SHEEP AND BEEF CATTLE HEALTH AND PRODUCTION MANAGEMENT SERVICE

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HAMILTON EVERGRAZE PROOF SITE:

IMPACT OF CHANGING MANAGEMENT REGIMES ON PROFITABILITY

FINAL REPORT

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Background

The experiment at the Hamilton Proof site at PVI was conducted by EverGraze between 2006 and 2010. The 'Standard' livestock enterprise run at the site was a Merino ewe joined to a Terminal ram. The second system run at the site was a Composite ewe joined to Terminal ram. In addition, the 2 livestock systems were both run on the following 2 pasture systems (i) Perennial ryegrass system – PRG - (3 cultivars of ryegrass in different parts of the landscape – Fitzroy, Avalon, and Banquet) or (ii) Triple System (3 species in different parts of the landscape – Sardi 7 lucerne, Avalon PRG and Quantum tall fescue). For these 4 systems, several simulations were conducted to evaluate the impact of changing prices, different seasonal conditions, and changing management (allocation of green feed in summer, lambing time, stocking rate). Three alternative livestock systems were also evaluated. They were a self-replacing Merino flock, a self-replacing composite ewe enterprise and a self-replacing beef herd. All simulations are described in Table 1.

Methods: GrassGro version 3.1.3 was used. Simulated data was compared with actual experimental data in 2006 to validate the Standard system prior to investigating alternative management options or livestock enterprises. All simulations were run over 40 years from 1970 to 2009. Enterprise details and management operations are summarised in Table 1. Ewe conception rates were adjusted to give similar weaning percentages to that achieved at Hamilton. That is, around 90% for Merino ewes and around 140% for adult composite ewes (note actual Hamilton weaning % were slightly higher as non-pregnant ewes were removed from mobs). Merino ewe systems used a ewe genotype weighing 55 kg and producing 5.5 kg of 21 micron wool. Composite ewe systems used a ewe genotype weighing 65 kg and producing 4.0 kg of 33 micron wool. Ewes were purchased in all systems except the alternative self-replacing systems. The self-replacing beef herd consisted of August calving Angus cows (500 kg) selling calves as yearlings at 450 kg live-weight. Except for the stocking rate comparison, all simulations used a stocking rate of as near as possible to 30 DSE/ha (average annual) as used at the Hamilton experiment.

To simulate the Perennial ryegrass pasture systems a 990 ha 3 paddock farm was used with 330 ha of each perennial ryegrass cultivar. Legume content set at 30%. To simulate the Triple pasture systems a 990 ha 3 paddock farm was used with 330 ha of each perennial species. Legume content set at 30% for the perennial ryegrass and fescue pasture. Perennial ryegrass was added to the lucerne to approximate the winter growth rate observed at the Hamilton experiment. Soil depth was adjusted for each paddock in each system to simulate crest, slope, and valley position in the landscape. Soil, pasture type and standard price assumptions are shown in Appendix 1 and 2.

Table 1. Description of livestock systems simulated

	Join	Conception	Lamb/ calve	Wean	Sell lambs/ calves	Replace/ purchase	CFA (6-7 years)	Shear
Standard animal systems at standard, high and low prices - including different ewe replacement costs (both standard systems run on PRG and Triple pasture systems).								
Mer x T	1 Mar	70:30[A]	1 Aug	1 Dec	44 kg or by 14 Dec	1 Feb	20 Dec	15 Dec
Composite x T	1 Mar	10:90	1 Aug	1 Dec	44 kg or by 14 Dec	1 Feb	20 Dec	15 Dec
Changing lambing time								
Mer x T	3 Feb	80:20	1 Jul	1 Nov	44 kg or by 14 Dec	1 Jan	20 Dec	15 Dec
Mer x T	5 Apr	70:30	1 Sep	1 Jan	44 kg or by Jan 14	1 Feb	20 Jan	15 Jan
Different stocking rates: 12-18 ewes/ha								
Mer x T	1 Mar	70:30	1 Aug	1 Dec	44 kg or by 14 Dec	1 Feb	20 Dec	15 Dec
Standard system (Mer x T) also run under different seasonal conditions (dry autumn, dry spring)								
Alternative livestock systems								
SR Merino	5 Apr	70:30	1 Sept	1 Dec	16 mths	20 Dec	20 Dec	15 Dec (weaners also shorn)
SR Composite	1 Mar	10:90	1 Aug	1 Dec	44 kg or by 14 Dec	20 Dec	20 Dec	15 Dec (weaners also shorn)
SR Beef	22 Oct	95%	1 Aug	15 Feb	450 kg or 1 Jan	21 Oct	16 Feb (9-10 yrs)	-

[A]Conception rates are percent of ewes with single or twin pregnancies

Mer x T – Merino ewes mated to White Suffolk rams; ewes purchased

Comp x T – Composite ewes mated to White Suffolk rams; ewes purchased

SR – self-replacing Merino; wether and excess ewe lambs sold at 16 mths (20 Dec)

Validation

Pasture growth data from the Hamilton site from 2006-2009 was used to validate the pasture growth data generated by GrassGro over the same time period. Since the full range of pasture species used in the experiment are not parameterised in GrassGro, pasture species root depth and soil depth was fine-tuned for each part of the landscape (Crest, mid-slope, Valley) to match as closely as possible the actual Hamilton site data. A relatively good fit was achieved between the modelled ryegrass cultivars and the actual data (Figure 1) as was for the lucerne and fescue cultivars (Figure 2). Average annual pasture production (tDM/ha) was similar for all modelled cultivars and the actual data (Appendix 2). After this validation, the performance of the animal enterprises could be modelled with confidence over the 40 year period.

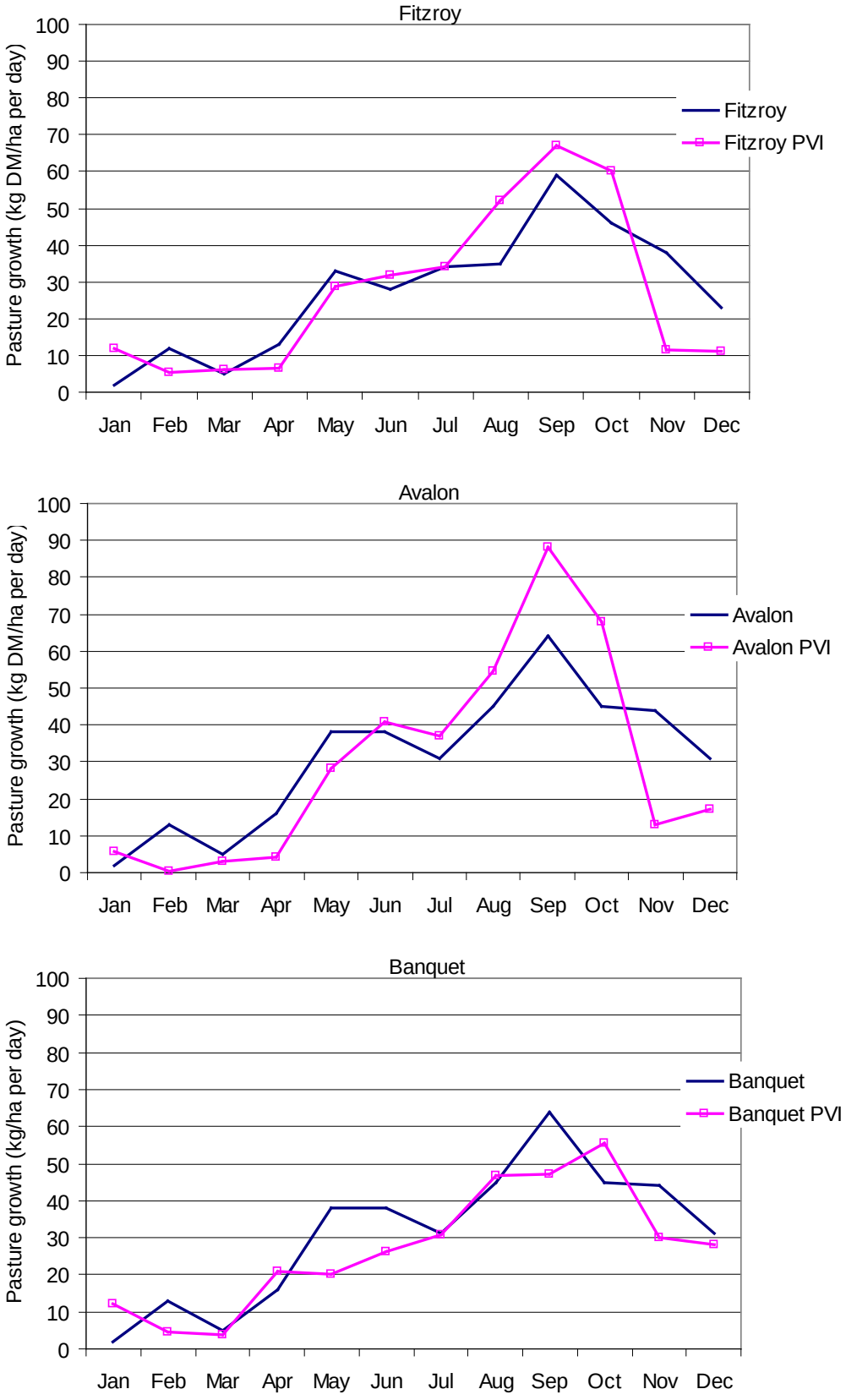

Figure 1. Comparison of GrassGro simulated perennial ryegrass pastures with actual growth data from Hamilton (2006-2009).

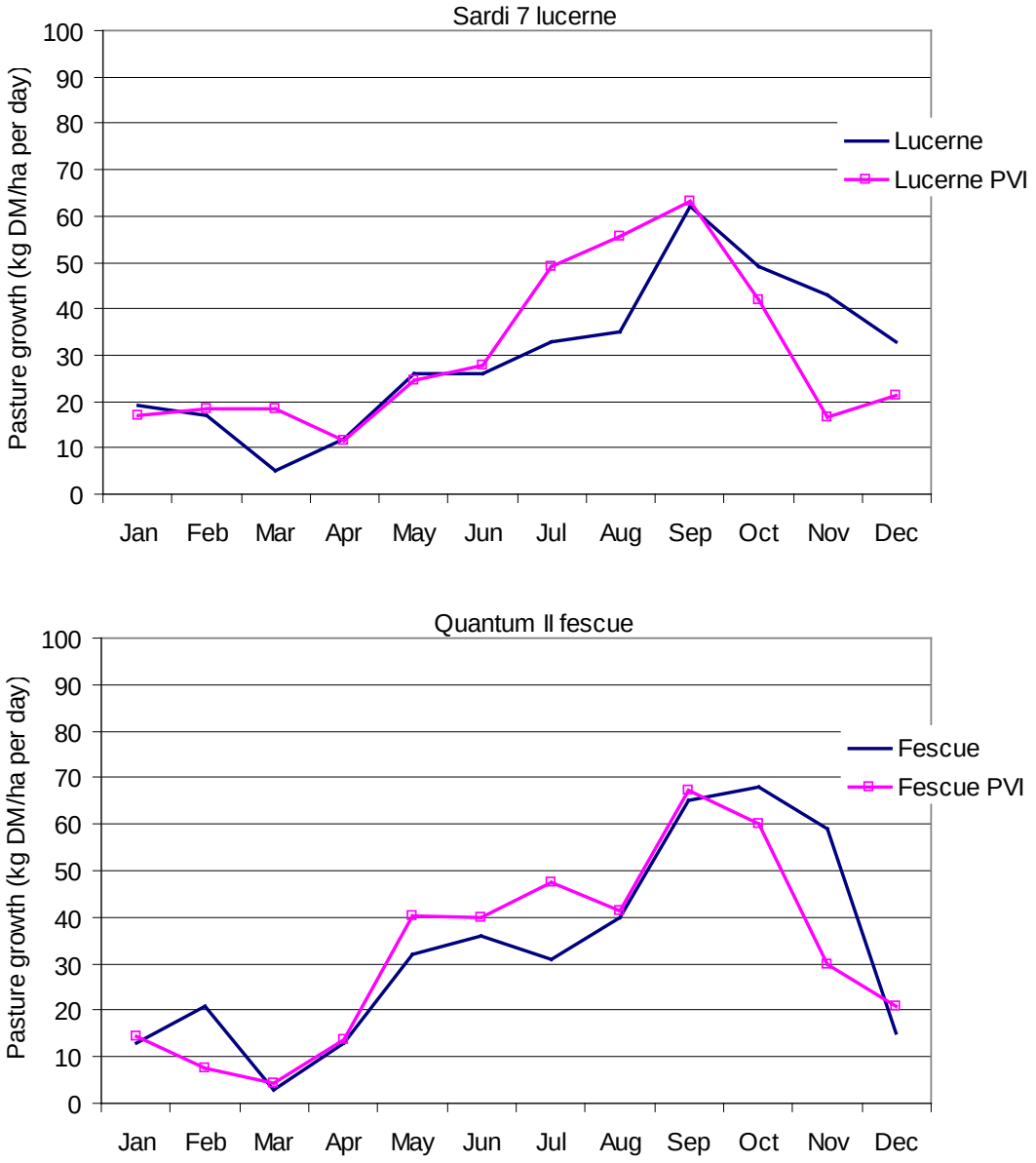

Figure 2. Comparison of GrassGro simulated lucerne and fescue pastures with actual growth data from Hamilton (2006-2009).

Results

1. Comparison of Standard systems with standard, low and high prices.

At standard prices and on perennial ryegrass pastures, the August lambing Merino x Terminal system was slightly less profitable than the Composite x terminal system with a difference in gross margin of $-27/ha (Table 2). Total income ($/ha) was actually higher for the Merino x Terminal system but costs ($/ha) were slightly higher as more ewes/ha had to be run to achieve the same grazing pressure (DSE/ha) as the Composite x terminal system. The variability in gross margin across the 40 years appeared to be similar for both sheep enterprises (Figure 3).

Adding summer active species (lucerne and fescue) to the pasture base in the TRIPLE system had a small impact on the mean gross margin for both enterprises (Table 2). The mean gross margin increased by $16/ha and $24/ha, for Merino x T and Composite x T, respectively. This increase in gross margin was due to savings in supplementary feed for the ewes for both enterprises. The probability of having to feed ewes greater than 30 kg/head per year was only 1 in 20 years compared with 3 in 20 years for the PRG system. The TRIPLE system had the impact of reducing the variation in gross margin over the 40 years relative to that for the PRG system (Figure 3).

The summer-active species did not increase lamb turn-off weights as lambs were sold off in mid-December so there were none on hand to make use of any summer green feed. Lambs in the PRG system were able to grow well on the quantity and quality of pasture available in spring.

Lucerne reduced deep drainage on the crest by 60 mm/year compared with the Fitzroy ryegrass. The tall fescue reduced deep drainage on the valley by 20mm/year compared with the Banquet ryegrass (Table 2).

Table 2. Profitability, productivity and risk of Standard systems - Merino x Terminal and Composite x Terminal (August lambing) - on PRG or TRIPLE pasture system at standard prices.

	PRG system		TRIPLE system	
	Mer x Term	Comp x Term	Mer x Term	Comp x Term
stock rate (ewes/ha)	**16.0**	**11.8**	**16.0**	**11.8**
stock rate (DSE/ha 15 Jul)	27.8	25.0	27.1	24.6
Mean annual stock rate (DSE/ha)	**30.4**	**30.3**	**30.6**	**30.4**
Mean Gross margin ($/ha)	928	955	944	979
GM lower ; upper deciles	727 ; 1071	739 ; 1086	781 ;1076	846 ;1105
$/ha per 100 mm rainfall	*138.71*	*142.75*	*141.11*	*146.34*
$/DSE	*30.53*	*31.52*	*30.85*	*32.20*
Wean %	88	138	89	140
clean wool produced (kg/ha)	71	39	71	40
lamb sold (LWT kg/ha)	570	714	569	715
total meat sold (kg/ha)	772	886	770	885
avg wth lamb sale wt (kg LWT)	43.2	46.5	42.8	46.2
avg ewe lamb sale wt (kg LWT)	39.0	42.2	38.7	41.7
wool income ($/ha)	419	91	420	91
Sale income lambs ($/ha)	1072	1401	1065	1405
Sale income CFA ($/ha)	187	159	187	158
total income ($/ha)	1678	1651	1672	1654
total costs ($/ha)	750	696	728	675
Supp feed ($/ha)	52	50	30	28
Supp feed (kg/ewe)	9.8	12.3	5.7	7.12
Supp feed ($/ewe)	$2.94	$3.69	$1.71	$2.14
% income meat	75	94	75	94
% income wool	25	6	25	6
Prob feed >30kg/ewe (years)	*0.15*	*0.15*	*0.05*	*0.05*
Prob < 800 kg DM March				
Fitzroy vs lucerne	*0.03*	*0.03*	*0*	*0*
Avalon	*0.01*	*0.02*	*0.02*	*0.02*
Banquet vs fescue	*0.01*	*0.05*	*0.01*	*0.02*
Prob < 800 kg DM April				
Fitzroy vs lucerne	*0.02*	*0.09*	*0*	*0*
Avalon	*0.05*	*0.05*	*0.02*	*0.02*
Banquet vs fescue	*0.15*	*0.20*	*0.05*	*0.05*
Utilisation (%)	67	67	64	63
Total pasture grown (t DM/ha)	12.9	12.9	13.8	13.9
Pasture grown Dec-Apr (t DM/ha)	2.8	2.8	3.3	3.3
Drainage below root zone avg/yr (mm)				
Fitzroy vs lucerne	129	129	65	64
Avalon	134	134	134	134
Banquet vs fescue	94	94	76	77

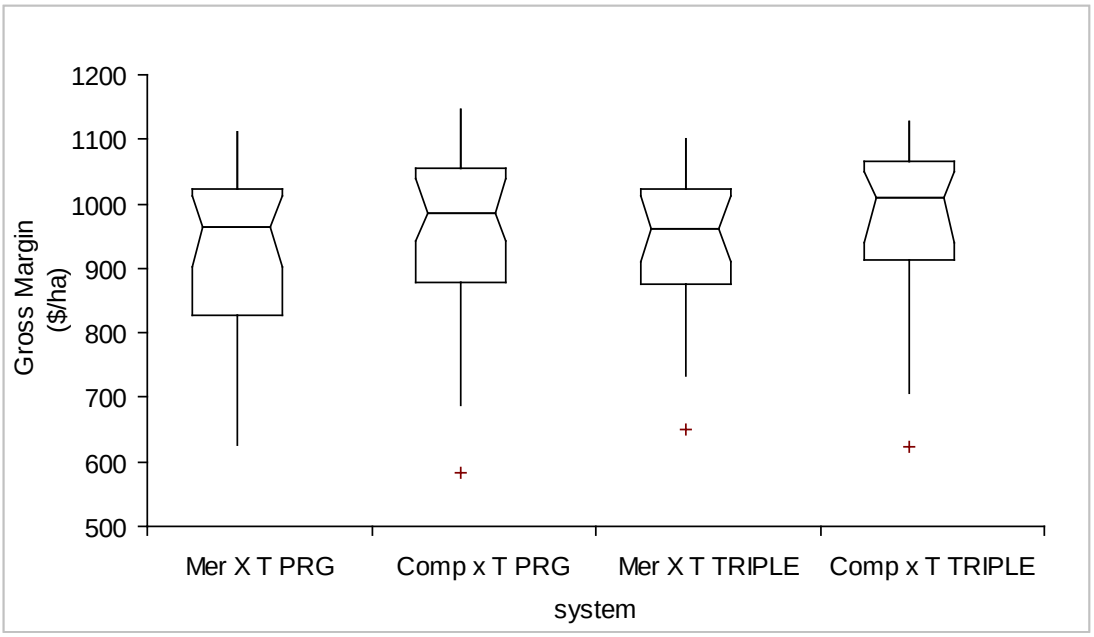

Figure 3. Box pots of the Merino x Terminal and Composite X Terminal on PRG or TRIPLE pasture system with standard prices. Boxplots represent median, range and interquartile range, x indicates outliers and o indicates extreme values.

A 30% increase or decrease in wool and sheep prices (meat, skins, replacement ewes) had a similar effect on the Merino x Terminal enterprise and the Composite x Terminal enterprise (Table 3; Figure 4). Gross margins increased by around 40% at the higher prices and dropped by around 40% at the lower prices. The impact was the same for both pasture systems.

Table 3. Gross margin mean, median, range and lower and upper deciles for standard systems on PRG or TRIPLE pasture systems, at standard and +/- 30% prices for wool and meat.

	PRG		TRIPLE	
	Mer x Term	**Comp X Term**	**Mer x Term**	**Comp X Term**
Standard prices				
Mean Gross margin ($/ha)	928	955	944	979
Median	963	984	960	1009
lower range	625	690	732	710
upper range	1110	1150	1100	1120
lower decile	727	739	781	846
upper decile	1071	1086	1076	1104
30% lower prices				
Mean Gross margin ($/ha)	529	551	547	574
Median	560	582	565	597
lower range	262	311	390	330
upper range	660	690	660	680
lower decile	353	378	421	456
upper decile	643	654	644	666
30% higher prices				
Mean Gross margin ($/ha)	1306	1312	1321	1337
Median	1341	1339	1345	1366
lower range	973	1000	970	1040
upper range	1510	1550	1510	1510
lower decile	1076	1066	1155	1177
upper decile	1477	1466	1483	1488

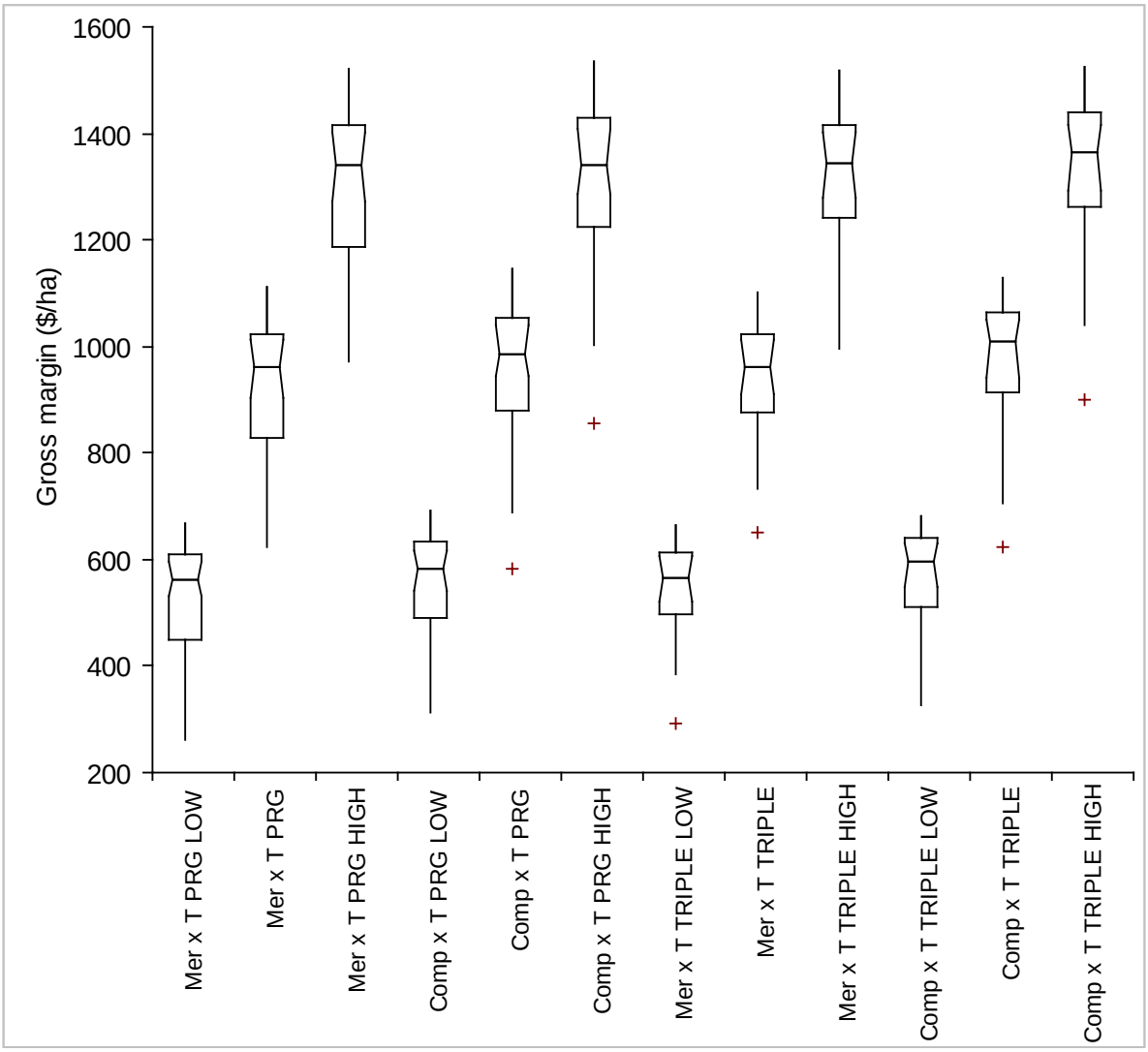

Figure 4. Boxpots of the Merino x Terminal and Composite x Terminal on PRG or TRIPLE pasture sytems at low (-30%) standard and high (+30%) sheep and wool prices. Boxplots represent median, range and interquartile range, x indicates outliers and o indicates extreme values.

2.Different seasonal conditions

The effect of dry conditions on the performance of the Merino x Terminal enterprise on the different pasture systems was investigated. For the 40 years simulated, the ten years with the lowest April to June rainfall and the ten years with the lowest September to November (inclusive) rainfall were selected to represent dry autumn and dry spring conditions. The rainfall in these years is shown in Table 4, and show that dry conditions at one end of the season is not, on average, associated with a large reduction at the other end of the season.

Dry autumn

For the PRG system there was very little difference in mean gross margin for the 10 years with dry autumn compared with the average 40 year gross margin (Table 6). The amount of supplements fed to ewes was slightly higher (11.5 kg/ewe vs 9.8 kg/ewe) but total lamb sold was also higher (584 vs 570 kg/ha). A similar result occurred with the TRIPLE system. The amount of supplements fed to ewes was slightly higher (7.5 kg/ewe vs 5.7 kg/ewe) than the 40 year average but total lamb sold was also higher (585 vs 569 kg/ha).

The median gross margin for the dry autumns was higher than the 40 year median for both pasture systems (Figure 6, Table 6).

Dry spring

The years with a dry spring had a larger negative impact on gross margins for both the PRG and TRIPLE systems than the years with dry autumns. Lamb sale weights were lower on both pasture systems than for the average years which reduced total lamb sold kg/ha by around 3%. Supplements fed to ewes increased by 45% and 70%, for the PRG and TRIPLE pasture systems, respectively. The TRIPLE system maintained the same small advantage in gross margin, compared with PRG, for the dry spring, dry autumn and average year due to slightly less supplementary feeding.

The median gross margin for the dry springs was lowers than the 40 year median for both pasture systems (Figure 6, Table 6).

Table 4. Mean annual, April-June and September-November rainfall (mm) in years with dry autumn, dry spring or average years (1970-2009)

Rainfall (mm) over	Average year	Years with Dry Autumn	Years with Dry spring
Whole year	669	599	552
Apr-June	176	**116**	155
Sep-Nov	187	172	**118**

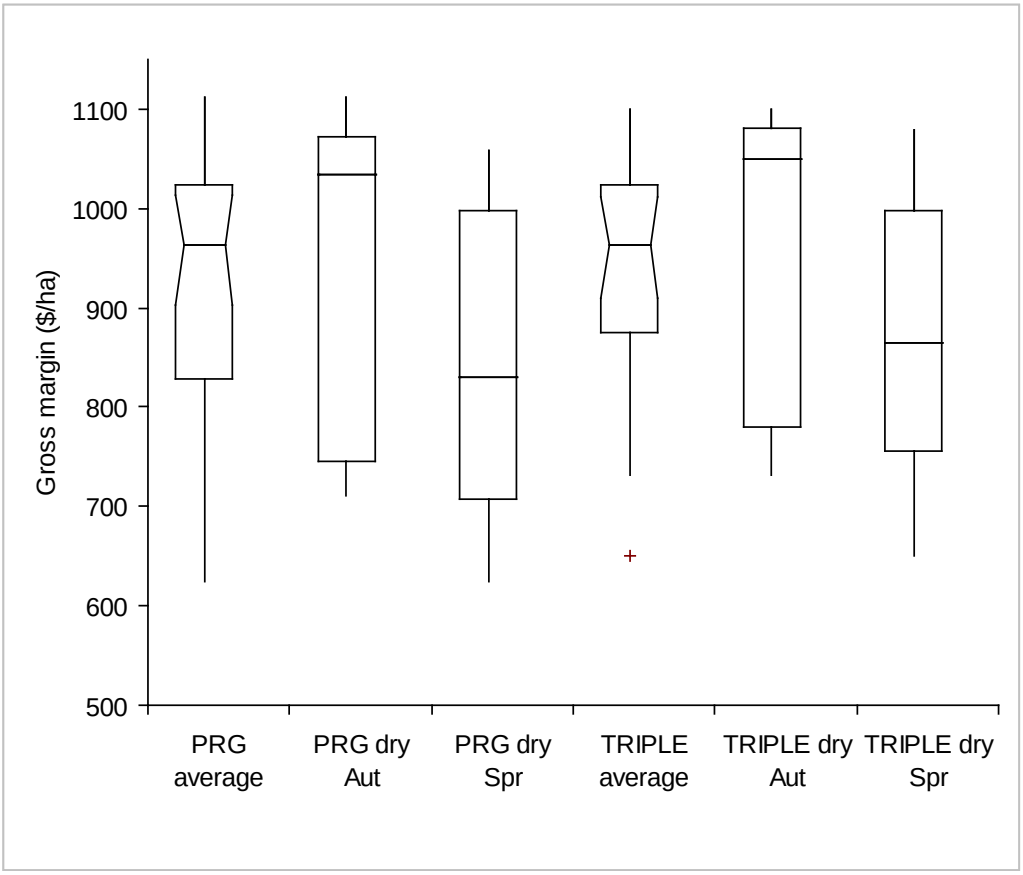

Figure 5. Boxplots of gross margins for the Merino x terminal (August lambing) system on PRG or TRIPLE pasture system in average year compared with years with a dry autumn or dry spring. Boxplots represent median, range and interquartile range, x indicates outliers and o indicates extreme values.

Table 6. The effect of dry autumn or dry spring conditions the Merino x terminal enterprise on the PRG or TRIPLE pasture systems

Parameter	Dry autumn		Dry spring	
	PRG	TRIPLE	PRG	TRIPLE
Mean Gross Margin ($/ha)	936	960	846	877
Median	1034	1049	831	864
Range				
lower	711	732	625	651
upper	1111	1100	1058	1079
Change in Gross margin from average year for the same pasture system (%)	**+ 1.0%**	**+ 2.0%**	**- 9.0%**	**- 7.0%**
Clean wool (kg/ha)	71	72	70	70
Sale wt wth lambs (kg LW)	42.1	41.9	41.5	41.5
Sale wt ewe lambs (kg LW)	38.2	38.0	37.7	37.6
Weight lamb sold (kg /ha)	584	585	548	552
Supplement (kg/ewe)	11.3	7.5	14.1	9.7
Total pasture grown (t DM/ha)	12.7	13.6	11.3	12.1
Pasture grown Dec-Apr (t DM/ha)	2.1	2.7	1.9	2.2

3. Different management decisions for Standard enterprise: Merino x Terminal

3a. Options for utilising green feed in summer-early autumn

With the standard livestock system modelled the lambs are all sold in mid-December or at 44 kg liveweight (which ever occurs first). In years when there is adequate summer rain, pasture grown after lambs are sold will be utilised by the ewes. The question that arises is – *"is grazing the ewes on the green pasture the best way to utilise the summer feed or should lambs be kept on for longer to reach heavier sale weights"?*

The impact of ewes eating the green pasture (in the years this occurs) is already partially taken account of in GrassGro. Ewes with better nutrition over summer will be in better condition at joining and will have slightly higher weaning rates. The benefit that is not accounted for in GrassGro is any impact the green feed might have on flushing ewes – increasing ovulation rates – prior to joining.

In order to answer this question, the probability of having significant amount of green feed over summer that could contribute to finishing lambs or be useful for flushing ewes, was analysed. For lambs to continue to grow at a rate of at least 80-100g/day more than 500 kg DM/ha of available green pasture is required. For ewes, as little as 200 kg DM/ha of green pasture is required 2 weeks prior to joining to have a flushing effect.

The percentiles for the amount of green pasture available in January, February or March are shown in Figure 6 for the PRG and Figure 7 for the TRIPLE pasture systems. The probability of having adequate green pasture for different purpose is summarised in Table 7. Note, these

probabilities have been generated assuming lambs are sold in mid December. Keeping lambs on for different time periods will alter these probabilities.

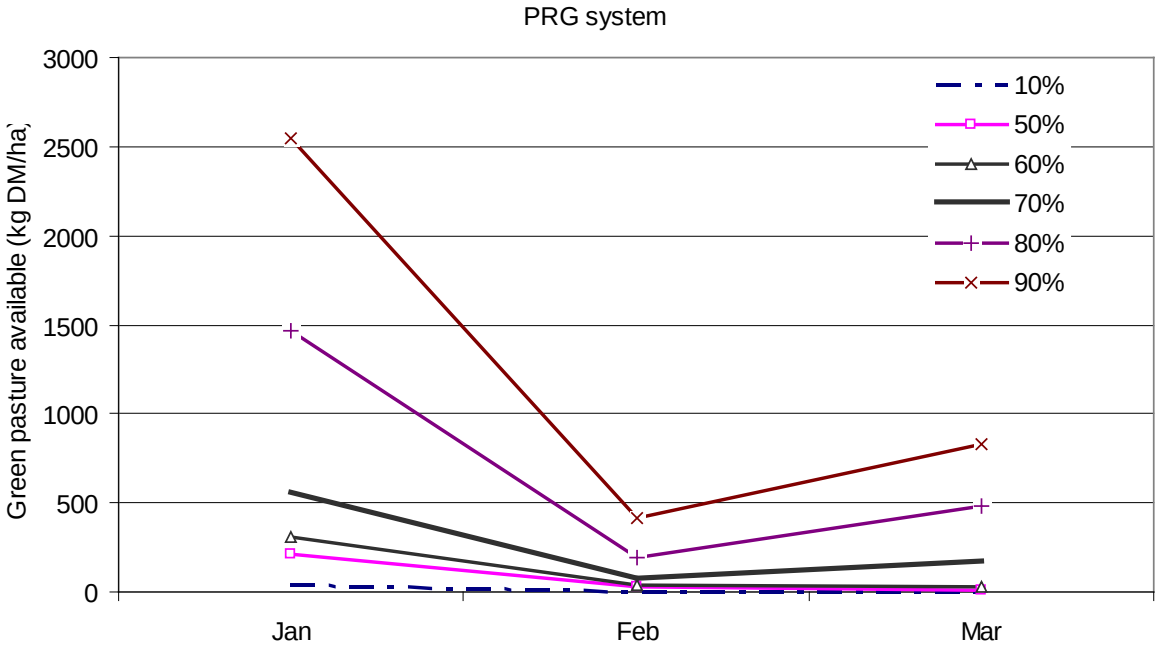

Figure 6. Percentiles for green pasture availability (kg DM/ha) in summer for the PRG pasture system if lambs are sold in mid December.

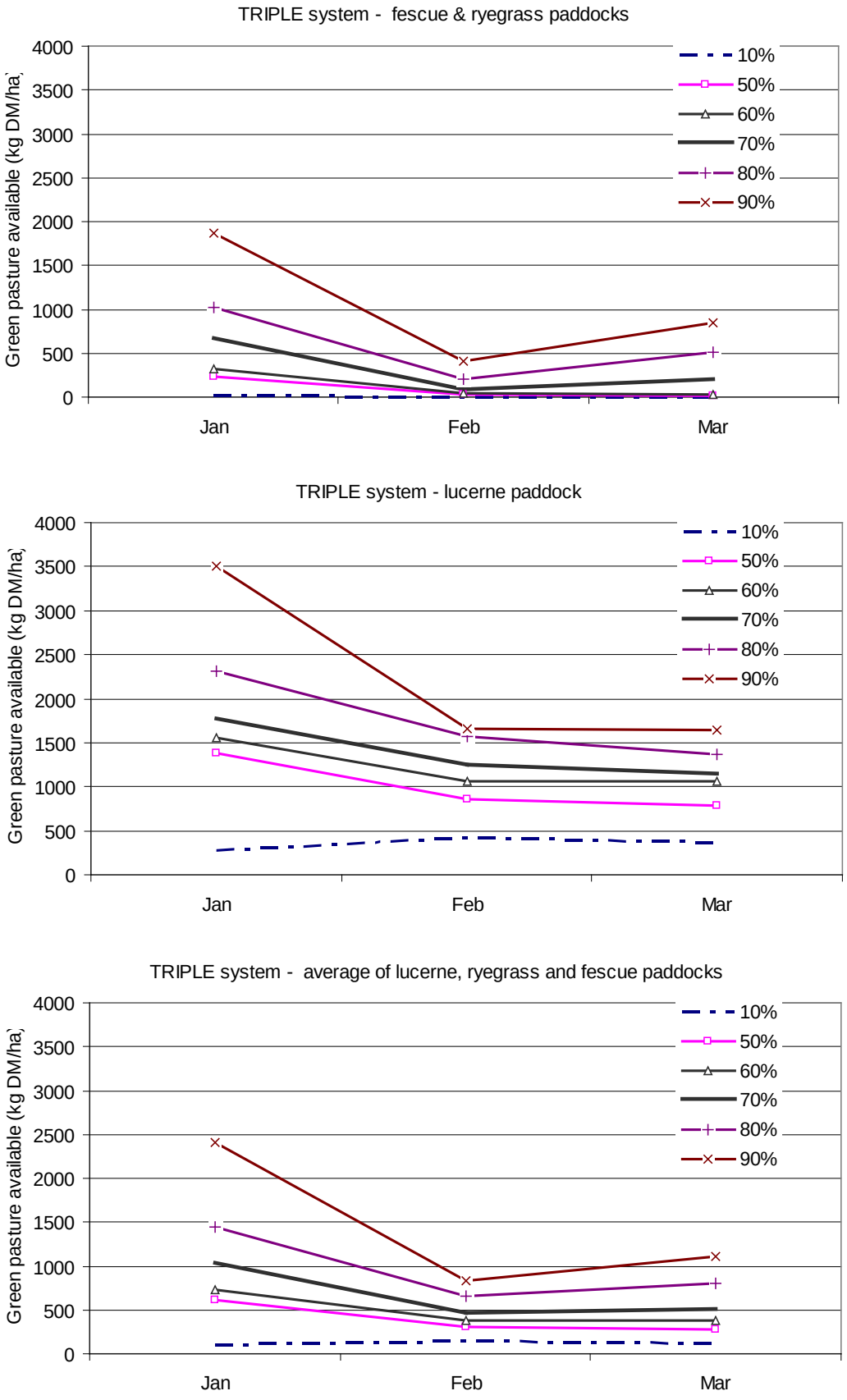

Figure 7. Percentiles for green pasture availability (kg DM/ha) in summer for the TRIPLE pasture system and its component pastures in different parts of the landscape if lambs are sold in mid December.

Table 7. Probability of having adequate green pasture over summer for finishing lambs or flushing ewes (probabilities generated using lamb sell date of mid Dec)

Amount of green pasture required	mid –late Dec	January	February	March
	PRG system			
Finish lambs >500 kg DM/ha	34/39 years	11/39 years	2/39 years	6/39 years
Flush ewes > 200 kg DM/ha	-	-	8/39 years	12/39 years
TRIPLE system				
Finish lambs >500 kg DM/ha	37/39 years	23/39 years	13/39 years	13/39 years
Flush ewes > 200 kg DM/ha	-	-	31/39 years	30/39 years

On the PRG system, if lambs are sold in mid December, there will be adequate green feed in late February-early March to flush ewes 8/39-12/39 years or 1 in 4 years for no cost (Table 7). Lambs could easily be kept until the end of December in most years (34/39). In 11/39 years it would be worthwhile keeping lambs until the end of January but lambs could only be kept on until end of February in 2/39 years. Although there might be enough feed for lambs in March 6/39 years, since only 2/39 years in February would be suitable this would limit a March turn-off to 2/39 years. So for most years there would be little benefit carrying over lambs past late January, hence there would be no competition with the ewes for any green pasture later on. *NOTE the economics of grain feeding lambs when there is inadequate pasture is not the focus of this analysis.*

On the TRIPLE system, if lambs are sold in mid December, there will be adequate green feed in late February-early March to flush ewes 30-31/39 years or 8 in 10 years for no cost (Table 7). As with the PRG system, lambs could easily be kept until the end of December in most years. However, on the TRIPLE system there is a much higher probability of having enough green geed to be able to keep lambs on until January and February to reach higher weights than on the PRG system. The higher probability of having extra green feed in the TRIPLE system from January -March is mainly due to the contribution of the lucerne paddock (Figure 7). The fescue and ryegrass paddocks in the TRIPLE system provide a similar amount of green feed as the PRG system over this time period (Figure 6). However, as all stock (ewes & lambs) have to graze the 3 paddocks in a rotation, the average amount of green pasture available across the 3 paddocks has been used to derive the probabilities shown in Table 7.

The inclusion of lucerne in the farm system does not allow the opportunity to carry over lambs every year. This is for 2 reasons; it can't grow much in very dry years/drought (e.g. 1983, 2006-2008) and even in average years the one paddock (1/3 farm) in lucerne cannot provide enough green feed.

PRG system:

The summer of 1970/1971 was identified as a year when the there was greater than 500 kg DM/ha green pasture available in December, January, February and March. The impact of selling lambs by mid December versus keeping them for longer periods was investigated for this year (Table 8). To do this, GrassGro was run from 1970 to 1971 with the new lamb selling option. Data for the financial year 1st July 1971- 30th June 1971 is shown in Table 8 to allow for lambs being carried over into the new calendar year.

For this year, keeping lambs for longer to reach heavier sale weights was more profitable than the standard selling time. Increases in gross margin ranged from $191/ha to $276/ha. There was minimal benefit holding lambs past the end of February. The amount of pasture dropped below 600 kg DM/ha in March producing relatively small increases in lamb growth and turn-off weights. There was no penalty for the ewes in 1971 as there was still adequate green feed available in the 2 weeks prior to joining (19 February- 5 March) to be able to flush them.

The additional value of any flushing effect on the ewes also need to be factored in. Assuming flushing results in an extra 10% lambs (10 lambs per 100 ewes) conceived and 6% of these lambs survive to marking/weaning, this would equate to an extra 1 lamb/ha (16 ewes/ha X 0.06) to sell. If the lamb received $70/head (net of costs) then this is an extra $70/ha that could be added onto the gross margin for the next financial year.

Table 8. Effect of changing lamb selling date on Gross Margin for PRG system in a year with a high level of green feed in summer (1970-1971).

	Lamb selling date			
	mid Dec/44kg (standard)	end January	end February	end March
Average annual stocking rate (DSE/ha) 1970/71	31.7	34.5	36.1	37.2
mean Gross margin ($/ha) 1970/71	**921**	**1112**	**1186**	**1197**
Extra $/ha 1970/71	**-**	*191*	*265*	*276*
Wean % 1970	78	78	78	78
1971	87	87	86	86
Wth lamb sale wt (kg LWT)	44.2	52.2	56.5	57.5
Ewe lamb sale wt (kg LWT)	39.9	45.7	49.0	49.6
Green pasture available (kg DM/ha) pre-joining:	969	768	757	757

TRIPLE system

As for the PRG analysis, the summer of 1970/1971 was used to look the impact of selling lambs by mid December versus keeping them for longer (Table 9).

For this year, keeping lambs for longer to reach heavier sale weights was more profitable than the standard selling time. Increases in gross margin ranged from $194/ha to $281/ha. There was minimal benefit holding lambs past the end of February. The amount of pasture dropped below 800 kg DM/ha and digestibility dropped below 70 % in March producing relatively small increases in lamb growth and turn-off weights. There was no penalty for the ewes in 1971 as there was still adequate green feed available in the 2 weeks prior to joining (19 February- 5 March) to be able to flush them.

Since the base stocking rate (16 ewes/ha) is the same for the TRIPLE system as for the PRG system, the additional value of any flushing effect on the ewes could result in an extra $70/ha gross margin in the following financial year (1971/72).

Table 9. Effect of changing lamb selling date on Gross Margin for TRIPLE system in years with high levels of green feed in summer (1970-1971).

	Lamb selling date			
	mid Dec/44kg (standard)	end January	end February	end March
Average annual stocking rate (DSE/ha) 1970/71	31.7	34.6	36.2	37.5
mean Gross margin ($/ha) 1970/71	**977**	**1171**	**1240**	**1258**
Extra $/ha 1970/71	-	*194*	*263*	*281*
Wean % 1970 1971	80 87	79 87	78 86	78 86
Wth lamb sale wt (kg LWT)	43.8	52.3	56.9	58.3
Ewe lamb sale wt (kg LWT)	39.5	45.6	49.3	50.2
Green pasture available (kg DM/ha) pre-joining:	1171	1218	1000	992

In years when there is summer rain/good profile moisture to enable pasture to grow beyond late December, there is the opportunity to carry over lambs to higher weights (if this is not detrimental to meeting lamb specifications /marketing arrangements) on both pasture systems.

Note – this increases the overall stocking rate but in years with surplus feed this is a good way of increasing pasture utilisation.

The addition of lucerne to the system increased the number of years when lambs could be carried over and could still have adequate green feed to flush ewes. For both systems, in years when the amount of summer green pasture drops below 500 kg DM/ha it would seem more economic to sell the lambs when their growth rates declined to minimal levels. If this is done, this increases the probability of having adequate green feed to flush ewes to the levels indicated in Table 7.

In practice in a good season, for a lamb producer to decide which path to follow – sell lambs at normal date/ maximise green feed for ewes versus keep lambs – this could only be done after doing a feed budget (coupled with knowledge of soil moisture) and a partial budget at the time. Pasture availabilities, ewe condition and lamb growth rates would have to be monitored to give the complete picture and to fine-tune lamb sell date. An example of how a feed budget and partial budget can be used to make a decision is shown in Appendix 3.

3b. Changing lambing time for Standard Merino x Terminal enterprise.

Changing time of lambing from 1st August to 1st July (sell lambs @44kg/mid Dec) or 1st September (sell lambs @44kg/mid Jan) was analysed for the Merino X Terminal enterprise. Stocking rate (ewes/ha) was adjusted to keep the average annual grazing pressure similar.

July lambing was more profitable than August lambing with September lambing having the lowest mean gross margin (Table 10). Income was greater for the July lambing due to selling older lambs with higher sale weights leading to higher meat income $/ha - even though there were slightly less ewes run per ha which reduced wool income per ha. The September lambing sold lambs in mid January – a time when feed quality was declining – which led to lower lamb sale weights even though lambs were the same age at sale as August born lambs. Total costs ($/ha) were similar for all 3 lambing times. Supplementary feed cost ($/ewe & $/ha) were highest for the July lambing. Maintenance supplementary feed costs ($/ewe) were slightly higher for the September lambing than the August lambing, as lambs competed with ewes for feed in late December/early January.

Median gross margins were higher for the July lambing than for August or September lambing, but the August lambing had less variation in gross margin across the 40 years (Figure 8). For the July lambing, the higher and more variable level of supplementary feeding was responsible for the greater variation in gross margins while for the September lambing this was driven by lower and more variable lamb turn-off weights.

Table 10. The effect of changing lambing time for Merino x Terminal systems with PRG pasture base.

Lamb date		1st August	1st July	1st Sept
stock rate (ewes/ha)		**16.0**	**15.6**	**15.9**
stock rate (DSE/ha 15 Jul)		27.8	41.0	26.3
Mean annual stock rate (DSE/ha)		**30.4**	**30.3**	**30.3**
Mean Gross margin ($/ha)		**928**	**993**	**825**
GM lower ; upper deciles				
$/ha per 100 mm rainfall		*138.71*	*148.43*	123.32
$/DSE		*30.53*	*32.77*	27.23
Wean %		88	89	87
clean wool produced (kg/ha)		71	68	73
lamb sold (LWT kg/ha)		570	599	526
total meat sold (kg/ha)		772	795	721
avg wth lamb sale wt (kgLWT)		43.2	44.1	39.7
avg ewe lamb sale wt (kg LWT)		39.0	43.7	36.3
wool income ($/ha)		419	400	428
Sale income lambs ($/ha)		1072	1181	965
Sale income CFA ($/ha)		187	182	181
total income ($/ha)		1678	1763	1574
total costs ($/ha)		750	770	750
Supp feed ($/ha)		52	81	60
Supp feed (kg/ewe)		9.8	15.3	11.1
Supp feed ($/ewe)		$2.94	$4.59	$3.33
% income meat		75	77	73
% income wool		25	23	27
Prob feed >30kg/ewe (years)		*0.15*	*0.22*	*0.20*
Prob < 800 kg DM March				
	Fitzroy	*0.03*	*0.03*	*0.08*
	Avalon	*0.01*	*0.07*	*0.05*
	Banquet	*0.01*	*0.05*	*0.08*
Prob < 800 kg DM April			*0.11*	*0.30*
	Fitzroy	*0.02*	*0.06*	*0.08*
	Avalon	*0.05*	*0.20*	*0.30*
	Banquet	*0.15*	*0.03*	*0.08*
Utilisation (%)		67	65	68
Total pasture grown (t DM/ha)		12.9	12.9	12.8
Drainage below root zone avg/yr (mm)				
	Fitzroy	129	129	130
	Avalon	134	134	135
	Banquet	94	94	94

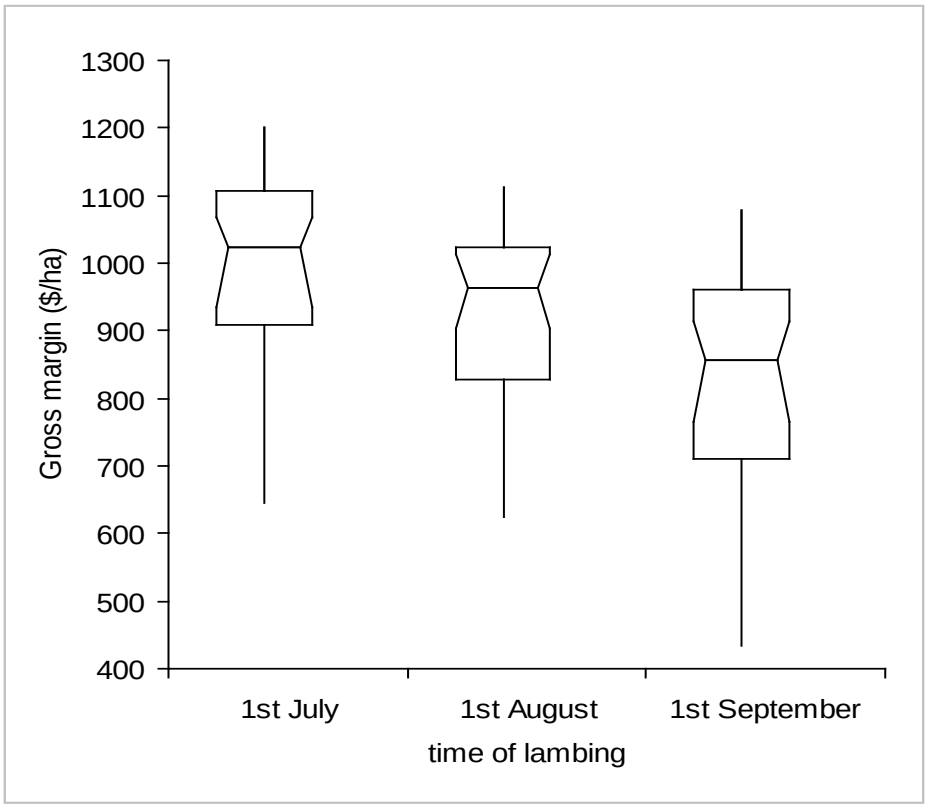

Figure 8. Box plots for gross margins for time of lambing for the Merino x Terminal enterprise on the PRG pasture system. Box plots represent median, range and interquartile range, x indicates outliers and o indicates extreme values.

3c. Changing stocking rate for standard systems.

The impact of stocking rates on profitability and sustainability was investigated for the Merino x Terminal enterprise on the PRG pasture system. Stocking rates of between 12 and 22 ewes/ha were used.

Mean gross margins continued to increase above the standard stocking rate of 16 ewes/ha up to 20 ewes/ha but declined after that point (Table 11). Although total income (mainly due to extra meat income) increased up to a stocking rate of 22 ewes/ha, the escalating feed costs were responsible for reducing gross margins at that point.

The probability of falling below a critical pasture mass of around 800 kg DM/ha (total) also increased to unacceptable levels for the 2 highest stocking rates simulated (Table 11). Drainage below the root zone also increase with stocking rate indicating plant growth/root growth was being compromised.

The variability in gross margins increased as stocking rate increased –particularly above 18 ewes/ha. This indicates increasing risk as stocking rate is increased (Figure 9). At 18 ewes/ha, the downside risk (lower range of box plots) was no worse than at 16 ewes/ha, but the median and upper range in gross margin was higher. At 20 ewes/ha, the median gross margin was no better than for 16 ewes/ha.

Table 11. Mean gross margin of Merino x Terminal (August lambing) system on the PRG system at different stocking rates.

	Stocking rate (ewes/ha)					
	12	**14**	**16**	**18**	**20**	**22**
stock rate (DSE/ha 15 Jul)	20.7	24.3	27.8	30.9	33.7	36.0
Mean annual stock rate (DSE/ha)	23.4	27.0	30.4	33.6	36.5	39.1
Mean Gross margin ($/ha)	**733**	**844**	**928**	**985**	**997**	**949**
GM lower ; upper deciles	651; 802	704;947	727;1071	674;1158	589;1276	426;1308
$/ha per 100 mm rainfall	109.57	126.16	*138.71*	147.23	149.03	141.85
$/DSE	31.32	31.26	*30.53*	29.32	27.32	24.27
Wean %	89	89	88	87	86	84
clean wool produced (kg/ha)	55	63	71	79	85	90
lamb sold (LWT kg/ha)	439	507	570	629	681	723
total meat sold (kg/ha)	593	685	772	853	926	987
avg wth lamb sale wt (kgLWT)	43.6	43.4	43.2	42.7	42.1	41.1
avg ewe lamb sale wt (kg LWT)	39.4	39.3	39.0	38.7	38.1	37.2
wool income ($/ha)	321	372	419	462	500	532
Sale income lambs ($/ha)	831	958	1072	1178	1274	1349
Sale income CFA ($/ha)	143	166	187	208	228	246
total income ($/ha)	1295	1495	1678	1849	2002	2127
total costs ($/ha)	562	651	750	863	1005	1178
Supp feed ($/ha)	10	26	52	94	164	267
Supp feed (kg/ewe)	2.5	5.4	9.8	15.5	24.3	35.7
Supp feed ($/ewe)	$0.75	$1.62	$2.94	$4.65	$7.29	$10.71
% income meat	75	75	75	75	75	75
% income wool	25	25	25	25	25	25
Prob feed >30kg/ewe (years)	*0*	*0.07*	*0.15*	*0.22*	*0.38*	*0.52*
Prob < 800 kg DM March						
Fitzroy	*0*	*0.02*	*0.03*	*0.05*	*0.12*	*0.30*
Avalon	*0*	*0.01*	*0.01*	*0.05*	*0.12*	*0.22*
Banquet	*0*	*0.01*	*0.01*	*0.08*	*0.08*	*0.48*
Prob < 800 kg DM April						
Fitzroy	*0*	*0.01*	*0.02*	*0.10*	*0.25*	*0.45*
Avalon	*0*	*0.01*	*0.05*	*0.10*	*0.15*	*0.28*
Banquet	*0*	*0.01*	*0.15*	*0.30*	*0.48*	*0.55*
Utilisation (%)	53	60	67	73	78	83
Total pasture grown (t DM/ha)	12.6	12.8	12.9	12.8	12.8	12.5
Drainage below root zone avg/yr (mm)						
Fitzroy	128	128	129	130	130	131
Avalon	133	134	134	135	135	136
Banquet	93	93	94	95	96	98

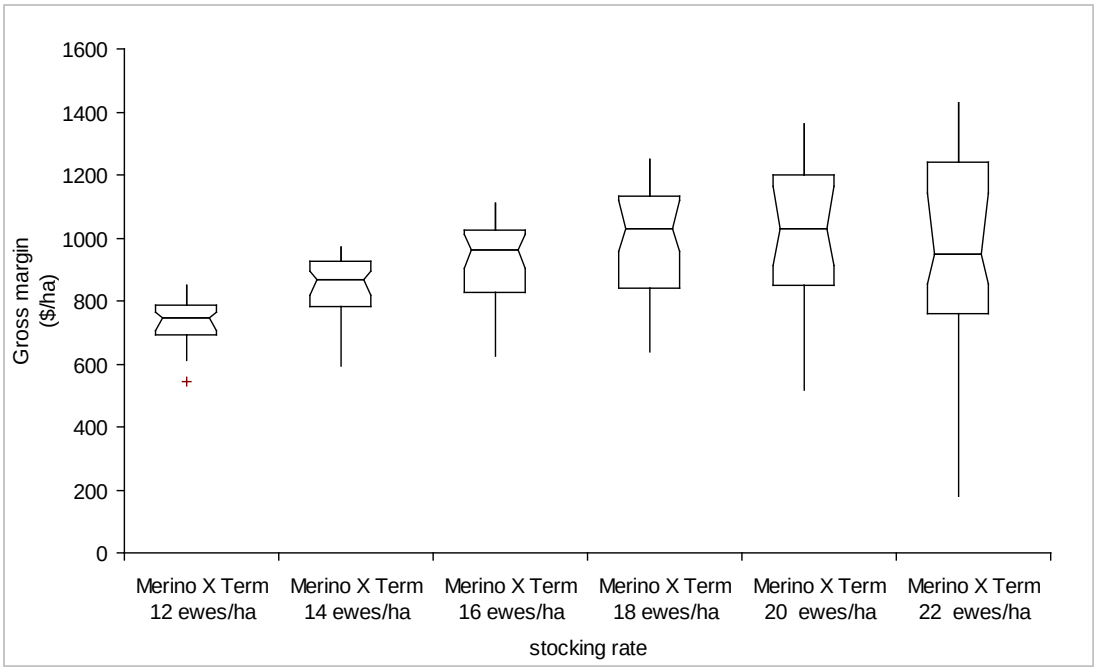

Figure 9 Box plots of gross margins ($/ha) at different stocking rates for the August lambing Merino x Terminal system on the PRG system. Boxplots represent median, range and interquartile range, x indicates outliers and o indicates extreme values.

3d. Optimising lambing time and time of sale for Standard Merino x Terminal enterprise on the TRIPLE pasture system.

Changing time of lambing from 1st August to 1st July (sell lambs @44kg/mid Dec) or 1st September (sell lambs @44kg/mid Jan) was analysed for the Merino X Terminal enterprise run on the TRIPLE pasture system. Stocking rate (ewes/ha) was adjusted to keep the average annual grazing pressure similar. The impact of selling September born lamb in February was investigated. In addition, the upper sustainable stocking rate was also investigated for the September lambing/ January sale date.

July lambing was more profitable than August lambing with September lambing having the lowest mean gross margin (Table 12). This was a similar trend to that obtained for the PRG system. Income was greater for the July lambing due to selling older lambs with higher sale weights leading to higher meat income $/ha - even though there were slightly less ewes run per ha which reduced wool income per ha. The September lambing sold lambs in mid January – a time when feed quality was declining – which led to lower lamb sale weights even though lambs were the same age at sale as August born lambs. Total costs ($/ha) were similar for all 3 lambing times. Supplementary feed cost ($/ewe & $/ha) were highest for the July lambing. Maintenance supplementary feed costs ($/ewe) were slightly higher for the September lambing than the August lambing, as lambs competed with ewes for feed in late December/early January.

Lambing in September and holding on to lambs until mid February to try and make better use of the lucerne was of no advantage to earlier lambing dates or lambing in September/selling in mid January. Lambing in September/selling in mid January but increasing the stocking rate to

the upper sustainable level had a slightly higher gross margin than other September options (Table 12).

Median gross margins were higher for the July lambing than for August or September lambing, but the August lambing had less variation in gross margin across the 40 years (Figure 10). For the July lambing, the higher and more variable level of supplementary feeding was responsible for the greater variation in gross margins while for the September lambing this was driven by lower and more variable lamb turn-off weights.

Table 12. The effect of changing lambing time for Merino x Terminal systems with TRIPLE pasture base.

Lamb date	1st Aug	1st July	1st Sept (sell Jan)	1st Sept (sell Feb)	1st Sept sell Jan/high stock
stock rate (ewes/ha)	**16.0**	14.8	16.2	15.5	**18.0**
stock rate (DSE/ha 15 Jul)	27.1	38	26.2	25.7	28.5
Mean annual stock rate (DSE/ha)	**30.6**	30.7	30.5	30.7	33.4
Mean Gross margin ($/ha)	**944**	**1080**	**872**	**886**	934
GM lower ; upper deciles	781;1076	874;1225	699;1017	645;1086	696; 1126
$/ha per 100 mm rainfall	141.11	161.43	130.34	132.44	139.61
$/DSE	30.85	35.18	28.59	28.86	27.96
Wean %	89	93	88	88	88
clean wool produced (kg/ha)	71	66	71	68	78
lamb sold (LWT kg/ha)	569	634	542	543	591
total meat sold (kg/ha)	770	818	741	734	810
avg wth lamb sale wt (kgLWT)	42.8	49.5	40.3	43	39.9
avg ewe lamb sale wt (kg LWT)	38.7	44.3	35.9	37.8	35.5
wool income ($/ha)	420	389	416	401	458
Sale income lambs ($/ha)	1065	1240	1000	1029	1088
Sale income CFA ($/ha)	187	172	185	177	204
total income ($/ha)	1672	1800	1602	1607	1750
total costs ($/ha)	728	720	730	722	815
Supp feed ($/ha)	30	51	28	43	49
Supp feed (kg/ewe)	5.7	10.0	4.8	6.8	7.6
Supp feed ($/ewe)	$1.71	$3.00	$1.44	75	$2.28
% income meat	75	78	74	75	74
% income wool	25	22	26	25	26
Prob feed >30kg/ewe (years)	*0.05*	*0.12*	*0*	*0.03*	*0.07*
Prob < 800 kg DM March					
Fescue	*0.00*	*0.01*	*0.01*	*0.02*	*0.05*
Avalon	*0.02*	*0.05*	*0.05*	*0.05*	*0.08*
Lucerne	*0.01*	*0.01*	*0.05*	*0.08*	*0.08*
Prob < 800 kg DM April					
Fescue	*0.00*	*0.01*	*0.02*	*0.02*	*0.05*
Avalon	*0.02*	*0.05*	*0.08*	*0.18*	*0.20*
Lucerne	*0.05*	*0.08*	*0.08*	*0.12*	*0.18*
Utilisation (%)	64	63	64	65	*69*
Total pasture grown (t DM/ha)	13.8	13.9	13.9	13.8	*13.9*
Drainage below root zone avg/yr(mm)					
Fescue	65	65	66	66	*67*
Avalon	134	135	135	135	*135*
Lucerne	76	75	76	75	*76*

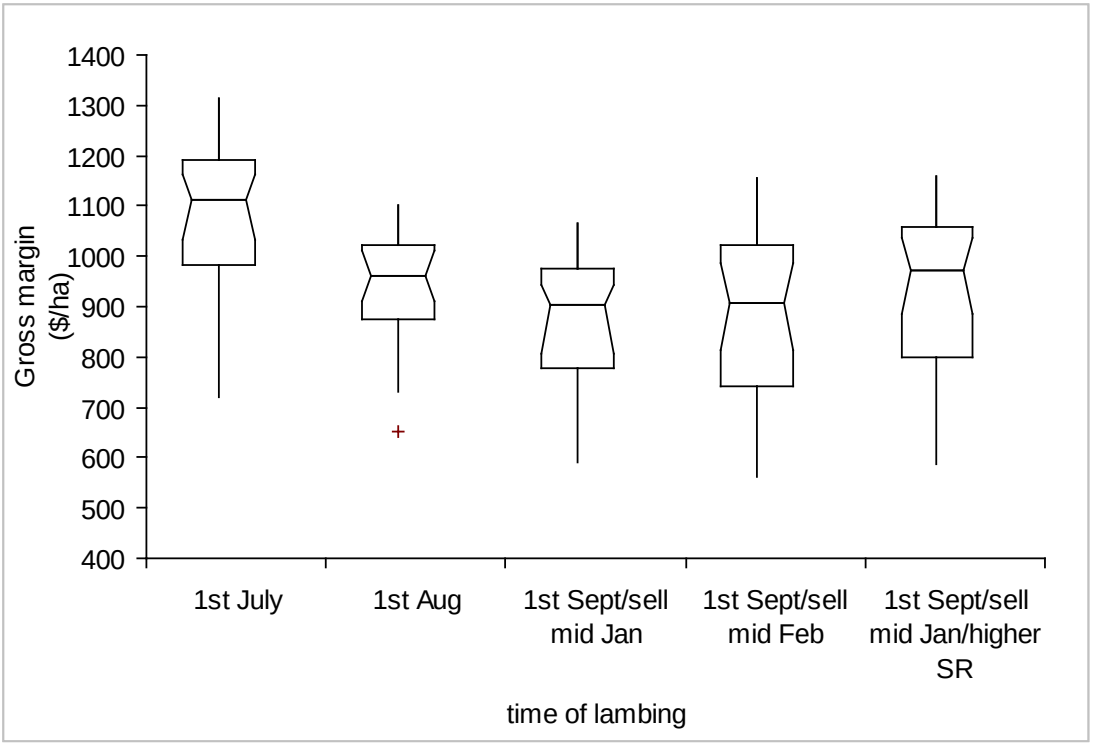

Figure 10. Box plots for gross margins for time of lambing for the Merino x Terminal enterprise on the TRIPLE pasture system. Box plots represent median, range and interquartile range, x indicates outliers and o indicates extreme values.

3e. Changing stocking rate for Merino x Terminal enterprise on the TRIPLE pasture system.

The impact of stocking rates on profitability and sustainability was investigated for the Merino x Terminal enterprise on the TRIPLE pasture system. Stocking rates of between 12 and 22 ewes/ha were used.

A similar trend was observed with gross margins on the TREIPLE pasture systems as for the PRG system. Mean gross margins continued to increase above the standard stocking rate of 16 ewes/ha up to 20 ewes/ha but declined after that point (Table 13). Although total income (mainly due to extra meat income) increased up to a stocking rate of 22 ewes/ha, the escalating feed costs were responsible for reducing gross margins at that point.

The probability of falling below a critical pasture mass of around 800 kg DM/ha (total) also increased to unacceptable levels for the 2 highest stocking rates simulated (Table 13). Drainage below the root zone also increased marginally with stocking rate indicating plant growth/root growth was being compromised.

The variability in gross margins increased as stocking rate increased –particularly above 18 ewes/ha. This indicates increasing risk as stocking rate is increased (Figure 11). At 18 ewes/ha, the downside risk (lower range of box plots) was no worse than at 16 ewes/ha, but the median and upper range in gross margin was higher. At 20 ewes/ha, the median gross margin was no better than for 16 ewes/ha.

Table 13. Mean gross margin of Merino x Terminal (August lambing) system on the TRIPLE system at different stocking rates.

	Stocking rate (ewes/ha)					
	12	**14**	**16**	**18**	**20**	**22**
stock rate (DSE/ha 15 Jul)	20.2	23.9	27.1	29.9	32.7	35.5
Mean annual stock rate (DSE/ha)	23.5	27.1	**30.6**	33.8	36.8	39.5
Mean Gross margin ($/ha)	**734**	**849**	**944**	**1016**	**1036**	**1020**
GM lower ; upper deciles	672; 802	744;947	781;1076	775;1187	675;1252	546;1369
$/ha per 100 mm rainfall	109.72	126.91	141.11	151.87	154.86	152.47
$/DSE	31.23	31.33	30.85	30.06	28.15	25.82
Wean %	90	89	89	88	87	85
clean wool produced (kg/ha)	55	63	71	79	86	92
lamb sold (LWT kg/ha)	444	507	569	627	679	721
total meat sold (kg/ha)	594	685	770	850	922	984
avg wth lamb sale wt (kgLWT)	43.3	43.1	42.8	42.3	41.6	40.6
avg ewe lamb sale wt (kg LWT)	39.2	39	38.7	38.3	37.7	36.8
wool income ($/ha)	321	373	420	465	504	541
Sale income lambs ($/ha)	825	948	1065	1175	1269	1345
Sale income CFA ($/ha)	143	165	187	207	226	244
total income ($/ha)	1289	1486	1672	1847	1999	2130
total costs ($/ha)	555	637	728	832	963	1110
Supp feed ($/ha)	3	12	30	61	122	199
Supp feed (kg/ewe)	0.8	2.5	5.7	10.0	17.9	26.5
Supp feed ($/ewe)	$0.24	$0.75	$1.71	$3.00	$5.37	$7.95
% income meat	75.10	74.90	74.88	74.82	74.79	74.60
% income wool	24.90	25.10	25.12	25.18	25.21	25.40
Prob feed >30kg/ewe (years)	*0.00*	*0.00*	*0.05*	*0.15*	*0.25*	*0.40*
Prob < 800 kg DM March						
Fitzroy	*0.00*	*0.00*	*0*	*0.02*	*0.02*	*0.10*
Avalon	*0.02*	*0.02*	*0.02*	*0.08*	*0.22*	*0.45*
Banquet	*0.02*	*0.02*	*0.01*	*0.08*	*0.15*	*0.35*
Prob < 800 kg DM April						
Fitzroy	*0.00*	*0.00*	*0.00*	*0.02*	*0.12*	*0.22*
Avalon	*0.02*	*0.02*	*0.02*	*0.20*	*0.40*	*0.50*
Banquet	*0.05*	*0.05*	*0.05*	*0.28*	*0.45*	*0.65*
Utilisation (%)	50	57	64	70	75	81
Total pasture grown (t DM/ha)	13.6	13.8	13.8	13.8	13.7	13.5
Drainage below root zone avg/yr (mm)						
Fitzroy	63	64	65	66	67	68
Avalon	133	134	134	135	135	136
Banquet	74	75	76	77	78	80

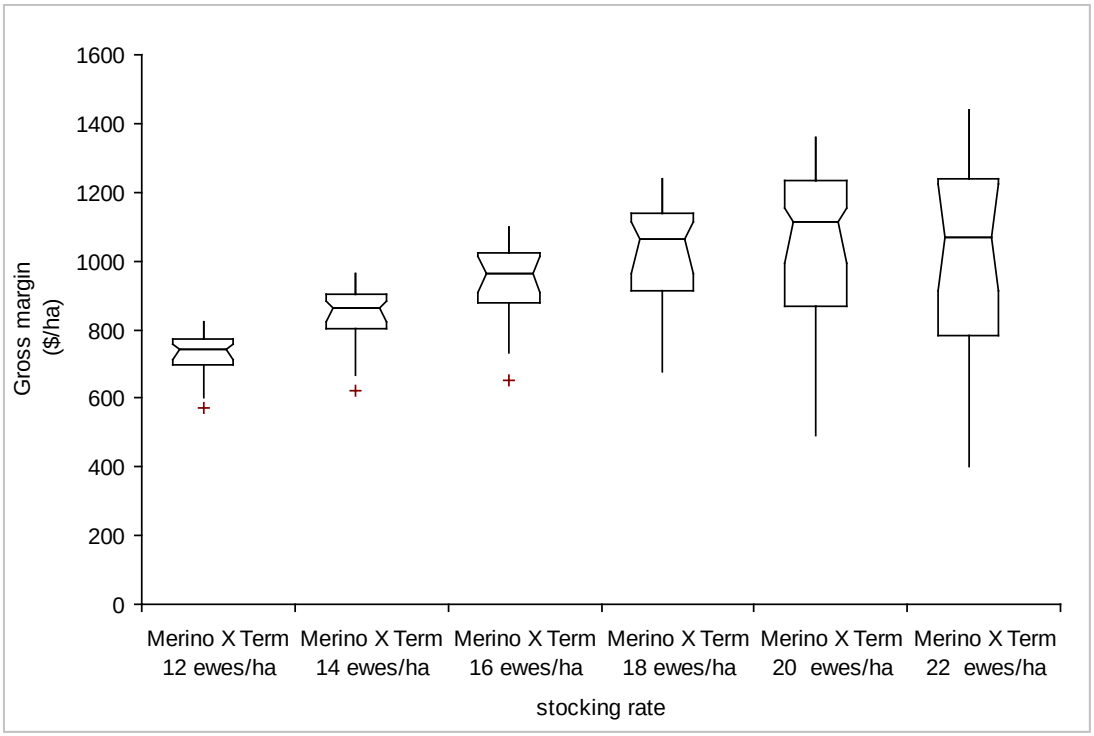

Figure 11. Box plots of gross margins ($/ha) at different stocking rates for the August lambing Merino x Terminal system on the TRIPLE system. Boxplots represent median, range and interquartile range, x indicates outliers and o indicates extreme values.

4. Different livestock options – PRG pasture system

Different livestock enterprise options were compared using the standard prices and the pasture base of perennial ryegrass and all were run at a similar average annual stocking rate of 30.4 DSE/ha. The alternative enterprises have been compared with the standard livestock enterprise of Merino x Terminal (Table 14; Figure 12). The self-replacing Merino flock lambed in September and sold lambs as hoggets at 16 months of age. The self-replacing composite flock lambed in August and sold surplus lambs at 44 kg/mid December similar to the standard systems. The replacement composite ewes were joined at 7 months of age – this reduced the overall weaning rate for the flock from 138% (all adult ewes) to 133%. The self-replacing beef herd consisted of August calving Angus cows (500 kg) selling steer calves and surplus heifer calves as yearlings at 450 kg /1st January.

The mean gross margin for the Merino x Terminal system was $226/ha higher than for the self-replacing Merino flock. This difference was due to the greater amount of meat income produced in the Merino x Terminal system. Total costs ($/ha) were higher in the Merino x Terminal systems due to costs of replacement ewes and lamb marking etc.

The mean gross margin for the self-replacing Composite system was only $57/ha higher than for the Merino x Terminal system. Total income ($/ha) was higher for the Merino x Terminals but total costs were also higher due to additional costs of running more ewes/ha.

Mean gross margin for the self-replacing composites ($985/ha) was similar to the purchased Composite ewe x Terminal system ($955/ha). This was achieved by joining replacement ewes at 7 months of age allowing for slightly lower conception rates. If ewes are joined at 18 months of age, gross margins would be lower. The self-replacing system is buffered against several risks in comparison to purchasing ewes. This system is not exposed to high replacement ewe prices or disease risk such as introducing foot-rot or OJD.

The performance of the Composite system (using purchased ewes or self-replacing) against the Merino x Terminal system is highly sensitive to weaning percentages achieved. In this analysis a high weaning percentage of 138% was used for composites but if a lower rate was achieved than the Merino x Terminal system would be more profitable.

The self-replacing beef herd was the least profitable of all enterprises simulated. It also carried more risk than the sheep enterprises as shown by the larger range in gross margins over the years. In 2 years this enterprise actually suffered losses while all sheep gross margins were positive (Figure 10). Losses were incurred in poor years due to the amount of supplementary feeding required to maintain cattle and reduced meat income. This enterprise has a much poorer match of animal demand with the average pasture curve, compared with a prime lamb system, as all calves are carried over the summer and not sold until the following spring/summer.

Table 14. Profitability, productivity and risk of alternative enterprises compared with Merino x terminal (August lambing) at standard prices, on the PRG system

	Merino x Term	Self replace Merino	Self replace composite	Self replace Beef herd
Stock rate (ewes/ha or cows/ha)	**16**	**11.7**	**12.0**	**1.9**
stock rate (DSE/ha 15 Jul)	27.8	31.5	25.4	30.8
Mean annual stock rate (DSE/ha)	**30.4**	**30.4**	**30.4**	**30.0**
Mean Gross margin ($/ha)	**928**	**702**	**985**	**642**
GM lower ; upper deciles	727 ; 1071	539 ; 834	784 ; 1109	414 ;817
$/ha per 100 mm rainfall	*138.71*	*104.93*	*147.23*	*95.96*
$/DSE	*30.53*	*23.09*	*32.40*	*21.47*
Wean %	88	88	133	95
clean wool produced (kg/ha)	71	134	45	-
Lamb/beef sold (LWT kg/ha)	570	417	593	532
total meat sold (kg LWT /ha)	772	535	735	638
avg wth lamb or steer sale wt (kgLWT)	43.2	72.9	44.1	447
avg ewe lamb or heifer sale wt (kg LWT)	39.0	61.0	42.3	391
wool income ($/ha)	419	546	99	-
Sale income lambs/calves ($/ha)	1072	489	1166	889
Sale income CFA ($/ha)	187	110	132	123
total income ($/ha)	1678	1145	1397	1012
total costs ($/ha)	750	443	412	370
Supp feed ($/ha)	52	75	50	123
Supp feed (kg/ewe or cow)	9.8	9.1	12.5	115
Supp feed ($/ewe or cow)	$2.94	$2.73	$3.75	$24.15
% income meat	75	52	93	100
% income wool	25	48	7	-
Prob feed >30kg /ewe, 300kg /cow (yrs)	*0.15*	*0.20*	*0.20*	*0.15*
Prob < 800 kg DM March				
Fitzroy	*0.03*	*0.03*	*0.04*	*0.02*
Avalon	*0.01*	*0.06*	*0.03*	*0.02*
Banquet	*0.01*	*0.05*	*0.08*	*0.05*
Prob < 800 kg DM April Fitzroy	*0.02*	*0.12*	*0.10*	*0.10*
Avalon	*0.05*	*0.12*	*0.03*	*0.08*
Banquet	*0.15*	*0.22*	*0.22*	*0.20*
Utilisation (%)	67	67	67	65
Total pasture grown (t DM/ha)	12.9	12.9	12.9	12.9
Pasture grown December-April (t DM/ha)	2.8	2.8	2.8	2.8
Drainage below root zone avg/yr (mm)				
Fitzroy	129	129	129	129
Avalon	134	135	134	134
Banquet	94	94	94	93

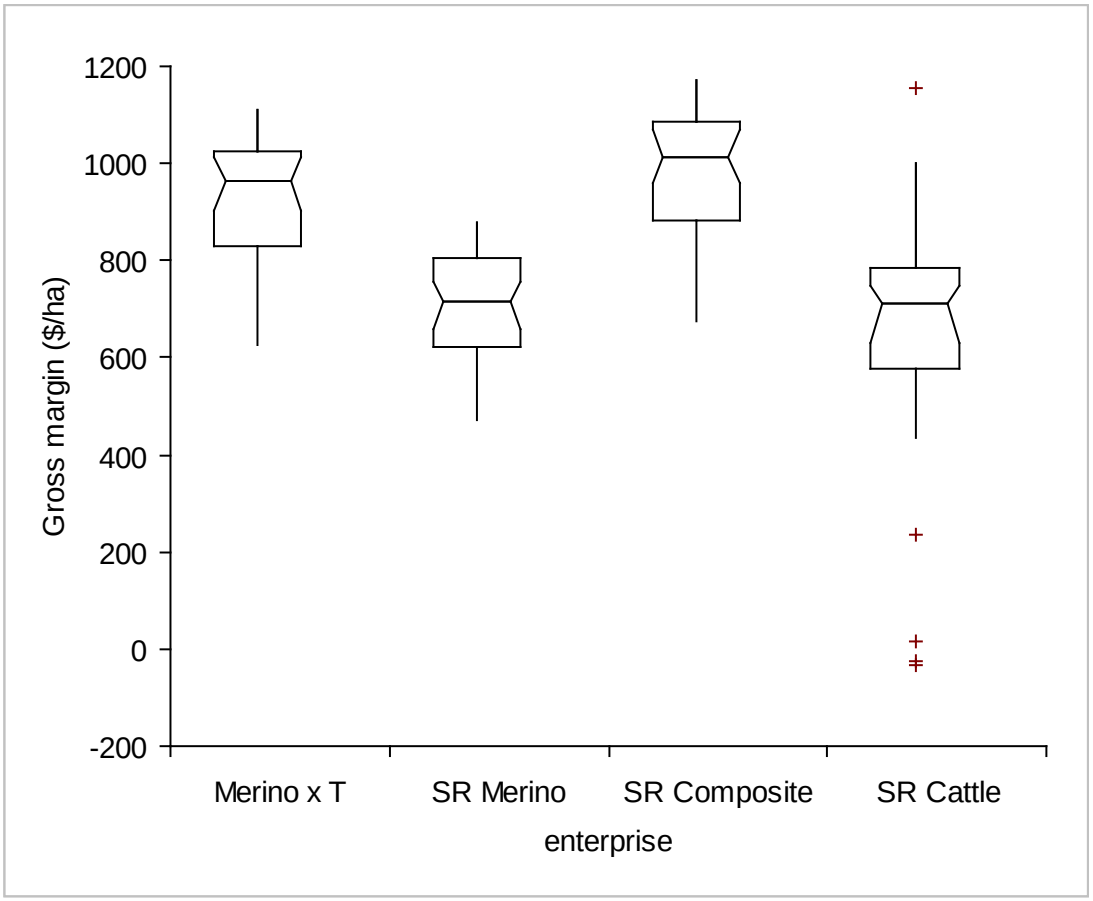

Figure 12. Box plots for alternative enterprises compared with the Merino x Terminal (August lambing) at standard prices and on PRG system. Box plots represent median, range and inter-quartile range, x indicates outliers and o indicates extreme values.

Conclusion

Three sheep system simulated, Merino x Terminal, Composite x terminal, self-replace composite, were all more profitable than a self-replacing Merino flock on a standard perennial ryegrass pasture base. These 3 systems produced gross margin of similar magnitudes.

The self-replacing cattle enterprise was the least profitable of all enterprises simulated and carried the highest risk of making losses in poor years.

The optimum time of lambing for the Merino x Terminal system, on PRG and TRIPLE, was 1st July as this enabled lambs to more reliably reach target sale weights. This time was more profitable than the 1st August or 1st September lambing dates.

For the 40 year period simulated, GrassGro indicated there was an opportunity to increase the stocking rate of the Merino x Terminal system, on both PRG and TRIPLE pasture systems, from 16 to 18 ewes/ha and increase gross margin without having negative environmental consequences. However, very dry years prevailed during the years that the Evergraze experiment was conducted at Hamilton (2006-2010). Hence it would have been difficult to run more than the 16 ewes/ha achieved during the experiment without having to de-stock more often and supplementary feed ewes for longer periods than what did occur.

The addition of lucerne to the pasture system did not have a great impact on mean gross margin for the standard livestock systems -Merino x Terminal, Composite x Terminal. It did however reduce some risks by improving gross margins in the dry years.

The addition of lucerne also increased the number of years when lambs could be carried over, to reach higher sale weights, and could still have adequate green feed to flush ewes. For both systems, in years when the amount of summer green pasture dropped below 500 kg DM/ha it would seem more economic to sell the lambs when their growth rates declined to minimal levels. On the PRG system, there would be an opportunity to hold onto lambs to sell at the end January in 11/39 years, but little opportunity to keep them into February. On the lucerne there would be an opportunity to hold onto lambs to sell at the end January in 23/39 years and until the end of February 13/39 years.

APPENDIX 1

Standard price assumptions

The standard prices used in this analysis were the average 4 year prices from 2006/07-2009/10.

Factor	Value
33 micron composite wool (c/kg clean)	347
21 micron Merino wool (c/kg clean)	885
Lamb < 18 kg (c/kg DWT)	334
Lamb >18 kg (c/kg DWT)	380
Merino hogget (c/kg DWT)	266
CFA Sheep (c/kg DWT)	200
Skins ($/head)	
Bare shorn CFA sheep/Merino hoggets	2
Lambs (unshorn)	10
Replacement Merino ewes ($/ewe)	90
Replacement Composite ewes ($/ewe)	110
Rams ($/ram)	600
Cattle – yearling 400+kg (c/kg LWT)	167
CFA cattle (c/kg LWT)	116
Bulls ($/bull)	1200
Feed grain ($/t)	300
Pasture hay ($/t)	211
Single superphosphate ($/t)	400
Pasture maintenance cost ($/ha)	100
(mainly maintenance fertiliser)	

APPENDIX 2

Pasture and soil assumptions used in GrassGro

Perennial ryegrass (PRG) System	**Fertility scalar**	**Root depth (mm)**	**Cumulative depth**		**Soil type**
			Top soil (mm)	**Subsoil (mm)**	
Fitzroy – crest	0.90	500	250	700	Silty clay loam overlying medium clay (white)
Avalon – mid-slope	0.95	450	250	500	As above
Banquet - valley	0.90	800	250	1000	As above
Triple System					
Sardi-7 Lucerne – crest (modelled as winter active lucerne plus perennial ryegrass)	1.0	1000	250	1000	Silty clay loam overlying medium clay (white)
Avalon PRG – mid-slope	0.95	450	250	500	As above
Quantum II Fescue –valley (modelled as cocksfoot)	1.0	1000	250	1000	As above

Monthly pasture growth rates (kg DM/ha per day)-2006-2009 and total annual pasture growth (kg DM/ha) from GrassGro.

Month	**Fitzroy**	**Avalon**	**Banquet**	**Lucerne**	**Fescue**
Jan	2	2	2	19	13
Feb	12	13	6	17	21
Mar	5	5	6	5	3
Apr	13	16	4	12	13
May	33	38	22	26	32
Jun	28	38	30	26	36
Jul	34	31	26	33	31
Aug	35	45	40	35	40
Sep	59	64	52	62	65
Oct	46	45	52	49	68
Nov	38	44	48	43	59
Dec	23	31	30	33	15
total growth for year kg DM/ha	**9977**	**11315**	**9673**	**10950**	**12045**
PVI data 2006-2009	**9922**	**10965**	**9926**	**11126**	**11781**

APPENDIX 3 – Feed budget and partial budget

Question:

"Should I sell lambs in mid-December (usual sale date) and save any green feed in the lucerne paddock to flush ewe in late February (OPTION A) or should lambs be kept on to reach heavier sale weights and graze the lucerne while ewes graze the perennial grass paddocks (OPTION B) "?

Assumptions:

Triple pasture system – 3 paddocks of 330 ha (fescue; perennial ryegrass; lucerne).

Average annual stocking rate - 30.4 DSE/ha (16 ewes/ha @ wean 88% weaning).

15840 Merino ewes & 13939 1st cross lambs.

As at Mid –late December:

- Fescue & ryegrass paddocks: 3500 kg DM/ha available (green; 70% digestibility)
- Lucerne paddock: 2500 kg DM/ha available (green; 75% digestibility)
- Lamb weights: 43 kg (wethers) & 39 kg (ewes)
- soil profile moisture – good

Assume average pasture growth rates for lucerne and the perennial grasses.

Assume autumn break occurs in early May.

Mean gross margin: $ 928/ha

Extra income from flushing: extra 6 lambs weaned per 100 ewes (1 lamb per 16 ewes/ha @ $70/lamb net of animal husbandry costs) = extra $70/ha gross margin.

Extra costs of flushing ewes: Nil (but if feed was limiting during winter/late pregnancy there would be an additional supplementary feed cost for ewes due to the higher pregnancy rate)

Extra income from lamb reaching higher weights: $3.80/kg DWT

Extra growth: lambs put on around 180- 200 g/head (LWT) per day on the lucerne.

Extra costs of delaying sale of lambs: NIL (but might incur shearing cost if held until March/April & would compete for feed with the ewes – the feed budget should determine if this will be a problem).

OPTION A:

Step 1. Feed budget: estimate if there will be enough feed to maintain the ewes over summer and how much green feed there might be in the lucerne paddock in late February?

Note: All lambs sold in December. Ewes graze perennial grass paddocks in January until mid February while lucerne is rested. Then all ewes graze lucerne for 2 weeks prior to joining and during joining. Ewes graze perennial grass pasture in April and lucerne is rested.

FEED BUDGET 1 **Date:** 31st Dec

Site: 2 perennial grass paddocks (660 ha) **Start feed:** 3500 kg DM/ha **Quality:** moderate

Period	Stock. rate animals/ha	DSE/hd	DSE/ha	kg DM/ha/day required	Pasture growth rate	Difference kg/ha/day	Increase in Feed kg DM /ha/mth	Available feed end of period	Stock in paddock
Jan	24	1.2	28.8	37.4	9	-28.4	-882	2618	***all ewes***
Feb	12	1.2	14.4	18.7	6	-12.7	-356	2262	***ewes for 14 days***
Mar	0	1.2	0.0	0.0	9	9.0	279	2541	***none***
Apr	24	1.2	28.8	37.4	25	-12.4	-373	2168	***all ewes***
	A	B	A*B=C	C*1.3=D	E	E-D=F	F*days in month		

Feed budget 1 indicates that there will be adequate feed in the perennial grass paddocks to maintain ewe condition (feed quality will be declining) and provide adequate ground cover leading up to the autumn break. Feed budget 2 (lucerne paddock) indicates that there will be at least 2800 kg DM/ha green available when ewes are put in the paddock pre-joining. Hence all ewes will effectively be "flushed".

FEED BUDGET 2 **Date:** 31st Dec

Site: lucerne paddock (330 ha) **Start feed:** 2500 kg DM/ha **Quality:** good

Period	Stock. rate animals/ha	DSE/hd	DSE/ha	kg DM/ha/day required	Pasture growth rate	Difference kg/ha/day	Increase in Feed kg DM /ha/mth	Available feed end of period	Stock in paddock
Jan	0	1.2	0.0	0.0	28	28.0	868	3368	***none***
Feb	24	1.2	28.8	37.4	20	-17.4	-523	2845	***ewes for 14 days***
Mar	48	1.2	57.6	74.9	16	-58.9	-1825	1020	***all ewes***
Apr	0	1.2	0.0	0.0	29	29.0	899	1919	***none***
	A	B	A*B=C	C*1.3=D	E	E-D=F	F*days in month		

Step 2. Change in income/costs from flushing ewes.

- Average gross margin = $928/ha
- plus extra income from 1 extra lamb/ha at next lambing period = $70/ha
- New gross margin = **$ 978/ha**

OPTION B:

Step 1. Feed budget: estimate if there will be enough feed to maintain the ewes over summer in perennial grass paddocks and how many lambs can be kept on lucerne & for how long?

Note: All ewes graze the 2 perennial grass paddocks. All lambs graze the lucerne paddock. Lambs gradually sold off to adjust stocking rate on the lucene to maintain at least 1000 kg DM/ha of green feed so that lambs can keep growing at around 180g/day.

FEED BUDGET 1 **Date:** 31st Dec

Site: 2 perennial grass paddocks (660 ha) **Start feed:** 3500 kg DM/ha **Quality:** moderate

Period	Stock. rate animals/ha	DSE/hd	DSE/ha	kg DM/ha/day required	Pasture growth rate	Difference kg/ha/day	Increase in Feed kg DM /ha/mth	Available feed end of period	Stock in paddock
Jan	24	1.2	28.8	37.4	9	-28.4	-882	2618	***all ewes***
Feb	24	1.2	28.8	37.4	6	-31.4	-880	1738	***all ewes***
Mar	24	1.2	28.8	37.4	9	-28.4	-882	856	***all ewes***
Apr	24	1.2	28.8	37.4	25	-12.4	-373	483	***all ewes***
	A	B	A*B=C	C*1.3=D	E	E-D=F	F*days in month		

Feed budget 1 indicates that there will be just enough feed in the perennial grass paddocks to maintain ewe condition (feed quality will be declining) and provide some ground cover (slightly lower amount than desirable) leading up to the autumn break. Feed budget 2 (lucerne paddock) indicates that all lambs (42 lambs/ha) could be kept until the end of January but only 25 lambs/ha could be fed through February with only 10 lambs/ha remaining in March before resting the lucerne.

FEED BUDGET 2 **Date:** 31st Dec

Site: lucerne paddock (330 ha) **Start feed:** 2500 kg DM/ha **Quality:** good

Period	Stock. rate animals/ha	DSE/hd	DSE/ha	kg DM/ha/day required	Pasture growth rate	Difference kg/ha/day	Increase in Feed kg DM /ha/mth	Available feed end of period	Stock in paddock
Jan	42	1.1	46.2	60.1	28	-32.1	-994	1506	***all lambs***
Feb	25	1.1	27.5	35.8	20	-15.8	-441	1065	***lambs***
Mar	10	1.1	11.0	14.3	16	1.7	53	1118	***lambs***
Apr	0	1.2	0.0	0.0	29	29.0	870	1988	***none***
	A	B	A*B=C	C*1.3=D	E	E-D=F	F*days in month		

Step 2. Change in income/costs from keeping lambs.

- Average gross margin = $928/ha
- plus extra income from extra lamb live weight kg/ha sold = $252/ha (see table 3 below for calculations)
- New gross margin = **$ 1180/ha**

Table 3. Value of extra lamb (dressed wt) sold from grazing lucerne

Period	lambs/ha	extra kg/head	extra LWT kg/ha	extra DWT/ha	extra $/ha (lucerne only)	extra $/farm
Jan	42	6.2	260	117	445	148
Feb	25	5.0	126	57	215	72
Mar	10	5.6	56	25	95	32
					TOTAL	**252**

Conclusion:

Given the assumptions about pasture availability in late December, the example shows that using the lucerne preferentially for the lambs was more profitable than saving the lucerne for the ewes for pre-joining through to joining.