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Wannon River - Improving Consistency of Production and Yield of High Quality Meat

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Abstract

A series of experiments were undertaken to examine how genetics and management can be used to profitably meet market specifications in real supply chains, with a focus on producing larger and uniform valuable retail cuts. Sourcing appropriate animals to enter a finishing system is a critical decision, with a range of variables having a pronounced effect on performance. Sire and dam genotype were shown to be important as was the actual finishing system adopted. Other factors, such as early management differences, can persist and are difficult to predict other than through prior experience. A fourth class of variables (such as birth type and birth date) can have large and predictable effects if their status is known and can therefore be differentially managed in order to meet specifications. In general, differences in growth rates were more important in this supply chain than differences in carcase quality, once adjustments were made for carcase weight.

Executive Summary

The Management Solutions portfolio was established with an ambitious goal – to examine how genetics and management (including nutrition) can be used to profitably meet market specifications in real supply chains. The Wannon River Lamb Alliance (WRLA) project had an additional objective of identifying factors that result in larger and uniform valuable retail cuts from lamb producer supply networks. A series of 4 experiments were undertaken:

Experiment 1 (supervised by Vic DPI) – was designed to benchmark WRLA members' flocks for meeting market specifications, by bringing them together for common backgrounding and evaluation of performance in three finishing systems – two high quality finishing systems (feedlot and irrigated pasture) and "average" local pastures. Lambs from 21 different groups were taken over in late spring 2001, subjected to 3 different finishing systems and slaughtered in the following autumn and winter. The effect of owners group (a combination of genetics and pre-weaning management) had a significant effect on carcass measurements and the value of fully trimmed wholesale cuts. When the data were analysed in actual units, then owners' group had an important effect on value of meat recovered. The difference between the best and worst groups was 13.5% of the overall mean value of recovered cuts. However when the data were adjusted for hot carcass weight, this difference, although remaining statistically significant, was reduced to 7.3%. This relatively small difference suggests that, while carcass conformation is worth attempting to improve, differences in growth rate and drafting accuracy may be more amenable to improvement.
When looking at the distribution of cuts it is not obvious that the variation between owners group and any particular cut contributed unduly to overall carcass value. The three finishing systems, grain, lucerne and pasture/grain, had very little impact on carcass composition and value. However, the three different finishing systems had very different intervals to slaughter and there was a significant interaction between owners group and feeding system. The comparison highlighted the problems that can be experienced with lamb finishing systems due to ryegrass staggers, lucerne red gut syndrome and possibly coccidiosis.

Experiment 2 (supervised by Vic DPI to weaning and Bruce Farquharson post-weaning) – This experiment was designed to quantify maternal and paternal factors influencing productivity in a lamb feedlot system. 16 groups of members' ewes were mated to a selected sire using AI, with the resulting lambs finished in a common environment. An additional component involved testing three different rams (a high merit Poll Dorset, a NZ composite and a Texel) across a common group of ewes using AI. In combination, the two components enabled a comparison of the relative magnitude of sire and dam contributions. A superimposed treatment involved allocating different nutritional treatments to the progeny in order to quantify growth responses and efficiency of liveweight gain when lambs were offered various intake levels of a high quality ration in the backgrounding phase (i.e. growing from around 30kg to 40kg liveweight). Restricting feed intake during backgrounding (prior to feedlot entry) was not shown to impact favourably on feed conversion efficiency. Such systems may also impose additional costs due to a higher labour requirement. Consequently, this work suggests that *ad lib* feeding may be the most cost-effective and produce faster growth rates during backgrounding.
Feedlot growth rates varied from 147 g/day in the worst-performing maternal line to 205 g/day in the best line – a difference of 39%. Differences in carcase weights were also recorded due to dam line, even when adjusted to a common pre-slaughter live weight. Comparisons between sire lines were only valid for the three sires used across the single line of ewes, and these results revealed a difference of 17% in feedlot performance. This was less then the variation due to dams, and was obviously a function of the particular rams chosen. One sire was noted as an early-maturing genotype, and while its progeny performed moderately well during the back-grounding phase, their

growth rates declined during lot-feeding relative to the other two sires. None of the factors tested were found to affect carcase value once carcases were adjusted to a common weight of 27 kg. This implies that there were no commercially important differences in carcase conformation between the different genotypes in this particular study.

Experiment 3 (supervised by Vic DPI) – The effect of high and low planes of nutrition on the performance of ewes and their lambs was examined by monitoring the growth of their offspring from birth to weaning. Sheep used for this experiment were the crossbred cohort of the Maternal Central Progeny Test at the Pastoral and Veterinary Institute, Hamilton. The experiment aimed to demonstrate the effect of the interaction between genetics and nutrition on lamb performance. It was found that modest differences in the nutrition of ewes during pregnancy and lactation (roughly equivalent to a 15% difference in stocking rate) can translate into a 6% difference in lamb growth to weaning. This is sufficient to determine the suitability of lambs for intensive finishing. The trial also highlighted the importance of ewe genetics: lambs with a Corriedale maternal grand-dam were 8% heavier at birth than lambs with a Merino maternal grand-dam; and lambs with a Border Leicester maternal grand-sire grew about 25% faster to weaning than lambs with a Finn maternal grand-sire. Thus for rapid finishing of lambs in feedlot situations, ewe nutrition must be adequate and the ewe's genetics can be critical. It was not possible to draw general conclusions about the impact on lamb growth rate of interactions between ewe paternal genotype and ewe nutritional status, due to uncertainty about the level of difference in mean condition score between ewes in the HNL and LNL treatments during pregnancy and lactation. Interactions between ewe paternal genotype and ewe nutritional status may still occur where ewes are managed for a greater separation in condition score than that which was recorded in this experiment ? See comment above?

Experiment 4 (supervised by Bruce Farquharson) –involved the joining in a second year of the ewes contributed by members in Experiment 2. The objective was to compare the meat yield produced in lambs produced by ewes varying in genetic make-up and mated to nine sires, drawn from three different breeds of terminal rams: Poll Dorsets, Composites and Texels. A clear relationship was found between ewe body weight at the time of artificial insemination and the number of foetuses scanned. A mothering score assigned at lamb marking was found to have a weak association with lamb survival rates and subsequent lamb performance. It was shown that the heavier the lambs were at weaning, the higher their growth rate after weaning and the more likely they were to reach feedlot entry weight and follow a rapid growth path to slaughter weight. Lambs weaned at less than 25 kilograms at 13 weeks after the start of lambing had much lower weight gains than their heavier peers and it would be unlikely to be profitable to carry them through to finishing weights. Sire groups varied appreciably in their growth rates. Sires with high breeding value for growth will produce lambs that require a shorter finishing time, which is especially important for producers finishing lambs on pasture or crops when the quality of the feed can deteriorate rapidly.

Collectively, these results highlighted the importance of lamb growth pathway in meeting specifications. Ewe nutrition during pregnancy can determine the likelihood of lambs being suitable for intensive finishing. During back-grounding, it is imperative that lambs are maintained in good health, as they are vulnerable at this stage and require careful monitoring. Unless grain prices are low, lambs should enter a feedlot only 6-7 kg lighter than their target weight. The maternal and paternal genetics of a lamb are both critically important in determining performance – there is as much variation within a breed as between breeds and performance records can be used to identify the best source.

Contents

1 Background

The Management Solutions portfolio was established with an ambitious goal – to examine how genetics and management (including nutrition) can be used to profitably meet market specifications in real supply chains. In the case of the Wannon River Lamb Alliance (WRLA) project, there is an additional objective of providing larger and uniform valuable retail cuts from lamb producer supply networks.

A series of experiments were set up that involved WRLA members and their animals, with most experimental work actually carried out on producers' farms and feeding facilities. The suite of projects was conducted under the scientific supervision of Victoria's Department of Primary Industries staff at the Pastoral and Veterinary Institute Hamilton (Dr Leo Cummins and Mr Martin Dunstan) from late 2001 to February 2003, and subsequently by Dr Bruce Farquharson, a NSW-based veterinary consultant. The experiments were designed to elucidate some of the factors that contribute to variation in lamb performance, carcase quality and overall profitability.

2 Experiment 1

2.1 Objective

[The aim of experiment 1 was to benchmark product variation from WRLA members' properties in achieving specification of lambs by bringing them together for common backgrounding and evaluation of performance in three finishing systems, namely two high quality finishing systems (feedlot and irrigated pasture) and "Average" local pastures.

2.2 Methodology

2.2.1 Description of lambs and treatments

Fifty crossbred lambs from each of 21 WRLA members' properties were selected for Experiment 1. The procedure used for selection involved weighing a single mob on each property and selecting lambs at random from within a weight range of 32 to 38 kg.

The distribution of breeds involved in this trial is perhaps a little unusual for many parts of the prime lamb industry with a higher influence of East Friesians and Texels than is common now. It should be stressed that conclusions about the merit of various breeds should not be drawn from these results as they are not necessarily an adequate sample of the breeds used. Rather, they typify the spectrum of animals used by this particular group of producers.

At weighing, selected lambs were allocated by ear-tag to one of 3 treatments:

- feedlot (at Kerang)
- dryland and later, irrigated lucerne at Darlington, or
- "average" local pastures at Warrnambool. Due to difficulties with ryegrass staggers, this treatment was altered to a pasture/feedlot combination.

Before being sent off to their treatments, lambs were shorn, vaccinated and given "Extender" capsules (Benzimidazole-based) and kept as one flock for 6 weeks on pasture at Camperdown.

Owner	Sire	Dam
CG1	Texel	Bond x East Friesian
CG2	East Friesian x Romney	Coopworth
DB	3/4 Texel x 1/4 Hampshire Downs	Border Leicester x Merino
DW	Texel x East Friesian	East Friesian x Coop x Corriedale
TD	Texel x South Hampshire	Border Leicester x Merino
E1	Poll Dorset	Finn x Leicester x Merino
E2	Poll Dorset	East Friesian x Merino
E3	Poll Dorset	Border Leicester x Merino
EP	Composite	Border Leicester x Merino
NG	Texel	East Friesian x Coop, East Friesian x Corriedale
BK	Texel	East Friesian x Coop
JK1	Composite Poll Dorset Texel	Border Leicester x Merino x Coopworth
JK2	Composite Poll Dorset Texel	Border Leicester x Merino x Coopworth
ME1	Texel	East Friesian Coopworth
ME2	Texel cross	East Friesian x Merino
RT	7/8 East Friesian	Coopworth
JS	½ White Suffolk x ½ Texel	1/4 Bond x 1/4 EF x l/4 WS, 1/4 Tex
T1	East Friesian x Coopworth	Coopworth
T2	Texel	Merino x Coopworth
AW1	East Friesian x Coopworth	East Friesian x Corriedale
AW2	Texel	East Friesian x Coopworth x Corriedale

2.2.2 Slaughter and boning procedure

The lambs were drafted based on live weight, into groups suitable for slaughter. For convenience, slaughter groups of approximately 100 lambs were created. The minimum weight to meet slaughter specifications varied slightly but was generally 50 to 53 kg. The lambs were slaughtered at a small abattoir at Kerang. Immediately after slaughter, hot carcass weight was recorded. The carcasses were then chilled and transported to a boning room at Bendigo. Boning took place 2 days after slaughter. The lambs were removed from the chiller, cold carcass weight recorded and a cold GR measurement taken. The GR site is 110 mm around from the chine (backbone) and measures total soft tissue depth from the surface fat to the underlying 12th rib. A band saw was then used to cut the carcass into primal cuts. The forequarter was removed leaving 4 ribs in the cut. It was weighed with no further processing (ie. This cut included all the meat fat and bone). The saddle was then removed and divided into rack and short-loin and split along the backbone. For the rack, the backbone was removed and the flap sawn off to leave 6 to 8 centimetres of rib bones exposed after the cut had undergone the next stage of processing. This was the rib-loin sub-primal cut. The flap was not weighed. The rib-loin was processed to a fully trimmed (denuded) “frenched” (intercostal muscle removed) rib-rack. This cut consists only of the fully trimmed eye-muscle and the rib bones. This cut was weighed, but the trimmed fat and muscle were not weighed. The short-loin sub-primal was trimmed of any remaining channel fat and weighed. The tenderloin was removed trimmed and weighed. The eye of short-loin was trimmed and denuded and weighed. The trimmed bone and fat and muscle were not weighed. The hind legs were weighed as a leg pair chump on. In most cases the shank was removed and weighed, then the legs were boned out and trimmed to provide boneless legs and rump. These cuts were weighed. Again no attempt was made to weigh the trimmed tissue. In addition to these measurements the loin was measured at its anterior end to obtain a C fat (subcutaneous) depth, an eye-muscle depth, an eye-muscle width and a short-loin length.

2.2.3 Data analysis

Carcass measurement data (weights and distances) was subject to analysis of variance, firstly considering owner, treatment and sex of lamb and secondly as before, but with hot carcass weight as a co-variate. Before analysis, the data was inspected, with any errors corrected and any measurements from light weight (<20 kg) carcasses removed. The edited data file represented 942 animals from 21 different owners groups, 3 finishing treatments and of 2 sexes.

2.3 Results and Discussion

2.3.1 Carcass information

Means of lamb carcass measurements and values are shown in Table 1, by owner group, treatment and sex. Table 3 shows the results of a similar analysis, but with adjustments made for hot carcass weight. The weights given are the combined weights of each cut from the left and right sides. The extreme groups are highlighted. Both tables also show wholesale values for cuts; which are the averages of the 3 different prices received. These differences were a function of time of sale.

2.3.2 Weight of meat cuts

Owner group had a highly significant effect ($P<0.001$) on the weights of all cuts of meat that influence carcass value to the wholesaler, as did the effect of treatment; however the sex effect only achieved high significance ($P<0.001$) for the forequarter, eye rack and shank. Importantly the interaction between owner and treatment is not significant ($P>0.1$). This means that the different owners groups rank similarly for weights of meat cuts in the 3 different treatments.

2.3.3 Total value of meat

The lowest value group was from owner T1 with a value of $91.11, compared with the highest value group, DW, valued at $104.25. The difference is $13.14, which represents 13.5% of the overall mean value. The lambs from owner DW had the heaviest carcass weight, were the leanest and had the heaviest forequarter, the heaviest tender loin, the heaviest eye of rack, the heaviest boneless leg and the heaviest rump. The lambs from owner TI had the lightest carcasses, the lightest forequarter and the lightest boneless leg. However, the differences in carcass weight between owner groups complicate the interpretation of meat yield data.

To clarify where differences in meat value lie, the cut weights from the 5 highest value groups (DW, NG, ME1, ME2 and AW2) were compared with the 5 lowest value groups (CG2, DB, TD, RT and TI). This showed that while the differences in many of the cut weights appeared to be relatively small, they were consistent with the overall differences in value. Similarly, the correlations between mean cut weights for owners groups and value were quite high and of similar magnitude (apart from GR which was lower and negative in sign, as expected). This would suggest there is no particular cut weight that is contributing more to the final value. Again one possible implication of this is that differences in cut proportions and final value are largely driven by differences in carcass weight.

The treatment effects on meat cut weights due to owner, finishing treatment and sex were highly statistically significant (mostly P<0.001), but of relatively small magnitude. In terms of final dollar value using average valuations for all the cuts, the first feedlot group returned about 50 cents per head less than the lucerne group or the pasture/feedlot group. Since the first feedlot group was killed earlier than the other two groups this may reflect a slight difference in maturity. The sex effect was slightly larger than the treatment effect, with castrated males being worth $2.20 more than females.

2.3.4 Accounting for differences in carcass weight

Adjusting the data for hot carcass weight allows the comparisons between animals/groups to be made as if they were at the same hot carcass weight: Following adjustment for hot carcass weight, the effect of owner on the various cut weights is still statistically significant (P<0.001), as is the effect of treatment (except for forequarter weight). The effect of sex is sometimes significant, while there is no interaction between owner and treatment for cut weights. In other words the different owners groups ranked similarly for all three treatments.

Again, looking at the total value recovered after adjustment for carcass weight, the best group was from owner DW with a mean value of $101:06, while the lowest group was from owner DB with a value of $93.91. This carcass weight adjustment has halved the difference between the best and lowest-value groups and now only amounts to 7.3% of the overall mean. Based on adjusted data, the cold carcass weight from DW were the lightest, but DW lambs were still the leanest, and had the heaviest tender loins, eye of rack and rump. On the other hand lambs from owner DB had the lightest boneless leg and shank.

As before, a comparison was made between the best 5 (CGI, DW, NG, ME1 and AW2) and the lowest value 5 owner groups of lambs (DB, TD, EI, EP and TI). For the best group, 4 out of 5 owners groups remain on top after adjustment for hot carcass weight. Similarly, for the 5 lowest value groups, 3 out of 5 owner groups are in common. The correlation between owners groups before and after adjustment is quite high at 0.87. After adjustment for carcass weight, the difference between the best and lowest value groups is smaller, but obviously still very important. The importance of GR in determining final value is more obvious, while trimmed eye of rack and the boneless leg remain very important.

The regression coefficients were all statistically significant, showing that as hot carcass weight increased the various cut weights all increased.

The treatment effect was still significant but the difference in value remained small ($3.13) with the latest slaughtered group (pasture/feedlot) being the most valuable. This may be a reflection of maturity. The sex effect was sometimes significant, with the males being worth about 88 cents more than females even when considered at the same hot carcass weight.

In conclusion, there were real differences found between owners groups in terms of the carcasses produced. The difference in value of the wholesale carcass components amounted to 13.5%. About half this owner effect was due to differences in hot carcass weight. In other words, more precise drafting for slaughter (which may not be practically achievable) should have reduced the difference to $7.14.

2.3.5 Further carcass measurements

A number of other cut weights and measurements were recorded and analysed after adjustment for hot carcass weight (see 2002 annual report for details). The effect of owner and treatment were statistically significant ($P<0.01$), but the effect of sex was often not significant and the interaction between owner and treatment was usually not significant. The loin ratio and rack ratio are proportions of the final trimmed cut over the sub-primal weight and are indicators of the amount of trimming required.

The fatness measures of GR and C are highly correlated. The amount of trimming required in the loin is only modestly correlated with the GR measurement, but the amount of trimming in the rib rack is highly correlated with this measure of fatness. Similarly the amount of trimming required in the loin is quite well correlated with the final $ value and the amount of trimming required in the rib rack is highly correlated with the final $ value. The eye muscle depth and eye muscle area (EMA) were quite well correlated with trimmed loin weight, while eye muscle width had a much lower correlation and short loin length was negatively correlated with trimmed loin weight. There were some differences when comparing the adjusted and unadjusted values, but these did not affect these interpretations.

2.3.6 Time to finish

The other major consideration is the time taken for finishing. Treatments F and L were killed in 4 batches and treatment P/F only had 2 batches. The analysis has been done in 2 ways, firstly looking at the effects of owner and sex on days to finish and secondly on these same parameters after adjustment for hot carcass weight.

It is clear that there were significant differences between owners in the day of slaughter. The adjustment for carcass weight only caused minor differences. In contrast to the carcass analysis above there were highly significant interactions between owner and treatment. This would indicate that lambs from some owners grew better in the feedlot than on lucerne and vice-versa. This could be a genotype by environment interaction or perhaps some carryover effect from pre-weaning management. After adjustment for carcass weight, the best 5 owners groups in the feedlot were TD, NG, BK, ME1, and RT, while the worst groups were E1, E2, JK1, JK2, and JS. On the lucerne the best groups were DW, EP, ME1, RT and T1, while the worst groups were TD, E1, JK1, JS and AW 2.

The actual performance of all these treatment groups was very modest. The overall mean liveweight at the end of the first grazing period at Camperdown in January was 38Kg. Using an assumed dressing percentage of 45 this would give a carcass weight of 17.1 kg. This gives an implied average carcass weight gain of 87 grams per day for the feedlot group, 65 grams per day for the lucerne group and 43 grams per day for the pasture/feedlot group. The feedlot group was penalised by the low starting weight (the feedlot operator was very disappointed by the weights, however all groups were similar). They were perhaps also set back by a very long transfer between grazing and the start of feedlotting. The lucerne group had problems with "red gut" and the pasture group had problems with perennial ryegrass staggers.

The question of what these differences in time to finish, actually cost is worth considering. For example the feedlot bill comes in 2 parts, a management fee of 5 cents per day and a feedlot cost of around 38 cents per day. This is usually interpreted to mean that each extra day the animals spend on feed cost 43 cents per day. This means that a range of 18.3 days between best and worst has cost owner E1 $7.87 more than owner NG. This takes no account for potential differences in feed conversion efficiency or appetite. Similarly for the lucerne group the feed costs here were based on liveweight gain but this can be converted back to a feed cost of 10 cents per day and additional labour of 2 cents per day. This means that owner AW2 would be paying $2.14 more than owner T1. These cost make it quite clear that the cost of finishing systems is a major issue for these heavy lambs. If feedlotting is a requirement to ensure eating quality in particular branded lamb products, then management of the feedlot process needs to be improved. This is likely to involve better selection of lambs, improved management of the start of the process (both factors that our co-operator had little control in our experiment) as well as better diets and management in the feedlot itself.

2.3.7 Eating quality

The meat from the boning room went into commercial retail outlets. We received adverse feedback from both groups of lambs in the pasture/feedlot treatment. The meat was claimed to be tough, and the problem was considered commercially important. The reason for this problem is unclear, particularly since these lambs had a final period in the feedlot. One possibility is that perennial ryegrass staggers, which affected the lambs in the final phase of the pasture period, had a carryover effect on eating quality. The commercial severity of the problem means that eating quality needs to be monitored more thoroughly.

2.4 Success in Achieving Objectives

The objective of Experiment 1 was to benchmark product variation and major differences in profitability were found due to producer group. Group effects encompass a combination of genetics and early management, as the contributed lambs were reared on their properties of origin.

The objective was met, as owner group was shown to have a large effect on growth rates during back-grounding (range 45 g/day to 129 g/day). Furthermore, there were large differences in feedlot growth rates (101 g/day to 196 g/day) due to owner group as there were in performance on lucerne (102 g/day to 138 g/day). Failure to detect differences in the pasture/feedlot system were probably due to small group sizes and an outbreak of ryegrass staggers.

Importantly, no association was found between back-grounding growth rates and finishing growth rates, which highlights the fact that for proper comparisons of animals from different sources, a period of acclimatisation is necessary and even then, early effects can persist.

Furthermore, this work showed that rankings in one finishing system can be quite different to rankings in another. Other research suggests that this is more likely to be caused by carry-over of early management differences than genetics, but both can contribute.

3 Experiment 2

3.1 Objective

Experiment 2 involves single-sire mating of members' ewes (16 groups) to a selected sire using AI, with the resulting lambs to be finished in a common environment. The sire used was a Poll Dorset, No 1623681998980211, or "5 Star". An additional component was to test three different rams (a Poll Dorset, a NZ composite and a Texel) across a common group of ewes using AI, with natural mating of a back-up ram used on ewes that failed to conceive to AI. Information from this experiment will provide information on the effects of sire line on achieving lamb carcase specifications, when joined to ewes of different background.

An additional aim was to quantify growth responses and efficiency of liveweight gain when lambs were offered various intake levels (relative to *ad libitum*) of a high quality ration in the backgrounding phase (i.e. growing from around 30kg to 40kg liveweight).

3.2 Methodology

3.2.1 Animals

16 groups of ewes from 13 owners (25 per group) were joined by AI to the ram identified as 1623681998980211 or "5 Star", a top-performing and widely-used sire. The groups of ewes were known as "Producers ewes". An additional uniform line of 200 Friesian x Merino ewes (known as "Alexanders ewes" were inseminated using AI to semen from three sires selected for breed variation and high performance on LAMBPLAN: a top NZ Composite ram, a Texel and a Poll Dorset.

3.2.2 Ewe management

Producers' ewes were assembled at "Yallambee" Skipton on 14-15 February 2002. Progestagen sponges were inserted on 12th and 13th March. Twelve days later, sponges were removed and ewes injected with 500iu PMSG. AI was conducted on 26th and 27th March. The 200 supplementary ewes (Alexanders) followed a similar regime and were inseminated by AI on 10th April. White Suffolk rams were used as back-ups for both groups through natural mating, introduced two weeks after AI.

Ewes were run as two groups – Producers and Alexanders. Ewes were pregnancy scanned on 16th May (Producers) and 28th May (Alexanders) to identify ewes conceiving to AI. Prior to lambing, ewes were allocated to groups based on pregnancy scanning results:

- Producers ewes expecting singles
- Producers ewes expecting twins
- Producers ewes expecting triplets
- Alexanders ewes expecting singles
- Alexanders ewes expecting multiples
- Ewes in lambs to backup rams (drawn from both groups)

During lambing, lambs were identified to their mothers, tagged and weighted.

3.2.3 Lamb management

Lambs were marked on separate occasions in October according to group. In mid-December, pasture conditions deteriorated and lambs were introduced to barley grain supplement while still on their mothers and weaned 20-28th January 2003. Following weaning lambs were drafted into 3 groups – Producers lambs under 40kg, Producers lambs over 40kg and Alexanders lambs. Weaners continued to receive barley supplement post-weaning. In February, an outbreak of Coccidioisis caused approximately 25 lamb deaths and lambs were treated with sulphadimidine.

3.2.4 Lamb feeding and finishing treatment

This component tested the hypothesis that restricting the intake of lambs in the backgrounding phase will increase the efficiency of liveweight gain (conversion of feed to liveweight). After weaning the lambs from Experiment 2 were transported to a feedlot. Lambs that weighed 40 kilograms or heavier (n=41) went directly into the feedlot to be finished for slaughter. The remaining lambs were drafted into three groups of equal numbers and based on bodyweight. This gave a group of heavy lambs, a group of average lambs and a group of light lambs. Each weight range of lambs was stratified according to bodyweight and randomly allocated to one of four groups. Each group in the weight range was randomly allocated to a treatment group. Each group in each weight range received a different amount of the pelleted diet, based on the total weight of lambs in that group:

Group	Number	Average weight	Diet as % of weight
1	50	34.1	4.0 %
2	40	34.1	3.6 %
3	53	33.8	3.2 %
4	65	33.8	2.8 %
5	51	27.8	4.0 %
6	53	27.4	3.6 %
7	51	27.6	3.2 %
8	52	27.8	2.8 %
9	46	21.8	4.0 %
10	49	22.3	3.6 %
11	50	21.5	3.2 %
12	52	21.7	2.8 %

Lambs were weighed weekly and animals that attained 40 kilograms or heavier were moved to the feedlot for finishing. The weight of the remaining lambs was tallied and the new feed allocation calculated for the following seven days. Lambs in the feedlot were fed *ad lib* on a pelleted diet with continuous access to reticulated water and weighed every two weeks. When they attained 54 kilograms in live weight or heavier they were sent to an abattoir for slaughter.
At the end of June any lambs that had not reached 48 kilograms were sold.

3.2.5 Lamb carcase measurements

The lambs sent for slaughter were transported to an abattoir the day after weighing and were slaughtered the following day. On the day of slaughter the hot carcase weight was measured and the fat score and GR fat measurement taken and recorded. The day after slaughter the carcases were boned out into commercial cuts of meat and the individual cuts were weighed. When the last assignment of lambs was sent for slaughter the carcases were subjected to Viascan tomography to assess meat yield, prior to the carcases being boned out.

3.3 Results & Discussion

3.3.1 Birth and weaning weights

Birth weights varied according to ewe source. Among singles, the lightest group averaged 3.7kg at birth and the heaviest group averaged 5.1kg. Among twins, the group averaged ranged from 3.3-4.4kg and among triplets, the range was 3.0-4.1kg. Respective pre-weaning weights ranged from 36.5-44.0kg for singles, 26.4kg-36.6kg for twins and 24.5-31.7kg for triplets. Maternal effects on weaning weight due to ewe source were larger than identified in the Maternal Central Progeny Test. Differences due to sire, by comparison, were small.

Ewe group sizes were too small to enable reproduction rates to be adequately compared, but the number of lambs weaned per producer group varied from 18 to 43, with 227 born to the (Alexanders ewes – is this the first mention of these ewes, does Alexanders mean anything?. The majority of lambs were twins (268) with 147 singles and 66 triplets weaned. The average weaning weight was 32.0kg, with group averages ranging from 27.1kg to 35.1kg.

3.3.2 Backgrounding

Statistical analyses revealed that all factors fitted had a significant effect on growth rate during background feeding:

<u>Dam flock</u> Least squares means for dam flocks ranged from 162±26 g/day (Richardson flock #2) to 232±22 g/day (Bailleu). Lambs that had reached 40kg and taken straight into the feedlot without back-grounding were drawn from all dam sources except one.
<u>Sire</u> Progeny of the 5 Star sire grew the fastest during back-grounding (237±14 g/day). Furthermore, of the 41 lambs that did not require background feeding most (n=34) were sired by 5 Star. However, it should be noted that all 5 Star lambs were born 2-5 weeks prior to the other lambs. Of the three sires that could be validly compared, the fastest growth was by progeny of the Poll Dorset site (212±26 g/day) and the slowest was by progeny of the Texel sire (172±27 g/day).
<u>Gender</u> Males had significantly higher growth rates during back-grounding than females (least-squares means 216±18 g/day vs. 185±18 g/day, respectively) and also accounted for 28 of the 41 lambs not requiring back-grounding.
<u>Birth-rearing rank</u> Thirty-two of the single born and reared lambs did not require background feeding. Of the lambs that were background-fed, the fastest average daily gains were reared as singles (225±16 g/day for single-born-single reared, [1/1] and 235±32 g/day for 3/1), while the slowest growth rates were among those with a higher order birth rank (183±18 g/day for 3/3, 189±41 g/day for 4/3). Twins that lost a litter-mate also grow slowly (189±19 g/day).
<u>Feed treatment</u> Heavy lambs had the highest average daily gains during back-grounding. In all but one instance, growth rates increased with level of feeding within each weight category. The one exception was in medium-weight lambs fed 3.2% of the body weight, which had an unusually low average growth rate. This same group had exceptionally high feed conversion ratios.

The amount of feed consumed per kg of weight gained during backgrounding tended to decline as feeding levels approached *ad lib*. This indicates that feed conversion efficiency was not improved by restricting feed intake; in fact it appeared to be adversely affected.

3.3.3 Feedlot growth rates

A total of 517 lambs had feedlot records that were suitable for statistical analysis. Average feedlot growth rates were some 8% lower than during background feeding and were found to be independent of birth-rearing status and back-grounding ration. However, the effects of dam flock, sire, gender and weight category all significantly ($P<0.05$) influenced feedlot performance:

Genotype – Least squares means for dam flocks ranged from 147±19 g/day (Richardson flock #2) to 205±18 g/day (Turner). The correlation between back-grounding growth rate and feedlot growth rate on a dam flock basis was not statistically significant ($r = 0.39$). Among the sire groups, the fastest rates were attained by progeny of 5 Star (196±8 g/day). Again, it should be noted that 5 Star lambs were born 2-5 weeks prior to the other lambs. Of the three rams that could be validly compared, the Poll Dorset sire produced the fastest-growing progeny in the feedlot (174±19 g/day) and the NZ composite ram produced the slowest-growing (147±20 g/day).
Gender and weight category – Males also had significantly higher feedlot growth rates than females (least-squares means 190±13 g/day vs. 160±13 g/day, respectively). Of the three weight categories defined prior to background feeding, lambs classified as “heavy” had faster feedlot growth rates than those classified as “medium” or “light” (201±13, 168±13 and 155±14 g/day, respectively). However, back-grounding ration had no statistically detectable effect on feedlot growth rates.

3.3.4 Hot standard carcase weights (HSCW)

Statistically, HSCW was unaffected by sire or gender, but when adjusted to a common live weight of 54kg, dam source ($P<0.05$) and birth-rearing rank ($P<0.01$) were significant sources of variation in HSCW. Lambs with “Turner” dams had the lowest carcase weights (25.9±0.04kg) while those from “Bennett 2” ewes had the highest weights (28.6±0.6kg).

3.3.5 Fat scores

Although lambs from the various dam groups had least-squares means ranging from 3.9 to 4.9 scores, differences in fat score due to dam genotype were not translated into statistically detectable differences in GR measures, with no lines deviating significantly from the overall least-squares mean of 17.3±0.8mm, or from each other when data were adjusted to a standard 27kg carcase weight. The only significant effect was due to birth-rearing rank ($P<0.01$), which did not follow any obvious pattern and seemingly unrelated to mean feedlot growth rate (correlation between means, $r = 0.14$).

3.3.6 Carcase values

None of the factors tested were found to affect carcase value once carcases were adjusted to a common weight of 27 kg. This implies that there were no commercially important differences in carcase conformation between the different genotypes in this particular study.

3.4 Success in Achieving Objectives

Experiment 2 was designed to provide information on the effects of sire line in achieving lamb carcase specifications, when joined to ewes of different background. The experiment was effectively in two parts – the first, using contributed ewes, provided information on the maternal contribution, as ewes were all mated by AI to just one sire. The second component, using a uniform line of ewes, provided information on three different sires. In combination, the two components enabled a comparison of the relative magnitude of sire and dam contributions. Feedlot growth rates varied from 147 g/day in the worst-performing maternal line to 205 g/day in the best line – a difference of 39%. Differences in carcase weights were also recorded due to dam line, even when adjusted to a common pre-slaughter live weight.

Comparisons between sire lines were only valid for the three sires used across the uniform line of ewes, and these results revealed a difference of 17% in feedlot performance. This was less then the variation due to dams, and was obviously a function of the particular rams chosen.

The experiment achieved the objective of quantifying variation due to maternal and paternal contributions.

The treatment designed to determine whether restricting feed levels during backgrounding leads to improved feed utilisation for growth, showed that this was not the case. In fact, there was a suggestion that the reverse may have occurred i.e. the amount of feed consumed per kg of weight gained during backgrounding tended to decline as feeding levels approached *ad lib*. Feed restrictions during backgrounding appeared to have no effect on subsequent feedlot performance. Thus the objective was met, as the hypothesis tested was rejected. I am really surprised at this?

4 Experiment 3

4.1 Objective

This experiment examined the effect of high and low planes of nutrition on the performance of ewes and their lambs by monitoring the growth of their offspring from birth to weaning. Sheep used for this experiment were the crossbred cohort of the Maternal Central Progeny Test (see Fogarty 2005) at the Pastoral and Veterinary Institute, Hamilton. The experiment aimed to demonstrate the effect of at maternal genetics and ewe condition score on lamb performance.

4.2 Methodology

4.2.1 Lambs and treatments

297 crossbred ewes were joined in March 2002 to a team of composite (formerly bred as Jonesdale) terminal sires, selected for similarity in their LAMBPLAN figures. These ewes had been bred out of either Merino or Corriedale dams that had been joined in groups to a range of 12 sires representing seven maternal sire breeds (Finn, Coopworth, East Friesian, Corriedale, Romney, Border Leicester and Booroola Leicester). Following pregnancy scanning in June, the ewes were allocated to high nutrition level (HNL) or a low nutrition level (LNL) treatment group within their genotype.

Nutritional treatments were developed by altering stocking rates and by providing additional supplementation to the HNL group. The stocking rates for the two groups we re 8.9 ewes/ha for the HNL group and 10.2 ewes/ha for the LNL group. Supplementation of the HNL group with lupins was used in late pregnancy to increase the nutritional differences between the treatment groups. This supplementation ceased at the start of lambing in early August. Ewes and lambs were monitored until weaning in early December.

Ewe body condition was measured on three occasions, prior to joining (20/02/02), at joining (12/03/02) and at weaning (4/12102). On the 20/02/02 and 12/03/02, the ewes were weighed and fat scanned using an ultrasound machine. An analysis of variance was conducted to determine if the two nutritional treatments varied significantly in fat measurements across the experimental period. On the 20/02/02 and the 12/03/02 the nutritional treatments did not vary significantly in fat depth ($P>0.05$). Alternatively, at weaning on the 4/12/02, a significant difference in fat score was observed ($P<0.05$) between the nutritional treatments. on this date, the mean condition score for ewes in the HNL treatment was 2.3, whilst the mean condition score of ewes in the LNL was 2.12, (1.s.d.=0.175, $P=0.05$).

Although the difference in condition score at weaning was significant, it was also insufficient to reflect a meaningful separation in nutritional status that could be practically managed on farm. The primary means of achieving the nutritional differences was by use of a 15% increase in stocking rate for the LNL treatment. However, the nature of the season and resultant levels of available pasture severely limited the success of this method. It is acknowledged that more frequent measurement of ewe condition score throughout pregnancy would have identified the minimal separation being achieved in condition scores much earlier. One response could have been to increase the level of supplementary feeding within the HNL treatment, but this did not happen. Although the condition score measurements taken at weaning suggest that there was a likely condition score separation between treatments at lambing, there was no evidence collected to support a difference in condition score at that time.

Lambing commenced early August 2002 with 241 and 234 lambs being born in the LNL and HNL groups, respectively.

The stocking rate/nutritional differences imposed on the ewes had a small effect on pasture availability during spring. Pasture measurements taken on 29/10/02 revealed that the LNL treatment had a pasture mass of 1730 kg DM/ha compared to the HNL treatment pasture mass of 2150 kg DM/ha. Feed quality on this date was very similar for both treatments, with Crude Protein levels of 11.8 – 12.0% and Digestible Dry Matter levels of 60 – 62%.

The lambs were weighed at marking (mid September) and again at weaning in early December, when the ewes were also shorn. At marking, all lambs were tail-docked and male lambs were castrated.

Experimental lambs were weaned in December 2002, with approximately 73% and 74% of lambs born in the LNL groups (175 lambs) and HNL (173 lambs) being present at weaning.

4.2.2 Data analysis

Lamb birth weight data was subject to a REML analysis considering treatment, crossbred ewe maternal breed, crossbred ewe sire, sex of lamb and number of offspring (i.e. reared as singles or multiples).

Growth rate was calculated as average daily weight gain between birth and weaning. This data was also subjected to a REML analysis considering treatment, crossbred ewe maternal breed, crossbred ewe sire, rearing rank (singles vs multiples) and sex of lamb.

Before analysis, the data was inspected, with any errors corrected and any measurements from lambs that subsequently died removed from the data. The edited data file represented 347 animals from 2 dam breeds, by 12 sires, 2 nutritional treatments, 2 rearing ranks and of both sexes.

4.3 Results & Discussion

4.3.1 Lamb birth weight

Crossbred ewe maternal breed had a highly significant effect (P<0.001) on lamb birth weight, as did lamb sex (P<0.001) and number of offspring (P<0.001). The interaction between treatment and crossbred ewe sire was significant (P<0.01) indicating that the lambs' maternal grand-sires ranked differently for birth weight across the two nutritional treatments.

The crossbred ewe maternal breed significantly affected lamb birth weights, with predicted mean birth weights of lambs born from Corriedale-cross dams being 5.71 kg, which is 0.45kg (7.9%) heavier than lambs born from Merino-cross dams (5.26 kg).

Lamb sex also significantly affected lamb birth weights, with predicted birth weights for male lambs being 5.67 kg, which is 0.36 kg (6.4%) heavier than female lambs (5.31 kg). The interaction between crossbred ewe maternal breed and lamb sex is not significant (P>0.1), meaning that crossbred ewe maternal breed ranked similarly for birth weight regardless of the sex of the lamb.

The number of lambs born per ewe (litter size) also significantly impacted upon birth weight, with predicted mean birth weights for lambs born as singles being 6.17kg, which is 1.24kg (20%) heavier than multiples lambs (4.93 kg).

The interaction between the nutritional treatment and crossbred ewe sire indicates that crossbred ewe sires ranked differently for birth weight across the two nutritional treatments. The predicted means for lamb birth weights for crossbred ewe sires for the nutritional treatments are shown in the following table.

Crossbred ewe sire			**Least squares means for birth weight (kg)**	
Number	**Name**	**Breed**	**HNL treatment**	**LNL treatment**
7	Warrayure 930057	Finn	4.77	4.87
4	Oaklea 940449	Coopworth	4.96	5.26
12	UNSW 96002	Finn	5.13	5.00
8	Gippfinn 950054	Finn	5.17	5.03
9	Oaklea 940241	Coopworth	**5.31**	**5.87**
10	Silverstream 940B26	East Fresian	**5.73**	**5.03**
11	Stanbury 880491	Corriedale	5.81	5.51
3	Claymore 930246	Romney	5.83	5.65
1	Kelso 845291	Border Leicester	6.00	5.11
2	Inverbrackie 950246	Border Leicester	6.04	6.08
5	Struan 924287	Booroola Leicester	6.07	5.84
6	Narambla 930069	Coopworth	6.10	5.70
	Grand Mean		**5.58**	**5.45**

l.s.d. (P=0.05)* (Across sires, within same nutritional treatment) = 0.89. Sires that differ by more than 0.89 kg for birth weight within a nutritional treatment were significantly different for birth weight.
l.s.d. (P=0.05)* (Across nutritional treatment, within same sire) = 0.51. Individual sires that differ by more than 0.51 kg for birth weight between nutritional treatment were significantly different for birth weight.

Lamb birth weight was found to be significantly affected by crossbreed ewe maternal breed, sex of lamb and number of offspring. Higher lamb birth weights were recorded across both nutritional treatments for lambs born from crossbred ewes with Corriedale maternal genotypes, rather than Merino genotypes. Likewise, higher lamb birth weights were recorded across both nutritional treatments for male lambs and for lambs born from ewes bearing single offspring rather than multiple lambs. Only two sires, Sires 9 and 10, produced significantly different birthweight lambs across the nutritional treatments (Ls.d.=0.51, P=0.05).

Sire 9 produced heavier lambs in the LNL treatment, whilst Sire 10 did the reverse, producing heavier lambs in the HNL treatment. It was identified that a highly significant interaction was present between the effects of nutritional treatment and crossbred ewe sire on lamb birth weight. In other words, not all sires ranked similarly for birth weight across the nutritional treatments. The difference between the lowest and highest predicted means for birth weight in the HNL and LNL treatments were 1.33 and 1.21kg respectively.

4.3.2 Lamb growth rate from birth to weaning

Nutritional treatment had a highly significant effect (P<0.001) on lamb growth rate from birth to weaning, as did the crossbred ewe sire (P<0.001) and rearing rank (P<0.001). Lamb sex and crossbred ewe maternal breed did not have a significant effect (P>0.1) on lamb growth rate from birth to weaning. Importantly, the interaction between treatment and crossbred ewe sire and the interaction between treatment and lamb rearing rank were not significant (P>0.1), indicating that lambs from different crossbred ewe sires and lamb rearing ranks performed similarly across the nutritional treatments. The predicted means for growth rate for the crossbred ewe sires are as follows:

Crossbred Ewe Sire			Growth rate from birth to weaning
Number	Name	Breed	(kg/head/day)
8	Gippfinn 950054	Finn	0.204[a]
7	Warrayure 930057	Finn	0.216[ab]
6	Narambla 930069	Coopworth	0.218[ab]
12	UNSW 96002	Finn	0.223[ab]
11	Stanbury 880491	Corriedale	0.224[ab]
3	Claymore 930246	Romney	0.235[abc]
9	Oaklea 940241	Coopworth	0.236[abc]
4	Oaklea 940449	Coopworth	0.243[abc]
10	Silverstream 940B26	East Fresian	0.243[abc]
5	Struan 924287	Booroola Leicester	0.246[bc]
1	Kelso 84S291	Border Leicester	0.258[c]
2	Inverbrackie 950246	Border Leicester	0.261[c]
	Grand Mean		**0.234**

Sires with different subscripts had significantly different growth rates from birth the weaning.

The predicted growth rate for lambs in the HNL group is 241g/hd/day, which is 14g/hd/day (5.8%) faster than for lambs in the LNL group (227g/hd/day). Likewise, the predicted growth rate for lambs reared as singles is 262g/hd/day, which is 56g (21%) faster than for lambs reared as multiples (206g/hd/day).

Lamb growth rate was found to be significantly affected by crossbred ewe sire, nutritional treatment and lamb rearing rank.

Significantly higher lamb growth rates were recorded across both nutritional treatments for lambs born from crossbred ewes that had been sired by a Border Leicester rather than a Finn. Likewise, the HNL treatment resulted in a growth rate increase of 5.8%, and rearing as single lambs produced a 21% increase in growth rate. The analysis indicates that lamb sex and crossbred ewe maternal breed did not have a significant effect on average daily growth rate from birth to weaning.

In contrast, it was not possible to draw general conclusions about the impact on lamb growth rate of interactions between ewe paternal genotype and ewe nutritional status, due to uncertainty about the level of difference in mean condition score between ewes in the HNL and LNL treatments during pregnancy and lactation. Interactions between ewe paternal genotype and ewe nutritional status may still occur where ewes are managed for a greater separation in condition score than that which was recorded in this experiment.

4.4 Success in achieving objectives

This experiment was designed to demonstrate the effect of the interaction between genetics and nutrition on lamb performance. Such an interaction was detected for birth weights, where a statistically significant interaction was found between the effects of nutritional treatment and crossbred ewe sire on lamb birth weight. That is, not all sires ranked similarly for birth weight across the nutritional treatments. Importantly, the interaction between treatment and crossbred ewe sire was not statistically significant, indicating that lambs from different crossbred ewe sires performed similarly across the nutritional treatments. In addition, lamb growth rates were found to be significantly affected by crossbred ewe sire. Significantly higher lamb growth rates were recorded across both nutritional treatments for lambs born from crossbred ewes that had been sired by a Border Leicester rather than a Finn. Likewise, the HNL treatment resulted in a growth rate increase of 5.8%. Unfortunately, it was not possible to draw general conclusions about the impact on lamb growth rate of interactions between ewe paternal genotype and ewe nutritional status, due to differences in mean condition score between ewes in the HNL and LNL treatments during pregnancy and lactation not being quantified. Interactions between ewe paternal genotype and ewe nutritional status may still occur where ewes are managed for a greater separation in condition score than that which was recorded in this experiment.

The objectives of this experiment were met to a large extent, although some questions remained unanswered due to uncertainty about the extent of differences in mean condition score between ewes in the HNL and LNL treatments during pregnancy and lactation.

5 Experiment 4

5.1 Objectives

Experiment 4 involved the joining in a second year of the ewes contributed by members in Experiment 2. The objective is to compare the meat yield produced in lambs produced by ewes varying in genetic make-up and mated to nine different terminal rams – 3 Poll Dorsets, 3 Composites and 3 Texels. This rams were chosen to provide a range of carcase characteristics and were not chosen to be representative of their breeds. The results should therefore not be interpreted as a breed comparison.

5.2 Methodology

5.2.1 Ewes and joining

The 535 ewes that were assembled for Experiment 2 were allocated to nine different mating groups by randomly allocating the ewes in each flock-of-origin to one of the mating groups. The ewes were synchronized into oestrus using progesterone sponges and pregnant mare serum gonadotropin. Each group was inseminated by intrauterine insemination with fresh semen collected from the rams on the day of insemination. Insemination was performed on 12th and 13th March 2003.

Each group of ewes was then grazed in its group with the ram allocated to that group. This would give the opportunity for any ewes that did not conceive to artificial insemination to be mated naturally and become pregnant to the same ram used for AI.

5.2.2 Sires

The nine rams used to sire the lambs were purchased from three commercial ram breeding properties and each ram had LAMBPLAN values for meat yield. The three rams from each breed were selected from above, average and below the flock average for meat yield. In addition the rams were subjected to DXA assessment at University of Melbourne, Werribee, Victoria as an additional measurement of meat yield.
The nine rams used had the following characteristics. The composite rams contained 5/8 Poll Dorset, 1/4 White Suffolk and 1/8 Texel genes.

Ram No.	Full ID	Breed	Estimated Breeding Values			Breeding Index	
			Pwwt	Pfat	Pemd	Carcase+	60:20:20
PD 216		Poll Dorset				120.3	
PD 289		Poll Dorset				135.2	
PD 290		Poll Dorset				136.9	
Comp 160	2350032001010160	Composite	2.79	-1.32	-0.22	136.6	122.1
Comp 177	2350032001010177	Composite	3.06	-0.90	-0.10	132.4	122.7
Comp 454	2350032001010454	Composite	0.00	-0.95	0.74	123.4	122.8
Tex 661	1700802001010661	Texel	4.23	-0.73	0.35	141.3	123.8
Tex 689	1700802001010689	Texel	2.00	0.21	1.67	125.6	122.7
Tex 741	1700802001010741	Texel	2.96	-0.78	0.07	131.5	120.2

5.2.3 Ewe management

The ewes were all scanned for pregnancy 44 days after insemination. Any ewe detected pregnant was considered to have conceived to artificial insemination. Those ewes in which pregnancy was not detected were again scanned on day 85 and those that were diagnosed pregnant were considered to have conceived to a natural mating. The ewes diagnosed as not pregnant were removed from the trial and sold. The ewes were grazed at pasture as one mob throughout pregnancy. The ewes were shorn in June 2003.

Ten days prior to lambing (which began on 4th August 2003), the ewes were administered an albendazole controlled release capsule with a Triton combination drench primer for internal parasite control and received a subcutaneous dose of 5-in-1 vaccine with selenium. In addition each ewe had her eartag number written in large numbers on her flank using aerosol coloured markers so she could be readily identified. The ewes were grazed as three groups during lambing and lactation. One group contained the early ewes that were diagnosed with multiple lambs, one group contained the early ewes diagnosed with a single lamb. The third group comprised all of the later lambing ewes that had conceived to natural mating. Each paddock used for lambing had an initial pasture cover of approximately 1,200 kgs d.m./ha. During lambing the ewes and lambs were inspected every day. On the day each lamb was born, the lamb was given an uniquely-numbered eartag, it was weighed, and recordings were made of the date, the lamb number, the ewe number, the weight of the lamb, the gender and birth rank of the lamb.

The lambs were grazed in their mobs until weaning. If the pasture cover in any paddock was below 1,000 kgs d.m./ha, the mob was moved on to another paddock with a higher pasture cover.

5.2.4 Mothering score

Each ewe was allocated a mothering score whilst the lamb was being tagged and weighed. The score was based on the distance the ewes stood away from the lamb during this procedure and was as follows:

Mothering Score	Distance from Lamb
1	< 1 metre
2	< 5 metres
3	< 10 metres
4	< 20 metres
5	> 20 metres

5.2.5 Lamb management

The lambs were marked at 25 days after the start of lambing for the early-born lambs and 29 days after the start of lambing for the late-born lambs. At marking each lamb was weighed, had its tail docked using a hot knife, the male lambs were castrated using an elastrator rubber ring and they received a single subcutaneous dose of 5-in-1 vaccine containing selenium.

All of the lambs were weaned on day 98 after the start of lambing. Each lamb was weighed and the weight recorded. In addition they each received a single subcutaneous dose of 5-in-1 vaccine containing selenium and were given an oral dose of the combination anthelmintic “Triton”.

Throughout the grazing period from March to January faecal samples were collected for faecal egg counts and sent to Paratech Veterinary Laboratory, Willaura, Victoria for bulk faecal egg counts.

Any lambs that weighed 40 kgs or heavier were transported to the feedlot. As the pasture deteriorated the lambs were supplemented with pellets to achieve a weight gain of at least 100 grams per day.

In March the property on which the lambs were grazing was sold. All of the remaining lambs were either transported to the feedlot or if less than 35 kgs, were sold.

5.2.6 Lamb finishing

Prior to transport to the feedlot, the lambs each received an oral dose of the combination anthelmintic “Triton”, administered at the recommended dose for sheep of 40 kilograms. Lambs in the feedlot were fed *ad lib* on a pelleted diet manufactured by Teangi Feeds, Colac, to which they had continual access; and lambs were weighed every two weeks. Any lamb that weighed 54 kilograms or heavier was sent to slaughter. The lambs were transported to the abattoir the day after being weighed and were slaughtered, and carcase Viascan readings were taken on the following day.

At the end of May the trial was terminated as the only lambs remaining had an uneconomic weight gain. At the final weigh all lambs weighing 46.0 kgs or heavier were sent for slaughter. The remaining lambs were sold at market.

5.2.7 Data analysis

Data were analysed fitting fixed effects models with ASReml (Gilmour et al. 2002). Effects tested are detailed in the results section.

5.3 Results & Discussion

5.3.1 Reproduction

Due to small group sizes, there was no statistically significant effect of ewe flock on the number of lambs born per ewe or on the number of lambs weaned per ewe. There was a significant effect ($P<0.01$) of post-mating weight on number of foetuses scanned. For each 1kg increase in post-mating weight, the number of foetuses increased by 0.0122 ± 0.005. Neither ewe flock nor sire affected the number of foetuses scanned per ewe.

5.3.2 Mothering score

Mothering score was not affected by sire group or ewe flock. Mothering score was not associated statistically with the number of foetuses scanned, the number of lambs born per ewe, the number of lambs weaned per ewe or the number of lambs lost between lambing and weaning per ewe; although ewes with the lowest mothering score were able to rear a higher percentage of lambs and the group that had the highest lamb survival also had the lowest mothering score. This group of ewes also had the highest lambing percentage so these ewes were able to rear a higher percentage of twin lambs. In 15 of the 17 groups, the lambs that died were born to ewes with a higher mothering score than lambs that survived to weaning.

5.3.3 Weaning weights

A number of non-genetic factors had a significant effect ($P<0.05$) on weaning weight, as follows (in kg):

Least-squares mean		**31.8**
Gender	Male	32.8
	Female	30.8
Birth rank	Single	35.8
	Twin	32.7
	Triplet	31.3
	Quad	27.4
Rearing rank	Single	32.9
	Twin	30.9
	Triplet	28.1
Paddock	1	30.0
	2	33.1
	3	31.9
	Unrecorded	32.2
Age at weaning	(kg/day)	+0.186

The lambs with the highest growth rate to weaning based on the flock of origin had a16% higher growth rate than the lowest performing group, although it should be recognized that much of this may have been due to chance, as the ewe effect did not quite reach statistical significance at the 5% level. The influence of sire breed was significant. The progeny of the Composite rams had birth to weaning growth rates approximately 6% greater than the progeny from the other two breeds; and there was a 16% difference in weaning weight between the progeny of sire Comp 160 and Texel

569. Dam's mothering score had no detectable effect on weaning weight, nor did the insemination method (AI vs natural), after other factors were accounted for.

Source of ewe had an effect on weaning weights that approached significance (P=0.06), while sire effects were highly significant (P<0.001). Least squares means were as follows (in descending order):

Sire	**Mean**	**SE**	**Ewe source**	**Mean**	**SE**
Comp 160	34.4	1.4	BA	33.7	1.5
Comp 454	32.9	1.4	ST	33.5	1.5
Dorset 216	32.2	1.3	GU	33.1	1.5
Texel 741	32.0	1.4	BR	32.9	1.6
Comp 177	31.8	1.4	WA	32.8	1.5
Dorset 289	31.7	1.4	B2	32.6	1.9
Dorset 290	31.5	1.4	B1	32.4	1.6
Texel 661	30.7	1.4	WI	31.9	1.5
Texel 689	29.5	1.4	MA	31.7	1.5
SED:		*0.8*	K2	31.5	1.5
			TR	31.5	1.5
			CO	31.5	1.3
			R1	31.3	1.6
			KA	31.1	1.5
			R2	30.6	1.5
			K1	30.5	1.6
			TC	28.7	1.6
			SED:		*1.3*

The lambs in this study grew at high growth rates between birth and weaning. An average growth rate of 324 grams per day is above the industry average – the result of the high quality pasture offered to the ewes and lambs.

After accounting for all known sources of variation, the average marking weights had a range of 3.3kg due to ewe flock (12.9kg–16.2kg). By weaning, the range in ewe flock effect was 5.0kg (28.7kg–33.7kg). For the nine sires sampled for this experiment, there was a range in marking weights of 2.3kg due to sire (13.5kg–15.9kg), which reached a differential of 4.9kg by weaning (29.5kg–34.4 kg).

5.3.4 Lifetime weight gains

Average daily weight gains from birth to disposal were analysed, with records from 431 animals suitable for analysis. Factors that had no statistical effect on these rates of gain were mothering score of the dam, paddock and source of dam. However, gender, birth date, birth-rearing rank and sire all influenced growth rates (P<0.05) – see following table for least-squares means. The overall mean rate of gain of these lambs was 194±16 g/day, which, it should be noted, included varying periods of back-grounding and lot-feeding.

Effect	Level	g/day	se	No
Mean	Mu	194	16	413
Gender	Male	201	17	199
	Female	186	16	214
Birth/rearing	21	210	15	21
	11	218	5	196
	22	177	5	188
	32	218	34	4
	31	192	68	1
	33	171	48	2
	42	170	68	1
Date of birth	B date (/day)	-0.63	0.46	413
Sire	Comp 160	212	19	53
	Dorset 289	204	19	54
	Dorset 216	200	18	50
	Dorset 290	200	19	38
	Comp 454	199	19	46
	Texel 741	195	19	40
	Texel 661	193	19	40
	Comp 177	179	19	50
	Texel 689	161	18	42

The lifetime weight gain of the progeny of the various sires ranged between 161 and 212 grams per day – a 32% difference. When classified by breed of rams, the progeny of the Poll Dorset rams had the highest weight gains at an average of 201 grams per day compared to the progeny of the Composite rams and the Texel rams of 197 grams per day and 183 grams per day respectively. However, it is important to note the variation between sires within breeds.

The relationship between the weaning weight of lambs and their growth rate after weaning were positively correlated. The heavier lambs had a higher post-weaning growth rate, and also a higher percentage of the lambs reached slaughter weight. The data suggest that when lambs are 35 kilograms or heavier at weaning they will maintain a high growth rate and that the majority of the lambs will finish to acceptable slaughter weights.

The percentage of lambs that reached feedlot entry weight (40kg) varied according to the flock of origin, but the difference was not statistically significant when other factors were accounted for. The percentage to reach feedlot entry weight varied by 15% to 47% according to sire of lambs; a difference that was highly significant ($P<0.01$). Paddock (range 23%–42%), birth-rearing rank (61% for single born and reared lambs; 28% for twin born and reared) and gender (27% females, 37% males) all had a significant effect on whether lambs reached feedlot entry weight of 40kg.

5.3.5 Carcase results

The following tables summarise the dressing percentage, the meat yield as measured using Viascan tomography for the total carcase and for the loin.

Classification	Level	Count	Dressing %	Meat Yield	Loin Yield	Meat Value ($)
Flock	BA	10	46.1	52.7	6.0	116.00
	BR	9	46.7	53.4	6.0	117.57
	B1	5	47.0	53.4	6.1	118.01
	B2	5	46.6	52.5	6.3	117.54
	GU	8	45.2	52.5	6.1	116.22
	KA	9	46.9	52.1	6.1	115.52
	K1	5	45.9	52.2	5.9	115.00
	K2	9	44.4	52.8	6.0	116.22
	MA	10	45.5	53.1	6.0	116.95
	R1	4	42.2	53.9	6.1	116.99
	R2	8	46.2	53.1	6.1	117.15
	ST	9	47.2	53.9	6.1	118.76
	TC	8	44.7	52.6	6.0	115.78
	TR	8	45.7	53.0	6.0	116.89
	WA	12	47.5	52.8	6.0	116.53
	WI	9	44.9	52.7	6.1	116.72
	CO	54	45.4	53.4	6.0	117.46
Sire	PD 216	22	45.8	52.6	6.0	115.99
	PD 289	26	46.2	52.4	6.1	116.14
	PD 290	20	46.5	52.4	6.0	115.47
	Comp 160	28	46.5	53.3	6.1	117.43
	Comp 177	19	46.0	53.1	6.0	116.84
	Comp 454	20	44.2	53.5	6.1	117.73
	Tex 661	10	47.0	54.2	6.0	118.81
	Tex 689	12	45.1	53.9	6.1	118.37
	Tex 741	16	45.3	53.5	6.1	117.98
Gender	Female	87	45.4	53.0	6.0	116.88
	Male	103	45.9	53.1	6.1	117.10
Flock	Single	125	45.9	52.9	6.0	116.64
	Twin	54	45.3	53.4	6.0	117.55
	Triplet	3	47.3	54.1	6.0	118.42
Average		**192**	**45.8**	**53.1**	**6.0**	**116.98**

In addition the meat yield has been calculated using the values of $6.00 per kilogram for meat and $25.00 for loin. The results are summarised for flock of origin, sire of the lambs, and by gender and birth rank, with data adjusted to 27kg carcase weight. As raw data were not available, the results could not be subjected to statistical analysis, but it is clear that differences due to any effect were very small – for example the maximum difference due to ewe flock was 3.3%, to sire was 2.9%, to gender was 0.2% and to birth rank was 1.5%.

5.4 Success in achieving objectives

The objective was to compare the meat yield produced in lambs produced by ewes varying in genetic make-up and mated to three different breeds of terminal rams, each with different breeding values for eye muscle. This objective was only partially met. In this experiment, source of ewe and sire line both had effects on weaning weights (range of about 17%), but the ewe effect barely reached statistical significance as a result of smaller group sizes. Probably for the same reason, ewe effects did not significantly affect lifetime growth rates, but sire effects were profound, with up to a 32% difference. The Viascan results were disappointing, with no appreciable differences found between any of the categories analysed. The experiment also highlighted the relative importance of factors such as birth type and gender in determining performance.

A supplementary objective was to determine the effective of mothering score on subsequent lamb growth and survival. Although there were some trends evident in the expected directions, these were not significant for any of the traits studied.

6 Impact on Meat and Livestock Industry

This series of experiments demonstrated a number of factors affecting the ability of lambs to meet market specifications under pasture-based and grain-based finishing systems. Most of these factors are systematic and repeatable, but not all can be anticipated in advance without some prior knowledge. Effectively, the factors fall into four categories.

- First are the genetic factors, determined by the genotype of both the sire and the dam. This work has demonstrated the importance of both genetic pathways in determining performance, particularly growth. Fortunately, the breeding of animals need not be a mystery and LAMBPLAN provides breeding value information on a wide range of traits related to maternal and paternal performance.
- The second category are environmental and a consequence of management practices imposed relatively early in life. These can vary considerably from property to property, highlighted in this work by changes in relativities of groups of animals that occurred once they had all been allowed a period of adjustment to a common environment. Without some knowledge of the earlier management of animals sourced for finishing, this adds an element of unpredictability and therefore risk. Lamb finishers will encounter some sources of animals that perform well under their system and some that don't. Those producers that are successful will form alliances based on accumulated experience that will help remove this element of risk.
- The third category are those that are imposed on individual animals by virtue of their birth/rearing status and when they were born relative to the others in their cohort. Another effect in this category is the age of a lamb's dam, which was not a variable studied in this project. These effects can be profound and often persist well beyond weaning age. If the individual status of animals is known, appropriate management strategies can be adopted to improve predictability of performance. Pregnancy scanning can be used as a basis for differentially managing such effects, and some of the individual animal management systems under development in the Australian Sheep Industry CRC may also offer benefits. However, in the absence of systems for acquiring the relevant information and managing the consequences, this class of factors will simply add to the "noise" that contributes to performance differences.
- Finally, there are factors directly related to current management practices. Examples from this project include the actual finishing system adopted, back-grounding ration and dam nutrition

during pregnancy and lactation. A further example implied in this project and quantified in other research, is the effect of ewe nutrition on ovulation rate and foetal retention.

Collectively, these effects underpin much of the between-animal variability found in lamb supply chains. Leading lamb finishers have already recognised the importance of many of these factors and have developed strategies for reducing uncertainty and therefore risk. Information obtained from this project has aided in this process and will help guide future decisions as the lamb finishing industry matures.

7 Conclusions and Recommendations

7.1 Experiment 1

Experiment 1 showed the importance of allowing a period of adjustment before making comparisons between animals from different sources, and even then, early effects can persist. It is important that lamb finishers identify the best sources of feeder animals for their particular system, as this can have a major bearing on profitability. This is best gained from knowledge acquired through experience, as source effects are due to a combination of genetics and early management and this study showed that even between ewe groups of similar breeding, differences can still occur.

There was a difference of 18.3 days between best and worst performing group in the time taken to finish in the feedlot. This translates into a cost differential of at least $7.87 per head. On the lucerne treatment, the differences in feed finishing costs were probably of the order of $2.14 per head. These costs make it quite clear that the cost of finishing systems is a major issue for these heavy lambs. If feed-lotting is a requirement to ensure eating quality in particular branded lamb products, then management of the feedlot process needs to be improved. This is likely to involve better selection of lambs, improved management of the start of the process (both factors that our co-operator had little control in our experiment) as well as better diets and management in the feedlot itself.

Real differences were found between owners groups in terms of the carcasses produced. The difference in value of the wholesale carcass components amounted to 13.5%. About half this owner effect was due to differences in hot carcass weight. In other words, more precise drafting for slaughter (which may not be practically achievable) should have reduced the difference to $7.14.

7.2 Experiment 2

This experiment highlighted the importance of dam genetics in determining growth rates, with differences in growth rates of up to 39% during feedlot finishing. Consequently, it is critical that feedlot operators give careful consideration to the maternal line used to produce their lambs, as it can have a major bearing on feed costs and time to market. These determinants of profitability can equally be affected by sire genotype. Fortunately, many prime lamb sires are sold with breeding value information available for growth and carcase characteristics, and these should be used as a guide to progeny performance. Comparative growth rates and rate of maturity can both impact on feedlot performance, particularly when heavier weight ranges are targeted.

Restricting feed intake during backgrounding (prior to feedlot entry) was not shown to impact favourably on feed conversion efficiency. Such systems are also likely to impose additional costs as they are likely to have a higher labour requirement. Consequently, this work suggests that ad lib feeding is likely to be the most cost-effective and produce faster growth rates during backgrounding.

7.3 Experiment 3

This experiment showed that modest differences in the nutritional given to ewes during pregnancy and lactation can translate into a 6% difference in lamb growth to weaning. This is sufficient to determine the suitability of lambs for intensive finishing. The trial also highlighted the importance of ewe genetics: lambs with a Corriedale maternal grand-sire were 8% heavier at birth than lambs with a Merino maternal grand-sire; and lambs with a Border Leicester maternal grand-sire grew about 25% faster to weaning than lambs with a Finn maternal grand-sire. Thus for rapid finishing of lambs in feedlot situations, ewe nutrition must be adequate and the ewe's genetics can be critical.

7.4 Experiment 4

A clear relationship was found between ewe body weight at the time of artificial insemination and the number of foetuses scanned. It cannot be determined from this study the extent to which this relationship was caused by genetic differences, or the extent to which it ovulation rate can be affected by nutritional manipulation. However, in a recent review, Walker et al. (MS.009) described a differential nutrition strategy that potentially increases ovulation rate, reduce embryo mortality and increase implantation rates. Such a strategy would be particularly suited to situations where there is synchrony of ovulation, such as in an AI program.

Mothering score as assessed in this experiment was found to have a relatively weak association with lamb survival rates and subsequent lamb performance. However, work in another MLA project (SHGEN.025) has established that temperament is a heritable trait and a related project (AHW.085) is designed to specifically investigate the association between ewe temperament and neonatal lamb survival.

Experiment 5 showed that the heavier the lambs were at weaning, the higher their growth rate after weaning and the more likely they were to reach feedlot entry weight and follow a rapid growth path to slaughter weight. Lambs weaned at less than 25 kilograms at 13 weeks after the start of lambing had much lower weight gains than their heavier peers. In addition, a higher percentage of the heavier lambs did reach slaughter weight within an acceptable time. In most feeding systems it would not be profitable to carry the light lambs through to finishing weights.

Sire progeny groups varied appreciably in their growth rates. Sires that produce faster-growing progeny are best identified through their individual breeding values rather than the specific breed from which they are derived. Sires with high breeding value for growth will produce lambs that require a shorter finishing time, which is especially important for producers finishing lambs on pasture or crops when the quality of the feed can deteriorate rapidly. Relatively little is known about genetic variation in feed conversion efficiency and this is likely to be an important consideration in feeder systems. Some data on this are available from other MLA-supported projects and the results of analysis will be of considerable interest.

Although not demonstrated clearly here, carcase composition and meat yield have been shown in other research to vary, depending on the genetics of the dam and sires of the lambs. The influence of the higher-priced cuts, especially the loin on the value of the carcase is large. Purchasing terminal rams with high estimated breeding values for eye muscle area will lead to progeny with a higher proportion of high-value cuts, all other things being equal.

Finally, sire groups ranked differently when meat value was determined from the carcase weight rather than the liveweight of the lamb prior to slaughter. Therefore producers need to know the live weight of their lambs and the carcase weight at slaughter, in order to calculate the dressing percentage of the lambs produced from their flocks and from the diet they are being fed. Meat processors have an obligation to furnish this data to their clients to encourage them to produce a higher valued carcase for the benefit of both parties.

8 Bibliography

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