ANALYSIS OF THE PROFITABILITY OF SHEEP WOOL AND MEAT ENTERPRISES IN SOUTHERN AUSTRALIA

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SUMMARY

Analyses were undertaken to compare the profitability of a range of sheep meat and wool enterprises and to investigate the impact that management variables had on production and gross margins. GrassGro was used to model fourteen sheep enterprises at four different locations in south-eastern Australia: Mortlake, Rutherglen, Naracoorte and Cowra. Simulations were run over 37 years (1965-2002), using historical weather data for each location and relevant soil types and pasture species. The enterprises modelled were: Merino wethers (both super-fine and fine fibre diameter); Self-replacing Merino ewes (both fine and medium) turning off store lambs or yearlings; Dual purpose - Merino ewes (fine and medium) turning off first-cross store lambs or lambs finished to 44kg; Prime lamb - first-cross ewes turning off second-cross stores, 44kg or 53 kg lambs. The management of all enterprises was optimised prior to making any comparisons.

- **The dual purpose enterprise using fine Merino ewes was consistently the most profitable**. It was followed by prime lambs, then the self-replacing Merino enterprises, with the Merino wethers the least profitable enterprise at all four locations and at two commodity price scenarios. In general, the self-replacing Merino enterprises were only slightly less profitable than the prime lamb enterprises. However, when a large price premium existed for super-fine wool (i.e. 5 year average price, 1999-2003), the super-fine Merino yearling enterprise was as profitable as the dual purpose enterprise.

- **The enterprises in which replacement ewes were purchased, rather than bred, were more profitable**. More joined ewes could be run per hectare allowing more meat/ha to be produced. However, the enterprise gross margin was sensitive to the price paid for replacement ewes. In reality, most producers of first-cross lambs are doing so as an adjunct to their self-replacing Merino enterprise. The self-replacing Merino flock turning off store lambs was able to run more ewes per hectare and turn-off similar quantities of meat but slightly less wool per hectare, to the enterprise turning off Merino yearlings. The higher gross margins for the self-replacing Merino lamb enterprise were mainly due to higher prices for Merino lamb compared with yearlings (2-tooth) and lower supplement requirements. The Merino yearling enterprise would be slightly more profitable if there was no price discount for yearling meat (i.e. 30% discount.)

- **The results highlight that there is considerable scope for all sheep producers to improve the gross margins of their current enterprise by refining their time of lambing and stocking rates.** The focus should be on optimising the amount of meat and wool produced per hectare and not on maximising per head animal performance.

- **The full economic benefit of changing time of lambing was not realised unless stocking rate was increased.** At low stocking rates, changing the time of lambing resulted in small changes in gross margin. The main advantage of optimising time of lambing (i.e. changing from autumn to late winter or spring) was that it allowed the stocking rate to be increased without increasing reliance on supplementary feeding of ewes. Lambing earlier meant maximum grazing pressure coincided with low winter pasture growth rates, and was a constraint to increasing stocking rate.

- **Guidelines for the optimum time of lambing for each enterprise were developed**, and were related to the length of the average growing season at each location. Recommended times of lambing for each enterprise are: Merino yearling enterprise – lamb three months before the end of the growing season; store lamb (Merino, first-cross or, second-cross lambs) enterprise – lamb four months prior; Trade lamb (44 kg liveweight) enterprise (first-cross or second-cross) or Export lamb (53 kg liveweight) enterprise – lamb four-five months prior. The most profitable time of lambing was that with the greatest production for the lowest total supplementary

feed costs. There was no benefit in lambing prior to June for any of the enterprises evaluated, due to reduced meat production per hectare and increased supplementary feeding costs.

- **Stocking rate had the largest bearing on enterprise gross margin.** Optimum stocking rates for each enterprise were selected on the basis of environmental and production risk criteria (relating to pasture mass and probability of feeding supplements), and generally were below the level where gross margin/ha was maximised. This indicated that, at the grain price used ($150/t) and if environmental and production risks were not considered, it was profitable to run much higher stocking rates and increase the probability of feeding supplements for maintenance.

- **A range of other production factors were investigated, such as ewe frame size, weaning percentage, lamb carcase weight, and price differentials for time of sale and carcase weight** as they are often quoted as having a large impact on profitability. Increasing Merino ewe frame size, while increasing lamb growth rate marginally, did not necessarily lead to increased meat/ha, as this reduced the numbers of ewes per hectare that could be run. Using the five year price scenario, if an increase in ewe frame size was associated with an increase in fibre diameter, then gross margins decreased.

- **Increasing ewe fertility and the number of lambs weaned per ewe by 10%, increased gross margin by approximately 10%** (i.e.$ 50-$70/ha or $3.50 - $5.00/ewe). This also increased grazing pressure. Producers who are understocked will get greater benefits from increasing ewes per hectare rather than focussing on just increasing weaning percentage. For producers who are running an optimum stocking rate of ewes/ha, an increase in weaning percentage will be profitable, even after allowing for a small decrease in ewes per hectare.

- **Lambing in late winter or spring was most profitable.** Increasing lamb sale weight by lambing in June and keeping lambs until the end of the growing season, was not as profitable as lambing later (as outlined above). Lambing earlier resulted in increased maintenance feed costs for ewes, so less ewes per hectare could be sustained on the pasture. The increase in lamb sale weight did not compensate for the reduction in stocking rate and meat produced per hectare. Price premiums for heavier carcase weights have generally not been high enough to make the earlier lambing time profitable. However, lambing at the optimum time (as per guidelines above), maintaining higher ewe numbers/ha and finishing second-cross lambs to target weights using grain, was profitable at the grain price used. Finishing first-cross lambs to 44 kg was not always as profitable as producing first-cross stores. In this finishing system, to optimise the gross margin, the optimum time of lambing was slightly earlier and the optimum ewes per hectare slightly lower, than for the store system. The small gain in meat per hectare by producing heavier lambs did not compensate for loss in wool income, but feeding to a target weight did reduce the economic risk.

- **Running a dual purpose enterprise offers producers some resilience against changes in commodity prices**, but producers should still pay close attention to the genetic merit (wool cut per head and fibre diameter in relation to live weight) of the ewes they purchase to reap full benefits. The results support the option that many producers with self-replacing Merino flocks have been taking, that is joining a portion of ewes to terminal sires. Producers contemplating changing over to first-cross ewes need to exercise caution as they may not be any better off, particularly if paying very high prices for ewes or if they don't achieve high weaning percentages. In high rainfall environments where producers often experience feet problems with Merinos or difficulty managing internal parasites, cross-bred ewe enterprises have some advantages. Although a self-replacing flock may not be as profitable as enterprises where replacement ewes are purchased (under the price scenarios modelled), purchasing ewes has the risks of introducing disease, lack of control with genetics, and exposure to high ewe prices.

INTRODUCTION

Large changes have occurred to the Australian sheep flock over the last decade. The total sheep and lamb numbers are now around 100 Million, the lowest level since 1948 (ABS 2003). Over the past decade, wool production has declined in Australia as sheep numbers have fallen, but lamb production has increased. Sheep numbers have declined in response to recent, widespread drought conditions. However, over the longer term the relative price of wool and sheep meats compared with grain and beef cattle have also had a large impact on sheep numbers (Barrett *et al*. 2003). However, wool is still the major product from the sheep industry in Australia. In fact, almost of third of Australia's commercial farms continue to produce wool and the wool industry remains one of Australia's most important agricultural industries with $2.5 billion export income (Barrett *et al*. 2003).

The number of Merino sheep in Australia has fallen at a faster rate than crossbred sheep numbers over the past decade, and the national flock is now younger and contains a higher proportion of ewes (Barrett *et al.* 2003). ABARE surveys of producers involved in prime lamb production (ABARE 2004), indicate that the number of Merino ewes joined to Merino rams decreased from 40.7 million in 1996/1997 to 31.8 million in 2004/05, while the numbers joined to short wool rams (terminal sires) or long wool rams increased from 9.7 million to 11.4 million in the same period. The number of crossbred Merino or other breeds of ewes has increased from 4.5 to 7.6 million over that 8 year period.

For many farmers, revenue from lamb sales is contributing a greater proportion of farm receipts, and prime lamb production is now considered by a growing number of sheep producers to be their primary activity (Connell and Hooper 2001). Wool producers are becoming more interested in running dual purpose Merino flocks, for wool and meat production, as a hedge between price fluctuations of either commodity. Only 30% of wool producers sold lambs for slaughter in 1992, however by 2002, this had risen to 47% (Barrett *et al.* 2002). Specialist prime lamb producers have become more focussed on producing larger carcase weights to meet specifications of processors, and capture price premiums. All of these changes are a reflection of the relative price of meat to wool.

The increased interest in meat production by woolgrowers has led to management changes, such as joining Merino ewes to terminal sires, lambing earlier (i.e. autumn or early winter) to produce heavier lambs, altering breeding programs to breed larger-frame Merino ewes or injection of SAMM or Dohne genetics, and more focus on increasing lambs weaned per ewe. Many producers who have traditionally run self-replacing Merino flocks are switching over to first-cross ewes for prime lamb production. The price of replacement first-cross ewes has increased as a consequence of the increased demand. The changes being made to enterprises may not be the most profitable options. Producers appear to be focused on price/kg meat not meat/ha and many may be running less ewes/ha as a consequence.

Benchmarking studies indicate that dual purpose flocks have been performing better than wool (pure Merino) or prime lamb flocks over the past few years (Holmes, Sackett and Associates, 2003). One analysis of the relative profitability (profit after interest, $/ha) of different grazing enterprises over the last five years, indicates that beef trading has been more profitable than running a beef herd or a sheep flock, but it was much more volatile (i.e. more variation in returns and hence higher risk) (Holmes, Sackett and Associates, 2002). The data also shows that beef herds had similar profitability and variation in profit (risk) to dual purpose sheep flocks, prime lamb flocks were next most profitable with wool flocks least profitable. Based on the last three years data, dual purpose flocks (Merino ewe joined to terminal sire) have stood out as an enterprise having a high level of profit and acceptable volatility. An analysis of farms in south-western Victoria by Beattie (2002) shows similar trends to those of Holmes, Sackett and Associates (2003). For 2001-02, average gross margins for prime lamb flocks (first and second-cross enterprises) were $421/ha, beef herds were $335/ha, while wool flocks had the lowest gross margins of $284/ha.

While the benchmarking studies allow a comparative analysis of profitability between enterprises and farms that allow producers to focus on the areas of their business where they can improve, there are a number of limitations when trying to extrapolate about optimising production systems. For example, they do not allow specific recommendations about the most profitable management practices for different environments to developed (e.g. time of lambing). The analysis of financial data-bases highlights the strong linear relationship that exists between kg meat/ha or kg wool/ha and gross margin or profit, with stocking rate identified as the main driver of these. However, the relative contribution of other variables such as weaning rate or genetics to this animal output/ha, or optimum ranges for other variables in the production system are not determined. Modelling the biology of farm systems and price/cost sensitivity analysis may allow a better understanding of the interaction between components, and the conditions under which variables may or may not be profit drivers.

Given that an increasing number of producers are starting to integrate wool and meat production into their systems in response to price signals, it is critical they have a better understanding of the profit drivers and risks associated with different enterprises and combinations.

The modelling work in this project was undertaken to evaluate the profitability of a range of sheep meat and wool enterprises and more specifically to answer the following questions:

1. Which production factors in each enterprise have the biggest impact on profitability (what are the key profit drivers)?

2. How do the enterprises compare (in the same environment) when the management is optimised (i.e. time of lambing, appropriate stocking rate)?

3. What impact do commodity prices have on the relative profitability of the enterprises?

An additional aim was to develop guidelines (biological and economic) for sheep producers to optimise profit and minimise risk, which can be adapted to suit a range of environments. The intention being that producers use this information to make better decisions about the management of their sheep enterprise, to improve the profitability and sustainability of their business.

METHOD

The profitability of a range of sheep enterprises was modelled using the computer program *GrassGro* (Moore *et al.* 1997). *GrassGro* versions 2.4.3 and 2.4.4 (for self-replacing flocks) were used and simulations were run from 1st January 1965 to 31st December 2002. The first year's data were not used. A batch processing program, "Batch Gro" (version 6/7/04) was developed by CSIRO, and used to create and execute the factorials of the simulation experiment.

Four case study locations, where wool and sheep meat production are major industries, were selected for the analysis. These southern Australian locations chosen were:

Mortlake region in south-western Victoria,
Rutherglen region in north-eastern Victoria,
Cowra region in Central West of NSW,
Naracoorte region in south-eastern South Australia.

A wide range of enterprises were selected that were based on enterprises currently run by producers in the four locations. The impact of a range of management options on profitability, were also analysed. These were: breed, genotype (fibre diameter, fleece weight), time of lambing, stocking rate, and time of sale/finishing system for slaughter lambs. Details of all systems investigated for each locality are presented in Table 1. Two options for selling Merino lambs were included; as 18 week old weaned lambs or as 12 month old hoggets/yearlings. Although selling Merino lambs at four months old is not practised in all four localities, this option was included to allow comparisons with the cross-bred lamb enterprises. Merino lambs were first shorn as yearlings. The timing of husbandry practices are summarised in Table 2, and ewe conception rates used are summarised in Table 3. Standard weights and conception rates of ewes varied with seasonal conditions.

A supplement of wheat was fed to maintain liveweight whenever livestock body condition (Jeffries, 1961) fell below a threshold. The supplementary feeding rules used for each class of stock were:

- Wethers – fed when average condition was 1½ (lowest 1)
- Ewes – fed when average condition was 2 ½ (lowest 2)
- Weaners – fed when average condition was 2 (lowest 1½)
- Lamb finishing – weaners production fed to reach a "Trade" liveweight of **44 kg/20 kg carcase weight** (first and second-cross lambs) or to an "Export" liveweight of **53 kg/24kg carcase weight** (first-cross lambs only).

The quality specifications for the wheat used in the simulations were: 89% dry matter, 14% crude protein, 90% digestible dry matter, 92% rumen degradable protein, and 13.8 MJ/kg DM metabolisable energy.

A production feeding rule was also used to finish first cross and second cross lambs to a target liveweight. Production feeding with wheat took place after weaning, in the paddock, in any year it was required.

The effect of pasture type and soil fertility on productivity and profitability was not investigated. This analysis assumed that the pasture species composition and soil fertility were not limiting factors in each system. The pasture types and soil types used for each location are summarised in Table 4. A fertility scalar of **0.9** was used for all simulations. Also, the legume content was fixed at **30%** to remove this as a source of error. A paddock size of 1000 ha was used to minimise rounding errors.

The assumptions used for prices and costs are shown in Table 5. Both five year (1999-2003) and one year (July 2003-June 2004) average wool and meat prices were used to investigate the impact of changes in commodity prices on gross margins. Average five year prices for wool were similar to the 12 year average, i.e. post reserve price scheme.

For each enterprise, profitability was calculated as gross margin/ha and per 100mm of rainfall, these being two common indices used in farm financial benchmarking studies. Gross margins for the first year of the simulations were not used. Physical benchmarks such as stocking rate (DSE/ha), and clean wool and meat produced per ha were also extracted. Risks (economic, production and environmental) associated with the enterprises and management options were also assessed. The key financial and physical performance indicators, or benchmarks, extracted from each run in *GrassGro* are summarised in Table 6.

In order to compare the profitability of a wide range of sheep enterprises, a stocking rate was selected for each enterprise that took into consideration risks of supplementary feeding and low pasture mass in late summer/autumn (Mason *et al.* 2003). The following two "rules" were developed:

(i) *Pasture mass rule: Maintain more than 800 kg dry matter/ha (dead and total) on the paddock from 1st January through to 30th April for at least 8 out of 10 years (i.e. will tolerate reducing kg DM/ha below this target in two out of ten years).*

(ii) *Supplementary feeding rule: Prepared to feed ewes >30 kg grain/head per year in only four out ten years. Prepared to feed wethers >20 kg grain/head per year in only two out of ten years (i.e. only feed heavily in drought or very dry years).*

The upper limit for stocking rate for each enterprise was defined as the highest that could meet these two rules.

Table 1. Sheep enterprises and management variables used in GrassGro simulations

Enterprise	Liveweight of ewe[B] in average condition[A] (kg)	Ewe fibre diameter[A] (µm)	Ewe greasy wool cut[A] (kg/hd)	Stocking rates (sheep/ha)[C]	Time of lambing [D]	Time of sale - cast for age sheep	Time of sale - lambs
Merino wethers	45	17.5 (SUPER-FINE)	3.6	6 – 20	-	6 years, after Dec shearing	-
	50	19 (FINE)	4.1	6 - 20	-	6 years, after Dec shearing	-
	55	21 (MEDIUM)	4.5	6 - 20	-	6 years, after Dec shearing	-
Self replacing flock (Merino ewe X Merino ram)	45	17.5	3.6	6 - 18	April - Oct	6 years, after wean/vary with lambing	**1. Lambs**/weaners (18 weeks old) and **2. Yearlings** (12 mths old), time varies with lambing
	50	19	4.1	6 - 18	April - Oct	6 years, after wean, /vary with lambing	As above
	55	21	4.5	6 - 18	April - Oct	6 years, after wean, /vary with lambing	As above
First-cross lambs (DUAL PURPOSE ENTERPRISE) (Purchased Merino ewes X terminal sire)	50	19	4.1	6 - 18	April - Oct	6 years, after wean, /vary with lambing	**Store lambs** Sell at 44 kg LWT (20 kg DWT) or by 18 weeks of age.
	55	21	4.5	6 - 18	April - Oct	As above	As above
First-cross lambs FINISH	50	19	4.1	6 - 18	April - Oct	6 years, after wean, /vary with lambing	**Finish lambs**: Production feed & sell at 44 kg LWT/20 kg DWT or by 26 weeks of age.
	55	21	4.5	6 - 18	April - Oct	As above	As above
Second-cross lambs (PRIME LAMB ENTERPRISE) (Purchased first-cross ewes X terminal sire)	60	29	4.0	4 - 18	April - Oct	6 years, after shear, /vary with lambing	**1. Store lambs** Sell at 44 kg LWT (20 kg DWT) or by 18 weeks of age **2. Finish lambs (Trade):** Production feed & sell at 44 kg LWT/20 kg DWT or by 26wks **3. Finish lambs (Export):** Production feed & sell at 53 kg LWT/24 kg DWT or by 26 wks.

[A] Alex Ball (2004). "Average" genotypes used based on data in Merino Genetic Services (MGS) and LAMBPLAN databases.
[B] Liveweight, fleece weight and fibre diameter are for the ewe of the nominated breed.
[C] "Sheep" are wethers in wether enterprises and ewes in breeding flocks.
[D] The mean date of lambing is the start of the month specified.

Table 2. Timing of husbandry operations for flocks simulated in GrassGro

Enterprise	Lamb	Shear[A]	CFA[B] (6-7 years)	Replace/ purchase	Mate	Wean	Sell lambs
Merino wethers	-	15 Dec	31 Dec	1 Jan	-	-	-
Merino lambs – self-replacing flock	April	1 Mar	2 Jul	15 Oct	1 Nov	1 Jul	1 Aug (18 wks) or 27 Mar (52 wks)
	May	1 Apr	2 Aug	15 Nov	1 Dec	1 Aug	1 Sept or 26 Apr
	June	1 May	2 Sept	15 Dec	1 Jan	1 Sept	1 Oct or 27 May
	July	1 Jun	2 Oct	15 Jan	1 Feb	1 Oct	1 Nov or 27 June
	Aug	1 Jul	2 Nov	15 Feb	1 Mar	1 Nov	1 Dec or 26 July
	Sep	1 Aug	2 Dec	15 Mar	1 Apr	1 Dec	1 Jan or 26 Aug
	Oct	1 Sep	2 Jan	15 Apr	1 May	1 Jan	1 Feb or/ 25 Sep
First-cross lambs (purchased Merino ewes)	As above	As above	As above	As above	As above	As above	1. At 44 kg LWT (20 kg DWT) or by 18 weeks 2. Prod. Feeding - At 44 kg LWT (20 kg DWT) or by 26 weeks.
Second cross lambs (purchased first-cross ewes)	As above	As above	As above	As above	As above		1. At 44 kg LWT (20 kg DWT or by 18 weeks 2. At 53 kg LWT (22 kg DWT or by 26 weeks.

[A] Shearing date for ewes is the month pre-lambing to allow the Merino yearlings to be shorn prior to sale.
[B] CFA = cast for age

Table 3. Relative conception rates used for Merino[A] and cross-bred[B] ewes simulated in GrassGro

Ewes	Lamb date	Mating date (day of year)	Conception rate %	Singles %	Twins %
Merino	April	1 Nov (300)	80	70	5
	May	1Dec (330)	90	80	5
	Jun	1 Jan (1)	110	90	10
	Jul	1 Feb (32)	120	80	20
	Aug	1 Mar (60)	130	70	30
	Sep	1 Apr (90)	130	70	30
	Oct	1 May (120)	120	80	20
Crossbred					
	April	1 Nov (300)	105	65	20
	May	1Dec (330)	120	60	30
	Jun	1 Jan (1)	135	55	40
	Jul	1 Feb (32)	148	48	50
	Aug	1 Mar (60)	156	40	58
	Sep	1 Apr (90)	156	40	58
	Oct	1 May (120)	145	45	50

[A] Freer *et al*. (1997).
[B] Neal Fogarty (2004) personal communication.

Table 4. Site details, and pasture and soil types used in simulations

	Mortlake[A]	Rutherglen[E]	Naracoorte[F]	Cowra[G]
Pasture species				
Legume (Fixed at 30%)	-	-	-	-
Grass & root depth	Perennial ryegrass (480 mm)	Phalaris (700 mm)	Phalaris (700 mm)	Annual ryegrass (450 mm)
Soil type				
Northcote description[B]	Dy 3.43 (yellow duplex)	Dr 2.22 (red duplex)	Dy 5.43 (yellow duplex)	Gn 2.15 (red earth)
Cumulative depth (mm)				
Topsoil	275	500	300	500
Subsoil	800	1000	850	1000
Average annual rainfall (mm)[C]	663	619	567	633
Rainfall pattern[D]	Winter dominant	Winter dominant	Winter dominant	Uniform
Median length of growing season[H] (months)	9 (early April-end Dec)	8 (mid Apr-end Nov)	7 (May-end Nov)	7 (mid April-mid Nov)

[A] Unless otherwise indicated, Mortlake locality details from Steven Clark (2003) pers. comm. Victorian Department of Primary Industries, Hamilton, and Graeme Ward (2003) pers. comm. Victorian Department of Primary Industries, Warnambool.
[B] Northcote (1965).
[C] 1965-2002 *(GrassGro)*
[D] 1965-2002 *(GrassGro)*
[E] Unless otherwise indicated, Rutherglen locality details from Angela Avery and Charlie Showers (2003) pers. comm., Victorian Department of Primary Industries, Rutherglen.
[F] Unless otherwise indicated, Naracoorte locality details from Andrew Craig and Jock McFarlane (2003) pers. comm., South Australian Research and Development Institute (SARDI), Struan.
[G] Unless otherwise indicated, Cowra locality details from Doug Alcock (2004) pers. comm., NSW Department of Primary Industries, Cooma.
[H] Median length of the growing season is the number of months in which pasture growth occurs in at least half the years.

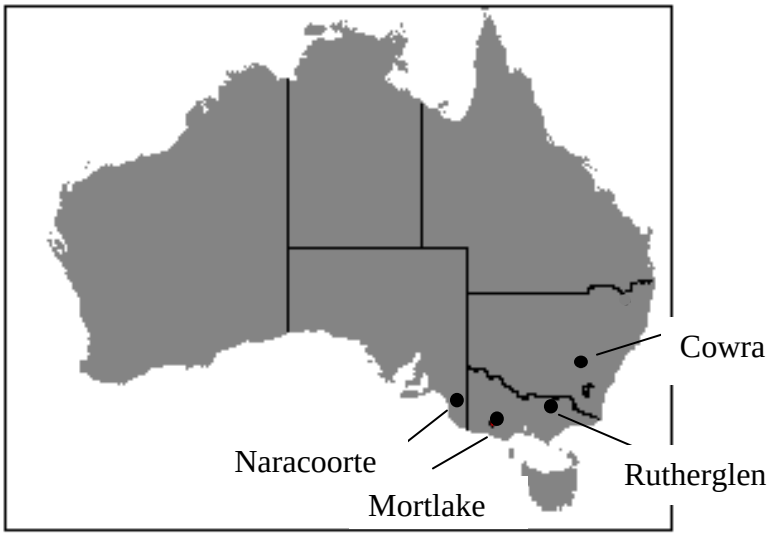


Figure 1. Location of four case study sites in relation to climate classification (Bureau of Meteorology, 2004).

Table 5. Commodity prices and input costs used in GrassGro simulations

Inputs		*5 year average price: Jan 1999 - Dec 2003 (adjusted for CPI)*	*Average price: July 2003 - Jun2004*
Pasture management (cost of phosphorus/sulphur fertiliser).		$30/ha (i.e.140kg/ha superphosphate@ $220/t spread)	
Merino rams		$500	$500
Merino ewes		$50	$80
First-cross ewes		$80	$150
Merino wethers		$40	$45
Shearing		$5/head ($3/head lambs)	
Husbandry		$2/head (wethers, lambs), $3/hd (ewes)	
Livestock commission		5%	
Wool commission		5%	
Other sale costs		$1.20/head	
Supplementary feed (wheat)		$150/t	
Prices Received		***5 year average price: Jan 1999 - Dec 2003 (adjusted for CPI)***	***Average price: July 2003 - Jun2004***
WOOL [A] (AWEX[B])	**Fibre Diameter**	**c/kg clean**	**c/kg clean**
	17 µm	2301	1203
	18 µm	1521	1045
	19 µm	1223	985
	20 µm	910	934
	21 µm	798	907
	22 µm	759	881
	23 µm	732	856
	28 µm	526	569
	29 µm	526	527
MEAT (NLRS[C])	**Carcase weight[D]**	**$/kg (DWT)**	**$/kg (DWT)**
Merino hoggets	18-24 kg	1.66	2.11
Merino lambs	<16 kg	2.03	2.61
	16-18 kg	2.29	2.10
	>18 kg	2.59	2.40
First-cross lambs	<16 kg	2.42	1.91
	16-18 kg	2.61	2.13
	>18 kg	3.07	3.77
Second-cross lambs	<18 kg	2.72	1.93
	18-22 kg	3.17	2.26
	>22 kg	3.20	3.84
Lamb skin		$5/head	$10/head
Cast for age sheep		$0.64/kg (LWT)	$0.80/kg (LWT)

[A] *Assume all wool is sound.*
[B] *Wool prices from AWEX = Australian Wool Exchange.*
[C] *Meat prices from NLRS = National Livestock Reporting Service.*
[D] *Assume dressing percentage of 45%.*

Table 6. Parameters extracted from GrassGro simulations to use as indicators of financial and physical performance and risk

Financial	*Physical*	*Risk*
Average gross margin ($/ha)	Wool - clean kg/ha Meat - liveweight kg/ha	Average gross margin Range in gross margin over years: median, lower and upper quartiles
Gross margin ($/ha)/ 100 mm rainfall	No. lambs/ewe (weaning %) Average sale weight of wether lambs (kg)	Probability of feeding supplements (>30 kg/mature ewe per year or >20kg mature wether per year)
Percentage of income from wool & meat (%)	Average DSE/ha Winter DSE/ha (1 Jul)	
Cost of supplement for maintenance ($/ha) Cost of supplement for production feeding ($/ha)	Average annual supplement fed (kg/head per ewe/wether and weaner) Pasture utilised (%)	Soil erosion/soil health risk: Probability of falling below target pasture mass (800 kg DM/ha total mass) during January -April

RESULTS

CLIMATE AND PASTURE GROWTH CHARACTERISTICS OF LOCALITIES

The four localities selected all fall within the temperate pasture zone (Figure 1) but the macro-climate varies markedly between sites. Naracoorte, Rutherglen and Mortlake all have a winter dominant rainfall pattern (Figure 2), and average annual rainfall of 567mm, 619 mm and 663 mm respectively (Table 4), while Cowra has a uniform rainfall pattern and average annual rainfall of 633 mm. Rutherglen and Cowra have a more continental influence to the climate, with a greater range in minimum and maximum temperatures than Naracoorte and Mortlake (Figure 2).

The three winter rainfall dominant sites had a similar seasonal pattern of pasture growth (Figure 2). That is, there was an obvious autumn break, a winter trough (the extent of which depends on the minimum winter temperatures), and a spring peak (the duration of which is dictated by the amount of November and December rainfall, and soil type). Based on the 50th percentile for pasture growth (Figure 2), the length of the growing season for Mortlake, Rutherglen and Naracoorte, was 9 months (early Apr-end Dec), 8 months (mid Apr-end Nov) and 7 months (May-end Nov) respectively. In contrast, the annual pasture simulated at Cowra, had greater autumn growth but less spring production than the other sites where a perennial pasture was simulated. The period of pasture growth at Cowra was 7 months (mid Apr-mid Nov). Although this site received almost twice the amount of summer rainfall compared with the other sites, there were no summer-active perennials simulated in this pasture.

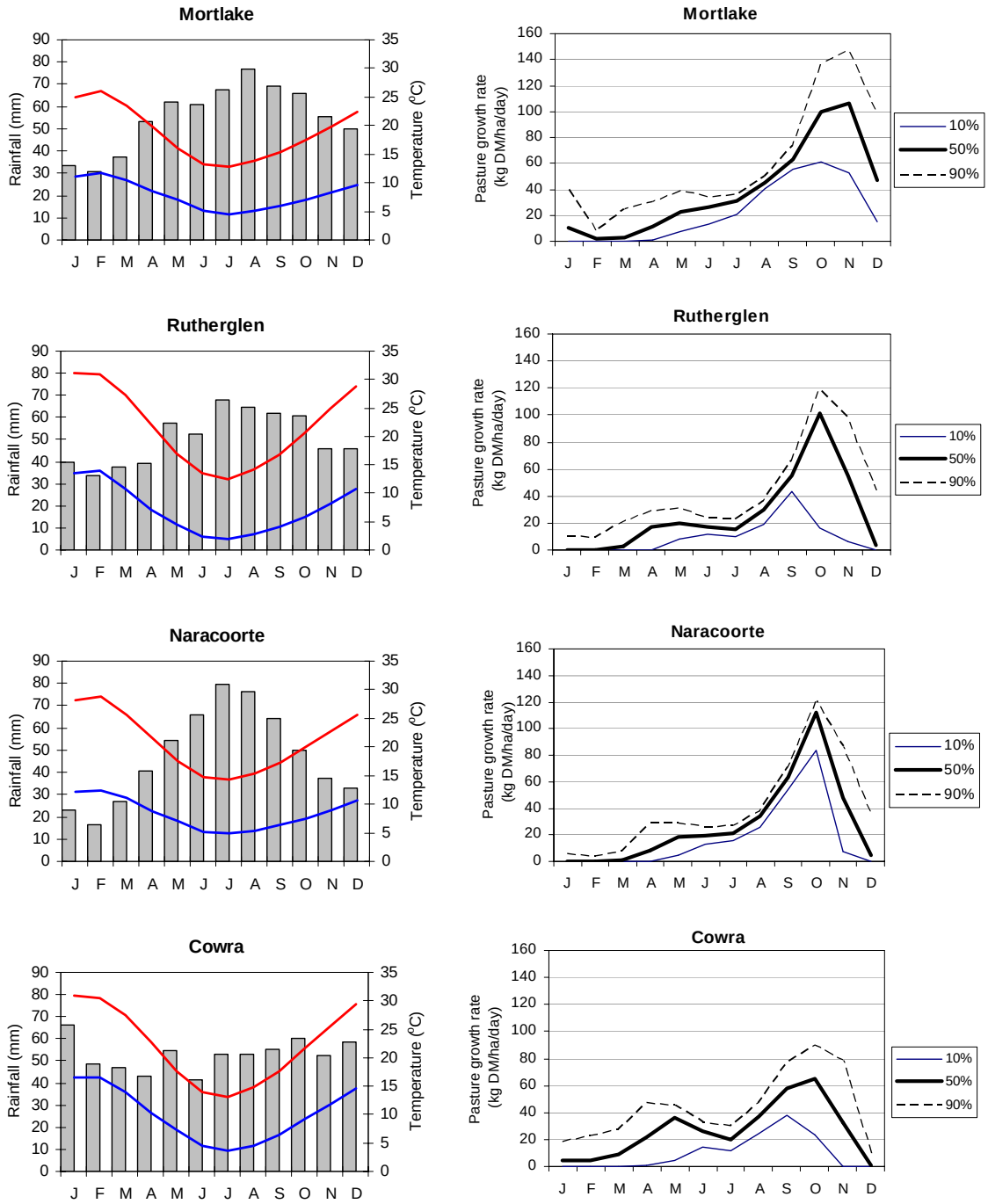


Figure 2. Average monthly rainfall, average minimum and maximum temperatures and percentiles for pasture growth (from 1965 - 2002) for the four localities studied.

EFFECT OF MANAGEMENT VARIABLES ON GROSS MARGIN AND RISK

(I) TIME OF LAMBING

The optimum time of lambing for each enterprise was defined as the time where the average gross margin was maximised (Figure 3). Lambing date was investigated in monthly increments from April through to October. For each month of lambing simulated, the mean date of lambing (when most lambs born) was the start of the month. In effect, some ewes would have started lambing ten days before the mean date of lambing.

For a given stocking rate (in terms of number of ewes/ha), the optimum time of lambing occurred when meat production per ha was maximum and supplement costs per ha was minimum. Time of lambing did not affect wool production (kg per ha). The same relationships between time of lambing, meat production and supplement costs were observed at each locality, but the lambing date varied depending on the length of the growing season and the extent of the spring peak (Figure 3). For example, the optimum time of lambing for all store lamb enterprises was around August/September for Mortlake, August for Rutherglen and Naracoorte, and July/August for Cowra (Figure 3a). The optimum time of lambing was around a month earlier if the lambs were kept for longer and fed, to achieve higher sale weights (Figures 3c and 3d). The optimum time of lambing for the Merino yearling enterprise was October for Mortlake, September/October for Rutherglen and Naracoorte, and August/September for Cowra (Figure 3b).

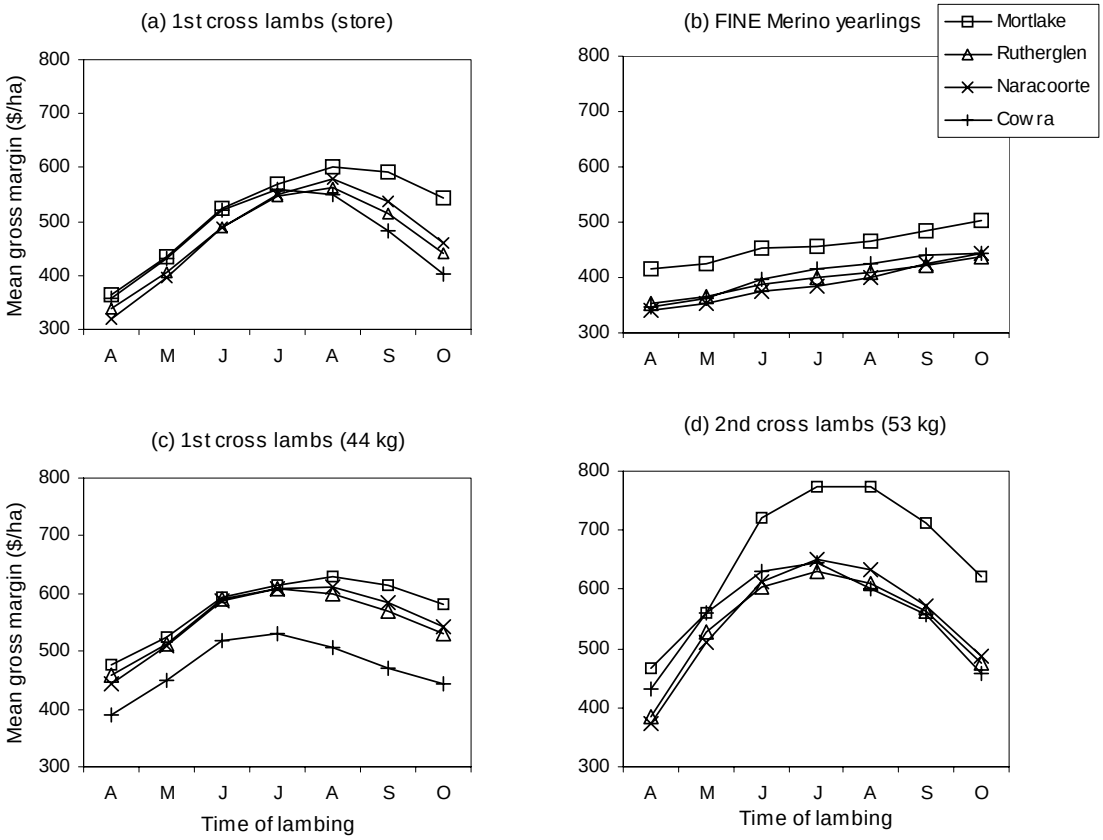


Figure 3. Effect of time of lambing on mean gross margin ($/ha) for four locations at a stocking rate of ten ewes/ha. (At each location the same number of ewes/ha does not represent equivalent grazing pressure between enterprises). (a) FINE Merino ewes producing store first-cross lambs, (b) FINE self-replacing flock, turning off Merino yearlings, (c) FINE Merino ewes, finishing first-cross lambs to 44kg liveweight, d) first-cross ewes joined to terminal sire, finishing second-cross lambs to 53 kg.

For the store lamb and yearling systems, in which no production feeding occurred, the major variable cost was supplement for maintenance of ewes. The time of lambing with the highest gross margin ("optimum") was that with the greatest meat production/ha and the least supplement cost (Figure 4). For the store lamb enterprise, lambing beyond August/September, reduced ewe supplementary feed costs marginally but also reduced sale weight of lambs (Figure 5). For the yearling enterprise, lambing later in the year (September-October) meant that ewe supplement costs were lowest and sale weight was also highest (Figure 5). Lambing earlier meant 12 month old yearlings were sold when pasture availability and live weight gain were low. Lambing later than September/October also resulted in increased costs of supplementation to ewes and weaners.

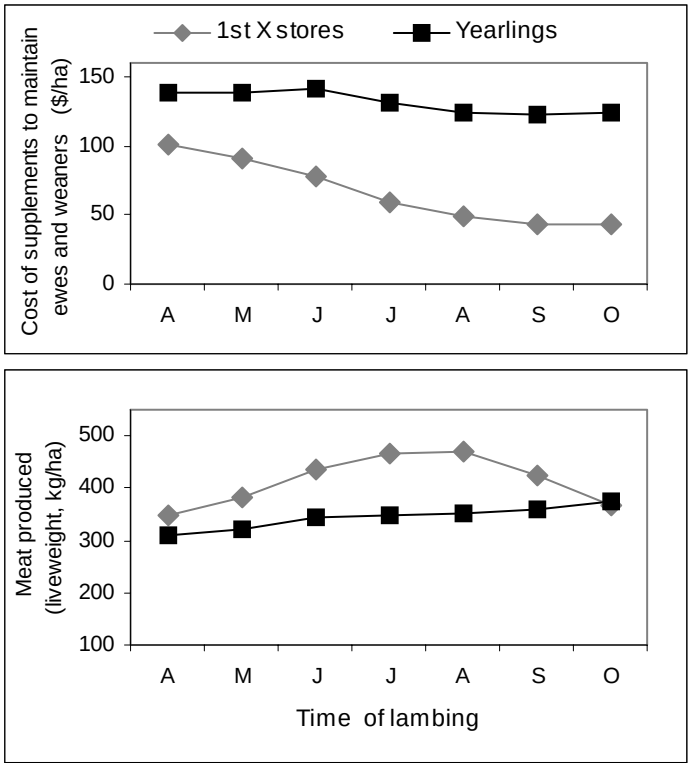


Figure 4. Effect of time of lambing on annual supplement cost (to maintain ewes and weaners) and meat produced (live weight, kg/ha), for a first-cross store lamb (FINE Merino ewes) and a FINE Merino yearling enterprise at Rutherglen, for a stocking rate of 10 ewes/ha.

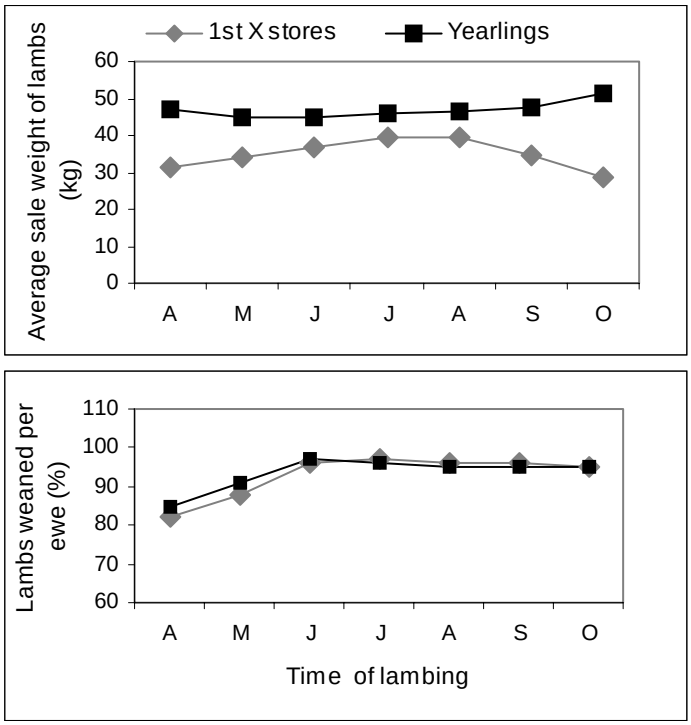


Figure 5. Effect of time of lambing on the number of lambs weaned per ewe and the average sale weight of wether lambs for a first-cross store lamb (FINE Merino ewes) and a FINE Merino yearling enterprise, at Rutherglen for a stocking rate of 10 ewes/ha.

At a given stocking rate, meat (live weight) per ha was the product of the number of lambs weaned per ewe and the average sale weight of lambs. The impact on time of lambing on these two variables is shown in Figure 5. Although only data for Rutherglen are shown, the same trend was apparent at all locations. Conception rates were higher for both Merino and first-cross ewes lambing from June through to October, and peaked in August and September (Table 3). Lamb mortalities due to wind chill tended to increase after July, and were most extreme at Mortlake (data not shown). The net result was a similar weaning percentage from Merino ewes lambing in June to October (Figure 5) and from first-cross ewes lambing from June to September (Figure 6).

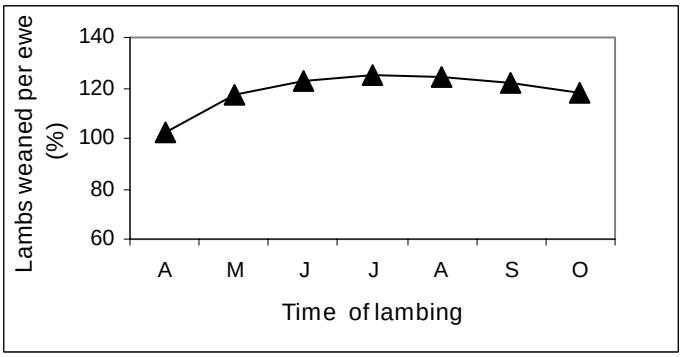


Figure 6. Effect of time of lambing on the number of lambs weaned per ewe for a second-cross store lamb enterprise, at Rutherglen for a stocking rate of 10 ewes/ha.

For the systems where lambs were supplemented to reach a target weight, the optimum time of lambing was that with lowest total supplement costs (maintenance and production) (Figure 7). The heavier the target weight, or the shorter the growing season, the earlier the optimum time of lambing. This time occurred, of course, within the range of lambing dates in which meat/ha was highest. Lambing very early in April or May was the least profitable time for all enterprises, because the number of lambs weaned per ewe (due to lower ewe fertility at joining) was lowest (Figures 5 and 6) and supplementary feed costs (for maintenance) the highest (Figures 4 and 7). Lamb sale weight was not a variable in this instance, as lambs were sold after they reached a target weight.

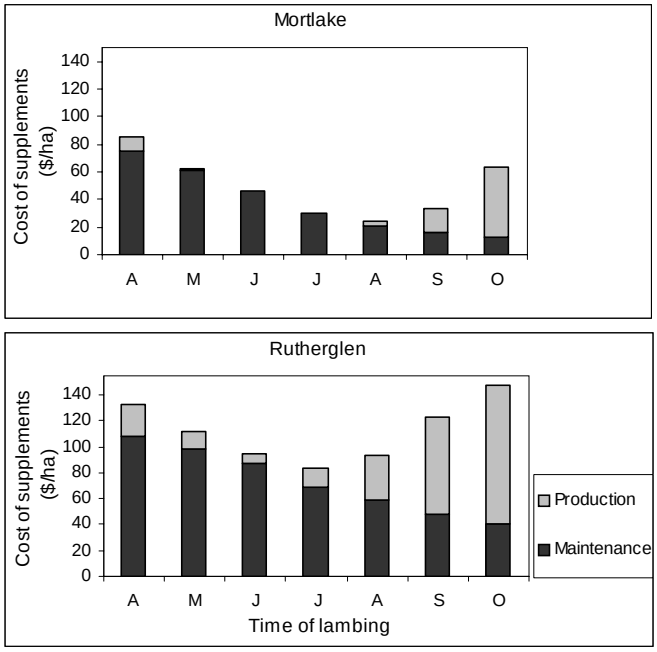


Figure 7. Effect of time of lambing on cost of supplements (maintenance and production) for a first-cross lamb enterprise (finishing lambs to 44 kg) using FINE merino ewes, stocked at 10 ewes/ha, at Mortlake and Rutherglen.

(II) STOCKING RATE

Simulations were run at a range of stocking rates for each enterprise, time of lambing and location (Appendices 2, 3, 4 and 5). The highest stocking rates tested were 20 wethers/ha and 18 ewes/ha. A response curve was obtained for time of lambing versus mean gross margin for each stocking rate (Figure 8).

Gross margins increased as stocking rate increased for the Merino wether enterprises and all the Merino ewe enterprises at all 4 locations. Gross margins decreased at the highest stocking rate tested (18 ewes/ha) for the first-cross ewe enterprises (producing store, trade or export second-cross lambs) at Rutherglen, Naracoorte and Cowra because of high supplement costs (Figure 8). At Mortlake, gross margins decreased at the highest stocking rate, only for the first-cross ewe/second-cross store lamb enterprise lambing in April May or June (Figure 8). Gross margins increased as stocking rate increased for the second-cross trade and export lamb enterprises at Mortlake.

The length of the growing season and winter pasture growth rates at the different locations gave rise to different potential carrying capacities. Mortlake had a longer growing season, greater spring pasture growth and relatively good winter growth rates compared with the other sites. Hence Mortlake had higher gross margins, due to lower supplement costs, for a given number of ewes/ha compared with the other three locations (Figure 8).

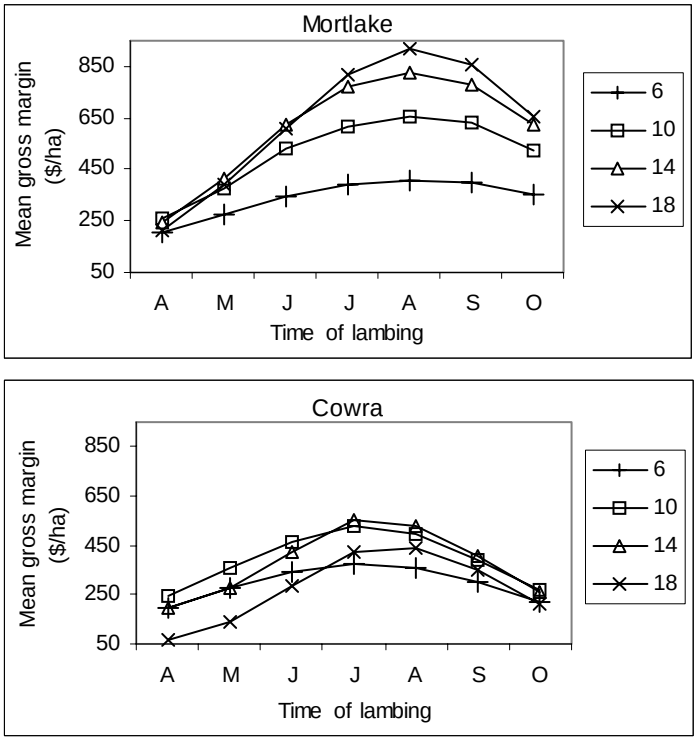


Figure 8. Effect time of lambing on gross margin for a second-cross store lamb enterprise at four stocking rates (6, 10, 14 or 18 ewes/ha) at Mortlake and Cowra.

The year to year variation in gross margin increased with stocking rate, indicating higher risk. However, the analysis indicated that it was profitable to increase supplementary feeding (at the grain price of $150/t) to maintain stocking rates above those generally considered acceptable in these locations (Figure 9). For all lambing times, stocking at 18 ewes/ha was more profitable than stocking at six ewes/ha (Figure 9). This indicates that stocking rate is a more important driver of profit than time of lambing. However, there are likely to be interactions with high stocking rates being more profitable at the later lambing dates. Figure 9 shows that optimising time of lambing can increase gross margin at a low stocking rate, but as stocking rate increases the benefits become larger. Even though risk increased with the higher stocking rate, the downside risk could be minimised if the time of lambing was

optimised. Data for all enterprises, depicting the economic risk for various time of lambing and stocking rate combinations, is presented in Appendices 1.1, 1.2, 1.3 and 1.4.

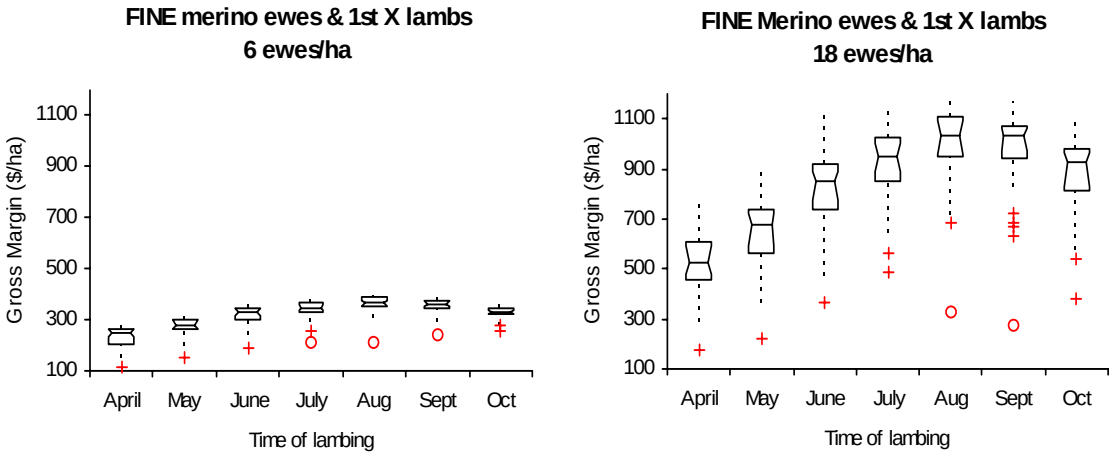
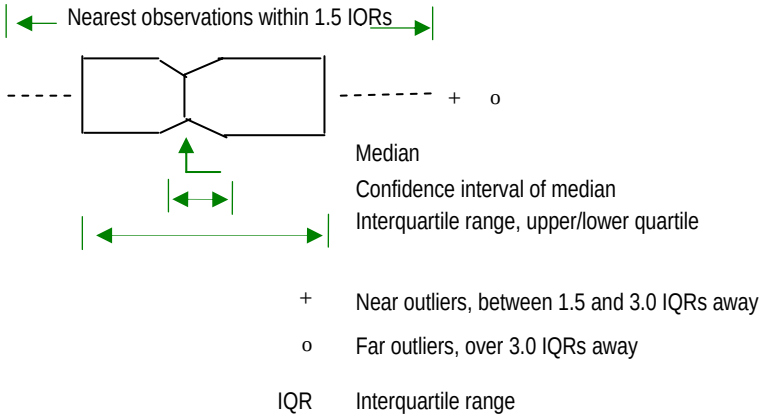


Figure 9. Effect of time of lambing and stocking rate on average gross margin and the variation in gross margin (risk) from 1966-2001, for a first-cross lamb enterprise (FINE merino ewes) at Mortlake.

LEGEND:



(III) TIME OF LAMBING AND STOCKING RATE INTERACTIONS – CONSIDERATION OF RISK FACTORS

In this study, enterprises were compared at the time of lambing and stocking rate that was most profitable. However, selecting the stocking rate on the basis of maximum gross margin does not account for production and environmental risks encountered by producers. Selecting the stocking rate on the basis of maintaining a similar winter DSE/ha for each enterprise does not fully capture the different risks of the enterprises. Hence, the highest sustainable stocking rate was selected for each of the enterprises on the basis of whether it met the two key risk criteria – i.e. the pasture mass (ground cover) and supplementary feed rules.

These additional criteria modified the choice of stocking rate and lambing dates at each location. For example, at Mortlake, the initial optimum time of lambing for first-cross store lamb (FINE Merino ewes) enterprise was August/September, with August having marginally higher gross margin (Figure 3a). When the risk criteria was overlaid on these times of lambing, the highest sustainable stocking rate that could be carried for August lambing was 17.5 ewes/ha with a gross margin of $966/ha compared with 20 ewes/ha for September lambing with a gross margin of $1042/ha. Lambing later reduced the probability of feeding

ewes and the sale of lambs as stores, reduced the grazing pressure on the pasture over summer and autumn. This allowed more ewes to be safely carried. In enterprises in which wool is of high value (e.g. super-fine and fine wools at the five year price scenario), it was more profitable to lamb at the later end of the optimum range, and run more ewes per ha, as the marginal return per ewe was still substantial (i.e. extra $30 gross margin per additional ewe). If the extra return per additional ewe/ha is small, then there is little benefit lambing at the later end of the range and running additional ewes. There would be a risk, or opportunity cost, from having capital invested in additional ewes with a low return.

A table was prepared for each enterprise at each location, to highlight the effect of time of lambing and stocking rate on average gross margin (Appendices 2, 3, 4 and 5). Examples of the gross margin tables for a Merino yearling and first-cross lamb enterprise for Mortlake are shown in Tables 7 and 8. The tables highlight the additional risks of managing the enterprise under the different combinations of stocking rate and time of lambing, using the criteria relating to supplementary feeding and maintaining adequate pasture cover. The risk of supplementing ewes decreases (i.e. pale shaded cells in Tables) as lambing occurs later in the year, to coincide with the increase in pasture availability (Tables 7 and 8). Hence more ewes/ha can be carried and higher gross margins obtained. More ewes/ha can be run for the store lamb enterprise than for the yearling enterprise, as lambs are sold at four months of age and grazing pressure over winter is reduced. Lower grazing pressure at the end of the growing season, also reduced the risk of pastures falling below the target 800 kg DM/ha (total) in summer and early autumn. This is demonstrated for the yearling enterprise in Table 7, where the dark shaded or dotted cells indicate the “pasture cover” rule has been exceeded.

Table 7. Effect of lambing and stocking rate combinations on average gross margin ($/ha) and risk (sustainable stocking rate criteria), for a FINE Merino yearling enterprise at Mortlake. Average five year prices used. Pale shaded cells indicate combinations where maintenance supplementary feeding rule cannot be met. Dotted cells indicate where ground cover rule cannot be met. Dark shaded cells indicate combinations where both rules cannot be met.

Ewes/ha	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	279	281	293	298	305	311	316
10	416	426	452	456	467	485	502
14	516	538	568	569	584	611	647
15	540	564	597	596	616	643	680
16	565	588	619	619	638	668	708
17	586	608	640	638	661	690	734
18	604	627	658	658	678	710	754

Table 8. Effect of lambing and stocking rate combinations on average gross margin ($/ha) and risk (sustainable stocking rate criteria), for a FINE Merino ewes/first-cross store lamb enterprise at Mortlake. Average five year prices used. Pale shaded cells indicate combinations where maintenance supplementary feeding rule cannot be met.

Ewes/ha	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	235	276	323	344	361	357	331
10	363	436	523	569	600	592	544
14	456	563	692	766	812	796	724
17	506	628	784	885	947	928	836
18	518	644	809	920	986	967	873
19	529	657	835	954	1025	1008	905
20	540	670	856	984	1062	1042	937

The optimum time of lambing for each enterprise and locality could be further refined when the interactions between stocking rate and risk were considered. The broad guidelines for the optimum time of lambing is summarised diagrammatically in Figure 10.

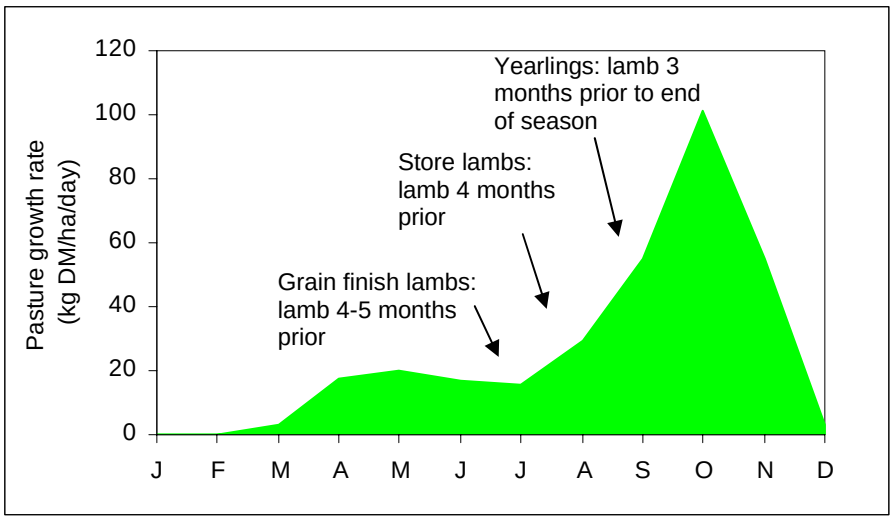


Figure 10. Guidelines for the optimum time of lambing can be related to the length of the growing season for a given pasture and environment.

(IV) GENOTYPE

The genotypes (average live weight, wool cut per head, fibre diameter) for each breed used for the main simulations were based on "average" sheep from Lambplan and Merino data bases (A. Ball pers. com. 2004). Given the wide genetic variation that exists within breed and between breeds (Fogarty *et al.*, 2005), the impact of using "superior" animals on gross margins was also investigated.

FIBRE DIAMETER AND FLEECE WEIGHT

When Merino ewes with a different "average" genotype were stocked at their optimum rate (using both economic and sustainability criteria), the amount of wool and meat produced per ha were similar (Table 9). However, when premiums were paid for the finer Merino wools, such as during 1999 -2003 (i.e. average five year price scenario) then the enterprises with the SUPER-FINE and FINE ewe genotypes had higher gross margins than the MEDIUM ewe enterprises (Table 9). Without price premiums, then there would be little difference in gross margins for the three genotypes. (The impact of changing commodity prices will be discussed in a later section). The wool cut per head of the "average" sheep was around 8.2% of their live weight (when in average condition). If more productive sheep are run, for example, ewes capable of producing a wool cut around 10% of their live weight (but with similar live weight and fibre diameter to "average" sheep), then the wool production per ha and gross margins will increase accordingly (Table 9). In this simulation, a 22 % increase in wool cut per head and per ha resulted in around a 19% increase in gross margin. If selection for higher fleece weight is accompanied by increased ewe live weight, the number of ewes run per ha will decrease.

Table 9. Effect of fibre diameter and fleece weight on the profitability of a Merino yearling enterprise, lambing in October, at Rutherglen.

Genotype	Stocking rate (ewes/ha)	Ewe live weight (kg) (in average condition)	Ewe fibre diameter (µm)	Ewe greasy wool cut (kg/head)	**Gross Margin[A] ($/ha)**	Wool produced (kg/ha)	Meat produced (kg/ha)
SUPER-FINE	9.5	45	17.5	3.6	**569**	38	334
FINE	8.5	50	19	4.1	**398**	38	333
MEDIUM	8.0	55	21	4.5	**311**	39	344
Superior genetics							
FINE plus (22% more wool)	8.5	50	19	5.0	**474**	47	331

[A] 5 year average (1999-2003) prices used

EWE LIVEWEIGHT /FRAME SIZE

Increasing the frame size (live weight) of the ewe, (but maintaining similar conception rates), will result in higher lamb birth weights and growth rates (Table 10). Hence it is a variable in which producers, who are focused on meat production, are interested. However, if ewe live weight is increased, the number of ewes/ha that can be carried has to be reduced, if grazing pressure is to be kept constant. Increasing ewe frame size may not necessarily result in an increase in meat/ha or gross margins, particularly if fibre diameter also increases (Table 10). The exceptions would be if the larger ewes also had greater feed conversion efficiency or greater fertility.

Table 10. Effect of ewe frame size on the profitability of a first-cross store lamb enterprise, lambing in August, at Rutherglen.

Genotype	Stock rate[A] (ewe/ ha)	Ewe live weight (kg) (in average condition)	Ewe fibre diameter (µm)	Ewe greasy wool cut (kg/head)	**Gross Margin[B] ($/ha)**	Average lamb growth rate (g/day)	Lamb sale weight (kg)	Meat (kg/ha)
FINE	10.5	50	19	4.1	**584**	245	39	489
MEDIUM	9.7	55	21	4.5	**506**	258	41	480
FINE – heavier ewe	9.7	55	19	4.5	**587**	258	41	480

[A] Stocking rate was adjusted for each genotype to achieve same winter grazing pressure (17.1 DSE/ha at 1 July) and meet risk criteria

[B] five year average (1999-2003) prices used in this simulation

(V) NUMBER OF LAMBS WEANED PER EWE (JOINED %)

The effect of increasing the fertility of the Merino ewe on gross margin was investigated for a first-cross store lamb enterprise at Mortlake (Figure 10). In this example, it was assumed that the increase in fertility was the effect of genotype, and not due to options with additional costs to the enterprise (e.g. feeding ewes more supplements prior to joining). The costs of any additional supplements required by the ewes, during pregnancy or lactation, have been included in the simulation.

Gross margin increased as weaning percentage increased, for all four stocking rates tested (Figure 11). For every 10% increase in weaning %, the gross margin increased by around 8 - 10% for the 4 stocking rates, using the five year average price scenario. This equated to an additional $24, $50, $61or $74 per ha for the five, 10, 15 or 20 ewes/ha stocking rates,

respectively. On a gross margin per ewe basis, a 10% increase in weaning equated to an additional benefit of around $4.00 -$5.00/ewe.

Increasing the stocking rate from five to 10 ewes/ha or from 10 to 20 ewes/ha had a much greater impact on gross margin than increasing weaning percentage. Doubling the stocking rate effectively doubled the gross margin (Figure 11).

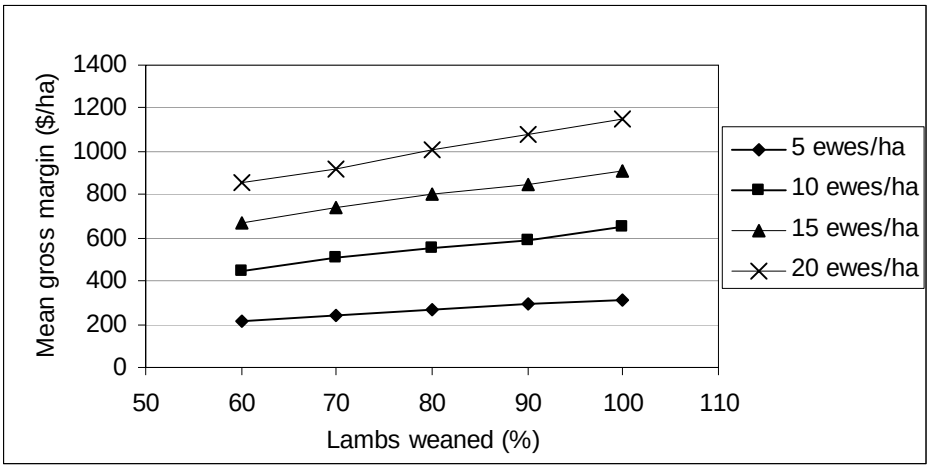


Figure 11. Effect of weaning % on Gross Margin for a first-cross store lamb enterprise, with FINE Merino ewes lambing in September, at Mortlake, at four stocking rates.

Increasing the number of lambs weaned per ewe also increased the grazing pressure, in dry sheep equivalent (DSE) terms. At Mortlake, 20 ewes/ha was the maximum number of ewes that could be run for this enterprise, when the "pasture mass" and the "supplementary feeding" rules were applied. When the standard conception rates were used (Table 3), stocking ewes at 20/ha, resulted in a weaning rate of 85%. Increasing the weaning % above this level by increasing the proportion of twins conceived/born (Figure 11), meant that the "supplementary feeding" rule could not be met. The paddock would be overstocked and the ewes/ha would need to decrease to compensate. The number of ewes per ha that could be run for the different weaning percentages (assuming the grazing pressure measured on the 1st July is kept constant and the two stocking rate rules are met) is shown in Table 11.

For the fully-stocked farm scenario, it was more profitable to wean more lambs per ewe and run slightly less ewes/ha, if there were no additional costs associated with the increase in fertility. For the under-stocked farm scenario (10 ewes/ha), there would be greater benefit from increasing the stocking rate first rather than focusing on increasing weaning %.

Table 11. Effect of weaning percentage on the number of ewes/ha that could be carried[A] and the associated gross margins, for a first-cross store lamb (FINE ewes) enterprise, lambing in September, at Mortlake.

Weaning %	Stocking rate (ewes/ha)	Winter DSE/ha[B] (1 July)	Gross margin ($/ha)
50	21.0	28	814
60	20.5	28	868
70	20.0	28	920
80	20.0	28	1006
90	19.5	28	1059
100	19.0	28	1105

[A] Stocking rate was adjusted to maintain similar winter grazing pressure and meet the sustainable stocking rate rules. Stocking rate was rounded off to nearest 0.5 ewe/ha.
[B] DSE/ha = dry sheep equivalents. A 50 kg dry sheep in average condition is equivalent to 1 DSE in *GrassGro.*

Simulations were also run to investigate the effect of increasing the fertility of first-cross ewes on gross margin (Figure 12). Similarly the results for the Merino ewes, for every 10% increase

in weaning %, the gross margin increased by around 8-10%, using the five year average price scenario. This equated to an additional $40 or $73 per ha for the seven and 14.5 ewes/ha stocking rates, respectively. On a gross margin per ewe basis, a 10% increase in weaning equated to an additional benefit of around $5.00-$6.00/ewe.

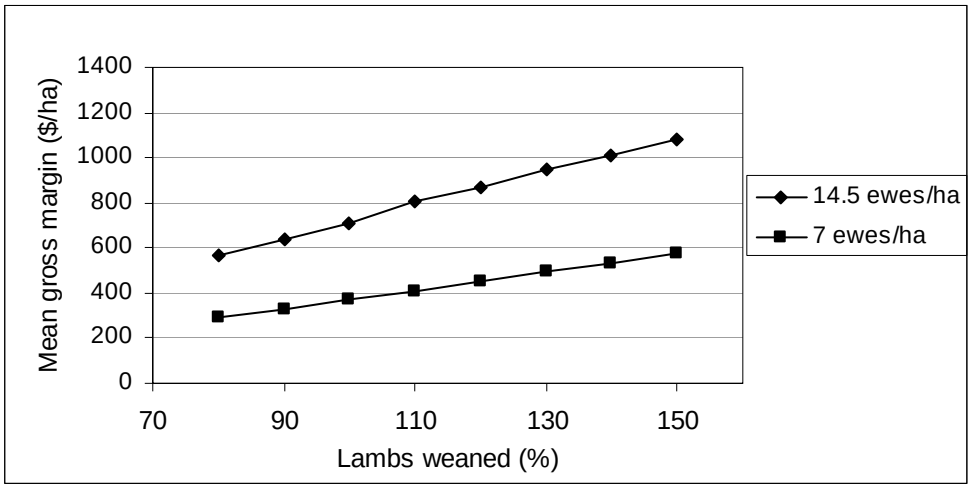


Figure 12. Effect of weaning % on gross margin for a second-cross trade lamb enterprise, with first- cross ewes lambing in August, at Mortlake, at two stocking rates.

Weaning percentage was more important for the profitability of the second-cross lamb enterprise compared to the first-cross lamb enterprise. For the first-cross lamb enterprise, stocked at 20 ewes/ha (the optimum using pasture mass and supplementary feeding rules), and using the standard conception rates (Table 3) the weaning rate was 85% and the gross margin $1042/ha. For the second-cross lamb enterprise, stocked at 14.5 ewes/ha, and using the standard conception rates, the weaning rate was 120% and the gross margin was $870/ha. Figure 13 shows the effect of varying weaning percentage, while keeping the number of ewes/ha constant, for the first-cross store lamb (FINE Merino ewes) and the second-cross trade lamb (first-cross ewes) enterprises. For the second-cross lamb enterprise to generate a similar gross margin to the first-cross lamb enterprise, a weaning rate of 145% was required (Figure 13).

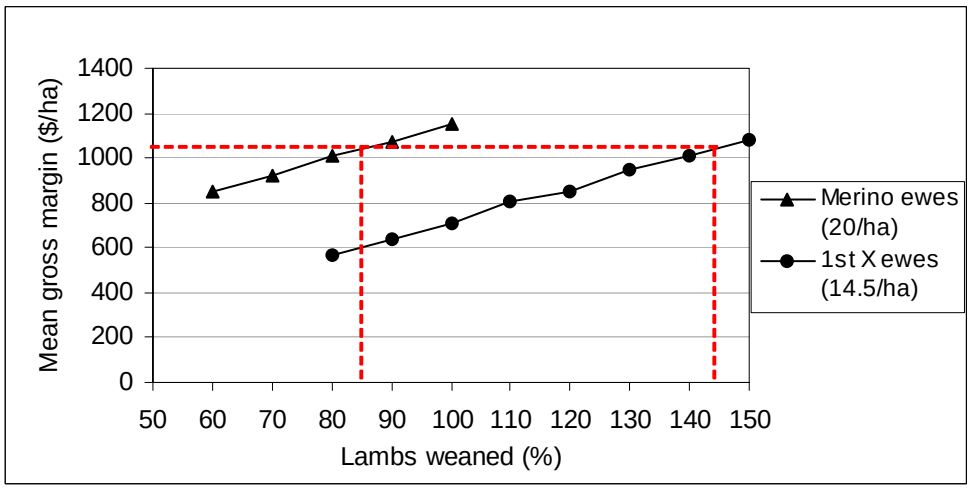


Figure 13. Comparison of the effect of weaning % on gross margin for a first-cross store lamb (FINE ewes) and a second-cross trade lamb enterprise, at Mortlake. (1999-2003 average prices).

(VI) CARCASE WEIGHT & KG MEAT/HA

The effect of producing heavier lambs on gross margin was investigated for a first-cross lamb enterprise at Mortlake (Table 12). In this example, rather than feed lambs grain to increase sale weight, the option of lambing earlier (in June) and keeping lambs for a longer time (until the end of December or until they reached 44 kg live weight) was explored. This option was compared with the store lamb option that lambed in September and sold lambs at four months of age (end of December), at a stocking rate of 20 ewes/ha. The upper sustainable stocking rate for the earlier lambing option (based on the pasture mass and supplementary feeding rules) was 12 ewes/ha. Lambing earlier meant lambs were sold at an older age and higher average live weight. However, as 40% less ewes/ha could be carried this resulted in around 30% less live weight/ha and 40% less wool/ha produced, and a reduction in meat and wool income per ha.

A price grid was used in the simulation, that allowed lambs of different sale weights over the 37 years to receive the appropriate sale price. Although the 44 kg lambs would have attracted a price premium of 20c/kg (live weight) on average, compared with the 38 kg lambs, this was not high enough to compensate for the lower meat and wool production per ha (Table 12).

Table 12. Effect of time of lambing and lamb sale age on the number of ewes/ha that can be carried, and the associated gross margins, for a first-cross lamb (FINE ewes) enterprise at Mortlake.

System	Stocking rate[A] (ewes/ha)	Gross margin ($/ha)	Average lamb live weight when sold (kg)	Wool income ($/ha)	Meat income ($/ha)	Maintenance supplement cost ($/ha)
Lamb June/sell end Dec	12	704	44	323	797	71
Lamb Sept/sell end Dec	20	1042	38	593	1086	101

[A] Stocking rate adjusted using pasture mass and supplementary feeding rules.

Following on from the above example, the effect of keeping lamb sale date constant (lambs sold by end December or when reach 44 kg live weight) but varying time of lambing from April through to October was investigated. Stocking rate was adjusted using the pasture mass and supplementary feeding rules as above. Lambing in September, running more ewes/ha and selling lambs at a younger age and lighter live weight was more profitable than all earlier times of lambing (Figure 14). Although lambing in October allowed more ewes/ha to be run, the meat income was less than from lambing in September due to lower average lamb sale weights (i.e. 30 kg).

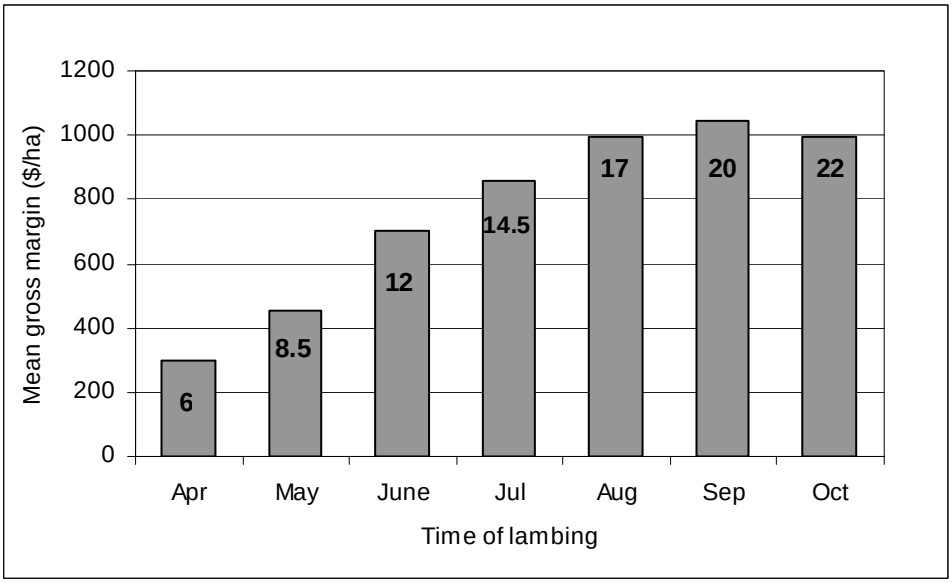


Figure 14. Effect of time of lambing and lamb sale age (lambs sold by end December or when reach 44 kg live weight) on the number of ewes/ha that can be carried (figures in bold), and the associated gross margins, for a first-cross lamb (FINE ewes) enterprise at Mortlake.

(VII) TIME OF SALE – SEASONAL VARIATION IN MEAT PRICE

Wool can be stored in order to manage price risk but producers selling lambs have less flexibility with the timing of lamb sales. This exposes them to the risk of seasonal price fluctuations, which could affect gross margins. So far in the analysis average yearly meat prices for each weight category have been used for simplicity. The 5 year average, monthly variations in first-cross lamb prices are shown in Figure 15. Prices vary from $0.50 -1.00/kg carcase weight, depending on the carcase size category, and there is a tendency for prices to be slightly higher from January to June. Since the times of lambing investigated ranged from April through to October, store lambs were sold from August to January, finished lambs sold from August to March, and yearlings sold from March to September. So there is potential for large differences in the price of lambs based on time of sale.

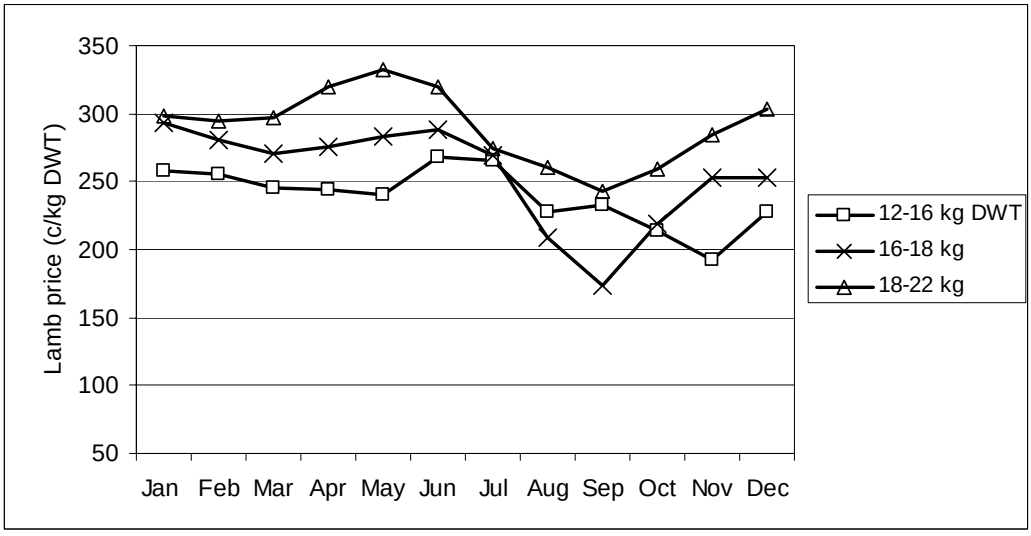


Figure 15. Effect of month of sale on price received for first-cross lambs (five-year average: July 1999-June 2004) (National Livestock Reporting Service, 2004).

The impact of seasonal price variation was investigated for a first-cross store lamb (FINE ewes) enterprise at Mortlake, stocked at 10 ewes/ha (Figure 16). Using the actual monthly prices reduced gross margins for the April to July lambing times (selling lambs from August to November), but had little impact for the later lambing/selling times. In this case, using the monthly prices did not affect the optimum time of lambing previously determined. Lambing in October or later, meant an escalation in maintenance feeding costs for the lambs and ewes and less meat produced per ha. The price premiums which are evident in January and June are not high enough to compensate for this.

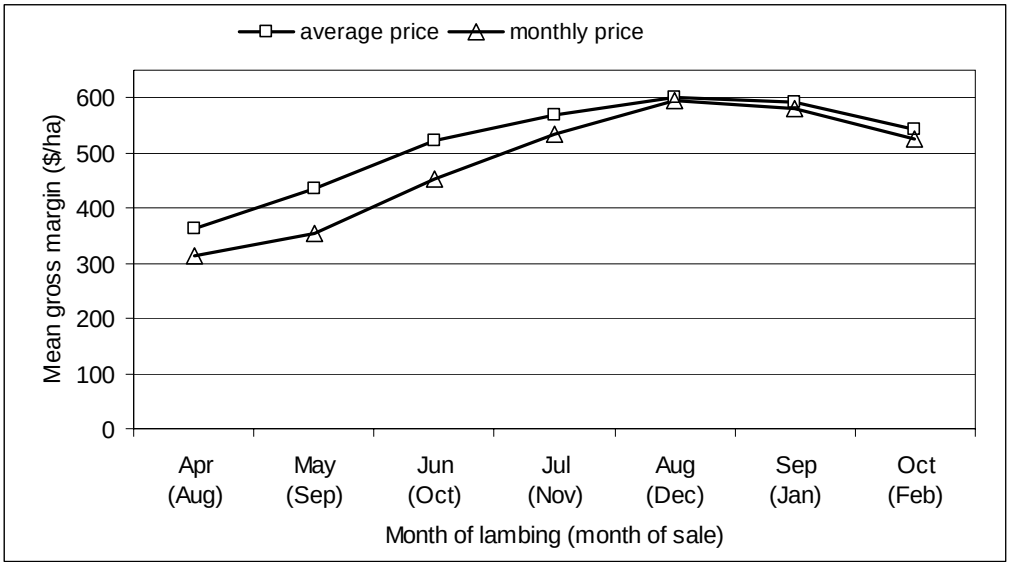


Figure 16. A comparison of using actual monthly lamb sale price versus a yearly average on the gross margins, for a first-cross lamb enterprise at Mortlake, stocked at 10 ewes/ha.

The effect of lambing in spring, but holding lambs over to sell the following winter, on gross margin, was also investigated for a first-cross lamb enterprise. This is a tactic that some lamb producers undertake in an attempt to sell lambs when prices are higher. Table 13 compares Merino ewes lambing in September, selling first-cross store lambs at the end of December, and run at the optimum stocking rate (based on the pasture mass and feeding rules) with selling lambs the following June. While delaying selling lambs increased the average sale weight and sale price (using actual average monthly prices from 1999-2004), the additional grazing pressure over summer and autumn reduced the number of ewes that could be carried. The result was less meat and wool income per ha and a lower gross margin.

Table 13. Effect of lamb sale age on the number of ewes/ha that can be carried, and the associated gross margins, for a first-cross lamb (FINE ewes) enterprise at Mortlake.

System	Stocking rate[A] (ewes/ha)	Gross margin[B] ($/ha)	Average lamb live weight when sold (kg)	Wool income ($/ha)	Meat income ($/ha)	Maintenance supplement cost ($/ha)
Lamb Sept/sell mid June	14.5	782	42	431	856	105
Lamb Sept/sell end Dec	20	1032	38	593	1075	100

[A] Stocking rate adjusted using pasture mass and supplementary feeding rules.
[B] Actual monthly price used for time of sale

ENTERPRISE COMPARISONS UNDER "OPTIMUM MANAGEMENT" CONDITIONS.

In this study, "optimum management" related to the time of lambing and stocking rate selected for each enterprise. The optimum time of lambing was selected and the highest sustainable stocking rate was selected for each of the enterprises on the basis of whether it met the two key risk criteria as described above (i.e. the pasture mass and supplementary feed rules). The stocking rates selected and the associated financial and production data are summarised in Appendices 6.1, 6.2, 6.3 and 6.4, for each location.

A comparison of gross margin (using five year average prices) for each enterprise when run under "optimum management" is shown for Mortlake, Rutherglen, Naracoorte and Cowra in Figure 17. The relative profitability of each enterprise at the four locations was similar. The dual purpose (first-cross lambs) enterprise was most profitable, followed by prime lambs (second-cross lambs), with the self-replacing flocks (lambs and yearlings) least profitable, the exception being the SUPER-FINE yearling enterprise. FINE wethers were less profitable than ewes, but the SUPER-FINE wethers compared favourably with the FINE Merino lamb enterprise. The effect of micron premiums was apparent for the Merino enterprises when the five year average prices were used.

There was no advantage in keeping Merino lambs to shear and sell as yearlings. Slightly more wool/ha was produced in the yearling system, and similar meat/ha was produced. A 30% price discount for yearling meat, compared with lamb, reduced meat income. If Merino yearlings received the same meat price (c/kg) as Merino lambs, then this enterprise would be marginally more profitable than the Merino lamb enterprise (Appendices 6.1, 6.2, 6.3 and 6.4).

The magnitude of the gross margins at the different locations was largely a function of the different stocking rates that could be carried. The Mortlake perennial pasture had the highest carrying capacity, and the Cowra annual pasture had the lowest.

Finishing first cross lambs to 44 kg live weight was not as profitable as producing stores, and this was most obvious at Cowra. The length of the growing season and the size of the spring peak in pasture supply also had a bearing on the relative value of finishing lambs. Finishing first-cross lambs (MEDIUM ewes) to a live weight of 44 kg (compared with lambing later, running more ewes and turning off store lambs), returned, on average, a loss of $7/ha at Mortlake, $6/ha at Rutherglen, $7/ha at Naracoorte, and a loss of $77/ha at Cowra. At the 4 locations, the average sale weight of first-cross store lambs ranged from 39 kg (Cowra) to 41kg (Rutherglen). Feeding grain reduced production risk by adding on average, an additional 4-6 kg live weight to the lambs. However, the small decrease in ewes/ha, meant wool production per ha was reduced at the expense of a small or no net gain in meat production per ha.

Finishing second-cross, prime lambs to a live weight of 44 kg (compared with turning off stores), increased gross margin by $26/ha at Mortlake, $6/ha at Rutherglen, $3/ha at Naracoorte, and a loss of $20/ha at Cowra, for the grain price used in this analysis. Finishing second-cross lambs to a heavier live weight of 53 kg (compared with 44kg), increased gross margin by $61/ha at Mortlake, $28/ha at Rutherglen, $61/ha at Naracoorte, and $65/ha at Cowra.

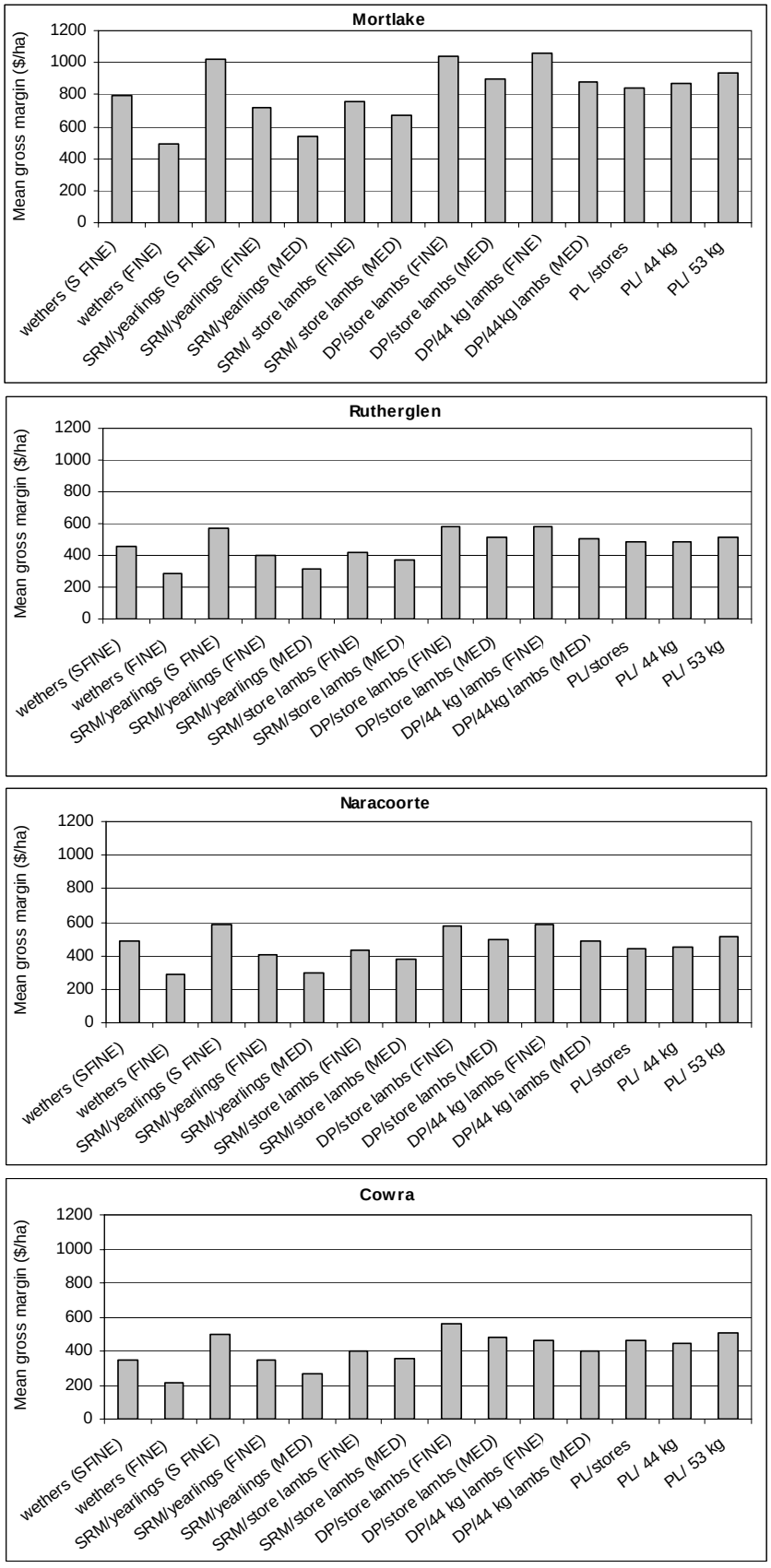


Figure 17. Comparison of gross margins for a range of sheep enterprises at Mortlake, Rutherglen, Naracoorte and Cowra (five year average prices used). SRM = self replacing merino flock. DP = dual purpose flock, merino ewes joined to terminal sire. PL = prime lamb flock, first-cross ewe joined to terminal sire.

The dual purpose and prime lamb enterprises produced more meat per ha than the self-replacing Merino enterprises and correspondingly received more meat income/ha (Table 14, Figure 18). This is because more joined ewes could be run per ha, as all ewe replacements were purchased, and not bred. The FINE and MEDIUM dual purpose enterprises also had a higher wool income than the prime lamb enterprises, due to the higher value of the wool.

Table 14. Comparison of meat (live weight) and wool produced per ha for the sheep enterprises simulated at Rutherglen.

Enterprise	Clean wool (kg/ha)	Live weight (kg/ha)
Wethers (FINE)	42	158
SRM/yearlings (FINE)	38	333
SRM/store lambs (FINE)	32	325
DP/store lambs (FINE)	33	489
DP/44 kg lambs (FINE)	30	503
PL/store lambs	26	537
PL/44 kg lambs	24	543
PL/53 kg lambs	21	552

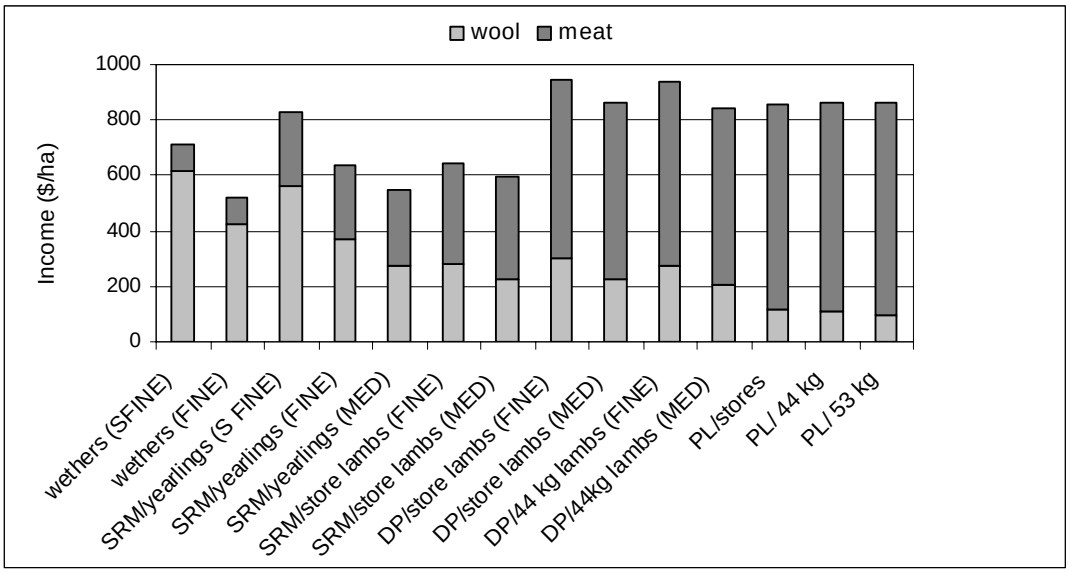


Figure 18. Proportion of income derived from wool or meat for a range of sheep enterprises at Rutherglen (five year average prices used). SRM = self replacing merino flock. DP = dual purpose flock, merino ewes joined to terminal sire. PL = prime lamb flock, first-cross ewe joined to terminal sire.

The economic risk associated with each enterprise can be represented by the variation in gross margins over the 37 years the simulations were run. Although FINE wethers were less profitable than ewe enterprises, there was less variation in gross margins (Figure 19). The ewe enterprises with the SUPER-FINE and FINE wool had less range in gross margins than those with the MEDIUM genotype. Feeding lambs, when required, to achieve a target live weight of 44 kg or 53 kg, reduced economic risk. The trends were similar at each location.

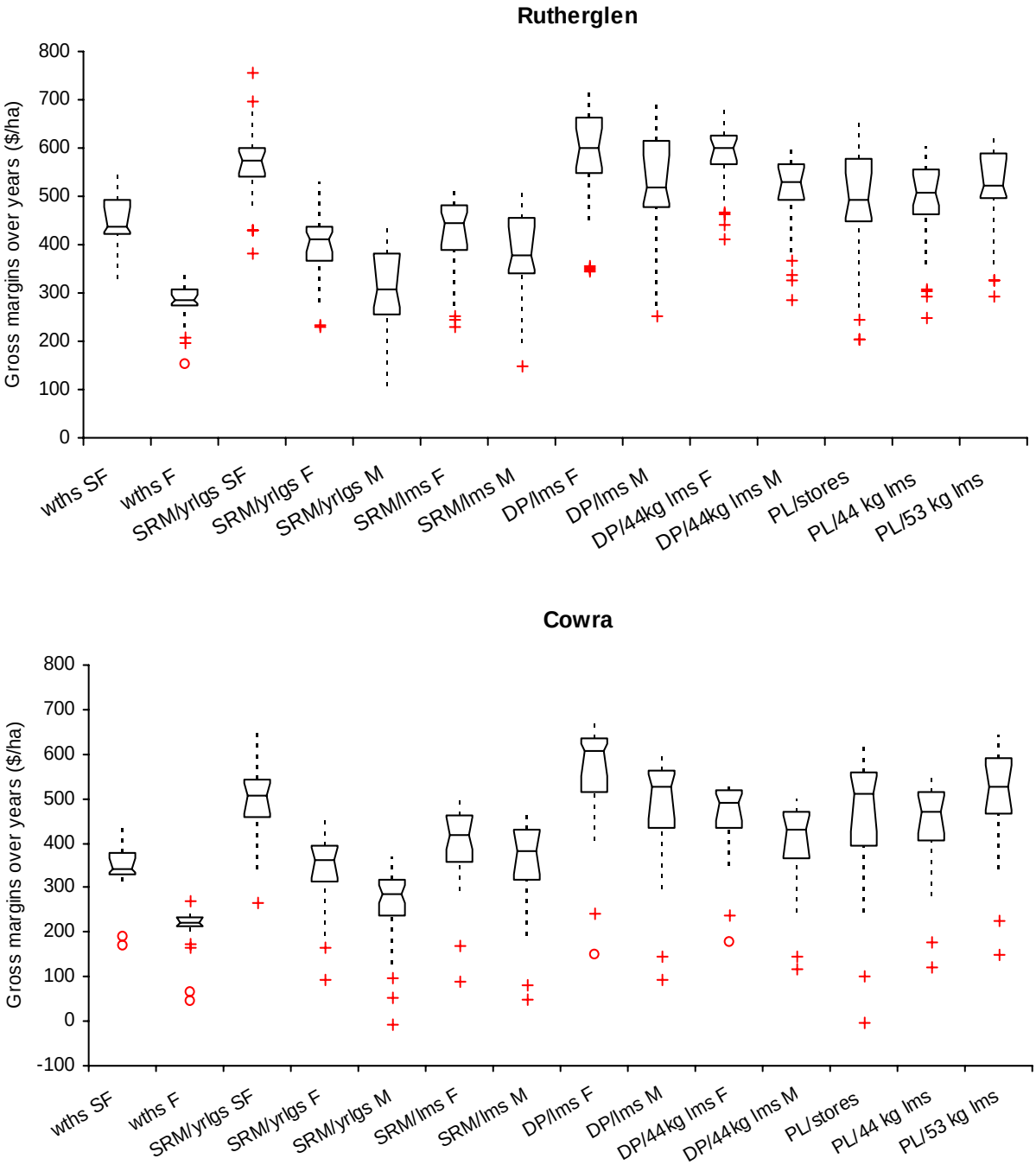
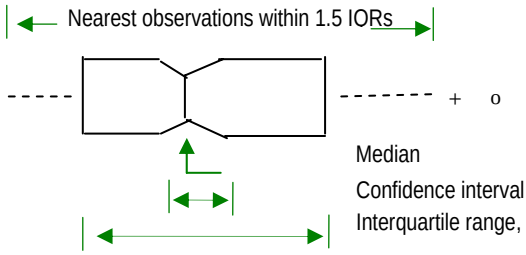


Figure 19. Range in enterprise gross margins from 1966 -2001, at Rutherglen and Cowra (five year average prices).

LEGEND



Median

Confidence interval of median

Interquartile range, upper/lower quartile

\+ Near outliers, between 1.5 and 3.0 IQRs away

o Far outliers, over 3.0 IQRs away

IQR Interquartile range

SENSITIVITY OF GROSS MARGINS TO CHANGES IN COMMODITY PRICES

Over 2003-04 the micron premium fell, while meat prices remained relatively high (Table 5). The impact of using the past year's (July 2003-June 2004) prices on the profitability of the sheep enterprises at Rutherglen and Mortlake is shown in Figure 20. The relative ranking of the enterprises on the basis of gross margin was similar to that pattern described for the five year average price scenario, for each location. The main difference was that the advantage of the SUPER-FINE and FINE ewe genotypes disappeared, with the demise of the micron premiums. The average gross margins for the dual purpose and prime lamb enterprises increased with the increase in meat income.

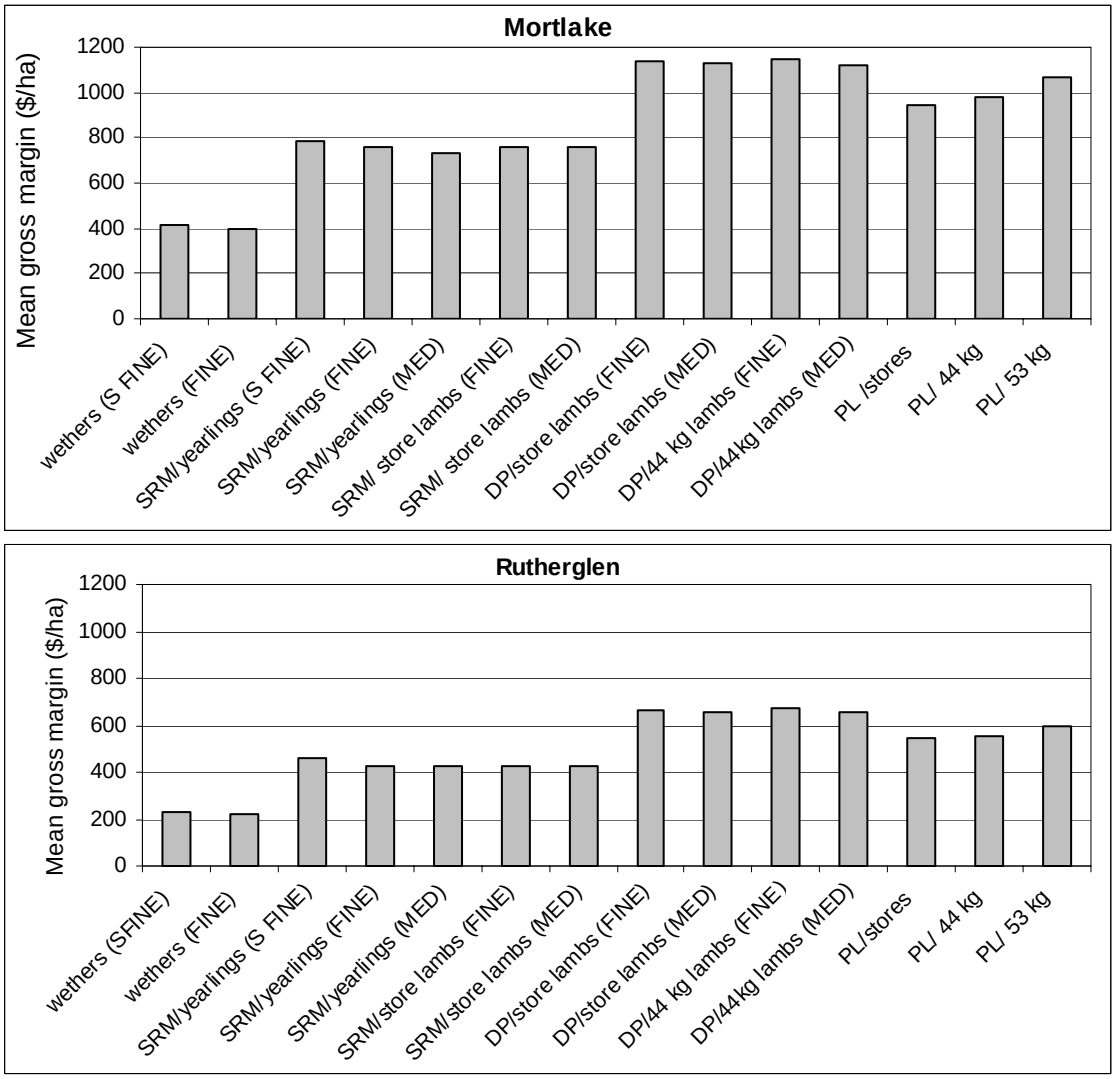


Figure 20. Comparison of gross margins for a range of sheep enterprises at Mortlake and Rutherglen (2003-04 average prices used). SRM = self replacing merino flock. DP = dual purpose flock, merino ewes joined to terminal sire. PL = prime lamb flock, first-cross ewe joined to terminal sire.

SENSITIVITY OF GROSS MARGIN TO WEANING % WITH 2003-04 AVERAGE PRICES

The effect of weaning % on the relative profitability of a first-cross lamb and a second-cross lamb enterprise was demonstrated in Figure 13, using the five year average prices for meat and wool. The relative profitability of the two enterprises was also compared using the 2003-04 average prices, for a range of weaning percentages (Figure 21).

Using the 2003-04 average prices, the 1st cross lamb enterprise stocked at 20 ewes/ha (optimum using pasture mass and supplementary feeding rules) and using the standard conception rates (Table 3) achieved a weaning rate of 85% and a gross margin of $1139/ha.

For the second-cross lamb enterprise stocked at 14.5 ewes/ha and using the standard conception rates, the weaning rate was 120% and the gross margin was $981/ha. Figure 21 shows the effect of varying weaning percentage while keeping the number of ewes/ha constant for the first-cross store lamb (FINE Merino ewes) and the second-cross trade lamb (first-cross ewes) enterprises. For the second-cross lamb enterprise to generate a similar gross margin to the first-cross lamb enterprise, a weaning rate of 135% was required (Figure 21). This was a slightly lower break-even weaning rate (145%) than that generated using the 1999-2003 average prices (Figure 13). These results indicate that for a second-cross lamb enterprise to be as profitable as a first-cross store lamb enterprise, a weaning rate of 135 - 145% needs to be achieved based on the two commodity price scenarios investigated.

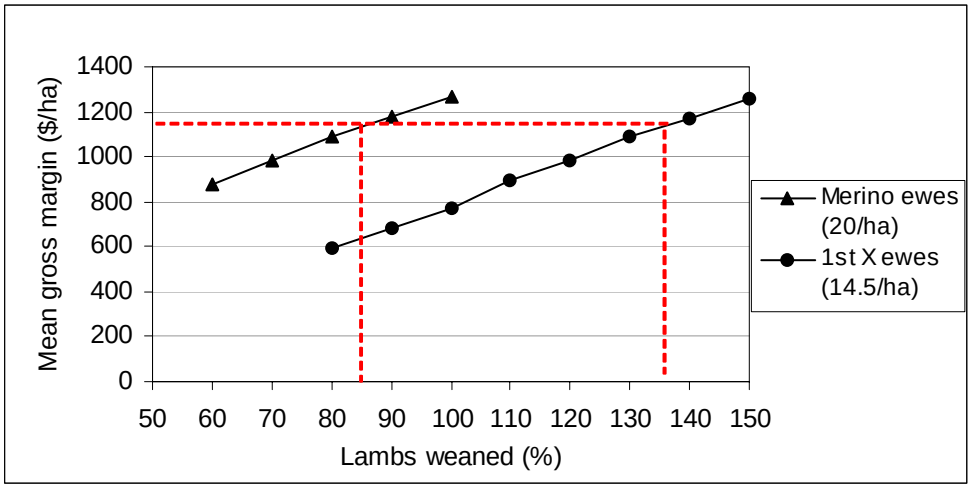


Figure 21. Comparison of the effect of weaning % on gross margin for first-cross store lamb (FINE ewes) and second-cross trade lamb enterprise at Mortlake. (2003-04 average prices).

SENSITIVITY OF GROSS MARGIN TO EWE PURCHASE PRICE

The purchase price of replacement Merino or crossbred ewes was an important variable affecting the relative profitability of the first and second-cross lamb enterprises. Using the 2003-04 average prices for wool and meat, but varying ewe price, Figure 22 shows that if ewe purchase price was similar for both enterprises, gross margins would also be similar. However, average prices for 2003-04 were around $80 for Merino ewes and $150 for first-cross ewes.

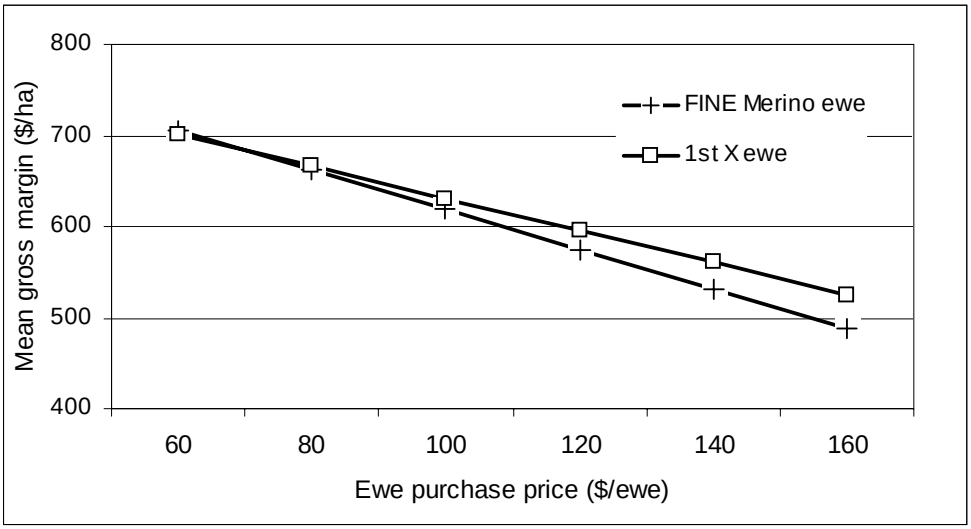


Figure 22. Effect of ewe purchase price on gross margin, for a first-cross store lamb (FINE Merino ewes) enterprise lambing in August and stocked at 10.5 ewes/ha, and a second-cross store lamb (first-cross ewes) enterprise lambing in August and stocked at 8.5 ewes/ha, at Rutherglen (2003-04 average prices). (The stocking rate was based on the pasture mass and supplementary feed rules).

ENTERPRISE CHANGE

The price paid for ewes has a large impact on gross margin and risk associated with changing enterprises (Table 15). The economics of changing from a self-replacing Merino flock to a first-cross ewe flock was investigated using the 2003-04 commodity prices and a range of first-cross ewe purchase prices, at Rutherglen. The sale price of Merino ewes (FINE) was kept at $80/head for each first-cross ewe price scenario. Although the gross margin for the first-cross ewe enterprise was higher than for the self-replacing Merino enterprise at the range of ewe prices investigated (Table 15), paying more than $150 for a first-cross ewe would be risky, due to the long time taken to break-even with the "do-nothing" scenario.

Table 15. Effect of first-cross ewe purchase price (in a second-cross store lamb enterprise) on gross margin and the number of years to break-even (cumulative cash flow) compared with running a self-replacing Merino flock (FINE ewes), producing yearlings, at Rutherglen. (First-cross ewes lamb in August and stocked at 8.5/ha, and Merino ewes lambing in October and stocked at 8.5/ha).

Option	Ewe price ($/head)	Mean gross margin[A] ($/ha)	Time to break even with Merino enterprise (years)
"Do nothing" -Keep self-replacing Merino flock (yearlings)	-	429	-
Sell Merino ewes[B] & Purchase first-cross ewes	100	631	1
	130	578	2
	150	542	5
	180	490	13
	200	454	40

[A] 2003-04 prices for wool and meat used.
[B] Merino ewes sold for $80/head

DISCUSSION

ENTERPRISE COMPARISONS

The dual purpose enterprise using Merino ewes was consistently the most profitable enterprise, followed by prime lambs, then the self-replacing Merino enterprises, with the Merino wethers the least profitable enterprise, at all four localities and at two commodity price scenarios. In general, the self-replacing Merino enterprises were slightly less profitable than the prime lamb enterprises. However, when a large price premium existed for super-fine wool (i.e. five year average price, 1999-2003), the super-fine Merino yearling enterprise was as profitable as the dual purpose enterprise.

In this study, gross margins extracted from *GrassGro* were used as an indicator of profitability of an enterprise. This is of course a simplistic view as differences in labour costs to manage the different enterprises are not considered. However, benchmarking studies indicate that there is a strong correlation between income/ha or gross margin/ha and ultimate net farm income/ha or profit (Webb Ware 2002).

The results for enterprise gross margins from this study agree with data from farm financial benchmarking studies (Holmes, Sackett and Associates, 2002; Beattie, 2004). Data from Holmes, Sackett and Associates (2002) highlighted the greater profitability of dual purpose flocks, followed by prime lamb flocks and then wool flocks. Based on their data from 1999 to 2002, dual purpose flocks (Merino ewe joined to terminal sire) stood out as an enterprise having a high level of profit and acceptable volatility. An analysis of 55 farms in south-western Victoria by Beattie (2002, 2004) showed similar trends. For 2001-02, average gross margins for prime lamb flocks were $421/ha, beef herds were $335/ha, while wool flocks had the lowest gross margins of $284/ha. In this analysis prime lambs included first and second-cross lamb enterprises.

The self-replacing Merino enterprise turning-off store Merino lambs was slightly more profitable than that producing yearlings. The lamb system ran more joined ewes/ha and produced a similar amount of meat per ha but slightly less wool per ha than the yearling system. The meat income was higher for the lamb system as the yearlings received a price discount of around 30%. If there was no price discount for yearlings (two–tooth), then this enterprise would have a marginally higher gross margin than the lamb enterprise. These results differ to those of McEachern (2004), who found that gross margins from a Merino yearling enterprise were higher than from a Merino lamb enterprise. In that study, enterprises were compared at the same time of lambing (September) and the same winter stocking rate of 15 DSE/ha.

The gross margins and relative risk of each enterprise simulated was only compared after variables such as time of lambing and stocking rate were optimised. This was done in order to remove the management variability factor that is so evident in farms involved in benchmarking. An example of this farm variation is shown in Table 14, where the profitability of a range of grazing enterprise, is expressed as profit $/DSE (less interest). As discussed previously, this data set from Holmes, Sackett and Associates (2002) highlights the good performance of dual purpose flocks. It also highlights that for any enterprise there is an enormous range between the bottom 20% of producers and the top 20% of producers within the one year. Expressing profit on a per DSE basis is done to allow a fairer comparison of enterprises that are run in different locations.

Table 14. Differences in profitability ($/DSE) for four different grazing enterprises for 2001-02 (Holmes, Sackett and Associates 2002).

	Bottom 20%	Average	Top 20%
Wool	$ -2.43	$ 9.38	$ 19.10
Dual purpose sheep	$ 1.13	$ 17.93	$ 34.84
Prime lamb	$ 3.10	$ 11.91	$ 20.21
Beef	$ 1.50	$ 12.34	$ 22.92

Both the simulation and the financial benchmarking data (Table 14) highlight that there is considerable scope for producers with wool flocks, dual purpose flocks or prime lamb flocks to be more profitable without changing enterprise, but simply do a better job of what they are currently doing. The productivity of the farm and efficiency of the operator can make them highly profitable regardless of enterprise or enterprise combinations (Beattie 2002). A recent lamb producer survey (ABARE, 2004) indicates that over the past eight years the number of crossbred ewes to be joined for second-cross lamb production had doubled, even though the benchmarking data shows the dual purpose flocks to be more profitable on a DSE basis, on average.

Producers respond to price signals, as indicated by the trend to production of finer wools (Beattie 2004) and heavier carcase weight lambs (Barrett *et al*. 2003), and the increase in sheep meat production (ABARE 2004). However, price received for product is only one element of the profit equation. If costs increase or product/ha falls, then an increase in profit is not guaranteed. It is important for producers to understand the key factors which drive the profitability of their wool or sheep meat enterprise, so that they can make wise management decisions.

PROFIT AND PRODUCTION DRIVERS IN WOOL AND MEAT ENTERPRISES

Meat and wool per ha – Stocking rate

Stocking rate was demonstrated to have a major impact on gross margins. This is because it had the biggest impact on the amount of meat (and wool) produced per ha, compared with other variables evaluated such as weaning percentage, carcase weight, and time of sale. At low stocking rates, changing time of lambing from autumn to late winter or spring resulted in small increases in gross margins. However, the greatest advantage of optimising the time of lambing was that it enabled stocking rate to be increased without increasing the risk of feeding ewes. For a given stocking rate, optimising the time of lambing reduced maintenance supplement costs and increased gross margins. However, the greatest advantage of getting time of lambing right is that it enabled stocking rate to be increased while minimising risks. The economic benefit of optimising time of lambing was greater at higher stocking rates. Lambing earlier meant maximum grazing pressure coincided with low winter pasture growth rates, and was a constraint to increasing stocking rate.

For a given enterprise, the optimum time of lambing was similar for a range of stocking rates. Sometimes further refinements could be made and lambing could occur at the later end of the optimum range, if the extra returns from each additional ewe run were justified. The optimum time of lambing was not sensitive to commodity or grain prices as the optimum time occurred where supplementary feed costs were the lowest and meat per ha the highest.

An analysis of a farm benchmarking database by Holmes, Sackett and Associates (2004), highlighted that for a prime lamb flock, gross margin ($/ha/100 mm rainfall) was highly correlated with kg lamb/ha/100 mm rain and numbers of lambs weaned/ha/100 mm rain. They indicated that there was no relationship between gross margin and weaning percentage, sale weight of lamb or price received (c/kg dressed weight basis). This analysis was conducted on specialist prime lamb enterprises for the 2001/2002 year, and all data was adjusted to allow for the different rainfall zones where farms were located. Although lambs weaned/ha is a

function of both stocking rate and weaning percentage, the authors argued that in their study, stocking rate was more important. The results of the simulations are generally consistent with this farm data.

Unlike the results from the analysis of the farm data (Holmes, Sackett and Associates 2004), the simulations showed that there was a linear relationship between weaning percentage and gross margin. When stocking rate (ewes/ha) was held constant, increasing weaning percentage increased grazing pressure (DSE/ha). Increasing weaning percentage by 10% increased gross margin by approximately 10% for both the first and second-cross lamb enterprises. This was equivalent to an additional gross margin of $24-74/ha (depending on stocking rate) or $4-5/ewe for the first-cross lamb enterprise and $5-6/ewe for the second-cross lamb enterprise.

In the simulations the costs of any additional supplements required by the ewes, during pregnancy or lactation, were included but any costs associated with obtaining the increase in fertility was not. So, if we assume half of this $4-5/ewe or $5-6/ewe gross margin benefit needs to be kept as profit, then there is $2.00-3.00 available per ewe to spend on increasing weaning rate by 10%. This could be spent on feeding ewes an extra 13-20 kg grain/ewe (i.e. wheat at $150/t) above the maintenance ratio, to increase live weight pre-joining by around 2-3 kg (assuming feed conversion ratio of 7:1) and increase ovulation rates. For every 1kg increase in Merino ewe live weight you can expect 1.5% extra lambs born (Cahill 1984, Hygate 2003). Therefore, increasing ewe live weight by 2-3 kg would result in an extra 3 to 4.5 more lambs born per 100 ewes. Clearly, this option of feeding extra grain to ewes would not be profitable as it is unlikely to lead to a 10% increase in weaning rate. Alternatively, the extra dollars could be spent reducing lamb mortalities, such as on shelter.

Increasing the stocking rate had a much greater impact on gross margin than increasing weaning percentage. For fully-stocked farms, it would be more profitable to wean more lambs per ewe and run slightly less ewes/ha, if there were no additional costs associated with the increase in fertility. For under-stocked farms, there would be greater benefit from increasing the stocking rate first rather than focusing on increasing weaning %. This of course involves a capital investment to purchase more ewes.

Weaning percentage was more important for the profitability of the second-cross lamb enterprise compared to the first-cross lamb enterprise. For the second-cross lamb enterprise to break-even with the first-cross lamb enterprise in terms of gross margin, the weaning percentage had to be around 60-70% higher.

Genotype and Breed

The importance of genotype of the sheep on production efficiency and gross margins was also demonstrated in this study. The benefit of super-fine and fine wool Merino genotypes was clear when the five year average prices were used, as there was a substantial micron premium. The results also highlighted that fibre diameter was important even for a dual purpose enterprise. Increasing ewe frame size could reduce gross margins if fibre diameter increased.

Increasing the fertility of the ewe (by changing genotype) also increased gross margins, but not to the same extent as optimising the stocking rate. Producers who are understocked would benefit more from increasing stocking rate than focusing on weaning percentage. For producers who are fully stocked, increasing weaning percentage would be beneficial, but the number of ewes/ha would have to be reduced.

The value of using superior genetics has also been shown in the Maternal Central Progeny Test (Cummins *et al*. 2002). In that study the choice of maternal sires had a major impact on the profitability of a specialist lamb production system with differences in returns from lamb meat per ewe of up to $45 between sire groups (Cummins *et al*. 2002).Cummins *et al.* also estimated that for a specialist lamb producer with 2000 breeding ewes the choice of sire could result in differences in gross income per year of $80,000. However, it is difficult to determine the full impact of this on farm profit, as the costs associated with the improved per head

performances are not evaluated (i.e. do the better progeny cost more to run or are they simply converting pasture more efficiently?). The potential value of these different breeds and genotypes could be explored through modelling.

Income versus costs

The GrassGro simulations suggested that stocking rate had to be pushed to very high levels before gross margins hit their peak and then declined. The additional income generated from the extra wool and meat produced per ha outweighed the extra costs of supplements. According to Webb Ware (2002) low gross income is a consistent feature of unprofitable farms, which is directly related to low production, inherently unprofitable enterprises or a combination of both. Webb Ware also stated that farm costs are important on some farms, but usually of much lower priority than low production in terms of driving farm profitability. Producers who have adopted improved practices (improved pastures and stocking rate, appropriate time of lambing) have been able to demonstrate large increases in net farm income: Increases in gross margins were responsible rather than a reduction in costs (Lean *et al.* 1997).

CONCLUSIONS

The dual purpose enterprise using Merino ewes was consistently the most profitable enterprise, followed by prime lambs, then the self-replacing Merino enterprises, with the Merino wethers the least profitable enterprise, at all four localities and at two commodity price scenarios. In general, the self-replacing Merino enterprises were slightly less profitable than the prime lamb enterprises. However, when a large price premium existed for super-fine wool (i.e. five year average price, 1999-2003), the super-fine Merino yearling enterprise was as profitable as the dual purpose enterprise.

The results highlight that there is considerable scope for all sheep producers in areas similar to those modelled to improve the gross margins of their current enterprise by refining their time of lambing and stocking rates. The focus should be on optimising the amount of meat and wool produced per ha and not on maximising per head animal performance.

Running a dual purpose enterprise offers producers some resilience against changes in commodity prices, but producers doing so should still pay close attention to the genetic merit (wool cut per head and fibre diameter in relation to live weight) of the ewes they buy in to reap full benefits. The results also support the option that many producers with self-replacing Merino flocks have been taking, that is joining a portion of ewes to terminal sires. Producers contemplating changing from Merino ewes to first-cross ewes, need to exercise caution as they may not be any better off, particularly if paying very high prices for ewes or obtaining low weaning percentages. In high rainfall environments where producers often experience feet problems with Merinos or difficulty managing internal parasites, cross-bred ewe enterprises have some advantages. Although a self-replacing flock may not be as profitable as enterprises where replacement ewes are purchased (for the prices and costs modelled), purchasing ewes carries risks of introducing disease, lack of control with genetics, and exposure to high ewe prices.

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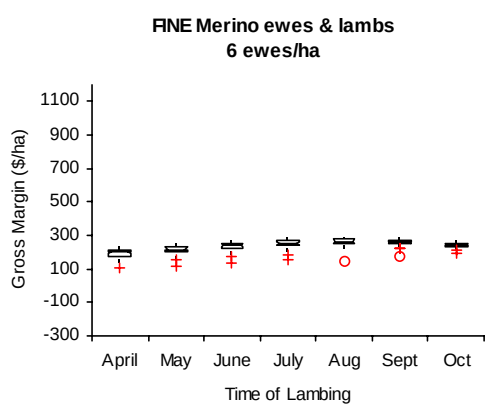
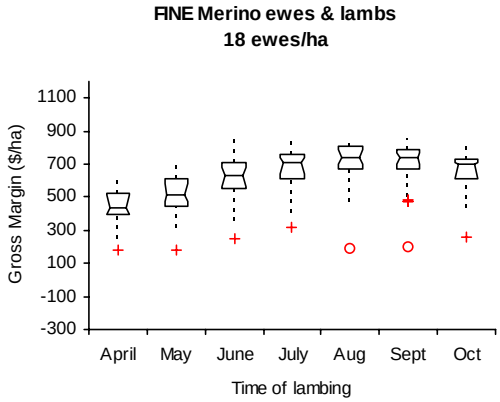
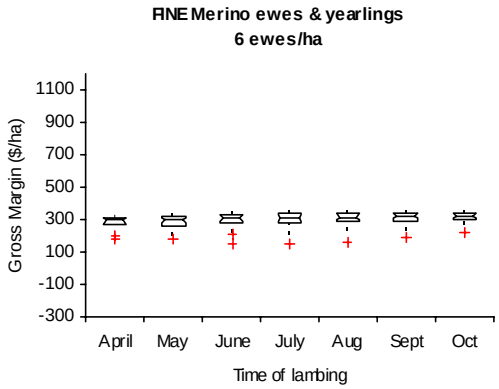
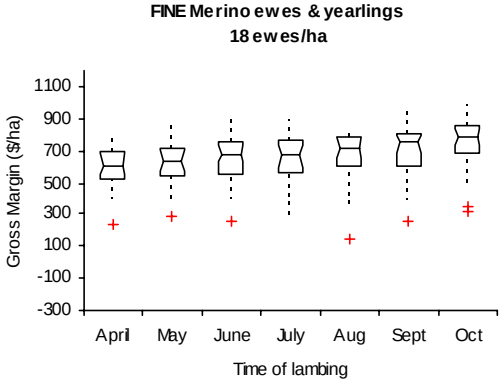
APPENDICES

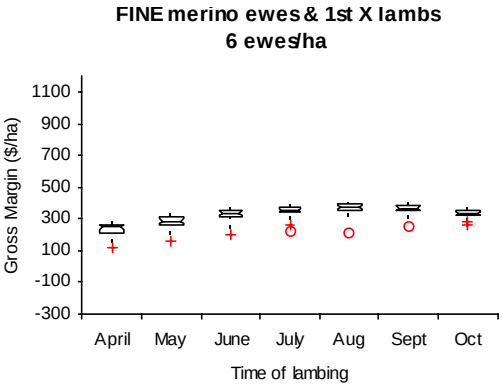
APPENDIX 1.1 EFFECT OF TIME OF LAMBING ON VARIATION IN GROSS MARGIN (1966-2001) FOR TWO STOCKING RATES AND A RANGE OF SHEEP ENTEPRISES AT MORTLAKE. (PRICES: FIVE YEAR AVERAGE)

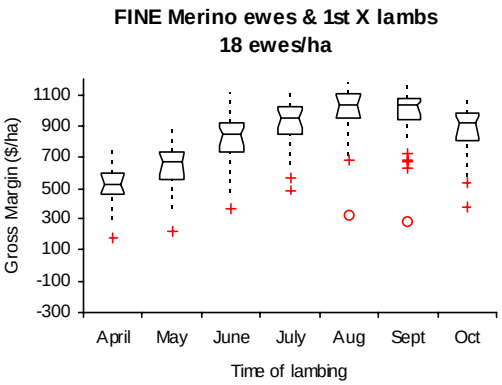


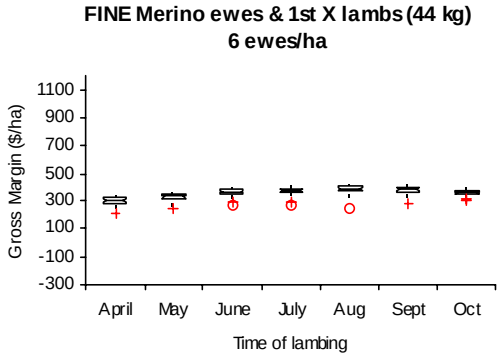


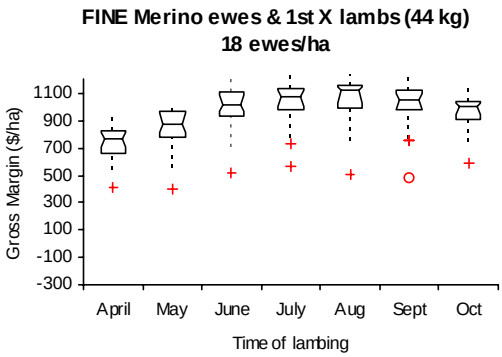


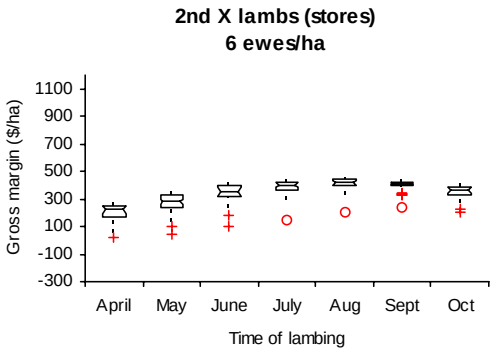


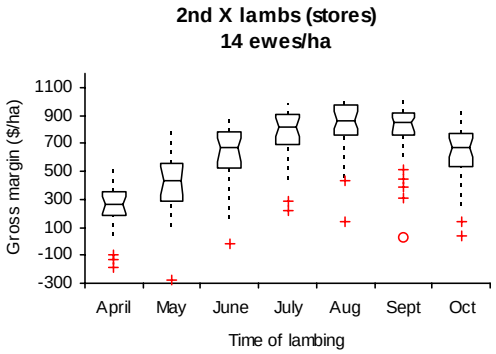


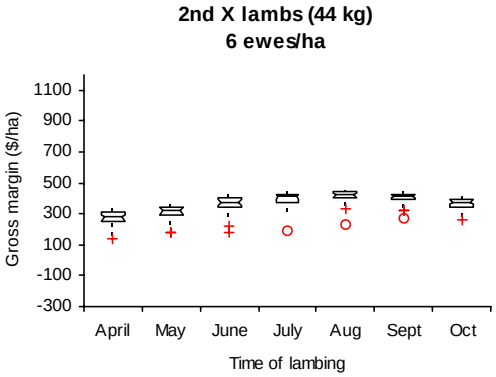


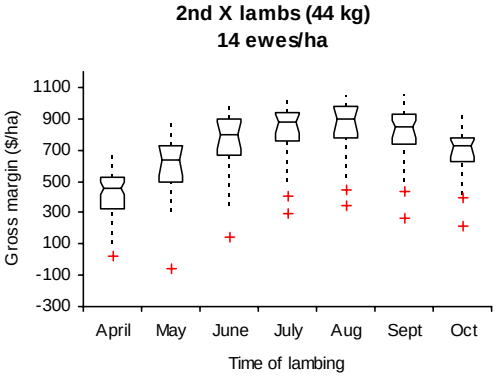


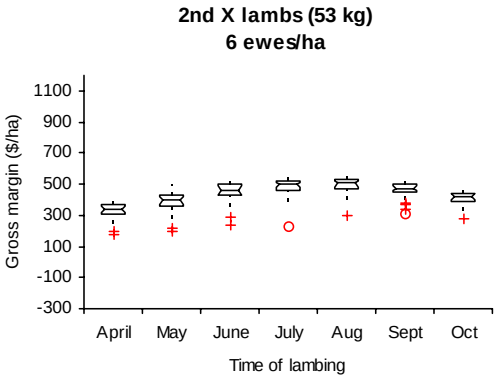


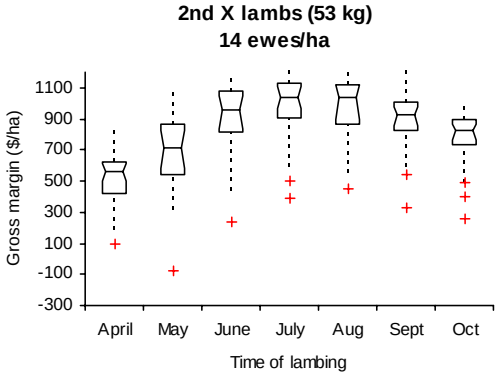

2nd X lambs (stores)
6 ewes/ha
Gross margin ($/ha)
1100
900
700
500
300
100
-100
-300
April
May
June
July
Aug
Sept
Oct
Time of lambing


2nd X lambs (stores)
14 ewes/ha
Gross margin ($/ha)
1100
900
700
500
300
100
-100
-300
April
May
June
July
Aug
Sept
Oct
Time of lambing

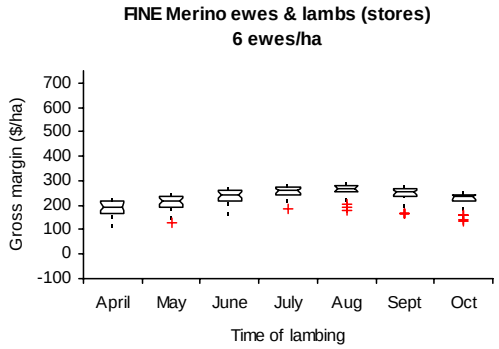

2nd X lambs (44 kg)
6 ewes/ha
Gross margin ($/ha)
1100
900
700
500
300
100
-100
-300
April
May
June
July
Aug
Sept
Oct
Time of lambing

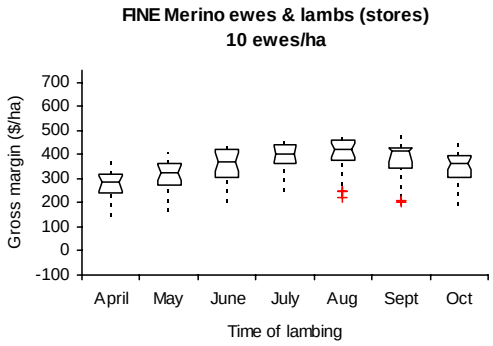

2nd X lambs (44 kg)
14 ewes/ha
Gross margin ($/ha)
1100
900
700
500
300
100
-100
-300
April
May
June
July
Aug
Sept
Oct
Time of lambing

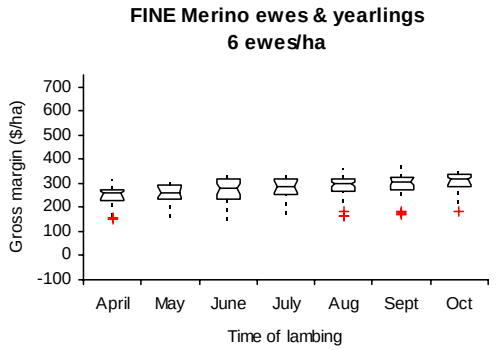

2nd X lambs (53 kg)
6 ewes/ha
Gross margin ($/ha)
1100
900
700
500
300
100
-100
-300
April
May
June
July
Aug
Sept
Oct
Time of lambing

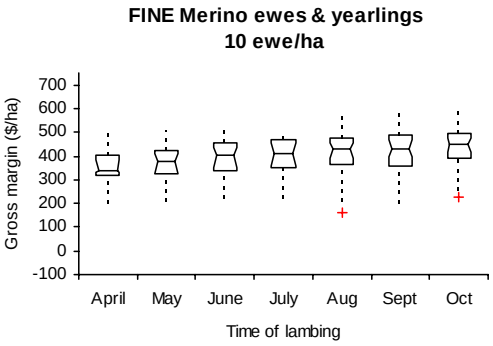

2nd X lambs (53 kg)
14 ewes/ha
Gross margin ($/ha)
1100
900
700
500
300
100
-100
-300
April
May
June
July
Aug
Sept
Oct
Time of lambing

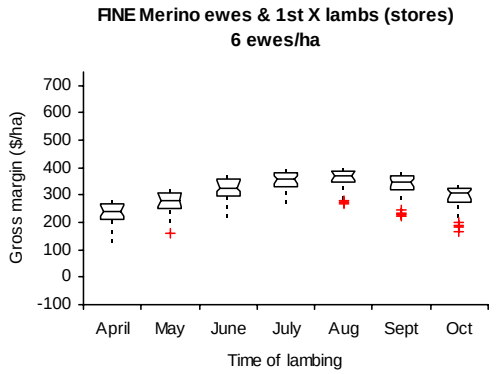
APPENDIX 1.2 EFFECT OF TIME OF LAMBING ON VARIATION IN GROSS MARGIN (1966-2001) FOR TWO STOCKING RATES AND A RANGE OF SHEEP ENTEPRISES AT RUTHERGLEN (PRICES: FIVE YEAR AVERAGE)

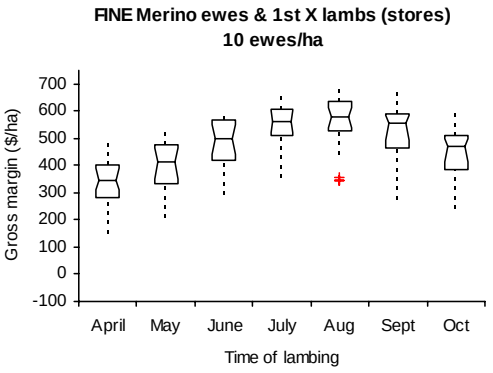


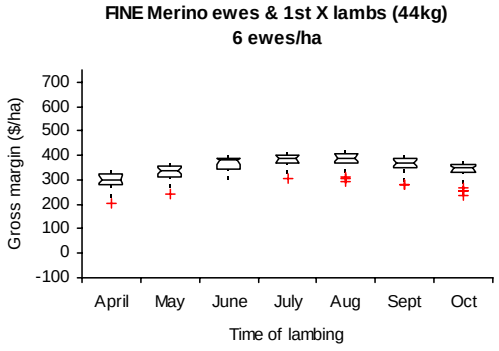


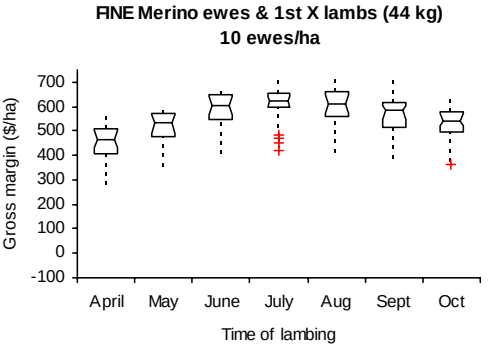


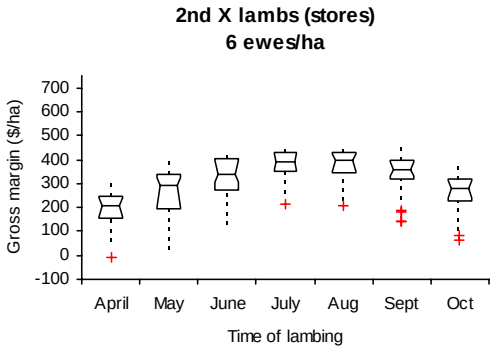


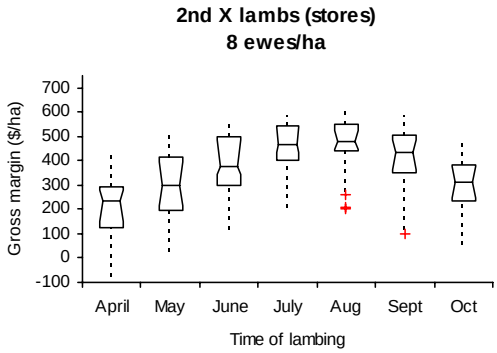


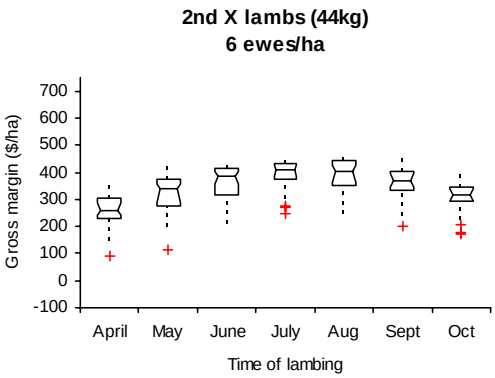


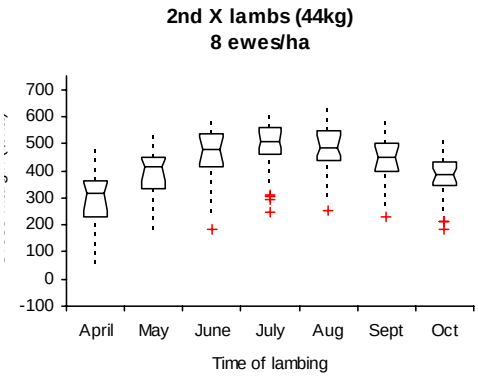


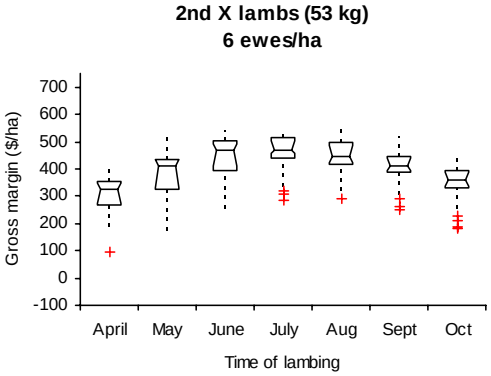


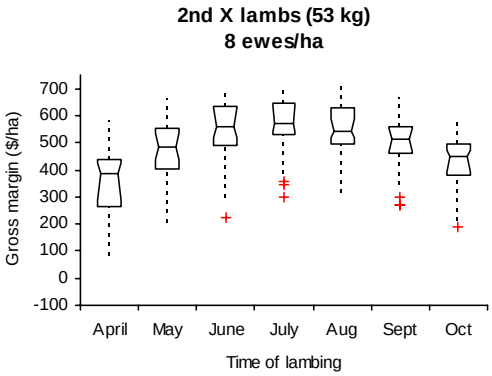

2nd X lambs (stores)
6 ewes/ha
Gross margin ($/ha)
700
600
500
400
300
200
100
0
-100
April
May
June
July
Aug
Sept
Oct
Time of lambing


2nd X lambs (stores)
8 ewes/ha
Gross margin ($/ha)
700
600
500
400
300
200
100
0
-100
April
May
June
July
Aug
Sept
Oct
Time of lambing


2nd X lambs (44kg)
6 ewes/ha
Gross margin ($/ha)
700
600
500
400
300
200
100
0
-100
April
May
June
July
Aug
Sept
Oct
Time of lambing

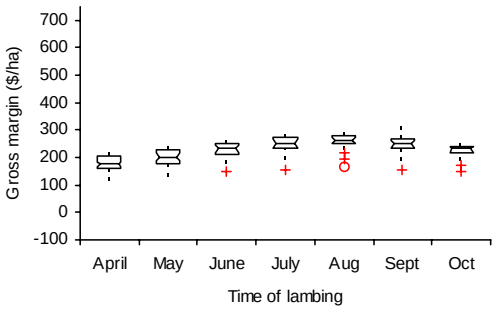

2nd X lambs (44kg)
8 ewes/ha
700
600
500
400
300
200
100
0
-100
April
May
June
July
Aug
Sept
Oct
Time of lambing


2nd X lambs (53 kg)
6 ewes/ha
Gross margin ($/ha)
700
600
500
400
300
200
100
0
-100
April
May
June
July
Aug
Sept
Oct
Time of lambing

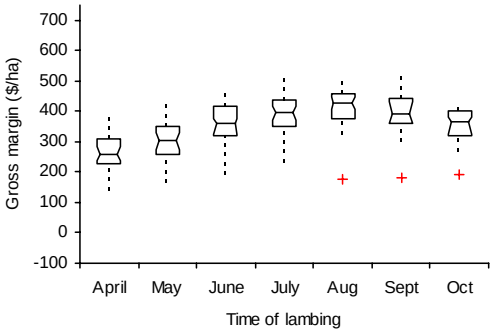

2nd X lambs (53 kg)
8 ewes/ha
Gross margin ($/ha)
700
600
500
400
300
200
100
0
-100
April
May
June
July
Aug
Sept
Oct
Time of lambing

APPENDIX 1.3 EFFECT OF TIME OF LAMBING ON VARIATION IN GROSS MARGIN (1966-2001) FOR TWO STOCKING RATES AND A RANGE OF SHEEP ENTEPRISES AT NARACOORTE (PRICES: FIVE YEAR AVERAGE)

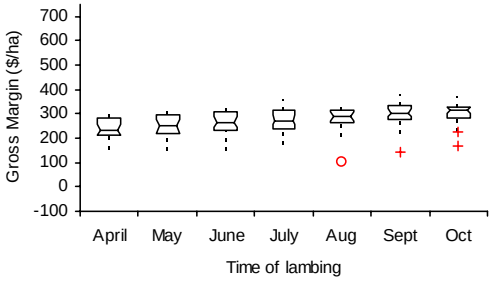
FINE Merino ewes & lambs (stores)
6 ewes/ha



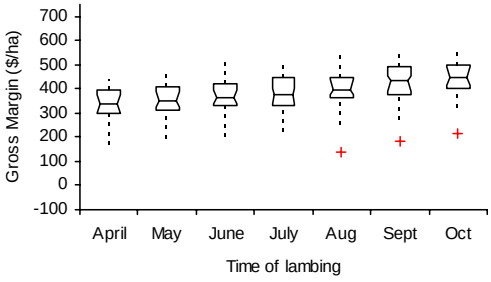
FINE Merino ewes & lambs (stores)
10 ewes/ha



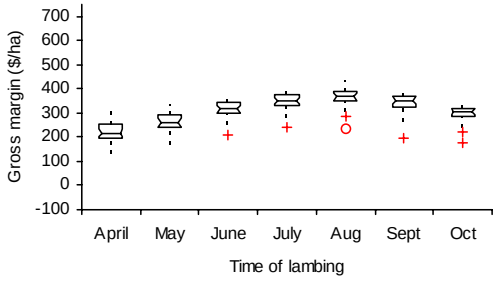
FINE Merino ewes & yearlings
6 ewes/ha



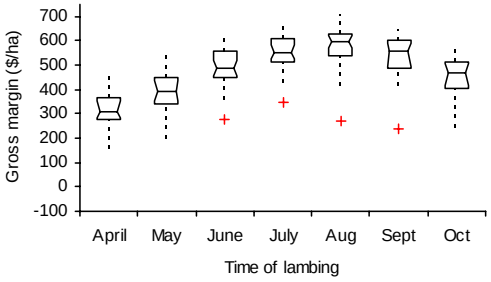
FINE Merino ewes & yearlings
10 ewes/ha



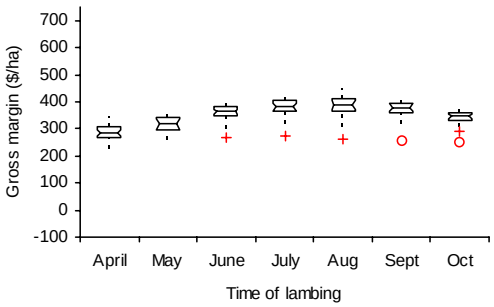
FINE Merino ewes & 1st X lambs (stores)
6 ewes/ha



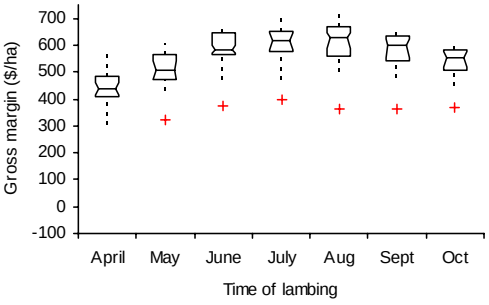
FINE Merino ewes & 1st X lambs (stores)
10 ewes/ha

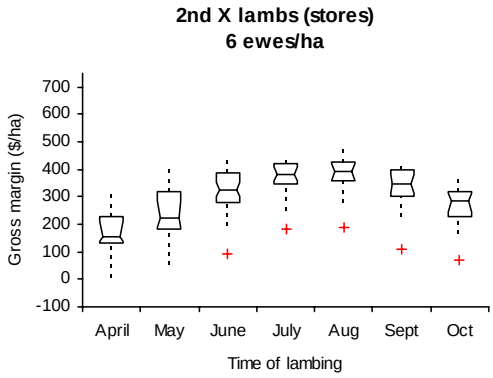


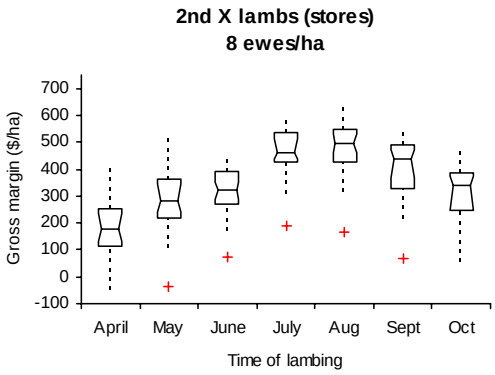
FINE Merino ewes & 1st X lambs (44 kg)
6 ewes/ha

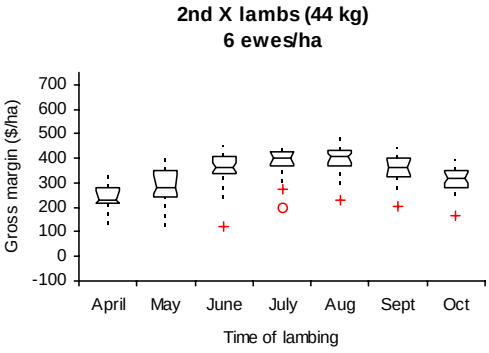


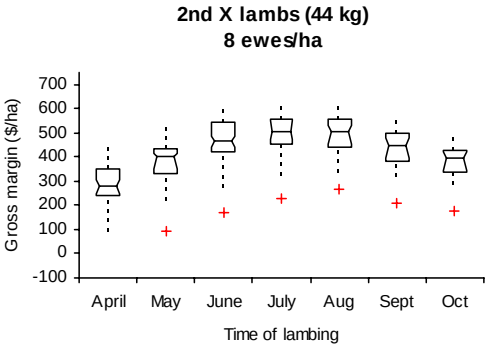
FINE Merino ewes & 1st X lambs (44 kg)
10 ewes/ha

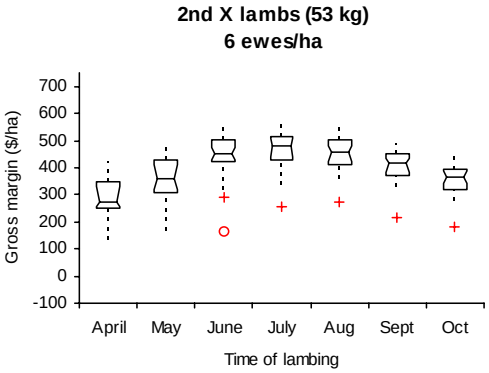


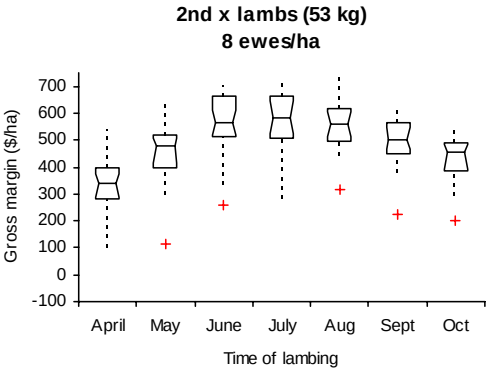

2nd X lambs (stores)
6 ewes/ha
Gross margin ($/ha)
700
600
500
400
300
200
100
0
-100
April
May
June
July
Aug
Sept
Oct
Time of lambing


2nd X lambs (stores)
8 ewes/ha
Gross margin ($/ha)
700
600
500
400
300
200
100
0
-100
April
May
June
July
Aug
Sept
Oct
Time of lambing

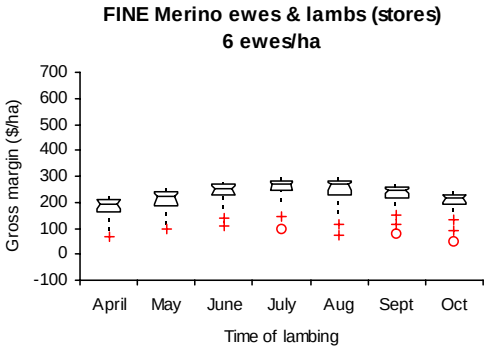

2nd X lambs (44 kg)
6 ewes/ha
Gross margin ($/ha)
700
600
500
400
300
200
100
0
-100
April
May
June
July
Aug
Sept
Oct
Time of lambing

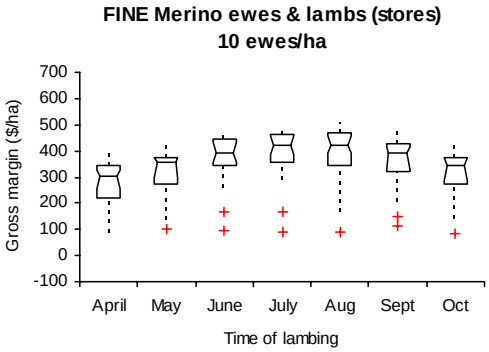

2nd X lambs (44 kg)
8 ewes/ha
Gross margin ($/ha)
700
600
500
400
300
200
100
0
-100
April
May
June
July
Aug
Sept
Oct
Time of lambing

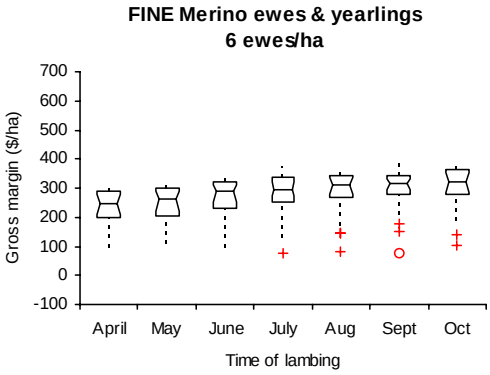

2nd X lambs (53 kg)
6 ewes/ha
Gross margin ($/ha)
700
600
500
400
300
200
100
0
-100
April
May
June
July
Aug
Sept
Oct
Time of lambing

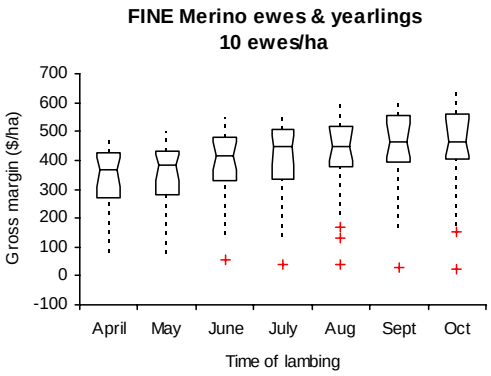

2nd x lambs (53 kg)
8 ewes/ha
Gross margin ($/ha)
700
600
500
400
300
200
100
0
-100
April
May
June
July
Aug
Sept
Oct
Time of lambing

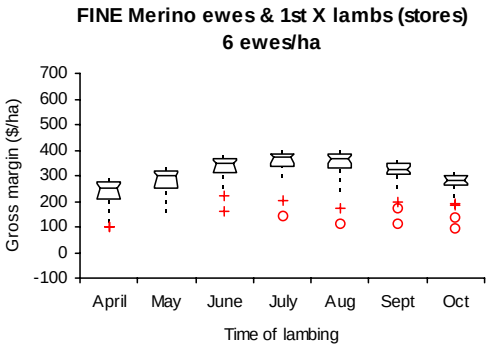
APPENDIX 1.4 EFFECT OF TIME OF LAMBING ON VARIATION IN GROSS MARGIN (1966-2001) FOR TWO STOCKING RATES AND A RANGE OF SHEEP ENTEPRISES AT COWRA (PRICES: FIVE YEAR AVERAGE)

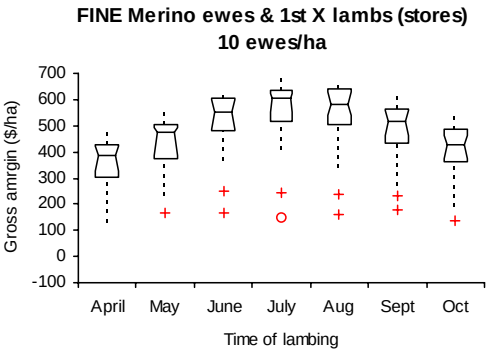


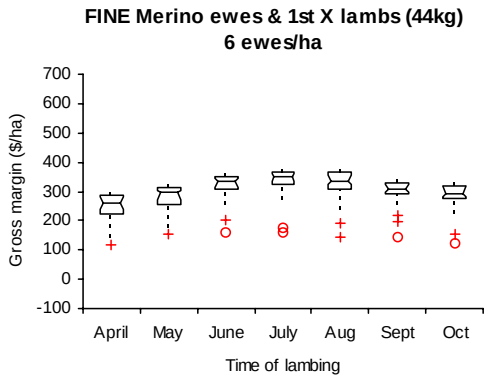


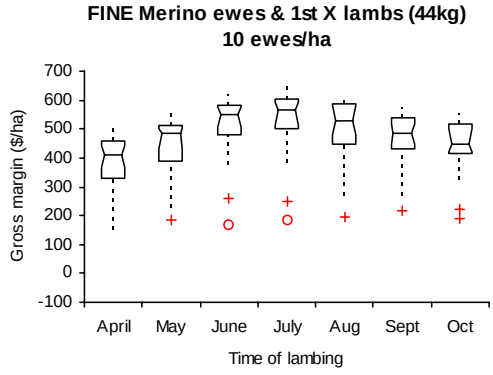


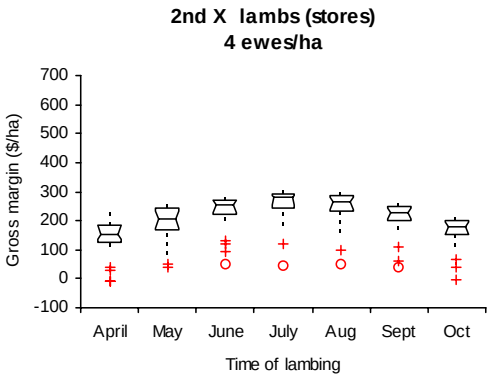


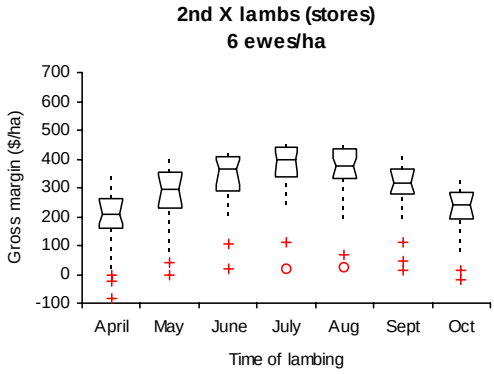


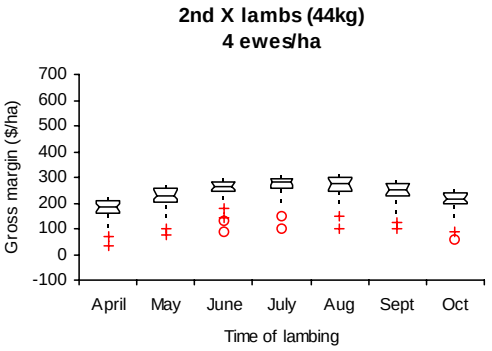


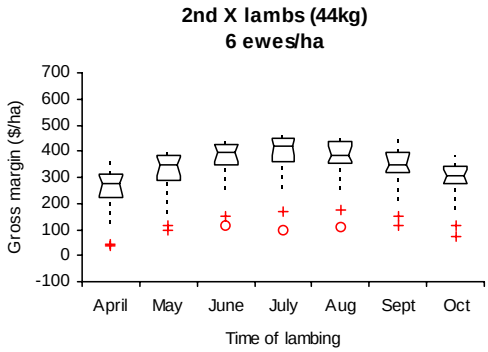


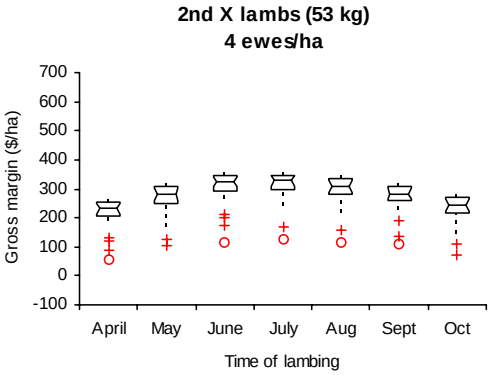


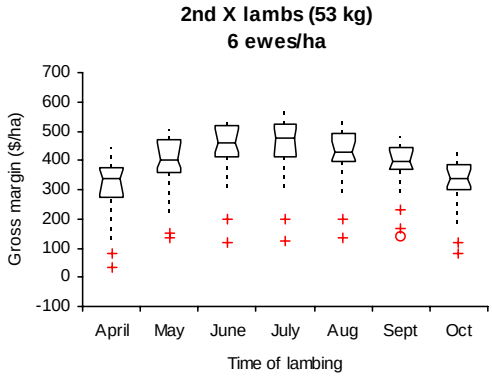

2nd X lambs (stores)
4 ewes/ha
Gross margin ($/ha)
700
600
500
400
300
200
100
0
-100
April
May
June
July
Aug
Sept
Oct
Time of lambing


2nd X lambs (stores)
6 ewes/ha
Gross margin ($/ha)
700
600
500
400
300
200
100
0
-100
April
May
June
July
Aug
Sept
Oct
Time of lambing


2nd X lambs (44kg)
4 ewes/ha
Gross margin ($/ha)
700
600
500
400
300
200
100
0
-100
April
May
June
July
Aug
Sept
Oct
Time of lambing


2nd X lambs (44kg)
6 ewes/ha
Gross margin ($/ha)
700
600
500
400
300
200
100
0
-100
April
May
June
July
Aug
Sept
Oct
Time of lambing


2nd X lambs (53 kg)
4 ewes/ha
Gross margin ($/ha)
700
600
500
400
300
200
100
0
-100
April
May
June
July
Aug
Sept
Oct
Time of lambing


2nd X lambs (53 kg)
6 ewes/ha
Gross margin ($/ha)
700
600
500
400
300
200
100
0
-100
April
May
June
July
Aug
Sept
Oct
Time of lambing

APPENDIX 2 EFFECT OF STOCKING RATE AND TIME OF LAMBING ON MEAN GROSS MARGIN ($/HA) AND RISK (SUSTAINABLE STOCKING RATE CRITERIA) AT MORTLAKE. (AVERAGE FIVE YEAR PRICES: 1999-2003)

LEGEND

Ewe maintenance feeding criteria can't be met
Autumn pasture cover criteria can't be met
Both criteria can't be met

APPENDIX 2.1 MERINO EWES (FINE)/LAMBS (STORES)

Stocking rate (ewes/ha)	**Time of lambing**						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	190	212	236	250	261	259	243
10	301	339	388	417	437	431	405
14	385	443	519	562	589	581	545
18	443	516	612	669	708	703	659
20	471	546	653	717	761	757	712

APPENDIX 2.2 MERINO EWES (FINE)/YEARLINGS

Stocking rate (ewes/ha)	**Time of lambing**						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	279	281	293	298	305	311	316
10	416	426	452	456	467	485	502
14	516	538	568	569	584	611	647
15	540	564	597	596	616	643	680
16	565	588	619	619	638	668	708
17	586	608	640	638	661	690	734
18	604	627	658	658	678	710	754

APPENDIX 2.3 MERINO EWES (FINE)/FIRST-CROSS LAMBS (STORES)

Stocking rate (ewes/ha)	**Time of lambing**						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	235	276	323	344	361	357	331
10	363	436	523	569	600	592	544
14	456	563	692	766	812	796	724
17	506	628	784	885	947	928	836
18	518	644	809	920	986	967	873
19	529	657	835	954	1025	1008	905
20	540	670	856	984	1062	1042	937

APPENDIX 2.4 MERINO EWES(FINE)/FIRST-CROSS LAMBS (FINISH 44KG)

Stocking rate (ewes/ha)	**Time of lambing**						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	298	321	356	366	376	373	354
10	478	525	592	613	628	615	581
14	627	706	811	837	854	828	784
17	714	819	954	986	1006	972	925
18	740	855	1000	1029	1052	1016	969
20	795	915	1081	1116	1141	1102	1055

APPENDIX 2.5 FIRST-CROSS EWES/SECOND-CROSS LAMBS (STORES)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	207	272	343	389	409	402	353
10	263	373	528	618	652	629	525
14	246	413	622	769	825	781	622
15	236	415	633	791	858	812	634
16	226	414	629	806	884	831	647
17	216	404	628	811	905	846	652
18	212	394	611	818	922	856	653

APPENDIX 2.6 FIRST-CROSS EWES/SECOND-CROSS LAMBS (FINISH 44KG)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	270	312	366	399	412	405	366
10	385	461	587	642	664	634	552
14	430	601	756	822	850	796	683
15	442	627	785	857	890	825	713
16	449	651	811	886	921	853	742
17	465	664	831	903	944	874	763
18	480	660	834	931	966	897	782

APPENDIX 2.7 FIRST-CROSS EWES/SECOND-CROSS LAMBS (FINISH 53 KG)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	330	383	450	485	493	465	411
10	467	560	722	775	774	711	623
12	503	632	829	893	887	807	705
14	530	694	910	981	974	894	781
16	560	724	968	1050	1042	962	844
18	592	698	974	1090	1092	1016	895

APPENDIX 3 EFFECT OF STOCKING RATE AND TIME OF LAMBING ON MEAN GROSS MARGIN ($/HA) AND RISK (SUSTAINBLE STOCKING RATE CRITERIA) AT RUTHERGLEN. (AVERAGE FIVE YEAR PRICES: 1999-2003)

LEGEND

Ewe maintenance feeding criteria can't be met
Autumn pasture cover criteria can't be met
Both criteria can't be met

APPENDIX 3.1 MERINO EWES (FINE)/LAMBS (STORES)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	188	211	237	254	261	247	224
10	279	315	364	395	404	383	347
14	333	374	437	483	507	479	435
18	359	397	470	531	569	542	493

APPENDIX 3.2 MERINO EWES (FINE)/YEARLINGS

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	250	257	273	281	288	299	306
8	304	317	336	346	355	367	381
10	353	367	389	400	409	422	439
14	416	436	462	467	469	479	491

APPENDIX 3.3 MERINO EWES (FINE)/FIRST-CROSS LAMBS (STORES)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	237	277	324	353	361	336	293
10	340	405	488	546	562	516	441
12	372	440	544	621	643	589	495
14	392	465	579	674	707	642	538

APPENDIX 3.4 MERINO EWES(FINE)/FIRST-CROSS LAMBS (FINISH 44KG)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	299	331	369	383	383	366	339
8	385	429	487	501	496	472	439
10	458	513	590	608	599	568	530
14	561	617	746	775	765	734	686

APPENDIX 3.5 FIRST-CROSS EWES/SECOND-CROSS LAMBS (STORES)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	196	260	325	375	381	338	259
8	207	293	388	455	466	401	294
10	195	290	401	499	519	440	306
14	128	195	321	472	538	442	284

APPENDIX 3.6 FIRST-CROSS EWES/SECOND-CROSS LAMBS (FINISH 44KG)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	260	317	364	393	389	359	309
8	303	388	457	487	480	434	373
10	328	437	509	549	542	491	426
14	311	435	526	582	597	570	492

APPENDIX 3.7 FIRST-CROSS EWES/SECOND-CROSS LAMBS (FINISH 53 KG)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	309	383	439	460	443	404	348
8	356	468	544	562	540	493	420
10	385	527	605	631	609	563	475
14	370	546	634	676	689	660	538

APPENDIX 4 EFFECT OF STOCKING RATE AND TIME OF LAMBING ON MEAN GROSS MARGIN ($/HA) AND RISK (SUSTAINBLE STOCKING RATE CRITERIA) AT NARACOORTE. (AVERAGE FIVE YEAR PRICES: 1999-2003)

LEGEND

Ewe maintenance feeding criteria can't be met
Autumn pasture cover criteria can't be met
Both criteria can't be met

4.1 MERINO EWES (FINE)/LAMBS (STORES)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	178	201	230	249	261	249	227
8	224	257	297	324	341	324	294
10	254	305	358	394	416	393	356
14	319	367	437	495	523	495	446

APPENDIX 4.2 MERINO EWES (FINE)/YEARLINGS

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	242	251	264	273	283	297	305
8	302	314	333	342	358	377	390
10	341	353	376	384	401	424	445
14	412	426	453	464	476	495	517

APPENDIX 4.3 MERINO EWES (FINE)/FIRST-CROSS LAMBS (STORES)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	221	264	315	346	365	343	300
8	274	334	406	453	478	445	388
10	320	395	488	550	579	538	459
14	381	460	582	692	740	673	561

APPENDIX 4.4 MERINO EWES(FINE)/FIRST-CROSS LAMBS (FINISH 44KG)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	290	319	360	377	384	372	343
8	370	418	478	499	503	484	448
10	445	509	586	608	612	585	542
14	552	631	750	783	788	759	704

APPENDIX 4.5 FIRST-CROSS EWES/SECOND-CROSS LAMBS (STORES)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	173	239	316	375	389	343	273
8	184	281	390	464	486	406	313
10	183	299	419	539	559	441	325
14	124	220	337	512	592	452	299

APPENDIX 4.6 FIRST-CROSS EWES/SECOND-CROSS LAMBS (FINISH 44KG)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	245	294	357	391	396	360	317
8	291	379	460	497	494	434	383
10	320	442	522	575	563	495	434
14	313	438	544	603	623	576	502

APPENDIX 4.7 FIRST-CROSS EWES/SECOND-CROSS LAMBS (FINISH 53 KG)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	291	362	438	464	454	408	358
8	339	452	559	580	559	498	434
10	374	511	612	652	632	571	486
14	383	498	622	697	722	673	547

APPENDIX 5 EFFECT OF STOCKING RATE AND TIME OF LAMBING ON MEAN GROSS MARGIN ($/HA) AND RISK (SUSTAINBLE STOCKING RATE CRITERIA) AT COWRA. (AVERAGE FIVE YEAR PRICES: 1999-2003)

LEGEND

Ewe maintenance feeding criteria can't be met
Autumn pasture cover criteria can't be met
Both criteria can't be met

APPENDIX 5.1 MERINO EWES (FINE)/LAMBS (STORES)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	182	209	240	254	251	231	205
8	234	272	313	334	327	301	266
10	280	326	378	402	396	362	318
14	347	403	477	515	503	457	400

APPENDIX 5.2 MERINO EWES (FINE)/YEARLINGS

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	239	251	273	285	295	303	307
8	298	313	341	357	369	377	386
10	347	363	398	417	426	442	444
14	419	441	489	508	508	515	510

APPENDIX 5.3 MERINO EWES (FINE)/FIRST-CROSS LAMBS (STORES)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	235	279	330	353	348	312	269
8	303	361	432	462	452	404	343
10	359	432	521	561	549	483	404
14	436	522	654	720	701	606	489

APPENDIX 5.4 MERINO EWES(FINE)/FIRST-CROSS LAMBS (FINISH 44KG)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
6	250	280	321	334	326	302	288
8	325	369	424	436	423	392	372
10	391	450	519	532	507	471	445
14	492	570	669	683	654	609	570

APPENDIX 5.5 FIRST-CROSS EWES/SECOND-CROSS LAMBS (STORES)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
4	146	195	236	259	249	214	166
6	198	274	338	373	355	299	224
8	234	334	417	464	437	358	256
10	243	356	460	527	492	393	271
14	196	281	420	550	525	406	257

APPENDIX 5.6 FIRST-CROSS EWES/SECOND-CROSS LAMBS (FINISH 44KG)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
4	178	220	252	268	264	244	211
6	255	323	371	391	375	342	294
8	316	411	467	492	466	420	362
10	361	476	539	567	530	487	417

APPENDIX 5.7 FIRST-CROSS EWES/SECOND-CROSS LAMBS (FINISH 53 KG)

Stocking rate (ewes/ha)	Time of lambing						
	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**
4	220	267	307	313	298	274	234
6	314	394	444	450	421	387	328
8	384	497	554	561	522	480	402
10	433	561	630	644	602	556	457

APPENDIX 6.1 COMPARISON OF ALL ENTERPRISES AT MORTLAKE WHEN RUN AT OPTIMUM[A] TIME OF LAMBING AND STOCKING RATE.

			Physical parameters								Financial parameters								Risk	
														Income						
Mortlake Enterprise	**EWE Geno-type**	**Lamb time**	**Stock rate (ewes or wths /ha)**	**1 July DSE/ha**	**Avg annual DSE/ha**	**Pasture used %**	**Wool-clean kg/ha**	**Meat (LWT) kg/ha**	**Wean %**	**Sale wt. kg**	**GM $/ha**	**GM $/DSE**	**GM $/ha/ 100 mm**	**Wool $/ha**	**Meat $/ha**	**% from wool**	**Maint. supp fed $/ha**	**Prod. supp fed $/ha**	**Prob. < 800 kg DM/ha Jan-Apr**	**Prob. feed >30kg grain**
wethers	S FINE	-	22.0	29.5	27.0	51	68	271	-	65.9	**797**	**30**	120	1043	173	86	42	-	0.19	0.20
	FINE	-	20.0	28.8	27.1	52	70	274	-	73.6	**496**	**18**	75	709	175	80	41	-	0.19	0.20
Self-replacing Merino flock																				
Yearlings	S FINE	Oct	18.0	32.8	31.9	55	67	566	86	46.6	**1021**	**32**	154	1015	454	69	159	-	0.20	0.32
(12 mths)	FINE	Oct	16.5	33.0	32.1	56	70	574	86	51.4	**720**	**22**	109	692	456	60	159	-	0.20	0.36
	MED	Oct	15.0	32.8	31.8	55	69	576	86	56.4	**537**	**17**	81	484	453	52	150	-	0.20	0.35
Merino lambs	FINE	Sept	20.0	28.0	31.1	54	60	560	86	36.2	**759**	**24**	114	541	609	47	101	-	0.19	0.34
(18 wks)	MED	Sept	19.0	28.8	32.0	55	62	580	86	39.5	**669**	**21**	101	432	624	41	107	-	0.20	0.34
Dual purpose flock																				
1st X lambs	FINE	Sept	20.0	28.2	32.1	55	62	845	85	38.3	**1042**	**32**	157	593	1086	35	101	-	0.19	0.35
(18 wks)	MED	Sept	19.0	28.8	32.8	56	63	850	85	39.8	**893**	**27**	135	433	1081	29	108	-	0.20	0.34
1st X lambs (44 kg)	FINE	Aug	17.0	27.2	30.2	51	53	843	88	44.0	**1006**	**33**	152	490	1100	31	95	18	0.14	0.40
	MED	Aug	16.5	28.4	30.7	52	56	839	88	44.0	**886**	**29**	134	377	1082	26	100	15	0.15	0.38
Prime lamb flock																				
2nd X lambs (18 wks)		Aug	14.5	27.3	30.4	52	44	918	121	43.0	**844**	**28**	127	201	1259	14	89	-	0.14	0.38
2nd X lambs (44 kg)		Aug	14.5	27.3	31.3	53	44	955	120	44.0	**870**	**28**	131	200	1311	13	94	16	0.16	0.38
2nd X lambs (53 kg)		Aug	13.0	24.9	31.0	52	40	990	120	53.0	**931**	**30**	140	180	1367	12	82	47	0.14	0.38

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ABBREVIATIONS: WTHS = WETHERS, AVG = AVERAGE, MAINT = MAINTENANCE, PROD = PRODUCTION, SUPP = SUPPLEMENTARY, PROB = PROBABILITY

APPENDIX 6.2 COMPARISON OF ALL ENTERPRISES AT RUTHERGLEN WHEN RUN AT OPTIMUM [A] TIME OF LAMBING AND STOCKING RATE.

			Physical parameters								Financial parameters								Risk	
														Income						
Rutherglen **Enterprise**	**EWE Geno-type**	**Lamb time**	**Stock rate (ewes or wths /ha)**	**1 July DSE/ha**	**Avg annual DSE/ha**	**Pasture used %**	**Wool-clean kg/ha**	**Meat (LWT) kg/ha**	**Wean %**	**Sale wt. kg**	**GM $/ha**	**GM $/DSE**	**GM $/ha/ 100 mm**	**Wool $/ha**	**Meat $/ha**	**% from wool**	**Maint. supp fed $/ha**	**Prod. supp fed $/ha**	**Prob. < 800 kg DM/ha Jan-Apr**	**Prob. feed >30kg grain**
wethers	S FINE	-	13.0	19.2	15.8	49	40	154	-	64.3	**459**	**29**	74	615	99	86	20	-	0.2	0.19
	FINE	-	12.0	19.5	16.2	50	42	158	-	71.3	**282**	**17**	46	422	101	81	21	-	0.2	0.20
Self-replacing Merino flock																				
Yearlings	S FINE	Oct	9.5	20.5	17.9	50	38	334	95	48.3	**569**	**32**	92	559	270	67	87	-	0.19	0.32
(12 mths)	FINE	Oct	8.5	20.4	17.7	50	38	333	95	53.4	**398**	**22**	64	372	266	58	81	-	0.19	0.32
	MED	Oct	8.0	20.9	18.1	51	39	344	95	58.4	**311**	**17**	50	275	273	50	84	-	0.19	0.38
Merino lambs	FINE	Aug	10.5	16.6	16.9	48	32	325	97	36.7	**422**	**25**	68	282	362	44	48	-	0.17	0.38
(18 wks)	MED	Aug	10.0	17.3	17.6	49	33	339	97	40.0	**373**	**21**	60	223	374	37	57	-	0.17	0.40
Dual purpose flock																				
1st X lambs	FINE	Aug	10.5	17.1	17.7	49	33	489	96	39.1	**584**	**33**	94	304	640	32	57	-	0.17	0.40
(18 wks)	MED	Aug	10.0	17.6	18.1	50	34	492	96	40.6	**514**	**28**	83	228	637	26	59	-	0.17	0.40
1st X lambs (44 kg)	FINE	July	9.5	18.0	17.4	47	30	503	97	44.0	**583**	**34**	94	271	666	29	60	13	0.18	0.40
	MED	July	9.0	18.5	17.4	47	31	487	97	44.0	**508**	**29**	82	205	638	24	58	9	0.18	0.40
Prime lamb flock																				
2nd X lambs (18 wks)		Aug	8.5	16.4	17.8	49	25.7	537	126	41.7	**481**	**27**	78	116	740	14	51	-	0.18	0.40
2nd X lambs (44 kg)		July	8.0	18.3	17.7	48	24.0	543	127	44.0	**487**	**28**	78	109	754	13	57	9	0.17	0.40
2nd X lambs (53 kg)		July	7.0	16.1	17.2	46	21.4	552	127	53.0	**515**	**30**	83	96	770	11	45	26	0.16	0.40

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APPENDIX 6.3 COMPARISON OF ALL ENTERPRISES AT NARACOORTE WHEN RUN AT OPTIMUM [A] TIME OF LAMBING AND STOCKING RATE.

			Physical parameters								Financial parameters								Risk	
														Income						
Naracoorte Enterprise	**EWE Geno-type**	**Lamb time**	**Stock rate (ewes or wths /ha)**	**1 July DSE/ha**	**Avg annual DSE/ha**	**Pasture used %**	**Wool-clean kg/ha**	**Meat (LWT) kg/ha**	**Wean %**	**Sale wt. kg**	**GM $/ha**	**GM $/DSE**	**GM $/ha/ 100 mm**	**Wool $/ha**	**Meat $/ha**	**% from wool**	**Maint. supp fed $/ha**	**Prod. supp fed $/ha**	**Prob. < 800 kg DM/ha Jan-Apr**	**Prob. feed >30kg grain**
wethers	S FINE	-	13.5	19.3	16.4	47	42	157	-	61.0	**488**	**30**	86	649	103	86	21	-	0.11	0.19
	FINE	-	12.0	18.7	16.2	47	43	161	-	72.4	**288**	**18**	51	425	103	80	20	-	0.11	0.19
Self-replacing Merino flock																				
Yearlings	S FINE	Sept	10.0	21.2	18.5	48	40	331	95	44.2	**582**	**31**	103	582	268	68	88	-	0.11	0.39
(12 mths)	FINE	Sept	9.0	21.1	18.4	48	40	332	95	49.0	**406**	**22**	72	390	266	59	85	-	0.11	0.39
	MED	Sept	7.5	20.0	17.1	46	38	313	96	54.9	**298**	**17**	53	255	248	51	61	-	0.08	0.36
Merino lambs	FINE	Aug	10.5	16.5	17.1	44	33	335	97	37.9	**433**	**25**	76	280	372	43	47	-	0.06	0.38
(18 wks)	MED	Aug	9.5	16.4	16.9	44	32	334	98	41.5	**378**	**22**	67	213	364	37	43	-	0.06	0.38
Dual purpose flock																				
1st X lambs	FINE	Aug	9.5	15.3	16.2	42	30	461	97	40.8	**555**	**34**	98	272	604	31	42	-	0.06	0.38
(18 wks)	MED	Aug	9.0	15.7	16.5	43	31	462	97	42.4	**496**	**30**	87	206	599	26	42	-	0.06	0.40
1st X lambs (44 kg)	FINE	Aug	9.5	15.4	17.5	44	30	503	95	44.0	**586**	**33**	103	276	662	29	47	23	0.06	0.38
	MED	Aug	8.5	14.7	16.5	43	29	463	96	44.0	**489**	**30**	86	194	602	24	43	13	0.06	0.40
Prime lamb flock																				
2nd X lambs (18 wks)		Aug	7.5	14.2	16.0	42	23	498	128	43.1	**446**	**28**	79	104	687	13	33	-	0.05	0.36
2nd X lambs (44 kg)		Aug	7.0	13.4	15.6	41	22	484	127	44.0	**449**	**29**	79	97	668	13	32	10	0.07	0.35
2nd X lambs (53 kg)		Aug	7.0	13.7	17.3	43	22	557	126	53.0	**510**	**29**	90	97	772	11	34	46	0.05	0.38

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APPENDIX 6.4 COMPARISON OF ALL ENTERPRISES AT COWRA WHEN RUN AT OPTIMUM [A] TIME OF LAMBING AND STOCKING RATE.

			Physical parameters								Financial parameters								Risk	
														Income						
Cowra Enterprise	**EWE Geno-type**	**Lamb time**	**Stock rate (ewes or wths /ha)**	**1 July DSE/ha**	**Avg annual DSE/ha**	**Pasture used %**	**Wool-clean kg/ha**	**Meat (LWT) kg/ha**	**Wean %**	**Sale wt. kg**	**GM $/ha**	**GM $/DSE**	**GM $/ha/ 100 mm**	**Wool $/ha**	**Meat $/ha**	**% from wool**	**Maint. supp fed $/ha**	**Prod. supp fed $/ha**	**Prob. < 800 kg DM/ha Jan-Apr**	**Prob. feed >30kg grain**
wethers	S FINE	-	10.5	16.7	13.0	38	33	126	-	65.1	**347**	**27**	55	476	81	85	14	-	0.16	0.13
	FINE	-	9.5	16.7	13.0	38	33	128	-	72.7	**214**	**16**	34	326	82	80	13	-	0.16	0.13
Self-replacing Merino flock																				
Yearlings	S FINE	Sept	8.0	19.8	16.0	42	34	304	103	47.6	**496**	**31**	79	476	267	64	66	-	0.19	0.35
(12 mths)	FINE	Sept	7.0	19.3	15.5	41	34	297	104	53.0	**345**	**22**	55	311	239	57	59	-	0.19	0.35
	MED	Sept	6.0	18.3	14.7	39	32	284	104	58.7	**266**	**18**	42	219	226	49	49	-	0.20	0.30
Merino lambs	FINE	July	10.0	18.2	16.4	43	31	327	103	36.4	**402**	**25**	64	263	367	42	54	-	0.19	0.35
(18 wks)	MED	July	9.0	18.0	16.2	42	31	326	104	40.0	**354**	**22**	56	204	362	36	50	-	0.19	0.35
Dual purpose flock																				
1st X lambs	FINE	July	10.0	18.9	17.0	44	31	483	102	38.1	**561**	**33**	89	283	636	31	58	-	0.19	0.35
(18 wks)	MED	July	9.0	18.5	16.5	43	31	458	102	38.7	**479**	**29**	76	208	597	26	52	-	0.20	0.35
1st X lambs (44 kg)	FINE	July	8.5	16.1	16.1	41	27	474	102	44.0	**462**	**29**	73	241	546	31	42	19	0.19	0.35
	MED	July	8.0	16.3	15.9	41	27	458	102	44.0	**402**	**25**	64	185	523	26	45	13	0.20	0.38
Prime lamb flock																				
2nd X lambs (18 wks)		July	8.0	18.4	17.0	44	24	522	131	41.7	**463**	**27**	73	108	721	13	51	-	0.19	0.38
2nd X lambs (44 kg)		July	7.0	16.2	15.9	41	21	494	131	44.0	**443**	**28**	70	95	684	12	42	13	0.20	0.40
2nd X lambs (53 kg)		July	7.0	16.2	17.6	43	21	569	130	53.0	**508**	**29**	81	94	791	11	44	46	0.19	0.40

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