

DYNAMIC DAMS **for** **LAMB PRODUCTION:**

More \$\$\$s from Crossbred Ewes with the Right Genetics

N. Fogarty, V. Ingham, L. McLeod, J. Morgan & G. Gaunt



NSW DEPARTMENT OF
PRIMARY INDUSTRIES
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with the Right Genetics**

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Published by: NSW Department of Primary Industries
Orange Agricultural Institute
Orange NSW 2800 Australia

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The correct bibliographical reference for this document is:

Fogarty, N., Ingham, V., McLeod, L., Morgan, J. and Gaunt, G. 2005. *Dynamic dams for lamb production: more \$\$\$s from crossbred ewes with the right genetics*. Technical Bulletin 50, NSW Department of Primary Industries, Orange, Australia.

This publication is also available at:

[http:// www.agric.nsw.gov.au/reader/sheep-meat/dynamic-dams.html](http://www.agric.nsw.gov.au/reader/sheep-meat/dynamic-dams.html)

ISBN 0 7347 1631 1

ISSN 1039-2602

Publication Number 5591

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FOREWORD

The lamb revolution over the last decade or so is a remarkable success story of rural Australia. Lamb now has a greater profile and consumer appeal and farm productivity and profitability have been lifted to new highs. Genetic improvement and its supporting research have played an important role in the success of this revolution. However the uptake of genetic technology and improvement in the maternal breeding sector of the lamb industry was lagging behind other sectors. Productivity of the crossbred ewe flock has a major impact on the profitability of lamb enterprises and the task is to achieve greater genetic improvement among the commercial flocks of crossbred ewes. To address this concern, breeders and lamb producers together with the state Departments in NSW, Victoria and SA and Meat and Livestock Australia initiated a national maternal sire central progeny test (MCPT) in 1997. The objective of the MCPT was to evaluate the variation in first and second cross progeny performance of maternal and dual purpose (meat and wool) sires and the scope for genetic improvement in the sector.

The MCPT progeny tested 91 sires from many maternal breeds including Border Leicester, Coopworth, East Friesian and Finnsheep at 4 sites in south eastern Australia (Cowra, NSW, Hamilton and Rutherglen, Vic and Struan, SA). The major focus has been on evaluation of the lamb production of the 2,700 1stX ewe progeny and their 11,000 2ndX slaughter lambs. The survival and growth of the 1stX lambs and carcass performance of 1stX wethers were also evaluated in the first phase.

The results have clearly demonstrated the considerable genetic variation among maternal genetics that can be exploited to dramatically improve productivity and profitability of lamb enterprises. There was a range of over \$40 gross margin /ewe / year in the profitability of the 1stX daughters of the sires tested. This can mean more than \$20,000 higher annual profit for the average lamb producer. On an industry basis a modest increase of 5% in lamb carcass turnoff amongst the top 30% of production represents an annual increase of over \$18 million to producers.

This Technical Bulletin provides results and *Take home messages* from the combined analysis of the MCPT, along with implications for the various sectors of the lamb industry. By applying the results to ensure their ewe flocks comprise superior maternal genetics, lamb producers can obtain immediate benefits. Preliminary results have been published progressively over the years in the *Dynamic Dams Newsletter* and elsewhere that have been adapted and implemented by many breeders and producers. More detailed results are available in the papers listed in the publications (Appendix A4). Considerable change has occurred within the maternal breeding sector since the MCPT was initiated in 1997. The challenge is for more widespread adoption and for new industry structures and breeding alliances to be facilitated and developed to foster the uptake of genetic technology such as LAMBPLAN by the maternal breeding sector and by commercial producers to exploit these opportunities.

The MCPT has been a major project over 8 years with considerable dedication from the staff involved at each site and inputs from the NSW Department of Primary Industries, Department of Primary Industries Victoria and the South Australian Research and Development Institute. Meat and Livestock Australia provided substantial funding and support throughout the project. The Australian Sheep Industry Cooperative Research Centre also provided financial support to assist with the data analysis. The MCPT was made possible by those enthusiastic breeders with the long-term vision to enter rams and the commitment to genetic improvement of maternal genetics.

Dr Neal Fogarty
MCPT Project Leader
January 2005

SUMMARY

The Maternal sire Central Progeny Test (MCPT) has progeny tested 91 sires from many maternal breeds including Border Leicester, Coopworth, East Friesian and Finnsheep at 4 sites (Cowra, NSW, Hamilton and Rutherglen Vic and Struan, SA). Common sires were used to provide genetic links across the sites and years to enable combined analysis of the data. The major focus was on evaluation of the 1stX ewe progeny which were grown out and mated for 3 lambings and their 2ndX slaughter lambs. The survival and growth of the 1stX lambs and carcass performance of 1stX wethers were also evaluated in the first phase.. Performance of the 2,700 1stX ewes was assessed by their lamb turnoff rate, the growth and carcass merit of their 11,000 2ndX lambs and their wool production.

The results have clearly demonstrated the considerable genetic variation among maternal genetics that can be exploited to dramatically improve productivity and profitability of lamb enterprises. While there were some significant differences between the maternal sire breeds in performance of their progeny, the variation among individual sires within the breeds was far greater for most production traits. The range among the 18 Border Leicester sires tested was over \$40 gross margin / ewe / year in the profitability of their 1stX daughters. This means a \$20,000 higher annual profit for a 1000 ewe enterprise by having 1stX ewes sired by top rather than average maternal genetics.

Variation in lambing rate of the 1stX ewes was the major profit driver that contributed to the differences in gross margins. Over 80% of enterprise income was derived from lamb sales and less than 20% from wool. There were differences of up to 45% for lamb weaning rate between 1stX ewe progeny groups of sires within a breed. In addition there were significant differences in 2ndX lamb growth (up to 3.6 kg for post

weaning weight) and carcass fat (2.2 mm GR or almost half a fat score). These differences contributed to the gross margin through total weight of carcass turned off and varying proportions of the carcasses meeting market specifications. There were also large differences between breeds and sires within breeds for early age of puberty, milk production and weight and fibre diameter of wool from the 1stX ewes. Most breeds had at least some sires that had high performing 1stX daughters.

Taking account of the variation in feed requirements for the 1stX ewes and their 2ndX lambs, which affects carrying capacity, generally had little impact on the rankings of the maternal sires, with a couple of exceptions. The best sire groups of 1stX ewes varied to some extent at least with the production system. For example some groups of ewes with very high lambing rates performed relatively better in a spring rather than autumn joining system because of better lamb survival at a lambing time when weather conditions were more benign. The importance of carcass weight and fat levels also varies with the target market (domestic or export and saleyard or grid based selling). This emphasises the importance of breeders clearly identifying their production and marketing system and matching it with the most appropriate genetics.

Using LAMBPLAN EBVs to maternal sires results in higher performing crossbred ewes. The correlations between the maternal sire LAMBPLAN EBVs and the growth, carcass and wool production performance of their progeny in MCPT were positive and moderately high. The relative performance of the sires in the growth and carcass of their 1stX progeny was also consistently expressed in their 2ndX progeny. The relationships between LAMBPLAN EBVs of the maternal sires and 1stX ewe reproduction traits were positive although lower than for growth

and carcass traits. This reflects the smaller number of animals with recorded reproduction information in the LAMBPLAN data base compared to growth and carcass traits, resulting in lower accuracy of these EBVs. The more widespread recording of reproduction information on maternal breed animals should improve the accuracy of these reproduction EBVs.

Lamb producers can benefit immediately from applying the results of the MCPT project by ensuring that their ewe flocks comprise superior maternal genetics. This means breeding or purchasing crossbred ewes that are by rams with high LAMBPLAN EBVs for the traits that match the lamb enterprise and ensuring that they are bred from high performing base ewe flocks. The results show that an increase of \$20 gross margin/ewe/year can be achieved from 1stX ewes by top maternal sires compared to those by average sires.

1. INTRODUCTION

The lamb industry exploits crossbreeding with over 5 million crossbred (generally Merino 1st cross) ewes mated annually to terminal sire breed rams for production of second cross (2ndX) slaughter lambs. Considerable genetic improvement in growth and carcass traits has been achieved by breeders of terminal sires through the use of improved breeding programs and widespread adoption of LAMBPLAN. However, genetic improvement of the maternal breeding sector which produces the sires of 1stX ewes has lagged behind. The national maternal sire central progeny test program (MCPT) was initiated by breeders and lamb producers through Meat and Livestock Australia in 1997 to evaluate the variation in first and second cross progeny performance of maternal and dual purpose (meat and wool) sires and the scope for genetic improvement in the sector.

The MCPT progeny tested 91 maternal sires (Appendix A3) that were mated by AI to Merino ewes at 3 sites (Cowra NSW, Hamilton, Vic. and Struan SA) over 3 years. The sires were entered by seedstock breeders throughout Australia from several breeds. Common link sires were mated at each site in each year so that all 91 sires could be compared across sites and years.

The MCPT focussed on evaluating the performance of the 1stX ewes by the different sires as well as the growth and carcass performance of the 1stX and 2ndX progeny. The 1stX wether progeny were evaluated for growth and carcass performance and the 1stX ewe progeny were grown out and retained for breeding. The 1stX ewes were mated to high EBV terminal sire rams over 3 years to evaluate their lambing rate and wool production and the growth and carcass performance of their 2ndX lambs. (The 1stX ewes bred at Struan were evaluated at Rutherglen, Vic).

Over 3000 1stX wethers were slaughtered

and 2700 1stX ewes (approx. 20-30 per sire) were evaluated along with their 2ndX slaughter lambs (approx. 11,000). The 91 maternal sires that have been progeny tested across the various sites were from many breeds, although several had very few sires represented. The breeds with the most sires tested included: Border Leicester (18), East Friesian (12), Finnsheep (12), Coopworth (9), White Suffolk (7), Corriedale (6) and Booroola Leicester (6). Other breeds with fewer sires tested were combined for the analysis under "Other" and included: Hyfer, English Leicester, Gromark, Merino, Romney, Poll Dorset, Cheviot, SAMM, South Hampshire Down, Texel, White Dorper and Wiltshire Horn as well as a composite breed (Coronga).

Most of the sires have current LAMBPLAN EBVs. These sire EBVs cover a very large range within their breed for most traits. The MCPT sire average EBVs for yearling weight were generally 1.5 to 2 kg higher than the average for all animals of their breed, with the White Suffolk sires averaging 3.6 kg higher than the Terminal sire average. For most other traits the average EBVs for the MCPT sires were reasonably close to their breed means.

The results are from the overall analysis that used the link sires to compare the performance of all sires across sites and years. The results show differences between the average progeny of sires for the breeds adjusted to remove known environmental effects. While there are important and significant differences between the breed averages for the various traits it must be remembered that the differences between the individual sires within the breeds were large with overlap between the breeds. There were also only relatively small numbers of sires of each breed that were progeny tested.

The production systems for evaluation of the 1stX ewes varied with the sites to account for regional differences (Appendix A2). At Cowra the 1stX ewes were randomly split to

autumn and spring joining groups prior to their first mating. The autumn joined 1stXewes were mated in Feb/March to lamb in July/Aug and the spring joined groups were mated in Oct/Nov to lamb in March/April. At Hamilton the 1stX ewes were mated in autumn (March/Apr) to lamb in Aug/Sept and at Rutherglen the 1stX ewes were mated in late spring (Nov/Dec) to lamb in Apr/May. The ewes in each group were evaluated on the average annual performance from joinings in 3 years. The autumn joined ewes at Cowra and Hamilton were first mated at 7 months of age to lamb at 12 months of age, whereas the spring joined ewes at Cowra were first joined at 14 months of age and those at Rutherglen were first joined at 17 months of age.

The average annual autumn and spring performance cannot be directly compared as the 1stX ewes were joined for the first time at very different ages. Lambing performance increases dramatically with age and was

higher from the older spring joined ewes than the younger autumn joined in the first year. The differences between the seasons were reduced in later years when the relative difference in ages of the ewes was smaller.

This report contains the main findings of the project which are summarised in the following sections, with more details provided in the Appendix tables. The results show the considerable variation found for most measures of performance across the sire breeds and particularly among the individual sires tested. The results are presented for \$ gross margin performance of the 1stX ewe progeny of the maternal sires and the growth and carcass performance of the 1stX and 2ndX lambs. While only a limited number of sires from each breed have been tested the results provide seedstock breeders and lamb producers with a sound basis for decision making and genetic improvement in the maternal sector of the lamb industry.

ANALYSIS:

The analysis used mixed models procedures that took account of site, year and season differences as well as other known environmental effects (e.g. age, type of birth, carcass weight) as appropriate for the various traits. The breed and sire progeny means shown for liveweights are adjusted to average age and type of birth and rearing. The common link sires at each site and year allowed the analyses to compare all 91 sires used in MCPT with the sire progeny means for various traits shown in Appendix A1.

Sire breeds:

BL = Border Leicester (18 sires)

EF = East Friesian (12 sires)

Fi = Finnsheep (12 sires);

Cp = Coopworth (9 sires)

WS = White Suffolk (7 sires)

Cr = Corriedale (6 sires)

BoL = Booroola Leicester (6 sires)

Others = All other breeds combined (21 sires).

Figures: The mark (T) above each bar on the figure indicates the standard error of the mean. As a guide, for two means to be significantly different they need to differ by more than the sum of their standard errors.

2. \$ GROSS MARGIN PERFORMANCE OF CROSSBRED EWES

Take home messages

- Average \$ gross margin had a range of \$19/ewe/year among sire breeds of the 1stX ewes
- The range in average \$ gross margin among maternal sires was twice that between breeds with considerable overlap of the breeds eg. the 18 Border Leicester sires had a range of \$41/ewe/year (from \$67 to \$108) - this means \$20,000 higher annual profit for a 1000 ewe enterprise by having 1stX ewes sired by top rather than average sires
- Lamb turnoff rate was the major profit driver with lamb growth rate and carcass fat levels also contributing to the proportion of lambs meeting carcass specifications
- There was some variation in ranking of sire breeds (and sires) with the production system (autumn and spring joining) and environment

The income for lamb enterprises is made up of the sales of lambs, which include the value of the carcasses and skins, and the sale of wool produced by the ewe. The total value of the lamb carcass is determined by weight and price which varies with its market specification. The gross margin (GM) per ewe is the income from the lamb and wool sales and takes account of the costs of production and marketing (but does not include the cost of replacement ewes). Details of values are shown in the Gross Margin Box.

Overall the results showed a range in annual GM among the sire breeds of almost \$19 per ewe from \$81.22 for the Corriedale to \$100.03 for the East Friesian 1stX ewes (Fig. 2.1).

However there was a considerably greater range in annual gross margin among the sires within the breeds. For example, among the 18 Border Leicester sires there was a range of \$41 GM/ewe/year for the sire progeny means which ranged from \$67 for BL35 to \$108 for BL2. There was considerable overlap between the Border Leicester and East Friesian sires (Fig. 2.2) with means for all sires shown in Appendix A1.1. The range of

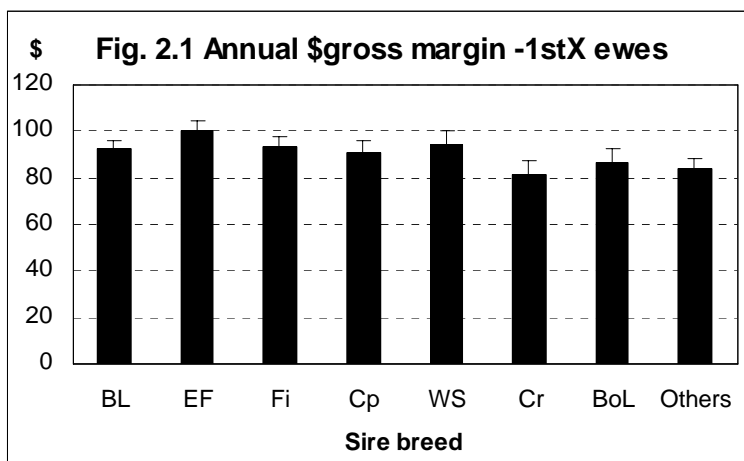
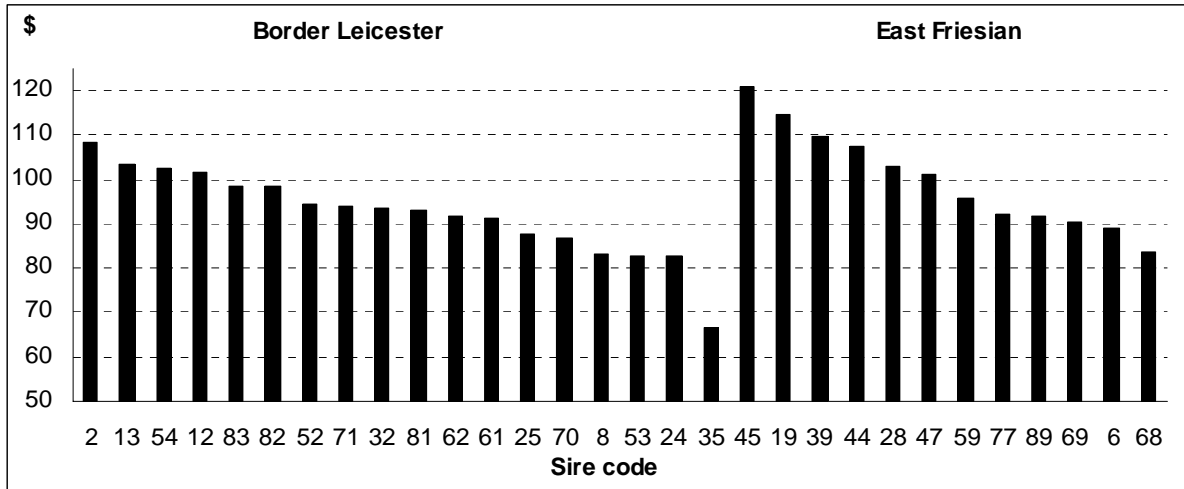
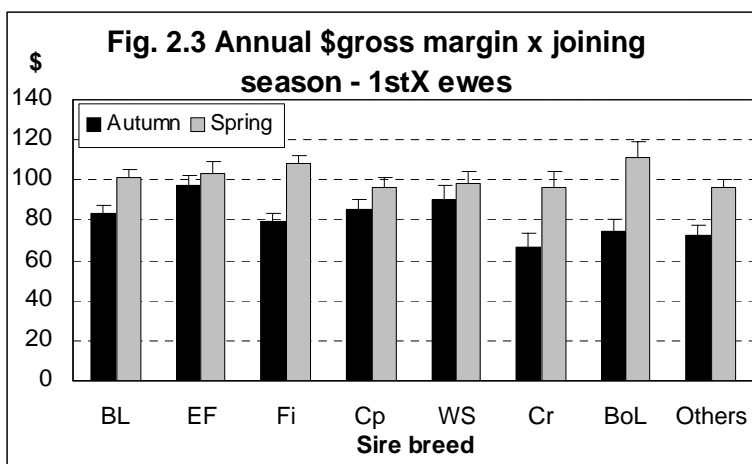


Fig. 2.2 Annual \$gross margin - 1stX ewes



about \$40 gross margin /ewe/year means a \$20,000 higher annual profit for a 1000 ewe enterprise by having 1stX ewes sired by top rather than average maternal genetics.

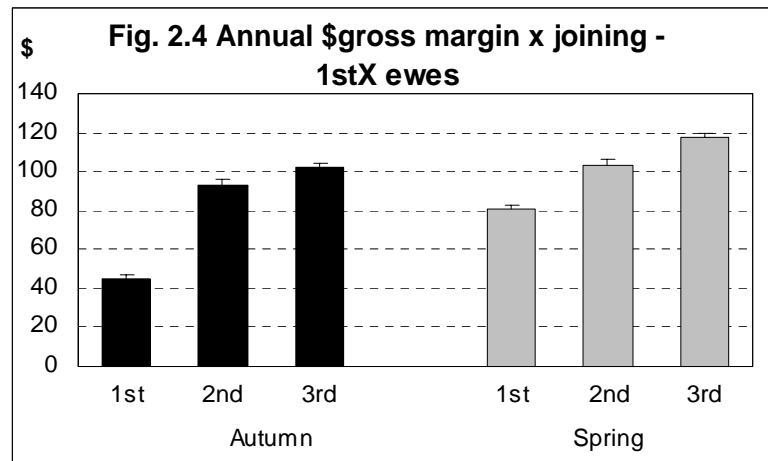
The lamb turnoff rate was the major driver for the \$GM with over 80% of income from lamb sales and less than 20% from ewe wool. While the number of lambs turned off (which is a combination of lambs born per ewe joined and lamb survival) was the major profit driver, lamb growth rate and fat level (which affect carcass weight and price) also affected profit. Lamb carcass price was determined by carcass weight and fat level which affected the proportion of lambs meeting the market specifications.



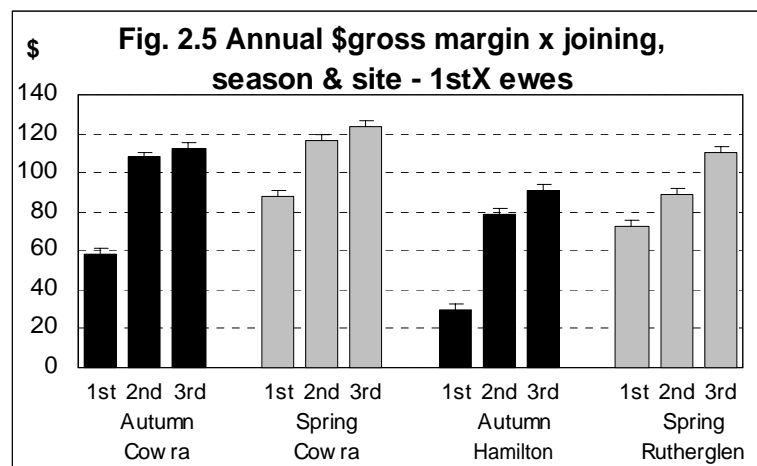
The ranking of the sire breeds (and some sires) also varied with the production system and environment in which their 1stX daughters were evaluated. In particular, the 1stX daughters of the Finnsheep and Booroola Leicester sires had a relatively higher ranking (compared to the other breeds) from the spring than the autumn joining (Fig. 2.3). This was largely because the 1stX ewes from both these sire breeds had high lambing rates with a high proportion of triplets and higher order

births. Lamb survival tended to be low for these from the autumn joining (lambing in late winter), whereas the spring joining, which is out of season, resulted in fewer higher order births and lambing occurred in autumn with better weather conditions and higher lamb survival.

As expected the annual \$GM/ewe increased with age of the 1stX ewes from their first to third joining. The \$GM almost doubled from the first autumn joining where the ewes were lambing at 12 months of age compared to the second autumn joining (Fig. 2.4). The differences between the autumn and spring joinings were due to both the season and age of ewe effects. These effects can't be separated in these results for the first and second joinings at least although the age effect would be expected to be small for the third joining.



There were differences in performance of the 1stX ewes at the various sites over the 3 joinings that are shown in Fig. 2.5. The low \$GM / ewe from the first joining at Hamilton was largely due to low lambing performance resulting from the joining at 7 months of age. These ewes did not grow out to sufficiently heavy weights prior to joining so that only a small proportion of ewes reached puberty and subsequently lambed. This highlights the importance of providing adequate ewe nutrition prior to joining.



There were also some differences between the sire breeds in their relative performance from autumn and spring joinings and the age of ewe effects. Although these effects were smaller than those noted above they did cause significant interactions

and may need to be considered when applying the results. The East Friesian sired 1stX ewes had higher performance than the other ewes at the first autumn joining indicating that a high proportion reached puberty at 7 months. The East Friesian 1stX ewes had relatively lower performance at spring than autumn joinings indicating poorer out of season breeding ability. The Finnsheep 1stX ewes had relatively higher performance at spring than autumn joinings because of less higher order multiple births and better lamb survival because of more benign weather at lambing as discussed above.

CALCULATION OF \$ GROSS MARGIN

The total income was calculated for each 1stX ewe in each of her first 3 years. The income from lambs was derived from the number of 2ndX lambs slaughtered and their carcass weight and fat score which determined the carcass and skin prices. The income from the 1stX ewe wool was derived from the individual measured clean fleece weight and fibre diameter from their first hogget shearing and individual greasy fleece weight and bin line fibre diameter for the second and third shearing. The prices used for income and costs for calculation of gross margins were as follows:

Prices

2ndX lamb carcass: \$3.35/kg for carcasses in specs (≥ 20 kg and fat score 2-4)

Discount grid for carcasses out of specs (\$/kg):

Wt / FS	1	2-3	4	5
<16 kg	-1.50	-1.50	-1.50	-1.50
16-19.9 kg	-0.75	-0.20	-0.50	-1.00
≥ 20 kg	-0.75	0	0	-0.50

Carcasses 16-19.9kg, fat score 2-4 were only given a small discount because they would normally be sold in the trade market or kept longer and sold at heavier weights.

2ndX lamb skins: <20.1 kg carcass weight \$11.00; 20.1-24 kg \$13.50; >24 kg \$14.00.

Carcass and skin prices are based on 5 year averages (2000-2004)

1stX ewe wool: Ten year average (1995-2004) wool prices for the various micron categories were used to calculate wool returns. The individual ewe wool return was multiplied by 0.9 to account for the lower price of the skirtings and oddments.

Costs

The average costs applied to individual ewes and lambs for management and marketing were:

1stX ewes: \$6.24 (shearing, crutching, health, wool freight) + 7.25% of wool \$ (tax, testing, selling costs);

2ndX lambs: \$3.72 (health, freight) + 4.5% of carcass and skin \$ (selling costs).

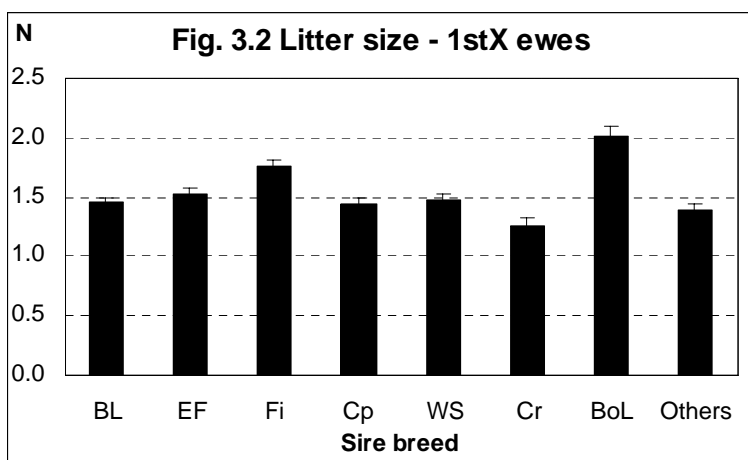
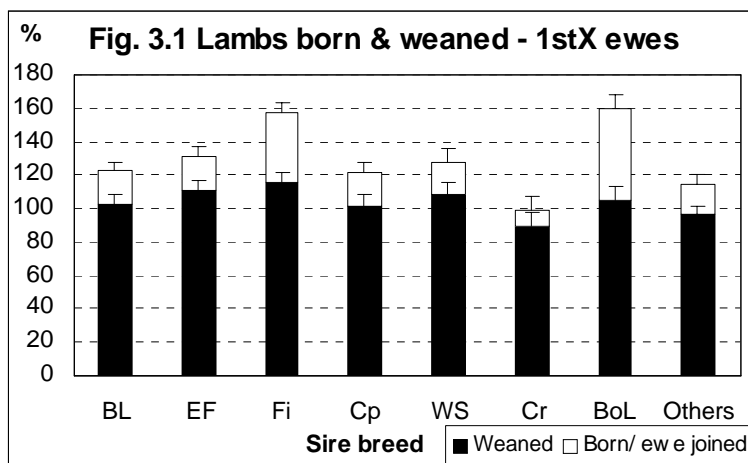
3. LAMBING PERFORMANCE OF CROSSBRED EWES

Take home messages

- There were large differences between the sire breed groups of the 1stX ewes for lambing rate (89 to 116% for lambs weaned and 99 to 160% for lambs born)
- Variation in lambing rate was considerably greater among individual sire1stX ewe groups within breeds eg. the 18 Border Leicester sires ranged from 94% to 140% for lambs born
- Lambing rate, including litter size and lamb survival, varied with season and environment, so that some breeds (and sires) changed rank in different production environments
- Those breeds with high lambing potential were more suited to spring joining where the out of season joining reduced the proportion of triplets and higher order births and lamb survival was enhanced by more benign weather conditions prevailing at lambing
- 1stX ewes from several sire groups successfully weaned over 90% of lambs when joined at 7 months of age in the autumn. While the ewes need to be well grown, it considerably reduces the cost of growing out replacement crossbred ewes.

The overall lamb weaning rate averaged over the first 3 joinings (lambs weaned of ewes joined) varied from 89% for the Corriedale 1stX ewes to 116% for the Finnsheep 1stX cross ewes (Fig. 3.1). There was an even greater range among the sire breeds for lambing rate at birth, from 99% for the Corriedale to 160% for the Booroola Leicester (Fig. 3.1). The difference between the lambs born and lambs weaned reflects lamb survival, which was considerably lower for the Booroola Leicester and Finnsheep than other 1stX cross ewes. These two groups had higher litter size (average number of lambs born per lambing ewe) than the other groups with a high proportion of triplet and higher order births (Fig. 3.2).

The variation in lambing performance among the sire groups of the 1stX ewes was considerably greater than that between the breeds. The range in average lambs weaned % among the 18 Border Leicester sires was 121% to 76% and for the 12 Finnsheep sires



was 133% to 92% (Fig. 3.3). The average lamb survival among the sire groups also showed considerable variation. The litter size, which largely reflects ovulation rate of the 1stX ewes, also showed considerable variation among individual sire groups (Fig. 3.4). Even though the average litter size for the Finnsheep sired ewes was high there was overlap between these and the Border Leicester sire groups. Progeny means for lambs weaned, lambs born and litter size for all sires are shown in Appendix A1.2.

Lambing rate increased with age (at joining) of the 1stX ewes and varied with environment. For lambs born and lambs weaned (of ewes joined) the lambing rate was low for the first

Fig. 3.3 Lambs born and weaned - 1stX ewes

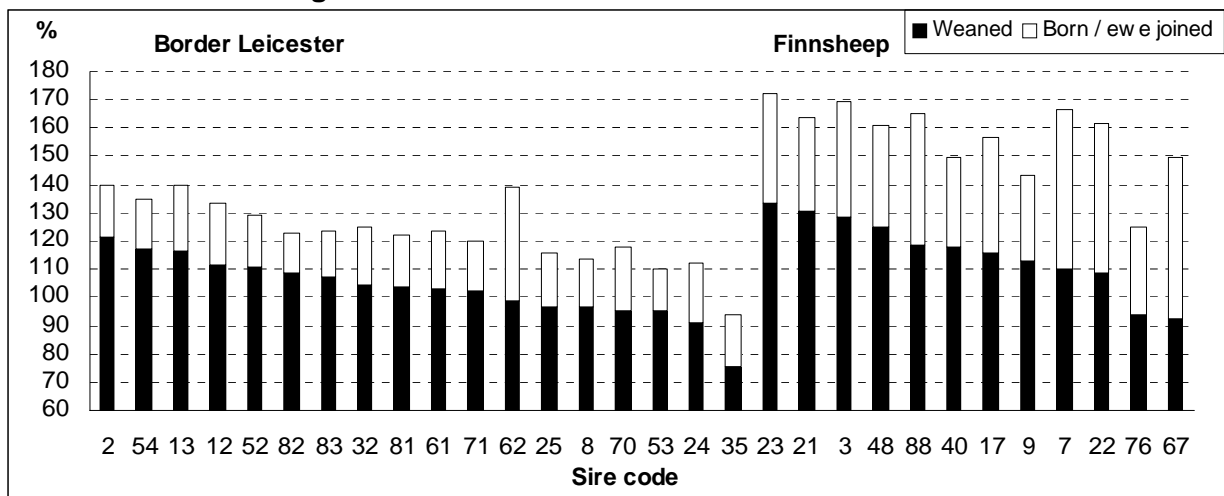
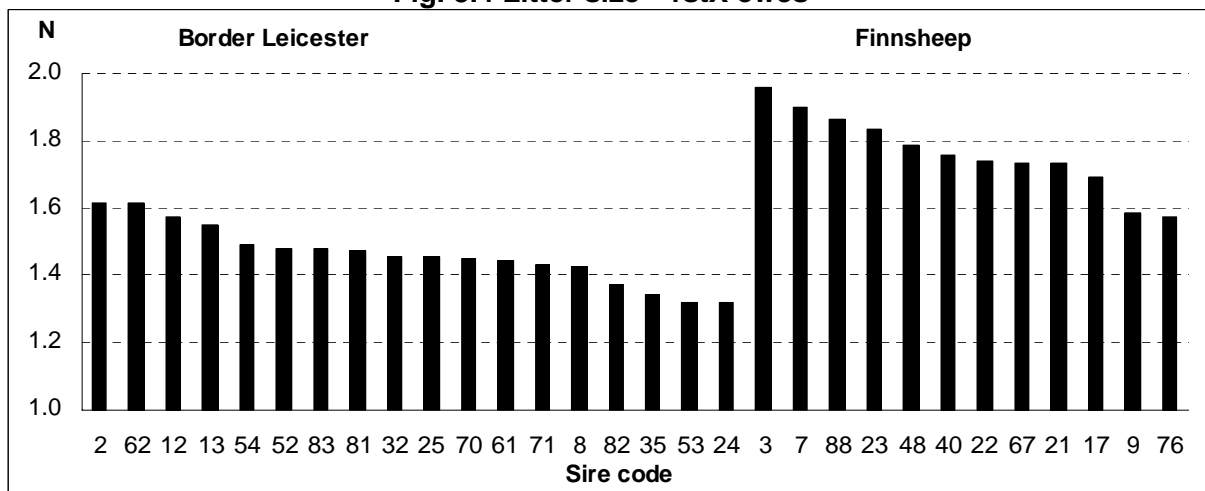
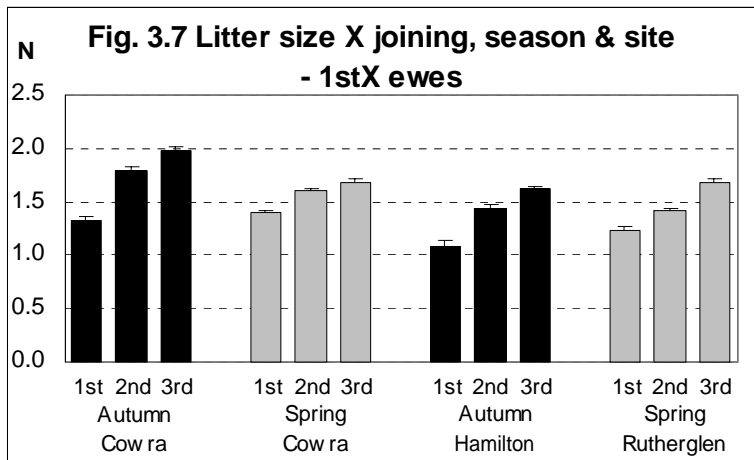
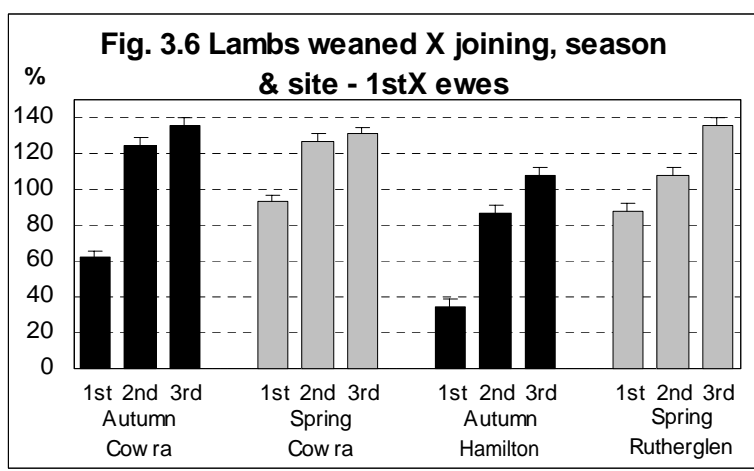
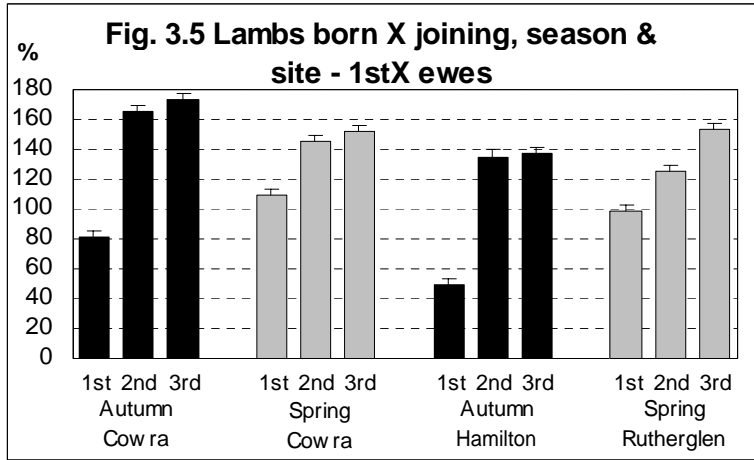


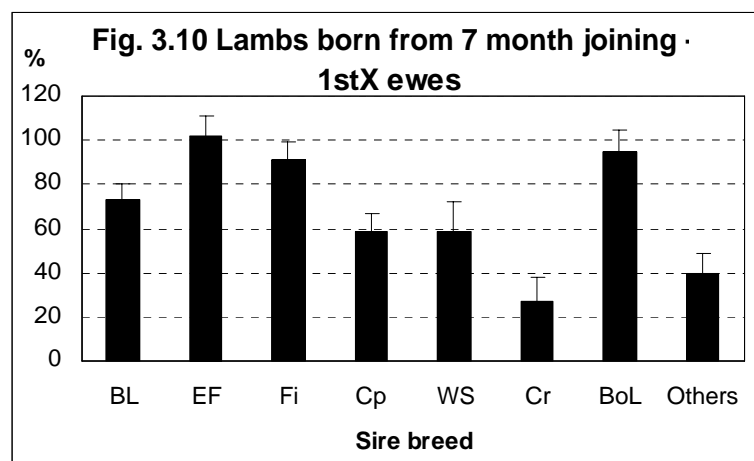
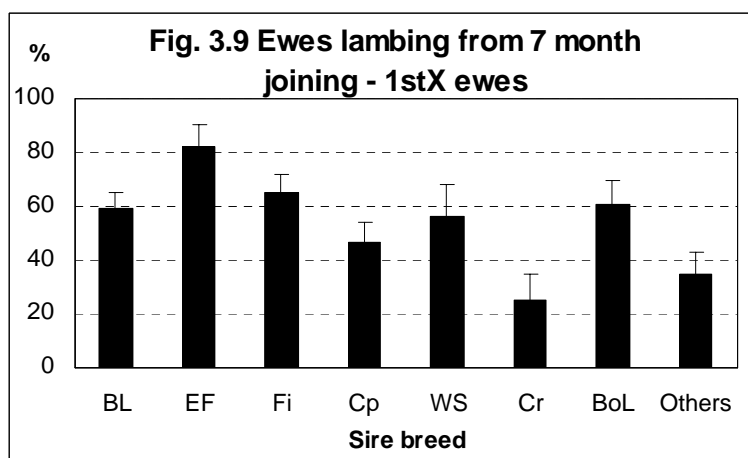
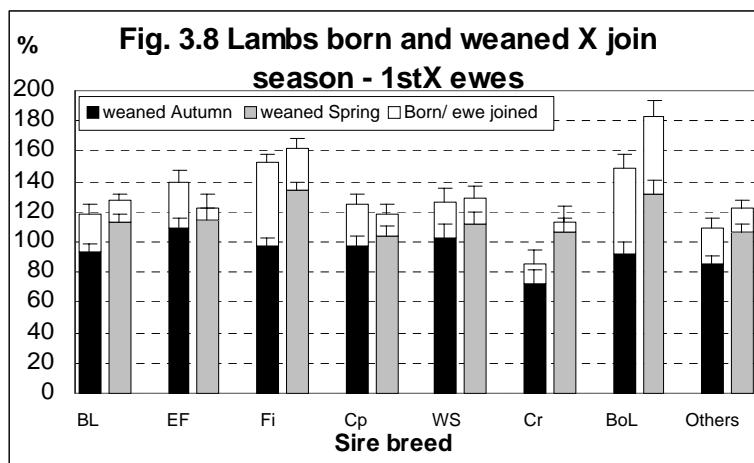
Fig. 3.4 Litter size - 1stX ewes



autumn joining at Cowra and Hamilton when ewes were joined at 7 months of age (Fig. 3.5) and (Fig. 3.6). This was because many of the young ewes had not reached puberty to successfully conceive and those that did get pregnant had fewer multiple births. For example of the ewes lambing at 1 year of age almost all had singles at Hamilton and only about 1/3 of the ewes had twins at Cowra, but the same ewes at Cowra averaged twins at 3 years of age (Fig. 3.7). For the 2 and 3 year old ewes at Cowra the autumn joined ewes had more lambs born than the spring joined ewes, mainly because of higher average litter size, but poorer lamb survival from the winter lambing resulted in little difference for lambs weaned per ewe joined. [Most breeds of sheep have a higher ovulation rate resulting in more multiples at birth if they are joined in the peak of the breeding season in autumn than if they are joined out of season in the spring.]

There were some differences between the sire breeds of the 1stX ewes in average lambing performance from the autumn and spring joinings (Fig. 3.8). In particular, the 1stX daughters of the Finnsheep and Booroola Leicester sires had a relatively higher lambing percentage (compared to the other breeds) from the spring than the autumn joinings. This was largely because the 1stX ewes from both these sire breeds had high lambing rates with a high proportion of triplets and higher order births. Lamb survival tended to be low for these from the autumn joining (lambing in late winter), whereas the spring joining, which is out of season, generally resulted in fewer higher order births and lambing occurred in autumn with better weather conditions and higher lamb survival.





The success of joining 1stX ewes at a young age (about 7 months) depends on them achieving puberty and starting to cycle and ovulate. The ewes need to reach a critical live weight (generally >40 kg) in the autumn breeding season. There were considerable differences between the breeds in the percentage of 1stX ewes lambing from the autumn joining at 7 months of age. These ranged from 25% for the Corriedale to 65% for the Finnsheep and 82% for the East Friesian sired 1stX ewes (Fig. 3.9) and resulted in 102% lambs born of ewes joined for the East Friesian 1stX ewes (Fig. 3.10). The Corriedale 1stX ewes were 5-6 kg lighter than all the other breed groups at joining and as a result few reached puberty in their first breeding season. The East Friesian 1stX ewes were only 1-2 kg heavier than the other ewe groups which were similar average weights (except for the Corriedale). The ewes at Cowra were 5-8 kg heavier at joining than those at Hamilton which resulted in a higher lambing rate at Cowra (82% v 50% lambs born of ewes joined, see Fig. 3.5). While on average the East Friesian and the Finnsheep 1stX ewes were more successful from the joining at 7 months than the other breeds there was considerable variation among individual sires from most of the breeds. For example at Cowra there were 6 sire groups of 1stX ewes that weaned more than 90% of lambs (of ewes joined) from their joining at 7 months of age (BL2, Fi3, BL12, Cp36, EF39 and BoL55). The cost of growing out replacement ewes is reduced dramatically when they successfully lamb in their first year. There was no detrimental effect on the ewes from lambing at 1 year of age as their subsequent lambing performance was generally significantly higher than ewes that did not lamb at 1 year of age.

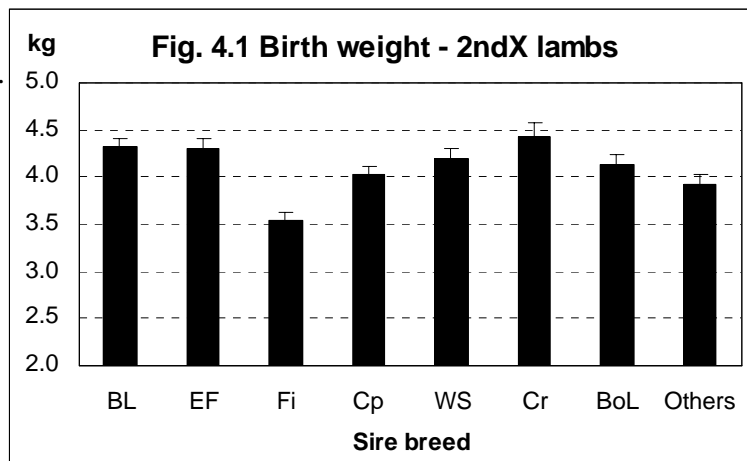
4. GROWTH OF 2ndX LAMBS

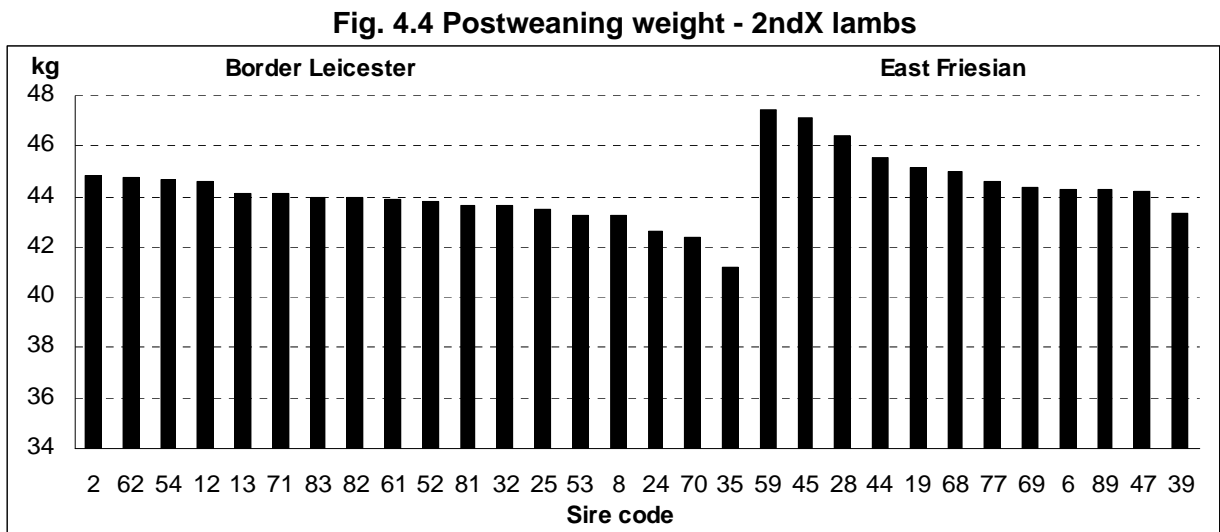
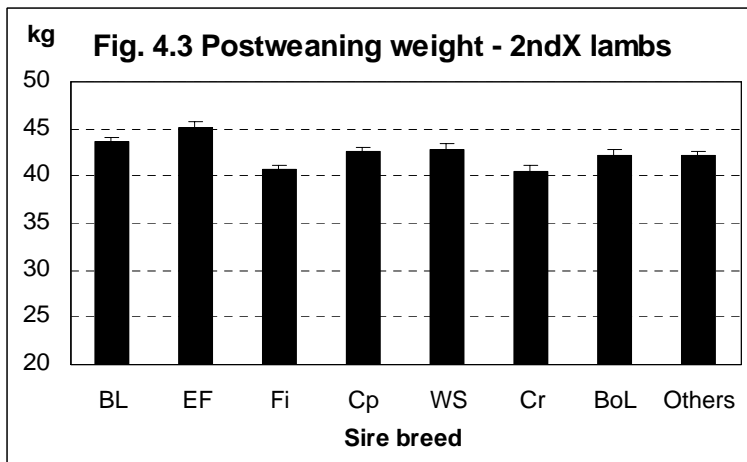
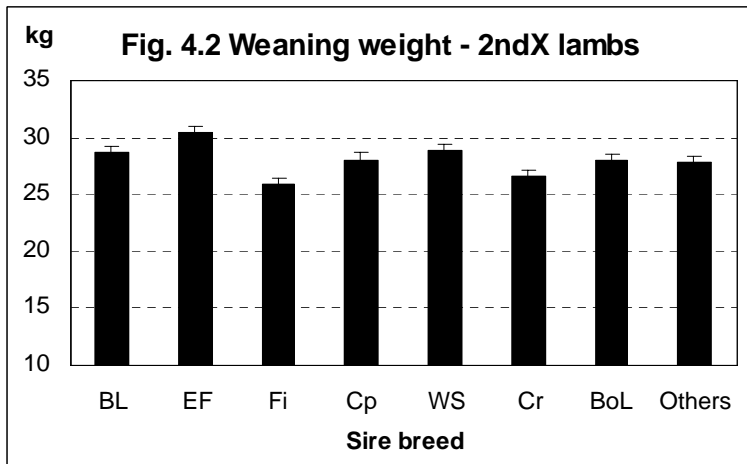
Take home messages

- There were differences between some maternal sire breeds for birth, weaning and post weaning weight (up to 4kg) of their 2ndX lambs
- There were large differences between progeny of individual maternal sires with an overlap between the maternal sire breeds

All the 1stX ewes at each site were joined to the same terminal sire rams to produce 2ndX lambs. Therefore the differences in growth of the 2ndX lambs presented here are due to a combination of the genes of the lambs that have been passed on from the sires of their mothers ($\frac{1}{4}$) and the maternal environment provided by the 1stX ewe mothers.

There were significant differences between the breed averages for birth weight (Fig. 4.1), weaning weight (Fig. 4.2) and post weaning weight (close to slaughter, Fig. 4.3) of the 2ndX lambs. The lambs from the Finnsheep 1stX ewes were about 0.5-0.8 kg lighter than all the other breed groups at birth. They were also significantly lighter, along with those from the Corriedale 1stX ewes, than most other groups at weaning and post weaning. They were about 4.5 kg lighter than the lambs from the East Friesian 1stX ewes, after adjustment for any differences in type of birth and rearing and age. There was also a large range among the progeny averages of the sires within the breeds with considerable overlap across the breeds. For example the 2ndX progeny averages for post weaning weight of the 18 Border Leicester maternal sires ranged from 41.2 to 44.8 kg whereas the range for the 12 East Friesian sires was from 43.4 to 47.5 kg (Fig. 4.4). Progeny means for all sires for birth, weaning and post weaning weight are shown in Appendix A1.3.





5. CARCASS OF 2ndX LAMBS

Take home messages

- There were differences between some maternal sire breeds for carcass weight of up to 2.6 kg and over half a fat score at the same carcass weight for their 2ndX lambs
- There were even greater differences in carcass weight and fat levels between progeny of individual maternal sires within breeds

The differences in growth rate between the breeds of sires of the 1stX ewes led to a range in 2ndX carcass weight across the breeds of 3.1 kg (Fig. 5.1) as there was little difference between the breeds in dressing %. While the 2ndX lambs from the East Friesian 1stX ewes were the heaviest (24.1kg) they were not significantly different from the Border Leicester (23.4 kg).

There was a large range in carcass fat levels among the sire breeds of 2.8 mm GR or more than ½ a fat score when compared at the same carcass weight (22.5 kg). The leanest carcasses were from progeny of the East Friesian 1stX ewes (13.0 mm GR) and the fattest from the Booroola Leicester 1stX ewes (15.8 mm GR) (Fig. 5.2). As with growth, there was considerable variation among the individual sire progeny groups for carcass fat levels. The 18 Border Leicester maternal sire groups ranged from 14.1 to 16.3 mm GR and the 12 East Friesian maternal sire groups ranged from 12.1 to 13.6 mm GR (Fig. 5.3). Even with the extreme differences between the averages of these two breeds the leanest Border Leicester maternal sire group was similar to the fattest East Friesian maternal sire group. Differences of half a fat score in carcass fat levels may have a significant impact on the proportion of 2ndX lambs meeting a market specification.

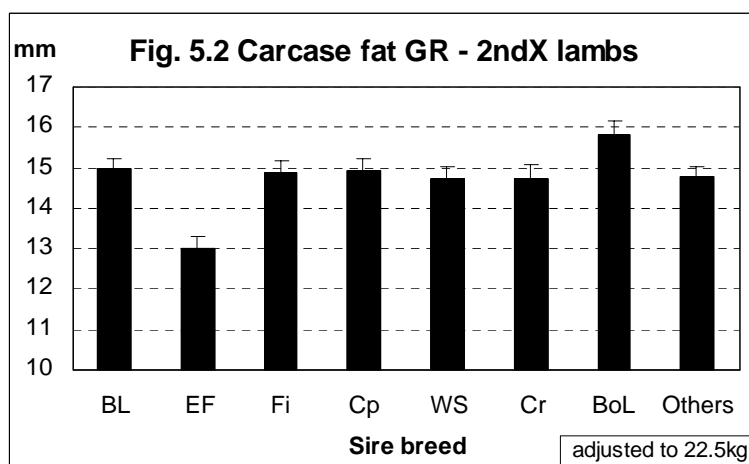
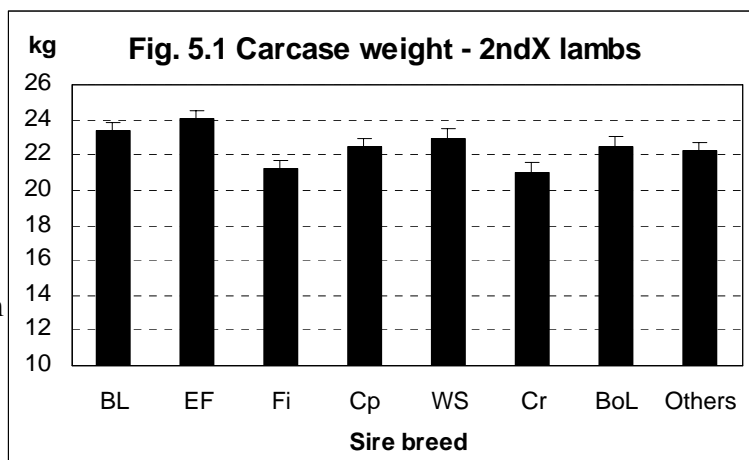
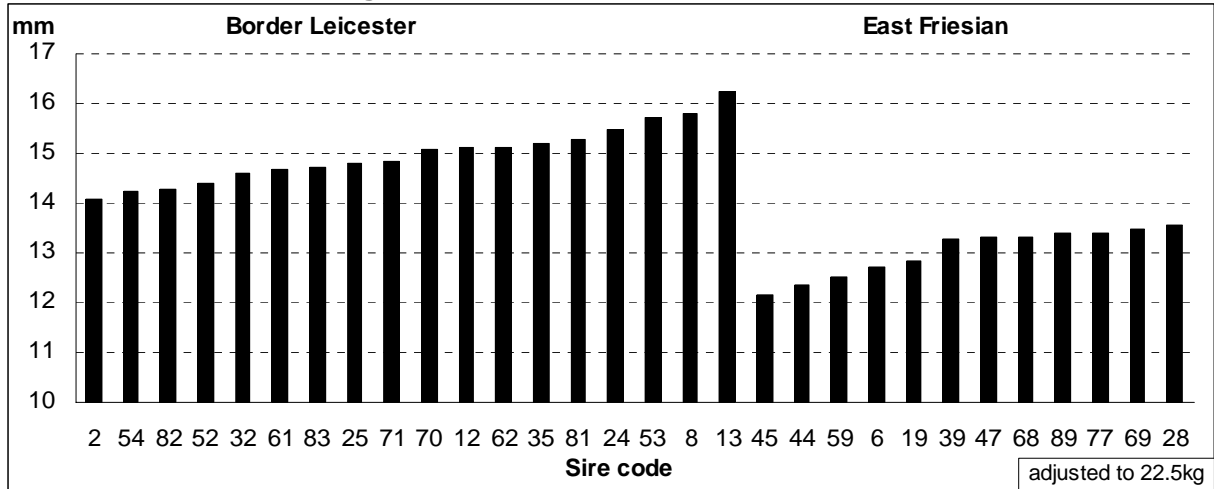
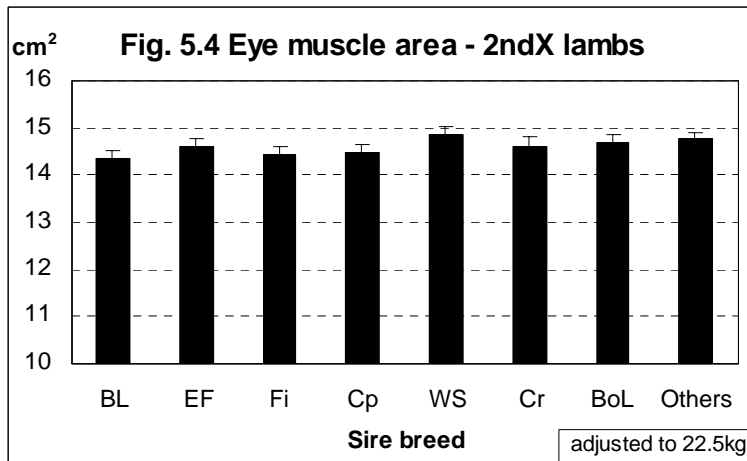


Fig. 5.3 Carcase fat GR - 2ndX lambs



There was a smaller range among the breeds for eye muscle area when the 2ndX carcasses were compared at the same weight (Fig. 5.4). There were some significant breed differences with the White Suffolk (14.9 cm²) having significantly larger eye muscle area than several of the other breeds of maternal sire. Progeny means for carcase fat and eye muscle area for all sires are shown in Appendix A1.3.



There were no significant differences between the breed averages for meat colour or meat pH, which are indicators of meat quality.

6. MILK PRODUCTION OF CROSSBRED EWES

Take home messages

- Ewe milk production of the young maiden 1stX ewes was 2.1 kg/d at peak lactation (21 days) and declined to 0.7 kg/d at lamb weaning (90 days)
- There were large variations in milk production between sire progeny groups of 1stX ewes (range of 522 g/d)
- Although there were limited numbers of sires tested of the various breeds, there were some significant breed differences
- Finnsheep 1stX ewes had lower peak milk yield and total lactation production with shorter persistence of lactation
- East Friesian 1stX ewes had greater persistence of lactation which also resulted in greater total lactation production
- Ewes suckling twins had greater peak milk yield than those suckling single lambs
- Breed and sire differences were generally small for milk composition (fat %, protein % and lactose %)

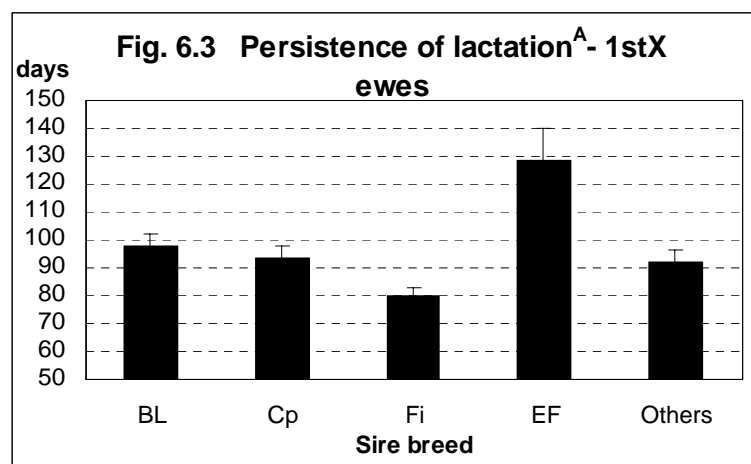
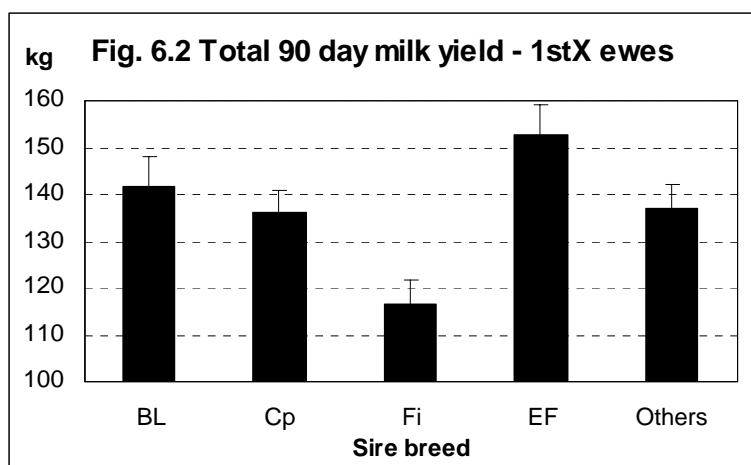
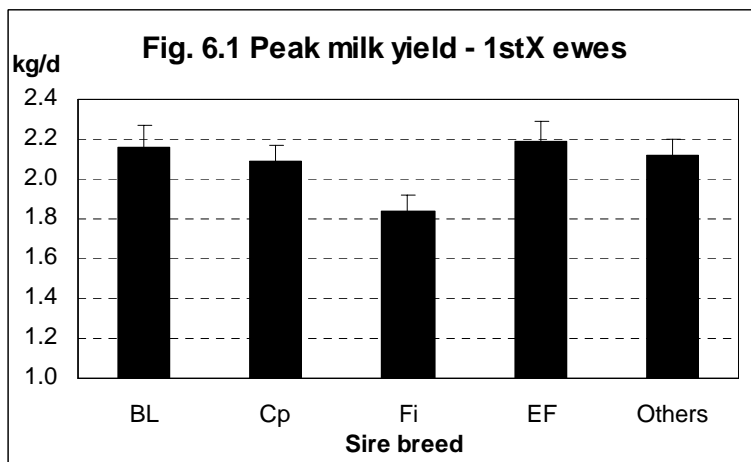
The milk production results presented here are from a detailed analysis of the data collected at Cowra. The milk production and milk composition of about half the 1stX ewes from all sire groups at Cowra (528 ewes) were measured on 3 occasions (about 3, 4 and 12 weeks) during their first lactation. Daily milk production was estimated using a standard 4 hour test, in which the ewes were milked out initially (by machine and hand stripping after injection with oxytocin to bring about milk let down) and milked again approximately 4 hours later. The milk from this latter milking was weighed, the time recorded and samples dispatched to a commercial laboratory for analysis of milk composition.

The 1stX ewes were the progeny of 30 maternal sires from the 1997, 1998 and 1999 drops at Cowra. There was an average of 15 daughters of each sire milked with an average of 45 daughters from the 3 link sires that

IMPORTANCE OF MILK PRODUCTION

Milk production of the dam is a major determinant of early lamb growth. Lambs are wholly dependent on milk for about the first 4 weeks, after which their rumen is sufficiently developed for them to begin to digest pasture. Lambs continue to benefit from a good milk supply long after they start eating pasture through enhanced growth rate and feed conversion efficiency and development of their capacity to increase pasture intake as they mature.

Ewe milk production reaches a peak at about 3-4 weeks and then steadily declines over the lactation. Lambs are generally weaned at 12-14 weeks as ewe milk production has usually declined to low levels. Sheep milking breeds have been selected for higher production and longer persistence of lactation than wool and meat breeds.



^ADays for milk yield to drop to 600g/day

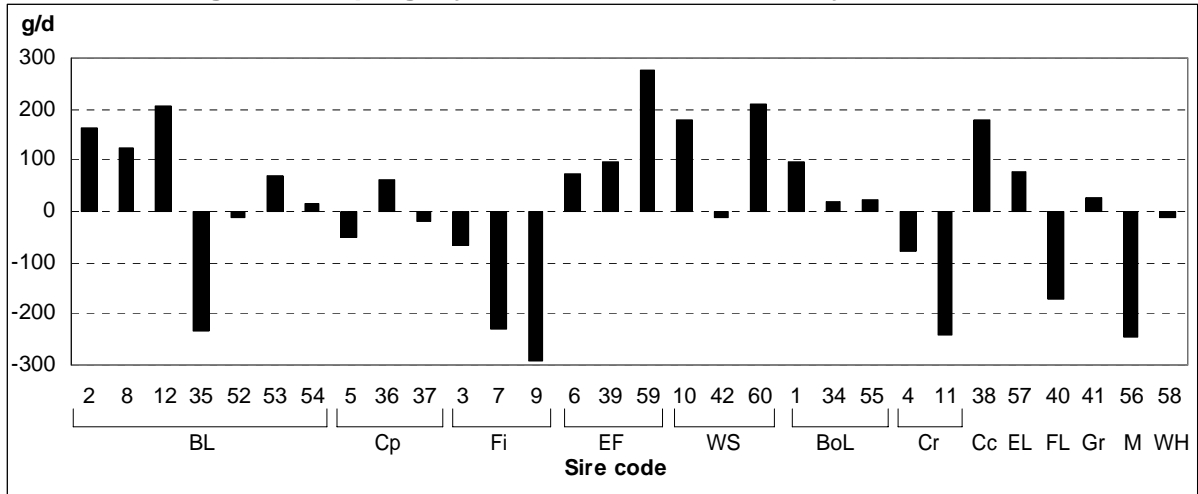
were represented in each drop. These ewes were joined in either the autumn or spring and lambed for the first time at 12 and 19 months of age respectively.

Average milk production from these maiden 1stX ewes was 2.1 kg/day at the peak of lactation (21 days) and declined to 0.7 kg/day at lamb weaning (90 days). There was a considerable range in milk production among the ewes and sire progeny groups as was the case with the other growth and reproduction traits. While there were a limited number of sires of each breed tested there were some significant breed differences in the milk production of their 1stX daughters. Fig. 6.1 shows the peak milk yield at 21 days from daughters of 7 Border Leicester sires, 3 sires each from the Coopworth, Finnsheep and East Friesian breeds and 14 sires from the various Other breeds tested.

Peak milk production from the Finnsheep 1stX ewes (1.8 kg/d) was lower than all the other breed crosses which ranged from 2.1 to 2.2 kg/d. The Finnsheep 1stX ewes also had the lowest total milk yield of 117 kg over the 90 day lactation, with the East Friesian 1stX ewes the highest at 153 kg (Fig. 6.2). The Border Leicester (142 kg) and Coopworth (136 kg) 1stX ewes were intermediate as was the average of the Other sire groups.

The higher total milk yield of the East Friesian 1stX ewes, despite their similar peak yield to most of the groups, was due to greater persistence of lactation. Their daily milk yield declined at a slower rate over the lactation and they were producing more milk at lamb weaning than the other groups. To illustrate this we defined milking persistence as the number of days for milk yield to

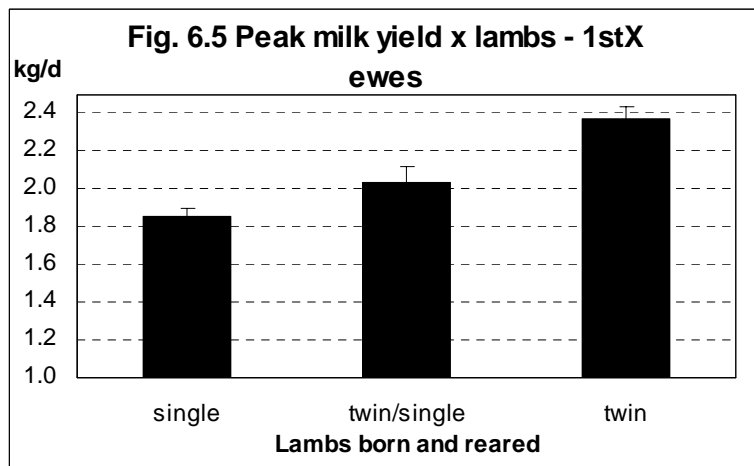
Fig. 6.4 Sire progeny mean deviations for milk yield - 1stX ewes

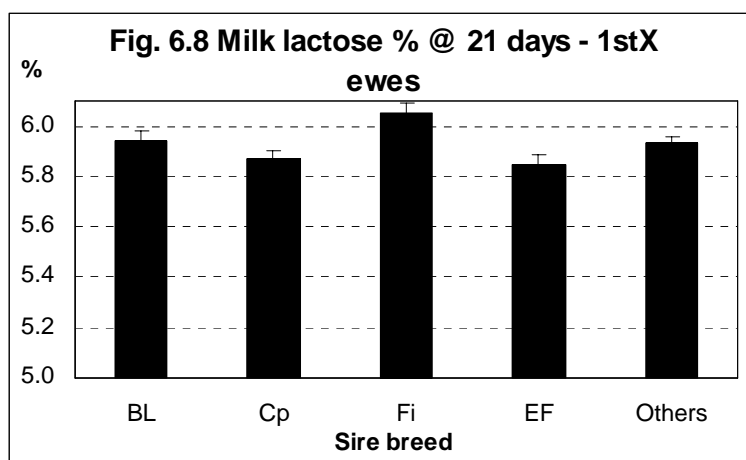
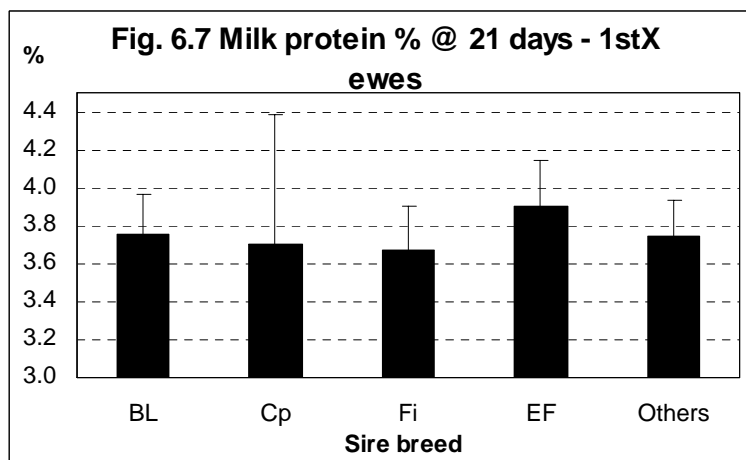
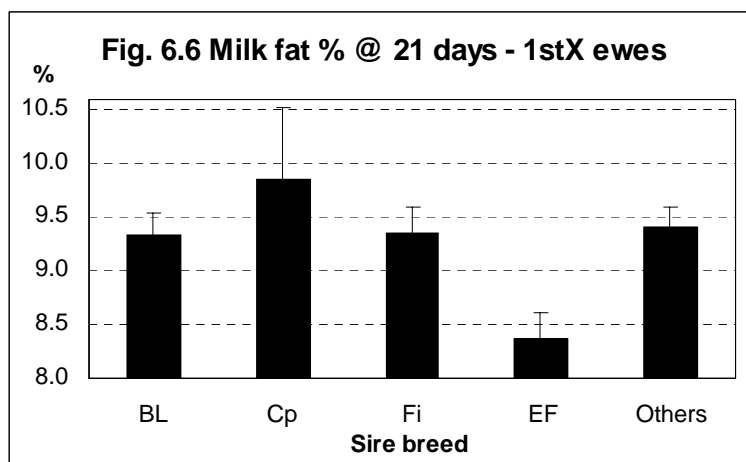


decline to 600 g/d. We used the 3 milking records on each ewe to predict persistence for each of the sire breed groups (Fig. 6.3). The East Friesian 1stX ewes had much greater persistence (129 days) than the Border Leicester (98 days) and Coopworth (94 days) and particularly the Finnsheep (80 days) 1stX ewes.

There was considerable variation among the sire groups within breeds for milk production. Fig. 6.4 shows the mean ewe progeny deviations for daily milk yield for the 30 maternal sires tested. These are similar to half the breeding values for the sires as they are based on actual 1stX progeny performance.

There was a difference in 1stX ewe milk production of 441 g/d for the 7 Border Leicester sires, which ranged from +208 g/d (BL12) to -233 g/d (BL35). There were also large differences among the 3 East Friesian sires although they were all positive (+276 to +75 g/day) and the 3 Finnsheep sires which were all negative (-68 to -292 g/d). There was a moderate range among the 3 Coopworth sires (+63 to -49 g/d), while the 3 White Suffolk sires had a large range from +210 to -12 g/d. The range among the other sires tested was large, from +179 g/d (Cc38) to -246 g/d (M56).





The number of lambs that a ewe bears and suckles as well as their genetic makeup affects milk production of the ewe. Ewes that bear and rear twins produce more milk than similar ewes that bear and rear singles because of greater mammary development during gestation and greater suckling stimulus during lactation. Lambs with greater genetic potential for growth also provide greater suckling stimulus to increase ewe milk production.

At Cowra (Fig. 6.5) the 1stX ewes bearing and rearing twins produced 0.5 kg/d more milk at peak lactation than the ewes bearing and rearing singles (2.4 v 1.9 kg/d). The peak milk production of ewes that lost one twin at lambing was intermediate (2.0 kg/d). These lamb effects were highly significant for peak lactation yield at 21 days, although they were less important by the end of lactation. The difference in persistence of milking for ewes with singles and twins was only 7 days (92 v 99 days respectively).

There were small changes in milk composition over the lactation. Fat % increased from 9.2% at 21 days to 10.3% at 90 days, during which there was a considerable reduction in milk yield. Over the same time protein % increased (3.8 v 5.4 %) and lactose % decreased (5.9 v 5.2 %) from 21 to 90 days respectively. Differences in milk composition between the breeds were generally small and not significant at 21 days (fat % Fig. 6.6, protein % Fig. 6.7, lactose % Fig. 6.8). The exceptions were low fat % for East Friesian sired ewes and high lactose for Finnsheep sired ewes. There was also a large range among the 3 Coopworth sires (see error bars) for fat % (range of 1.8%) and protein % (range of 0.3%), although they had only a small range in yield (see Fig. 6.4).

7. WOOL PRODUCTION OF CROSSBRED EWES

Take home messages

- There were significant differences between the 1stX ewe sire breeds for wool weight and mean fibre diameter
- The Coopworth, Corriedale and Border Leicester sire breeds had the highest fleece weights, with overlap between the sire groups across the breeds
- Fleeces from the Corriedale and Finnsheep 1stX ewes were 3-4 microns finer in average fibre diameter than the other breed groups

There were large differences between the breed averages for wool production (Fig. 7.1) and fibre diameter (Fig. 7.3) for the 1stX ewes at their hogget shearing. The Coopworth cross ewes had the highest average clean (and greasy) fleece weight (3.6 kg), with the Corriedale (3.5 kg) and Border Leicester (3.3 kg) 1stX ewes also relatively high, while the Finnsheep (2.8 kg) and White Suffolk (2.4) 1stX ewes were low. There were significant differences between the breeds for yield ranging from 77% for the Coopworth and Border Leicester to 72% for the White Suffolk cross ewes. There were moderate ranges in clean fleece weight among the 1stX ewe sire groups within the breeds, with overlap occurring between the Border Leicester, Coopworth and Corriedale sire groups (Fig. 7.2).

Average fibre diameter ranged from 24.5 microns for the Corriedale and 24.9 microns for the Finnsheep to 28.9 microns for the Coopworth and 29.1 microns for the Border Leicester 1stX ewes (Fig. 7.3). There were also moderate ranges among the sire progeny groups within the breeds, with overlap between the Border Leicester and Coopworth sired 1stX

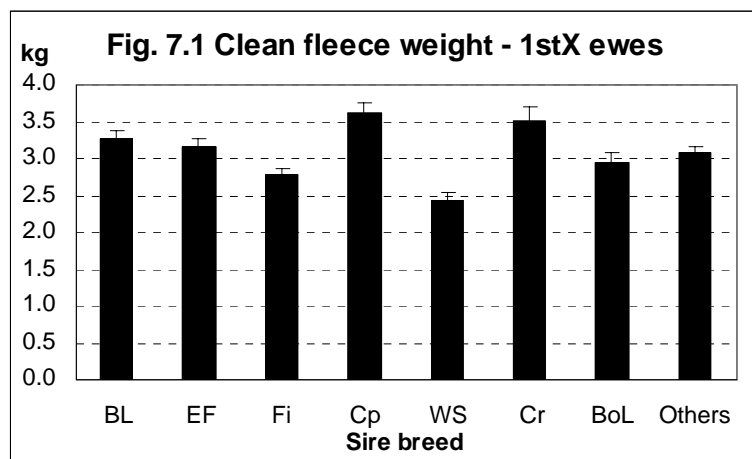
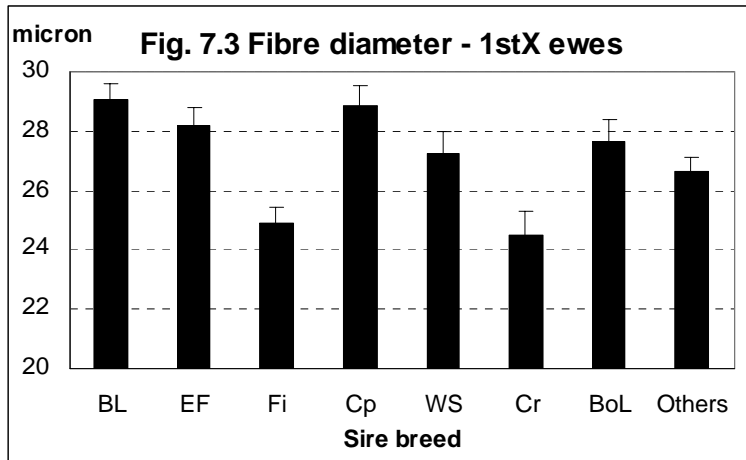
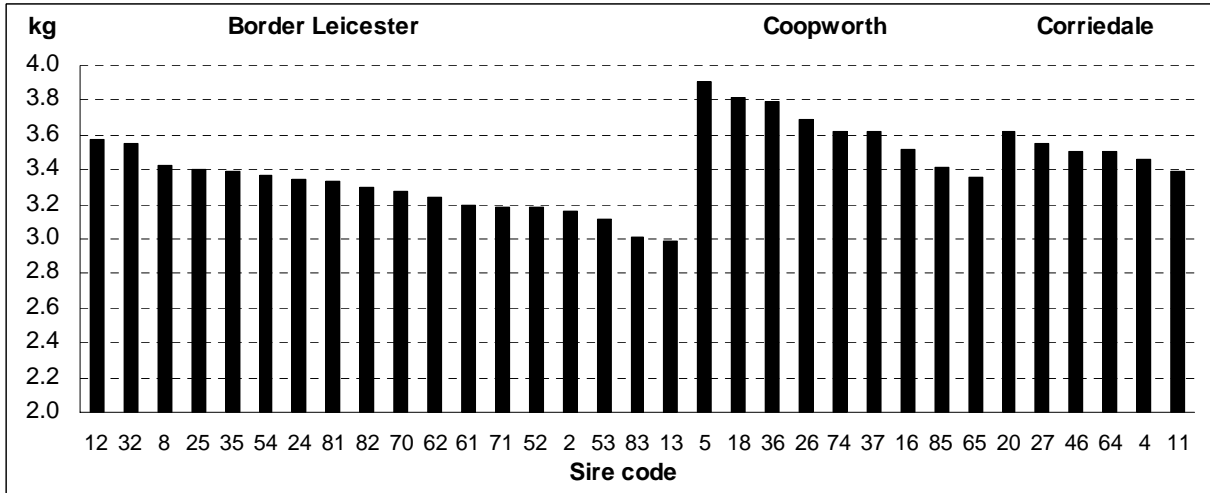
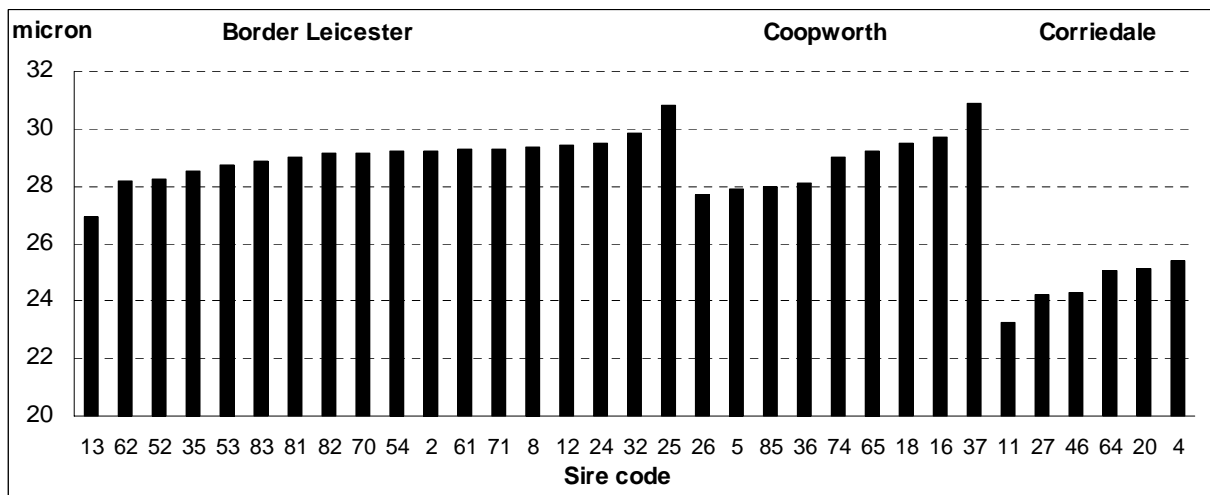


Fig. 7.2 Clean fleece weight - 1stX ewes



ewe groups (Fig 7.4). The Corriedale 1stX ewe sire groups ranged from 23.2 to 25.4 microns with all groups considerably finer than all the Border Leicester and Coopworth sire groups. Progeny means for hogget clean fleece weight and average fibre diameter for all sires are shown in Appendix A1.4.

Fig. 7.4 Fibre diameter - 1stX ewes

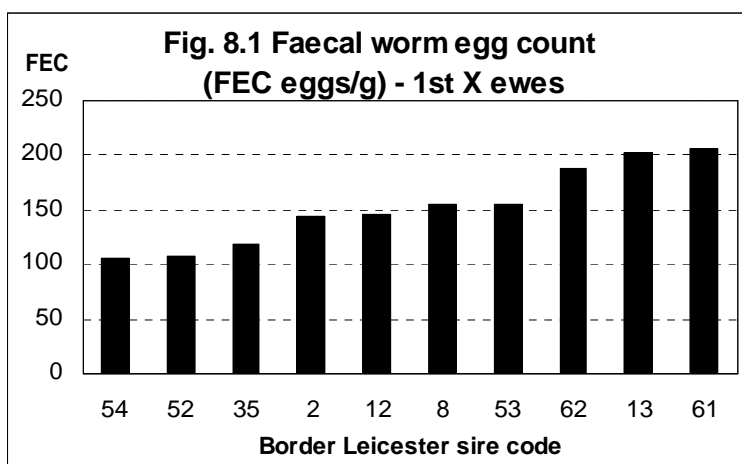


8. WORM RESISTANCE OF CROSSBRED EWES

Take home messages

- There were no breed differences in FEC for 1stX ewes, but the large differences among individual sire groups indicates selection for low FEC could improve the resistance to worms in crossbred ewe flocks

There were no significant breed differences for resistance to worms among the 1stX ewe lambs that were sampled for faecal worm egg count (FEC) in their first year. There were however large differences between individual sire groups of 1stX ewes with the range being almost two fold among the Border Leicester sire groups (Fig. 8.1). This indicates selection among individual sires for FEC could improve resistance to worms. Progeny means for all sires with FEC records are shown in Appendix A1.4.



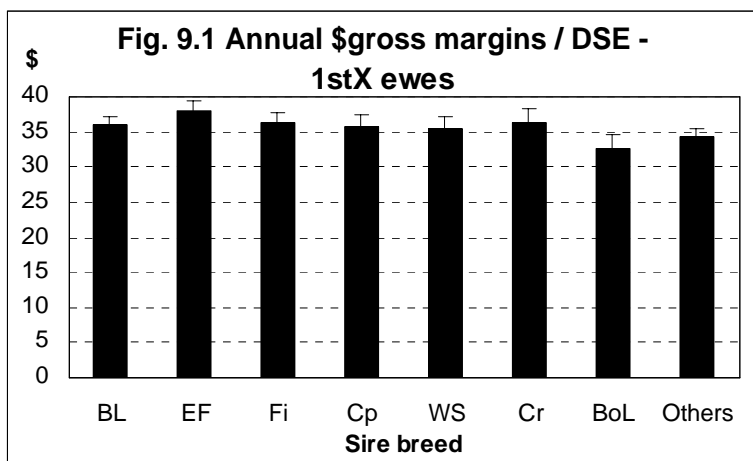
9. \$ GROSS MARGIN PER DSE: ACCOUNTING FOR VARYING FEED REQUIREMENTS

Take home messages

- Taking account of differences in feed requirements to express performance in terms of \$GM/DSE had little effect on the relative merit of the sire groups of 1stX ewes, with a few exceptions
- The feed requirements for ewe maintenance averaged about 60%, gestation, lactation and lamb growth to weaning about 22% and lamb growth from weaning to slaughter about 18% of the total annual requirements

The results presented in section 2 are the annual \$ gross margins on a per ewe basis. Another consideration is the feed requirements of the ewe and her lambs during lactation and subsequent lamb growth to slaughter, which may affect stocking rate. Heavier ewes with higher lambing percentage and faster growing lambs to higher slaughter weight will have greater feed requirements. To examine the effect of this the total annual feed requirements for the individual ewes and their lambs were estimated from their actual performance over the various years and put on a dry sheep equivalent (DSE) basis and expressed as *\$ gross margin per DSE per year*.

There needs to be some care in interpretation of these DSE values as the implicit assumption is that the feed required for all the phases of the production cycle and in the various seasons costs the same. In the real farm situation this is obviously not true. For example firstly the cost of high quality feed for lactating ewes or weaned lambs will generally be higher than that required for maintenance of dry ewes. Secondly the feed required for lambing at the start of the spring flush effectively costs a lot less than the same feed required for lambing in winter or before the autumn break.



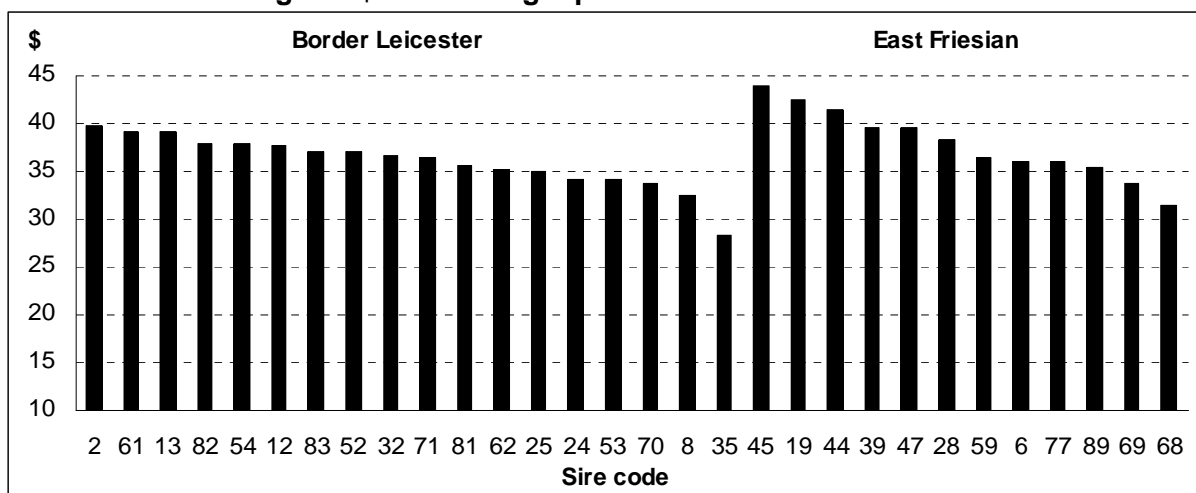
The average total annual feed requirement for the ewe and her lamb(s) grown out to slaughter was 2.2 DSE with a range of 1.5 to 2.7 DSE among the 1stX ewe sire groups. The feed requirements for ewe maintenance throughout the year averaged about 60%, gestation, lactation and lamb growth to weaning about 22% and lamb growth from weaning to slaughter about 18% of the total annual requirements. There was a range of about 10 kg in the average live weight among the contemporary 1stX ewe sire groups.

The range among the average of the sire breed groups in annual \$GM/DSE was \$5.28, ranging from \$32.62 for the Booroola Leicester to \$37.90 for the East Friesian sire breed (Fig. 9.1). However there was a considerably greater range among the sires within the breeds. For example, among the 18 Border Leicester sires there was a range of over \$11 GM/DSE/year for the sire progeny means which ranged from \$28.32 for BL35 to \$39.77 for BL2. There was considerable overlap between the Border Leicester and East Friesian sires (Fig. 9.2, with means for all sires shown in Appendix A1.1). The 1stX ewes with the highest average annual \$GM/DSE (\$44.03) were by the East Friesian sire EF45. Generally there were only small changes in the relative performance and rankings of the 1stX ewe sire groups when they were compared on a

\$GM/DSE basis rather than \$GM/ewe (compare Fig. 2.1 and Fig. 9.1). The exceptions were the Corriedale breed which improved relative to the other breeds and the Merino M56 sire which improved its relative position considerably on the \$GM/DSE basis, although it was still lower than many other sire groups. The M56 1stX ewes were 8-10 kg lighter than the average of other groups, which meant they had lower feed requirements for maintenance throughout the year. Although the M56 ewes had lower lambing % than most other groups, the lambs were mostly singles and had good lamb survival all of which contributed to a low feed requirement of less than 2.2 DSE. The M56 ewes had fewer lambs slaughtered at a lighter carcass weight and were lean, with most meeting the minimum carcass specification. This meant that the total \$ lamb income was lower, although the average wool income was considerably higher than many other groups. These results emphasise the need for producers to carefully consider their production system and select the ewes with the best genetics for their lamb enterprise.

There was little change to the pattern of the effects for season, environment and joining age when DSE was taken into account compared with that described in section 2 for \$GM/ewe.

Fig. 9.2 \$Gross margin per DSE - 1stX ewes

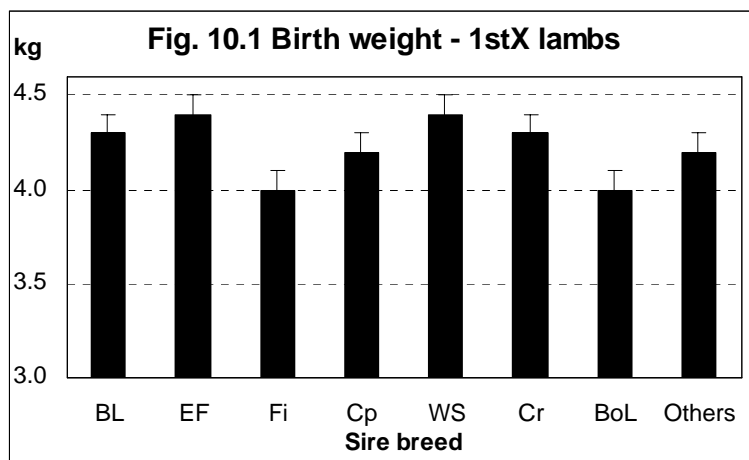


10. GROWTH OF 1stX LAMBS

Take home messages

- There were significant maternal sire breed differences of up to 7 kg for postweaning weight of their 1stX progeny
- There were also considerable variation among sires within breeds with overlap between most sire breeds

There were significant differences between the breed averages for birth weight (Fig. 10.1), weaning weight (Fig. 10.2) and post weaning weight (Fig. 10.3) of the 1stX ewe and wether progeny. The White Suffolk and East Friesian cross lambs were heaviest at all ages, while the Finnsheep and Booroola Leicester cross were lightest at birth and weaning together with the Corriedale cross at weaning and post weaning. The range from the lightest (Corriedale 32.8 kg) to heaviest (White Suffolk 39.0 kg) at post weaning (adjusted for type of birth and rearing and age) was over 7 kg. There was also a large range among the progeny averages of the sires within the breeds with considerable overlap across the breeds. For example the progeny averages for post weaning weight of the 12 East Friesian sires ranged from 36.2 to 42.2 kg whereas the range for the 18 Border Leicester sires was from 36.0 to 39.5 kg (Fig. 10.4). Progeny means for birth, weaning and post weaning weight for all sires are shown in Appendix A1.5.



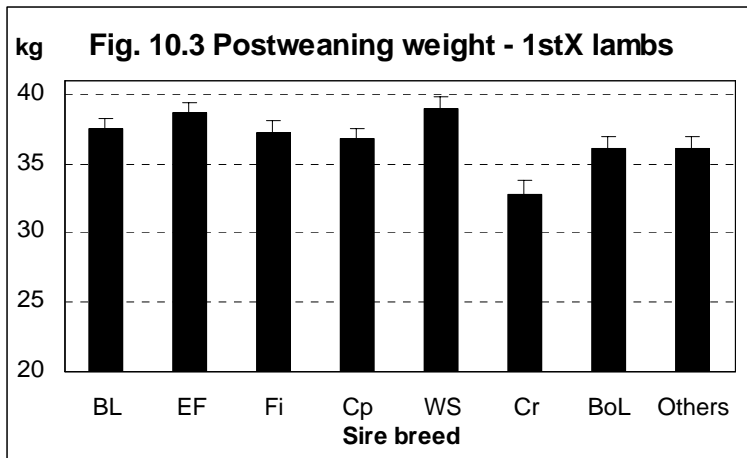
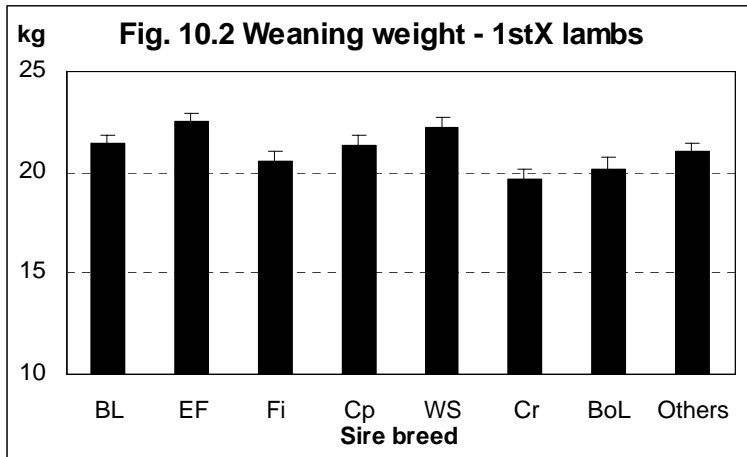
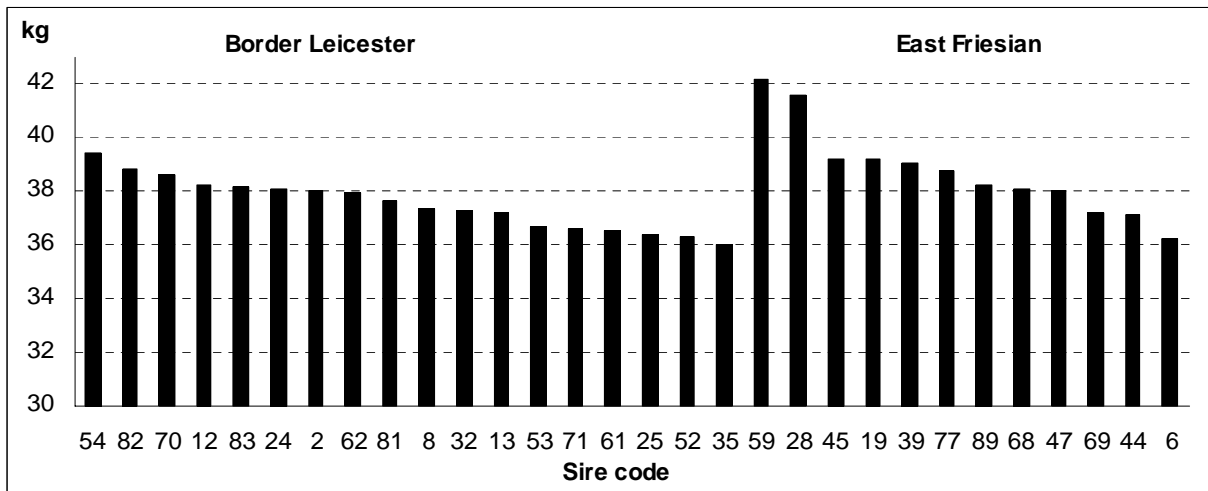


Fig. 10.4 Postweaning weight - 1stX lambs



11. CARCASS OF 1stX LAMBS

The differences in growth rate between the breeds led to a range in carcass weight of 3.7 kg across the breeds after adjusting for differences in type of birth and rearing and age at slaughter (Fig. 11.1). While the carcasses of White Suffolk 1stX wethers were the heaviest (22.6 kg) they were not significantly different from the Border Leicester (22.3 kg) or East Friesian (21.9 kg) carcasses. Dressing yield increased with higher carcass weight (about 0.4 %/kg), but there were no significant differences between the breeds when they were compared at the same carcass weight (22kg).

There was a very large range in carcass fat levels (6.1 mm GR or more than one fat score) between the breed averages (Fig. 11.2) when compared at the same weight (22 kg). The East Friesian carcasses were very lean (11.1 mm GR), with the Corriedale also being relatively low (13.3 mm GR), while the Booroola Leicester was the highest (17.2 mm GR) and the Border Leicester high (15.4 mm GR). As with growth, there was considerable variation among the individual sire progeny groups for carcass fat levels. The 12 East Friesian sires ranged from 9.7 to 13.5 mm GR and the 18 Border Leicester sires ranged from 13.1 to 17.5 mm GR (Fig. 11.3) which is almost 1 fat score range within each of the breeds. This can have a dramatic impact on meeting carcass specifications for weight and fat. Even with the extreme differences between the averages of these two breeds there was an overlap between the individual sire groups. For the 1stX wether carcasses the leanest Border Leicester sire group was leaner than the fattest East Friesian sire group.

Take home messages

- Differences in growth rate led to a range of 3.7 kg in carcass weight between the sire breeds of 1stX wethers at the same age
- The East Friesian 1stX wether carcasses were extremely lean, almost 1 fat score leaner than most other breeds
- There was a range of almost 1 fat score among sires within the breeds which can dramatically affect the proportion of carcasses meeting particular market specifications
- Variation for carcass eye muscle area was much less than for fat levels

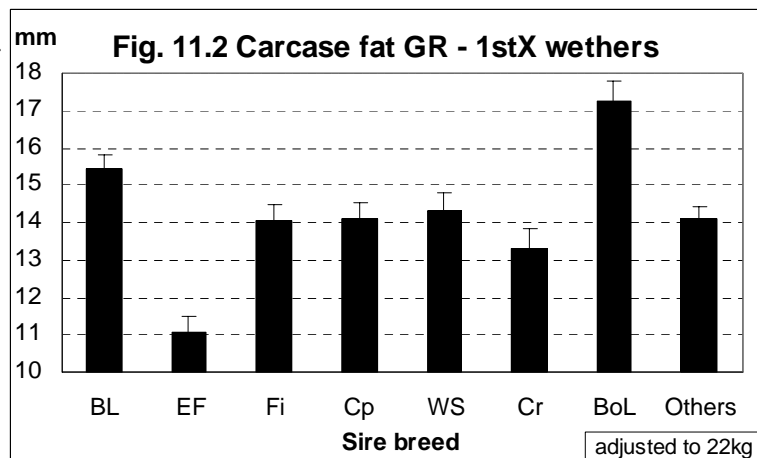
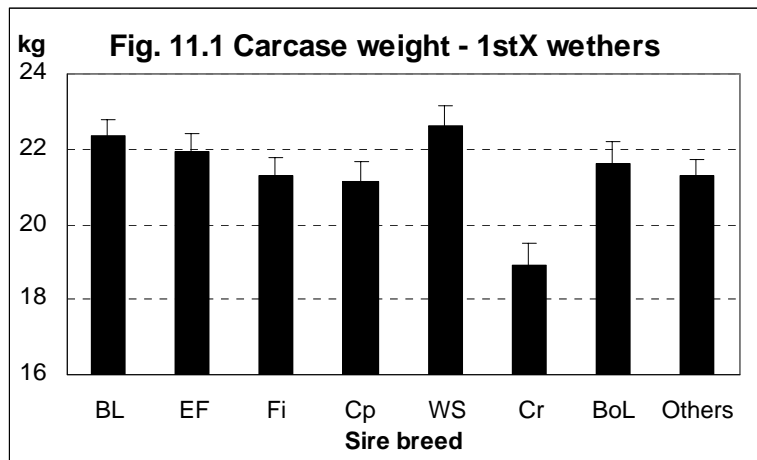
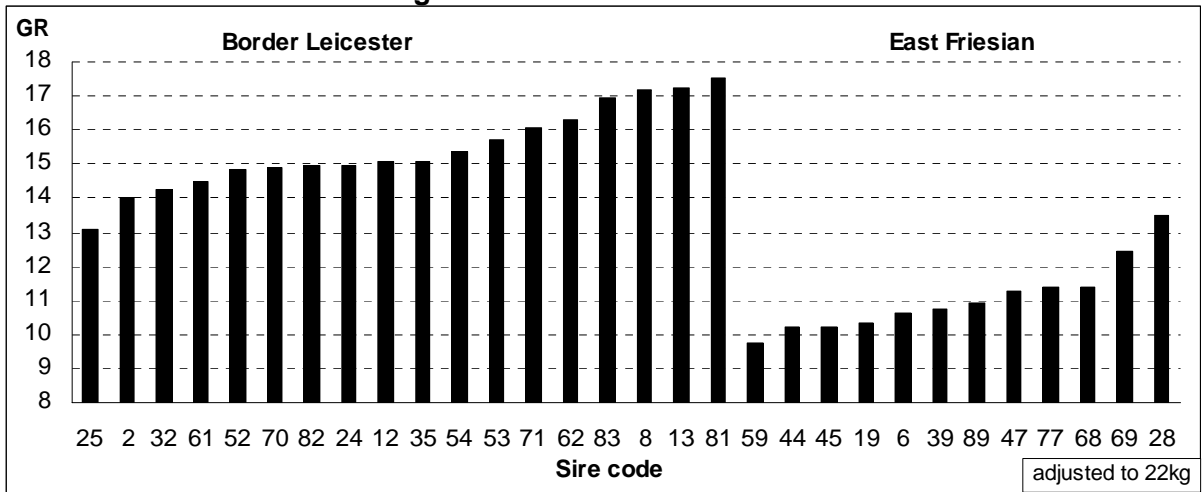
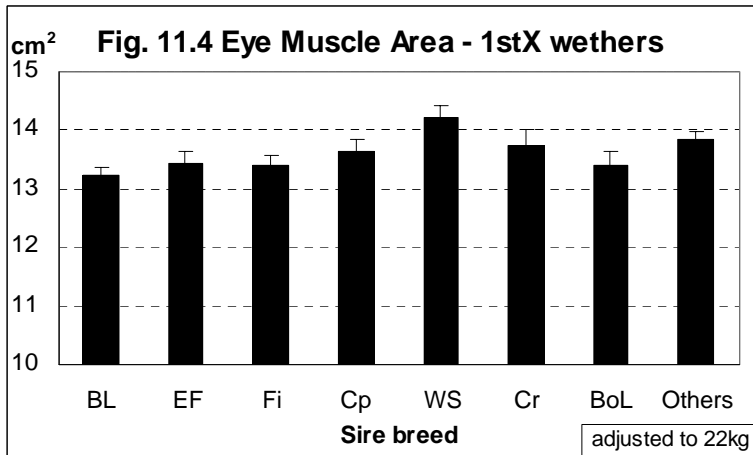


Fig. 11.3 carcass fat GR - 1stX wethers

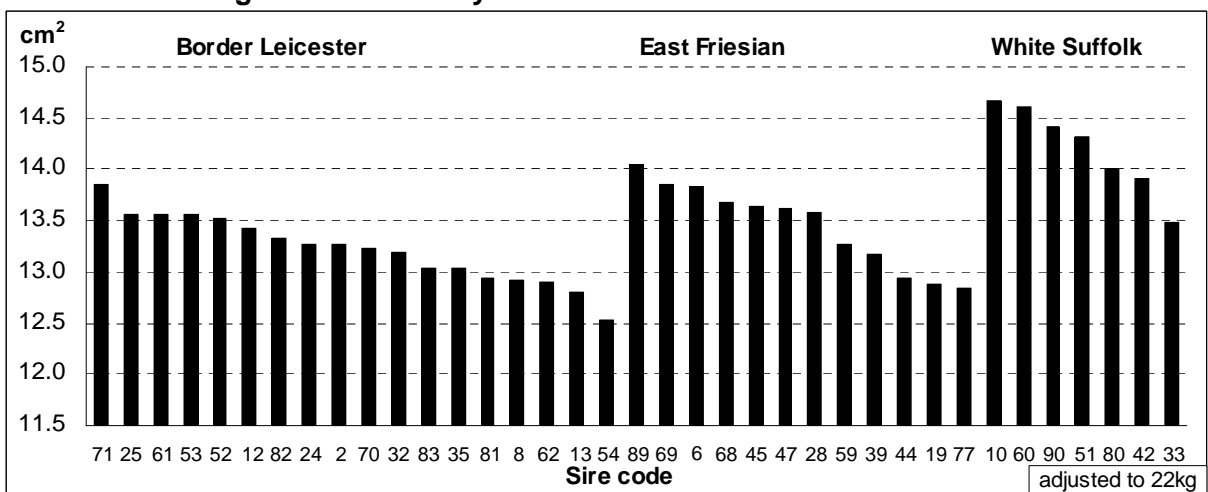


There was a smaller range among the breeds for carcass eye muscle area (Fig. 11.4), although there were significant breed differences when they were compared at the same carcass weight (22 kg). The White Suffolk (14.2 cm²) and Corriedale (13.8 cm²) had significantly larger eye muscle area than the Border Leicester (13.2 cm²) 1stX carcasses. However the variation among sire progeny means within breeds was such that there was still overlap between these extreme breeds (Fig. 11.5). Progeny means for carcass fat (GR) and eye muscle area for all sires are in Appendix A1.5.



There were no significant differences between the breed averages for meat colour or meat pH, which are indicators of meat quality.

Fig. 11.5 Carcass eye muscle area - 1stX wethers



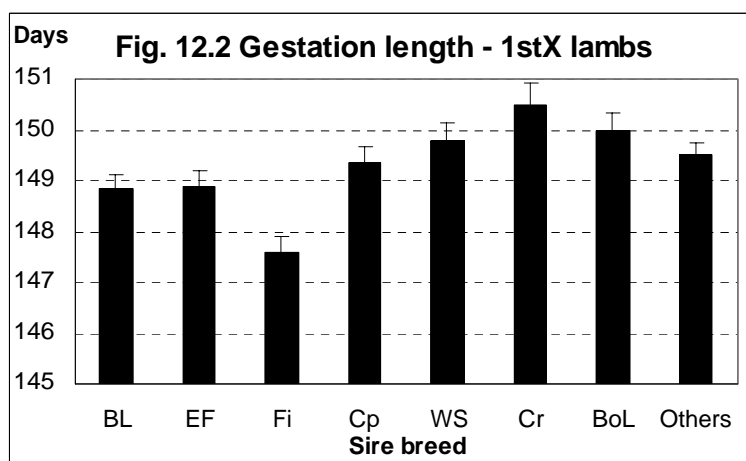
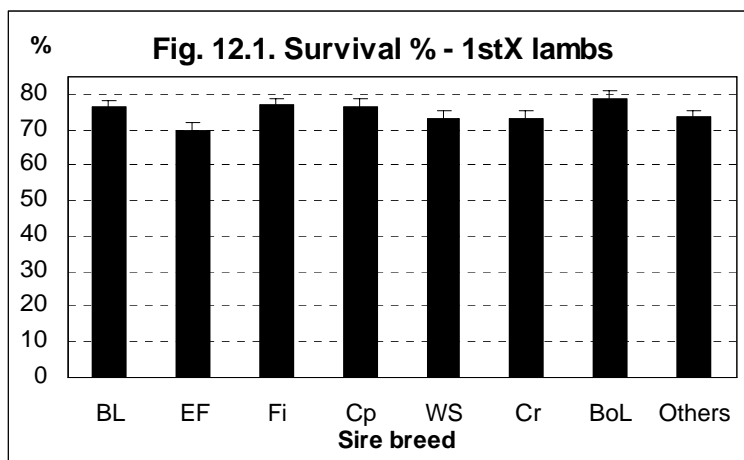
12. SURVIVAL AND GESTATION LENGTH OF 1stX LAMBS

The base Merino ewes (and Corriedale ewes at Hamilton) were treated with hormones prior to their mating to the maternal sires using artificial insemination. This resulted in a high proportion of multiple births, with an average of 1.8 lambs born per ewe lambing. Survival was higher for single (87%) than twin (77%) and triplet (60%) born lambs. There were significant differences between the breeds of sire for survival of the crossbred lambs, ranging from 70 to 77% (Fig. 12.1), after accounting for differences in type of birth. The highest survival was for the Booroola Leicester, Border Leicester, Finnsheep and Coopworth sired lambs, with the East Friesian, White Suffolk and Corriedale sired lambs having the lowest lamb survival. Dystocia and a high proportion of ewes requiring assistance at lambing contributed to the poorer lamb survival for the East Friesian (10.1%). The White Suffolk sires (6.3%) also had a higher proportion of ewes requiring assistance (relative to 3% for all other ewes). Progeny means for lamb survival for all sires are shown in Appendix A1.5.

The genotype of the lamb is more important than the dam in determining gestation length and there were significant differences between the sire breeds of the 1stX lambs (Fig. 12.2). The Finnsheep 1stX lambs had a shorter gestation (147.6 days) than other crosses, which accounts in part for their lower birth weight. The Corriedale (150.5 days), Booroola Leicester and White Suffolk 1stX lambs had a longer gestation length of about 150 days, while the other breed cross lambs were about 149 days.

Take home messages

- There was lower survival of 1stX lambs from the East Friesian, with a higher incidence of dystocia and ewes requiring assistance than from other sire breeds
- The Finnsheep 1stX lambs had a shorter gestation length (147.6 days) than the other breed crosses (149-150 days)



13. AI MATING PERFORMANCE

Take home messages

- High fertility and lambing rates can be achieved using thawed-frozen semen and laparoscopic insemination when an experienced operator is used and there is attention to detail, timing, ewe condition and management

Table 13.1 Lambing performance of Merino ewes mated by AI

	Ewes AI (n)	Fertility (%)	Litter size (n)	Lambs weaned (%)^A
Cowra				
1997	791	84	1.86	141
1998	825	82	1.87	136
1999	797	79	1.66	120
Hamilton				
1997	838	69	1.61	111
1998	831	40	1.33	113
1999	830	49	1.63	117
Struan				
1998	1092	56	1.30	102
1999	1065	52	1.37	109
2000	1071	52	1.15	111

^A Lambs weaned per ewe lambing (%)

The base Merino ewes (including some Corriedale ewes at Hamilton) were artificially inseminated by commercial operators at each site using thawed-frozen semen and laparoscopic insemination following hormone therapy to synchronise oestrous and boost ovulation. The subsequent lambing performance of the base ewes varied considerably between sites and years (Table 13.1). Fertility (ewes lambing per ewe inseminated) was consistently higher at Cowra (79 to 84% in the 3 years) than at Hamilton (40 to 69%) or Struan (52 to 56%). There were only small differences in fertility between the breeds of sire. Litter size (lambs born per ewe lambing) was also considerably higher at Cowra (1.8) than Hamilton (1.5) or Struan (1.3) as was the number of lambs weaned per ewe lambing. Sire breed was significant for number of lambs weaned per ewe lambing, which accounts for differences in litter size, lamb survival and ewe rearing ability with the range being 125% for Finnsheep to 108% for the East Friesian sires. The very good results achieved at Cowra were attributed to the attention to detail in management, condition of the ewes, timing of operations and experience of the operator. The details for the base ewe insemination and lambing results at each site in each year are shown in Appendix B1.

14. RELATIONSHIP OF MATERNAL SIRE LAMBPLAN EBVs WITH PROGENY PERFORMANCE

Take home messages

- LAMBPLAN EBVs work – rams with high EBVs have progeny that are high performing and earn more money
- Sires with high EBVs for growth and carcass generally produce better performing 1stX progeny and the superior merit is consistently passed on to 2ndX progeny
- More widespread recording of reproduction will increase the accuracy of reproduction EBVs and lead to more rapid genetic improvement

Most of the maternal sires used in the MCPT also have LAMBPLAN information available which is based on their own performance and that of relatives in industry flocks. The performance of the 1stX and 2ndX progeny of the sires in MCPT is an independent test of their LAMBPLAN EBVs. The correlations between the LAMBPLAN EBVs (Maternal EBVs September 2004) and mean progeny performance of the sires in MCPT for various traits are shown in Table 14.1. The correlations for 1stX progeny for postweaning weight, carcass fat and eye muscle depth were positive and moderately high (about 0.6), especially as the EBVs are based on live measurements and those in the MCPT are from carcasses. The correlations with 2ndX progeny performance were lower (0.3-0.4) than those with 1stX progeny, which is expected due to the reduced genetic contribution of the sires as they only contribute $\frac{1}{4}$ of the genes to the 2ndX progeny. The correlations between sire means for 1stX and 2ndX progeny growth and carcass performance in the MCPT were also positive and moderate to high (weight 0.49, fat 0.47, eye muscle depth 0.33). This indicates the relative performance of the sires from their 1stX progeny is carried through consistently to the 2ndX progeny. The correlation between the LAMBPLAN Maternal EBVs for yearling greasy fleece

weight and the wool production of the 1stX ewes was positive and moderate (0.43).

The correlations between LAMBPLAN Maternal EBVs for lambs weaned and the reproductive performance of the 1stX ewe progeny were positive although moderately low. This probably reflects the smaller number of animals with recorded reproduction information compared to growth and carcass traits in the LAMBPLAN data base and the resultant lower accuracy of the EBVs for number of lambs weaned. As more maternal breed animals have reproduction information recorded the accuracy of these EBVs will improve.

Overall the results clearly show that the use of LAMBPLAN EBVs in selection of maternal sires will result in improved performance of crossbred progeny, especially for growth, carcass and wool traits. The use of maternal sires with high EBVs for number of lambs weaned will also result in improved lambing rate from their 1stX daughters. The more widespread recording of reproduction information in LAMBPLAN by maternal seedstock breeders will increase the accuracy of the reproduction EBVs which will result in more rapid genetic improvement in this very important maternal trait for lamb production.

Table 14.1 Correlations (\pm standard error) between LAMBPLAN Maternal EBVs for maternal sires and MCPT performance of their 1stX and 2ndX progeny

LAMBPLAN	MCPT	Correlation
Post weaning weight	1stX post weaning weight	0.56 \pm 0.10
	2ndX post weaning weight	0.27 \pm 0.13
Post weaning fat	1stX carcass GR	0.65 \pm 0.08
	2ndX carcass GR	0.35 \pm 0.12
Post weaning emd	1stX carcass emd	0.56 \pm 0.10
	2ndX carcass emd	0.32 \pm 0.13
Yearling gfw	1stX yearling gfw	0.43 \pm 0.12
Lambs weaned	1stX lambs born	0.27 \pm 0.13
	1stX lambs weaned	0.22 \pm 0.14

15. HOW MUCH ARE MATERNAL SIRE EBVs WORTH?

Take home messages

- Using maternal rams with high EBVs produces progeny that earn more money (a top 10% EBV ram can earn \$1500 more than an average ram)
- Over 85% of the additional \$s from high EBVs are earned in the 2ndX enterprise
- All traits contribute to the additional \$s especially lambing rate (EBVnlw)

Maternal sires such as Border Leicester rams that have been tested through LAMBPLAN have estimated breeding values (EBVs) available at sale. Some questions for ram buyers are:

- how much more is a ram with superior EBVs worth?
- how can rams with varying EBVs for different traits be compared?

To help in making these decisions we have developed a computer program (*EBV \$ Calculator for Maternal Sires*©) that calculates the additional \$s generated over the lifetime of the ram (and his 1stX and 2ndX progeny) compared to a ram with all EBVs = 0. Maternal sires have EBVs for several traits including:

- maternal weaning weight (EBVmwwt)
- live weight (EBVwt)
- fat GR (EBVfat)
- eye muscle depth (EBVemd)
- number of lambs weaned (EBVnlw)
- greasy fleece weight (EBVgfw)

Use of rams with superior EBVs for these traits will result in progeny (1stX and 2ndX) that have higher performance and have higher returns. Each of the traits will contribute different amounts of \$ because they contribute to different products from 1stX and/or 2ndX progeny. For example, rams with positive EBVwt will have heavier progeny which will have higher returns from both 1stX and 2ndX lambs, whereas positive EBVnlw means better lambing rate from the 1stX ewes and more 2ndX lambs sold.

The returns will be different for the 1stX and 2ndX enterprises. They will also vary with

the breeding structure, production system and prices in each enterprise. Where maternal sires are mated to Merino or other base ewes in the 1stX enterprise, the wether progeny are sold for slaughter and the ewe progeny are sold for breeding. In the 2ndX enterprise the 1stX ewes are mated to terminal sires and all 2ndX lambs are sold for slaughter with additional returns from the 1stX wool.

Total returns from better production of the progeny of the ram depends on the superiority of the EBVs as well as several other factors relating to the production system and prices. These factors include the number of years the ram is mated, the number of base ewes, their lambing rate, the carcass weight of progeny, price of lambs, carcasses and wool, fat discounts and the discount rate that reduces the value of income in future years. The computer program allows all of these factors in the breeding structure, production system and prices to be varied to suit individual situations.

The additional \$ returns for a Border Leicester ram using the standard breeding structure, production system and prices (see box) are shown in Table 15.1. The EBVs used are for the Band 10 of the Border Leicester LAMBPLAN analysis of 15 Sept 2003 (ie a ram in the top 10% of Border Leicesters). The \$ values shown are the additional \$ contributed for each trait in both the 1stX and 2ndX enterprises compared with using a ram with all EBVs = 0. In this breeding structure the ram produces 60 1stX wethers and 60 1stX ewes over 3 years and his 60 1stX daughters produce 330 2ndX lambs plus wool over 5 years.

Table 15.1 Additional value from Band 10 BL sire EBVs

1stX enterprise \$		2ndX enterprise		\$
<i>1stX wethers</i>		Maternal weaning wt		416
1stX weight	137	2ndX weight		366
1stX fat	12	2ndX fat		33
<i>1stX ewes</i>		1stX ewe lambing rate		928
1stX weight	139	1stX ewe wool		141
Total 1stX	288	Total 2ndX		1884
Total (1stX + 2ndX)				2172

In the 1stX enterprise the 60 1stX wethers from this ram would be heavier and slightly leaner (less carcasses discounted for fat score 5) and the 60 1stX ewes would be heavier when sold. This would result in \$288 more returns than if a ram with EBVs = 0 was used.

In the 2ndX enterprise there are gains in carcass weight of the 330 2ndX lambs from maternal weaning weight (additional milk and nurturing) and weight as well as leanness (less carcasses discounted for fat score 5). The 60 1stX ewes also produce more lambs (from EBVnlw) and wool (from EBVgfw) over their 5 years in the flock. The total additional value in the 2ndX enterprise is \$1884.

The results highlight that the great majority (87%) of the additional returns from maternal sires with superior EBVs are in the 2ndX enterprise. This is because many of the economically important maternal

traits (maternal weaning weight, lambing rate and wool) are only expressed in the 2ndX enterprise and there are also a lot more expressions of performance (60 1stX ewes x 5 years). The important contribution of increased lambing rate is also highlighted.

The EBVs for animals in the various bands of the BL LAMBPLAN analysis (15 Sept 2003) are shown in Table 15.2, along with the additional \$ returns in the 1stX and 2ndX enterprises from use of a BL ram with these EBVs under the standard breeding structure and prices. The additional value from 1stX and 2ndX progeny of a BL ram with Band 10 EBVs (ie top 10%) is \$1508 (i.e. 2172-664) more than if a ram with Band 50 EBVs (i.e. top 50%, or current average for the breed) was used.

EBV \$ CALCULATOR FOR MATERNAL SIRESEX

The breeding structure, production system and prices used in the standard parameter set are:

1stX enterprise

Maternal ram mated to 50 Merino ewes x 3 years with a lamb weaning rate of 80%;

1stX wethers sold at 22 kg carcass weight (dressing 45 %) at \$3.20/kg with fat discounts of \$1/kg (FS1) and \$1.50/kg (FS5), with the average fat level being 15mm GR;

1stX ewes sold for breeding at \$1.44 /kg liveweight;

2ndX enterprise

1stX ewes mated to terminal sires x 5 years with an average lamb weaning rate of 110%;

2ndX lambs sold at 24 kg carcass weight (dressing 45 %) at \$3.50/kg with fat discounts of \$1/kg (FS1) and \$1.50/kg (FS5), with the average fat level being 15mm GR and lamb skins \$12;

1stX ewe wool production x 5 years at \$5.00/kg greasy A discount rate of 5% p.a. (above CPI) is applied to the dollar income in future years.

Table 15.2 Additional value of BL sire EBVs in 1stX and 2ndX enterprises.

BL sire	EBV mwwt	EBV pwwt	EBV pfat	EBV pemd	EBV nlw	EBV gfw	Total\$ 1stX	Total\$ 2ndX	Total \$
Band10	1.92	3.38	-0.40	0.59	0.08	0.23	288	1884	2172
Band 20	1.45	2.72	-0.31	0.37	0.06	0.15	231	1416	1647
Band 50	0.53	1.55	-0.06	0.00	0.02	0.04	128	536	664
Band 75	-0.16	0.56	0.12	-0.26	0.00	-0.03	42	-3	39

16. IMPLICATIONS FOR THE LAMB INDUSTRY

Take home messages

- There was a range of over \$40 gross margin/ewe/year due to the maternal sire of the crossbred ewes
- Lamb turnoff rate is the main profit driver, with 2ndX lamb growth and carcass fat (affect the proportion meeting market specifications) and ewe wool also contributing
- There are important differences between maternal sire breeds for reproduction, growth, milk, carcass fat, wool weight and fibre diameter
- There is considerably more variation among sire groups within breeds than between breeds with overlap of breeds for most traits
- The use of LAMBPLAN EBVs to assist in selections is the best way to exploit the genetic variation and improve maternal performance

The progeny test has demonstrated there is a great range of maternal genetics available to the industry. There is considerable genetic variation that can be exploited to dramatically improve productivity and profitability of lamb enterprises. While there were some important differences between the maternal sire breeds in performance of their progeny, the variation among individual sires within the breeds was far greater. There was a range among the 18 Border Leicester sires tested of over \$40 gross margin / ewe / year in the profitability of their 1stX daughters. This means a \$20,000 higher annual profit for a 1000 ewe enterprise by having 1stX ewes sired by top rather than average maternal genetics. Worm resistance of crossbred ewes (ensuring that the 1stX ewes are bred from top base Merino ewes could also contribute similar additional \$s to the annual gross margin.)

Variation in lambing rate of the 1stX ewes was the major profit driver (>80% of income was from lamb sales and < 20% from wool). There were differences of up to 45% for lamb weaning rates between 1stX ewe progeny groups of sires within a breed. In addition there were significant differences in 2ndX lamb growth (up to 3.6 kg for post weaning weight) and carcass fat (2.2 mm GR or almost half a fat score). These differences contributed to the gross margin through total weight of carcass turned off and varying proportions of the carcasses meeting market

specifications. There were also large differences between breeds and sires within breeds for milk production, early age of puberty and weight and fibre diameter of wool from the 1stX ewes. Most breeds had some sires that had high performing 1stX daughters.

Taking account of the variation in feed requirements for the 1stX ewes and their 2ndX lambs, which affects carrying capacity, generally had little impact on the rankings of the maternal sires, with a couple of exceptions. The best sire groups of 1stX ewes varied to some extent with the production system. Some groups of ewes with very high lambing rates performed relatively better in a spring rather than autumn joining system because of better lamb survival at a lambing time when weather conditions were more benign. The importance of carcass weight and fat also varies with a domestic or export market and for saleyard or grid selling. This emphasises the importance of breeders clearly identifying their production and marketing system and matching it with the most appropriate genetics.

The large ranges in growth and carcass fat among 1stX progeny of the maternal sires were twice the ranges found in terminal sire progeny tests. The relative 1stX performance of the maternal sires for growth and carcass was generally consistent in their 2ndX progeny. The LAMBPLAN EBVs of the maternal sires were generally well correlated with the growth, carcass and wool production of their 1stX and

2ndX progeny. The relationship between LAMBPLAN EBVs of the maternal sires for reproduction traits with their 1stX ewe lambing performance was less consistent. This reflects the smaller number of animals with recorded reproduction information compared to growth and carcass traits in LAMBPLAN and the resultant lower accuracy of these EBVs. As more reproduction information is recorded on maternal breed animals the accuracy of these reproduction EBVs will improve.

A major issue for the industry is to develop appropriate structures to facilitate the use of genetic information for improvement in the maternal breeding sector. Over 85% of the extra \$s generated by higher performance from superior maternal sires are reaped by the 2ndX enterprise and only 15% by the 1stX enterprise where the maternal sire rams are directly used. There is a large incentive for managers of 2ndX enterprises to ensure they have known superior genetics in their crossbred ewe flocks. Maternal seedstock breeders and their clients need to develop marketing strategies that allow the additional \$s generated by superior maternal genetics to be shared equitably by all breeders in the supply chain.

Specific implications for breeders who use maternal genetics at various levels in the industry include:

16.1 Maternal seedstock breeders

- There is considerable scope for genetic improvement of maternal traits including: lamb weaning rate, growth, carcass merit, milk production, worm resistance and wool, all of which may be genetically evaluated with LAMBPLAN EBVs
- Effective improvement requires development of a comprehensive breeding objective, genetic evaluation of available animals and use of an appropriate index to assist in selections
- Effective marketing strategies are needed to ensure an appropriate share of the additional value of the income generated from superior maternal genetics

16.2 1stX lamb producers

- Using rams with the right LAMBPLAN EBVs will produce heavier 1stX slaughter lambs that better match market specifications and earn higher prices
- Using rams with the right LAMBPLAN EBVs for maternal traits will result in more productive and valuable 1stX ewes for breeding which will bring higher prices if they are marketed effectively
- The selection and use of genetically superior rams has a much greater impact on 1stX progeny performance than the choice of a particular breed of ram
- Selection emphasising maternal traits in the base ewe flock will further increase productivity and income as well as increase the value of the 1stX ewe progeny

16.3 2ndX lamb producers

- Ensure that the 1stX ewes have the right genetics for the production and marketing system as they will earn considerably greater profits for the lamb enterprise
- This means genetics for high lamb weaning rate (for the lambing season and environment), maternal traits (mothering, milking, growth, carcass) and wool
- Demand more genetic information and background before purchasing 1stX ewes
- Developing an alliance or contract mating with a high performing Merino flock ensures greater genetic control of the 1stX ewes and regular supply of the best genetics
- Don't wait for the industry to deliver better 1stX ewes at sheep sales

16.4 Self-replacing flock breeders

- Implement a breeding program that emphasises maternal traits including: lamb weaning rate, growth, carcass, milk production, worm resistance and wool
- Emphasise early puberty by selecting ewes that rear lambs in their first year (reduces the cost of replacements)
- Decide on a longer term ram strategy (breeding or purchasing) that is practical and best fits management

APPENDIX A1 – SIRE PROGENY MEANS

A1.1 Sire progeny means for annual \$ income and gross margins - 1stX ewes

Sire	\$ Income	\$GM	\$GM/DSE	Sire	\$ Income	\$GM	\$GM/DSE
BL2	120.22	108.34	39.77	Cp36	111.91	96.07	37.79
BL8	98.79	83.26	32.56	Cp37	69.97	56.81	26.09
BL12	117.08	101.66	37.79	Cp65	93.18	79.45	31.62
BL13	118.39	103.40	39.09	Cp74	101.71	87.63	34.55
BL24	96.37	82.66	34.25	Cp85	129.63	114.33	41.28
BL25	101.72	87.76	34.91	WS10	100.14	89.29	33.81
BL32	107.74	93.35	36.67	WS33	115.88	100.54	37.22
BL35	81.13	66.67	28.32	WS42	113.60	98.73	35.96
BL52	108.93	94.52	36.99	WS51	112.07	98.15	36.53
BL53	98.20	82.75	34.20	WS60	98.23	82.70	32.88
BL54	119.46	102.54	37.81	WS80	96.78	82.71	31.80
BL61	105.68	91.19	39.11	WS90	123.24	108.00	39.33
BL62	106.09	91.61	35.29	Cr4	94.88	81.29	35.47
BL70	100.55	86.66	33.67	Cr11	87.64	73.97	33.32
BL71	108.40	94.14	36.40	Cr20	101.49	87.63	39.51
BL81	107.33	93.04	35.69	Cr27	94.44	81.28	35.28
BL82	112.99	98.49	37.99	Cr46	101.46	87.88	39.47
BL83	113.16	98.69	37.12	Cr64	88.43	75.25	34.68
EF6	105.06	89.01	36.05	BoL1	86.67	71.59	27.71
EF19	130.41	114.88	42.54	BoL15	107.09	96.35	34.76
EF28	118.14	103.10	38.38	BoL34	90.84	80.82	31.96
EF39	123.56	109.77	39.68	BoL43	104.62	94.16	34.98
EF44	122.45	107.34	41.38	BoL55	98.52	93.48	34.66
EF45	136.48	121.16	44.03	BoL63	92.75	82.81	31.62
EF47	116.09	101.09	39.58	Hy29	102.10	87.93	38.20
EF59	112.26	95.94	36.45	Hy30	103.61	89.29	38.2
EF77	106.76	92.21	36.02	Hy75	111.14	96.51	37.99
EFP68	98.01	83.76	31.53	Hy87	116.16	101.27	38.79
EFR69	104.95	90.29	33.70	EL57	86.79	72.08	31.42
EFP89	106.47	91.85	35.47	EL73	50.28	39.28	18.88
Fi3	114.44	98.51	36.68	Gr41	90.39	77.61	33.39
Fi7	104.58	89.92	34.62	Gr86	105.66	91.54	37.28
Fi9	103.15	87.43	35.66	M56	88.69	75.67	37.53
Fi17	112.52	97.34	37.52	M72	93.14	79.23	33.06
Fi21	117.14	101.77	40.13	Ro14	103.04	89.23	35.20
Fi22	102.87	88.26	36.37	Ro49	101.58	87.90	36.64
Fi23	113.11	97.49	38.11	PD31	111.91	97.15	37.59
FL40	113.16	98.06	36.75	PD79	88.81	75.54	30.47
FiF48	115.43	100.39	38.28	Ch66	94.27	80.86	31.47
Fi67	97.17	82.78	32.11	SAM84	125.82	110.80	41.23
FiF76	98.33	84.42	32.74	SHD78	87.19	73.89	30.61
Fi88	109.73	94.65	35.65	Tx50	96.21	82.95	32.85
Cp5	110.21	95.49	37.74	WD91	112.42	98.11	36.35
Cp16	120.14	105.16	40.17	WH58	97.43	81.91	31.18
Cp18	94.28	80.85	33.03	Cc38	93.15	81.95	33.16
Cp26	115.45	100.48	39.81				

\$ Income = average annual \$ income from 2ndX lambs slaughtered and 1stX ewe wool

\$GM = average annual \$ gross margin per ewe

\$GM/DSE = average annual \$ gross margin per dry sheep equivalent

Based on first 3 joinings and shearings of 1stX ewes

A1.2 Sire progeny means for annual lambing rate - 1stX ewes

Sire	LW (%)	LB (%)	LS	Sire	LW (%)	LB (%)	LS
BL2	121.4	139.7	1.62	Cp36	110.9	132.8	1.50
BL8	96.7	114.0	1.43	Cp37	64.8	89.4	1.31
BL12	111.7	133.7	1.57	Cp65	91.6	115.8	1.54
BL13	116.4	139.9	1.55	Cp74	96.2	119.3	1.47
BL24	91.2	112.4	1.32	Cp85	122.2	138.4	1.55
BL25	96.8	115.8	1.45	WS10	102.7	127.6	1.45
BL32	104.4	124.8	1.46	WS33	117.1	132.1	1.48
BL35	75.6	93.7	1.34	WS42	110.7	130.8	1.55
BL52	111.2	129.4	1.48	WS51	124.0	146.7	1.61
BL53	95.0	110.2	1.32	WS60	93.1	109.5	1.34
BL54	117.5	134.6	1.49	WS80	87.7	110.3	1.37
BL61	103.0	123.7	1.44	WS90	118.7	135.9	1.47
BL62	99.1	139.2	1.62	Cr4	92.4	101.3	1.31
BL70	95.0	118.2	1.45	Cr11	82.0	94.0	1.25
BL71	102.3	119.7	1.43	Cr20	95.7	109.6	1.21
BL81	103.5	121.8	1.47	Cr27	83.2	92.0	1.22
BL82	108.8	122.9	1.38	Cr46	103.8	109.4	1.25
BL83	107.5	123.5	1.48	Cr64	74.8	90.6	1.33
EF6	99.0	119.8	1.36	BoL1	86.3	144.1	2.02
EF19	133.9	149.6	1.59	BoL15	108.5	141.2	1.73
EF28	110.1	130.5	1.50	BoL34	99.5	157.4	2.10
EF39	125.8	156.2	1.75	BoL43	121.0	171.9	2.06
EF44	122.2	129.7	1.49	BoL55	115.5	177.7	2.04
EF45	130.2	140.6	1.60	BoL63	101.9	170.4	2.18
EF47	116.4	124.4	1.44	Hy29	102.6	119.9	1.38
EF59	100.9	119.2	1.44	Hy30	105.2	122.3	1.42
EF77	100.9	122.3	1.39	Hy75	112.0	130.8	1.51
EFP68	92.2	125.8	1.52	Hy87	116.2	141.8	1.57
EFR69	102.8	140.4	1.76	EL57	85.2	109.3	1.38
EFP89	99.7	117.5	1.44	EL73	35.7	52.1	1.28
Fi3	128.5	169.5	1.96	Gr41	85.9	100.3	1.20
Fi7	110.1	166.5	1.90	Gr86	98.0	112.8	1.32
Fi9	113.2	143.5	1.59	M56	79.0	92.3	1.17
Fi17	116.0	156.5	1.69	M72	93.0	115.6	1.47
Fi21	130.6	163.9	1.73	Ro14	92.2	109.4	1.26
Fi22	108.7	161.9	1.74	Ro49	108.2	113.4	1.28
Fi23	133.3	172.1	1.83	PD31	114.6	137.3	1.58
FL40	117.7	149.5	1.76	PD79	81.4	118.3	1.43
FiF48	125.1	160.8	1.79	Ch66	95.0	128.9	1.46
Fi67	92.2	149.3	1.73	SAM84	121.8	139.9	1.55
FiF76	94.0	124.6	1.57	SHD78	83.4	103.6	1.29
Fi88	118.7	165.4	1.87	Tx50	104.8	111.0	1.36
Cp5	110.9	129.6	1.54	WD91	111.8	129.1	1.50
Cp16	111.7	127.5	1.45	WH58	101.9	122.9	1.55
Cp18	81.5	100.6	1.22	Cc38	90.7	110.7	1.44
Cp26	116.9	138.3	1.52				

LW = lambs weaned per ewe joined (%); LB = lambs born per ewe joined (%)

LS = litter size (number of lambs born per ewe lambing)

Based on first 3 joinings of 1stX ewes

A1.3 Sire progeny means for lamb growth and carcass – 2ndX lambs

Sire	BW	WW	PWW	Fat	EMA	Sire	BW	WW	PWW	Fat	EMA
BL2	4.5	29.5	44.8	14.1	14.2	Cp36	4.1	27.3	41.7	15.2	14.5
BL8	4.3	28.5	43.2	15.8	14.3	Cp37	3.8	27.0	41.1	15.1	14.6
BL12	4.3	29.8	44.6	15.1	14.5	Cp65	4.1	28.3	43.0	15.3	14.5
BL13	4.3	29.6	44.1	16.3	14.3	Cp74	3.9	28.1	42.2	15.2	14.3
BL24	4.0	27.4	42.6	15.5	14.2	Cp85	4.4	30.7	45.9	14.0	14.4
BL25	4.2	28.8	43.5	14.8	14.6	WS10	4.3	28.9	42.8	14.6	14.8
BL32	4.4	28.7	43.6	14.6	14.4	WS33	4.2	28.6	42.3	14.5	14.8
BL35	4.1	26.9	41.2	15.2	14.2	WS42	4.3	29.2	43.5	14.1	14.9
BL52	4.5	28.9	43.8	14.4	14.5	WS51	4.2	29.4	43.1	14.5	15.0
BL53	4.2	28.9	43.2	15.7	14.5	WS60	4.0	28.7	42.2	15.3	14.9
BL54	4.6	29.3	44.7	14.2	14.1	WS80	4.0	28.3	42.3	14.8	14.6
BL61	4.5	28.8	43.9	14.7	14.4	WS90	4.4	29.1	43.4	15.1	15.0
BL62	4.4	28.3	44.8	15.1	14.3	Cr4	4.4	26.6	40.6	15.0	14.8
BL70	4.1	27.8	42.4	15.1	14.7	Cr11	4.5	26.7	40.5	14.8	14.4
BL71	4.4	29.4	44.1	14.8	14.4	Cr20	4.5	25.4	39.7	14.1	14.3
BL81	4.3	28.6	43.7	15.3	14.3	Cr27	4.4	28.3	41.9	14.7	14.6
BL82	4.6	28.8	44.0	14.3	14.2	Cr46	4.5	26.0	40.1	15.4	14.8
BL83	4.4	29.4	44.0	14.7	14.3	Cr64	4.3	26.3	40.1	14.5	14.8
EF6	4.4	29.3	44.3	12.7	14.5	BoL1	4.4	27.8	42.6	15.0	14.7
EF19	4.3	30.6	45.2	12.9	14.7	BoL15	4.2	28.9	42.9	15.6	14.8
EF28	4.6	31.9	46.4	13.6	14.6	BoL34	3.8	26.2	40.0	16.5	14.7
EF39	4.2	28.8	43.4	13.3	14.5	BoL43	4.1	28.3	41.9	15.7	14.7
EF44	4.4	31.4	45.6	12.4	14.4	BoL55	4.3	27.9	42.2	15.8	14.5
EF45	4.6	31.6	47.2	12.1	14.2	BoL63	4.0	28.4	42.8	16.2	14.6
EF47	4.3	30.0	44.2	13.3	14.8	Hy29	4.1	26.9	41.7	15.0	14.5
EF59	4.4	31.8	47.5	12.5	14.7	Hy30	3.9	27.4	41.0	14.8	15.0
EF77	4.2	29.5	44.6	13.4	15.0	Hy75	4.0	27.7	42.1	15.3	14.9
EFP68	4.4	31.0	45.0	13.3	14.7	Hy87	4.0	27.9	42.3	15.1	14.8
EFR69	4.0	29.9	44.4	13.5	14.8	EL57	3.8	27.5	41.0	15.5	14.4
EFP89	4.2	29.0	44.3	13.4	14.5	EL73	3.6	27.5	41.4	15.4	14.3
Fi3	3.3	25.1	40.1	14.4	14.7	Gr41	3.9	27.0	41.9	14.7	14.6
Fi7	3.4	26.2	40.9	15.2	14.7	Gr86	4.0	28.7	42.8	15.1	15.1
Fi9	3.5	25.8	39.9	16.0	14.4	M56	3.9	26.4	40.2	14.6	14.2
Fi17	3.4	25.6	39.9	16.0	14.6	M72	3.8	26.5	40.7	14.5	15.1
Fi21	3.5	25.2	40.0	14.9	14.5	Ro14	3.8	27.5	41.9	13.6	14.6
Fi22	3.6	25.6	40.4	14.5	13.9	Ro49	4.3	27.1	42.1	14.9	14.4
Fi23	3.4	25.4	39.9	14.8	14.2	PD31	3.8	28.9	42.9	15.4	15.1
FL40	3.7	26.4	41.0	14.8	14.7	PD79	3.9	28.8	42.8	14.9	14.8
FiF48	3.8	27.4	42.3	14.5	14.0	Ch66	3.6	26.8	42.2	14.7	15.0
Fi67	3.5	24.8	40.5	14.8	14.3	SAM84	4.2	29.3	44.3	14.7	14.7
FiF76	3.9	28.0	42.1	14.1	14.7	SHD78	3.8	26.9	41.1	14.5	14.8
Fi88	3.6	26.1	41.0	14.9	14.5	Tx50	4.0	27.4	42.2	14.5	15.2
Cp5	4.2	27.7	42.3	15.0	14.3	WD91	4.1	30.1	44.3	15.1	14.5
Cp16	4.1	27.7	42.6	15.1	14.5	WH58	4.1	29.1	43.0	14.2	15.1
Cp18	3.9	27.8	41.9	14.4	14.4	Cc38	4.0	28.5	42.2	14.3	14.9
Cp26	3.9	27.7	41.8	14.8	14.8						

BW = birth weight (kg); WW = weaning weight (kg); PWW = post-weaning weight (kg);
 Fat = carcass fat (mm GR); EMA = carcass eye muscle area (cm²), adjusted to 22.5 kg carcass weight.

A1.4 Sire progeny means for wool production and worm resistance of 1stX ewe hoggets and survival of 1stX lambs.

Sire	CFW	FD	FEC	SURV	Sire	CFW	FD	FEC	SURV
BL2	3.2	29.2	145.0	76.4	Cp36	3.8	28.1	140.4	75.4
BL8	3.4	29.4	154.9	76.3	Cp37	3.6	30.9	121.6	76.5
BL12	3.6	29.4	146.5	74.7	Cp65	3.4	29.2	78.0	76.4
BL13	3.0	27.0	202.5	77.1	Cp74	3.6	29.0		77.3
BL24	3.3	29.5		76.4	Cp85	3.4	28.0		76.7
BL25	3.4	30.8		77.1	WS10	2.7	27.2	123.1	72.9
BL32	3.6	29.8		76.6	WS33	2.8	28.5		72.9
BL35	3.4	28.5	118.8	77.6	WS42	2.4	28.9	91.1	74.2
BL52	3.2	28.2	108.3	76.5	WS51	3.0	28.8	105.9	73.6
BL53	3.1	28.7	155.0	76.5	WS60	2.9	28.2	118.6	73.1
BL54	3.4	29.2	106.1	77.1	WS80	2.8	27.4		72.2
BL61	3.2	29.3	206.6	76.4	WS90	2.6	27.7		73.3
BL62	3.3	28.2	187.4	76.6	Cr4	3.5	25.4	132.5	73.5
BL70	3.3	29.2		76.4	Cr11	3.4	23.2	142.1	73.4
BL71	3.2	29.3		77.0	Cr20	3.6	25.1	200.9	72.4
BL81	3.3	29.0		76.7	Cr27	3.6	24.2		73.1
BL82	3.3	29.1		76.7	Cr46	3.5	24.3	133.7	73.3
BL83	3.0	28.9		76.2	Cr64	3.5	25.1	207.6	72.8
EF6	3.1	27.9	136.8	69.9	BoL1	3.2	29.1	127.7	79.3
EF19	3.2	28.9	118.9	70.1	BoL15	2.7	27.3	96.5	78.4
EF28	3.2	28.5		70.1	BoL34	3.1	28.1	152.7	78.9
EF39	3.1	28.6	145.9	70.2	BoL43	2.8	26.9	131.4	78.4
EF44	3.0	27.5	156.0	69.5	BoL55	2.8	27.4	113.2	78.2
EF45	3.3	27.0	150.4	70.0	BoL63	3.1	27.6	167.0	79.1
EF47	3.3	29.0	138.8	69.2	Hy29	2.7	26.3		74.0
EF59	3.3	27.8	133.4	69.8	Hy30	2.9	26.3		74.4
EF77	3.1	28.6		70.2	Hy75	2.5	24.7		73.1
EFP68	3.2	28.2	180.4	69.3	Hy87	3.1	24.6		73.6
EFR69	3.1	28.3	116.9	70.4	EL57	3.8	28.8	126.9	73.0
EFP89	3.1	28.2		70.5	EL73	3.7	30.1		74.3
Fi3	2.7	25.0	139.2	77.1	Gr41	3.0	26.2	133.1	72.4
Fi7	2.7	23.8	144.0	76.6	Gr86	3.6	26.1		73.6
Fi9	2.6	25.0	168.3	77.4	M56	3.7	21.4	210.9	73.5
Fi17	3.0	26.2	144.8	76.6	M72	3.3	21.9		73.8
Fi21	2.8	25.3	143.5	77.3	Ro14	3.7	28.2	52.1	73.1
Fi22	2.8	23.9		76.1	Ro49	3.3	27.7	123.6	73.2
Fi23	2.7	23.1		76.9	PD31	2.8	27.0		73.9
FL40	3.2	25.4	167.2	77.0	PD79	2.6	27.8		73.7
FiF48	2.8	25.2	127.3	77.1	Ch66	3.3	27.0	40.9	73.5
Fi67	2.8	24.7	225.7	76.8	SAM84	3.1	22.2		72.6
FiF76	2.8	26.8		77.7	SHD78	2.8	27.0		73.8
Fi88	2.5	24.6		77.1	Tx50	3.1	28.7	100.1	73.7
Cp5	3.9	27.9	105.3	76.0	WD91	1.6	22.4		73.5
Cp16	3.5	29.7	148.4	78.0	WH58	2.5	29.4	87.0	74.5
Cp18	3.8	29.5	126.9	77.2	Cc38	2.9	28.7	95.0	74.6
Cp26	3.7	27.7		77.0					

CFW = hogget clean fleece weight (kg); FD =hogget fibre diameter (microns);
FEC =faecal worm egg count (eggs/g); SURV = 1stX lamb survival (%).

A1.5 Sire progeny means for lamb growth and carcass - 1stX lambs

Sire	BW	WW	PWW	Fat	EMA	Sire	BW	WW	PWW	Fat	EMA
BL2	4.3	22.2	38.0	14.0	13.3	Cp36	4.1	21.9	38.1	14.8	13.3
BL8	4.3	21.2	37.4	17.2	12.9	Cp37	4.1	21.0	35.3	14.8	13.5
BL12	4.2	21.8	38.2	15.1	13.4	Cp65	4.1	21.2	37.0	14.4	14.2
BL13	4.3	21.2	37.2	17.2	12.8	Cp74	4.2	20.5	35.2	13.9	13.6
BL24	4.1	21.0	38.1	15.0	13.3	Cp85	4.3	21.6	39.4	12.0	13.0
BL25	4.3	20.5	36.4	13.1	13.6	WS10	4.4	22.6	38.4	14.2	14.7
BL32	4.3	21.0	37.3	14.3	13.2	WS33	4.3	22.6	40.3	15.8	13.5
BL35	4.3	20.8	36.0	15.1	13.0	WS42	4.5	21.7	39.4	14.3	13.9
BL52	4.2	21.1	36.3	14.8	13.5	WS51	4.4	22.7	39.9	14.1	14.3
BL53	4.3	21.1	36.7	15.7	13.6	WS60	4.4	21.7	37.2	13.8	14.6
BL54	4.5	21.9	39.5	15.4	12.5	WS80	4.2	22.2	39.3	13.9	14.0
BL61	4.3	21.2	36.6	14.5	13.6	WS90	4.4	22.6	38.9	13.9	14.4
BL62	4.3	21.3	37.9	16.3	12.9	Cr4	4.3	20.0	32.3	12.0	14.6
BL70	4.4	21.9	38.6	14.9	13.2	Cr11	4.4	19.5	31.4	13.8	13.6
BL71	4.1	20.9	36.6	16.1	13.9	Cr20	4.2	19.2	33.9	13.5	13.6
BL81	4.3	21.7	37.7	17.5	12.9	Cr27	4.3	19.9	32.6	13.7	14.0
BL82	4.4	22.0	38.8	14.9	13.3	Cr46	4.3	19.3	33.9	13.8	13.3
BL83	4.4	21.8	38.2	17.0	13.0	Cr64	4.3	19.5	32.7	13.1	13.4
EF6	4.5	22.0	36.2	10.6	13.8	BoL1	4.0	20.2	36.8	16.4	13.2
EF19	4.3	22.1	39.2	10.3	12.9	BoL15	4.0	20.7	36.8	16.6	13.5
EF28	4.5	23.7	41.6	13.5	13.6	BoL34	4.0	20.1	34.5	18.2	13.9
EF39	4.6	22.5	39.1	10.7	13.2	BoL43	4.0	20.0	36.9	17.1	13.2
EF44	4.4	22.0	37.1	10.2	12.9	BoL55	4.1	20.4	36.2	16.6	13.5
EF45	4.4	22.7	39.2	10.2	13.6	BoL63	4.0	19.4	35.0	18.6	13.1
EF47	4.4	22.0	38.0	11.3	13.6	Hy29	3.9	20.3	34.1	12.6	13.8
EF59	4.5	23.3	42.2	9.7	13.3	Hy30	4.0	20.3	33.5	15.4	13.5
EF77	4.4	22.8	38.8	11.4	12.9	Hy75	4.1	20.5	35.8	15.4	14.5
EFP68	4.5	22.4	38.1	11.4	13.7	Hy87	4.0	20.7	37.4	13.8	14.2
EFR69	4.4	22.1	37.2	12.4	13.8	EL57	4.1	21.0	35.6	16.0	13.3
EFP89	4.4	22.0	38.2	10.9	14.1	EL73	4.3	21.6	38.0	13.9	13.2
Fi3	3.9	20.7	36.5	13.6	13.6	Gr41	4.2	20.1	35.0	14.8	13.2
Fi7	3.9	21.0	38.1	14.4	13.6	Gr86	4.3	21.2	36.5	14.7	14.1
Fi9	3.9	19.9	35.5	14.1	13.2	M56	4.1	19.6	31.1	12.7	13.5
Fi17	4.0	21.0	37.1	14.5	13.6	M72	4.1	20.6	34.3	12.9	12.9
Fi21	3.8	20.3	36.8	13.7	12.9	Ro14	4.4	21.2	35.8	13.3	13.8
Fi22	4.0	19.7	37.4	15.3	13.3	Ro49	4.4	21.1	37.1	13.9	13.6
Fi23	4.0	20.1	36.8	14.1	13.5	PD31	4.4	22.8	40.3	14.2	14.1
FL40	4.0	20.7	38.0	14.4	13.4	PD79	4.1	21.7	39.6	14.6	14.3
FiF48	4.2	21.0	38.3	13.5	13.4	Ch66	4.2	20.3	35.2	13.8	14.0
Fi67	4.0	20.9	38.9	14.2	13.5	SAM84	4.1	20.8	35.8	12.2	13.5
FiF76	4.1	20.8	37.1	13.4	13.1	SHD78	4.2	21.5	37.9	14.8	13.9
Fi88	3.9	20.0	36.6	13.6	13.5	Tx50	4.2	21.4	38.2	14.1	15.1
Cp5	4.3	21.6	36.7	14.8	13.4	WD91	4.2	20.5	37.0	14.2	13.6
Cp16	4.2	21.4	36.7	14.5	14.4	WH58	4.4	21.3	38.1	15.6	14.3
Cp18	4.2	20.8	35.2	14.4	13.6	Cc38	4.1	21.0	36.2	13.4	14.3
Cp26	4.2	21.6	38.0	13.3	13.7						

BW = birth weight (kg); WW = weaning weight (kg); PWW = post-weaning weight (kg);

Fat = carcass fat (mm GR); EMA = carcass eye muscle area (cm²), adjusted to 22 kg carcass weight.

APPENDIX A2 – MCPT DESIGN and PRODUCTION SYSTEMS

Maternal Sires X Merino Ewes

Matings of maternal sires at Cowra, Hamilton and Struan - 1997,1998,1999, 2000

1stX ewes - grown out

- survival
- growth
- breeding season
- wool wt, yield, fibre diam
- faecal egg count

1stX wethers - slaughtered

- survival
- growth
- carcass wt, fat, ema, pH, colour

Terminal sires X 1stX ewes (x 3 years)

- breeding season
- lambing rate
- wool wt

2ndX lambs - slaughtered

- survival
- growth
- carcass wt, fat, ema, pH, colour

Sites and Production Systems

Cowra Agricultural Research & Advisory Station

Base ewes: Merino medium wool –12 sires each year X approx 66 base ewes, March 1997, February 1998, 1999

1stX ewe progeny evaluation: ewes split to either autumn or spring joining systems and mated to Poll Dorset rams for 3 lambings.

Autumn - first joining at 7 months (autumn 1998)

Spring - first joining at 14 months (spring 1998)

Final drop of 2ndX lambs slaughtered September 2003

Hamilton Pastoral & Veterinary Institute

Base ewes: Merino fine wool and Corriedale – 12 sires each year X approx 70 base ewes, April 1997, March 1998, 1999

1stX ewe progeny evaluation: ewes joined in autumn to terminal sire rams for 3 lambings, with first joining occurring at 7 months (autumn 1998).

Final drop of 2ndX lambs slaughtered May 2003

Struan Agricultural Centre / Rutherglen Research Institute

Base ewes: Merino broad wool SA type – 14 sires each year X approx 70 base ewes, January 1998, 1999, 2000. The AI matings and base ewe lambings with 1stX wether progeny grown out to slaughter at Struan. The 1stX ewe progeny grown out at Struan to 10-12 months and transferred to Rutherglen for maternal evaluation.

1stX ewe progeny evaluation: ewes joined in spring/summer to White Suffolk rams, with first joining at 18 months (spring 1999).

Final drop of 2ndX lambs slaughtered November 2004

Link Sires

Three link sires were used at each site in each year. The links included a Border Leicester (Kelso, BL12), Coopworth (Oaklea, Cp5) and Finnsheep (Warrayure, Fi7) as a broad representation of the genotypes being tested in the project.

APPENDIX A3 - MATERNAL SIRE ENTRIES – DETAILS

Year	Site	Sire Code	Tag	Stud	Breed	Entrant	Phone No.		
1997	Cowra	BL1	920047	Struan	Booroola Leicester	PIRSA	08 8762 9100		
		BL2	950137	Johnos	Border Leicester	NW & JI Johnson	08 8756 6053		
		FI3	940001	Yamba	Finnsheep	M & L Burns	03 5798 1583		
		Cr4	940364	Maluka	Corriedale	P Secker	02 4848 1244		
		Cp5*	940449	Oaklea	Coopworth	DW & IA Peglar	08 8738 9291		
		EF6	94B021	Silverstream	East Friesian	A. Baillieu	03 5597 6598		
		FI7*	930057	Warrayure	Finnsheep	GM & MA Wake	03 5574 1254		
		BL8	950181	Inverbrackie	Border Leicester	CE & LJ Arney	08 8536 0031		
		FI9	935010	Warrayure	Finnsheep	Knight & Bottcher	03 5578 7250		
		WS10	910058	Leahcim	White Suffolk	AWSA/Michael	08 8865 2085		
		Cr11	930097	Coora	Corriedale	Coora Partnership	02 4848 1244		
		BL12*	94S291	Kelso	Border Leicester	GB Starritt & Son	03 5829 0144		
		1997	Hamilton	BL13	950246	Inverbrackie	Border Leicester	CE & LJ Arney	08 8536 0031
Ro14	930146			Claymour	Romney	Rouch & Gillman	03 5727 1552		
BoL15	924287			Struan	Booroola Leicester	PIRSA	08 8762 9100		
Cp16	930069			Narrambra	Coopworth	D Wigan	03 5577 2321		
FI17	950054			Gippfinn	Finnsheep	S & D Jones	03 5122 3328		
Cp18	940421			Oaklea	Coopworth	J Keiller	03 5526 5248		
EF19	94B026			Silverstream	East Friesian	A. Baillieu	03 5597 6598		
Cr20	880491			Stanbury	Corriedale	Cole & Risbey	03 5593 9278		
FI21	960002			UNSW	Finnsheep	S & D Jones	03 5122 3328		
1998	Struan			FI22	890049	ATC	Finnsheep	Jaydee Stud	08 8764 2065
				FI23	930049	Tambaroora	Finnsheep	Jaydee Stud	08 8764 2065
				BL24	960346	Gleneith	Border Leicester	CE & LJ Arney	08 8536 0031
				BL25	960188	Johnos	Border Leicester	NW & JI Johnson	08 8756 6053
		Cp26	960210	Oaklea	Coopworth	DW & IA Peglar	08 8738 9291		
		Cr27	921586	Coora	Corriedale	Coora Partnership	03 5578 6267		
		EF28	960133	Silverstream	East Friesian	A. Baillieu	03 5597 6598		
		Hy29	960028	Cowra	Hyfer	NSW DPI	02 6391 3813		
		Hy30	960128	Cowra	Hyfer	NSW DPI	02 6391 3813		
		PD31	960110	Wyndamah	Poll Dorset	GJ & BJ Oxley	03 5037 2355		
		BL32	95T138	Kelso	Border Leicester	GB Starritt & Son	03 5829 0144		
		WS33	951470	Galaxy Park	White Suffolk	AWSA/Gale	08 8210 5230		
		1998	Cowra	BoL34	950029	Caveton Park	Booroola Leicester	PIRSA	08 8762 9100
BL35	940765			Retallack	Border Leicester	BLA(NSW)/Grinter	02 6974 1153		
Cp36	960067			Narrambra	Coopworth	RJ & PH Lane	02 6362 7115		
Cp37	940274			Narrambra	Coopworth	RJ & PH Lane	02 6362 7115		
Cc38	960621			Coronga	Coronga Composite	Premier Breed. Tech	02 6365 8207		
EF39	94B040			Silverstream	East Friesian	A. Baillieu	03 5597 6598		
FL40	941016			Wycombe	Finn x Leicester	R & L Coddington	02 6775 5225		
Gr41	955551			Yangoora	Gromark	Yangoora Gromarks	02 6383 3254		
WS42	940069			Leahcim	White Suffolk	AWSA/Michael	08 8865 2085		
1998	Hamilton			EF43	960322	Struan	Booroola Leicester	PIRSA	08 8762 9100
				BoL44	960026	Silverstream	East Friesian	A. Baillieu	03 5597 6598
				EF45	94B019	Glenspean	East Friesian	S & J Cameron	03 5286 1455
				Cr46	950161	Gundwringa	Corriedale	HJ & CJ Prell	02 4848 1244
		EF47	950509	Silverstream	East Friesian	A. Baillieu	03 5597 6598		
		FIF48	960086	Gippfinn	Finn x Friesian	S & D Jones	03 5122 3328		
		Ro49	920089	Evergreen	Romney	C Duncombe	03 5264 5170		
		Tx50	949002	Coolana	Texel	Coolana Rural	03 5350 5531		
		WS51	900429	Galaxy Park	White Suffolk	AWSA/Gale	08 8210 5230		
		1999	Cowra	BL52	920070	Kegra	Border Leicester	BLA(NSW)/Golder	02 6977 1339
				BL53	960102	Inverbrackie	Border Leicester	CE & LJ Arney	08 8536 0031
				BL54	970030	Johnos	Border Leicester	NW & JI Johnson	08 8756 6053
				BoL55	950203	Struan	Booroola Leicester	PIRSA	08 8762 9100
M56	890183			Centre Plus	Merino	L Mortimer & Sons	02 6892 8259		
EL57	960043			Ostlers Hill	English Leicester	ELAssoc/Stephenson	03 5764 1298		
WH58	960505			Clifton Hills	Wiltshire Horn	AWHSBA/Ballantyne	03 5145 8225		
EF59	970100			Silverstream	East Friesian	A. Baillieu	03 5597 6598		
WS60	974842			Linden Genetics	PLG White Suffolk	Linden Genetics	02 6386 2020		
1999	Hamilton			BL61	970188	Wongajong	Border Leicester	AD & CM Wilson	02 5882 3338
				BL62	98X050	Kelso	Border Leicester	GB Starritt & Son	03 5829 0144
				BoL63	950160	Struan	Booroola Leicester	PIRSA	08 8762 9100
				Cr64	910415	Coolana	Corriedale	PG Munro	03 5575 3240
		Cp65	978431	Cashmore Park	Coopworth	J Keiller	03 5526 5248		
		Ch66	910L92	Grand Ridge	Cheviot	RN Waddell	03 5626 4244		
		FI67	960085	Gippfinn	Finnsheep	S & D Jones	03 5122 3328		
		EF68	981019	Yollom	East Friesian x Perendale	MF & ML Molloy	03 5596 2077		
		EFR69	970175	Price	East Friesian x Romney	EJ & KJ Price	03 5527 1110		
		1999	Struan	BL70	970310	Johnos	Border Leicester	NW & JI Johnson	08 8756 6053
				BL71	97W290	Kelso	Border Leicester	GB Starritt & Son	03 5829 0144
				M72	930051	Merinotech Mid	Merino	Merinotech Mid North	08 8665 4019
				EL73	950T82	Koenarl	English Leicester	CR Taylor	03 5595 0272
Cp74	970101			Oaklea	Coopworth	DW & IA Peglar	08 8738 9291		
Hy75	960215			Cowra	Hyfer	NSW DPI	02 6391 3813		
FIF76	960132			Gippfinn	Finn Friesian	S & D Jones	03 5122 3328		
EF77	960136			Silverstream	East Friesian	A. Baillieu	03 5597 6598		
SHD78	970155			Tauranga	South Hampshire Down	S & M Macmillan	03 5596 2251		
PD79	970101			Wyndamah	Poll Dorset	GJ & BJ Oxley	03 5037 2355		
WS80	970172			Koonawarra	White Suffolk	AWSA	08 8210 5211		
2000	Struan			BL81	960327	Morton	Border Leicester	JD & CM Corbin	08 8765 8058
				BL82	980260	Johnos	Border Leicester	NW & JI Johnson	08 8756 6053
		BL83	980085	Johnos	Border Leicester	NW & JI Johnson	08 8756 6053		
		SAM84	980046	Jeancourt	SAMM	W & M Heddle	08 8271 7080		
		Cp85	980091	Oaklea	Coopworth	DW & IA Peglar	08 8738 9291		
		Gr86	980144	Yangoora	Gromark	Yangoora Gromarks	02 6383 3254		
		Hy87	940278	Cowra	Hyfer	NSW DPI	02 6391 3813		
		FI88	538	Gippfinn	Finn	S & D Jones	03 5122 3328		
		EF89	981071	Yollom	East Friesian x Perendale	Karioi Seed Stock/Udy	03 5597 6621		
		WS90	960513	Langley Heights	White Suffolk	AWSA	08 8210 5211		
		WD91	990906	Axis	White Dorper	B & L Mawson	08 8537 0615		

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A4.5 Electronic

Prime Notes: CD-ROM. "Maternal Sires Central Progeny Test" QDPI

Internet site: <http://lambplan.une.edu.au/mcpt>

Software: EBV \$ Calculator for Maternal Sires (*N Fogarty & L McLeod*)

APPENDIX A5 - ACKNOWLEDGEMENTS

Meat and Livestock Australia provided financial support for this project as outlined in Section 10. Dr Rob Banks was closely involved with the design and management of the project through his earlier role as Manager LAMBPLAN and was the Project Co-ordinator for MLA from 2001. Laurie Thatcher was the Project Co-ordinator for MLA prior to 2001. Dr Alex Ball and Richard Apps through LAMBPLAN have been involved in recent years.

The Australian Government through The Australian Sheep Industry Cooperative Research Centre also provided financial support together with NSW Department of Primary Industries that assisted with the analysis of the results.

The two state Departments have provided considerable support to the project with resources and staff at the various sites.

NSW Department of Primary Industries - Dr David Hopkins and Dr Arthur Gilmour contributed to the design. Considerable expertise and technical support has been provided by Kelly Lees, Tony Markham, Ashley Radburn, David Stanley, Sharon Nielsen and Dr Alex Safari, as well as the Managers and other staff at Cowra and Orange Agricultural Institute. Dr Peter Holst provided valuable advice for the milking studies.

Department of Primary Industries Victoria – Hamilton – Dr Leo Cummins managed the Hamilton site and had considerable input into the project until his retirement in 2002. Trevor Pollard managed the project at Hamilton from 2002. Kerrie Groves and Murray Arnold have provided considerable technical support, with additional support from Roger Thompson, Alison Behrend, Victoria Condon, Michelle Carter, Brian Hurley, Phil Forsyth, and Brian Clark.

Department of Primary Industries Victoria – Rutherglen - Philip Kenney was involved in the early planning prior to his retirement in 1997. Greg Seymour, Paul Curran, Taffy Phillips, Max Daniel and Angela Avery have provided considerable technical and management support, together with other staff at Rutherglen.

Primary Industries South Australia and the South Australian Research and Development Institute ran a site during the first phase of the project at Struan (1998 – 2001). This site was managed initially by John Stafford until his retirement in August 2000 and subsequently by Dr Janelle Hocking Edwards and Dr Nick Edwards. Jack Rowe, Tamara Starbuck, Liz Abraham and Elke Hocking have provided considerable technical support, together with other staff John Cooper, Colin Windebank and Shane Walker

The Technical Transfer Advisory Group (TTAG) is thanked for their support and ongoing advice. The TTAG was convened by Laurie Thatcher and the members were Don Peglar, Lynton Arney, John Keiller, Charlie Prell, Robert Mortimer and Sandy Cameron.

We also wish to thank the managers and staffs of the abattoirs and meat processors for their cooperation and assistance in the lamb slaughters and carcass measurements over the several years of the project. These include Cowra Abattoir P/L, Tatiara Meat Company, Coles, Gundagai Meat Processors, Colac Abattoirs, Penny and Laing, Scotsdale Meats, Norvic and Hills of Darling.

Finally the breeders who entered sheep are thanked for making the MCPT possible by their enthusiasm and commitment to genetic improvement in the maternal sector of the lamb industry. The additional support from the owners of the three link sires, Bruce Starritt, Don Peglar and Garry Wake is greatly appreciated.