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MIDAS Insights on Profitably utilising Perennial Plants in Hamilton, Victoria.

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31 August 2004

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1.0 Introduction

MIDAS is a computer model used to assess the impact of change in a farming system. It describes the biological relationships of a representative farm. This information is used to estimate the profitability of particular enterprises or management strategies. MIDAS was selected as the modelling tool for the economic component of this project because it is a whole farm model that represents the spatial variation on a farm. This means that the feed supply from different areas of the farm can be integrated into an animal production system. Indeed, estimating the economic value of different pasture systems demands the feed availability for the whole farm is described. This is critical because the value of alternative species (mix) depends on the feed value of pasture in other paddocks. MIDAS also includes a powerful feed budgeting module that optimises animal and pasture management across the whole farm. This makes MIDAS an efficient tool to examine new and innovative systems.

To undertake analyses for the salinity CRC, MIDAS has been adapted to represent farms with a range of perennial plant species in three environments across southern Australia. In these environments rising groundwater tables are causing increased dryland salinity or stream salinity and there is a need for the development of practical, profitable farming systems that minimise recharge. Farming systems that include perennial plants that can be grazed by livestock have potential for profitably addressing salinity problems. This report documents the analysis for the Hamilton region of Victoria.

Modelling complex systems can enhance understanding of the components of the system and highlight areas where further research is required. This approach has been adopted for this project. Initially, information was gathered from innovative farmers and researchers in each region about the farming systems they currently operate and their ideas on new systems. In particular, the potential for including more or different perennial species and how they could best be used was explored. Subsequently, MIDAS was used to analyse aspects of these systems to ascertain which are most likely to increase profit. This information is likely to be useful to researchers in assessing priorities for future research. An additional workshop with the producer group was held to obtain feedback and ensure that the priorities being considered were relevant to producers. Some of the feedback received at the workshops is referred to throughout this report.

The role of the farm modelling component in this project was to:

1. Quantify some principles about feed supply and demand in grazing systems and enhance understanding of the economics of systems that include perennials. The principles that have been quantified are the:
 - a. value of energy at different times of the year
 - b. sensitivity of the system to altering the pasture supply
 - c. size of the niche that perennials are filling
2. Quantify the economic value of varying some parameters of different animal production systems (eg time of lambing, frequency of lambing, genotype – FD and growth rate, stocking rate).
3. Test the systems that are developed out of this understanding.

This report describes the MIDAS analysis carried out to address points 1 and 2 above. Point 3 is addressed elsewhere.

2.0 The model farm

2.1 Land management units

The model represents a ‘typical’ farm in the Hamilton region in south west Victoria. The total area of the farm is 1000ha and is comprised of 3 land management units (LMUs) (table 2.1).

Table 2.1: Description and area of each LMU on the model farm

Land Management Unit	Area (ha)	Description
Ridges	200	Well drained gravely soils at tops of hills.
Mid slopes	600	Moderately drained loams in the mid slopes
Flats	200	Clay soils in lower slopes that are often waterlogged.

2.2 Animal production systems

A range of sheep flocks have been examined in the sensitivity analysis sections of this analysis (see table 2.2). A brief description of each of the flocks is in the table below. Variation between flocks is related to the genotype of the ewes and the proportion of the ewe flock that is mated to terminal sires (from 0 to 100%).

Table 2.2: A description of the flock types included in this analysis.

Flock	Description
Traditional Merino: wool (<i>Wool</i>)	Current practice on wool enterprises based on top 20% of monitor farm project, 80% weaning percentages. Emphasis is on wool production. Wethers can be sold as lambs to other graziers or as shippers (18 months or older)
Wool-Meat Merino: wool (<i>Wool-Meat</i>)	Based on a multi purpose merino with high fertility (120% weaning) in a wool-meat system. Wethers can be sold as prime lamb, lambs to other graziers or as shippers (18 months or older)
Wool-Meat merino: self replacing with terminal sire (<i>Wool-Meat terminal</i>)	A self-replacing Wool-Meat Merino flock mating surplus ewes (cast for age or surplus ewe hoggets) to terminal sires for crossbred lamb production. Merino wethers can be sold as merino prime lamb or as lambs to other graziers or as shippers (18 months or older).
1 st cross ewes (<i>1st Cross</i>)	First cross ewes producing 2 nd cross lambs. Lambing percentage of 160%. Replacement ewes are bought in.

The genotypes are described in more detail by Thompson & Young (2002), the only difference is the weaning percentage as outlined in the above table.

The standard flock used for the majority of the analysis was the self replacing flock based on the Wool-Meat genotype with surplus ewes mated to a terminal sire. Where a flock type is not specified this is flock that has been presented.

2.3 Pasture systems

Three mixtures of pasture species have been evaluated:

1. 'Current': current typical pasture on farms based on top 20% of monitor farm project based on perennial ryegrass and sub-clover. This pasture is grown on all land management units.
2. 'High PRG': best possible pasture based on highly productive perennial ryegrass, high fertiliser and best grazing practice. This pasture is grown on all land management units.
3. 'Triple': Areas of land allocated to lucerne, tall fescue and highly productive perennial ryegrass. The lucerne has to be grown on the gravelly ridges and is an option on the mid slopes. The fescue has to be grown on the flats and is an option on the mid slopes. The highly productive perennial ryegrass is an option on the mid slopes.

The analysis doesn't include the ongoing costs of achieving the extra productivity of the 'High PRG' and the 'Triple' pasture systems. Extra fertiliser, insect control and weed control maybe required to achieve production levels assumed, but they have not been costed. Extra costs associated with reseeding the pastures have been included assuming the improved pastures need to be reseeded once every 10 years.

2.4 Pasture production

The growth rate of annual pastures has been based on simulations using the GrassGro model with climate data from the Hamilton weather station. Growth rate of the fescue & lucerne pastures have been based on the simulated production of highly productive perennial ryegrass pastures with adjustments made by Steve Clark (pers comm.). More details on the pasture productivity assumptions are presented in Appendix 1.

3.0 Optimum Management for different pasture systems

MIDAS was used to determine the optimum long term strategy for each of the animal systems run on each of the pasture systems described in the above section.

The optimum management identified by MIDAS for the current system with moderately productive perennial ryegrass pastures and the traditional merino genotype is running 14.3 DSE/ha and feeding 30 kg of supplement per DSE to a flock with 52% ewes and 24% wethers (table 3.1). This system generates a net profit of \$100/ha. Upgrading the pasture to the highly productive perennial ryegrass increases profit by \$163/ha. This is achieved by increasing stocking rate to 24 DSE/ha and increasing supplementary feeding to 39 kg/DSE. The 'triple' pasture system is not as profitable as the highly productive perennial ryegrass and generates \$226/ha or \$126/ha more than the 'current' pasture. The stocking rate was 22.3 DSE/ha and the level of supplementary feeding was unchanged at 39 kg/DSE.

Table 3.1: Production and management parameters for the optimum management for each pasture system running a traditional merino flock.

	Pasture System		
	Current	HPRG	Triple
Profit (\$/ha)	100	263	226
Stocking rate (DSE/WG ha) ⁴	12.9	21.6	20.1
Supplementary feeding (kg/DSE)	30	39	39
Flock structure (% ewes)	52	52	52
Lambing (%)	71	71	71
Area perennial ryegrass (% of farm)	100	100	60
Area lucerne (% of farm)	-	-	20
Area fescue (% of farm)	-	-	20
Pasture growth (t/ha)	9.0	12.4	11.8
Pasture utilization (%)	52	61	59
Wool income (\$/ha)	451	757	705
Sale sheep income (\$/ha)	69	118	108
Leakage below root zone (mm) ⁵	130	121	98

Switching to the 'Wool-Meat' genotype and concentrating on wool production increases the profitability of the 3 pasture types by \$20/ha, \$25/ha and \$39/ha (Table 3.2). If a greater focus is put on meat production and surplus ewes are mated to a terminal sire then a further \$52/ha, \$121/ha and \$132/ha profit can be made from each pasture type (Table 3.3). These results demonstrate that the increase in profit from more productive pastures is greatest if the pastures are utilised with a focus on meat production.

Table 3.2: Production and management parameters for the optimum management for each pasture system running a Wool-Meat merino flock.

	Pasture System		
	Current	HPRG	Triple
Profit (\$/ha)	120	288	265
Stocking rate (DSE/WG ha) ¹	14.0	23.9	23.0
Supplementary feeding (kg/DSE)	33	43	52
Flock structure (% ewes)	85	85	85
Lambing (%)	121	117	122
Area perennial ryegrass (% of farm)	100	100	60
Area lucerne (% of farm)	-	-	20
Area fescue (% of farm)	-	-	20
Pasture growth (t/ha)	9.3	13.3	12.9
Pasture utilization (%)	53	60	61
Wool income (\$/ha)	324	553	532
Sale sheep income (\$/ha)	221	362	383
Leakage below root zone (mm) ²	130	121	98

⁴ Stocking rate calculated using DSE ratings as outlined in the Farm Monitor Project, Dec 2001.

⁵ Approximate calculation of leakage below the root zone based on land use. More detailed calculations will be done by Craig Beverly using hydrological models

Table 3.3: Production and management parameters for the optimum management for each pasture system running a Wool-Meat merino with a terminal sire.

	Pasture System		
	Current	HPRG	Triple
Profit (\$/ha)	172	409	397
Stocking rate (DSE/WG ha) ¹	14.0	24.7	22.7
Supplementary feeding (kg/DSE)	36	39	41
Flock structure (% ewes)	84	87	87
Lambing (%)	114	110	114
Area perennial ryegrass (% of farm)	100	100	60
Area lucerne (% of farm)	-	-	20
Area fescue (% of farm)	-	-	20
Pasture growth (t/ha)	9.6	13.6	13.1
Pasture utilization (%)	51	60	59
Wool income (\$/ha)	337	567	529
Sale sheep income (\$/ha)	263	459	458
Leakage below root zone (mm) ²	130	121	98

Table 3.4: Production and management parameters for the optimum management for each pasture system running a specialist lamb producing flock based on a 1st cross ewe.

	Pasture System		
	Current	HPRG	Triple
Profit (\$/ha)	34	305	290
Stocking rate (DSE/WG ha) ¹	12.0	21.5	20.0
Supplementary feeding (kg/DSE)	37	38	30
Flock structure (% ewes)	100	100	100
Lambing (%)	112	142	133
Area perennial ryegrass (% of farm)	100	100	60
Area lucerne (% of farm)	-	-	20
Area fescue (% of farm)	-	-	20
Pasture growth (t/ha)	8.3	13.7	13.3
Pasture utilization (%)	47	53	52
Wool income (\$/ha)	141	218	212
Sale sheep income (\$/ha)	276	602	544
Leakage below root zone (mm) ²	130	121	98

On all pasture types a specialist lamb producer using 1st cross ewes is less profitable than a producer utilising the ‘Wool-Meat’ genotype and mating surplus ewes to a terminal sire (Table 3.4). For this flock type the increase in profit from utilising the ‘high’ perennial ryegrass and the ‘triple’ pasture is \$271/ha and \$256/ha respectively.

Leakage is highest under the ‘current’ pasture system at 130mm/yr. The ‘high’ production perennial ryegrass only reduces leakage by 9mm to 121mm/yr. The ‘triple’ pasture system with 20% of the farm under lucerne and 20% under fescue reduces

leakage by 32mm compared to the ‘current’ system. A difficulty for this project that has a dual goal to increase profit and reduce leakage is the high profitability of the ‘high’ production perennial ryegrass but its poor leakage value.

4.0 Sensitivity to changing Pasture Production

This section shows the results of the sensitivity analysis undertaken using the model. Parameter values are changed systematically (and individually) while the others are held constant. Sensitivity analysis can help improve our understanding of the farming system by estimating the change in whole farm profit resulting from changes to different components of the system (or parameter values). This can help identify parameters that are economically more important and thereby which components of the farming systems might be altered for the greatest economic gain. This can provide insights into the potential economic value of research.

While sensitivity analysis can be a powerful tool, results must be interpreted with care. Model results may indicate where research has the greatest potential benefit, however prior to research being conducted the cost of implementing change at the farm level is unknown. This should be a consideration when research priorities are being assessed. In addition the model results provide no indication of the ease with which research may lead to given change in the farming system (say an increase in winter pasture growth). For example a 5% change in winter growth may be more valuable than a 5% change in spring growth but it may be much more difficult (and costly) to achieve. A further consideration is the ease with which farmers may adopt prospective research outcomes. Improved management that increases the demand for labour for example is likely to be less readily adopted than an alternative option with less requirements for labour.

In this sensitivity analysis a range of pasture production parameters were changed. These changes are shown in Table 4.1.

Table 4.1: Pasture parameters varied in the pasture sensitivity analysis.

Parameter	Range examined
Pasture growth rate	
During winter	Increase of 20% achieved for 1 week
During early spring	Increase of 20% achieved for 1 week
During late spring	Increase of 20% achieved for 1 week
During summer	Increase of 20% achieved for 1 week
During autumn	Increase of 20% achieved for 1 week
Pasture digestibility	
Decline during summer	Reduce decline so that final digestibility is 5% higher

Table 4.2 shows the change profit per hectare resulting from the changes in pasture production shown in Table 4.1. The change in whole farm profit that occurred as a result of increasing pasture production or quality is expressed in the dollars per hectare of the ‘new’ pasture species.

Table 4.2: Increase in profit (\$/ha of pasture) achieved from varying a range of pasture parameters for 3 of the flock types.

Component	Traditional Wool	Wool/Meat	Wool-Meat Terminal	1 st cross
PGR				
Winter	2.70	2.40	2.60	2.50
Early Spring	1.60	1.60	2.00	2.45
Late Spring	0.60	1.20	2.10	3.15
Summer	0.10	0.45	0.70	0.45
Autumn	0.10	0.10	0.25	0.01
Digestibility				
Summer Decline	6	10	16	35

The profitability of all the flocks is sensitive to altering productivity during winter. This is consistent with the farmer group being very interested to research winter active species such as winter active fescue. Research projects aimed at this area would help increase farm profit, the challenge is to ensure they are consistent with increased water use.

The meat producing flocks are responsive to increasing summer digestibility. This indicates that new species aimed at meat systems should be screened for digestibility.

5.0 Characteristics of Animal Production Systems

5.1 Supplementary feeding levels

The optimum level of supplementary feeding identified by the MIDAS model for the ‘current’ ryegrass system is 30kg/DSE. The MIDAS sensitivity results (figure 5.1) indicate that farm profit is insensitive to supplement level down to about 10kg/DSE. These results demonstrate that although MIDAS identifies high levels of supplementary as most profitable, farmers who chose to feed much lower levels and run lower stocking rates are forgoing very little profit.

Including summer active perennials in the farm system increases the optimum supplementary feeding rate to between 20 and 50kg/DSE. This increase in supplement allows extra value to be extracted from the summer active perennials, by filling the winter feed deficit.

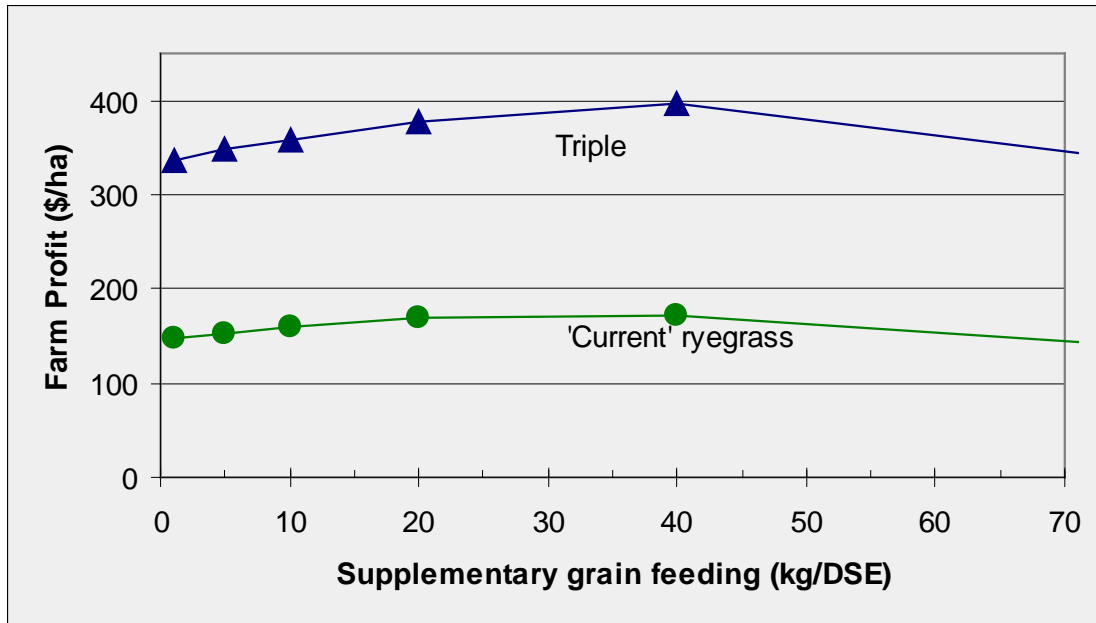


Figure 5.1: Sensitivity of profit to supplementary feeding levels for the ‘traditional’ farm and the ‘future’ farm.

5.2 Fodder conservation

The value of implementing a fodder conservation systems is low because there is very little surplus pasture produced on the farm at the optimum stocking rate. Even if the fodder can be conserved for \$37.50/t DM, fed out for \$17/t DM and the quality is high (11 MJ/kg) the increase in profit from conserving feed is only \$2.00/ha/yr (\$2000/farm).

Having a strategy for the poor years is an essential component of the farm system to minimise the cost of poor years and allow higher stocking rates to be run during the average and better years. Fodder conservation may have a role for this if it can be made cheaply in the years with above average spring flush. Using fodder conservation in this way changes the focus from short term storage (fodder rolls and buns) to longer term storage (silage pits).

The change in the value of drought reserves for a farm with more perennials has not been valued because tools to analyse this question are not available.

5.3 Pasture utilisation

Previous analyses have shown that utilising a high proportion of pasture is necessary to maximise profit from growing extra pasture.

Table 5.1: Change in profit (\$/ha of pasture) resulting from altering parameters associated with pasture utilisation for the 4 flock types lambing in September.

	Traditional Wool	Wool/Meat	Wool-Meat Terminal	1 st cross
Increase utilisation 10%	16	31	54	29
Increase summer residual				
from 1000 to 1500kg/ha	3	2	6	0
from 1500 to 2000kg/ha		11	23	11
Reduce trampling losses from 25% to 10%	57	63	81	68
Reduce decay in summer/autumn from 0.7% to 0.4%/day	3	2	6	0

Increasing pasture utilization has a medium value and reducing pasture wastage associated with grazing has a high value and improving them would contribute significantly to improving profitability. Reductions in pasture wastage and decay may be achieved from rotation grazing which is integral to management of the perennial sward. Measuring these parameters in a trial or on farm would allow more accurate feed budgeting and increase farmer's accuracy in utilizing their feed supply.

Reducing the decay of dry feed and reducing the minimum residual of dry feed at the break of next season both have very little value. This is because when the summer active perennials (lucerne and fescue) are being grown dry feed is only a small component of the diet and the utilisation of dry feed is low.

5.4 Reproductive rate

Reproductive rate is a combination of

1. fertility – the number of ewes lambing per ewe joined
2. prolificacy – the number of lambs born per ewe lambing
3. survival – the number of lambs alive at weaning per lamb born

Reproductive rate can be increased by improving the nutrition of the ewes, improving the genetic potential of the ewes or reducing the reproductive wastage caused by environmental factors. The extra profit from increasing reproductive rate is a tradeoff between the extra income achieved by having a flock with more surplus animals for sale and the extra costs associated with meeting the energy demands associated with more ewes pregnant or more ewes lactating.

Table 5.2: Increase in profit (\$/ha of pasture) achieved from producing an extra 10% lambs weaned for the 4 flocks.

Pasture System	Traditional Wool	Wool/Meat	Wool-Meat terminal	1 st cross
Current	8	17	26	23
High PRG	14	28	40	30
Triple	13	30	44	27

Increasing reproductive rate is between 20% and 70% more valuable on the ‘triple’ farm than the ‘current’ farm (table 5.2). Some of the extra value is due to the additional ewes being run on the ‘future’ farm because of the higher proportion of ewes in the flock and the higher stocking rates. The remaining increase in value is due to the extra returns that can be made from additional lambs on a farm with summer active perennials because the cost s of finishing lambs is lower.

A focus on improving reproductive rate is sensible for this project because increasing reproductive rate is more valuable on a farm with summer active perennials.

5.5 Time of Lambing

The profitability of lambing later is a trade-off between the lower energy demands of the ewes at the break of season and the higher energy demand of the younger and smaller progeny going into summer/autumn. Later lambing makes it possible to carry higher stocking rates through the feed shortage at the break of season and have more animals available to graze the spring flush.

When using the ‘triple’ pasture system lambing in November instead of September increases profitability slightly in the flocks concentrating on wool production (Table 5.3). In this system the energy requirements of the lambs are low because the target for the lambs is maintenance only. The benefit of higher stocking rates outweighs the extra costs associated with higher energy demands of the lambs in early summer. With ryegrass based pastures (both ‘current’ and ‘high’) lambing in November instead of September is marginally less profitable. This reflects the lower summer activity of the ryegrass pastures compared with the lucerne and fescue.

In contrast, later lambing reduces the profitability of the flocks with a focus on meat production. For these flocks the cost of the extra energy required to finish the later born lambs outweighs the benefits of lower costs or higher stocking rate during winter. In this flock the target for the lambs is maximum weight gain and this can be achieved cheaper if the lambs are born earlier and gain more weight during the spring flush.

Table 5.3: Effect on profit (\$/ha of pasture) of changing time of lambing for the four flocks run on ‘Triple’ pastures.

Lambing Time	Traditional Wool	Wool/Meat	Wool-Meat terminal	1 st cross
September	226	265	397	290
November	236	276	333	190

5.6 Accelerated Lambing

Changing the mating pattern of the flock so that ewes are joined every 8 months rather than every 12 months could increase the number of lambs weaned each year. In a 2 year period there would be 3 lambing opportunities rather than only 2. This could increase the number of lambs weaned by a half. It would also allow any ewes that didn’t conceive at one mating to be re-mated 4 months later rather than having to wait for a full 12 months.

The costs of the system are:

1. 2 of the 3 lambings are occurring at a non-preferred time and one of these is occurring in the middle of summer/autumn when the cost of growing the lambs will be very high.
2. high quality feed will be required by the ewes during lactation and after weaning to ensure the ewes reach target weights for the next joining because there is less time for weight gain in the accelerated lambing system.
3. The system would also require a much higher level of management input to keep track of the different groups of ewes and lambs and ensure that all the husbandry operations that need to be carried out are done on time.

5.7 Early joining (first lamb at 12mo)

With summer active perennials on the farm growing ewe weaners quickly and mating them for their first lamb at 12months of age may be achievable and profitable. MIDAS was run with the option of mating ewes at 7 months for a lamb at 12 months of age. The relationship between liveweight at joining and number of lambs conceived was assumed to be the same as maiden ewes joined at 19months of age. This may be an optimistic assumption based on trial work done by the Department of Agriculture WA. The increase in profitability of \$52/ha for a farm with 'triple' pasture (table 5.4) is a substantial increase and much higher than that achieved on the 'current' pastures.

Table 5.4: Increase in profit from mating ewes for their first lamb at 12 months of age. The lambing percentage for the 1yo ewes was 66%.

Pasture system	Increase in profit (\$/ha)
Current	15
High Ryegrass	50
Triple	52

5.8 A trading operation

Including a trading operation in which livestock are bought and sold within the one season can increase pasture utilisation. Livestock can be purchased to utilise surplus pasture and then sold again before the feed shortage. Biologically this is a very efficient system because the pasture can be utilised as it is growing and then the animals can be removed as the growth rate slows.

Whether a trading operation is profitable depends on the margin that can be extracted from the market. This makes the system very dependant on the entrepreneurial skill of the manager and the number of competing operators trying to buy and sell in the same market. A trading operation will not be possible for all participants in the industry because of the effects on supply and demand.

6.0 Value of Trees in the System

Trees and other woody perennials have not been formally modelled in MIDAS however some of the sensitivity analysis results are relevant to the profitability of including trees in the farming system. Including trees on a farm can impact on profitability in a number of ways, some are positive, others are negative. Some of their impacts on profitability are:

1. They reduce the area available for other land uses, effectively reducing the area of the farm. Including summer active perennials on the farm increases profitability and this increases the opportunity cost of taking land out of production to plant trees.
2. Some species can contribute to the cashflow of the farm in their own right through timber products.
3. Trees reduce the risk of wind erosion. In regions where this is a problem, such as on the South Coast of WA grazing during summer needs to be moderate to minimise the risk of erosion. Planting trees as wind breaks could allow heavier grazing of the dry residues during summer and autumn. The results showing the sensitivity of profit to the amount of pasture that must be left at the beginning of the next growing season (table 5.1) indicate the magnitude of the potential benefits.
4. Shading by trees has been shown to reduce the level of soluble carbohydrate in the pasture which reduces palatability and this may reduce utilisation of the shaded pasture.
5. They can impact on the productivity of the “normal” land use. This could be positive through enhancing the microclimate or it could be negative through competition for light and water. The results on the sensitivity of profit to changing pasture growth (table 4.2) can be used to estimate the profit impact of trees when the net impact on pasture growth can be estimated.

The net affect of trees has been calculated in table 6.1 using the following assumptions:

- a) reduced pasture growth in late spring by 10% because of competition for light and water
- b) increased pasture growth in winter by 10% through provision of shelter
- c) increased lamb survival by 5% through provision of a wind break
- d) reduced utilisation of feed by 5% because of the lower palatability of the shaded pasture
- e) each hectare of trees impact on 10ha of pasture

Table 6.1: An example calculation of the impact of trees on farm profit through effects on pasture growth. *Note: the values used for the effects of trees on pasture production are only included for the example calculation. They may not bear any resemblance to reality.*

	Calculation	Farm Profit (\$/ha)
Extra winter pasture 10% for 19 wks	$10/20 \times 2.6 \times 19$	+24.70
Lower spring pasture 10% for 15 wks	$10/20 \times 2.1 \times 15$	-15.70
Increase lamb survival 5%	$5/10 \times 44$	+22.00
Reduced utilisation	$5/10 \times 54$	-27.00
Net effect/ha of pasture		+4.00
Area impacted by 1ha of trees		10ha
Production effect/ ha of trees		+40.00
Opportunity Cost (average over farm)		-508.00
Net effect/ ha of trees		-468.00

7.0 Water use and Profit

MIDAS can estimate leakage over the whole farm⁶ by averaging the leakage (mm) of each land use across the farm. It has been used to calculate the trade-off between profitability and leakage by constraining leakage to set levels and calculating the most profitable combination of land use that has that level of leakage (figure 7.1). To reduce leakage the model reduces the area of perennial ryegrass pastures and increases the area of lucerne and fescue. The ryegrass systems that do not include any high water use options have no options to increase water use so they are simply represented as a single point.

The goal of this project is to increase profit by 50% and reduce recharge by 50%. The base line from which these targets will be measured is the farming system using 'current' perennial ryegrass and the 'wool-meat' genotype with surplus ewes mated to a terminal sire (Table 3.3). The targets for profit and leakage are a profit of \$258/ha (an increase of \$86/ha) and a leakage of 65mm (a reduction of 65mm).

The highly productive perennial ryegrass increases profit substantially but leakage is only reduced marginally (note: any extra inputs such as extra fertilizer have not been costed). The 'triple' system with 20% lucerne and 20% fescue uses more water than the highly productive perennial ryegrass but is slightly less profitable. When the model is constrained to lower levels of leakage fescue displaces highly productive perennial ryegrass on the mid slopes. Increasing the area of fescue is not as profitable as ryegrass and profit is decreased by \$26/ha for every 10mm reduction in leakage.

⁶ These calculations of leakage are only an estimate of leakage and are based on area of different land uses. More detailed calculations have been done by Craig Beverly using hydrological models.

Overall the 'triple' system easily achieves the project profit target with a profit of \$335/ha (target \$258/ha) and almost reaches the leakage target with a leakage of 70mm (target 65mm). At this extreme there is 20% of the farm under lucerne & 80% under tall fescue. However farmers would be foregoing significant profit to achieve the leakage target and therefore adoption of this extreme is likely to be low. This problem of low adoption of because of the high opportunity cost of the leaky perennial ryegrass requires species or mixtures of species that leak significantly less than fescue & lucerne (so smaller areas are required to achieve the target leakage) or produce more than fescue & lucerne (so the opportunity cost is reduced).

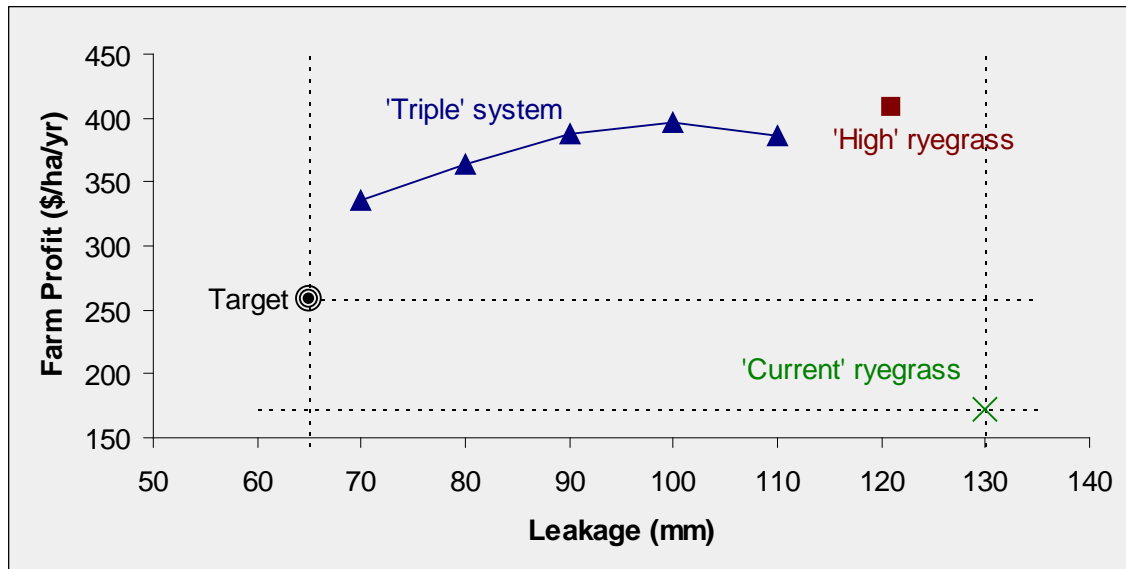


Figure 7.1: Trade-off between profit and leakage below the root zone for the 'current' system, the 'High PRG' and the potential 'Triple' system. The current profit and leakage and the target profit and leakage are also marked.

A further problem with the very high proportion of fescue is that grazing management may not be able to be controlled sufficiently well to ensure the long term survival of the fescue. Using a combination of summer active perennials (such as tall wheat grass and C4 grasses) may circumvent the problems associated with having a large area of a single species that has specific grazing requirements. This is dependant on the other species or mixture of species being able to generate similar growth rates and water use as fescue.

To test the optimum area of the different pasture species the model was run with the option of having 'high' perennial ryegrass over the wholefarm and also the option of including lucerne and fescue. The difference between this and the 'triple' system is that the lucerne and fescue are optional. When run with these pasture options the optimal area of fescue was 12.5% and the remainder of the farm was 'high' ryegrass. Lucerne was not part of the optimal farm system unless leakage was constrained to be below 90mm. The combination of ryegrass and fescue generated more profit than the straight ryegrass and leakage was slightly reduced (Figure 7.2). Neither of the lamb production scenarios examined (higher lambing percentage – up to +50%, mating ewes for first lamb at 12mths) made much difference to the optimum area of fescue.

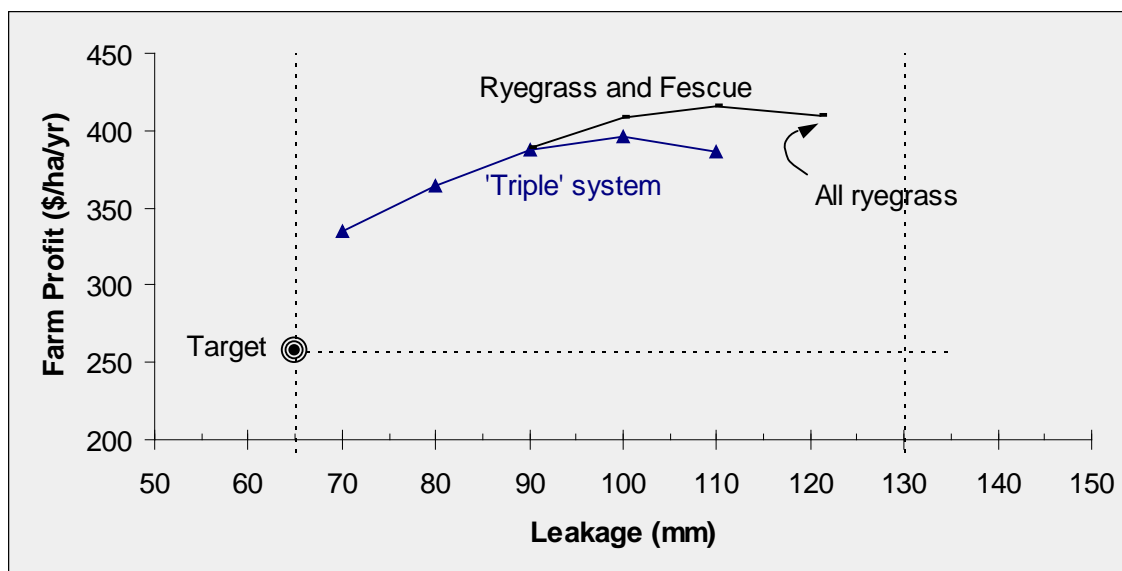


Figure 7.2: Trade-off between profit and leakage for a system with optimum proportions of ryegrass, fescue & lucerne.

8.0 Potential treatment matrix

Table 9.1: Profitability of different pasture systems being utilised with different animal systems with optimum grazing management.

Lambing Time	TOL	Pasture system		
		Control	High PRG	Triple
Wool	Sept	100	263	226
	Nov	93	250	236
Wool/Meat	Sept	120	288	265
	Nov	119	280	276
Wool/meat terminal	Sept	172	409	397
	Nov	127	336	333
1 st cross	Sept	34	305	290
	Nov	4	217	190

Table 9.2: Profitability of different pasture systems being utilised with different animal systems with lax grazing management (10% lower pasture utilisation).

Lambing Time	TOL	Pasture system		
		Control	High PRG	Triple
Wool	Sept	87	245	210
	Nov	78	226	215
Wool/Meat	Sept	100	264	240
	Nov	99	259	250
Wool/meat terminal	Sept	149	374	344
	Nov	110	300	300
1 st cross	Sept	26	291	271
	Nov	-3	198	178

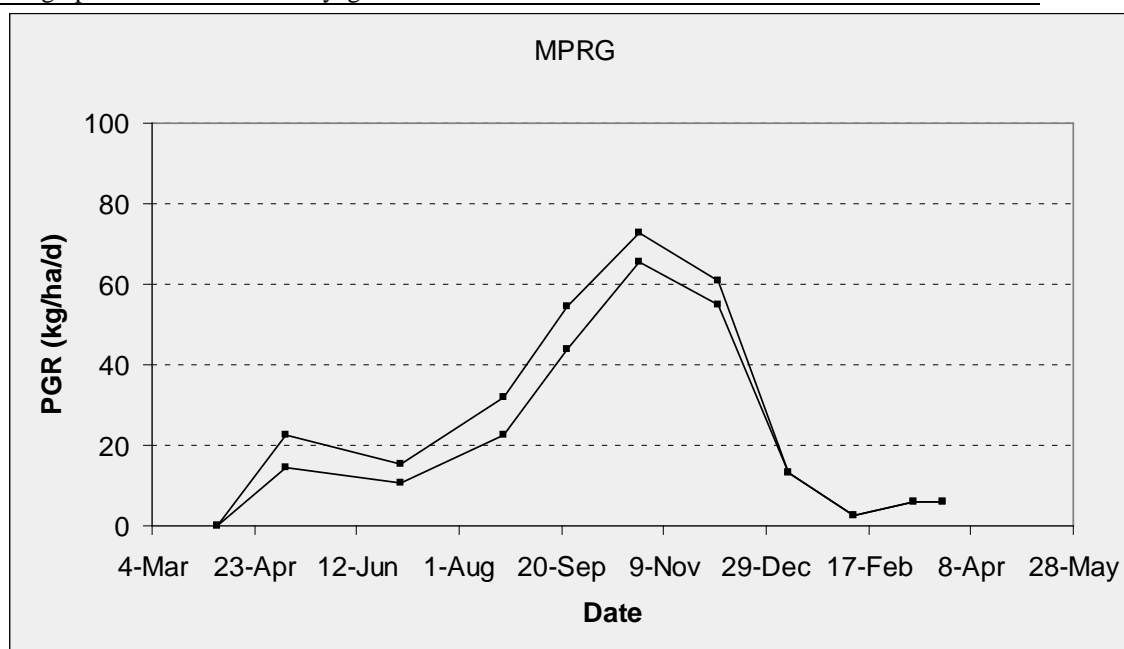
Appendix 1 – Pasture productivity assumptions

Scaling factor of pasture growth rate for the different soil classes.

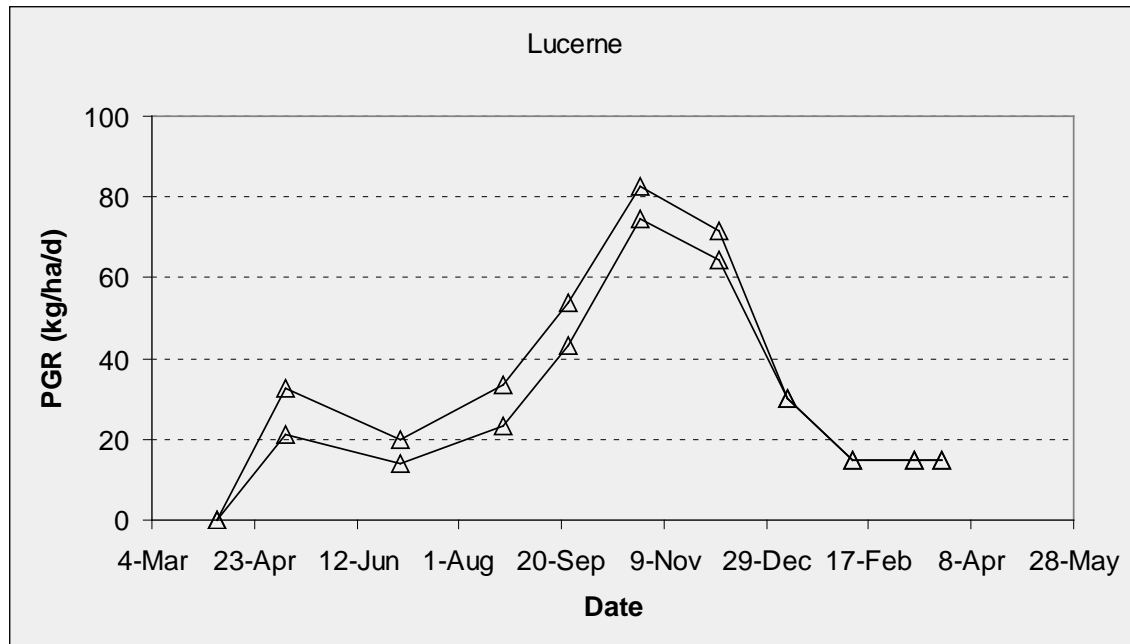
	Ridges	Mid-slopes	Flats
Medium production Perennial Ryegrass	1.0	1.0	1.0
Lucerne	1.0	1.0	-
Fescue	-	1.0	1.0
High production Perennial Ryegrass	1.0	1.0	1.0

Initial growth or germination (kg/ha) of each pasture type on each soil class during the first feed period.

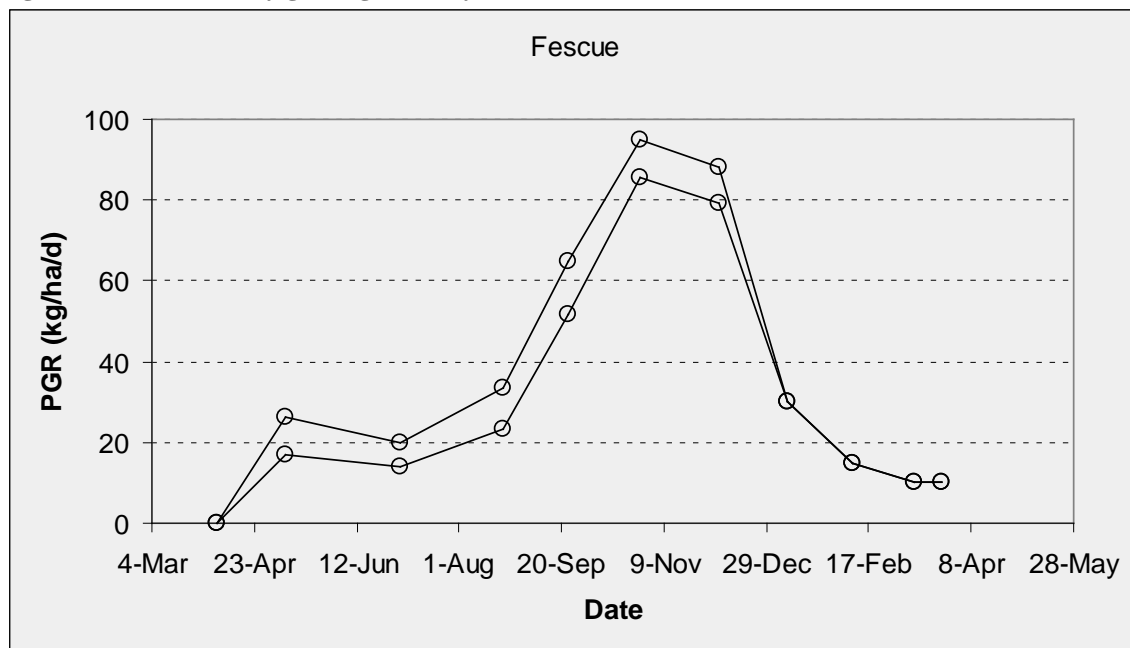
	Ridges	Mid-slopes	Flats
Medium production Perennial Ryegrass	426	426	426
Lucerne	738	738	-
Fescue	-	600	600
High production Perennial Ryegrass	594	594	594



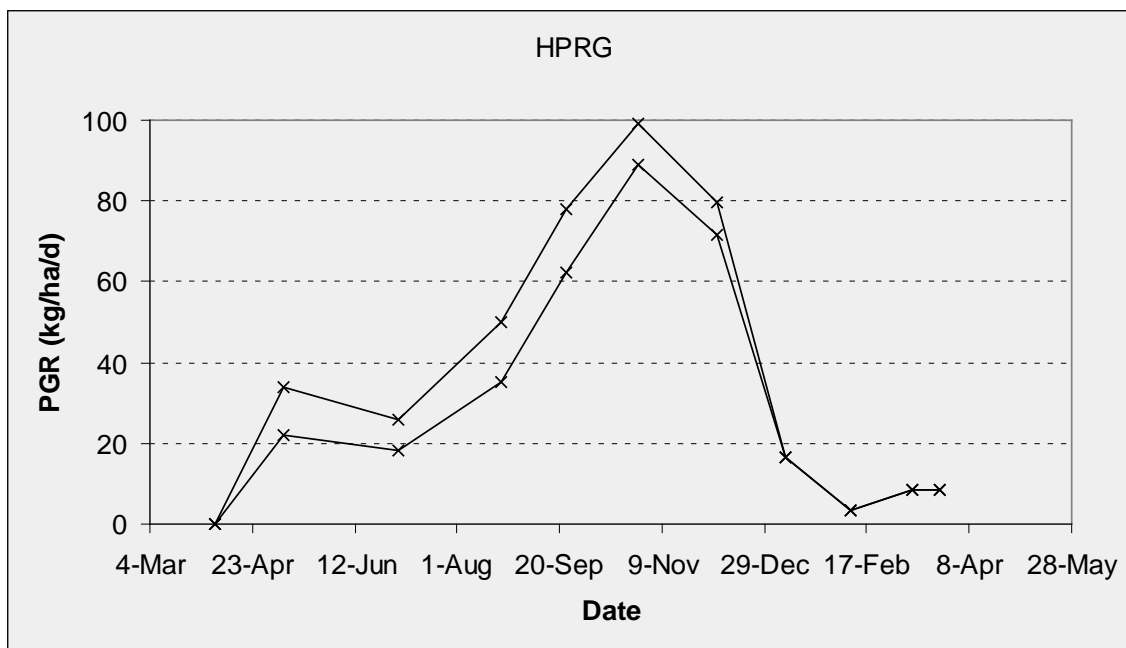
MIDAS inputs: Low & High PGR for medium productivity perennial ryegrass pasture in each feed period (1 to 10). Note the low and high PGR relate to the low & high FOO levels in the following graph. The MIDAS optimization algorithm is able to vary grazing intensity which alters FOO which then affects PGR.



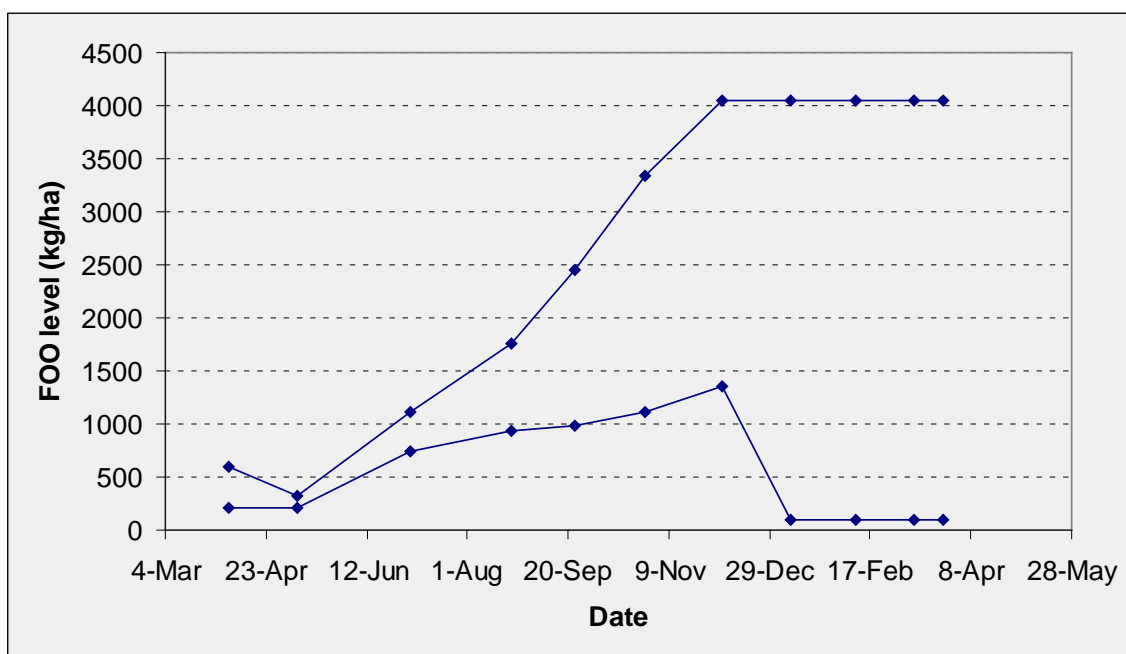
MIDAS inputs: Low & High PGR for lucerne pasture in each feed period (1 to 10). Note the low and high PGR relate to the low & high FOO levels in the following graph. The MIDAS optimization algorithm is able to vary grazing intensity which alters FOO which then affects PGR.



MIDAS inputs: Low & High PGR for fescue pasture in each feed period (1 to 10). Note the low and high PGR relate to the low & high FOO levels in the following graph. The MIDAS optimization algorithm is able to vary grazing intensity which alters FOO which then affects PGR.



MIDAS inputs: Low & High PGR for high productivity perennial ryegrass pasture in each feed period (1 to 10). Note the low and high PGR relate to the low & high FOO levels in the following graph. The MIDAS optimization algorithm is able to vary grazing intensity which alters FOO which then affects PGR.



MIDAS inputs: FOO levels for the 2 different PGR levels for all the pasture types.

Appendix 2 – Leakage assumptions

Pasture	Well drained (gravely loam)	Moderate drainage (clay-loam)	Poor drainage (clay)
‘Current’ ryegrass	120	140	110
‘High’ ryegrass	110	130	105
Lucerne	35	80	-
Fescue	-	82	60