Final MIDAS modelling for Hamilton EverGraze site

John Young, Andrew Bathgate & Ralph Behrendt
3 August 11

EverGraze® is a Future Farm Industries CRC research and delivery partnership:

Introduction
Pre-experimental modelling was carried out for the EverGraze project using estimates of pasture production and quality for perennial ryegrass, lucerne and summer active tall fescue (Young *et al* 2004).The initial estimates were based on GrassGro modelling with expert input used for finetuning.

The role of the pre-experimental MIDAS modelling was to develop pasture and animal systems that have been evaluated in on-ground trial work.

The role of this analysis was:

1. to validate the preliminary modelling using the trial data that has been collected and compare against a ‘base case’ pasture.
2. to include the maternal genotype that was evaluated in the final 2 years of the trial

Calibration of the pastures in the MIDAS model with the measured pasture production information has been described by Young & Behrendt (2010) and this report covers the calibration of the ‘base case’ pasture and the calibration of the animal systems.

Materials & Method
In this analysis five animal systems have been compared:

1. ‘Wool’: merino ewes mated to merino sires for wool production
2. ‘Terminal’: merino ewes mated to a terminal sire for prime lamb production, replacement merino ewes are purchased
3. ‘Terminal Self replacing’: Merino ewes mated to a terminal sire, but replacement ewes are bred on farm
4. ‘Coopworth’: Composite breed for prime lamb production with replacement ewes bought in and mated for their first lamb at 2yo
5. ‘Coopworth self replacing’: As above but replacements are bred on-farm and ewes are mated for their first lamb at 1yo.

and three pasture systems have been compared:

1. Base Case
2. Perennial Ryegrass
3. Triple Pasture (Lucerne, Tall Fescue and Ryegrass) – see Young *et al* (2004) for a description.

The ‘Wool’ system and the ‘Base Case’ pasture system were not included in the on-ground experimental design and production levels of these systems were estimated either from simulation modelling or the measured production levels of the merino ewes mated to a terminal sire.

Pasture Systems
The calibration of the ‘base case’ pasture was based on modelling done by Steve Clark (pers comm) using GrassGro. This modelling included the ‘base case’ pasture, perennial ryegrass and ‘triple’ pasture and was originally carried out for an analysis done by Claire Lewis (*is there a reference*).

The method used to calibrate the pasture growth rate in the MIDAS model used a combination of the values generated from GrassGro and the pasture growth values measured on the EverGraze plots. From the GrassGro modelling the growth rate of the ‘base case’ pasture was calculated as a proportion of the ryegrass pasture for each of the MIDAS pasture growth periods. The growth rate of the base case pasture that was entered into MIDAS was then calculated using this proportion and the growth rate of the perennial ryegrass pasture measured in the plot work.

Table 1: Peak PGR (kg/ha/d) for each pasture system. Note: there is no growth represented in period 1 because in MIDAS this is included in the 'initial green' quantity (kg/ha).

MIDAS Feed period		BaseCase	Ryegrass	Lucerne	Fescue
Number	Start Date				
Initial Green		426	600	738	594
1	25-Mar				
2	15-Apr	25.9	15.0	9.2	23.8
3	1-Jun	25.1	44.4	39.3	37.9
4	5-Aug	35.9	81.9	95.3	56.0
5	9-Sep	42.0	88.2	123.2	54.5
6	7-Oct	37.2	53.4	57.8	46.2
7	18-Nov	7.3	19.5	20.7	16.2
8	23-Dec	2.8	2.8	18.9	4.9
9	25-Jan	0.8	4.2	16.2	5.0
10	25-Feb	0.1	2.3	14.1	2.8

These base case pasture growth rates are higher after the break, lower in spring and much lower in summer and autumn than those used in the pre-experimental modelling.

A similar process was used to calibrate the pasture quality of the base case. The difference in pasture quality between the base case pasture and the ryegrass was calculated from the GrassGro modelling and this difference was imposed on top of the digestibility of the ryegrass measured in the trial.

Table 2:The difference in digestibility of green feed between the trial data and the pre-experimental modelling, based on all years of trial data.

MIDAS Feed period		Base Case	Ryegrass	Lucerne	Fescue
Number	Start Date				
1	25-Mar	-27%	7%	4%	5%
2	15-Apr	-34%	2%	2%	1%
3	1-Jun	-23%	5%	3%	3%
4	5-Aug	-9%	7%	5%	5%
5	9-Sep	-1%	9%	8%	7%
6	7-Oct	-2%	11%	9%	6%
7	18-Nov	-12%	6%	2%	-1%
8	23-Dec	-10%	8%	2%	8%
9	25-Jan	-15%	11%	0%	9%
10	25-Feb	-22%	15%	0%	5%

The green feed quality measured in the field for the ryegrass, lucerne and fescue were all higher than the values used in the pre-experimental modelling, however, the values generated in the GrassGro modelling for the base case pasture were all much lower particularly in early winter and summer/autumn. These very low values impact on the profitability of the Base Case and affect the amount of supplement that is required in this pasture system.

No differences in pasture persistence were assumed between the different species across the 3 land management units. This assumption was represented by having the same re-sowing interval for each pasture system.

Animal Systems

For this analysis a composite breed flock was added to the model and it was based on the work described by Young *et al* (2009). Animal production levels for the merino and composite breed were calibrated to be equivalent to the levels measured in the EverGraze experiment (Table 3). Production levels of the ewes in the merino wool flock were based on the production of the merino ewes mated to a terminal sire. Survival was estimated for single and twin born lambs based on the average survival and the proportion of singles and twins scanned.

Table 3: Production levels of merino ewes mated to a terminal sire and the Composite ewes as measured in the experiment.

Parameter	Merino with Terminal	Coopworth Composite
SRW @CS3	60	70
Scanning Rate	140% @ CS3.3	180% @ CS 3.9
Lamb Survival	76.2% average	86.5% average
Weaning %	103%	147%
Ewe CFW	3.6	2.6
Ewe FD	20.5	37.9

Leakage below Root Zone

The estimates of leakage below the root zone were updated based on experimental measurements (Table 4). The measurements indicated that

1. There was no movement of water past the root zone of lucerne
2. The movement of water past the root zone of fescue was similar to that for perennial ryegrass.

Table 4: Estimates of leakage of water beyond the root zone for each pasture system on each land management.

Pasture		Valley Floor	Slope	Crests
Base Case	Pre Expt	110	140	120
	Updated	nc	nc	nc
Ryegrass	Pre Expt	105	130	110
	Updated	nc	nc	nc
Lucerne	Pre Expt			35
	Updated			0
Fescue	Pre Expt	60		
	Updated	105		

nc = no change

The poorer leakage values measured for Fescue compared with the assumptions used in the pre-experimental modelling meant that the opportunity to reduce leakage by increasing the area of fescue didn't exist and unless lucerne could be grown on the mid-slopes then leakage could not be reduced below that of the standard Triple system.

Prices

Table 5: Prices used in the analysis and the variation applied in the sensitivity analysis

	Standard	Variation
Wool price (STB)		
18u	1335	+/- 25%
21u	920	
35u	630	
Meat Price		
Store Lamb ($/kg LW)	1.88	+/- 25%
CFA Ewe ($/kg LW)	0.90	all moved together
Wether ($/kg LW)	1.10	

The sensitivity analysis for meat prices was done by adjusting the price of all the animal types together and by the same percentage from the standard price i.e. when the price of lamb was increased by 25% the sale & purchase price of ewes was also increased by 25%. The presentation of the meat price sensitivity has been expressed using the price of lamb in $/kg DW because this is a measure that is widely accepted and identified with even though none of the animals in this analysis were sold on the basis of dressed weight. The standard price of lamb in this analysis was $4/kg DW and therefore the +/- 25% sensitivity analysis was varied in the range $3/kg up to $5/kg.

Results & Discussion

The profitability and carrying capacity of the Base Case pasture system is very low in this analysis (Table 6) and for the 'Coopworth' system it was not possible to get a feasible solution in the time available (Table 7). This difference compared with the pre-experimental modelling was due to the big differences in pasture growth rate and digestibility. Given that the calibration of the base case was based on GrassGro modelling in both instances it is difficult to draw any conclusions from the results of this analysis.

Compared with the pre-experimental modelling the 'Terminal' system has a slightly lower stocking (3-4 DSE/ha), lower grain feeding (3-8 kg/DSE) and higher profitability ($100/ha) for both the ryegrass and the Triple systems (Table 6). A number of factors have been altered in this analysis compared to the pre-experimental modelling and the contribution of each to the changes observed have not been quantified. The factors varied include:

1. Prices: the prices of sale animal and wool in this analysis are higher than in the original modelling.
2. Altered genotype based on production in the EverGraze trial
3. Addition of Coopworth genotype
4. Altered pasture growth rates based on production in the EverGraze trial.
5. Altered pasture digestibility based on production in trial & the GrassGro modelling, this was particularly obvious for the Base Case pasture.
6. Changes made to the underlying model in the period between analyses

Table 6: The farm plans identified as optimal for the 'Terminal' enterprise for the base case, high performance ryegrass and the 'triple' pasture systems based on the GrassGro modelling for the Base Case and field trial assumptions for Ryegrass and Triple.

	Base Case	Ryegrass	Triple
Profit ($/ha)	12	510	499
Stocking rate (DSE/WG ha)	10.0	20.3	19.7
(Ewes/ha)	5.9	14.3	13.9
Supp feed (kg/DSE)	110.2	36.4	33.2
Flock Structure (% ewes)	84%	100%	100%
Lambing (%)	85%	89%	89%
Area perennial ryegrass (% of farm)	100%	100%	60%
Area lucerne (% of farm)	0%	0%	20%
Area fescue (% of farm)	0%	0%	20%
Pasture Growth (t/ha)	7.4	11.6	11.3
Pasture utilisation (%)	40%	54%	54%
Wool income ($/ha)	288	523	506
Sale sheep income ($/ha)	202	444	430
Leakage (mm)	130	121	99

Table 7: The farm plans identified as optimal for the 'Coopworth' enterprise for the base case, high performance ryegrass and the 'triple' pasture systems based on the GrassGro modelling for the Base Case and field trial assumptions for Ryegrass and Triple.

	Base Case	Ryegrass	Triple
Profit ($/ha)		402	397
Stocking rate (DSE/WG ha)		16.4	16.0
(Ewes/ha)		10.4	10.1
Supp feed (kg/DSE)		38.9	35.4
Flock Structure (% ewes)		100%	100%
Lambing (%)		139%	139%
Area perennial ryegrass (% of farm)		100%	60%
Area lucerne (% of farm)		0%	20%
Area fescue (% of farm)		0%	20%
Pasture Growth (t/ha)		12.0	11.7
Pasture utilisation (%)		54%	54%
Wool income ($/ha)		172	167
Sale sheep income ($/ha)		655	639
Leakage (mm)		121	99

The profitability of the 'Coopworth' system is about $100/ha lower than the 'Terminal' system with the standard prices (Table 6&7). There is an increase in sales sheep income in the Coopworth system, however this is insufficient to compensate for the reduction in wool income. This finding is consistent with the pre-experimental modelling that showed a first cross lamb system was more profitable than the 2nd cross lamb system because of the reduction in wool value from moving to a 1st cross ewe. The difference in profitability between the animal systems is less when meat price is higher (Figure 1), extrapolating the results of the sensitivity analysis indicates that prices would need to be about $6/kg DW for lamb for the 2 systems to be equivalent.

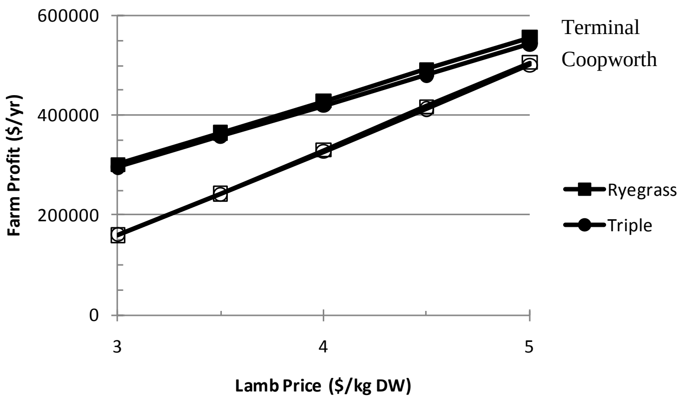

Figure 1: Impact of meat price on the profitability of the Terminal and Coopworth system for both the Ryegrass and Triple pasture systems.

The MIDAS feed budget identified that the optimum stocking rate for the Coopworth genotype was between 3 and 4 ewes/ha less than for the Merino ewe joined to a terminal sire. This is consistent with the difference in the trial.

The profitability of the Triple system was slightly less than the ryegrass system for the specialist meat producing flocks and slightly higher for the wool flock and the self replacing terminal flock (Table 8). Also, there was little impact of meat price on the relative profitability of each pasture system (Figure 2).

Table 8: Profitability of the 5 animal systems for the ryegrass and triple pasture systems.

	Ryegrass	Triple
Wool	513984	524639
Terminal	510134	499110
Terminal self-replacing	543748	550698
Coopworth	402201	397184
Coopworth self-replacing	421280	415598

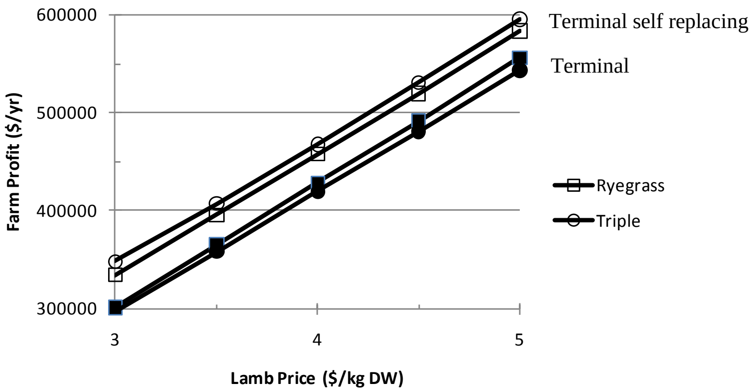

Figure 2: Impact of meat price on the profitability of the ryegrass and triple system for the 'Terminal' system and the 'Terminal self-replacing' system.

The self replacing flocks were both slightly more profitable than the equivalent flocks buying in replacement ewes (Table 8). This is a reflection of the purchase price of the ewes relative to the cost of breeding replacements and this cost is impacted on by the value of wool. In this analysis which reflects the current higher wool price and the current high ewe price, breeding replacements is more profitable than buying in, however, a different result would be achieved with different price assumptions and the most appropriate analysis would be to do a sensitivity analysis on replacement cost and wool price to determine the scenarios in which each strategy is profitable.

For the Coopworth system the switch to self-replacing also included mating the young ewes to achieve their first lamb at 12 months of age, however, it is not possible to determine the profitability of this strategy because it is confounded in the analysis with changing the flock structure.

The Triple system allows less water to leak below the root zone. This finding reflect the pre-experimental modelling, however, in the current modelling the Triple system is unable to reach the leakage target because of the experimental finding that Fescue was as 'leaky' as the ryegrass (Figure 3).

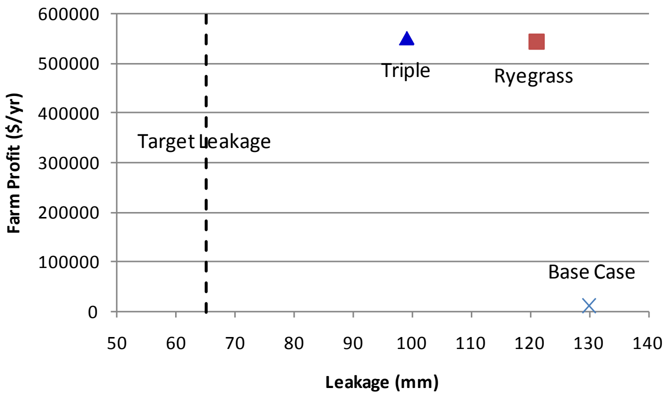

Figure 3: Relationship between leakage below the root zone and profitability for each of the pasture systems. The most profitable animal system is represented for each pasture system.

Conclusions

This analysis, based on the production levels observed in the EverGraze trial carried out at Hamilton, backs up the conclusions from the pre-experimental modelling, except for the conclusions on leakage. The profitability of the ryegrass and Triple pasture systems are similar and are both much greater than the Base Case pasture system. Regarding leakage, the on-ground trial showed that the Tall Fescue pasture had less capacity to reduce leakage and this is reflected in this analysis with less capacity to develop a farm system that will achieve the water use targets.

This analysis showed that the profitability of a 1st cross lamb system based on a wool-meat genotype was more profitable than a composite genotype unless meat prices are higher or wool prices are lower than was examined in this analysis. The MIDAS optimisation of the feed budget backs the management decisions made in the trial and identified that the optimum stocking rate of the Coopworth genotype is 3-4 ewes/ha lower than for a merino genotype mated to a terminal sire.

References

Young J, Bathgate A, Saul G, Clark S, Sanford P, Friend M (2004) MIDAS Insights on profitably utilising perennial plants in Hamilton, Victoria. Report to the CRC for Plant Based Solutions to Dryland Salinity. 28 August 2004

Young JM & Behrendt R (2010) Validating the EverGraze pre-experimental MIDAS modelling. Annual Report to Future Farm Industries CRC.

Young J.M., Thompson A.N. and Kennedy A.J. (2009). *Anim. Prod. Sci.* **50**: 748