EverGraze Tactical Management Regimes: GrassGro Simulations Albany

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Background

The target EverGraze catchment in Western Australia is the Albany Eastern Hinterland (AEH). This catchment is located to the far east of the Albany shire on the south coast of Western Australia. The catchment covers approximately 105,000 ha of which around 80% is either under pasture, crops or plantation. Rainfall across the catchment varies from 400 to 600 mm per annum. While it is uncertain what proportion of the catchment is at risk of salinity well over 50% is susceptible to soil erosion, waterlogging, soil acidity or water repellent soils in part as a result of farming systems based on annual crops and pastures. It is worth noting that the challenges faced in the AEH are typical of a much larger area that makes up the agricultural zone of the south coast of Western Australia.

Preliminary EverGraze modelling suggested that an opportunity existed in the AEH to substantially increase profit while reducing soil degradation through the adoption of a Perennial Based Lamb Production System based on summer-active perennials and high-performance meat production. To test this hypothesis a 60 ha field demonstration (Proof Site) of the modelled Perennial Based Lamb Production System was undertaken comprising of kikuyu, lucerne, tall fescue (summer-active), chicory and setaria/panic. The Proof Site ran Merinotech ewes joined in February to Poll Dorset rams. Livestock, pasture and soil measurements were taken from January 2006 until early 2009.

To evaluate the impact of perennials over a greater range of seasons, in different livestock production systems and with alternative management to that captured at the Proof Site the following scenarios were simulated;

1. Baseline systems used at the Proof Site run over 40 financial years 1970-2010 to look at long-term effects of the treatments on profitability and NRM outcomes.
2. Different seasonal conditions using the Baseline pastures and animal systems.
3. Different management decisions (lambing time, stocking rate) and the impact on profitability.
4. Different livestock systems on the Baseline pastures.

Methods

All the simulations presented in this report were generated using GrassGro version 3.2.4 (Moore *et al*. 1997). Parameters used are presented in the appendix. Soil parameters were derived from Proof Site measurements or observations. The climate file was constructed using SILO and Western Australian Department of Agriculture and Food local weather stations. Local weather station data was given preference over SILO data and historical SILO data was corrected based on the relationship between SILO and weather station data over the last 15 years. A mix of standard and custom plant parameter sets were used. The model was validated with the pasture and livestock Proof Site data from 2006. All simulations were initialised for five years prior to the data recording period of 41 years from 1970 to 2010.

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The individual pasture and livestock systems simulated are presented in Table 1 and 2. The combination of pasture and livestock systems analysed are presented in Table 3. The following scenarios where run;

1. Baseline systems

Long-term profitability, productivity, risk with the Proof Site. Run for 1970-2010 at Standard, High and Low prices (refer to appendix)

2. Different seasonal conditions

What is the effect of late autumn breaks, early spring finishes and wet springs on profitability and productivity using standard prices from 1970 – 2010?

- Dry autumn break; lowest 10 years rainfall April – June
- Dry spring; lowest 10 years rainfall September-November
- Wet spring; highest 10 years rainfall September – November

3. Different management decisions

3a. Allocation of high quality summer feed to ewes or lambs. For each pasture type how much high quality feed is available in summer?

3b. What is the effect of lambing in August compared to July?

3c. How is profitability and productivity effected by changing stocking rate?

All compared at standard price.

4. Different livestock options

Impact of alternative livestock systems

4a. Self replacing Merino flock.

4b. Cross bred ewes.

4c. Beef cattle

Validation

The field data collected from the Proof Site in 2006, 2007 and 2008 was used to validate the model. Pastures at the Proof Site comprised of separate plots of kikuyu, lucerne, tall fescue (summer-active), chicory and setaria/panic. The site ran Merinotech ewes joined in February to Poll Dorset rams.

Overall there is reasonable agreement between simulated and observed values for available green herbage in all pasture types (Figure 1). With the model best able to predict available green herbage for annual, kikuyu and lucerne pastures. While the fit between simulated and observed values for tall fescue is acceptable further work with the model could bring improvement. In the case of tall fescue and lucerne the model partly over estimates growth rates (not presented) in the late autumn early winter period resulting in more green herbage that is carried through until around the spring peak. GrassGro over estimated spring growth in kikuyu leading to a drying of the soil profile and lower growth rates in early summer. These discrepancies are also worthy of future analysis and model development.

The model did a reasonable job in simulating the liveweight of both the ewes and lambs at the Proof Site from March 2006 to December 2008 (Figure 2). However while it accurately simulated the rate of growth of lambs it consistently underestimated their liveweight suggesting that it may be worth looking at the animal parameters in the model as they relate to this particular genotype.

Overall GrassGro was able to provide a credible simulation of the Wellstead Proof Site from 2006 to 2008 such that it can be expected to provide useful comparisons of a range of different tactical management regimes.

Table 1. Description of pasture systems simulated

System	Subclover, ryegrass & capeweed pasture	Kikuyu & subclover pasture	Lucerne, ryegrass and subclover pasture	Tall fescue & subclover pasture
1.	100.0%	Nil	Nil	Nil
2.	76.5%	15.9%	7.6%	Nil
3.	48.4%	28.8%	11.4%	11.4%

Table 2. Description of livestock systems simulated.

System	Stock enterprise	SR (ewes or cows per ha)	Join	Conception	Lamb	Wean	Sell lambs	Replace/ purchase	CFA (9-10 years)	Shear
1.	Mer x T	6.5	7 Feb	50;50[A]	Jul	4 Nov	At 45kg or by 4 Feb	1 Jan	1 Jan	15 May
2.	Mer x T	7.5	9 Mar	50;50[A]	Aug	6 Dec	At 45kg or by 9 Mar	1 Jan	1 Jan	15 May
3.	Mer x T	3.9	7 Feb	50;50[A]	Jul	4 Nov	At 45kg or by 4 Feb	1 Jan	1 Jan	15 May
4.	Mer x T	5.2	7 Feb	50;50[A]	Jul	4 Nov	At 45kg or by 4 Feb	1 Jan	1 Jan	15 May
5.	Mer x T	7.8	7 Feb	50;50[A]	Jul	4 Nov	At 45kg or by 4 Feb	1 Jan	1 Jan	15 May
6.	Mer x T	9.1	7 Feb	50;50[A]	Jul	4 Nov	At 45kg or by 4 Feb	1 Jan	1 Jan	15 May
7.	SRM	6.5	7 Feb	50;50[A]	Jul	4 Nov	At 45kg or by 4 Feb	1 Jan	1 Jan	15 May
8.	XB x T	6.5	7 Feb	50;50[A]	Jul	4 Nov	At 45kg or by 4 Feb	1 Jan	1 Jan	15 May
9.	Beef cows	1.2	4 Nov	100%	Aug	1 Nov	Heifers at 350 kg, steers at 400 kg or by 31 Dec	1 Jan	19 Apr at 7 to 8 years of age	n/a

[A] Conception rates are percent of ewes with single or twin pregnancies for sheep; pregnant for cattle.

Mer x T – Merino ewes mated to Dorset type rams; ewes purchased

SRM – self-replacing Merino; wether and excess ewe lamb sold

XB x T – Dorset x Merino ewe mated to Dorset type ram; ewes purchased

Table 3. Combination of livestock and pasture systems simulated.

Factor analysed	Pasture system used	Livestock system used
	Baseline	
Annual pasture	1	1
25% Perennial pasture	2	1
50% Perennial pasture	3	1
	Different seasonal conditions	
Dry autumn	1, 2 & 3	1
Dry spring	1, 2 & 3	1
Wet spring	1, 2 & 3	1
	Different management decisions	
Allocation of high quality summer feed	1, 2 & 3	1
Time of lambing	1, 2 & 3	1 & 2
Stocking rate	2	1, 3, 4, 5 & 6
	Different livestock options	
Self replacing merino flock	2	7
Cross bred ewe	2	8
Beef Cattle	2	9

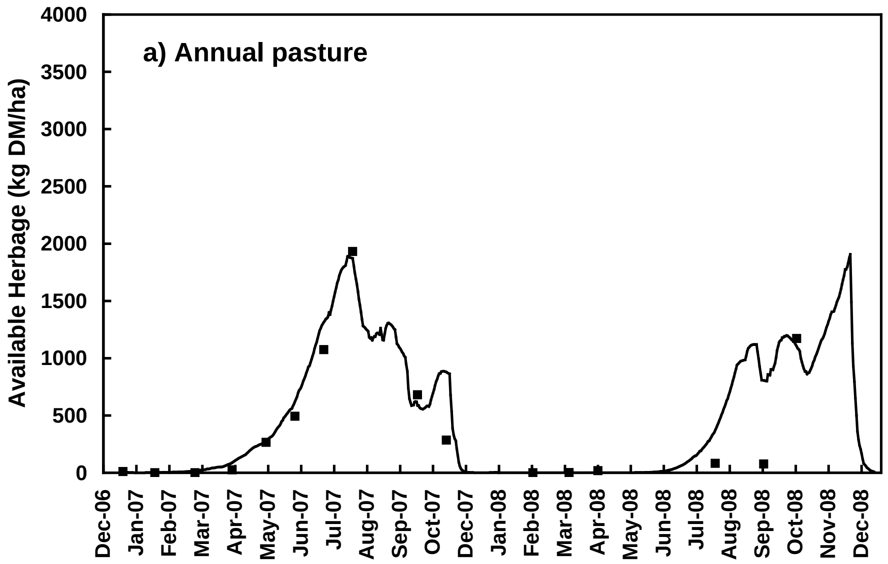
Results

1. Baseline - Comparison of annual, 25% perennial and 50% perennial systems at standard, low and high prices.

Introducing perennials into the feed base until they comprise of 25 or 50 percent of the pastures increased the average gross margin at standard prices by $17 to $20 per ha (Table 4). The difference in median gross margins was greater at $51 and $57 per ha. However this is not the whole story, based on the lower quartile range values perennial pastures consistently provided more profit in half of the 40 financial years simulated. As expected the differences in gross margins between the three baseline systems was primarily due to the reduced supplement fed with the perennial pastures, due to an increase in pasture yield in the December to April period for all of the perennials simulated, lucerne, tall fescue and kikuyu. Increases were on average 379, 562 and 780 kgDM/ha respectively (Table 4).

GrassGro estimated that the annual pasture system leaked on average 18 mm per annum or 4% of annual rainfall below the root zone for the period 1970 to 2010 (Table 4). All the perennial pasture types reduced drainage beneath the root zone to zero. At a whole of landscape scale 25% under perennials reduced drainage to 15 mm per annum and 50% under perennials reduced it further to 11 mm per annum.

A 30% increase or decrease in sheep prices had relatively no effect on the difference in gross margins between the three baseline systems modelled (Figure 3). Interestingly at lower prices perennials make the difference between a median value of no profit in the annual system and an average median profit for the perennial systems of $52 per ha. As expected all the baseline systems are very profitable at high prices.



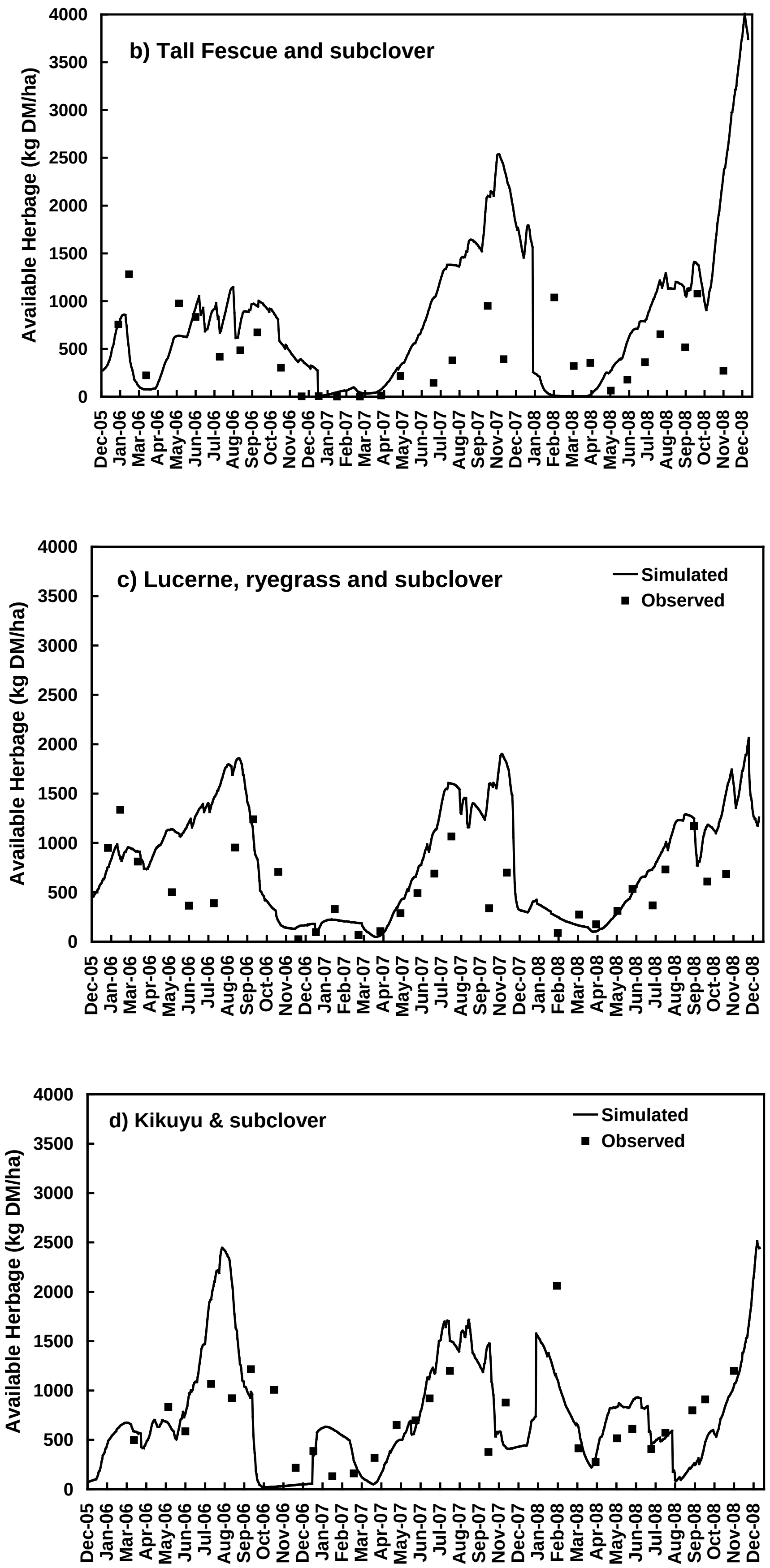


Figure 1. Simulated and observed green available herbage for a) anuual pasture b) tall fescue and subclover, c) lucerne, ryegrass and subclover and d) kikuyu and subclover pasture at Wellstead, Western Australia from 2006 to 2008.

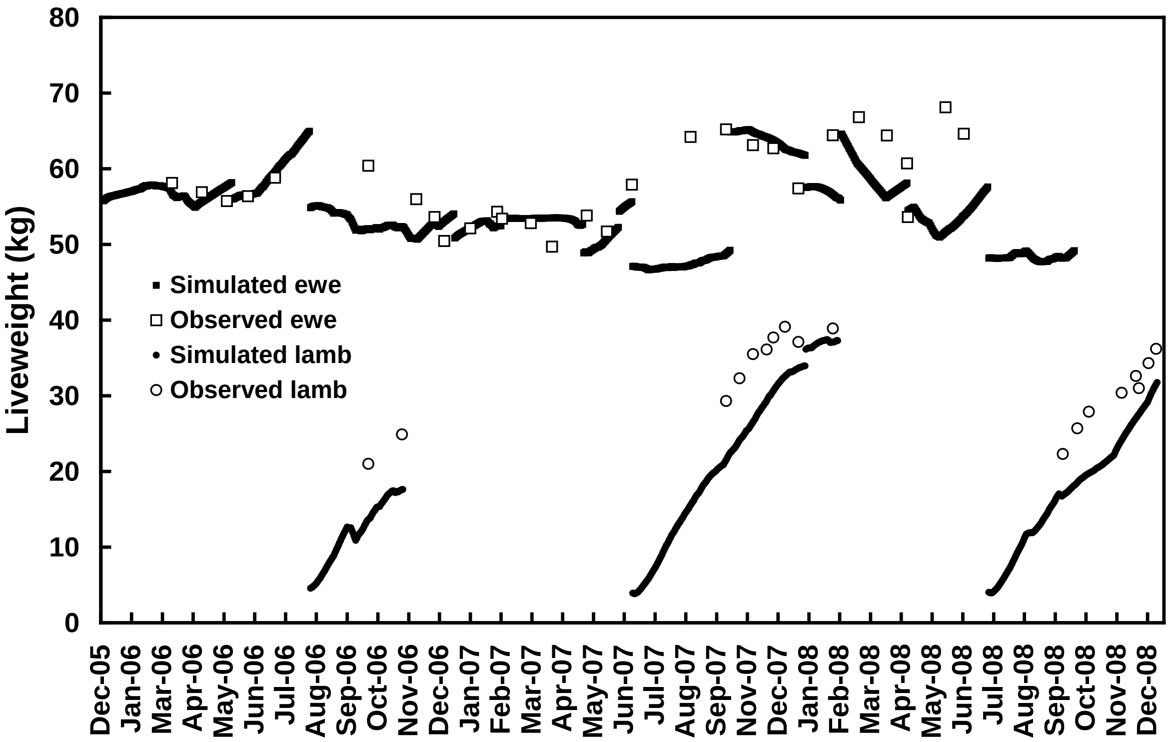


Figure 2. Simulated and observed merino ewe and lamb liveweight at Wellstead, Western Australia from 2006 to 2008.

Table 4. Profitability, productivity and risk of Baseline systems Annual, 25% perennial and 50% perennial pasture running Merino x Dorset ram at standard prices (refer to table 3).

	Annual pasture only	25% Perennial pasture	50% Perennial pasture
Mean annual rainfall (mm)	467	467	467
Stocking rate (ewes/ha)	6.5	6.5	6.5
DSE/ha 15 Jul	16.4	16.3	15.9
Mean annual DSE/ha	14.7	14.9	15.0
Lambing	Jul	Jul	Jul
Mean Gross Margin ($/ha)	**230**	**247**	**250**
Median	259	310	316
Range	-303; 512	-318; 520	-333; 523
Lower, upper deciles	60; 439	102; 439	101; 430
$/ha/100mm rainfall	49	53	54
$/DSE	16	17	17
Wean %	1.25	1.25	1.25
Clean wool (kg/adult)	3.9	3.9	3.8
Clean wool (kg/ha)	25	25	24
Sale weight lambs (kg LW)	44.9	44.9	44.8
Weight lamb sold (kg LW/ha)	364	362	359
Meat sold/ha (kg LW)	412	411	407
% income wool	22	22	22
% income meat	78	78	78
Total income	833	832	822
Total costs	603	585	572
Supplement (kg/ha)	632	587	558
Supplement (kg/ewe)	97	90	86
Supplement ($/ha)	253	235	223
Supplement ($/ewe)	39	36	34
Probability of feeding > 30kg/ewe (years)	34/41	33/41	34/41
Probability total pasture mass < 800 kg DM/ha	0.24	0.25	0.25
Pasture utilisation (%)	46	47	48
Drainage below root zone (mm)[A]	A 18 Overall 18	A 18 L 0 K 0 Overall 15	A 18 L 0 K 0 TF 0 Overall 11
Total pasture yield (kg DM/ha)	A 8206	A 8223 L 6783 K 8320	A 8202 L 6723 K 8520 TF 7019
Yield per mm rain (kgDM/ha/mm)	A 17.6	A 17.6 L 14.5 K 17.8	A 17.6 L 14.4 K 18.2 TF 15.0
Dec-Apr pasture yield (kg DM/ha)	A 1334	A 1339 L 1731 K 2095	A 1327 L 1692 K 2130 TF 1889
May-Nov pasture yield (kg DM/ha)	A 6872	A 6885 L 5053 K 6226	A 6875 L 5031 K 6390 TF 5129

[A] A = annual; L = lucerne; K = kikuyu and TF = tall fescue pastures

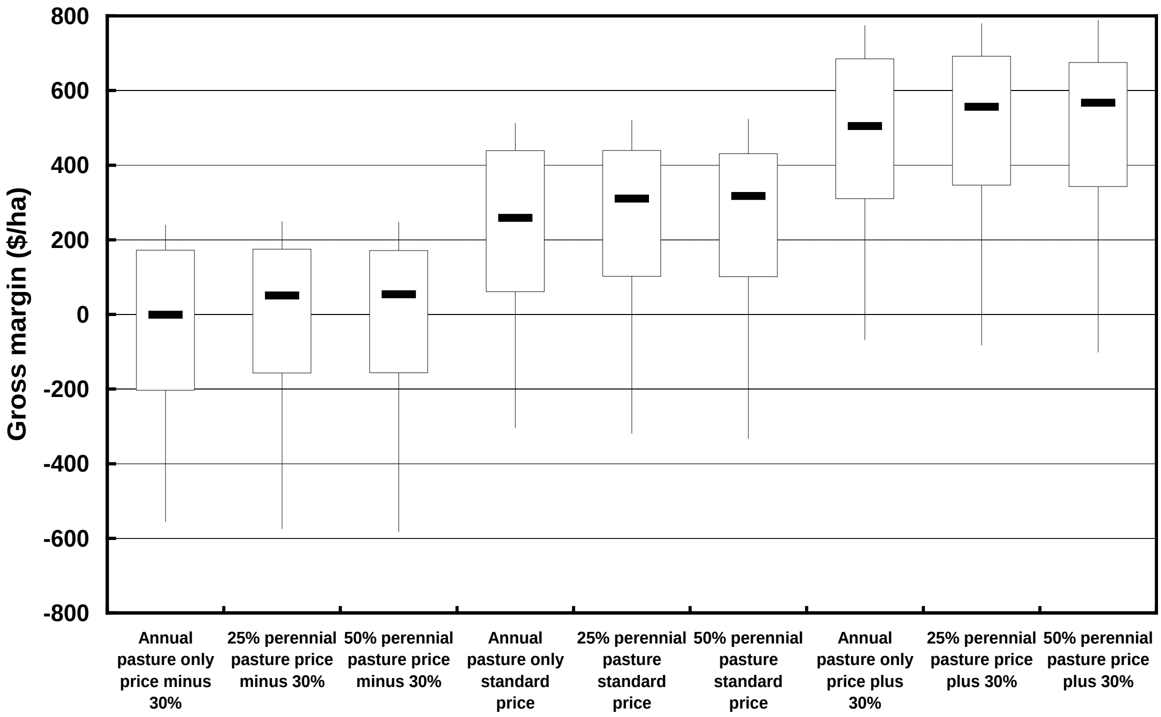


Figure 3. Boxplot of Annual pasture only, 25% Perennial pasture and 50% Perennial pasture at standard price minus 30%, standard price or standard price plus 30%. Boxplots represent median, quartile range and range.

2. Different seasonal conditions

Seasonal rainfall varied considerably at the Proof Site from 1970 to 2010 as indicated by the rainfall figures presented in Table 5. The site on average received 60 mm less in a dry autumn, 63 mm less in a dry spring and 75 mm more in a wet spring. The change in rainfall saw a corresponding change in the simulated pasture yield and amount of supplement fed (Table 6). For example in a dry autumn in the 50% perennial system the annual pasture grew on average 2058 kg DM/ha less in the period from May to November, lucerne yield was reduced 1375 kg DM/ha, kikuyu 2193 kg DM/ha and tall fescue 1078 kg DM/ha (Table 6). The difference in the other baseline systems was similar. As a consequence of less available herbage the amount of supplement fed increased 378, 357 and 343 kg/ha in the annual, 25% perennial and 50% perennial system respectively. The higher cost of supplementary feed was directly responsible for the lower mean gross margins with reductions of 91, 74 and 75 percent in the annual, 25% perennial and 50% perennial system respectively (Table 6).

Interestingly dry springs have an even greater impact on gross margins with reductions of 105, 96 and 83 percent with increasing perenniality (Figure 4). This is again due to an even higher cost in supplementary feed even though pasture yield is not typically reduced to the extent that it is in dry autumns. By contrast wet springs increase gross margins on average across the different systems by 70 percent due to a substantial increase in the May to November pasture yield and a corresponding reduction in the supplement fed by an average of 20 percent compared to the baseline scenarios (Table 4).

It is interesting to note that the annual pasture system experiences the biggest changes in gross margins across the different seasonal conditions compared to the perennials. For example in a dry spring the annual gross margins falls 105 percent compared to 83 percent in the 50% perennial yet in a wet spring the annual increases 84 percent compared to 61 percent in the 50% perennial. This suggests that the perennial systems are less dependent on the rainfall in anyone season and are more consistent with varying rainfall.

Table 5. Mean annual, April-June and September-November rainfall (mm) in years with dry autumn, dry spring or average years.

	Mean	Dry Autumn	Dry spring	Wet spring
Annual	467	391	386	532
Apr-June	138	78	129	111
Sep-Nov	127	117	64	202

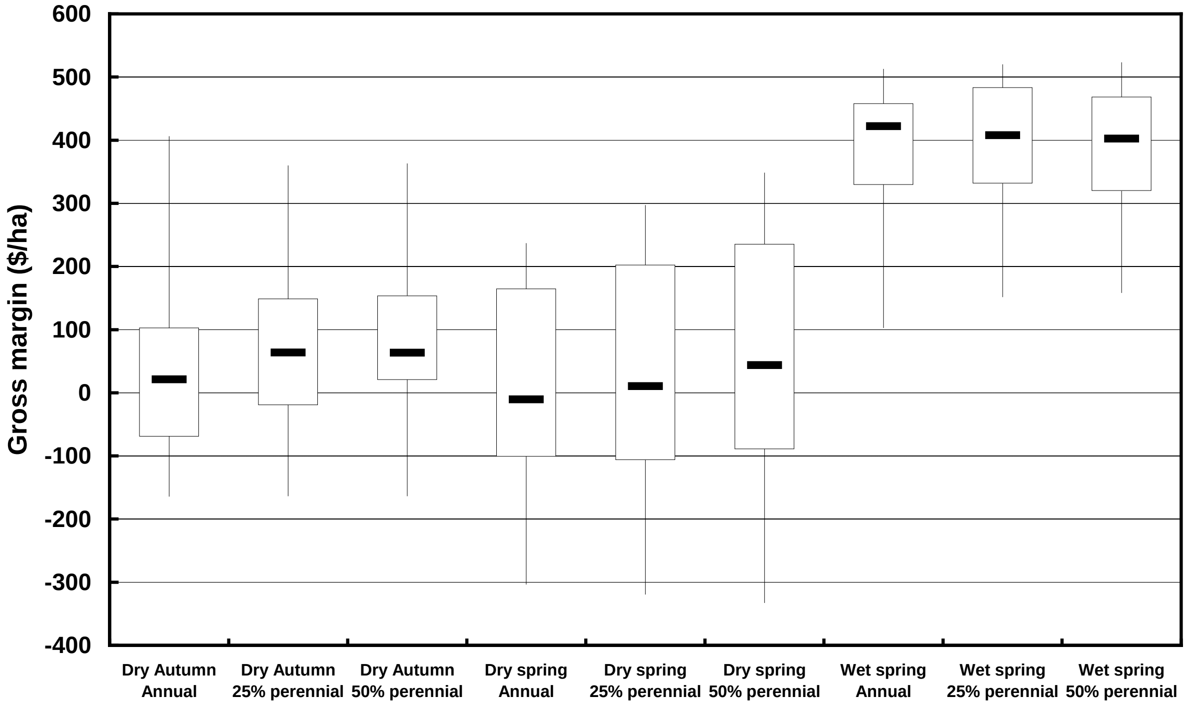


Figure 4. Boxplot of Annual pasture only, 25% Perennial pasture and 50% Perennial pasture at standard price in a dry autumn, dry spring and wet spring. Boxplots represent median, quartile range and range.

3. Different management decisions

3a. Allocation of high quality summer feed to ewes or lambs.

Summer rainfall in the Proof Site environment is highly variable (Figure 5) leading in turn to a large variation in the amount of green herbage available in this period of the year (Figure 6). In some summers yields can be quite high and rainfall events large enough to cause germination of annual pasture species (e.g. 2000, Figure 6). For the period simulated the annual pastures in the 50% perennial system on average produced 875 kg DM/ha of green feed between the 1st of December and the 31st March (Table. 7). In the driest ten years this fell to 262 kg DM/ha and increased to 1480 kg DM/ha in the wettest ten years. On average the perennial pastures produced between 441 and 805 kg DM/ha more than the annual pasture. In the driest years the deepest rooted perennials kikuyu and lucerne performed better than tall fescue producing between 258 and 504 kg DM/ha more green herbage than the annual species. Both kikuyu and tall fescue out performed lucerne and to an even greater degree the annual pastures in a wet year.

Given that the number of ewes per ha for this simulation is 6.5 and 50% of the pastures in the system are perennial based, all ewes could increase in condition score by 0.5 or be flushed for 14 days if perennials are able to provide sufficient green feed for 13 or more ewes per ha. The simulation suggests that the additional yield of the perennials with an average to wet summer would be sufficient to meet these targets (lucerne falls just short at 11 ewes/ha in an average summer) (Table 7). Only kikuyu produces sufficient green feed in dry summers to meet the needs of the whole ewe flock. Note that the estimated sheep numbers in Table 7 are a rough guide and assume that all perennials are equal in feed quality this is not the case with kikuyu in particular being lower than lucerne and tall fescue.

Table 6. The effect of dry autumn, dry spring or wet spring conditions for Annual, 25% Perennial or 50% Perennial pasture.

	Dry autumn			Dry spring			Wet spring		
	Annual	25% perennial	50% Perennial	Annual	25% perennial	50% Perennial	Annual	25% perennial	50% Perennial
Mean Gross Margin ($/ha)	54	79	90	-5	10	26	380	393	385
Median	21	64	63	-11	10	44	422	408	402
Range	-164; 406	-163; 360	-163; 363	-303; 237	-319; 297	-89; 348	103; 512	152; 520	159; 523
Change in mean from average year (%)	**-91**	**-74**	**-75**	**-105**	**-96**	**-83**	**+84**	**+65**	**+61**
Clean wool (kg/ha)	25	25	25	26	26	26	25	25	25
Meat sold/ha (kg LW)	358	351	349	310	329	326	472	473	469
Supplement(kg/ha)	1010	944	901	1184	1141	1059	280	262	265
Total pasture yield (kg DM/ha)[A]	A 6198	A 6172 L 6305 K 6298	A 6102 L 6317 K 6320 TF 6306	A 6697	A 6676 L 6799 K 6755	A 6601 L 6817 K 6791 TF 6831	A 9558	A 9516 L 9732 K 9728	A 9423 L 9727 K 9736 TF 9711
Dec-Apr pasture yield (kg DM/ha)	A 1269	A 1267 L 1890 K 2119	A 1258 L 1776 K 2135 TF 2162	A 1671	A 1661 L 2398 K 2662	A 1657 L 2296 K 2661 TF 2581	A 1530	A 1530 L 1558 K 2082	A 1532 L 1507 K 2226 TF 2011
May-Nov pasture yield (kg DM/ha)	A 4859	A 4839 L 3752 K 4191	A 4817 L 3656 K 4197 TF 4051	A 5393	A 5427 L 3644 K 4784	A 5434 L 3625 K 4801 TF 3830	A 7817	A 7815 L 5381 K 6966	A 7752 L 5279 K 7079 TF 6120

[A] A = annual; L = lucerne; K = kikuyu and TF = tall fescue pastures

If the additional summer feed produced was to be utilised to finish lambs instead of flushing or improving the condition of ewes the model suggests that none of the perennials in even a wet summer could finish all of the lambs produced (approximately 16 weaned lambs per ha on the perennial paddocks) (Table 7). One possible exception is kikuyu however based on its measured feed quality in summer it is unlikely to be sufficient to grow lambs alone.

In reality the utilisation of extra summer feed will vary depending on a range of factors e.g. the timing of summer rainfall. It is therefore likely that it will be used by both lambs and ewes when considered over a long period of time. Figures 7, 8 and 9 provide some approximate insights into the relative economic value of both ewes and lambs utilising additional perennial feed. Given that replacing supplement with extra perennial herbage is accounted for when comparing the gross margin of the annual system to the perennial systems at the same weaning percentage. Taking the current average weaning percentage on annuals at around 81% the median gross margin is $194/ha (Figure 7) compared to $261/ha on 50% perennials with a 100% weaning (assumes flushing ewes increases weaning by 19%) an additional $67/ha (Figure 9).

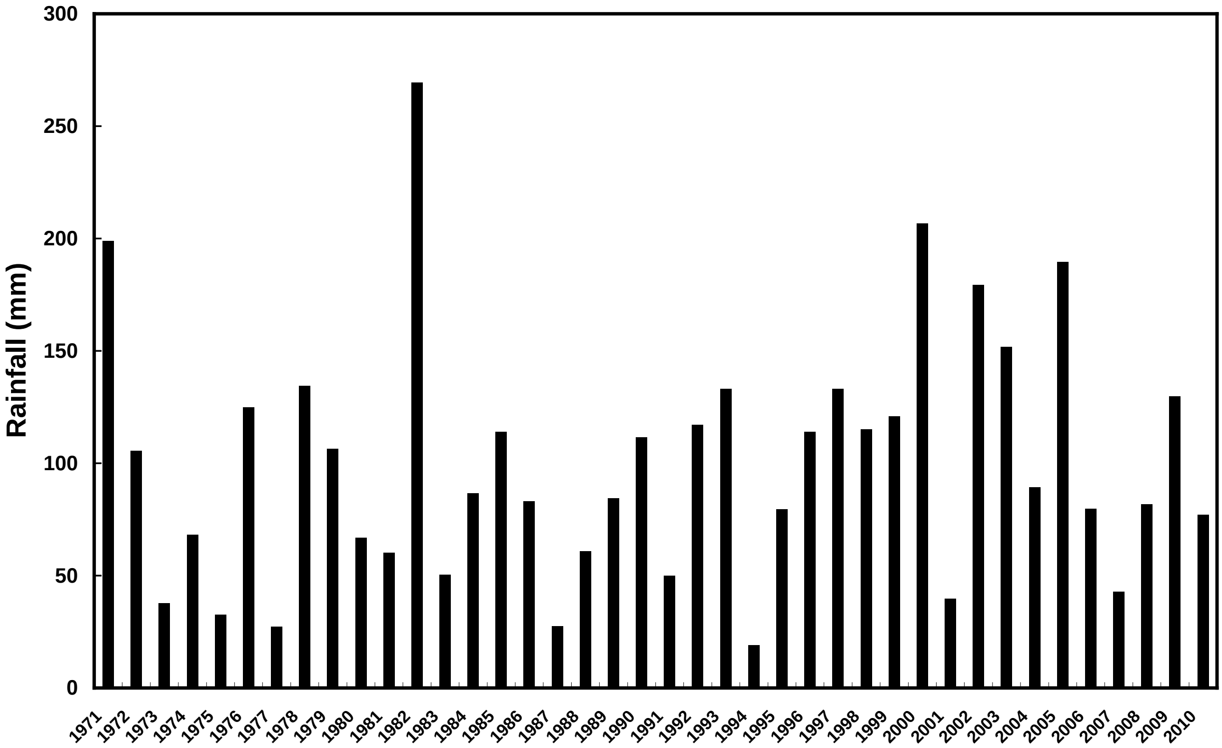


Figure 5. Total rainfall (mm) at Wellstead Proof Site between 1 December and 31 March 1971-2010.

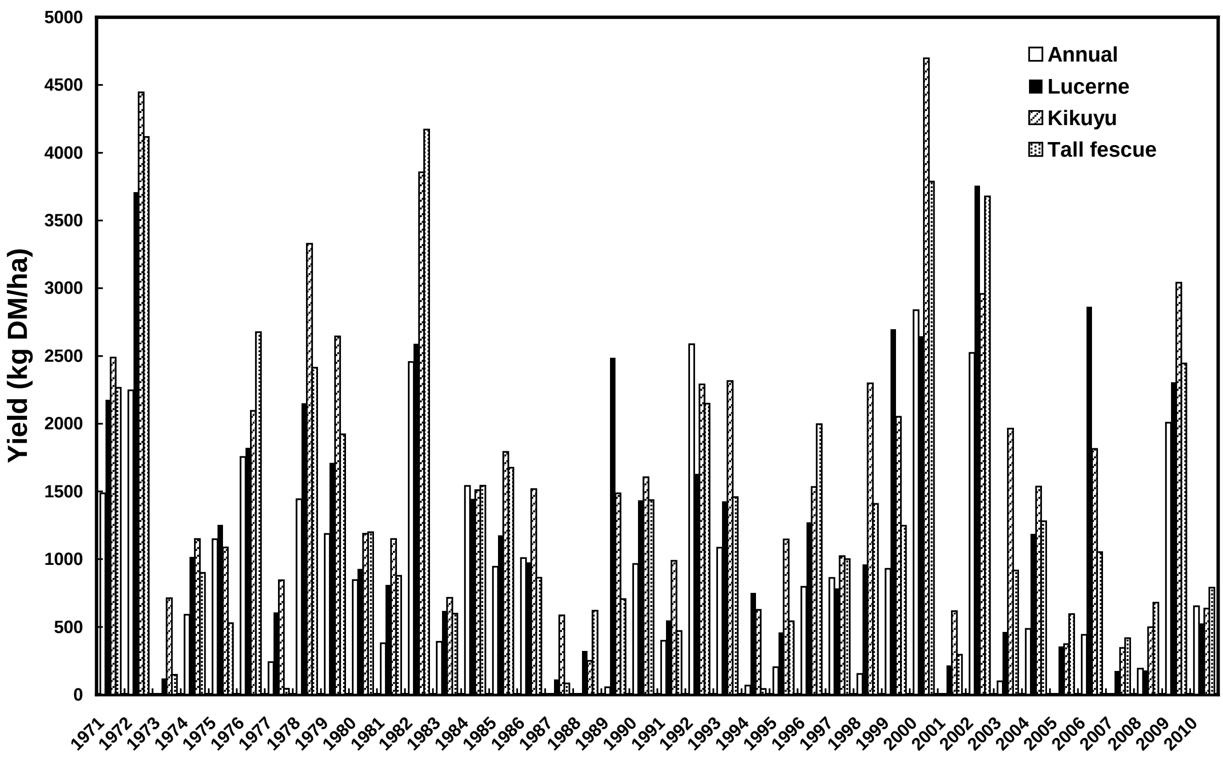


Figure 6. Yield of annual, lucerne, kikuyu and tall fescue pasture (kg DM/ha) between 1 December and 31 March 1971-2010 for the 50% perennials baseline system.

Table 7. The yield of annual, lucerne, kikuyu and tall fescue (kg DM/ha) in 50% perennial baseline system in average, dry and wet summers and estimated sheep production.

Pasture type	Summer rainfall	Pasture produced	No. of lambs/ha finished	No of ewes/ha increasing condition	No ewes/ha flushed
		(kg DM/ha)	70 kg to finish 1 lamb	40 kg to increase ewe condition score by 0.5	28 kg DM to flush ewes for 14 days
Annual	Average	875	13	22	31
	Dry	262	4	7	9
	Wet	1480	21	37	53
Lucerne	Average	1316	19	33	47
	Dry	520	7	13	19
	Wet	1865	27	47	67
Kikuyu	Average	1680	24	42	60
	Dry	767	11	19	27
	Wet	2604	37	65	93
Tall fescue	Average	1376	20	34	49
	Dry	350	5	9	13
	Wet	2273	32	57	81
		Difference to annual pasture			
Lucerne	Average	441	6	11	16
	Dry	258	4	6	9
	Wet	385	6	10	14
Kikuyu	Average	805	12	20	29
	Dry	504	7	13	18
	Wet	1125	16	28	40
Tall fescue	Average	501	7	13	18
	Dry	87	1	2	3
	Wet	793	11	20	28

3b. Changing lambing time.

A July lambing was more profitable than an August lambing for all the baseline systems modelled (Figure 10). Note stocking rate was increased for the August lambing from 6.5 to 7.5 ewes/ha. As expected the reduction in gross margin for an August lambing was least for the 50% perennial system ($65 per ha less) and most for the annual system ($101 less per ha). The reduced gross margin is associated with an increase in supplementary feed costs related to a higher feed demand in late spring and summer.

3c. Changing stocking rate for baseline systems

A range of stocking rates both higher and lower than that run at the Proof Site (6.5 ewes/ha) was simulated with the 25% perennial baseline system (Figure 11). The most profitable stocking rate was 6.5 ewes/ha with a median gross margin of $310/ha. As stocking rate increases both the gross margin quartile range and range increases representing more chance of a large loss or profit in any one year (Figure 11). The losses are associated with massive supplementary feed bills and the large profits with capitalising on years with a long growing season and high herbage yields. Given the increasing variability in seasons in the region a producer who is more risk averse could opt for a lower stocking rate of 5.2 ewes/ha and only incur a median gross margin loss of $28 per ha.

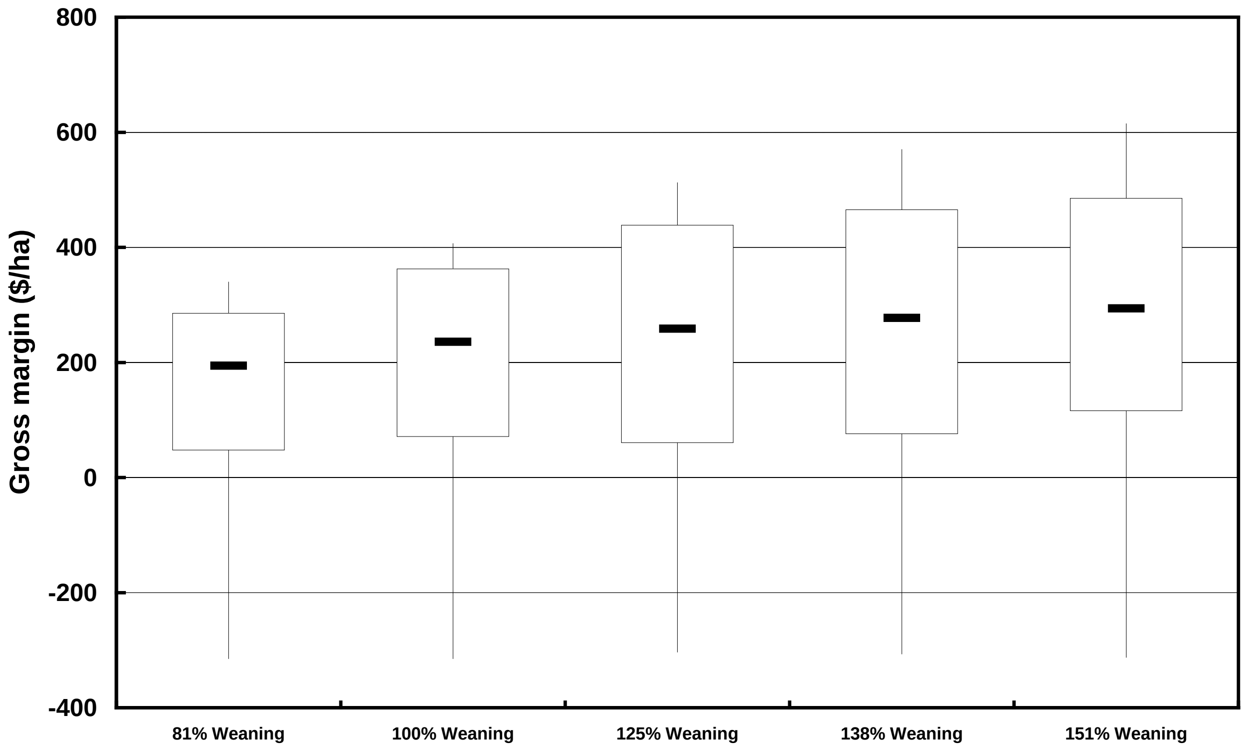


Figure 7. Boxplot of Annual pasture at standard price with 81, 100, 125, 138 and 151% weaning rates. Boxplots represent median, quartile range and range.

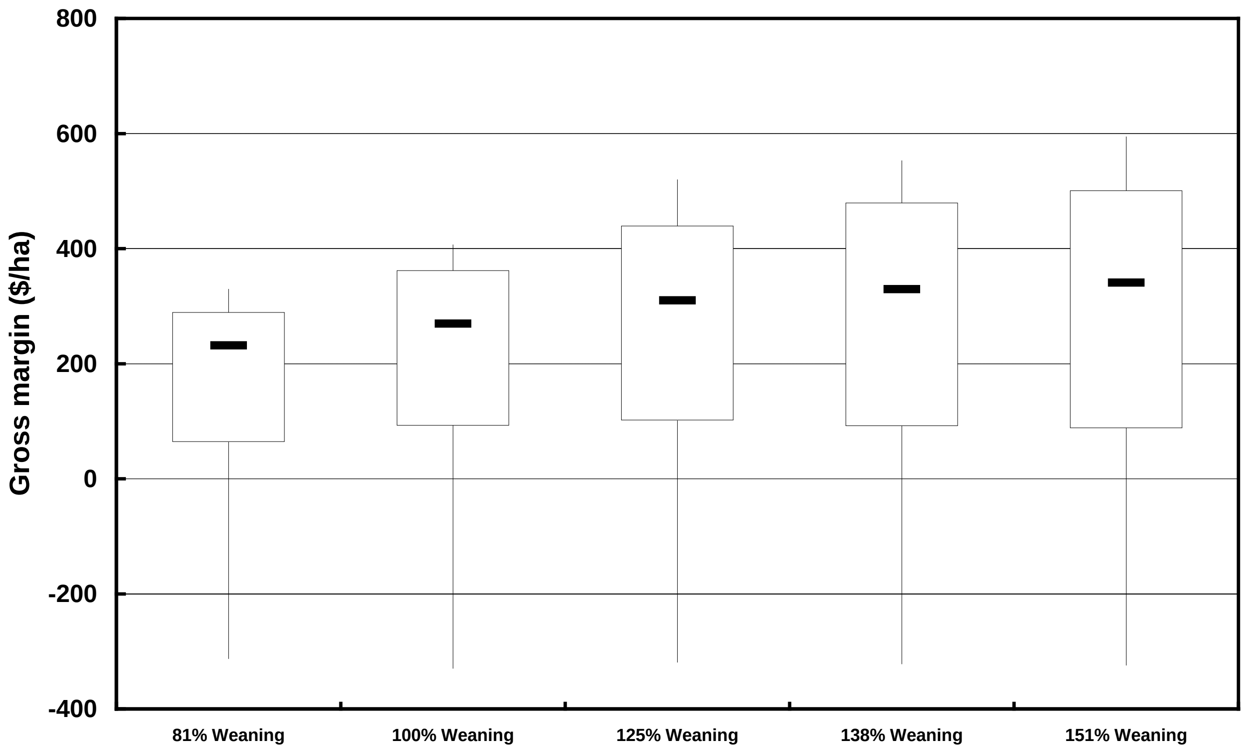


Figure 8. Boxplot of 25% perennial pasture at standard price with 81, 100, 125, 138 and 151% weaning rates. Boxplots represent median, quartile range and range.

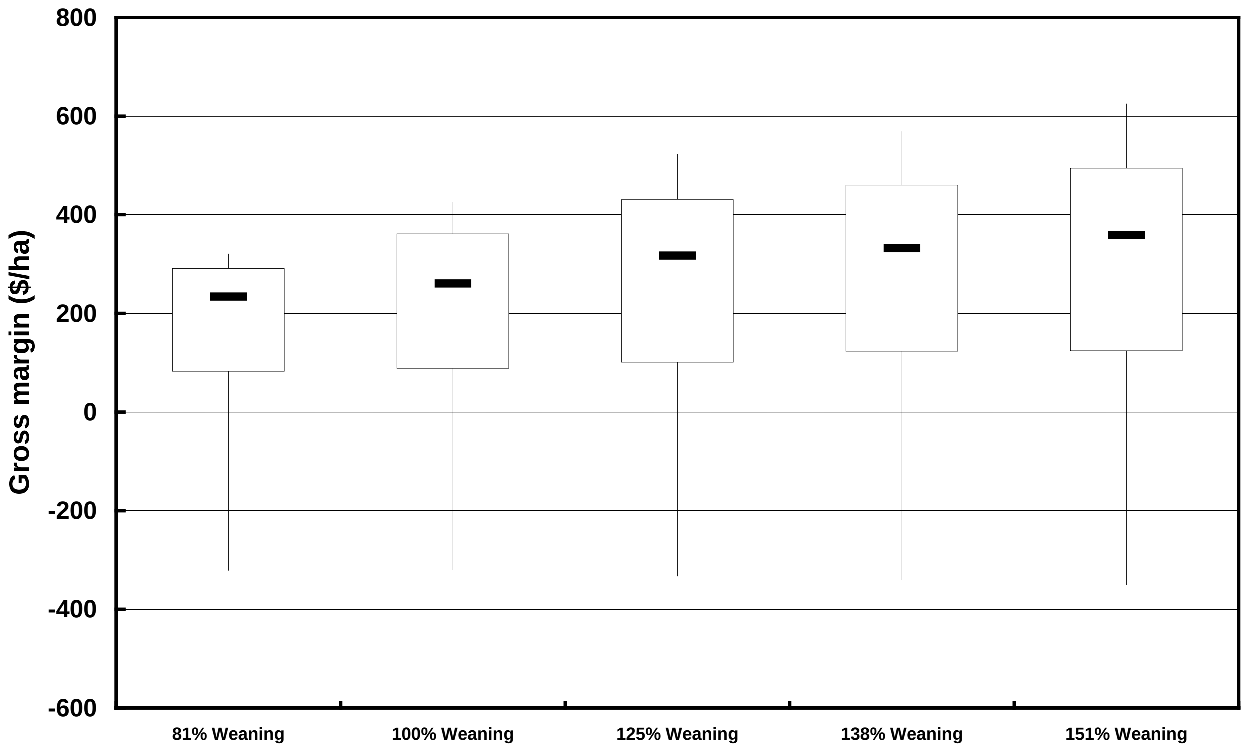


Figure 9. Boxplot of 50% perennial pasture at standard price with 81, 100, 125, 138 and 151% weaning rates. Boxplots represent median, quartile range and range.

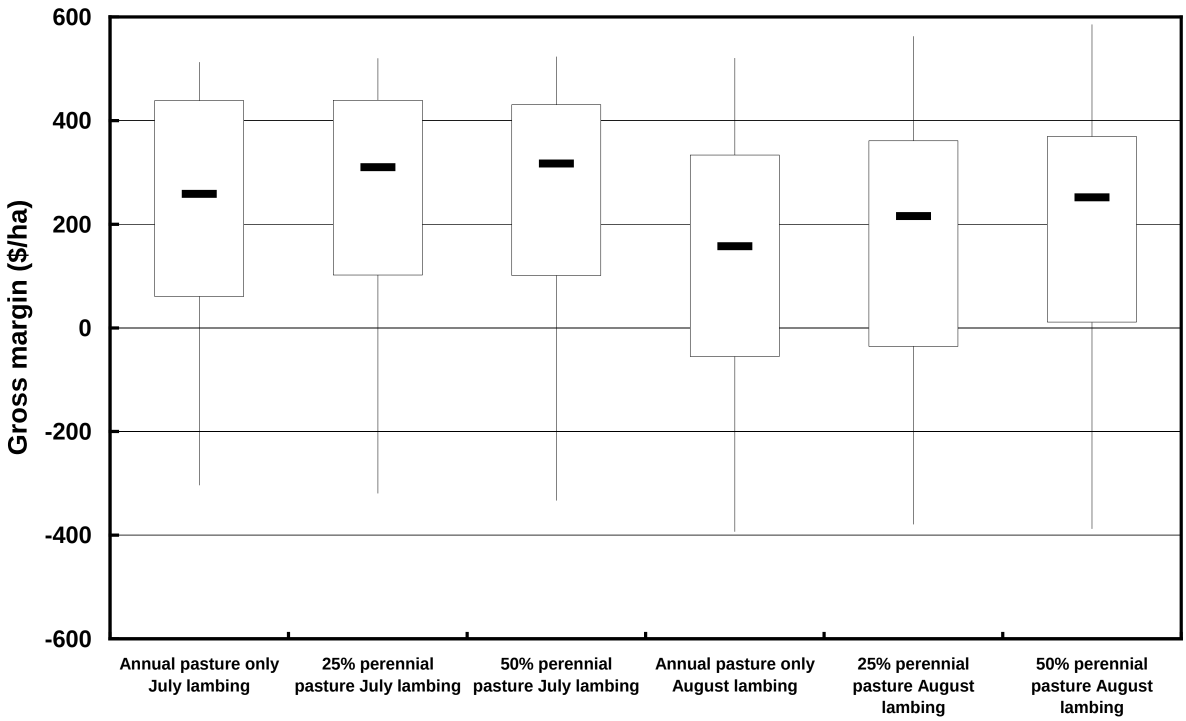


Figure 10. Boxplot of Annual pasture only, 25% Perennial pasture and 50% Perennial pasture with July or August lambing times. Boxplots represent median, quartile range and range.

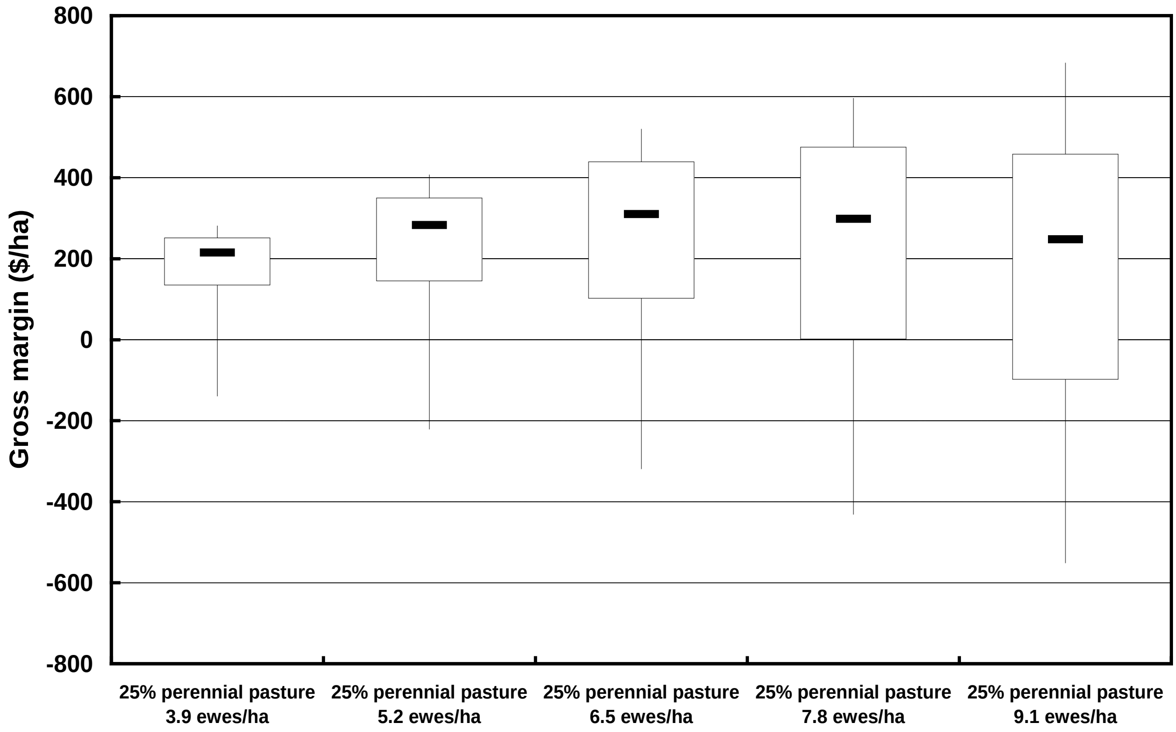


Figure 11. Boxplot of 25% Perennial pasture at standard price with 3.9, 5.2, 6.5, 7.8 or 9.1 ewes/ha. Boxplots represent median, quartile range and range.

4. Different livestock options

Different livestock enterprises were compared using the 25% perennial baseline system at standard prices (Figure 12; Table 8). All the sheep enterprises simulated (Merino x terminal, Merino self replacing and cross bred ewes) were substantially more profitable than beef cattle, average median gross margin of $308/ha compared to -$85/ha respectively. Various beef cattle scenarios were run however in this environment it was not possible to find profitable solutions given the lower beef price and the higher demand beef has for supplement.

The self replacing Merino system was the most profitable sheep enterprise by a small amount with a median gross margin of $320/ha. Nearly as profitable was the Merino x terminal system with a median gross margin of $310/ha. While the lamb income from the Merino x terminal system is higher it is not quite enough to make up the difference of having to purchase replacement ewes. In additional to being the most profitable the self replacing Merino system also appears to be slightly less risky based on the range of gross margin values experienced over the 40 year period simulated (Figure 12). As expected the cross bred ewe enterprise had the highest meat income per ha however the additional income was unable to overcome the lower wool value and extra costs associated with supplementary feed, replacement ewes and sale of sheep. However with a median gross margin of $294/ha this system was not substantially less profitable than the other sheep enterprises.

Across all the enterprises there were essentially no differences in either pasture yield or drainage of water below the root zone (Table 8).

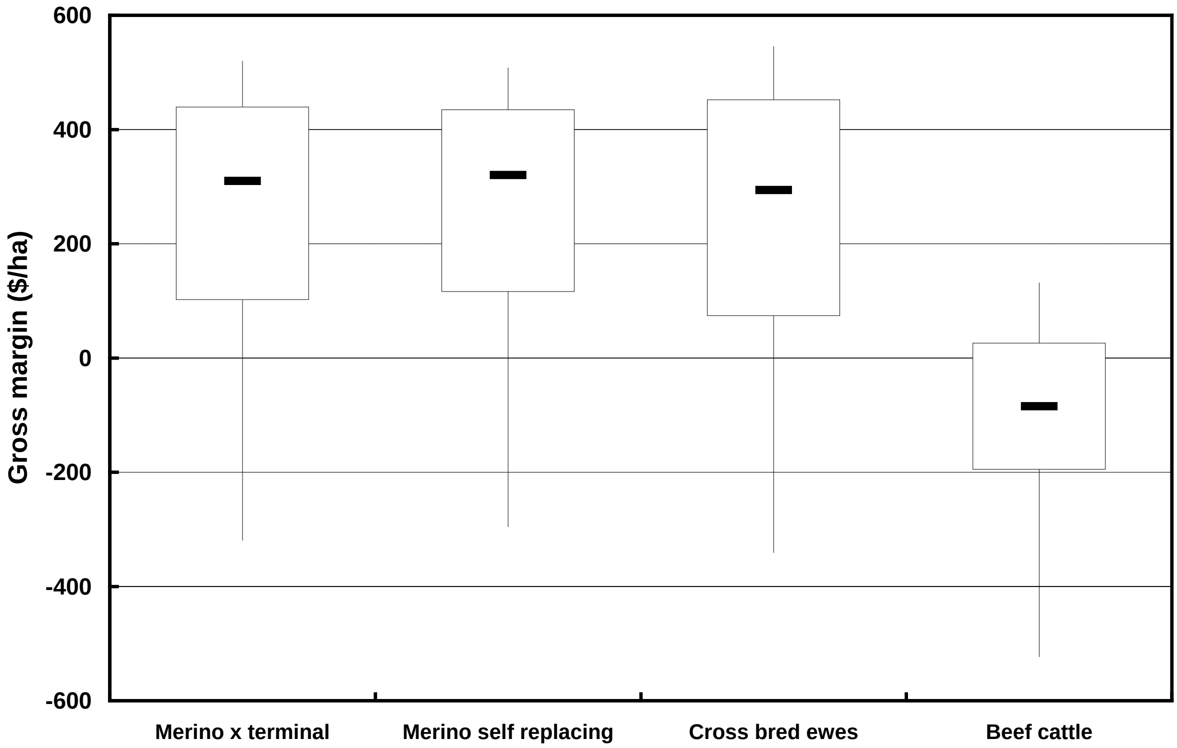


Figure 12. Boxplots for alternative livestock enterprises compared with the compared with Merino x terminal. All systems standard prices and 25% perennial pasture. Boxplots represent median, quartile range and range.

Discussion

Validation of the model and feedback from producers on the EverGraze Regional Group (not presented) suggest that the simulations are credible particularly for comparative purposes across a range of pasture systems, livestock enterprises and management tactics.

This analysis confirms the findings of Sanford and Bathgate (2011) that prime lamb enterprises comprising of between 20 and 50 percent perennial based pastures are more profitable than annual based pastures in the Wellstead environment. Previous paddock scale research suggests that the major drivers of increased farm profit with summer-active perennials are increased stocking rate and reduced supplementary feed (McDowall *et al*. 2003; Sanford *et al*. 2003). While the current analysis was not designed to explore the optimum stocking rates for all the respective systems it does support the principle that perennials such as lucerne and kikuyu reduce supplementary feed costs thereby increasing profit.

It is encouraging that gross margins for the perennial based systems was less affected than the annuals by dry autumns and springs particularly given that the climate in Wellstead is likely to be more variable in the future. The results indicate that the most robust livestock system in drier seasons is one with 50% perennial pastures.

The model was unable to directly test the most profitable way to utilise high quality summer feed with respect to the trade off between providing it to ewes or lambs. As a consequence a simple analysis was undertaken which does not provide a definitive answer. The results do highlight the fact that it is not possible to finish all of the lambs on summer perennial feed but it is possible to flush all the ewes. However, the choice a producer makes with respect to utilising summer feed will be determined as much by the timing of that feed as it is by the relative profitability. As a consequence lambs will be chosen more often as they are more flexible than flushing ewes for which the feed will need to be available at a particular time. The analysis did highlight that for producers currently weaning at the state average of around 80% increasing ovulation rate through flushing and other means can substantial lift profit.

Table 8. Profitability, productivity and risk of alternative systems compared with Merino x terminal. All systems standard prices and 25% perennial pasture.

	Merino x terminal	Merino self replacing	Cross bred ewes	Beef cattle
Mean annual rainfall (mm)	467	467	467	467
Stocking rate (ewes/ha or cows/ha)	6.5	6.5	6.5	1.2
DSE/ha 15 Jul	16.3	16.3	17.7	16.4
Mean annual DSE/ha	14.9	13.7	16.1	14.4
Lambing or calving	Jul	Jul	Jul	Aug
Mean Gross Margin ($/ha)	**247**	**255**	**244**	**-98**
Median	310	320	294	-85
Range	-318; 520	-295; 508	-341; 545	-523; 132
Lower, upper deciles	102; 439	138;431	74; 452	-195; 26
$/ha/100mm rainfall	53	55	52	-21
$/DSE	17	19	15	-7
Wean %	1.25	1.23	1.44	0.94
Clean wool (kg/adult)	3.9	3.9	3.4	n/a
Clean wool (kg/ha)	25	25	22	n/a
Sale weight lambs or calves (kg LW)	44.9	44.7	44.9	392
Weight lamb or calf sold (kg LW/ha)	362	320	418	274
Meat sold/ha (kg LW)	411	362	468	343
% income wool	22	24	15	0
% income meat	78	76	85	100
Total income	832	742	879	278
Total costs	585	487	635	377
Supplement (kg/ha)	587	584	691	713
Supplement (kg/ewe or kg/cow)	90	90	106	594
Supplement ($/ha)	235	234	269	210
Supplement ($/ewe or $/cow)	36	36	41	175
Probability of feeding > 30kg/ewe (years)	33/41	34/41	36/41	n/a
Probability total pasture mass < 800 kg DM/ha	0.25	0.25	0.29	0.24
Pasture utilisation (%)	47	47	51	48
Drainage below root zone (mm)[A]	A 18 L 0 K 0	A 18 L 0 K 0	A 18 L 0 K 0	A 18 L 0 K 0
	Overall 15	Overall 15	Overall 15	Overall 15
Total pasture yield (kg DM/ha)	A 8223 L 6783 K 8320	A 8229 L 6878 K 8285	A 8208 L 6998 K 8377	A 8252 L 6612 K 8612
Yield per mm rain (kgDM/ha/mm)	A 17.6 L 14.5 K 17.8	A 17.6 L 14.7 K 17.7	A 17.6 L 15.0 K 17.9	A 17.7 L 14.1 K 18.4
Dec-Apr pasture yield (kg DM/ha)	A 1339 L 1731 K 2095	A 1342 L 1727 K 2100	A 1338 L 1707 K 2075	A 1357 L 1640 K 2005
May-Nov pasture yield (kg DM/ha)	A 6885 L 5053 K 6226	A 6886 L 5150 K 6185	A 6870 L 5290 K 6302	A 6896 L 4972 K 6607

[A] A = annual; L = lucerne and K = kikuyu. n/a = not applicable.

The study indicates that for a Merino x terminal sire enterprise based on 25% perennials (kikuyu and lucerne) it is most profitable to run 6.5 ewes/ha, lambing in July with as high as is practical weaning percentage (e.g. 120%). Increasing perennial content to 50% might result in a very modest increase in gross margin however the main benefit appears to be increased drought proofing of the feed base and further reductions in drainage below the root zone. While summer-active tall fescue was included in the 50% perennial system field experiments have indicated that this type of tall fescue is not persistent in this environment due to its inability to survive the dry summers that occur occasionally (unpublished data). It is therefore recommended that producers adopt the proven and persistent perennials kikuyu and lucerne.

Beef cattle enterprises are uncommon in the study region a fact that is supported by this analysis which suggests cattle are for the most part unprofitable. All of the sheep enterprises simulated were economically viable with no one proving to be substantially more profitable than the other. It is possible that a split joining system could lift profit further by mating a percentage of Merino ewes to terminal sires and the remainder to Merino rams to provide replacement ewes. This may slightly lower the cost of replacement ewes and reduce risk associated with bad seasons.

These results point to a number of unanswered questions that could be tackled in the future. What are the optimal stocking rates for the annual and 50% perennial systems? Are there more profitable scenarios for the self replacing Merino and cross bred ewe enterprises? How profitable would a wool enterprise, particularly one based on fine wool on perennials, be in this environment?

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Supplement - Additional modelling questions

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July 2012

Background

The results from the original tactical management regime analysis documented in the main body of this report were presented to the WA EverGraze Regional Group. As a result of the discussion during the meeting the research team was tasked with answering the three additional questions stated below;

1. What is the most profitable combination of stocking rate, lambing time, weaning percentage and proportion of the pasture base sown to perennials for a Merino based prime lamb production system in Wellstead?
2. How profitable is the EverGraze livestock system in a 300 and 600 mm rainfall environment?
3. How profitable is a fine wool enterprise compared to a dual purpose Merino in Wellstead?

This supplement will report on the analysis of question 1 and 2.

Method

In addition to the proof site location at Wellstead with a long term annual rainfall of 467mm two additional locations on the south coast of WA were chosen to be modelled, Ongerup and Mt Barker with long term annual rainfall values of 376 and 656mm respectively. The climate files for the new locations were constructed using SILO the soil descriptions used were identical to Wellstead. Neither location was validated. The following variables were varied to determine the most profitable dual purpose Merino systems at each of the three locations;

1. Proportion of ewes carrying twins
2. Time of lambing
3. Stocking rate
4. Proportion of the whole feed base that is perennial
5. Number of days ewes were locked up on kikuyu in autumn

The pasture systems modelled and the timing of livestock management are described in Table 1 and 2. All the remaining parameters with the exception of grazing management are detailed in the appendix. The simulations were run for the period 1970 to 2010.

Table 1. Description of pasture systems simulated

System	Subclover, ryegrass & capeweed pasture	Kikuyu & subclover pasture	Lucerne, ryegrass and subclover pasture	Tall fescue & subclover pasture
Annual	100.0%	Nil	Nil	Nil
25% Perennial	76.5%	15.9%	7.6%	Nil
50% Perennial	48.4%	28.8%	11.4%	11.4%
75% Perennial	23.8%	35.4%	15.2%	25.6%
100% Perennial	Nil	43.8%	27.1%	29.1%

Table 2. Timing of livestock management for different lambing times used in simulations.

Lambing	**April**	**May**	**June**	**July**	**August**
Weaning	August	September	October	November	December
Replacement Ewes	October	November	December	January	February
Shearing	February	March	April	May	June

Results

Due to the large number of simulations undertaken the following results focus on the most profitable solutions for the pasture systems described in table 1 at each of the three locations. Initial simulations consistently showed that gross margins increased in a linear fashion with more twin lambs (data not shown). The decision was made to run all simulations with 50% singles and 50% twins as this was the approximate ratio achieved at the Proof Site and was considered most practical with Merino ewes given their mothering skills.

1. Albany Proof Site – Wellstead

The relationship between simulated gross margin and stocking rate is presented in figure 1. The highest gross margin modelled was $329 per ha for the 25% perennial system at 7.8 ewes per ha with a May lambing and stock locked up on kikuyu for 30 days in autumn. However, increasing the perennial content to 50% reduced gross margins by very little. Higher perennial content resulted in a later optimum lambing time (e.g. June and July) and increased the number of days stock could benefit from being locked up on kikuyu in autumn (e.g. 60 days). Interestingly the lowest gross margins were recorded for both the annual and 100% perennial systems. In the case of the annuals this was a consequence of a higher requirement for supplementary feed outside the growing season (Figure 3). Whereas the 100% perennial system yielded less annual dry matter on average (Figure 2) resulting in more supplement being fed (Figure 3) within the growing season. There were no differences in the clean wool and meat produced per ha per annum for each of the pasture systems (Figure 4 and 5) as these outputs are dependent on stocking rate and/or feeding supplement to finish all lambs at a given weight by a specific date.

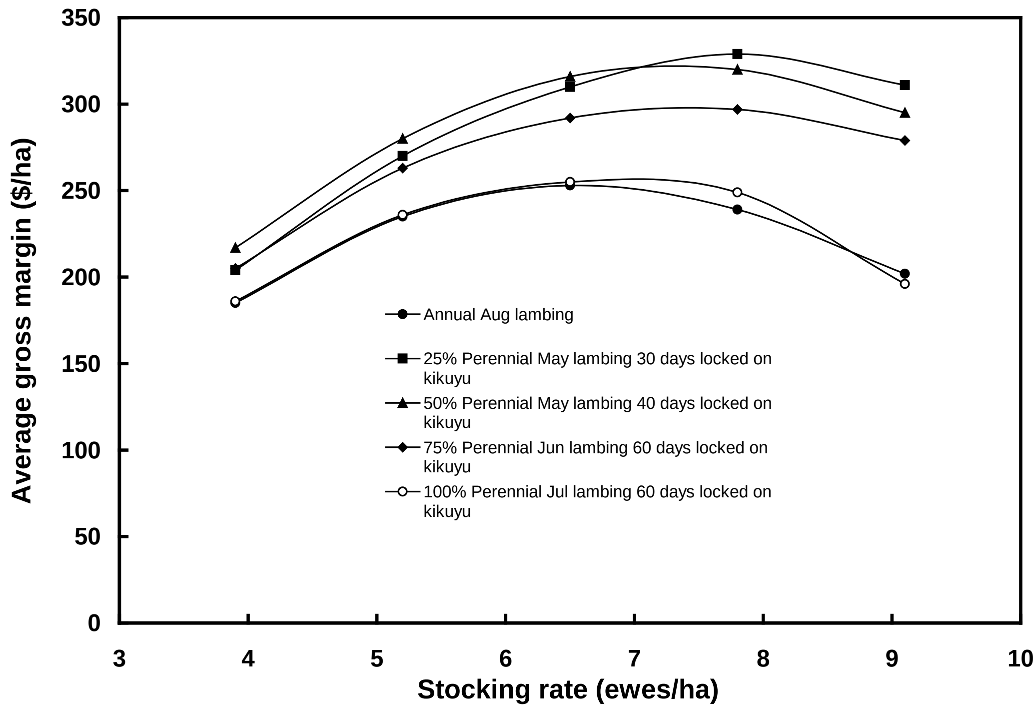

Figure 1. Relationship between stocking rate and average gross margin at Wellstead for the most profitable solutions for each of the pasture systems, annual, 25% perennial, 50% perennial, 75% perennial and 100% perennial.

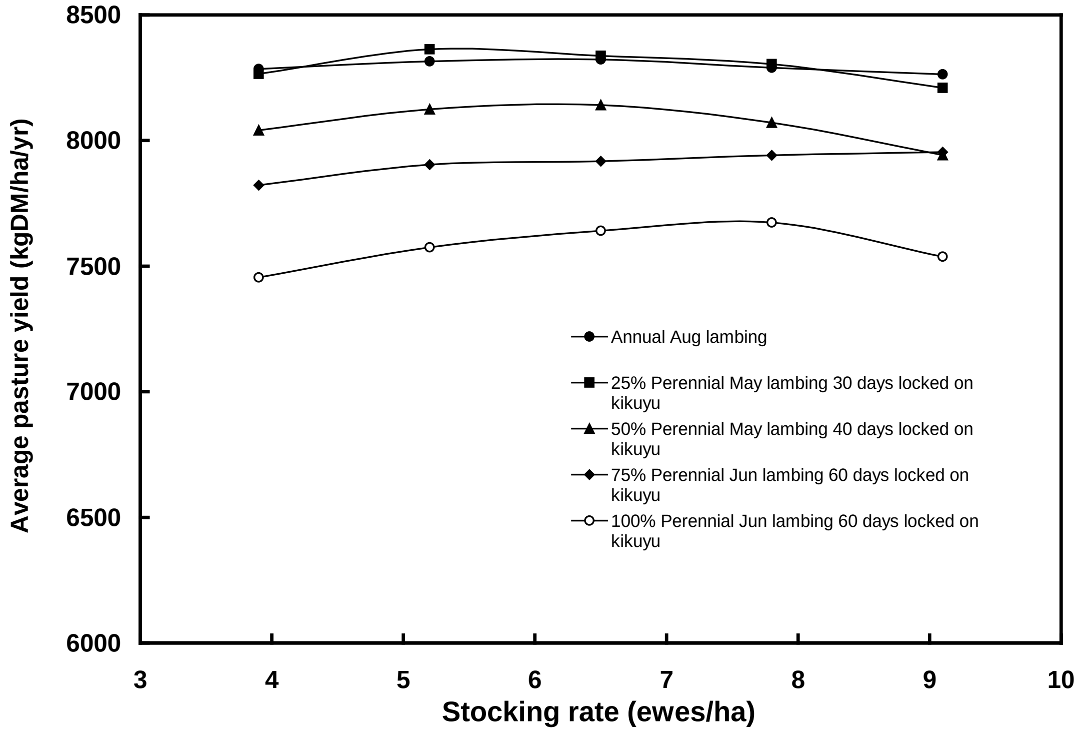

Figure 2. Relationship between stocking rate and average annual pasture yield at Wellstead for the most profitable solutions for each of the pasture systems, annual, 25% perennial, 50% perennial, 75% perennial and 100% perennial.

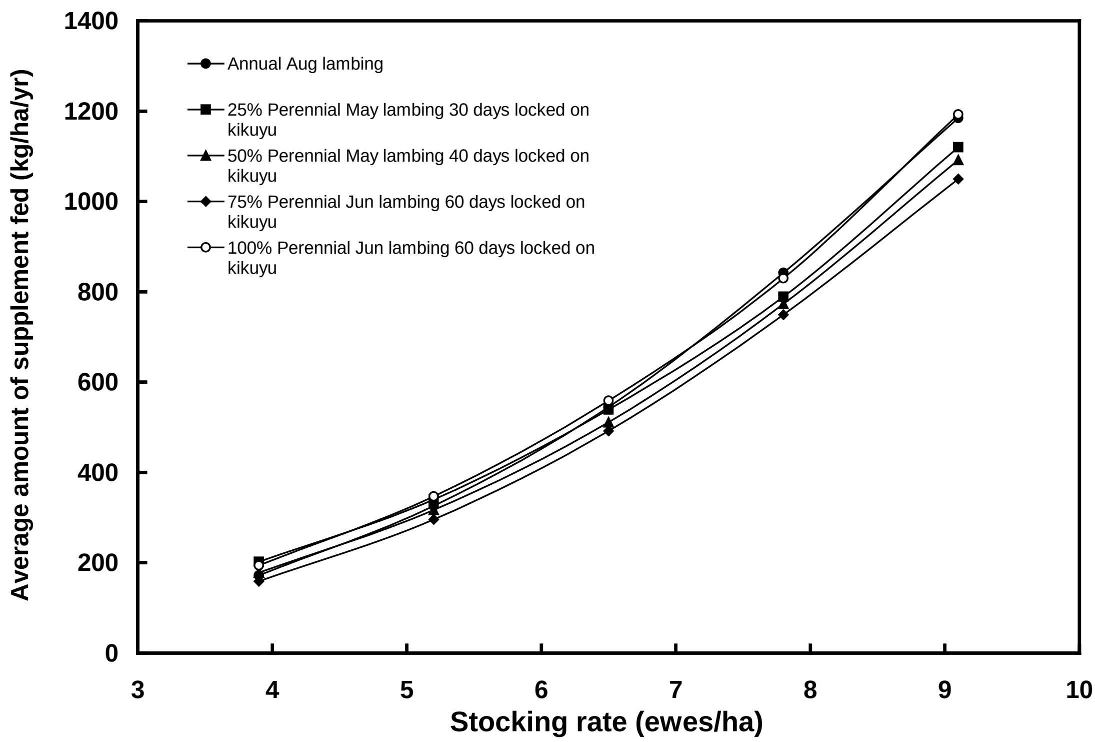

Figure 3. Relationship between stocking rate and average supplement fed at Wellstead for the most profitable solutions for each of the pasture systems, annual, 25% perennial, 50% perennial, 75% perennial and 100% perennial.

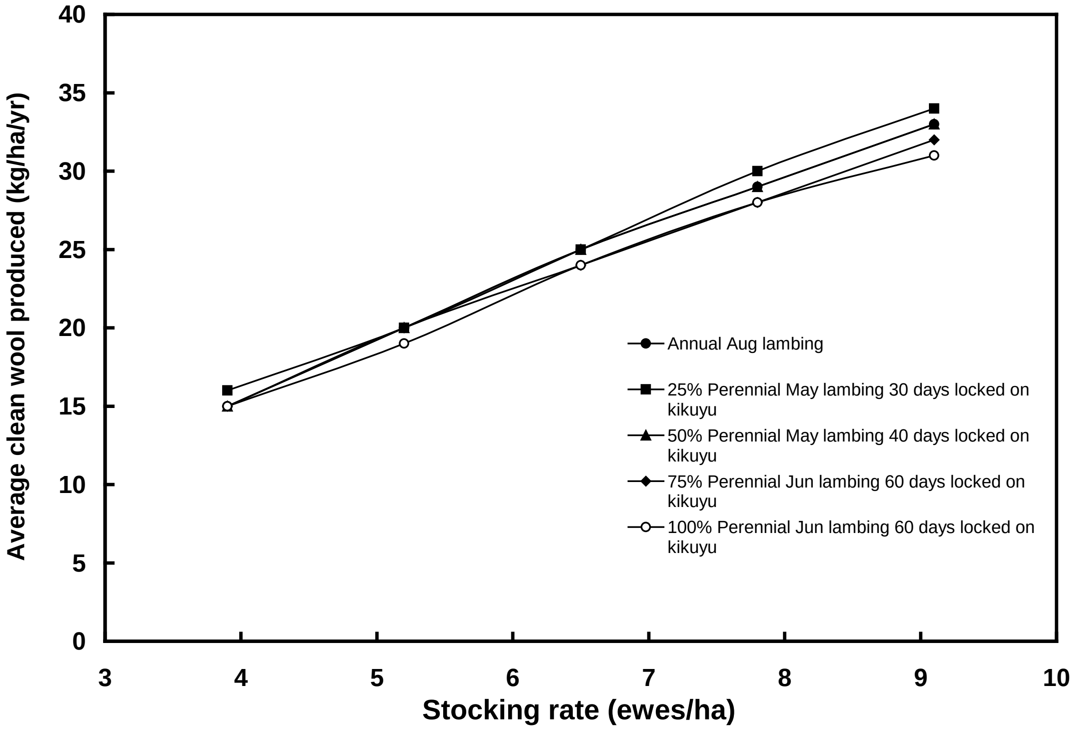

Figure 4. Relationship between stocking rate and average clean wool produced per ha per annum at Wellstead for the most profitable solutions for each of the pasture systems, annual, 25% perennial, 50% perennial, 75% perennial and 100% perennial.

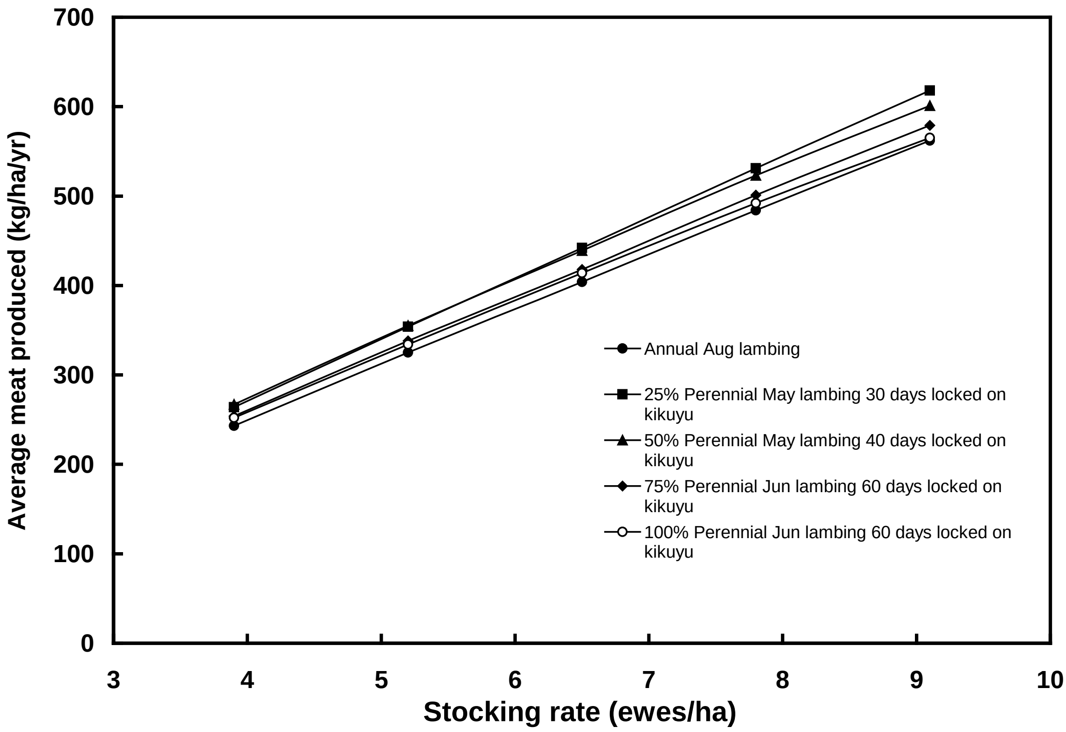

Figure 5. Relationship between stocking rate and average meat produced per ha per annum at Wellstead for the most profitable solutions for each of the pasture systems, annual, 25% perennial, 50% perennial, 75% perennial and 100% perennial.

2. Ongerup

Ongerup receives only 376mm of rainfall per annum on average compared to 467mm at the Wellstead Proof Site. In addition the growing season is shorter. As a consequence the gross margins are considerably lower with the highest modelled being $96 per ha per annum with a pasture system containing 75% perennials, stocked at 3.9 ewes per ha with ewes locked on kikuyu for 30 days in autumn. Gross margins for the 50% perennial system are very similar to that of the 75% perennial at the optimum stocking rate of 3.9 ewes per ha. Even though the average pasture yield across the 100% perennial pasture system was lowest (Figure 7) as a consequence of having to feed the least amount of supplement (Figure 8) this system achieved the third highest gross margin at a stocking rate of 3.9 ewes per ha or less. The simulations suggest that on average annual pastures out yield perennial based swards (Figure 7) but due to a relatively short growing season require larger quantities of supplementary feed (Figure 8) to finish lambs and maintain ewes. As a result the annual and 25% perennial systems returned substantially reduced gross margins at or around the optimum stocking rate of 3.9 ewes per ha (Figure 6). Like the Proof Site, at Ongerup as perennial content increases the optimum lambing time becomes later however there is a tendency for the ideal lambing time to be earlier at Ongerup. As expected the higher the area under kikuyu the greater the number of day's stock can be locked up on it in autumn. Clean wool and meat production results are provided in figures 9 and 10.

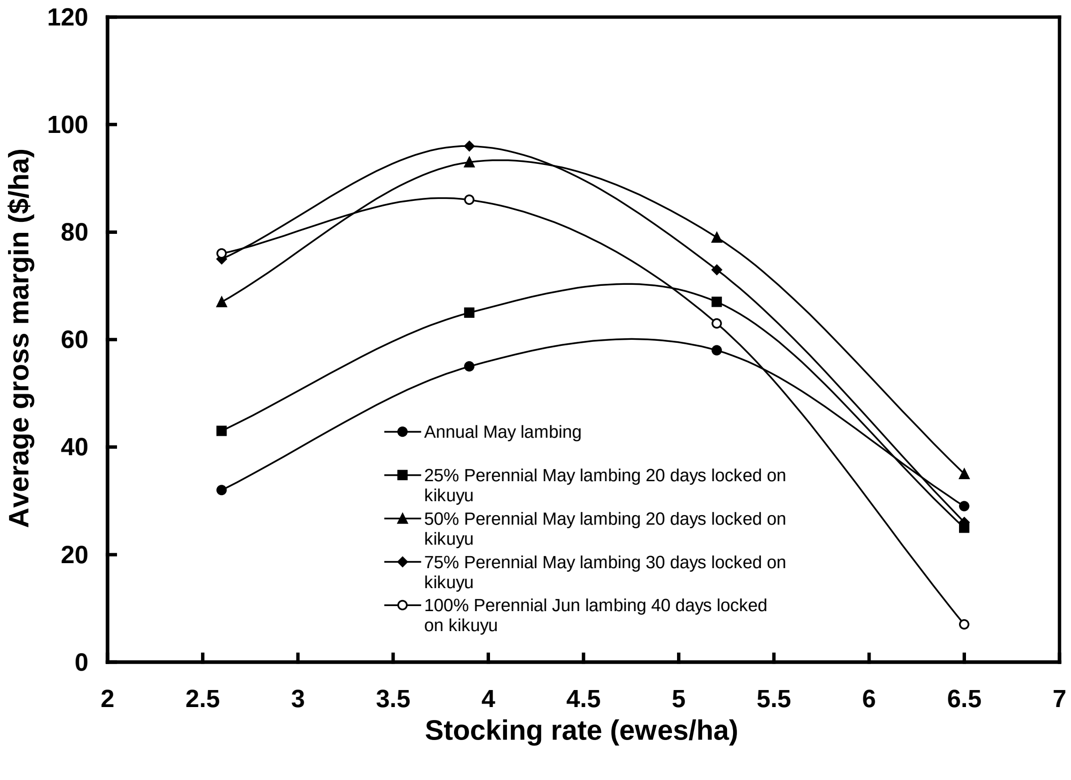

Figure 6. Relationship between stocking rate and average gross margin at Ongerup for the most profitable solutions for each of the pasture systems, annual, 25% perennial, 50% perennial, 75% perennial and 100% perennial.

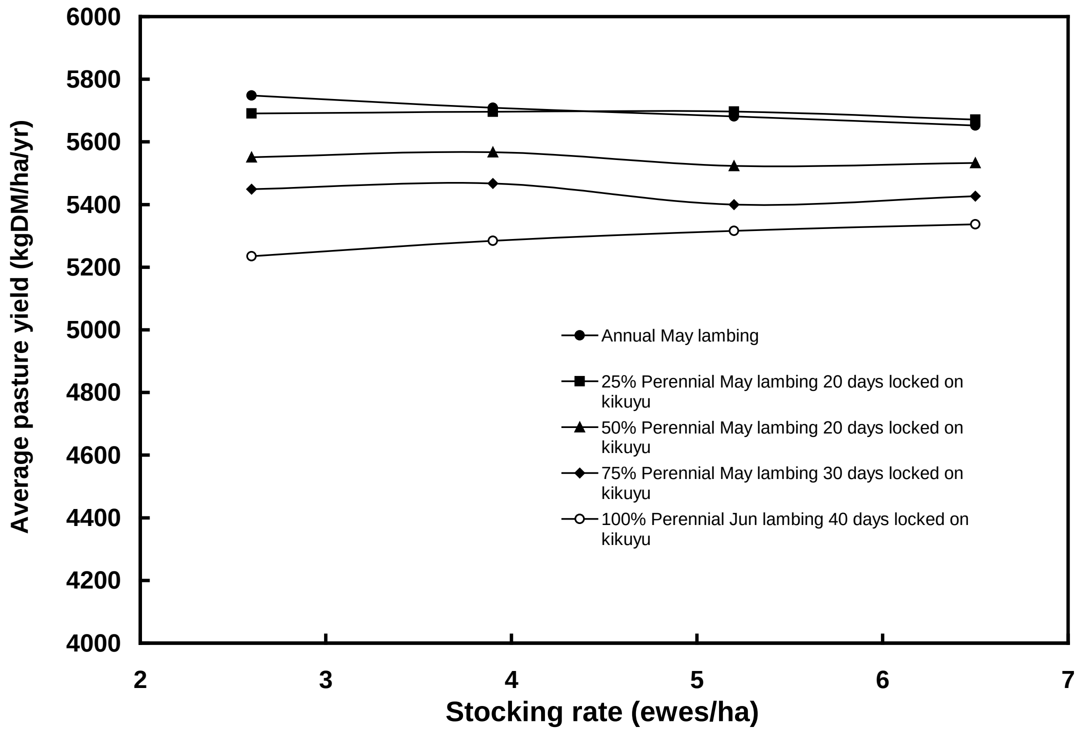

Figure 7. Relationship between stocking rate and average pasture yield at Ongerup for the most profitable solutions for each of the pasture systems, annual, 25% perennial, 50% perennial, 75% perennial and 100% perennial.

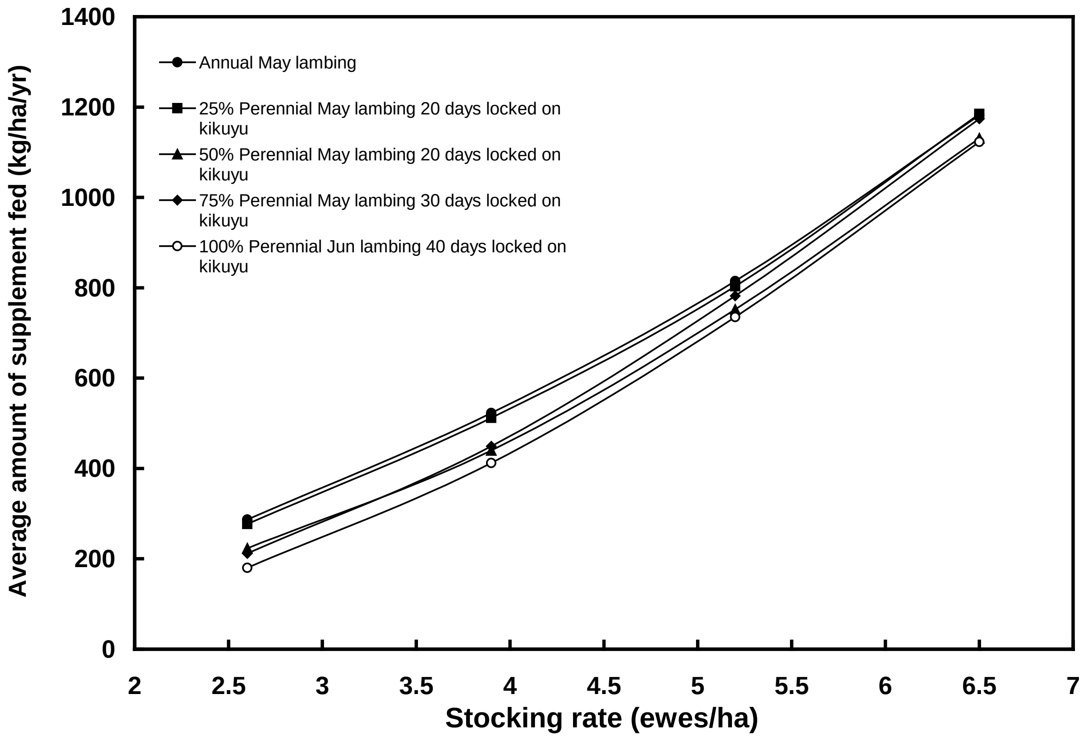

Figure 8. Relationship between stocking rate and average amount of supplement fed at Ongerup for the most profitable solutions for each of the pasture systems, annual, 25% perennial, 50% perennial, 75% perennial and 100% perennial.

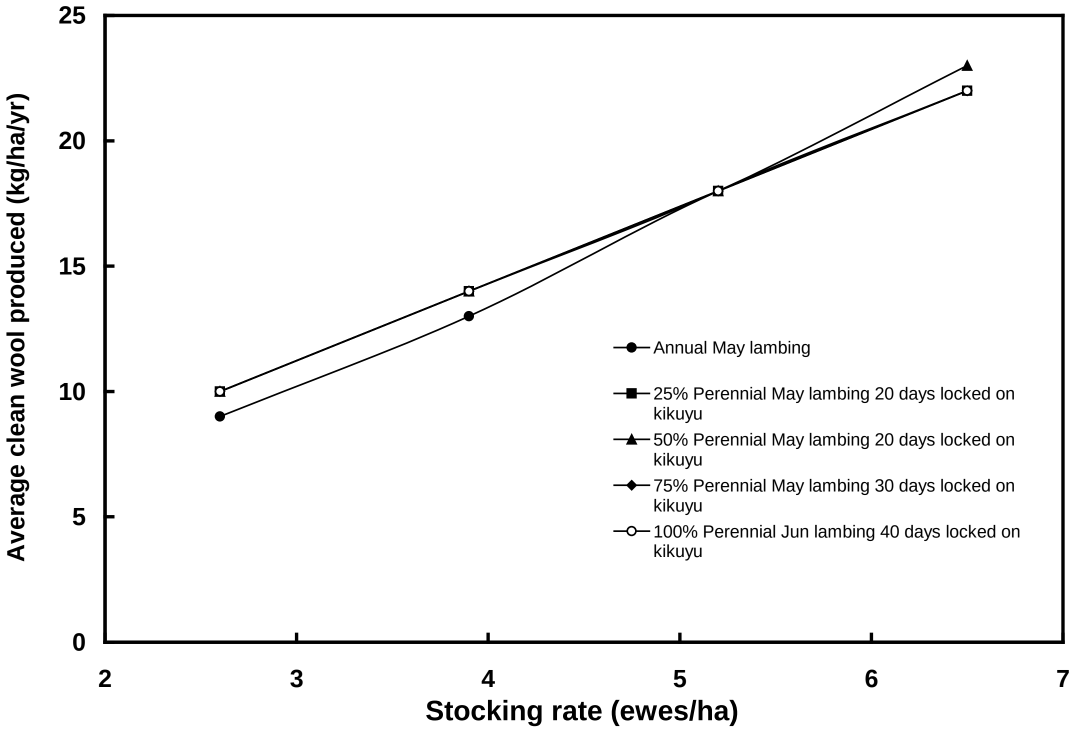

Figure 9. Relationship between stocking rate and average amount of clean wool produced at Ongerup for the most profitable solutions for each of the pasture systems, annual, 25% perennial, 50% perennial, 75% perennial and 100% perennial.

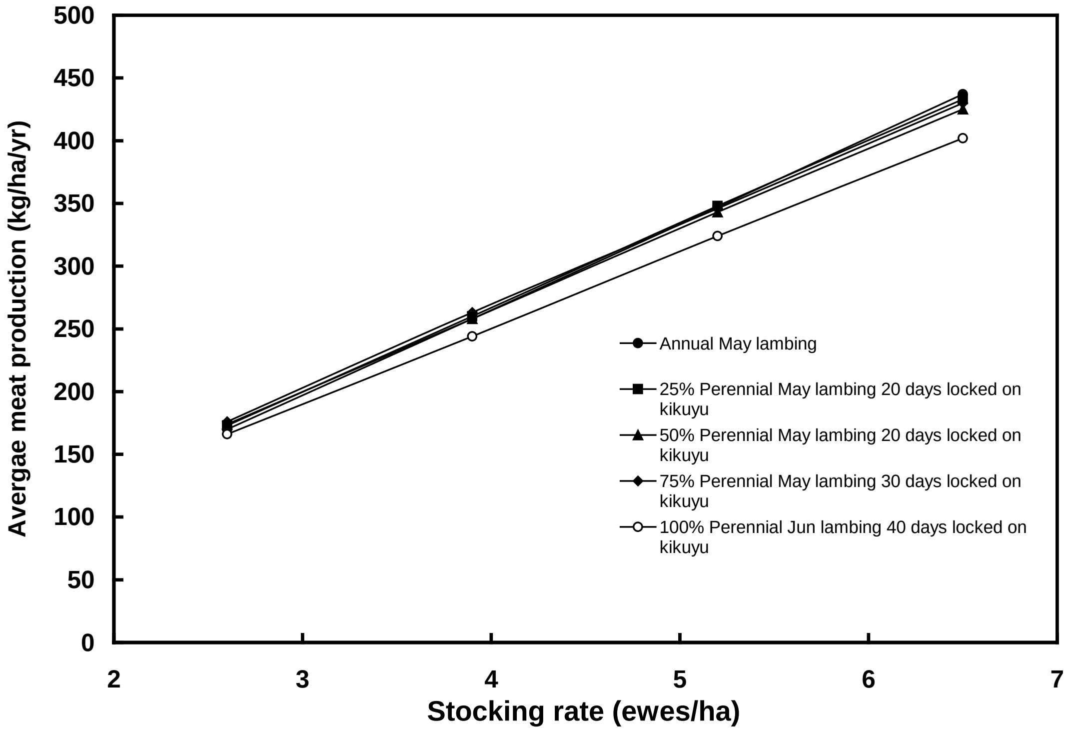

Figure 10. Relationship between stocking rate and average amount of meat produced at Ongerup for the most profitable solutions for each of the pasture systems, annual, 25% perennial, 50% perennial, 75% perennial and 100% perennial.

3. Mt Barker

Mt Barker is a higher rainfall environment receiving 656mm of rainfall per annum on average compared to 376 and 467mm at Ongerup and Wellstead respectively. As expected gross margins are considerably greater with the highest modelled being $688 per ha per annum with a pasture system containing 25% perennials, stocked at 11.7 ewes per ha and May lambing with ewes locked up on kikuyu for 40 days in autumn (Figure 11). Gross margins for both the 50% and 75% perennial systems are similar to that with 25% perennials. The annual system performs quite well in this environment in terms of pasture yield (Figure 12) however the increase in supplement required to run this system (Figure 13) resulted in lower gross margins (e.g. $628 per ha at 11.7 ewes per ha, Figure 11). As for both the Wellstead and Ongerup site the simulations suggest that the 100% perennial system results in a reduced pasture yield (Figure 12) leading to a higher cost in supplementary feed. As for the other sites as perennial content increases the optimum lambing time becomes later and the higher the area under kikuyu the greater the number of day's stock can be locked up on it in autumn. Clean wool and meat production results are provided in figures 14 and 15.

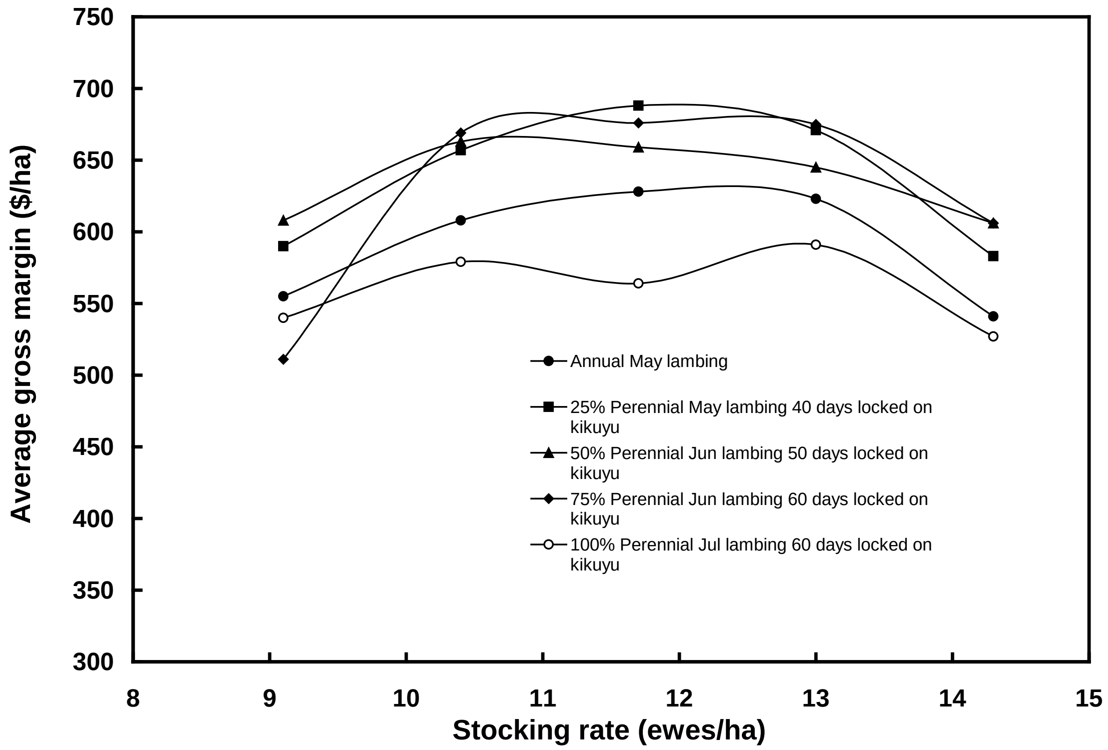

Figure 11. Relationship between stocking rate and average gross margin at Mt Barker for the most profitable solutions for each of the pasture systems, annual, 25% perennial, 50% perennial, 75% perennial and 100% perennial.

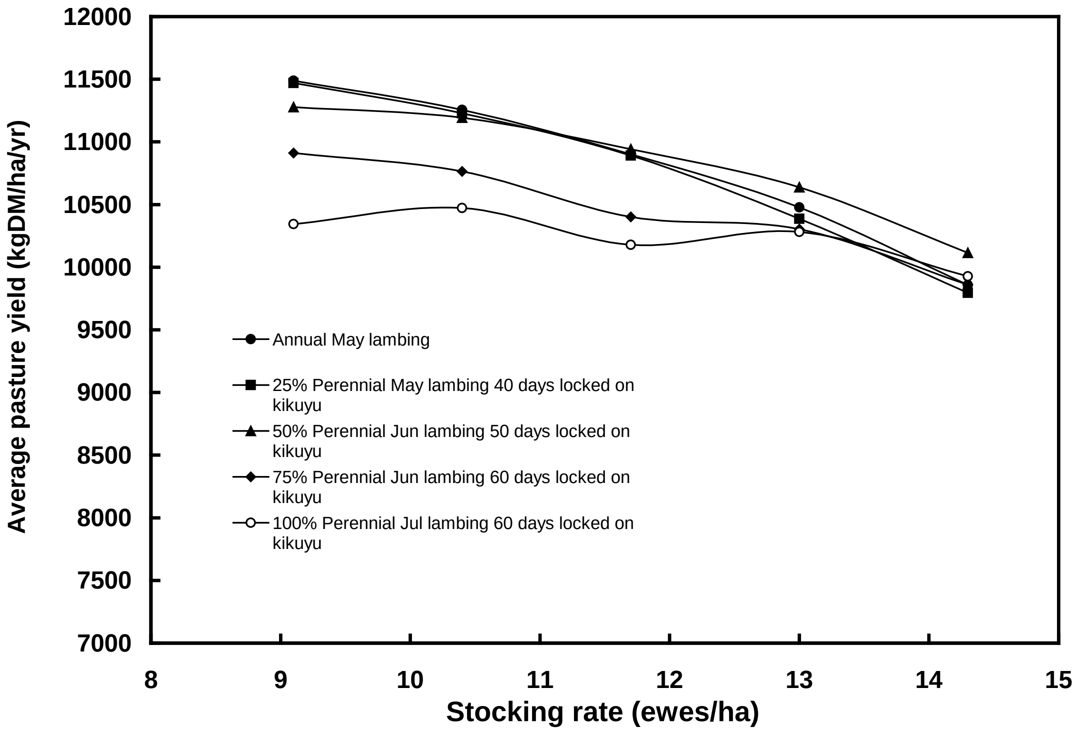

Figure 12. Relationship between stocking rate and average pasture yield at Mt Barker for the most profitable solutions for each of the pasture systems, annual, 25% perennial, 50% perennial, 75% perennial and 100% perennial.

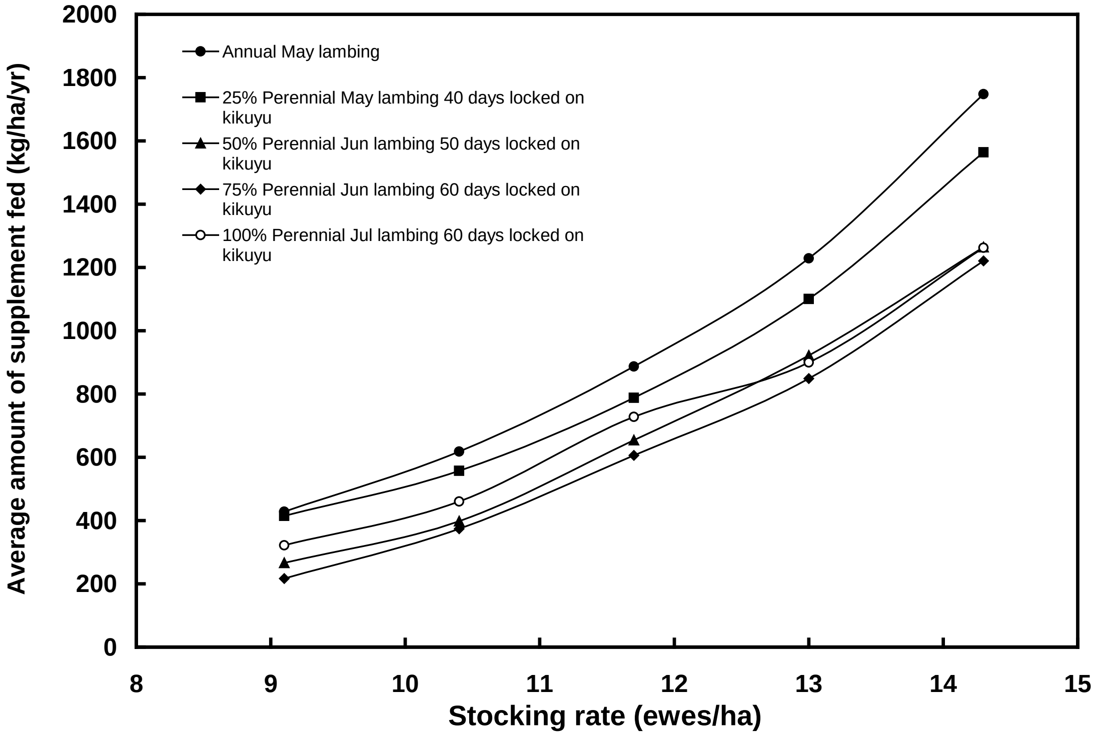

Figure 13. Relationship between stocking rate and average amount of supplement fed at Mt Barker for the most profitable solutions for each of the pasture systems, annual, 25% perennial, 50% perennial, 75% perennial and 100% perennial.

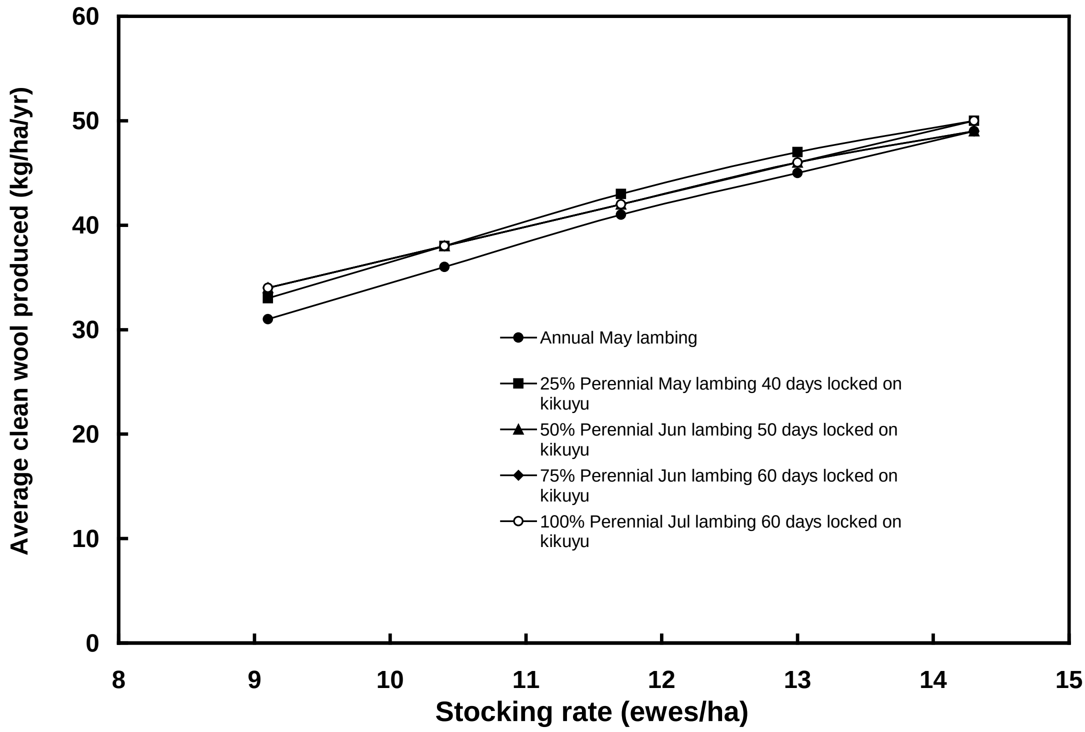

Figure 14. Relationship between stocking rate and average clean wool produced at Mt Barker for the most profitable solutions for each of the pasture systems, annual, 25% perennial, 50% perennial, 75% perennial and 100% perennial.

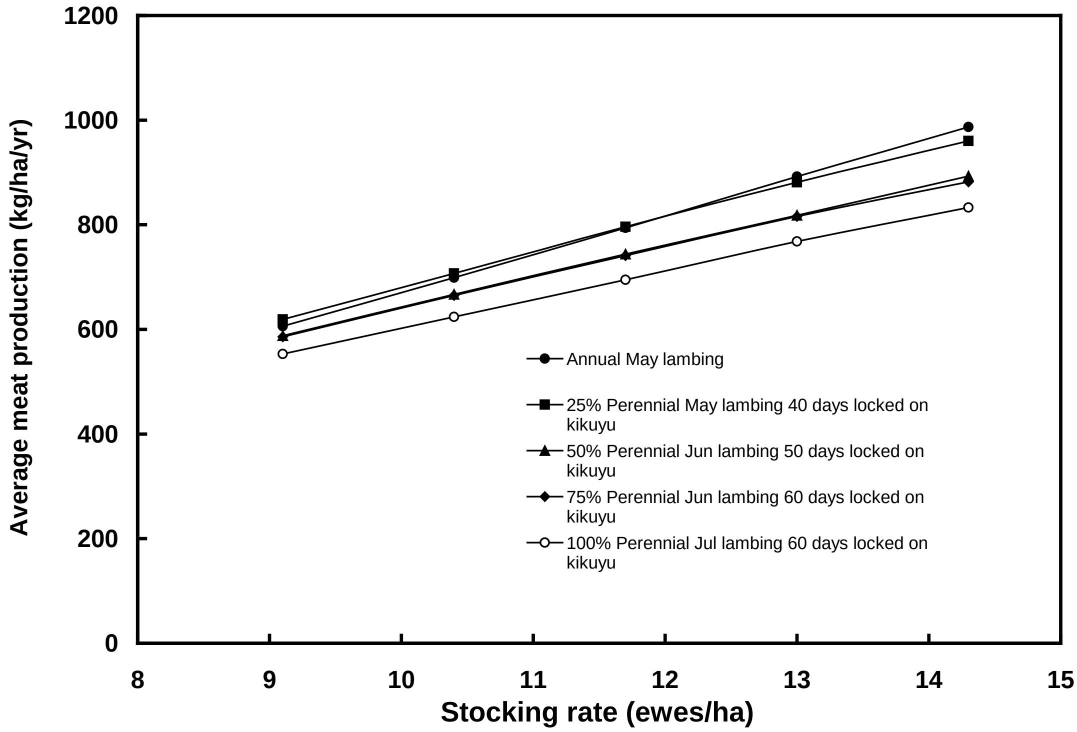

Figure 15. Relationship between stocking rate and average meat production at Mt Barker for the most profitable solutions for each of the pasture systems, annual, 25% perennial, 50% perennial, 75% perennial and 100% perennial.

4. Comparison across the three locations

The optimum pasture system at each of the three locations is compared in terms of gross margins, pasture yield and amount of supplement fed in figures 16, 17 and 18 respectively.

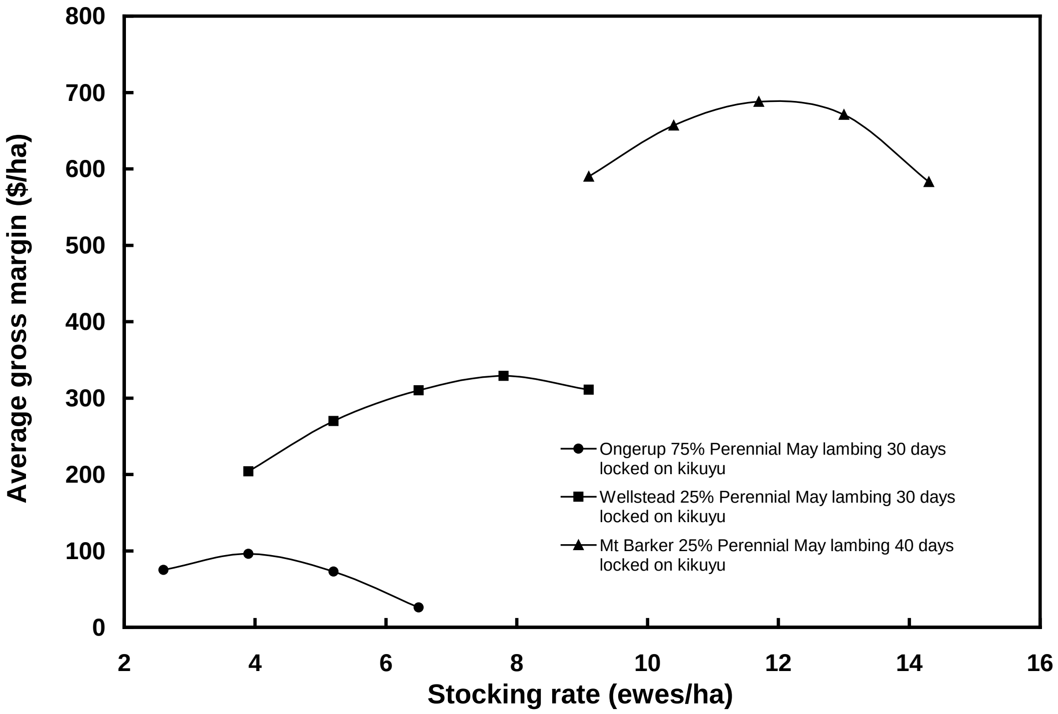

Figure 16. Comparison between stocking rate and average gross margin for the most profitable systems at Ongerup, Wellstead and Mt Barker.

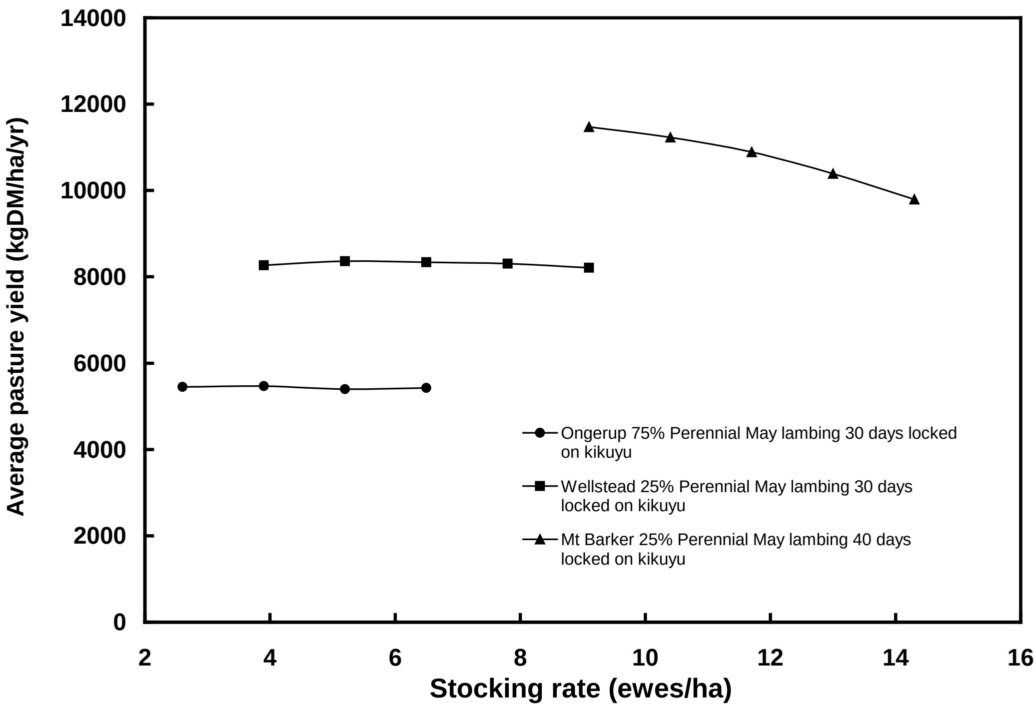

Figure 17. Comparison between stocking rate and average pasture yield for the most profitable systems at Ongerup, Wellstead and Mt Barker.

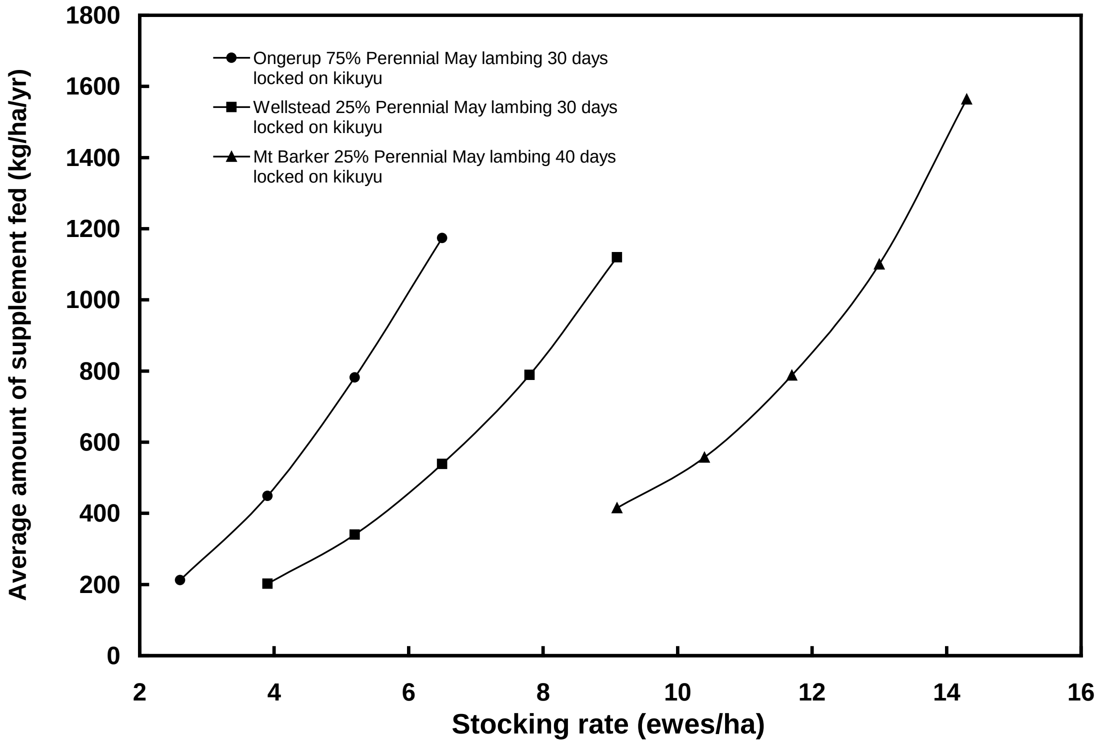

Figure 18. Comparison between stocking rate and average amount of supplement fed for the most profitable systems at Ongerup, Wellstead and Mt Barker.

Discussion

Caution must be used with the findings from both Ongerup and Mt barker as the GrassGro model was only rigorously validated for the Proof Site at Wellstead. However previous field data and experience simulating livestock systems at Mt Barker provide more confidence in the results for this site than Ongerup. In addition the model does not simulate perennial persistence well, field studies however have demonstrated that kikuyu and lucerne will persist at Mt Barker, Wellstead and Ongerup. The summer-active tall fescue used in these simulations has been show to not to persist for long periods at Wellstead and by extrapolation at Ongerup. It was included in this analysis as a generic summer-active temperate grass.

This analysis supports the original findings of the Tactical Management Regime investigation (see main body of report) in relation to the EverGraze Proof Site at Wellstead at least in terms of the optimal pasture system, that is, between 25 and 50% perennial pasture will provide the highest long term gross margin for a Merino ewe based prime lamb enterprise. However this analysis suggests that lambing in May and holding the ewes on kikuyu in the autumn can lift the optimum stocking rate from 6.5 to 7.8 ewes per ha and gross margins from $247 to $329 per ha. Presumably this result is based on a May lambing providing the best match between feed supply and animal demand and kikuyu filling to some extent the autumn feed gap. It must be noted however that moving from 6.5 to 7.8 ewes per ha increases the risk of financial loss in some years (data not presented) and therefore it is recommended that risk adverse producers aim for 6.5 ewes per ha. The goal of EverGraze is to lift profitability by 50% using the annual system as the benchmark the results suggest that changing to one with 25% perennial pastures can increase profit by 30%.

Using the model to assess the performance of the different pasture systems in a lower rainfall environment at Ongerup proved interesting. Counter to expectations a higher proportion of perennials in the pasture base compared to Wellstead proved to be the most profitable with 75% perennial, May lambing and 30 days locked on kikuyu returning the maximum gross margin of $96 per ha at a stocking rate of 3.9 ewes per ha. A 66% increase in profit compared to the most profitable annual system. It is likely that as a consequence of the shorter growing season for annuals that perennials while not yielding more at least lengthen the season both at the beginning and end to such an extent they provide substantial benefits in livestock performance and reduce supplementary feed. In addition there are likely to be more years in this environment in which annual pastures fail and perennials such as kikuyu provide some degree of drought proofing.

The Mt Barker simulations prove that prime lamb production in a high rainfall environment (656mm) is potentially highly profitable on annual pastures alone ($628 per ha per year). Adding perennials to the system to represent somewhere around 25 to 75% of the feed base can increase gross margins to between $659 to $688 per ha per annum which equates to an increase of between 5 and 10%. The change is more modest at Mt Barker compared to the other two locations because the annual pasture system is relatively productive particularly in spring, carrying feed into early summer and the out of season growing period for perennials shorter lessening the magnitude of their impact. The optimum stocking rate at Mt Barker is around 11.7 ewes per ha.

Unfortunately this analysis provides no insights into which of the three perennial species modelled, kikuyu, lucerne and tall fescue, provided the largest increase in gross margin. Based on historical field research on the south coast kikuyu has been the most effective perennial in reducing supplementary feed as a consequence of its ability to provide green feed not only in summer but also in autumn pre break of season. It would however be valuable for future modelling work to investigate which is the most profitable mix of kikuyu, lucerne and tall fescue at a system level (i.e. in separate paddocks).

In summary, introducing perennials into the feed base consistently increased gross margins at all three locations modelled covering a range of annual rainfall environments from 376 to 656mm on the south coast of WA. The main driver of this profit increase was a reduction in supplementary feed which is consistent with the findings of the original Tactical Management Regime report and historical research findings. The results also suggest that the higher the proportion of perennials in the system the later the optimum lambing time becomes and the longer ewes can be held on kikuyu in autumn for an increase in gross margin. These responses are understandable given that summer-active perennials lengthen the growing season and partly fill the traditional feed gap in summer and autumn. The findings of this study suggest that prime lamb producers on the south coast of WA that receive between 400 and 650mm annually can be more profitable if they introduce suitable summer-active perennials to make up to between 25 to 50% of their feed supply.

Appendix. Details for 50% perennial baseline GrassGro simulation.

Note: For annual and 25% perennial baseline systems the pasture species in paddocks were changed appropriately

Location

34º 30' S, 118º 36' E

Paddocks (all level)

Paddock	Paddock area (ha)	Fertility scaler	Soil profile	Pasture species
1	2.1	0.75	1	Subclover, capeweed & annual ryegrass
2	2.1	0.75	1	Subclover, capeweed & annual ryegrass
3	2.1	0.75	1	Subclover, capeweed & annual ryegrass
4	2.1	0.75	1	Subclover, capeweed & annual ryegrass
5	2.3	0.75	1	Subclover, capeweed & annual ryegrass
6	2.3	0.75	1	Tall fescue (summer-active) fixed legume at 15%
7	2.3	0.75	1	Tall fescue (summer-active) fixed legume at 15%
8	2.3	0.75	1	Tall fescue (summer-active) fixed legume at 15%
9	2.3	0.75	1	Subclover, capeweed & annual ryegrass
10	2.3	0.75	1	Lucerne (winter-active), subclover, annual ryegrass & capeweed
11	2.3	0.75	1	Lucerne (winter-active), subclover, annual ryegrass & capeweed
12	2.3	0.75	1	Lucerne (winter-active), subclover, annual ryegrass & capeweed
13a	3.7	0.75	1	Kikuyu & subclover
13b	5.9	0.75	1	Kikuyu & subclover
14	7.8	0.75	1	Kikuyu & subclover
15	1.9	0.50	1	Subclover, capeweed & annual ryegrass
16	2.6	0.75	1	Subclover, capeweed & annual ryegrass
17	3.6	0.75	1	Subclover, capeweed & annual ryegrass
18	3.6	0.75	1	Subclover, capeweed & annual ryegrass
19	3.6	0.75	1	Subclover, capeweed & annual ryegrass
Total	60.3			

Soil Profile 1

Soil description	Sand over clayey sand	
Soil albedo	0.17	
Soil evaporation	3.0 mm/d^{½}	
SCS runoff curve no.	Use default	
	Topsoil	Subsoil
Cumulative depth (mm)	500	4000
Field capacity (m^3/m^3)	0.23	0.23
Wilting point (m^3/m^3)	0.07	0.09
Bulk density (Mg/m^3)	1.5	1.6
Saturated conductivity (mm/hr)	500	45
Initial water (m^3/m^3)	0.09	0.15

Pastures

	Max rooting depth (mm)	Initial seed DM (kg/ha)
Subclover, capeweed & annual ryegrass		
Subclover	700	999
Capeweed	800	12
Annual ryegrass	700	9
Tall fescue (summer-active) fixed legume at 15%		
Tall fescue	1500	-
Lucerne (winter-active), subclover, annual ryegrass & capeweed		
Lucerne (winter-active)	3000	-
Subclover	300	96
Annual ryegrass	400	0
Capeweed	400	0
Kikuyu & subclover		
Kikuyu	3500	-
Subclover	800	965

Livestock

Breed	Large Merino
Standard reference weight (kg)	52.5
Greasy fleece weight (kg)	4.73
Fibre diameter (microns)	20
Fleece yield (%)	67
Ram breed	Dorset (Mature ram: 77.0 kg)
Death rate: adults (%/yr)	2
Death rate: weaners (%/yr)	2

Management policy: Ewe management		
Stocking rate	Rate	6.5/ha
Shearing date	Main flock	15-May
	Weaners	15-May
Replacement rule	Purchase	Purchase ewes on 1 Jan at age 18 months, live weight 55 kg and C.S. 3.0
	Cast for age	Sell stock aged 9 to 10 years on 1 Jan

Reproduction rule	
First join at	0 years
Mating date	7-Feb
Conception at CS 3	(1) 50%
	(2) 50%
	(3) 0%
Birth date	5-Jul
Castration	yes
Weaning date	4-Nov
One ram per	50 ewes
Keep rams for	5.0 years
Sell young ewes	Sell 0 year old animals as they reach a weight of 45 kg after 4 Nov; sell any remaining 0 year old animals on 4 Feb
Sell young wethers	Sell 0 year old animals as they reach a weight of 45 kg after 4 Nov; sell any remaining 0 year old animals on 4 Feb

Maintenance Feeding rule: Ewe Maintenance Feeding	
Description	Maintain condition when thinnest ewes < score 2.0 (weaners < score 3.0)
Main flock/herd	
Mature Females	Feed in paddock, applying the rule:
	If animal condition falls to 2.0 during 1 Jan to 31 Dec feed to maintain condition of the thinnest animals
	Or feed whenever total DM drops below 800 kg/ha
Immature Females	Feed in paddock, applying the rule:
	If animal condition falls to 2.0 during 1 Jan to 31 Dec feed to maintain condition of the thinnest animals
	Or feed whenever total DM drops below 800 kg/ha
Immature Males	Feed in paddock, applying the rule:
	If animal condition falls to 2.0 during 1 Jan to 31 Dec feed to maintain condition of the thinnest animals
Weaner flock/herd	
Weaners	Feed in paddock, applying the rule:
	If animal condition falls to 3.0 during 1 Jan to 31 Dec feed to maintain condition of the thinnest animals
	Or feed whenever total DM drops below 800 kg/ha

Supplement

Supplement	**Supplement: Pellets**	
	Ingredient	**Pellets**
	Proportion of mix (%)	100
	Dry matter content (%)	90
	Dry matter digestibility (%)	70
	ME:DM (MJ/kg)	11.3
	Crude protein (%)	14
	Rumen-degradable protein (%)	70

Production Feeding rule: Get weaners to 45kg		
Feeding rule	Target, from 5 Nov to read 45.0 kg on 3 Feb	
Supplement	**Supplement: Pellets**	
	Ingredient	**Pellets**
	Proportion of mix (%)	100
	Dry matter content (%)	90
	Dry matter digestibility (%)	70
	ME:DM (MJ/kg)	11.3
	Crude protein (%)	14
	Rumen-degradable protein (%)	70

Grazing management

Grazing rule: 20 paddock movements	
Ewes	
From 1 Jan to 31 Dec	Withhold: 1 day. Then check every 1 day. Move when average daily wt gain can be improved by 0.01 kg
	Paddock 1, Paddock 2, Paddock 3, Paddock 4, Paddock 5, Paddock 6, Paddock 7, Paddock 8, Paddock 9, Paddock 10, Paddock 11, Paddock 12, Paddock 13a, Paddock 13b, Paddock 14, Paddock 15, Paddock 16, Paddock 17, Paddock 18, Paddock 19
Ewe Weaners	
Same as	Ewes
Wether Weaners	
Same as	Ewe Weaners, Ewes

Sheep costs

Ewe Shearing		$5.65	/head
Shearing Lambs		$3.00	/head
Ewe Husbandry		$3.89	/head
Lamb Husbandry		$2.56	/head
Ewe Replacement		$95.00	/head
Rams		$538.00	/head
Sheep sales commission		11	%
Sheep sales cost		$2.00	/head
Pasture cost		$80.00	/ha
Supplement costs	Lupins	$285.00	/t
	Pellets	$400.00	/t

Cattle costs

Cow Husbandry		$21.67	/head
Calf Husbandry		$4.10	/head
Cow Replacement		$702.00	/head
Bulls		$1,173.00	/head
Cattle sales commission		13	%
Cattle sales cost		$17.30	/head
Pasture cost		$80.00	/ha
Supplement costs	Pellets	$400.00	/t
	Canola meal	$270.00	/t
	Cottonseed meal	$250.00	/t
	Cottonseed, whole	$170.00	/t
	Peas	$190.00	/t
	Hay	$211.00	/t
	Lupins	$230.00	/t
	Molasses	$47.00	/t
	Oats, whole	$170.00	/t
	Sorghum, whole	$180.00	/t
	Triticale, whole	$313.00	/t
	Wheat, whole	$195.00	/t
	Pea straw	$95.00	/t
	Barley, crushed	$200.00	/t
	Barley straw	$0.00	/t

Sheep prices

Wool prices for ewes			
	19 micron	1054	c/kg
	20 micron	926	c/kg
	21 micron	884	c/kg
	22 micron	851	c/kg
	Av. Fleece Price	90	%
	Wool commission	8.5	%
Ewe sales			
	Base price	189	c/kg
	Dressing percentage	42	%
	Skin price	$0.00	/head
Ewe lamb sales			
	< 18.0 kg	358	c/kg
	> 18.0 kg	374	c/kg
	Dressing percentage	45	%
	Skin price	$0.00	/head
Wether lamb sales			
	< 18.0 kg	358	c/kg
	> 18.0 kg	374	c/kg
	Dressing percentage	45	%
	Skin price	$0.00	/head

Cattle prices

Cow sales			
	Base price	116	c/kg
	Dressing percentage	45	%
	Hide value	$45.00	/head
Steer sales			
	Base price	167	c/kg
	Dressing percentage	46	%
	Hide value	$40.00	/head
Heifer sales			
	Base price	167	c/kg
	Dressing percentage	45	%
	Hide value	$38.00	/head