Profitability and risk evaluation of novel perennial pasture systems for livestock producers in the high rainfall zone: Context, Approach and Preliminary Results.

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The decision to invest in pasture improvement raises various questions for the livestock grazier, with the most pertinent being about the potential returns and risks. In the high rainfall zone of south-west Victoria, researchers have trialled novel perennial pasture systems with the aim of substantially increasing on-farm profits whilst simultaneously improving environmental outcomes. Results from the Hamilton EverGraze® proof site have shown potential to greatly improve livestock production. Promotion of the pasture technology is the next step. Key to this process is developing information about profitability and risk regarding the decision to invest in the new pasture. To help meet this need a model of a representative mixed livestock farm system for the region has been developed to generate information about profit, cash wealth and risk to aid extension and help inform decisions. The farm is comprised of a wool and meat producing sheep system and a beef enterprise. Using the model, the performance of two of the novel pasture systems can be evaluated against current practice, and compared to determine which of the two is the most beneficial EverGraze® option for the future. The risk associated with the pasture decision is assessed by considering different price structures and seasonal outcomes, and evaluating these effects on net benefits. Discounted cash flows, net present values and internal rates of return are estimated for the alternative systems, which include the effects of this price and seasonal variability. Preliminary results have been calculated, however further work is needed to confirm these. The method and results of the analysis provide information that is valuable for farm decisions about investing in a new pasture system and provide a basis for future economic analyses at the case study site and elsewhere.

1. Introduction:

Livestock grazing in Australia confronts many environmental challenges including dryland salinity, reduced 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.

EverGraze® is a national initiative established to develop and test new livestock grazing systems based on perennials across the high rainfall zone of southern Australia. To test these new farming systems, six 'Proof Sites' were set up over three states measuring soil, water, pasture and livestock inputs and outputs (EverGraze® 2007).

[1] Presenting author Claire Lewis is a Masters of Agriculture (Research) student from the Melbourne School of Land and Environment, Department of Agriculture and Food Systems, University of Melbourne c.lewis4@pgrad.unimelb.edu.au

[2] Melbourne School of Land and Environment, Department of Agriculture and Food Systems, University of Melbourne.

[3] Department of Primary Industries, Government of Victoria.

An EverGraze® proof site was set up at Hamilton in South West Victoria in 2005 with three pasture systems, as shown in

Table 1, running highly productive livestock. The systems focused on sowing the right plant on the right land class, and use rotational grazing.

Table 1 EverGraze® Hamilton Trial Pasture Systems *

EverGraze® Pasture System	Crest	Slope	Valley Floor
Best Practice Perennial Ryegrass System	*Fitzroy Perennial Ryegrass*	*Avalon Perennial Ryegrass*	*Banquet Perennial Ryegrass*
Triple Perennial Pasture System	*SARDI 7 Lucerne*	*Avalon Perennial Ryegrass*	*Quantum Tall Fescue*
Novel Perennial Pasture System	*Grasslands Puna Chicory*	*Crusader & Feast II Italian Ryegrass, Banquet II Perennial Ryegrass*	*Whittet Kikuyu*

*See Clark *et al.* (2008) for further details.

Trial results have shown 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 (Clark *et al.* 2009).

The next step for the trial is to promote the pasture technology to farmers. Saul *et al* (2009) recognised that producers concerns about the costs and returns involved in pasture establishment has lead to a reluctance to adopt more productive pasture systems in the past. To overcome this hurdle, a sound understanding of the profitability and risk associated with the EverGraze® pasture systems is required. With three years of trial results now available economic, financial and risk analysis can be undertaken to answer the following questions:

- Does investment in perennial pasture make economic and financial sense considering risk?
- What impact does pasture establishment have on the cash flow of the business overtime?
- What happens to cash flow and overall net benefits if pasture establishment fails and has to be re-established?

In this paper an approach is presented that has been developed to answer these questions and provide information for South West Victoria to aid increased on farm adoption of the EverGraze® pasture technology.

2. Approach:

Case study analysis can be of real farm businesses as they exist and are operated, or of synthetic or representative operations of such systems considered to be common or typical. In this study empirical information about farms in the Hamilton region was used to construct a farm business that is similar in major characteristics to many of the farms in the region. Whilst a potential short coming of representative farm analysis is their usually static nature (Carter 1963), Becker (1963) argues that although the exact outcomes from the representative farm will never be duplicated on individual farms, the relative effects are demonstrated. Further, modelling the performance of businesses over time enables an element of dynamism to be introduced: the firm can be changed in response to different circumstances. Decision makers can appraise the technological change as investigated for a similar system in light of their own individual resources. 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).

Three main sources of information were used to construct a representative farm – census, surveys and case studies. Whilst the census approach is the most thorough, it is impractical and costly (Elliott 1928). Therefore, this work drew on previously conducted farm monitor survey results to establish a modelled representative farm and the knowledge of a steering committee of local farmers. Further work on real whole farm case study analyses is to be conducted to complement this representative farm model. The combined approach of modelled and real farm case studies to represent farming practice will provide a better judgement of the potential profitability and risk of the pasture investment decision for livestock producers in the Hamilton region. The development of the representative farm model is described in the following sections.

2.1. The model

A representative whole-farm model to assess the profitability of investment in the EverGraze® pasture technology for livestock producers in the high rainfall zone of South West Victoria was created in Microsoft Excel.

The model incorporates economic theory for farm modelling exercises as outlined by Malcolm (2004). It accounts for marginal changes to the farm system, the effect of inflation on cash flows and required rates of return and interest rates. The model also incorporates changes in technical productivity over time and accounts for the flows of livestock to and from the system, as well as changes in feed supply and demand.

First current pasture practice for the region was established and is referred to as the 'Base Case'. Next the investment and performance of the alternative EverGraze® perennial pasture options was investigated. Comparison of farm investment options is between alternative futures, and not between the future and the status quo. The pasture investment decision for this Base Case considers the EverGraze® Triple Perennial Pasture and Best Practice Perennial Ryegrass pasture systems as alternative possible futures, as shown in Figure 1. These two systems were identified as the two systems with the greatest potential from the three systems trialled at Hamilton from 2005 to the present.

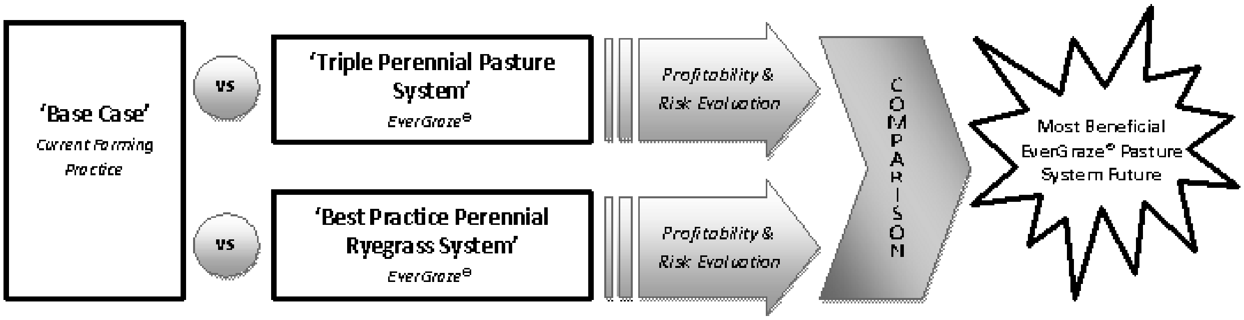

Figure 1. Outline of model

To determine accurately the return to capital from pasture investment, the extra benefits and costs of the investment must be analysed over the whole life of the project (Malcolm *et al.* 2005). A 15-year discounted cash flow (DCF) analysis is used in the model to encompass the effects of time on extra benefits and costs of the EverGraze® pasture technology above the Base Case situation, and to estimate the return on extra capital invested. Changes affecting the cash flow of the farming system, such as price and climate variability, are accounted for in this approach (Scott *et al.* 2000). The DCF is used to test the economic performance and the financial feasibility of the investment through Net Present Value (NPV), Internal Rate of Return (IRR) and Cumulative Net Cash Flow (CNCF) analysis.

The whole farm

The Base Case representative whole farm was based on the South West Farm Monitor Project 'Average' farm in the 650mm plus rainfall zone to align with the target audience of the EverGraze® pasture technology (Department of Primary Industries 2009). The model mixed livestock farm comprises 1000ha running a sheep enterprise of a self replacing Merino system and first cross prime lamb production, and a beef enterprise. Based on local knowledge and producer survey results, these two activities were identified as the major livestock activities for the region (Department of Primary Industries 2009; EverGraze® Regional Group 2009). A ryegrass/clover with capeweed pasture, with average soil fertility, represents a common pasture base. Input from the EverGraze® team, including the Hamilton proof site regional group, helped to 'ground truth' the major characteristics of the representative farm (EverGraze® Regional Group 2009).

In practical terms it is unlikely that producers would renovate the entire farm pasture area at once. It was assumed that 10%, or 100ha, is being considered for pasture improvement. Therefore, a partial development budget approach is taken in the model with a whole farm perspective, as the pasture investment involves adding to existing land, stock and other farm capital (Malcolm *et al.* 2005).This approach involves analysing the extra benefits, such as increased stocking rate, from the new pasture systems minus the extra costs and calculates the expected return on extra capital invested over the life of the project. The model is not an automatically optimising model but a simulation model, with the objective of testing whole farm profit using different scenario combinations. That is, a creep budgeting (Cocks 1964) approach is applicable in which combinations of key marginal changes to the system and their implications for profit can be explored i.e. 'creeping' around the production surface.

The farm enterprises

The enterprise specifications are shown in Table 2.

Table 2 Enterprise Description for Representative Farm

Description		Lambing/ Calving	Farm Area (grazed ha)	Livestock Enterprise Mix
Sheep				**80%**
	• *Self replacing Merino*	September	**800**	*(80%)*
	• *Merino X White Suffolk Prime Lamb*	July		*(20%)*
Beef	• *Angus*	April	**200**	**20%**

Source (Department of Primary Industries 2009; EverGraze® Regional Group 2009; Graham 2009)

Each enterprise is described in the model in terms of production parameters, flock/herd structure and products based on the 'Average' farm in the farm monitor project (Table 2). Examples of prime lamb production parameters used are shown in Table 3 .

Table 3 Typical Prime Lamb Production

Enterprise	Class	% lambs sold	Market
Prime Lamb			
First Draft	6 month mixed weaners @ 20kg Carcass Weight	80%	Trade Lamb
Second Draft	6 month mixed weaners @ 18kg Carcass Weight	20%	Trade Lamb

The performance of each 'Base Case' livestock enterprise was analysed for each of the Base Case, Triple Perennial Pasture System and Best Practice Perennial Ryegrass systems. In order to account for differences in the productivity of the pastures, the stocking rate and pasture utilisation were varied between the three pasture systems.

Stocking rate is depicted in Dry Sheep Equivalents per hectare (DSE/ha). The measure DSE is a measure of the animal energy requirements of livestock in terms of a standard livestock unit (Russell 2009), a mature 50kg Merino wether maintained at a constant weight. This animal has a DSE rating of 1; animals requiring more feed due to a larger liveweight, growth, pregnancy or lactation have a higher DSE rating, and those requiring less have a lower annual rating.

The Base Case stocking rate is that of an average farm in the SWFM 07/08 results, whilst the EverGraze® pastures are stocked based on the on-farm rates from the trials as shown in Table 4.

Table 4 Stocking Rates

	Base Case	Triple Perennial Pasture System	Ryegrass
Enterprises	Sheep & Beef	Sheep & Beef	Sheep & Beef
Stocking Rate (DSE/ha)	19.2	24	23
90%	-	*21.6*	*20.7*
80%	-	*19.2*	*18.4*

Source (Department of Primary Industries 2009)

In commercial practice the application of new technologies on farm often does not reach the levels produced in research trials. However, producers from the EverGraze Regional Group have indicated through their own experience, that the EverGraze pasture technology can deliver the level of production shown in research trial in a commercial environment. As these producers are considered to be well above the 'average' farm operator for the region, results are tested for the technology at 100%, 90% and 80% of the trial stocking rates (Table 4).

Whilst the type of pasture system may affect individual livestock performance, the degree to which this effect would happen on individual farms will be somewhat dependent on the genetic merit, response and environment for livestock on those farms. Furthermore, it is difficult to benchmark the extent to which the livestock on EverGraze are superior to livestock on other regional farms. Therefore, at this stage animal per head production is assumed constant across the three pasture systems but it may be possible to test the response of the model in future to the use of animals with higher genetic merit and productivity. In this case there would also be a need to build in a model of genetic improvement over time and or the costs associated with livestock changeover.

Pastures

The quantity of pasture supply in the model is described in terms of kg dry matter per hectare (DM kg/ha). 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.

Pasture quality is indicated by the metabolizable energy (ME) content, and is expressed as megajoules per kg of DM (MJ/kg DM). Metabolizable energy is the amount of energy available in a feed for animal use.

Pasture quantities and qualities for the Base Case were calculated for the Hamilton region using the simulation model GrassGro (CSIRO Australia 2007). For EverGraze® pastures, the experimental trial pasture supply and quality results are used. The results reflected the theoretical potential performance of the pasture technology if the same results could be achieved under farming conditions as under the trial conditions, when managed as recommended.

Seasonal Scenarios

For each of the three pasture systems, four seasonal scenarios were included described as good, average, poor and future. The future scenario is included to represent pasture production under future climate predictions, with recent research showing the effect ranging from small increases in production to reductions in production by up to 19% for southern Australia compared to current production levels, depending on the time period being considered (Cullen *et al.* 2009).

The Base Case pasture simulation was first run from 1961 to 2000 using historical data for the Hamilton site. The good scenario was the best 20% of these years, with the poor scenario being the worst 20%. The typical represented the remaining 60% of the years. The model was then rerun from the years 2036-2050 using the likely 2050 climate and CO_2 levels to give an average level of production as predicted for future climate conditions. The pasture growth curves for the Base Case are shown in Figure 2.

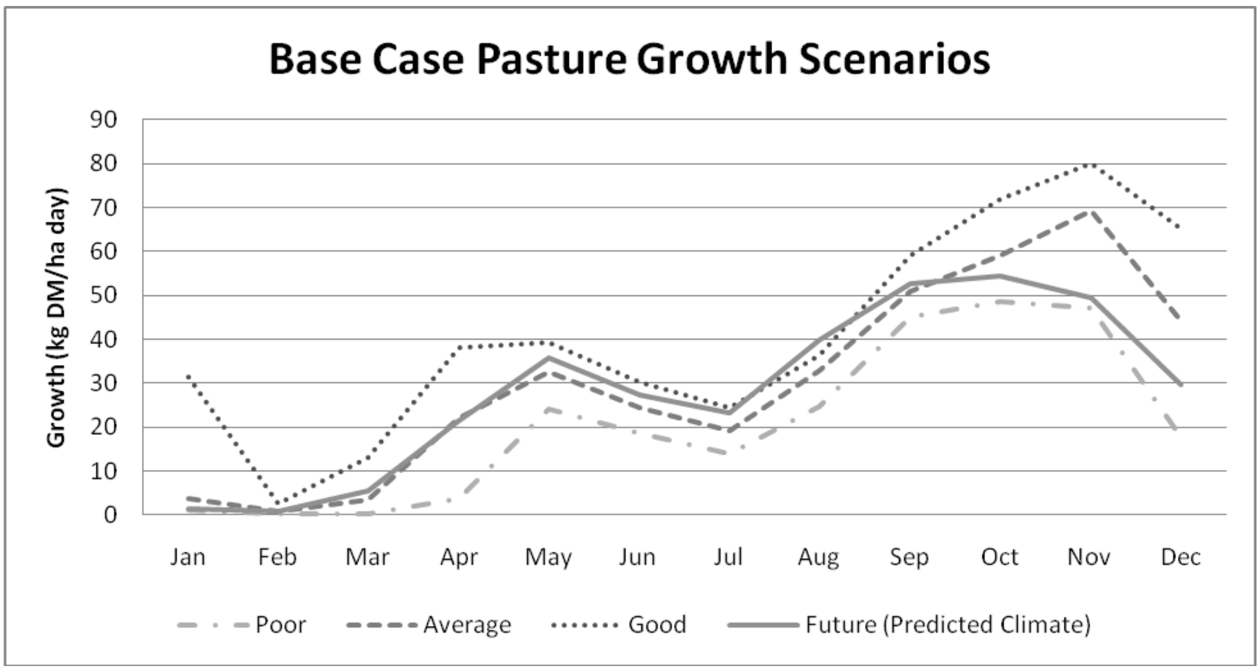

Figure 2 Base Case Pasture Growth Scenarios for Hamilton

For EverGraze® pastures, the 2007 season results were used to reflect the good scenario. The annual rainfall received in this year was 800mm compared to the long-term average of 684mm. In the 2006 season total rainfall was 493mm, well below the long-term average. Therefore, the 2006 results were used to represent poor seasonal conditions.

To date the trial has not experienced an historically typical season for the Hamilton region. To overcome this gap in the data, a midpoint between the poor and good season scenarios was chosen to reflect average growing conditions for the EverGraze® pastures for the near-term future. Future conditions were estimated using GrassGro (CSIRO Australia 2007).

Pasture demand vs. supply

The production parameters were used to calculate the livestock ME demand for a production year using the 'ME Required' spreadsheet model (CSIRO Plant Industry 2006).

This information was then used to calculate the pasture shortage/surplus for each month of the year. It was assumed that 40% of fresh pasture growth was utilised by the livestock in the Base Case pastures, and 50% in the EverGraze® pastures due to rotational grazing (Meat and Livestock Australia 2009).

If a feed surplus occurs, it was assumed that two-thirds of this excess is carried over to the next month's feed supply. This is consistent with the approach taken by the Meat and Livestock Australia calculator (Meat and Livestock Australia *et al.* 2008). If a pasture shortage occurs, a supplementary feed ration is calculated to cover the feed gap. It is assumed that 30% of the ration is wasted when fed out. Table 5 describes the supplementary feed ration for each of the livestock classes.

Table 5 Supplementary Feed Rations

	Mature Livestock	Growing Livestock
Sheep	80% Barley 20% Pasture Hay	70% Barley 20% Lupins 10% Pasture Hay
Cattle	100% Pasture Hay	80% Barley 20% Pasture Hay

Prices

The model includes four price levels and the expected value for the main wool, livestock and supplementary feed classes using the range of prices experienced in the past decade as a guide to the potential range of prices in the near-term future.

The probability of each price level occurring over the next 10 years will be estimated by the EverGraze® farmer regional group and the expected value calculated. An example of the calculation of the expected value for 18 micron wool is shown in Table 6.

Table 6 Example of Expected Value calculation for 18 micron wool price (Malcolm *et al.* 2005)

Price Level	Historical price $/kg clean *(adjusted to current $)*	Estimated Years in 10	Probability	Expected Value ($) *(Probability x Price)*
Best	$17.20	1 in 10	0.1	$1.72
Good	$14.50	2 in 10	0.2	$2.90
Most Likely	$12.00	4 in 10	0.4	$4.80
Poor	$11.50	2 in 10	0.2	$2.30
Worst	$11.30	1 in 10	0.1	$1.13
Expected Value ($/kg clean)				***$12.85***

Expected values based on the regional group probabilities about prices will be used in the place of historical averages. This gives an educated guess at what is believed might happen in the future rather than basing prices on past conditions which will never be repeated in exactly the same way.

Income

The price information in the model was used to calculate the livestock income from each activity.

Livestock are valued per head according to the market they are sold into, for example trade lambs or yearling steers. This information is used to create a livestock trading schedule to calculate the gross trading profit/loss for the production year for each activity. The wool clip is valued for each animal class and clip section as a percentage of the relevant micron price indicator. The value of the total fleece is then combined to give a per head gross wool income. If an enterprise records a total excess feed supply for the year, the assumption is made that this feed is baled at typical contractor costs and sold at pasture hay market value.

Variable costs

Livestock & General

The South West Farm Monitor 2007/2008 average variable costs per DSE were used for each enterprise as shown Table 7.

Table 7 Livestock & General Variable Costs

Cost	Sheep ($/DSE)	Beef ($/DSE)
Animal health	$1.47	$0.47
Shearing supplies	$0.19	-
Selling costs	$1.80	$2.87
Pasture Maintenance	$3.80	$3.80
Freight / Cartage	$0.34	$0.57
Repairs & maintenance	$0.53	$0.12
Contract services	$3.39	$0.07
Casual labour	$0.21	$0.03
Other	$0.40	$0.31
TOTAL	**$12.13**	**$8.24**

Source (Department of Primary Industries 2009)

The supplementary feed ration calculated as described earlier, is priced and included in the enterprise variable costs.

Replacement ewes were priced per head for the prime lamb system and incorporated into the livestock trading schedule.

Pasture Costs

The majority of producers apply phosphorus (P) fertiliser each year on their rolling and flat country - the most common land-classes in the south west region (EverGraze® Regional Group 2009).

Therefore, pasture maintenance costs for the Base Case included a yearly fertiliser application. P fertiliser application was estimated at 14 kg P/ha to reflect current practice for an average farm in the region (Armstrong 2010). Fertiliser was priced at current market value spread, as indicated by a local commercial agronomist (Armstrong 2010).

Once the pasture is established and fully stocked on the EverGraze® pasture systems, the recommended fertiliser application rate (given the assumed loss factors, pasture type and rainfall) of 13-14 kg P/ha is applied each year to maintain the pasture for the 15 year period (Cayley and Quigley 2005).

A resowing cost was also incorporated for the Base Case to maintain productive pastures. In Hamilton, the majority of producers believe that pasture decline is a concern in the region, with it taking 6-10 years for sown pasture species to weaken/disappear. Producers believe resowing of old/rundown pastures to be a worthwhile exercise in order to maintain desirable pasture species composition (EverGraze® Regional Group 2009; Reeve *et al.* 2000)

In line with current practice in the region, the Base Case representative farm would be fully resown every 20 years to maintain the current pasture base Therefore, it is assumed that 5% of the 100ha area underwent resowing each year with a cost of $230/ha to maintain the pasture base to continue to support stocking levels over the analysis period (Byrne and Young 2009).

The mix of perennial species in the EverGraze® systems has varying degrees of expected pasture 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 has been estimated that the entire Best Practice Perennial Ryegrass System and the Ryegrass and Lucerne portions of the Triple Perennial Pasture System , will need to be resown once after initial establishment during the 15-year period to maintain productivity.

A cost for spraying for red-legged earth-mite each year for both EverGraze® pasture systems is included, with winter cleaning of Lucerne occurring every 3 years. Winter cleaning involves spraying Lucerne with a herbicide to control annual weeds and maintain the long term productivity of the pasture.

2.2. Model Function

Enterprise Budgets

In order to assess the contribution each enterprise makes to whole farm profit and cash flow the physical, financial and economic outcomes of each enterprise is represented in the model. The livestock trading profit/loss, wool and fodder income minus all variable costs for each enterprise were used to calculate the contribution of each livestock activity to the farm business, termed the enterprise gross margin. An enterprise gross margin budget is calculated for each livestock activity on each of the three pasture bases. These budgets are used to establish the likely net benefit of each of the EverGraze® pasture technologies for the farm business as a whole over time.

Scenarios

The model has the option to create up to three enterprise gross margin budget scenarios, based on price and seasonal conditions. Once price and seasons are selected, the model will automatically calculate the financial contribution for each enterprise on each pasture base given the parameters set. This is done using the Excel Macro feature. The price per breeding unit is also calculated for each scenario.

Discounted Cash Flow

A partial budget DCF is calculated for the 100 ha being considered for pasture improvement by analysing the extra costs and benefits from the investment at both a whole farm and enterprise level., and estimating the expected return on extra capital invested over the life of the project.

A 15 year time period is long enough to see the full returns from the pasture investment and to consider the effects of time on pasture productivity such as decline or need for renovation.

A typical discounted net cash flow for pasture investment is represented in Figure 3.

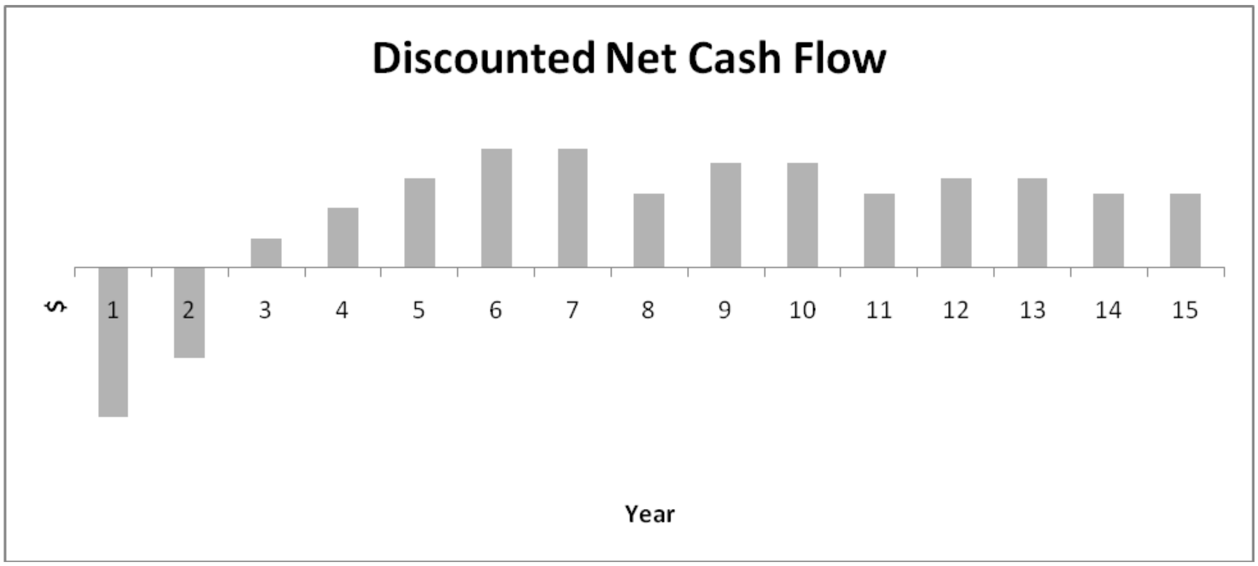

Figure 3. A typical Discounted Net Cash Flow

Benefits

The extra enterprise gross margin achieved by the new pasture technology is combined with capital salvaged to estimate the total extra benefits from the system. The model has the option to either sell off stock in year 1, or agist them off farm to allow for pasture establishment. If stock are sold, the income is recorded as capital salvaged in year 1. If agistment is chosen, the net income from the livestock is included as a benefit. Salvage value of the pasture establishment costs in year 15, with the pasture well maintained, was assumed to be 50% of the initial outlay for the economic evaluation (Malcolm *et al.* 2005). Permanent capital was salvaged at 10% of the initial cost and livestock purchased during the 15 yrs were sold at market value.

Costs

Pasture establishment, net income foregone livestock, and permanent capital costs, are combined to estimate the total extra costs per year. The recommended establishment practice was assumed to occur for each system, and costed accordingly as shown in Appendices I and II. Net income forgone takes into account lost production from the improved area when stock are sold off in year 1 during the establishment phase. If stock are to be kept, an off farm agistment cost is included during this period. When a stocking rate increase occurs for any of the three pasture systems, and extra stock need to be bought, a cost per breeding unit figure is used. This is calculated as shown in Table 9 for each livestock activity, using the ram/bull joining percentages.

Table 8 Breeding Unit assumptions and calculations

Enterprise	Breeding Unit Calculation
Sheep	*Cost of 1 Restocker Merino Ewe + 2% of the cost of a ram*
Beef	*Cost of 1 Mature Angus Cow + 3% of the cost of a bull*

To implement the EverGraze® technology which requires rotational grazing, other permanent capital requirements such as fencing and watering points are included in the extra capital invested.

These costs were then subtracted from the benefits to calculate the annual net cash flows within the 15-year period, like that shown in Figure 3.

2.3. Model Output

The output from the DCF gives the NPV, IRR and CNCF for the perennial pasture investment. A discount rate of 10% real after tax is used in the model as this is the return on capital seen in most average farming businesses, 5 and 15% are also used to sensitivity test (Malcolm *et al.* 2005). The nominal (after tax with inflation) CNCF was then calculated.

Net Present Value

The NPV was calculated by subtracting the adjusted future cost from future benefits, to give the net benefit in each of the 15 years of the investment after discounting.

Internal Rate of Return

The IRR was calculated to provide the actual rate of return on capital invested in the pasture improvement project over the analysis period.

Cumulative Net Cash Flow

If the investment options pass the NPV and IRR economic efficiency tests, financial analysis is performed using CNCF with an expected inflation level of 3% p.a. (Malcolm *et al.* 2005).

This analysis will identify the size and timing of peak debt for each of the pasture investment options. The time taken for the initial cash invested in the pasture technology to be recovered, and therefore the point when profits begin to be recorded, referred to as the payback period, is also identified.

2.4. Risk

Risk relates to the variability in expected income due to a number of factors, such as climate and prices, likely to impact the farm operating environment.

Price variability risk is accounted for by the inclusion of five different price levels for each of the major price categories of livestock, wool and supplementary feed prices. The probability of each price level occurring has been allocated by the EverGraze® farmer regional group, and the expected value calculated as described in the 'Prices' section.

The use of four seasonal conditions for pasture production incorporates climatic variability into the model, with each seasonal condition returning a different level of pasture quality and quantity.

Correlations between these season and prices levels will be investigated, and used to create various price and seasonal combinations. The effect of these combinations will be quantified for each enterprise using the 'Scenario' option of the model to calculate the responding enterprise gross margin budgets. This will show the effect of price and season variation on expected income in a given year, at both an enterprise and whole farm level.

Selected combinations will then be allocated across the 15-year cash flow period, to analyse the effect of fluctuations in the market and seasonal conditions. Probabilities to be indicated by the farmer regional group will be used to establish 'Best', 'Most Likely' and 'Poor' scenarios for analysis over the budget period.

The risk of pasture establishment failure is a major concern for producers considering pasture investment. To help address this, the scenario testing will be conducted when pasture establishment is successful in year 1, and for when it fails and sowing needs to be repeated in year 2.

The level (80, 90 and 100%) achieved of the EverGraze® trial stocking rates will be varied for all risk scenarios tested.

3. Preliminary Results

Preliminary results at the enterprise level were calculated to test the workings of the model, and to give an initial indication of the performance of the EverGraze® pasture technology. The preliminary analysis was conducted for the 100ha being considered for pasture development running sheep only, as the beef enterprise is yet to be finalised.

The parameters set for NPV and IRR the analysis were as shown in Table 9.

Table 9 Preliminary Analysis Assumptions

Parameter	As Set for Analysis
Enterprise Mix	100% Sheep
Area Improved	100ha (10% total farm area)
Agistment in Year 1?	Yes
Establishment Successful Year 1?	Yes

The enterprise gross margins were calculated using the model for each pasture base under 'Poor', 'Average' and 'Good' season scenarios as shown in Table 10. Wool and livestock prices were set at the 'Most Likely' level as determined by the authors. Due to difficulty in obtaining an accurate range of supplementary feed prices, current prices were used for this preliminary analysis.

Table 10 Enterprise Gross Margins ($/DSE)

System	Poor Season	Average Season	Good Season
Base Case	*$2.51*	*$ 13.74*	*$ 21.24*
Triple Perennial Pasture System	*$ 10.01*	*$ 18.03*	*$ 22.20*
Best Practice Perennial Ryegrass System	*$ 14.30*	*$17.11*	*$19.66*

Table 10 shows that the Triple Perennial Pasture System performs better per DSE in average and good seasons, and in the poor season, Best Practice Perennial Ryegrass System returns the largest gross margin. However, to fully analyse the performance of the new pasture technology overtime, NPV and IRR must be calculated with all costs involved in the pasture renovation accounted for. Two seasonal scenarios were tested for NPV and IRR as shown in Table 11, at 80 and 100% stocking rates to include an element of risk in the preliminary analysis. A partial budget DCF was used analyse the extra benefits minus the extra cost of each EverGraze® pasture system above the Base Case to estimate the expected return on extra capital of the investment over the 15 year period.

Table 11 Preliminary Results for EverGraze Pasture Systems

System	Seasonal Conditions	Price Conditions *(Supp Feed @ current market $)*	Percentage Stocking Rate Achieved *(in steady state)*	NPV @ 10% *(after 10% tax)*	IRR *(after 10% tax)*
Base Case vs. **Triple Perennial Pasture System**	**Yr 1-15**:Average	*Most Likely*	**100%**	$43,378.05	21%
			80%	$2,620.12	11%
	Yr 1-3: Average **Yr 4-5:** Poor **Yr 6-10:** Average **Yr 11:** Good **Yr 12-15**: Average	*Most Likely*	**100%**	$44,741.97	21%
			80%	$8,213.88	13%

Base Case vs. **Best Practice Perennial Ryegrass System**	**Yr 1-15**: Average	*Most Likely*	**100%**	$23,292.33	16%
			80%	-$12,666.40	5%
	Yr 1-3: Average **Yr 4-5:** Poor **Yr 6-10:** Average **Yr 11:** Good **Yr 12-15**: Average	*Most Likely*	**100%**	$38,307.61	21%
			80%	$3,499.28	11%

Under average seasonal conditions, the Triple Perennial Pasture System performed better than the Best Practice Perennial Ryegrass System returning a higher NPV at a 10% real discount rate at both the 100 and 80% stocking rates. The Best Practice Perennial Ryegrass System returned a negative NPV of -$12,666.40 at the 80% stocking rate level. The reduction in stocking rate level saw the IRR reduce 10% for the Triple Perennial Pasture System, and 11% for the Best Practice Perennial Ryegrass System.

When the discreet seasonal scenario, which included two poor seasons and one good, was analysed the Triple Perennial Pasture System again performed better than the Best Practice Perennial Ryegrass System with higher NPV values at the 10% real discount rate shown. All NPV's were positive under this discreet scenario. The IRR reduced 8% for the Triple Perennial Pasture System and 10% for the Best Practice Perennial Ryegrass System when stocking rate was reduced from 100% to 80%.

Whilst there was minimal difference in the IRR values for the Triple Perennial Pasture System between the average and discreet seasonal scenarios at both the 80 and 100% stocking rate, the Best Practice Perennial Ryegrass System showed IRR values 5-6% greater once seasonal variability was introduced compared to the systems performance with average seasonal conditions. Further analysis is needed to determine whether this difference is significant.

4. Discussion & Conclusions

In terms of the performance of the model, the gross margins in Table 10 and the IRR rates in Table 11 are within a sensible range for this type of farm investment. This indicates that the initial results can be considered as reasonable estimates, given the conditions set for the analysis. However, further testing is required to confirm this.

For the average seasonal scenario, the NPV results at the 10% real discount rate for the Triple Perennial Pasture System indicate that at the enterprise level this is the preferred future option for the Base Case, as it gives a NPV $15-20,000 higher than the Best Practice Perennial Ryegrass System at the 10% discount rate. This is supported by the IRR results, and remains true at both the 100 and 80% stocking rates.

The Best Practice Perennial Ryegrass System returns a negative NPV at a 10% discount rate for the average scenario when the stocking rate is reduced to 80%, indicating that the investment is earning less than the required 10% discount rate for the 15 yr period. The IRR supports this, showing the actual annual rate on the capital invested to be 5%. This is likely due to the fact that Best Practice Perennial Ryegrass System dropped below the Base Case stocking rate by 0.8 DSE/ha at this level as shown in Table 4, and the extra gross margin of $3.37 earned per DSE (Table 10) was unable to make up for this reduction. If producers are concerned about not reaching 100% of the EverGraze stocking rate, the Best Practice Perennial Ryegrass System shows a greater risk of not achieving the required rate return of 10% than the Triple Perennial Pasture System, given average seasonal conditions, and most likely livestock and wool prices over the 15 yr period.

When season variability is introduced to the analysis for the discreet seasonal scenario, the Triple Perennial Pasture System is again the most profitable investment option of the two EverGraze® pasture systems with greater NPV values at the 10% real discount rate at both stocking levels.

The discreet scenario shows the Best Practice Perennial Ryegrass System performing better with seasonal variability when compared to average conditions over the 15 yr period, as indicated by both higher NPV and IRR results. Interestingly in a good season, which occurs in year 11 for this analysis, the Base Case actually appears to outperform the Best Practice Perennial Ryegrass System at the gross margin level (Table 10). However, during the poor seasons of year 4 and 5 the Best Practice Perennial Ryegrass System has the greatest gross margin of all three systems. The extra gross margin of $11.19 per DSE compared to the Base Case appears to make up for the loss in year 11 and reduced stocking rate over the 15 years. This may also be aided by the poor years occurring earlier in the time period. Further analysis is needed to quantify these effects.

Whist these preliminary model results indicate the Triple Perennial Pasture System to be the most profitable EverGraze® future option for the Base case given the conditions tested, further work is needed to confirm this. This would require the inclusion of the beef enterprise, price variability and correlations, producer price probability estimates, establishment failure risk, further scenarios and analysis at the whole farm budget level. Real farm case studies will also be conducted to complement the modelled analysis.

5. Acknowledgements:

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6. References

Armstrong H (2010) Prices and Common Practice for Hamilton Region (*Personal Communication).*

Becker MH (1963) Discussion: Representative Farms: Guides for Decision Making? *Journal of Farm Economics* **45**, 1455-1457.

Byrne F, Young J (2009) Report on the value of providing shelter to increase the survival of twin lambs *(Unpublished Work)*

Carter HO (1963) Representative Farms: Guides for Decision Making? *Journal of Farm Economics* **45**, 1448-1455.

Cayley J, Quigley PE (2005) Phosphorus for sheep and beef pastures. (Victorian Government Department of Primary Industries: Hamilton).

Clark S, McCaskill MR, O'Brian B, Ward G, Raeside M, Cameron F, Behrendt R (2009) EverGraze® : Hamilton Proof Site Field Day 14th May 2009. (Victorian Department of Primary Industries: Hamilton).

Clark S, O'Brien B, Lawson A, Raeside M, Kennedy A, Behrendt R (2008) Hamilton Proof Site Field Day 16th May 2008 p. 50. (Victorian Government Department of Primary Industries: Hamilton).

Cocks KD (1964) Creep Budgeting. *Review of Marketing and Agricultural Economics* **32**, 137-148.

CSIRO Australia (2007) GrassGro™: matching management goals with land capability (CSIRO Plant Industries: Canberra)

CSIRO Australia, Bureau of Meteorology (2007) Climate Change in Australia - Technical Report 2007. CSIRO Marine and Atmospheric Research, Aspendale, Victoria.

CSIRO Plant Industry (2006) ME Required (CSIRO Plant Industry: Canberra)

Cullen BR, Johnson IR, Eckard RJ, Lodge GM, Walker RG, Rawnsley RP, McCaskill MR (2009) Climate change effects on pasture systems in south-eastern Australia. *Crop and Pasture Science* **60**, 933-942.

Department of Primary Industries (2009) South West Farm Monitor Project: Summary of Results 2007/08. Victorian Government Department of Primary Industries.

Elliott FF (1928) The "Representative Firm" Idea Applied to Research and Extension in Agricultural Economics. *Journal of Farm Economics* **10**, 483-498.

EverGraze® (2007) 'EverGraze® Home Page' Retrieved January 2010 from http://www.evergraze.com.au/

EverGraze® Regional Group (2009) EverGraze® Regional Group meeting (*Personal Communication).*

Friend M, Robertson S, Masters D, Avery A (2007) EverGraze® - a project to achieve profit and environmental outcomes in the Australian grazing industries. *Journal of Animal and Feed Sciences* **16**, 70-75.

Graham J (2009) Case Study - Beef for South West Victoria (*Personal Communication).*

Malcolm B, Makeham J, Wright V (2005) 'The Farming Game: Agricultural Management and Marketing.' (Cambridge University Press: Port Melbourne).

Malcolm L (2004) Farm Management analysis: a core discipline, simple sums, sophisticated thinking. *AFBM Journal* **1**, 45-56.

Meat and Livestock Australia (2009) 'Information Centre: MLA Pasture Utilisation' Retrieved November 2009 from http://www.mla.com.au/TopicHierarchy/InformationCentre/FeedAndPastures/Pasture+and+Grazing+management/Pasture+Utilisation.htm

Meat and Livestock Australia, CSIRO Australia, DJM Livestock Consultants (2008) MLA Feed Demand Calculator (Meat and Livestock Australia: Sydney)

Reeve IJ, Kaine G, Lees JW, Barclay E (2000) Producer perceptions of pasture decline and grazing management. *Australian Journal of Experimental Agriculture* **40**, 331-341.

Russell A (2009) How to use Dry Sheep Equivalents (DSEs) to compare sheep enterprises. (NSW Government Department of Primary Industries: Orange).

Saul G, Kearney G, Borg D (2009) Pasture systems to improve productivity of sheep in south-western Victoria. 1. Growth, composition, nutritive value and persistence of resown pastures. *Animal Production Science* **49**, 654-667.

Scott JF, Lodge GM, McCormick LH (2000) Economics of increasing the persistence of sown pastures: costs, stocking rate and cash flow. *Australian Journal of Experimental Agriculture* **40**, 313-323.

7. Appendix

I. EverGraze® Triple Perennial Pasture System Establishment Costs

	When	Area (ha)	Rate(kg/ha)	Cost/kg	Cost/ha
Year 1					
Sowing	**October**				
Sardi 7 Lucerne		33	9	$ 11.00	$ 99.00
Spreading	**October**				
SSP			100	$ 0.43	$ 42.50
Lime			5000	$ 0.03	$ 160.00
Sowing	**November**				
Quantum Tall Fescue		33	19	$ 11.70	$ 222.30
Year 2					
Sowing	**May**				
Leura Sub Clover			8	$ 8.30	$ 66.40
Gosse Sub Clover			3	$ 7.30	$ 21.90
Mink White Clover			1.5	$ 12.30	$ 18.45
Sowing	**June**				
Perennial Avalon Ryegrass		33	10	$ 5.80	$ 58.00
Leura Sub Clover			8	$ 8.30	$ 66.40
Gosse Sub Clover			3	$ 7.30	$ 21.90
Mink White Clover			1.5	$ 12.30	$ 18.45
Spreading	**June**				
MAP			80	$ 0.93	$ 74.00
Sowing	**August**				
Leura Sub Clover			8	$ 8.30	$ 66.40
Gosse Sub Clover			3	$ 7.30	$ 21.90
Mink White Clover			1.5	$ 12.30	$ 18.45
Related Costs					
Contract Labour					
Sowing & Spraying					$ -
Fuel					$ 20.00
Average Total $/ha					**$ 345.35**
Total $					**$ 34,535.00**
Lucerne $/ha					*$ 428.25*
Tall Fescue $/ha					*$ 349.05*
Ryegrass $/ha					*$ 258.75*

Subdivision Costs	Unit	$/Unit	Units Needed	Total Cost
Fencing	Metre	$ 3.00	1050	$ 3,150.00
Gates	Gate	$ 200.00	2	$ 400.00
Water Trough	Trough	$ 400.00	1	$ 400.00
Labour	Hours/km			$ -
Total Cost				**$ 3,950.00**

II. EverGraze® Best Practice Perennial Ryegrass System Establishment Costs

	When	Area (ha)	Rate(kg/ha)	Cost/kg	Cost/ha
Year 1					
Sowing	**June**				
Fitzroy Perennial Ryegrass		33	10	$ 6.55	$ 65.50
Leura Sub Clover			8	$ 8.30	$ 66.40
Gosse Sub Clover			3	$ 7.30	$ 21.90
Mink White Clover			1.5	$ 12.30	$ 18.45
Spreading	**June**				
MAP			80	$ 0.93	$ 74.00
Lime			2500	$ 0.03	$ 80.00
Year 2					
Sowing	**June**				
Avalon Perennial Ryegrass		33	10	$ 5.80	$ 58.00
Leura Sub Clover			8	$ 8.30	$ 66.40
Gosse Sub Clover			3	$ 7.30	$ 21.90
Mink White Clover			1.5	$ 12.30	$ 18.45
Spreading	**June**				
MAP			80	$ 0.93	$ 74.00
Sowing	**June**				
Banquet Perennial Ryegrass		33	20	$ 9.50	$ 190.00
Leura Sub Clover			8	$ 8.30	$ 66.40
Gosse Sub Clover			3	$ 7.30	$ 21.90
Mink White Clover			1.5	$ 12.30	$ 18.45
Spreading	**June**				
MAP			80	$ 0.93	$ 74.00
Related Costs					
Contract Labour					
Sowing & Spraying					**$ -**
Fuel					$ 20.00
Average Total $/ha					**$ 331.92**
Total $					**$ 33,191.67**
Fitzroy Perennial Ryegrass $/ha					$ 346.25
Avalon Perennial Ryegrass $/ha					*$ 258.75*
Banquet Perennial Ryegrass $/ha					*$ 390.75*

Permenant Capital Costs	Unit	$/Unit	Units Needed	Total Cost
Fencing	Metre	3	1050	$ 3,150.00
Gates	Gate	200	2	$ 400.00
Water Trough	Trough	$ 400.00	1	$ 400.00
Total Cost				$ 3,950.00