. Price breakeven and variability of extra net cash flows analysis was investigated, as was risk associated establishment failure. Considering economic returns, risk and finances, investing in these new perennial pasture systems can be an attractive option for farmers in the study region compared the performance of their farm systems under current common practice and also compared to alternative investments off the farm.

Keywords: Pasture Investment, Representative Farm Analysis

Sub Theme: Farm Management

Introduction:

Livestock grazing in Australia faces many environmental challenges including dryland salinity, loss of biodiversity and the risk of climatic change (CSIRO Australia and Bureau of Meteorology 2007; Friend *et al.* 2007). Increased awareness of these challenges has lead to research through projects such as EverGraze® into the wider use of perennial pasture species ((Friend *et al.* 2007).

An EverGraze® 'proof site' was set up at Hamilton in south west Victoria in 2005 with three perennial pasture systems running highly productive livestock enterprises. The systems focused on sowing what was considered to be the 'right plant' on the 'right land class', and employed rotational grazing. The experimental results suggest that the Hamilton EverGraze® pasture systems can increase stocking rate per hectare by as much as 30-40% compared to common practice for the region (Nicholls 2009).

Following the end of the experimental phase of the project, the next step is the economic and practical evaluation of the pasture technology and farm systems from the grazier's point of view. Saul *et al* (2009) recognised that producers concerns about the costs and returns involved in pasture establishment, combined with concerns regarding establishment failure (Scott *et al.* 2000; Trapnell *et al.* 2006) have lead to a reluctance by graziers to adopt potentially more productive and profitable pasture systems. Uncertainty about the performance of high stocking rate systems in practice in terms of physical, economic and financial performance of particular farm systems also inhibits adoption. This is combined with concerns about the risks of increased intensity of production and concomitant increased variability of returns. Therefore a sound understanding of the profitability, financial implications and risk associated with investing in the EverGraze® pasture systems is required.

Analysis of three years of trial results of two EverGraze® pasture systems was undertaken to establish whether investing in the perennial pastures makes economic and financial sense considering risk. In this paper the approach to the analysis of these questions and initial results of this analysis are presented.

Method

Regional representative farm analysis was used to evaluate the EverGraze® perennial pasture systems. Becker (1963) argues that, whilst the exact outcomes from a representative farm will never be duplicated on individual farms, the relative effects of alternatives are demonstrated realistically and reliably. Carter (1963) points out that a potential short-coming of representative farm analysis is that they are usually static in nature, encompassing a single time period. A further common limitation of static analyses is that whilst 'before' and 'after' situations can be represented, the interesting part with big implications – the process of implementing changes to farm systems – is assumed away. The limitations of static, single period farm analyses are avoided in this work by modelling the performance of businesses over time. This approach enables an element of real world dynamism to be introduced: the process of adopting the changed farm system is represented, and the operation of the firm can be changed in response to different circumstances over the whole run of the relevant planning period.

Case study farms have external and internal commonalities with other similar farms. The farm businesses face similar natural and economic external conditions, and similar internal biological processes. Representative farms can be powerful, highly useful tools for analytical purposes, as long as the development of a representative farm is tied closely with the purpose of the specific research question, and is typical of the farms and farmers under consideration (Becker 1963; Carter 1963; Elliott 1928; Malcolm 2004). The information that results from this type of analysis enables decision makers and researchers to form judgements about the technological change and the results of it for similar farm resources, systems and situations.

Representative Farm

The representative whole farm was based on the South West Farm Monitor Project 'Average' farm in the 650mm plus rainfall zone to align with a target audience for the EverGraze® pasture technology (Department of Primary Industries 2010; EverGraze® Regional Group 2009). The total effective area of the farm was 1000ha, with average soil fertility. Current common practice on this farm reflects the district average production system and is termed the 'Base Case'.

All major characteristics of the representative farm were validated by the Hamilton EverGraze® Regional Advisory Group consisting of local farmers and industry representatives to 'real world' test the assumptions used in the model (EverGraze® Regional Group 2009).

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Pastures

The analysis used the 'Base Case' pasture plus two of the experimental systems – the 'EverGraze® Triple' and the 'EverGraze® Ryegrass' pasture systems. The pasture systems described in Table 1 is the source of the pasture data used in the representative farm model.

Table 1 Description and source of data used in the representative farm model for the 'Base Case' and 'EverGraze®' pasture systems.

	Pasture Description	Pasture Growth (kg DM/ha day)[19]	Pasture Quality (MJ ME /kg DM)[20]
Base Case	Ryegrass/Subterranean clover with cape weed pasture base in the Hamilton region.	The simulation model GrassGro was run for the 2007, 2008 and 2009 seasons (CSIRO Plant Industries 2007)	The simulation model GrassGro was run for the 2007, 2008 and 2009 seasons (CSIRO Plant Industries 2007)
EverGraze® Triple **EverGraze® Ryegrass**	SARDI 7 Lucerne on the crest, Avalon Perennial Ryegrass on the slope and Quantum Tall Fescue on the valley floor (Nicholls 2009). Fitzroy Perennial Ryegrass on the crest, Avalon Perennial Ryegrass on the slope and Banquet Perennial Ryegrass on the valley floor (Nicholls 2009)	Used 2007, 2008 and 2009 EverGraze® experimental trial pasture supply fresh growth data. The results reflected the theoretical on-farm potential performance of the pasture technology when managed as recommended including adoption of rotational grazing.	Used 2007, 2008 and 2009 EverGraze® experimental trial pasture quality data. The results reflected the theoretical on-farm potential performance of the pasture technology when managed as recommended including adoption of rotational grazing.

Total pasture availability in dry matter (DM) kg/ha month was calculated by combining the fresh growth in each month plus two thirds of excess pasture carryover from the previous month, as detailed in Moore and Zurcher (2005).

For the Base Case, all associated annual variable costs of pasture maintenance as carried out by local producers in the Hamilton district were included in the analysis, including the cost of periodic over-sowing required to maintain stocking rates (Armstrong 2010; EverGraze® Regional Group 2009; Reeve *et al.* 2000). All costs associated with maintaining soil fertility and pasture status, as per standard good practice in the district, were included for the EverGraze® pasture systems (Armstrong 2010).

The different perennial species in the EverGraze® systems have varying degrees of expected persistence. For example, the persistence of perennial Ryegrass is sensitive to seasonal conditions and soil fertility, whereas summer-active Tall Fescue is expected to last indefinitely. To encompass this variation between the species, it was estimated that the entire 'EverGraze® Ryegrass' and the Ryegrass and Lucerne portions of the 'EverGraze® Triple' required resowing after six years to

[19] Described as kg dry matter per hectare per month (DM kg/ha month). Dry matter is the amount of feed quantity once all water has been removed. This measure allows feeds of different moisture content to be compared on a common quantity basis.
[20] Described as metabolizable energy (ME) content, and is expressed as mega joules per kg of DM (MJ/kg DM). Metabolizable energy is the amount of energy available in a feed for animal use.

maintain stocking rates. The ‘EverGraze® Triple’ system also required winter cleaning[21] of the Lucerne portion every three years.

Livestock system

The representative farm comprised mixed livestock enterprises as shown below in Table 2**Table 2**[22].

Table 2 Modelled representative farm livestock enterprises

	Description	Lambing/ Calving	Farm Area (grazed ha)	Livestock Enterprise Mix	Product
Sheep			**800**	**80%**	
	Self replacing Merino	September		*(70%)*	**Wool** 3.4 clean kg/head of 18.4 micron
	Merino X White Suffolk	July		*(30%)*	**Prime Lamb** 41-45kg liveweight trade lambs at six months
Beef	*Angus*	April	**200**	**20%**	**Beef** 400-420 kg liveweight steers for sale at 16 months and cull heifers sold at 19 months at 350 kg liveweight

Year-round stocking rates are depicted as Dry Sheep Equivalents per hectare (DSE/ha) as detailed by Russell (2009). Livestock feed demand was estimated in mega-joules of metabolisable energy per head per day (MJ ME/head/day) and energy needs were calculated using the ‘ME Required’ program (CSIRO Plant Industry 2006). The calculated MJ ME/head/day values were then used to determine the total pasture demand in terms of kg DM/ha month. When a feed gap occurred[23] supplementary feed was supplied and costed at the cost of production.

Stocking rate for the ‘Base Case’ was set at 16.2 DSE/ha/year to reflect the target EverGraze® audience. In the analysis the two EverGraze® systems were set to operate at a stocking rate of 27 DSE/ha/year as deemed achievable by the experimental results. The investment in extra livestock carried was part of the total extra capital invested in the improved pasture systems.

Analysis

This pasture investment decision analysis considers the ‘EverGraze® Triple’ and ‘EverGraze® Ryegrass’ pasture systems as alternative possible futures for the ‘Base Case’ farm investment. Options are compared between the outcomes achievable in alternative futures, and not between a future outcome and the current situation (the *status quo)*. That is, the comparison is between how the two new options are expected to perform over the life of the investment in the changed situation as a result of the investment.

In practice, it is not likely that producers will renovate the entire farm pasture area at once. For this analysis, the assumption is that 10% of total farm area, or 100ha, is being considered for pasture improvement. As the pasture investment involves adding capital to existing land, stock and other farm capital, a partial development budget was done, with a whole farm perspective (Malcolm *et al.* 2005). This approach included all the extra benefits of the EverGraze® systems, minus all the extra costs including pasture establishment costs, to calculate the expected return on extra capital

[21] Winter cleaning involves spraying Lucerne with a herbicide to control annual weeds and maintain the long term productivity of the pasture.
[22] Each enterprise was described in the analysis in terms of production parameters, flock/herd structure and products based on the ‘Average’ farm in the farm monitor project (Department of Primary Industries 2010 and input from the EverGraze regional advisory group (EverGraze Regional Group 2009).
[23] Feed gap defined as when total pasture demand exceeded total pasture supply

invested over the life of the project using discounted cash flow analysis (DCF). As well, nominal cumulative net cash flows are calculated to assess financial implications of the investment.

Economic analysis involved estimating Internal Rate of Return (IRR) and Net Present Value (NPV) at eight percent nominal[24]. With much of the risk of the investment included in the budgeted numbers, and not the discount rate, this eight per cent required rate of return per annum is similar to medium-term earnings in the share market, and is higher than less risky urban real estate or returns from risk free Commonwealth bonds (Malcolm *et al.* 2005). The criteria is that if the IRR exceeds the opportunity cost, and if the NPV is positive at the required rate of return, then the investment is more rewarding in economic terms than the alternatives that are available.

As well as the economic (efficiency) analysis, nominal cash flows were used to assess the financial feasibility of the investment. Cumulative Nominal Net Cash Flow (CNCF)[25] was calculated to identify the financial feasibility of the investment. This showed the size and timing of peak debt, and payback period. In practice this information is interpreted in the context of the existing debt to equity state of the farm balance sheet, the debt servicing ability of the investment as 'stand-alone', the sources of additional debt servicing ability from other cash flow and the amount of equity that may be required to be invested.

In practice, these measured potential performance results are weighed up by decision-makers in the context of the operation of the whole farm system, including the range of goals and practical aspects that are not able to be included explicitly in the quantitative analysis.

It was assumed that the actual recorded performance of the pastures in the trial work under the diverse seasonal conditions that occurred in 2007, 2008 and 2009 were reasonable representations of the likely range of seasons that could occur in the future planning period. The sequence of seasons in 2007, 2008, 2009 was assumed to repeat four times for the forthcoming 12 year planning period[26]. Using a run of three actual seasonal scenarios and projecting these into the future is one way of incorporating an estimate of the risk from seasonal variability and hence the effect of this variability on the extra annual net cash flows for each EverGraze® option. The extent of variability was measured by calculating the standard deviation (SD) of the extra net cash flows over the life of the investment as a quantitative indicator of the relative riskiness of each option. Breakeven analysis based on activity gross margin was conducted. This indicated the percentage the combined activity gross margin per hectare would need to fall for each of the alternative pasture investments to earn a return equal to the opportunity cost of capital[27].

In commercial practice the performance of new technologies on farm usually do not reach the levels produced in research trials, such as the high stocking rates recorded by the EverGraze® proof site of up to 27 DSE/ha. In this case, producers from the EverGraze® Regional Group were convinced, based on their own experience, that the EverGraze® pasture technology can deliver in a commercial environment the level of production shown in the research trial (EverGraze® Regional Group 2009). As these producers are considered to be well above the 'average' farm operator for the region, the analysis was conducted at the 27 DSE/ha, 24DSE/ha and 21DSE/ha trial rates of performance.

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[24] IRR indicates the return on capital invested over the life of each pasture investment. NPV represents the addition to investor's wealth *above* what they would gain if they invested the capital involved in an alternative that earned at the rate of 8% (discount rate of 5% real return plus 3% inflation).

[25] CNCF was calculated after tax of 10% of the approximate annual taxable income with 3% inflation p.a. and 8% interest p.a.

[26] As the pastures involved in the EverGraze systems have varying degrees of expected persistence, the analysis assumed a 12 year planning period. This accounted for 2 establishment phases of the Ryegrass and Lucerne pastures, with the Tall Fescue expected to last the full 12 years after initial establishment.

[27] That is, an NPV of $0 and IRR equal to 8%.

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The risk of pasture establishment failing is an often-expressed concern by producers considering pasture investment. To include this consideration, the economic performance and financial feasibility of each investment was calculated when pasture establishment was successful in year 1, and also for the case when establishment failed and sowing was repeated in year 2. The likelihood of pasture failing and the implications for the economic and financial returns from the investment is information the decision-maker then can weigh up.

Prices used for the analysis (in Table 3) were assumed to be the most likely levels for the medium term with consultation from the EverGraze® Regional Advisory Group (EverGraze® Regional Group 2009)

Table 3 Commodity prices used in analysis considered to be the most likely levels for the medium term

Commodity	Unit	Price
	Wool	
18 micron fleece	($/kg clean)	$12.00
	Meat	
Trade Lambs	($/kg carcass weight)	$4.40
Store Lambs	($/head)	$70
Mature Sheep	($/head)	$60
Cast For Age Ewes	($/head)	$40
Yearling Steers	($/kg carcass weight)	$2.00
Yearling Heifers	($/kg carcass weight)	$1.95
Mature Cows	($/head)	$600
Cast For Age Cows	($/head)	$450
	Supplementary Feed	
Feed Barley	($/tonne fed)	$160
Lupins	($/tonne fed)	$160
Pasture hay	($/tonne baled)	$81

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Results

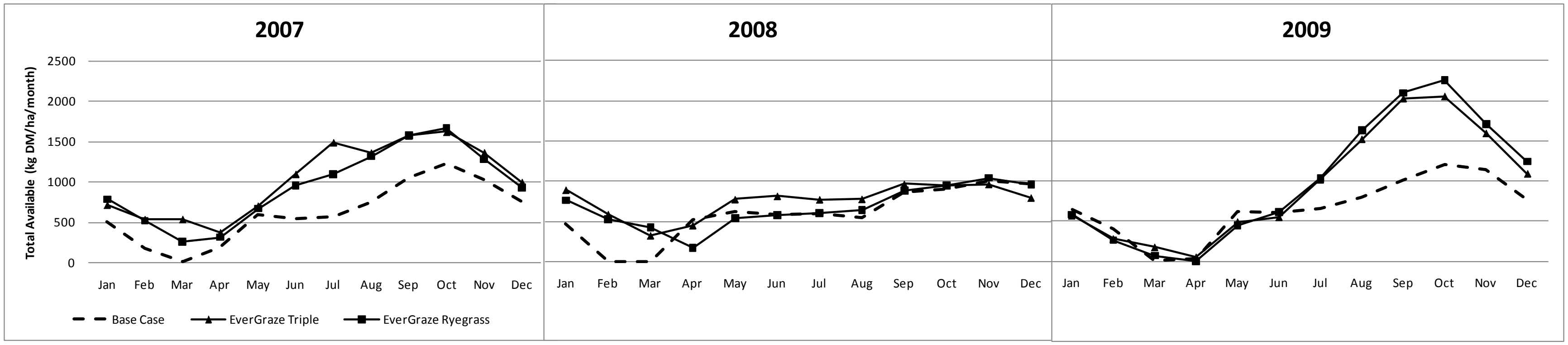

Figure 1 Total Available Pasture per ha per month for 2007, 2008 and 2009 with stocking rates of 16.2 DSE/ha for the Base Case and 27 DSE/ha for the EverGraze® systems.

In Figure 1 the total available pasture (fresh growth plus carryover from previous month) is depicted for the run of three seasons. The total feed available at the start of each season depended heavily on the carryover of feed from one year to the next. During the winter/spring period (June-November), the EverGraze® pasture systems showed higher supply levels than the Base Case in the 2007 and 2009 seasons. In 2008 the three systems were similar during this period. In the summer/autumn period (December – May) of 2007 the EverGraze® systems performed slightly better than the Base Case. The autumn of 2008 and summer/autumn of 2009 showed mixed results, with the Base Case providing greater supply than one or both of the EverGraze® systems at certain points in time.

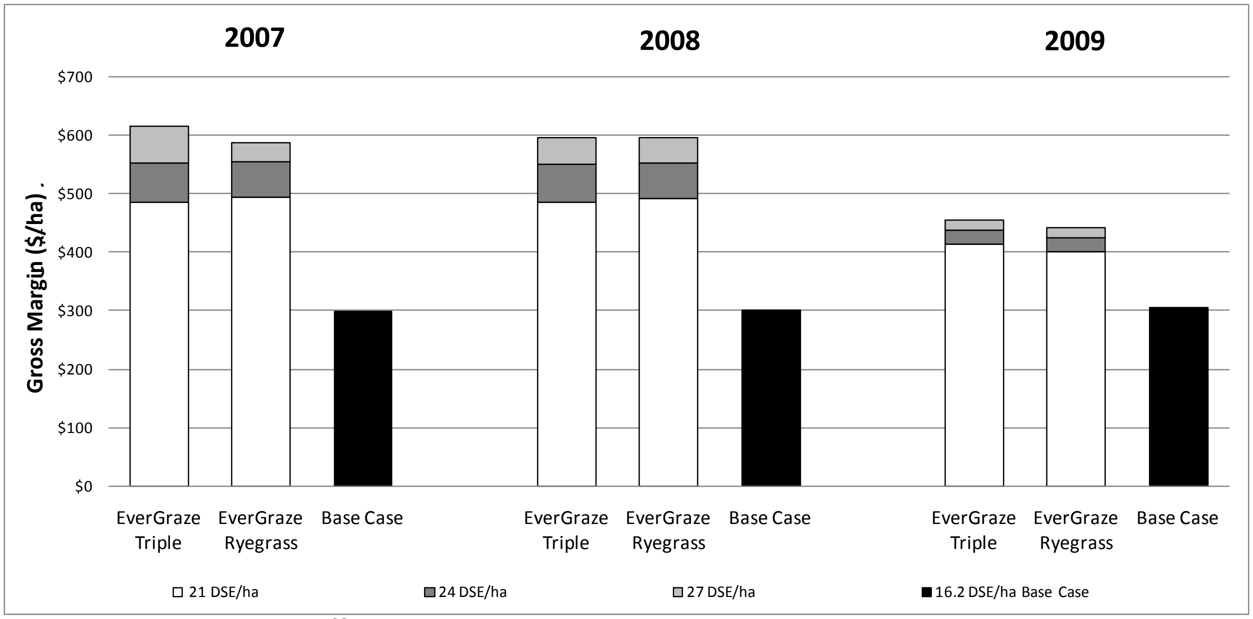

Figure 2 Gross Margin $/ha[28]

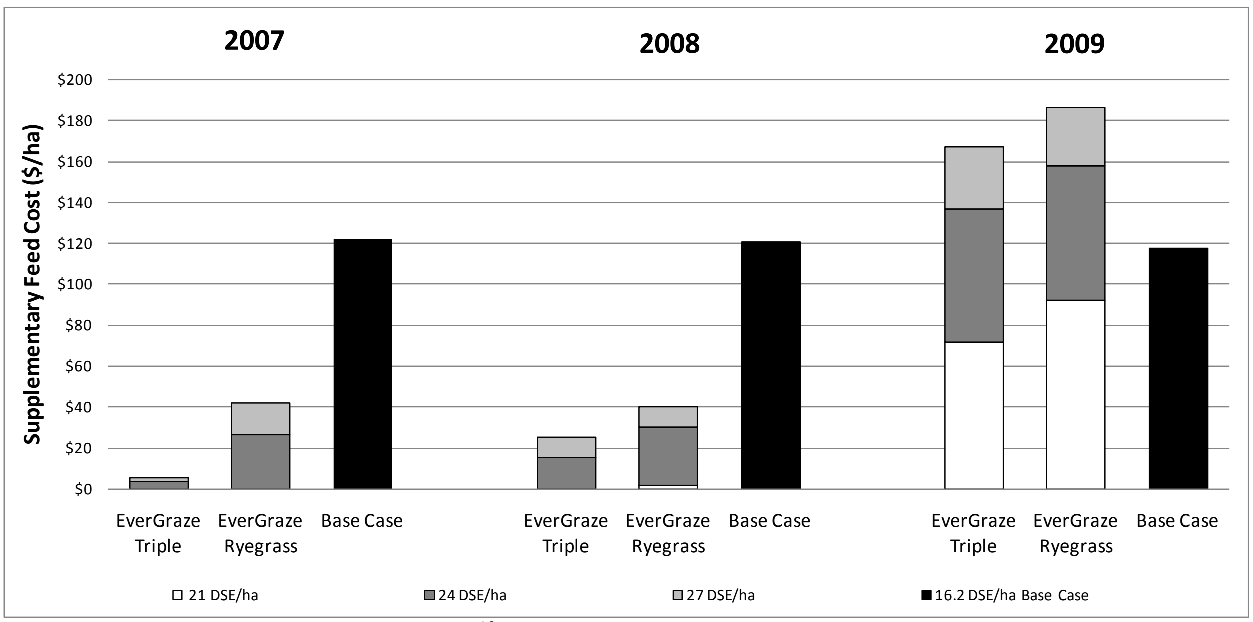

Figure 3 Supplementary Feed Cost $/ha[10]

Gross margin analysis was conducted for each pasture system for the three seasons, and included all variable costs and income from the livestock system (Figure 2**Figure 2**). Supplementary feed was identified as having a substantial effect on gross margin per hectare, as when the supplementary feed requirement increased in any season, the relative gross margin was reduced (Figure 2 & Figure 3). It must be noted that destocking during times of low feed supply was not an option in this analysis, and therefore stocking levels were maintained by supplementary feeding during feed gaps.

[28] Values represented in Figures 2 and 3 are cumulative for each system. For example, in Figure 2 the EverGraze Triple in 2007has a GM/ha of $615 at 27 DSE/ha, where at 21 DSE/ha the GM/ha is $485.

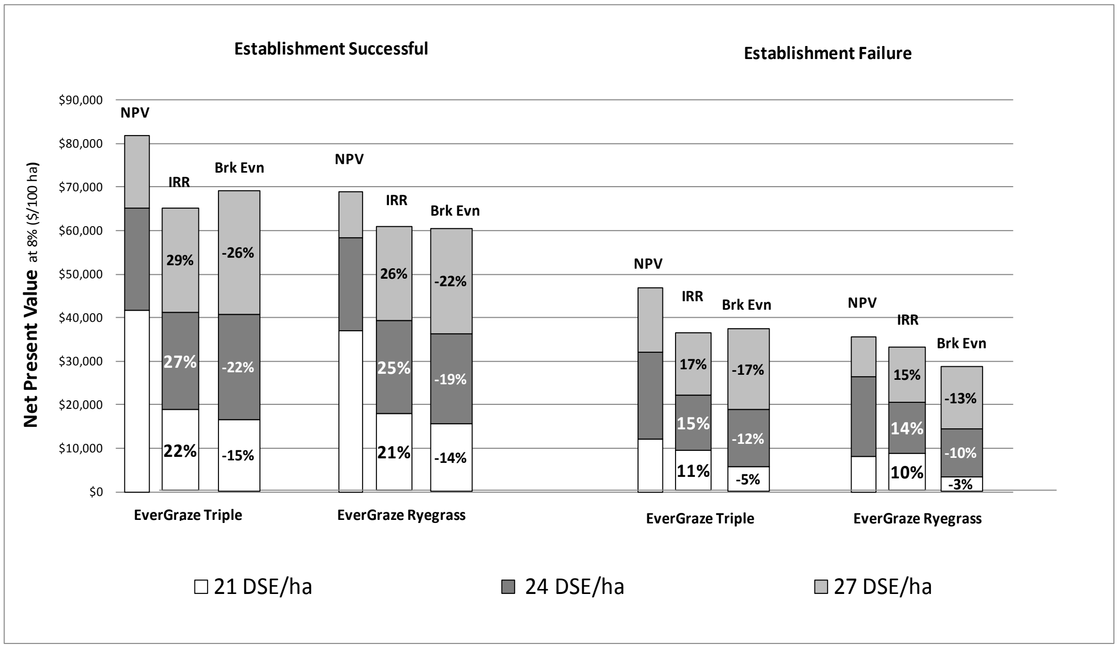

Figure 4 Net Present Values (NPV) @ 8% nominal after tax[29], Internal Rate of Return (IRR) after tax and Gross Margin Price Breakeven Analysis (% drop in GM/ha).

The economic analysis of NPV and IRR revealed that both pasture options were superior to the rewards from the opportunity uses of the capital (Figure 4).

Establishment failure in the EverGraze® systems has the potential to reduce addition to wealth, or NPV, by 40-50% over the life of the investment for the two highest stocking rates. At the lowest stocking rate tested this impact rose to approximately 70-80%. However, establishment failure is likely to occur only once in 10 years, making the *expected value* of the loss from when establishment fails only 10 per cent of the estimated loss. Even with an establishment failure the investment promised to earn more than an opportunity cost of the capital of eight percent after tax. The IRR indicates that both pasture improvement options are good investments relative to alternative investments, even when an establishment failure occurs (Figure 4).

Breakeven analysis identified that the EverGraze® systems gross margin per DSE would need to drop, for whatever reason[30], by an average 14-26% for every year of the 12 yr period from those used in this analysis for the investment to just breakeven with its opportunity cost, depending on stocking levels (Figure 4). This fall was reduced to 5-17% with unsuccessful establishment. There is considerable scope in any year for gross margins to decline from, or better, the levels used in the analysis.

[29] NPV values are cumulative for each system, for example the EverGraze Triple system with successful establishment has an NPV of $81, 970 at 27 DSE/ha and an NPV of $41,671 at 21DSE/ha.

[30] For example, price breakeven analysis determined that in the case of successful establishment the 18 micron price guide would need to fall by $7-$9 kg clean from a most likely price of $12 kg clean for the investment to breakeven with its opportunity cost. This was reduced to a fall of approximately $1-$5 kg clean for unsuccessful establishment.

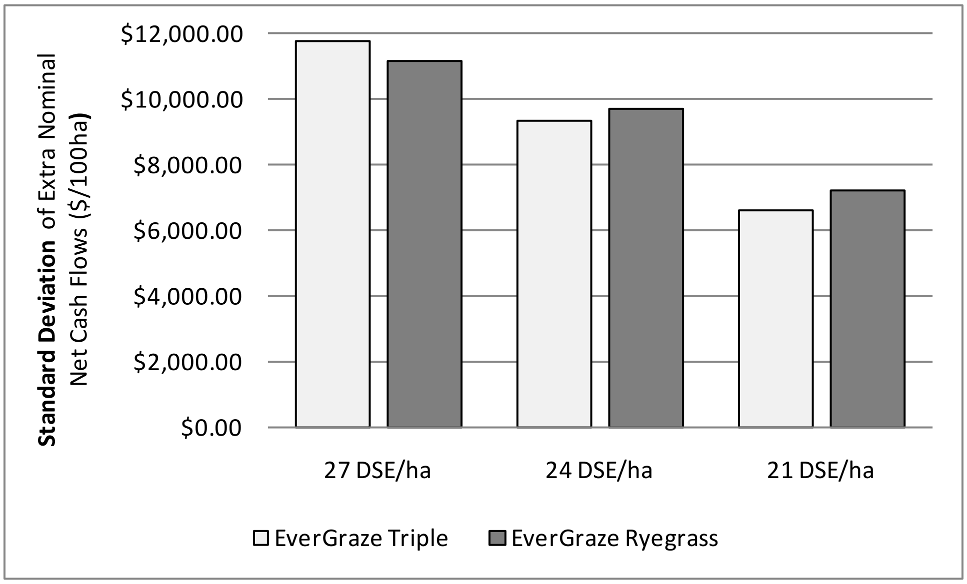

Figure 5 Standard Deviation (SD) of extra nominal net cash flows after tax over the 12 year period.

Figure 5 the standard deviation in annual net cash flows over the life of the investment in the pasture options was lower for lower stocking rates for both systems. This is consistent with the phenomenon that intensification of farm systems increases both the mean and variance of net returns.

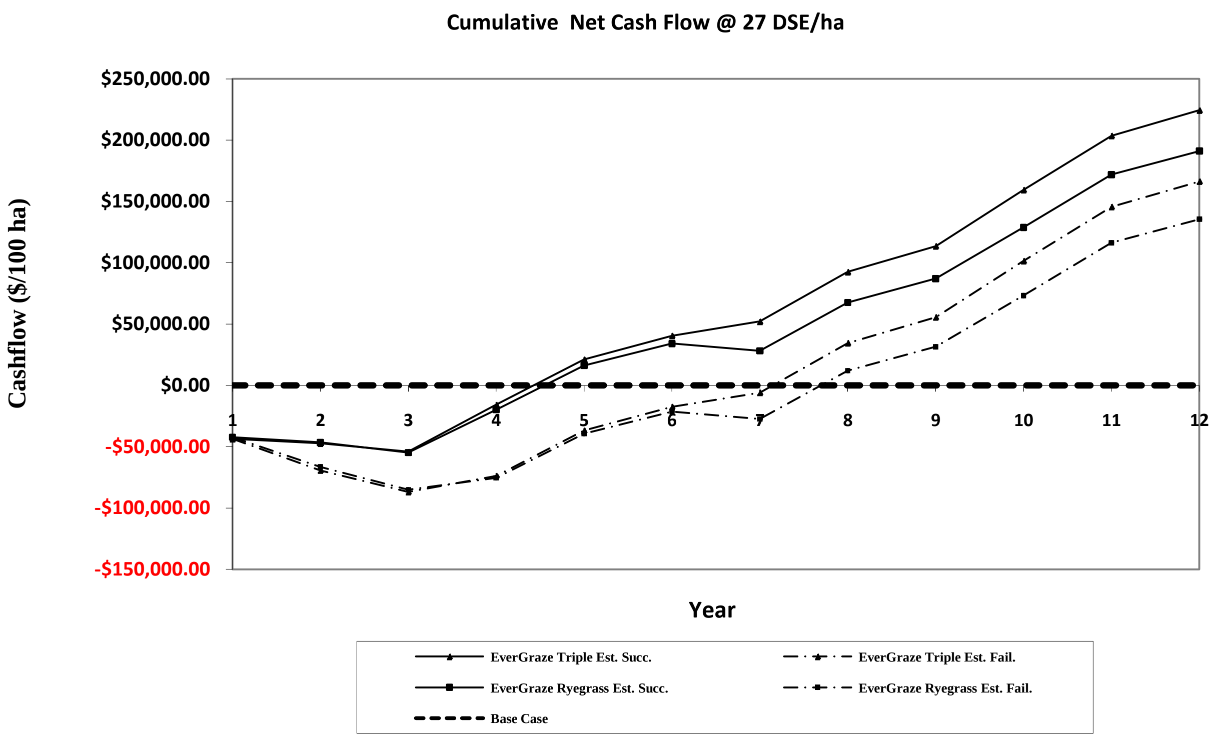

Figure 6 Cumulative Nominal Net Cash Flow (CNNCF) after tax of 10% with 3% inflation and 8% interest for the 100ha investment.

To service a 12 year loan of $50,000 at 8% p.a. required for the pasture investment with successful establishment an annuity of $6,635 p.a. is required. If establishment failure occurs, an annuity of $10,616 p.a. is needed to service the $80,000 loan required. As the after tax extra nominal net cash flows of the pasture systems in a steady state range from approximately $15,000 to $30,000 depending on seasonal conditions, either EverGraze® pasture investment has the ability to service the borrowed funds from the extra cash created if all extra capital is borrowed.

If all funds were borrowed, peak debt occurs in year 3 of the CNNCF in Figure 2 regardless of whether establishment succeeds in year 1 for both systems. The size of peak debt for the EverGraze® Triple for successful and unsuccessful establishment is -$54,113 and -$86,901 respectively, and -$54,773 and -$85,090 for the EverGraze® Ryegrass. The CNCF reduced slightly in year 7, when both pasture systems required some further investment in re-establishment to maintain productivity for the full 12 years.

Cash flows became positive in year five for both EverGraze® systems when establishment was successful. Establishment failure extended the payback period from five to eight years for both investment options.

Discussion

The two new perennial pasture systems trialled under the EverGraze® program and investigated as a 10 per cent addition to the existing pasture system of a whole farm in this analysis both look to be good investments considering economic returns, financial feasibility and risk. The likely returns to capital on the investment are attractive, and the investment generates annual net cash flows in the steady state that enable the debt to be serviced. The risks, as indicated by the volatility of the net cash flows, are not substantially different for each of the options investigated and the extra returns have a good chance of being considered by potential investors as reasonably commensurate with the extra risk involved.

There is a well-known economic phenomenon where marginal value of extra pasture is greatest when it is supplied in the most feed limiting period, as shown by Young *et al.*(2010). Moore *et al.* (2009) identify the late summer and early autumn period as the typical period of pasture deficit in south west Victoria. The analysis of activity gross margin per hectare highlights the importance of the summer/autumn feed supply on the potential contribution of the livestock enterprises to whole farm profit. When the EverGraze® systems showed greater total available feed supply than the Base Case during summer/autumn a proportion of this was translated into reduced supplementary feed costs and greater gross margin per hectare in the subsequent time. This is consistent with Moore *et al.* (2009), who state that reducing the summer/autumn feed gap through management practices such as perennial pasture lifts the profitability of a livestock enterprise in this region. During a summer/autumn period such as 2009 where reduced pasture carryover from the end of 2008 occurred with the EverGraze® systems, the activity gross margins per hectare of the perennial pasture systems were no better than the Base Case gross margin per hectare.

Investment in either of the perennial pasture systems showed returns greater than opportunity cost and both were similarly financial feasible, for all stocking rates tested, even with the occurrence of establishment failure. The level of risk is reduced at the lower stocking levels when considering seasonal effects on extra net cash flows. The impact of establishment failure on potential returns from investment in the EverGraze® options is significant at the lower stocking rate of 21 DSE/ha. When establishment fails in year one at the highest stocking rate of 27 DSE/ha, the time to payback the initial investment extends beyond year seven, when the EverGraze® systems required some further cash investment to maintain production. With a probability of establishment failure of one year in ten these impacts on potential returns and payback period are reasonably unlikely. Given the likelihood and the magnitude of the impacts this risk would probably be considered a reasonable chance to take by many farmers. To change the conclusion that the investment in the high performing new pasture systems is sound, the activity gross margin would need decline to breakeven levels in each year of the planning period to have a significant influence.

Interpreting the results of this analysis requires caution. The degree of complexity of systems, and the inherent flexibility to respond to change within systems, are the critical determinants of farm management success over the medium term. The results achieved by adding new pasture systems and increasing stocking rate on 10 per cent of the whole farm land area and pasture supply will be different from the situation where a larger proportion of the whole farm system is transformed. So too will the implications for complexity and flexibility be different as intensification proceeds. Complexity of systems does not usually increase in linear manner; neither do changes in flexibility in systems.

For example, an increase in stocking rate on a small proportion of the farm sums to a marginal increase in stocking rate of the total farm. This has different implications for the whole farm system, when compared to the same increase in stocking rate per hectare across most of the farm area, as the total increase in stock on the whole farm carried is much greater.
Transforming farm systems in major ways, such as large increases in total stock carried, involves some costs and benefits which can be measured and some which cannot. Costs associated with whole system complexity and inflexibility are not easily included in budget analyses, e.g. the higher management skills required can be allowed for with higher owner-operator allowance, but this is only part of the complexity story. The likelihood of major drought effects increase in proportion to total stock carried. Type of stock carried too matters. Major changes have greater implications for the balance sheet, especially gearing and exposure to debt servicing obligations, than minor changes. For each change and scale of change the expected future balance sheet situation, and associated cash flows and returns to extra capital invested, have to be calculated carefully.

The conclusion reached above, that these new perennial pasture systems can be an attractive investment applies to the situation analysed, as a minor change to a whole farm system. Further work will investigate the economic, financial and risk implications for a whole farm system when a more substantial proportion of the farm is transformed to utilize the EverGraze® perennial pasture systems analysed in this research. The findings from this analysis however are highly encouraging, suggesting that there's a reasonably good chance that, with all things considered, even larger proportion of the whole farm systems sown to these new pasture systems could be more than competitive with alternative existing pasture systems and stocking rates.

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