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Ewes for the future

– fertility, lambs & wool

Final Report – from study start Jan 2015 to October 2019

The team from the Campaspe Lamb Producers Group and sponsors after lamb marking

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Study outline

Sheep farmers are actively seeking unbiased information on the performance of sheep breeds and bloodlines within breeds to help improve their overall profitability. To help answer this question the Elmore Field Days Inc ran a comparison to determine the merit of six ewe genotypes for prime lamb and wool production from 2015 to 2019. Each of the six genotypes was represented by 42 ewes randomly selected from three properties. The ewes were joined annually to terminal sires for prime lamb production and run together as one mob except at lambing; there were five opportunities to lamb, the first as ewe lambs.

Selection preference was true commercial flocks rather than commercial flocks attached to studs. The main characters of interest are lambing percentages, lamb growth rates and wool production.

The six ewe types being compared: include three 'crossbred' and three 'merinos', they were

1. Border Leicester x Merino Crossbred ewes
2. Multimeat x Merino Crossbred ewes
3. Cashmore-Oaklea Performance Maternals (Composites)
4. Merino Loddon Valley
5. Leahcim Merinos
6. Centre Plus Merino

Statistical analyses will be conducted when funding is available; then least significant differences (LSD) will be shown where appropriate. In the meantime the LSDs from the Elmore Field Days first ewe comparison, 'Ewes for the future – lambs, wool & profit' from 2009 to 2014 are listed in this report.

Disclaimer

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Section 1. Summary

Sheep farmers are actively seeking unbiased information on the performance of sheep breeds and bloodlines within breeds to help improve their overall profitability. To help answer this question the Elmore Field Days Inc ran a comparison to determine the merit of six ewe genotypes for prime lamb and wool production from 2015 to 2019. Each of the six genotypes was represented by 42 ewes. Each genotype group was randomly selected from three properties, with 14 ewe lambs per property after an allowance for culling. The ewes were joined annually to terminal sires for prime lamb production and run together as one mob except at lambing; there were five opportunities to lamb, the first as ewe lambs.

Ewe genotypes compared were:

1. Border Leicester x Merino Crossbred ewes
2. Multimeat x Merino Crossbred ewes (carry the Booroola gene for higher lambing percentages)
3. Cashmore-Oaklea Performance Maternals (Composites)
4. Merino Loddon Valley (locally bred Merinos sourced from Loddon Valley Merino ram breeders)
5. Leahcim Merinos (a specialty dual purpose merino from South Australia)
6. Centre Plus Merino (a specialty dual purpose merino from New South Wales)

Lambing time varied from year to year, from April (autumn) to August (late winter) as ram introduction varied from 10 November and 26 February. Ewes were pregnancy scanned about 90 days after the rams were introduced and assigned as 'dry' or carrying a single, twin or multiple. They were divided into their breed groups immediately prior to lambing and run together again from lamb marking. Ewes were inspected at least daily during lambing and assistance was only given when needed. Individual lambs were not identified with their dam at lambing. Instead ewe udders were inspected at lamb marking and weaning and each ewe was classed as 'wet' or 'dry' or 'lambed and lost' when linked to scan information.

Shearing was in early October year and wool mid-side samples for wool quality characters were taken about 3 weeks before shearing. Lamb growth was assessed by live weights before sales and the proportion that would go to slaughter in the first draft. Lambs were weaned at 12 to 14 weeks and sold when a commercial draft reached a minimum live weight depending on the season, ranging from 43 kg in the poor 2018 season to 49 kg in the 2019 season. Carcase measurements were available for 3 slaughter batches of lambs totalling 390 lambs over three years. Underweight lambs were carried over the summer in three years.

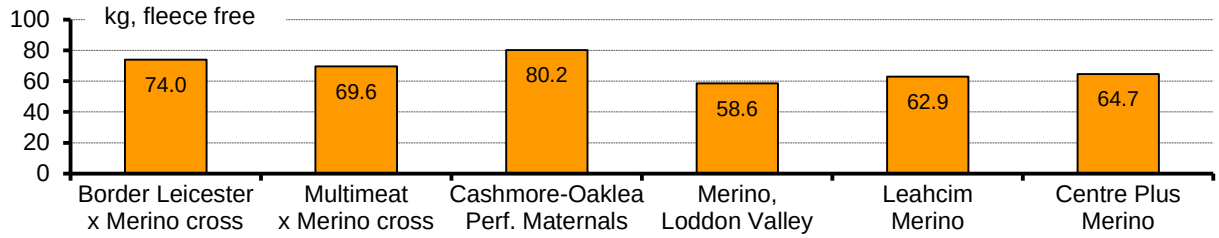
Wool and lamb returns per ewe were calculated each year using average prices over the previous 12 months. Wool prices differences mainly reflected fibre diameter, Price discounts for fibre length and strength were minor, bale core test results are shown in the detail. Lamb returns per ewe were calculated from lambing percentage, lamb live weight, dressing percentage and skin value.

The results in this summary are for the four adult years. Full results, including those as ewe lambs are shown in the detail.

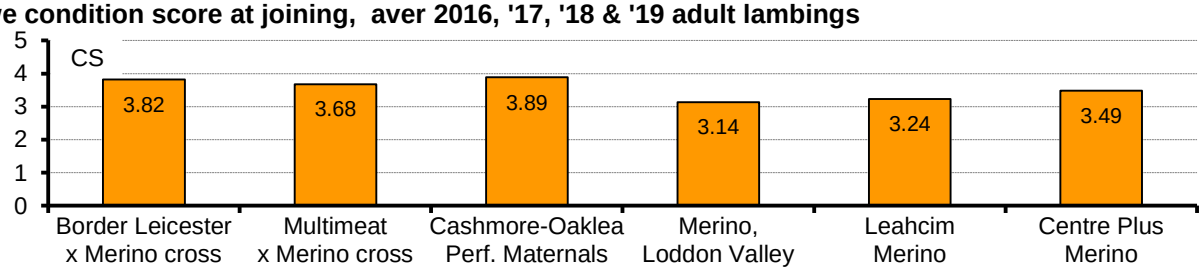
Statistical analyses will be conducted when funding is available; then least significant differences (LSD) will be shown where appropriate. In the meantime the LSDs from the Elmore Field Days first ewe comparison, 'Ewes for the future – lambs, wool & profit' from 2009 to 2014 are listed here. They are of some value as the two ewe comparisons were identical in design. LSDs were:- Ewe weight, fleece free at joining 8.1 kg. Condition score at joining (score 1-5) 0.17 CS units. Clean fleece weight 0.4 kg. Fibre diameter 1.3 µm. Lambs marked per ewe joined 6%. Lamb weight in spring, before any sales 0.5 kg. Dressing percent of lambs 0.3%.

The main results are shown in the following graphs

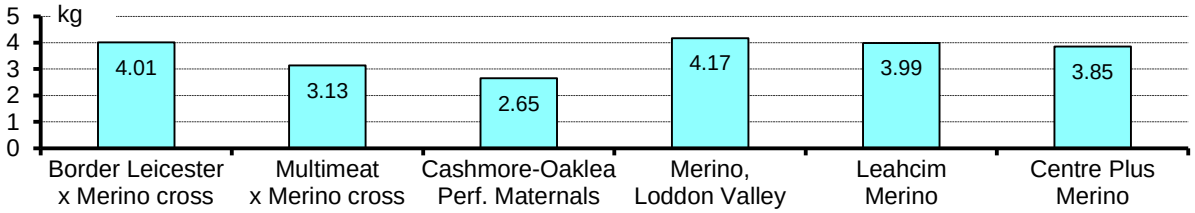
Ewe weight at joining, aver 2016, '17, '18 & '19 adult lambings



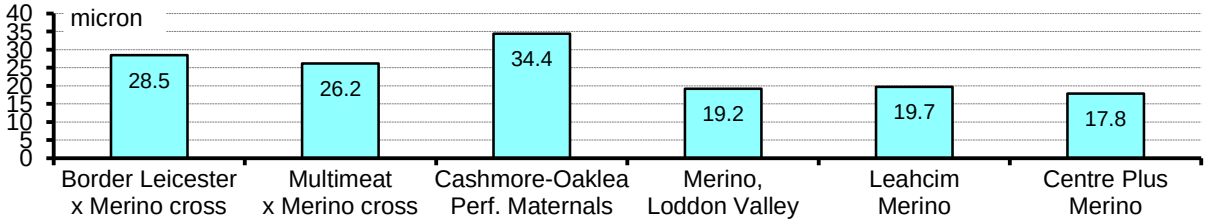
Ewe condition score at joining, aver 2016, '17, '18 & '19 adult lambings



Clean fleece weight, aver 2016, '17, '18 & '19 adult shearings

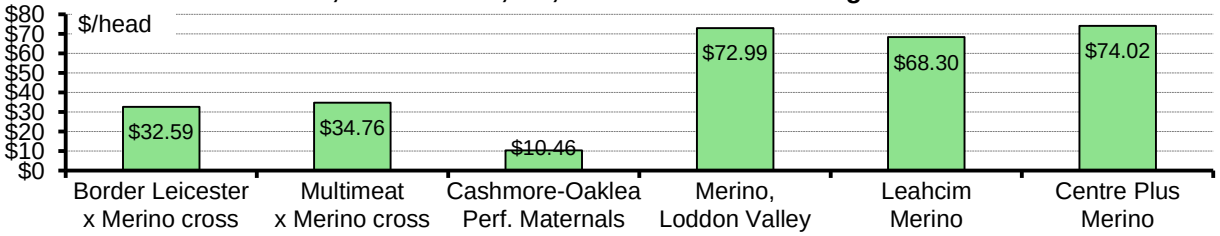


Wool Fibre diameter, aver 2016, '17, '18 & '19 adult shearings



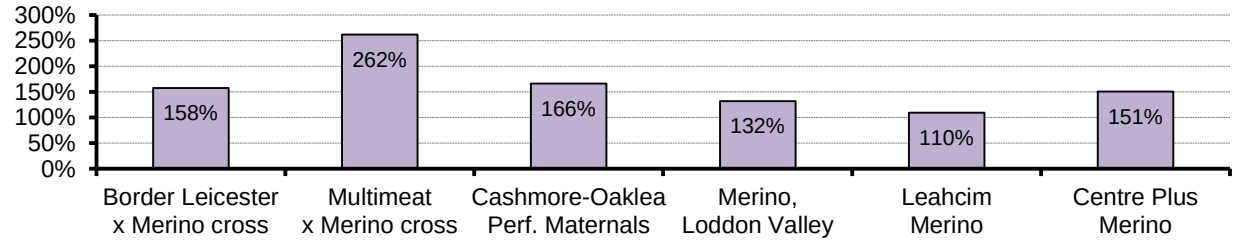
Fleeces were valued at each shearing using the average wool price for each type over the previous year. The results are shown below.

Fleece value as adult ewes, aver of 2016, '17, '18 & '19 adult shearings

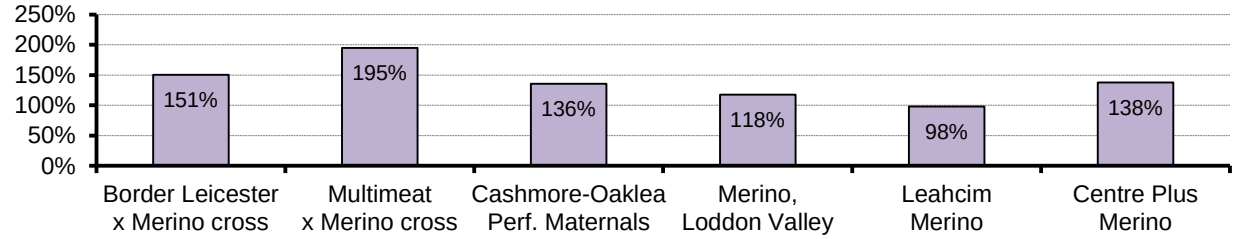


The question arises: How meaningful or accurate are comparisons of ewe reproduction, as conducted at Elmore? The answer is there have been 4 experiments with Australian Merinos and 2 in the United Kingdom with local breeds that indicate that ewe undernutrition as a foetus or in early life has small or no significant effects on lifetime ewe reproduction after the ewes have been run together as one mob for up to a year. This is discussed in detail later in this document.

Lambs scanned per ewe joined, aver 2016, '17, '18 & 19 adult lambings



Lambs born per ewe joined, aver 2016, '17, '18 & 19 adult lambings



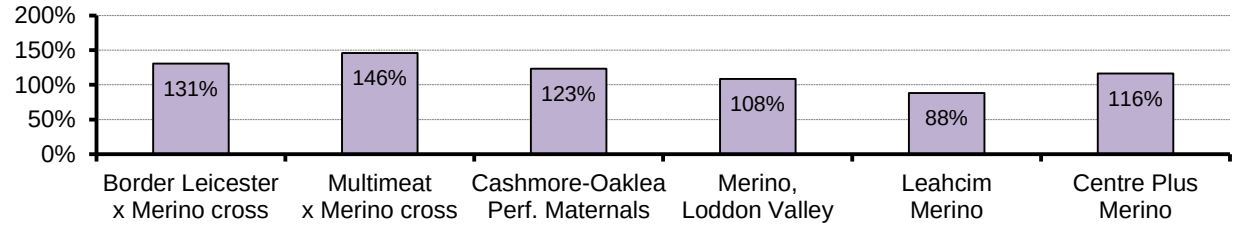
During lambing dead lambs were picked up at least daily, this was added to the number of lambs marked to calculate the number of lambs born. It is obvious there were some large differences between the pregnancy scanning rate and the number of lambs born. Reasons for this include:

(i) Embryo-foetal mortality between scanning and lambing. Small embryo losses are normal, but embryo losses increase with multiple embryos from twins to higher multiples.

(ii) Scanning accuracy is affected by several factors, which should be considered when interpreting implementing the results, especially in breeds with high fecundity. In general, the numbers of fetuses are overestimated at scanning and increase gradually with the number of fetuses diagnosed. Several overseas studies and personal reports from scanning training workshops indicate that scanning for fertility (pregnant vs dry) is highly accurate, scanning for singles vs twins has very good accuracy, but the accuracy of scanning for triplets or more has average to medium accuracy , around 65 to 70% with highly competent operators. Accuracy also decreases with increasing age of gestation and with increasing ewe fatness. The highest accuracy is obtained with sheep positioned on their backs in a VE machine examined at length with more specialised equipment. Some scanners say their accuracy is increased substantially if the scanning window is reduced so they are just scanning pregnancies ranging up to 70 days with the “empties” rescanned two to three weeks later. Operator error increases if ewes are overly boisterous, overly fat or overly full (ie not curfewed prior to scanning).

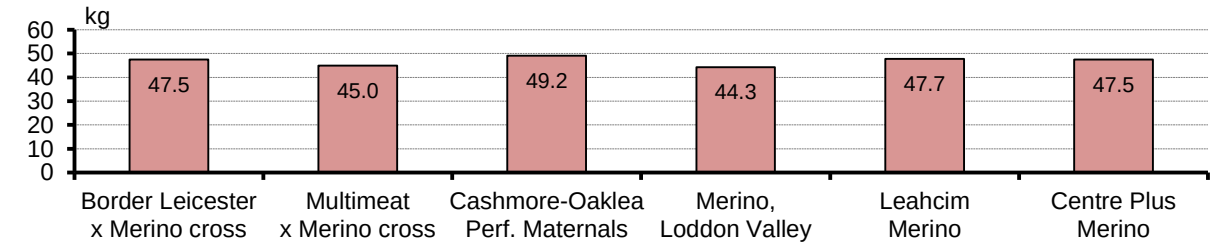
(iii) Predators. There is a chance of foxes removing lambs before the regular inspection each morning during lambing. However these losses are likely to be low.

Lambs marked per ewe joined, aver 2016, '17, '18 & 19 adult lambings

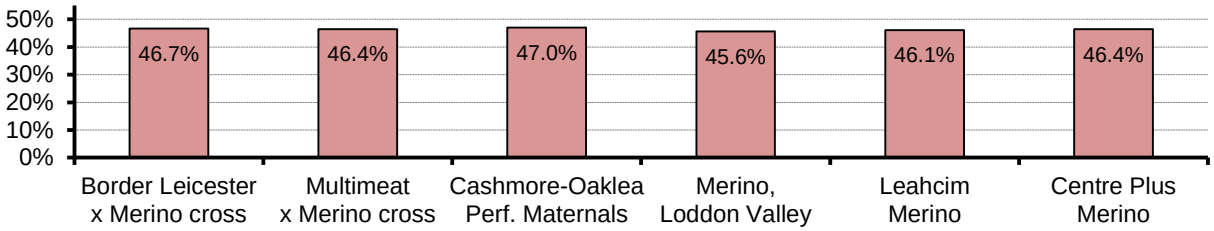


Ewes were separated into their breed groups a few days before lambing and then run together from lamb marking. The weights shown below are the average lamb weights of all lambs of each breed when the first batch of lambs was sold. In good seasons the first batch were sold at heavier weights and in poor seasons at lighter weights.

Lamb weight when first batch sold, aver 2016, '17 '18 & '19, ex adult ewes and terminal sires

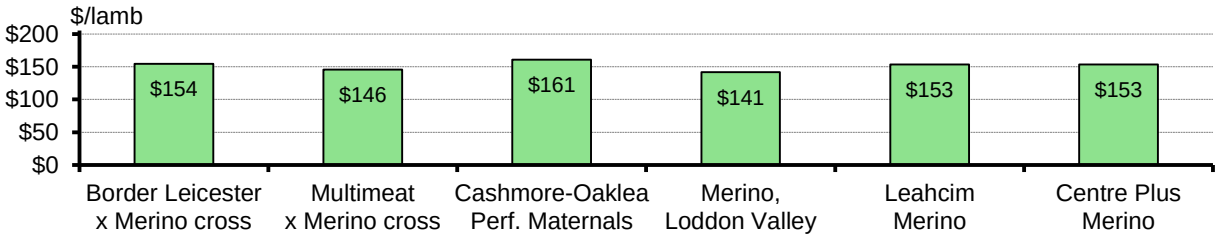


Dressing percent of lambs, aver 2016, '17 & '18 drops, '19 na



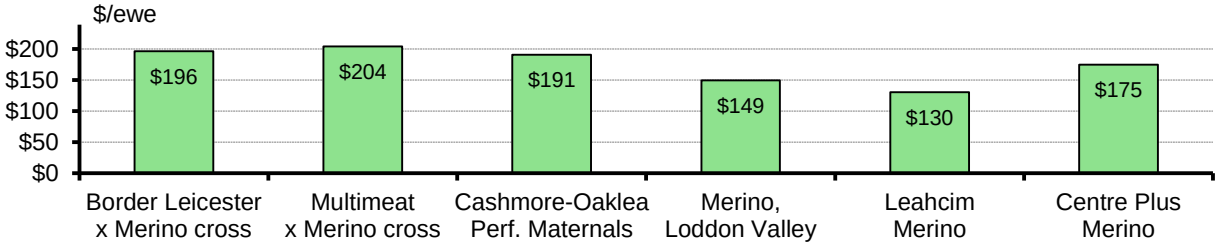
The lamb price per head was calculated from their estimated carcase weight when the first batch was sold, the average dressing percentage and the average carcase price over the previous year.

Lamb price aver 2016, '17, '18 & '19 drops, incl skins, $/lamb



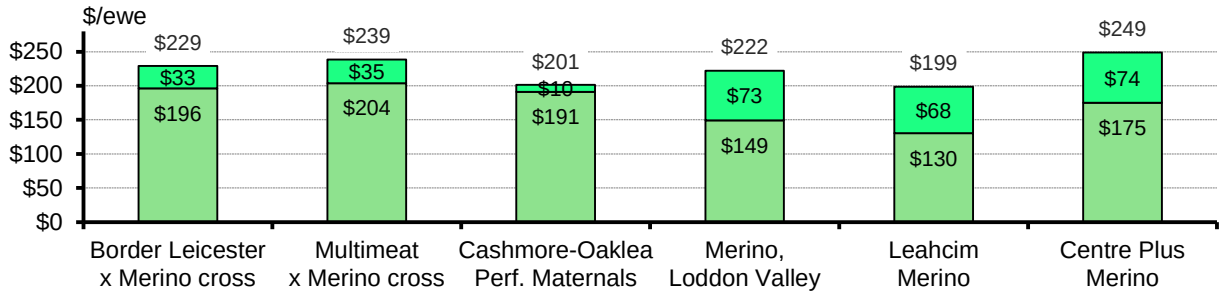
The lamb returns per ewe were calculated from the price per head and the lamb marking percentage after a small allowance for lamb deaths from marking to sale.

Lamb returns per ewe, aver 2016, '17, '18 & '19 drops, incl skins, $/ewe



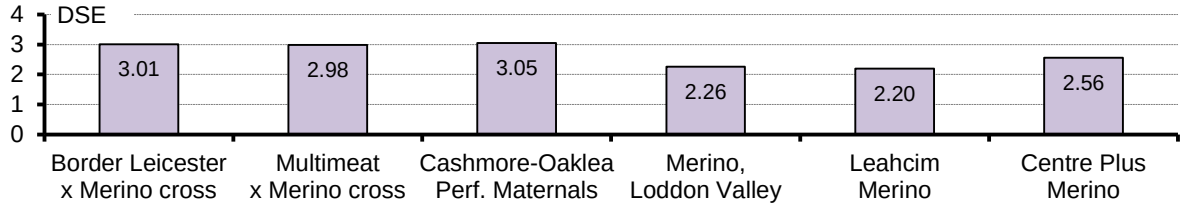
The total lamb and wool returns per ewe were averaged for the 2016, '17, '18 and '19 seasons to give the average total returns per ewe.

Total lamb and wool returns per ewe, aver of 2016, '17, '18 & '19



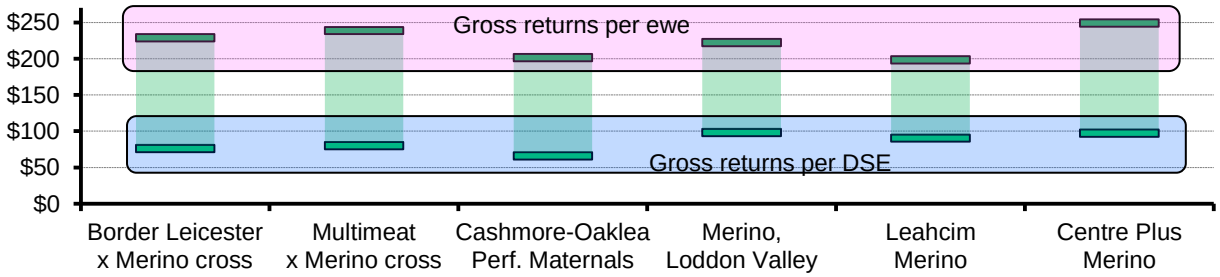
The DSE (dry sheep equivalent) per ewe indicates the feed eaten per ewe and lambs marked. This calculation allows for the extra feed needed with higher lambing percentages and higher ewe weights. One DSE is the amount of feed energy needed to maintain a dry sheep at 50kg live weight for one year; it equates to about 310 kg dry matter of pasture eaten.

DSE rating per ewe & lambs marked & grown to sale, aver 2016, '17, '18 & '19 seasons



A profitability analysis will be undertaken after the statistical analyses. In the interim a comparison of gross returns per ewe and per DSE is presented. The returns per DSE compare breeds at the same stocking pressure, it is the most relevant as it takes into account ewe size, lambing percent and lamb growth. At lower stocking rates the returns per ewe become more relevant as feed may not be limiting.

Gross returns from lamb and wool, (i) per ewe and (ii) per DSE, aver seasons 2016, '17, '18 & '19



Section 2: Background

Ewe breeds and management

What's the best sheep type for a combination of prime lamb and wool production? This question has been debated by sheep producers for years.
In January 2015, the Elmore Field Days study, Ewes for the Future – fertility, lambs & wool, began. The trial aims to compare the merits of six alternative sheep types in the Northern Victorian environment at Elmore. The results will assist sheep producers determine the merits of a number of ewe breed alternatives for prime lamb and wool production. The main characters tested were lambing percentages, lamb growth rates and wool production.

Six ewe types, three 'crossbred' and three 'merino' were compared:

Ewe breed type	***Background***
Border Leicester x Merino Crossbred	The most common prime lamb mother in the Elmore and northern districts. The ewes were sourced with the help of the Victorian State Committee of the Australian Border Leicester Association.
Multimeat x Merino Crossbred	Multimeats are a composite breed based on White Suffolk, Border Leicester and several other breeds. They supply rams that are DNA tested to carry 2 copies of the Booroola fertility gene. These rams breed first cross ewes from Merinos. The first cross lambs carry one copy of the gene. Multimeat breeders claim these ewes consistently rear 30% more lambs than normal crossbreds.
Cashmore-Oaklea Performance Maternals (Composites)	Cashmore-Oaklea Performance Maternals (Composites) have bred sheep from the following breeds: Coopworth, Border Leicester, East Friesian, Finn, SAMM (South African Meat Merino), Texel, Poll Dorset, White Suffolk, Merino, Corridale, NZ Romney and Perendale. They have achieved a reputation for good lambing percentages that are assisted by the hybrid vigour between the various breeds.
Merino Loddon Valley	The second most common prime lamb mother in the Elmore and northern districts. Rams are predominantly Peppin genetics but some studs contain some South Australian Merino genetics. Ewes were sourced with the help of the Loddon Valley Stud Merino Breeders Association from three properties in northern Victoria that use Loddon Valley Merino rams.
Leahcim Merinos	Leahcim is a South Australian Merino stud that has a long history of selecting a meat type merino with low wrinkle and high quality wool. The stud sells large numbers of rams annually and many studs and commercial flocks in Victoria have introduced Leahcim genetics.
Centre Plus Merino	Centre Plus is a group breeding scheme and registered Merino stud in Central West NSW that aims to produce dual purpose sheep. This Merino strain has achieved a good reputation from the high dual purpose and fine wool index ASBVs on the Sheep Genetics Australia website.

Ewe lambs, 2014 drop were delivered to the Elmore Field Days by early January 2015. They were fed a high-quality diet to reach a suitable joining weight in late February 2015, when they were joined to White Suffolk rams. The ewe breed groups were run together except during lambing. Ewes were shorn in early October each year at the Elmore Field Days and when appropriate, carryover lambs were shorn in early December. The table below shows key management dates.

Lambing	***Seasonal year***	***Ewe age at lambing***	***Join date***	***Mid lambing date***
1st	*2015*	*15 mths*	*late Feb 2015*	*Aug 2015*
2nd	*2016*	*2 yrs*	*late Jan 2016*	*July 2016*
3rd	*2017*	*3 yrs*	*early Jan 2017*	*June 2017*
4th	*2018*	*4 yrs*	*early Dec 2017*	*May 2018*
5th	*2019*	*5 yrs*	*early Nov 2018*	*April 2019*

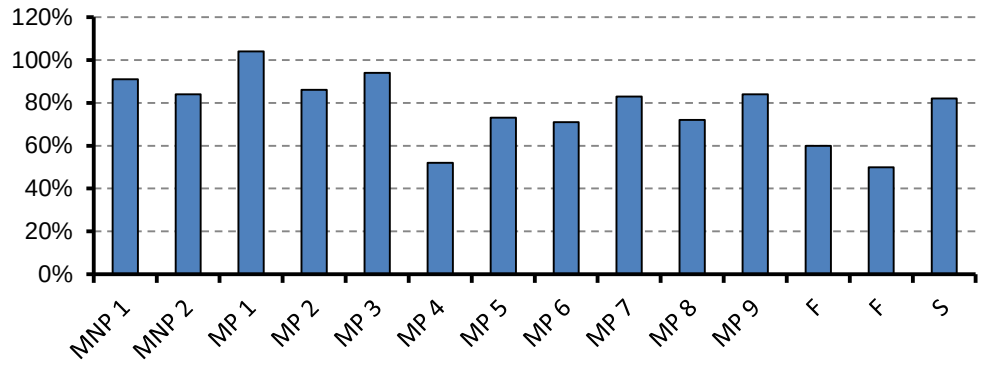
Are the ewes in the study representative of the breed groups? Ewes representing each breed were sourced from 3 properties because of the genetic and farm background variability between flocks within a breed. All ewe lambs in this study came from flocks nominated by breed society representatives. Sheep breeds are composed of many bloodlines; there are genetic differences between bloodlines, flocks within bloodlines as well as individuals in an

individual flock. For example, the Merino breed covers a wide range of types from those with a focus on very fine wool to those with a focus on dual purpose meat and wool characters. These results therefore, only apply to the sheep at Elmore and they may or may not be truly representative of the breeds in general.

Comparing lambing percentages in ewe trials

Research by the NSW Dept. Agriculture in the late 1970s and early 1980s found big differences between Merino bloodlines in lambing percentages when all ewes were reared together from conception to the end of the study, see results below (Mortimer et al 1985). However these distinct bloodlines may not exist today due to the widespread use of outside rams by merino ram breeders over the last 50 years, but they indicate large differences between merino strains in reproduction and that objective information on sheep breed and merino strain differences in reproduction need continual updating.

Lambs weaned per ewe joined for 14 merino strains at Trangie NSW, from late 1970s to early 1980s



Merino strains: MNP 1 & 2 - medium non Peppin, MP 1 to 9 - medium Peppin, F 1 & 2 - fine wool Saxon, and S - South Australia strong wool

In this Elmore study all ewes were reared on their home farms from birth to around 5 months of age before delivery to Elmore. A brief review of some factors affecting sheep reproduction and how they might impact on the Elmore results follows.

(i) Does the level of nutrition in early life as a foetus and as young lamb up to weaning and from weaning until entry to this study, affect mature body size, wool production and lambing percentages later in life? Overall, Australian and New Zealand research, in four trials with merino sheep, indicate the nutrition of the young merino ewe, from a foetus to weaning has small or non-significant long term effects on subsequent reproduction under commercial farm conditions; once the ewes have been run together for a year. (Allden 1979, Behrendt et Al 2011, Davis et al 1983 and Thompson 2012 pers comm). However, two trials in Britain with local breeds indicated that under nutrition as a young lamb lowered lambs born per ewe joined by around 4 to 5%. It was suggested this was due to a higher rate of embryo or foetal mortality during pregnancy rather than differences in dry ewes or number of eggs shed per ewe (Gunn et al 1995, Rhind 1998).

Some research details follow.

Lifetimewool core sites. At two sites (Vic. and WA) in each of two years, 2001 and 2002, a wide range in the live weight profiles of ewes were generated during pregnancy and lactation by varying the amount of supplements fed and feed on offer grazed. Across the four experiments this resulted in lamb weights ranging from 13.8 to 28.3 kg just before weaning. The studies found improving the nutrition of Merino ewes during pregnancy increases the fleece weight and reduces the fibre diameter of their lamb's wool during their lifetime (Thompson AN et al 2011b). The findings also suggest that the mature size of offspring is unlikely to be adversely affected by pre-weaning nutrition within the range of nutritional scenarios during pregnancy and lactation that are likely to be experienced within the Australian sheep industry (Thompson et al 2011a). However there were no effects on the ewe lambs reproduction performance after the 'high' and 'low' nutrition treatments were run together after weaning (Thompson AN 2012, pers comm).

Lifetimewool farm validation sites
The original Lifetimewool core research site results on the effects of improved nutrition of ewes during pregnancy on the lifetime production of their lambs were further tested in 14 paddock scale experiments across Australia. The researchers concluded "Maternal nutrition during pregnancy had no significant effect on the reproductive performance of ewe progeny as maidens", (95 vs 96% for high and low nutrition,

respectively, P = 0.8). (Behrendt et al 2011, page 209). This is in contrast to the effects on wool production where good nutrition of the foetus during pregnancy improved lifetime fleece weight and reduced fibre diameter by up to 0.2 microns.

New Zealand experiment with merino lambs and later lambing performance. New Zealand hill country merino lambs-hoggets were fed combinations of high and low nutrition over a 13 month period, from 6 to 19 months of age, so that the largest weight difference between groups was 15.1 kg. There were large differences in reproduction performance at the first joining at 19 months, but these differences did not persist to the later lambings, where there were no significant differences in dry ewes but a difference in lambs weaned of about 2% (Davis et al 1983). Compensatory growth of the low nutrition ewes after the feeding treatments finished ensured the low nutrition ewes made a full recovery.

South Australian Merino experiment in the 1960s. The growth of two groups of Merino lambs was severely restricted at different stages of early post-natal life so that at 420 days of age they weighed only 12 kg. Their normally grown sibs born 1 year later attained a similar weight at 53 days. Although the ewes subjected to growth restriction were smaller in later life; there was no significant difference in the number of dry ewes (8% dry in restricted vs 11% dry after normal feeding) or in the number of lambs born (96% in restricted vs 109% in normal feeding, very small numbers) but there was a suggestion that the unrestricted controls produced more twins than the other groups. The results of this experiment provide strong evidence that "the most severe and prolonged periods of nutritional stress in early post-natal life had as its sequel a permanent impairment of adult weight, reduced wool production and fewer wool fibres but the capacity of the Merino ewe to reproduce in later life is unlikely to be affected by very poor nutrition as a lamb" (Allden 1979).

British experiments. In Scotland, Scottish Blackface ewe lambs were undernourished up to weaning, but this resulted in no significant effects on the proportion of dry ewes, but a lifelong reduction of four percent in the incidence of multiple births. This was due to a reduction in embryo or foetal survival and not a reduction in ovulation rate (Gunn et al 1995). In Wales, Brecon Cheviot ewes were subjected to a restricted level of nutrition prior to weaning. This nutritional restriction did not significantly affect the proportions of dry ewes, but lowered the lifetime incidence of multiple births by about five percent (Rhind 1998).

(ii) How does hybrid vigour affect lambing percentage?. Hybrid vigour is well known in Border Leicester x Merino cross ewes. What is less known is the hybrid vigour when Merino strains are crossed. NSW Dept Agriculture research conducted from 1975 to 2000 indicated that when Merino bloodlines were crossed the average values of ewe or maternal hybrid vigour, expressed through a ewe being a pure bloodline or cross bloodline, were 1.2% for fertility (wet versus dry ewes), 2.9% for litter size (singles, twins or triplets), 6.8% for lamb survival and 8.2% for lambs weaned (Mortimer et al 1997). These NSW Dept Agriculture merinos were initially purchased in the early 1970s when merino bloodlines were more defined than present day merino studs as artificial insemination and the use of rams from other studs may have now reduced the differences between these traditional bloodlines. Reviews of research worldwide indicate average hybrid vigour of 14% in number of lambs weaned when any two breeds are crossed. This may have implications for the Merino flocks where some studs have used rams from diverse sources for many years.

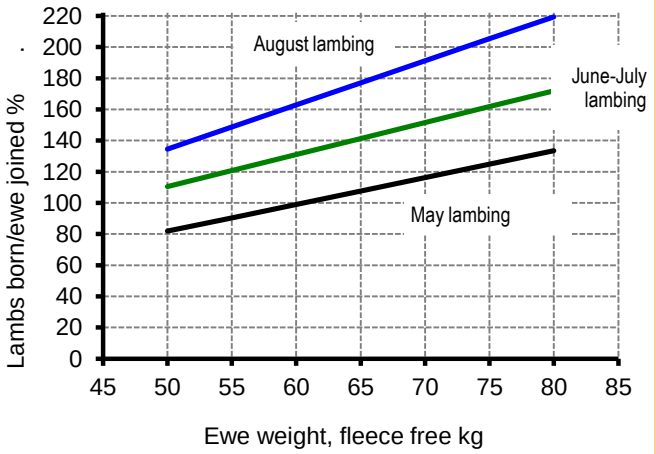
(iii) Seasonality of breeding season, weight and condition score. Sheep are mostly seasonal breeders. Joining early (Nov–Dec) will normally result in fewer lambs born than joining later (Jan–Apr). Some sheep can readily join any season of the year, while others join more reliably later in the breeding season from February to April. The choice of lambing time may thus put some breeds at an advantage or disadvantage to others. In this study the lambing times were varied to reduce any disadvantage to the more seasonal breeding breeds. For example the breeding season of Border Leicester x Merino ewes has been closely studied and ewes joined in March-April could have up to 70% more lambs born per ewe joined than ewes joined in December at a similar weight. This topic is discussed in the box following.

In this Elmore study joining time was varied to include two 'later' lambings; joining in January and February and two 'earlier' lambings; joining in November and December. This may give an indication of time of lambing effects on merinos versus crossbreds; but it was not the primary aim of the study.

The graph shows the relationship between live weight at joining and the percentage of lambs born to Border Leicester x Merino cross ewes at Rutherglen Research Institute during the 1970s. The experiment was run over six years at three stocking rates with three times of lambing.

For example ewes at 70 kg weight and lambing in May would be expected to lamb down at 115% lambs born per ewe joined. Ewes lambing 4 months later in August would be expected to lamb at 190%, an increase of 75% (see graph).

Heavier ewes or those in better condition at joining also have higher lambing percentages. The responsiveness also varies with the time of joining. A 10 kg increase in weight would be expected to lead to a 17% increase in lambs born with a May lambing, but an extra 30% with an August lambing. Derived from Reeve et al 1980.



(iv) Lambing management, for example not separating singles or twins after pregnancy scanning within each breed group might disadvantage breeds with a higher percentage of twins. In this study all ewes were fed to level to ensure optimal survival of twins.

(v) The ewes in this study were first joined as ewe lambs. The question then arises: What effect did lambing as a ewe lamb have on lambing in the following years? Did lambing as ewe lambs penalise those ewes so they had a lower lambing percentage the following year? An analysis in the previous Elmore ewe study indicated that lambing as a ewe lamb had no deleterious effects on lambing percentages in subsequent years. Other studies have given similar results; with good nutrition the lambs recover from the stresses of lambing and there is no lifelong effect on weaning percentage (Tyrrell 1976. and Kenyon et al 2008).

Statistical analyses

Statistical analyses will be conducted when funding is available; then least significant differences (LSD) will be shown where appropriate. In the meantime the LSDs from the Elmore Field Days first ewe comparison, 'Ewes for the future – lambs, wool & profit' from 2009 to 2014 are listed here. They are of some value as the two ewe comparisons were identical in design. LSDs were:- Ewe weight, fleece free at joining 8.1 kg. Condition score at joining (score 1-5) 0.17 CS units. Clean fleece weight 0.4 kg. Fibre diameter 1.3 µm. Lambs marked per ewe joined 6%. Lamb weight in spring, before any sales 0.5 kg. Dressing percent of lambs 0.3%.

The Elmore environment

The ewes were run on the Elmore Field Days site 3 km east of Elmore in northern Victoria. The long term average rainfall is 466 mm. The rain is winter dominant. Most sheep grazing is on annual pastures growing between late autumn and spring and dry pasture residues and crop stubbles over the summer. Annual crops of cereals, oilseeds and grain legumes are normally sown in late autumn and harvested in early summer. Summer storms in some years provide extra green feed from dry-land lucerne and green summer weeds. The trial sheep mostly grazed annual green pasture in the winter – spring growing season and dry pasture and crop residues in the summer. There was some dry-land lucerne that provided additional summer feed.

Notes 2015 season

Dry seasonal conditions were mostly experienced from March 2015 to April 2016. During joining and up to a month prior to lambing in 2015 joined ewes were fed a supplement of Coprice sheep pellets (1.4 kg/head/week, fed every few days) and hay. Prior to lambing the Coprice pellet ration was increased to 2.8 kg/head/week. Green pasture available improved immediately prior to lambing and during lambing the GrazFeed computer program predicted the ewes were eating about 1.0 to 1.3 kg green pasture DM per day. The supplement was then reduced to 1.4

kg/head/week of pellets plus hay. Lambing ewes were supplementary fed with Coprice sheep pellets and hay in their separate lambing groups during the 2015 lambing. The supplement was stopped several weeks after marking and commenced again just prior to weaning to train the lambs to readily take supplementary feed. There were no cases of Pregnancy Toxaemia (Twin Lamb Disease) during lambing, even though some ewes scanned with triplets or quads. Weaned lambs were fed Coprice pellets in the few weeks between weaning in mid-October and their sale as store-finisher lambs a few weeks later.

Notes 2016 season

From early December 2015 ewes were fed Coprice pellets (2.0 kg/head/week, fed twice per week) and high quality hay (2.0 kg/head/day fed in big bales twice per week) at pasture. In early March 2016 the ewes were confined to one paddock and fed Coprice pellets (average intake 3.7 kg/head/week, fed twice per week) and high quality hay (7.7 kg/head/day fed in big bales twice per week). The ewe weighing in early May indicated some crossbred breeds rapidly put on weight while the merino types maintained or slowly lost weight. It was obvious that some crossbred breeds were hogging the limited supply of pellets in the lick feeder. Ewes were then separated into condition score groups and fed according to 'Lifetime Ewe' principles to reach target condition scores about 5 weeks before lambing. Pasture supply increased rapidly due to the April-May rains. Supplementary feeding ceased when ewes were divided into their lambing paddocks in mid-June when the average pasture feed on offer was about 1400 kg green DM per hectare. From lambing onwards no supplements were fed due to the adequate amounts of green feed. The June – July lambing resulted in few lambs reaching heavy slaughter weights by the seasonal dry-off. The prime lambs were shorn in early December 2016 and finished on Coprice pellets. They were sold in two batches when they reach suitable weights in early 2017.

Notes 2017 season

Very good seasonal conditions existed during the 2017 season. Ewes were fed a supplement of oaten hay from late January to early May. The seasonal break occurred in late April and hay feeding finished when ewes were drafted into their breed group lambing paddocks on 9 May. The lambing paddocks averaged 2 t/ha of green feed at the start of lambing. The excellent pasture conditions resulted in excellent lamb growth until weaning in late October. The dry spring resulted in pastures drying off about 2 weeks earlier than normal, but overall it was a very good season. Approximately 60% of lambs were sold in wool in November while the remaining lambs were shorn then sold in early February 2018 after being fed Coprice pellets from late November.

Notes 2018 season

The ewes were joined in late November for an early lambing in May. Dry pasture available was low from mid-January 2018 and ewes were supplemented with oaten hay ad lib plus Coprice sheep pellets trail fed at 1.0 kg per ewe per week. Trail feeding was preferred because in 2016 ewes were fed from a lick feeder and the crossbred types, especially the composites seemed to hog the feeder at the expense of the merinos. Trail feeding seemed to give a more uniform group across breeds without a 'tail' of merinos. This rationed was maintained until several weeks before lambing when the pellets were increased to 3.0 kg per ewe per week. This ration of oaten hay and pellets was through to lamb marking. At lamb marking ewes were again run as one mob and fed both oaten hay and pellets ad lib in an Advantage sheep feeder. At weaning supplementary feeding of ewes ceased but lambs still had access to pellets ad lib in the Advantage feeder. Lambs remained on pasture with pellets ad lib until the first batch was sold on 21st September. After this the carryover lambs remained on pasture with pellets available in the feeder until sold on 21 Jan 2019 after shearing in mid-December.

Notes 2019 season

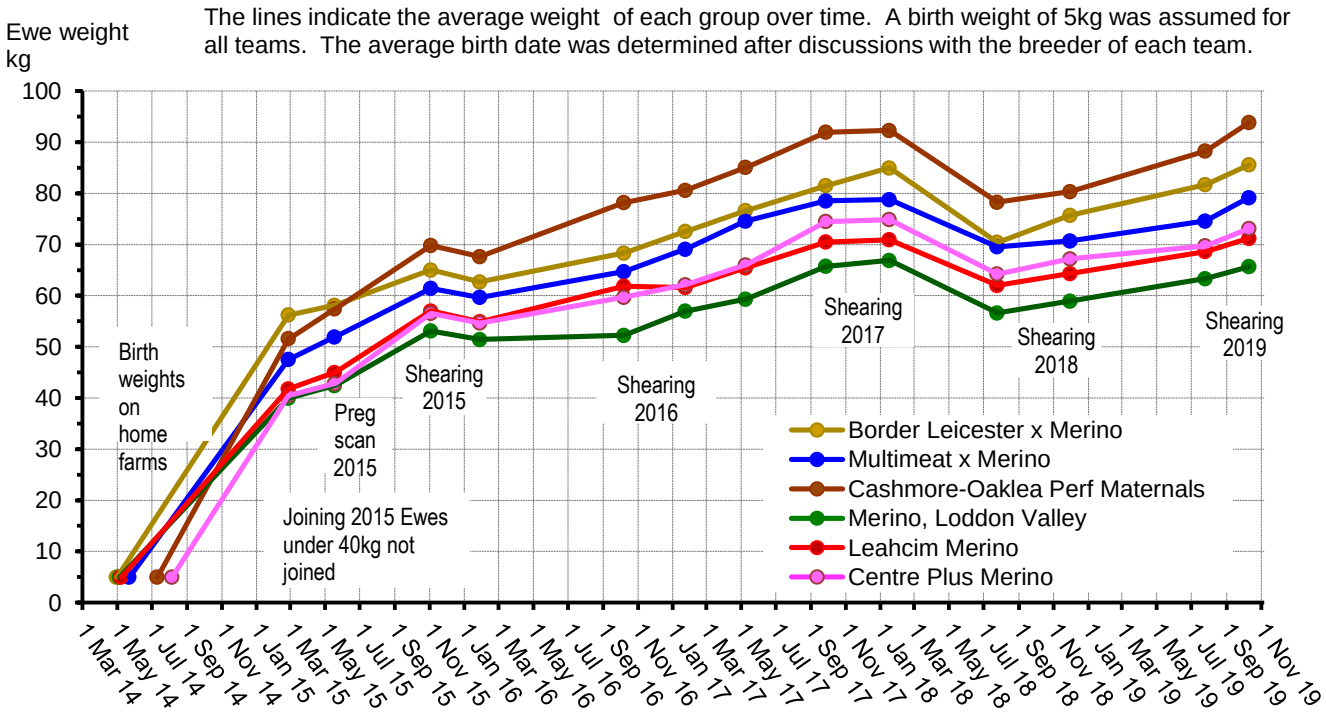
The ewes were joined in early November 2018 for an early lambing in April - May. The peak of lambing was about 5th May. Dry pasture available was low from early January 2019. Ewes were supplemented with oaten hay ad lib plus Coprice sheep pellets trail fed at 1.0 kg per ewe per week until mid-March when the pellets were increased to 3 kg per head per week. Immediately prior to lambing the pellets were increased to 4 kg per head per week. Rains on the 2nd May gave the pasture a good start and supplementary feeding finished in late June when there was sufficient green feed and the oaten hay was left uneaten. Lamb growth through the winter and spring was excellent averaging 321 g/day from lamb marking on 5 June to the 25th July. Lamb growth continued to be excellent averaging 319 g/day from 25 July to the sale of the first draft on 2 October.

Section 3: Results

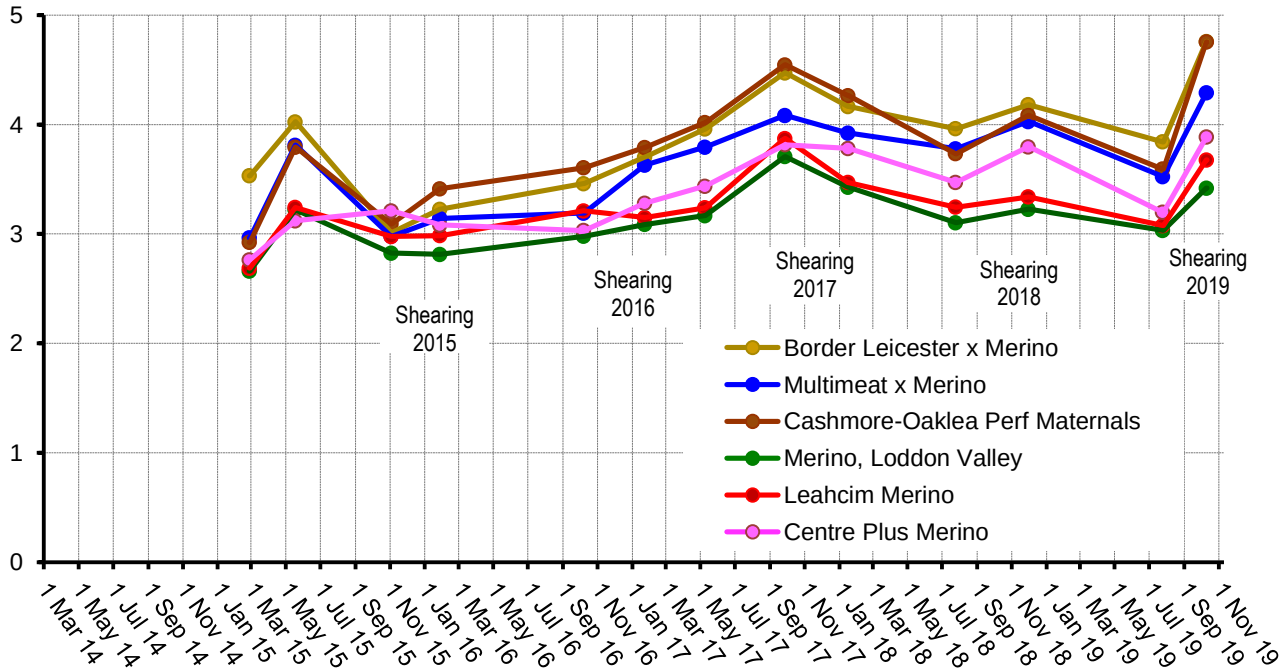
Ewe weight and condition score

Ewe lambs, 2014 drop were delivered to the Elmore Field Days by early January 2015. The weights and condition scores of each breed group are shown in the following graphs. The weights graph also shows the estimated weights at birth on their home farms, a 5 kg birth weight was assumed for all farms and the lambing date was estimated from farm manager interviews. The weights shown are 'fleece free' calculated from each ewe's fleece weight at shearing in early October.

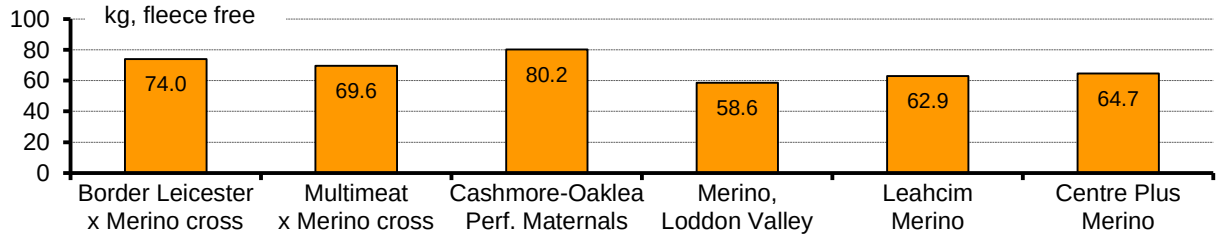
Ewe weights, fleece free, from birth on farms of origin and after arrival at Elmore



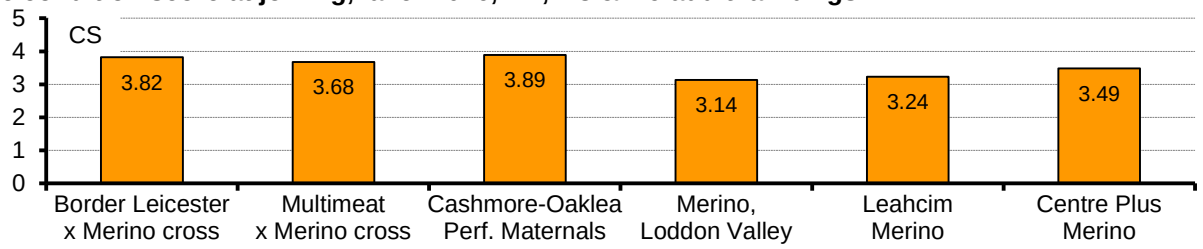
Ewe condition score



Ewe weight at joining, aver 2016, '17, '18 & '19 adult lambings



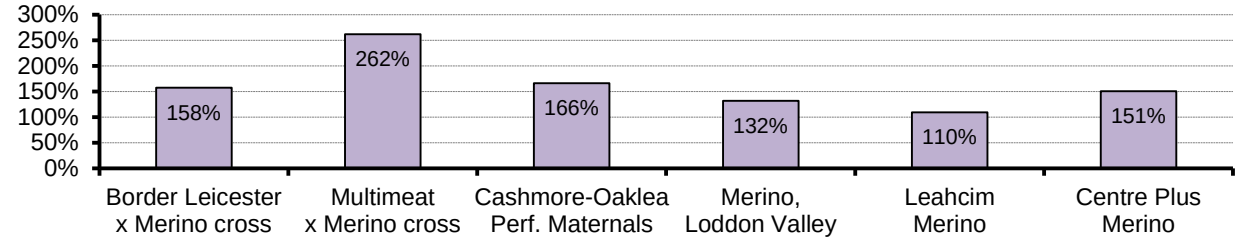
Ewe condition score at joining, aver 2016, '17, '18 & '19 adult lambings



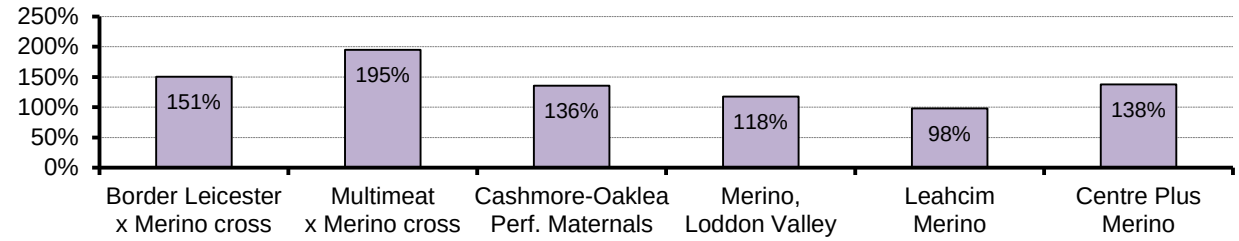
Lambing details

The question arises: How meaningful or accurate are comparisons of ewe reproduction, as conducted at Elmore? The answer is there have been 4 experiments with Australian Merinos and 2 in the United Kingdom with local breeds that indicate that ewe undernutrition as a foetus or in early life has small or no significant effects on lifetime ewe reproduction after the ewes have been run together as one mob for up to a year. This is discussed earlier in the *Background* section of this document.

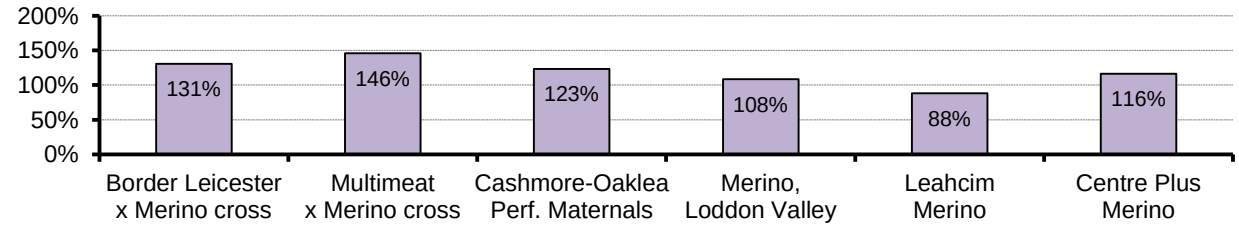
Lambs scanned per ewe joined, aver 2016, '17, '18 & 19 adult lambings



Lambs born per ewe joined, aver 2016, '17, '18 & 19 adult lambings

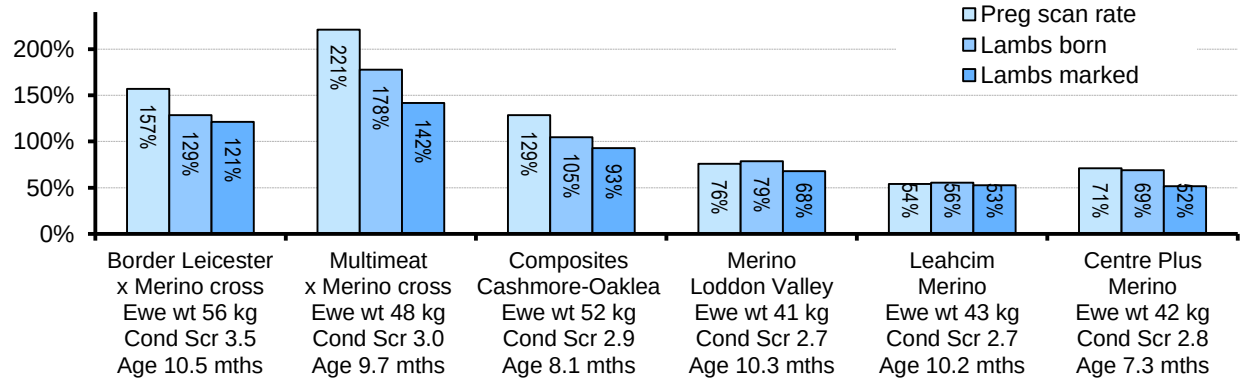


Lambs marked per ewe joined, aver 2016, '17, '18 & 19 adult lambings



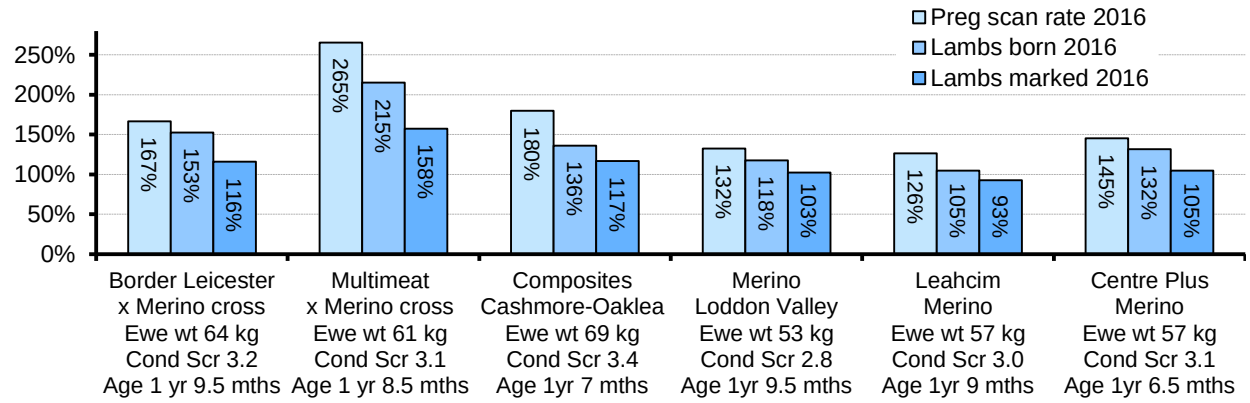
Lambing results by year

Lambing details 2015, joining 26Feb, preg scan 18 May, mid lambing 12 Aug.
Ewes not joined (under 40 kg) are not included in these analyses.



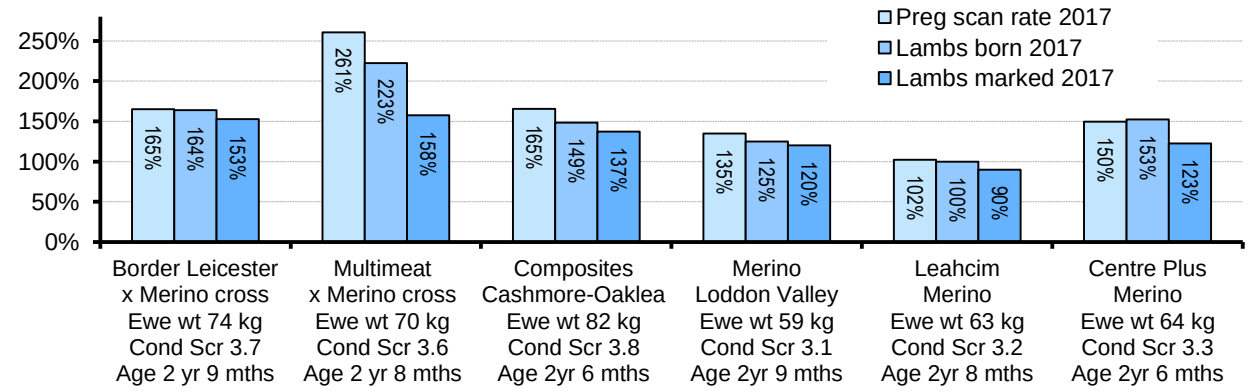
Details at joining: Ewe weight - fleece free, condition score and age at joining

Lambing details 2016, joining 26Jan, preg scan 20Apr, mid lambing 10Jul.



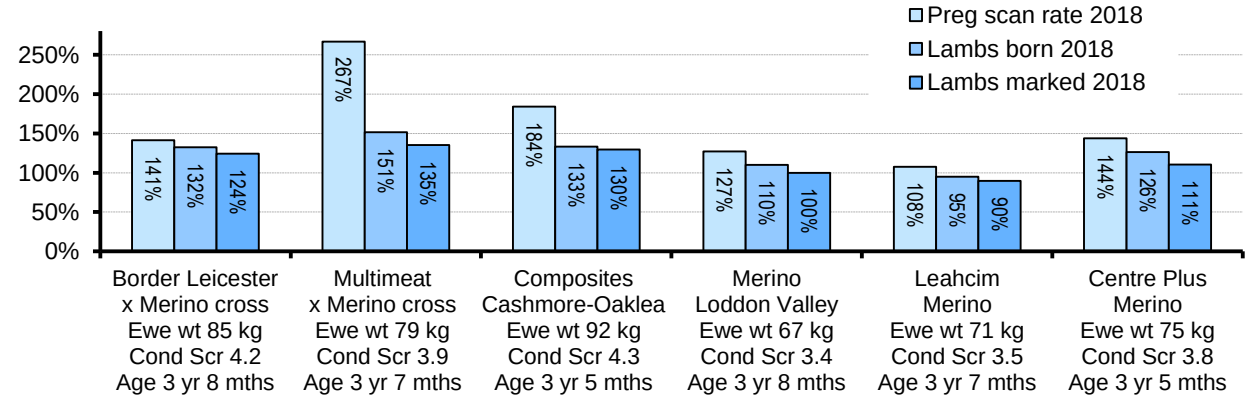
Details at joining: Ewe weight - fleece free, condition score and age at joining

Lambing 2017, joining 29Dec16, preg scan 31Mar17, mid lambing 15June



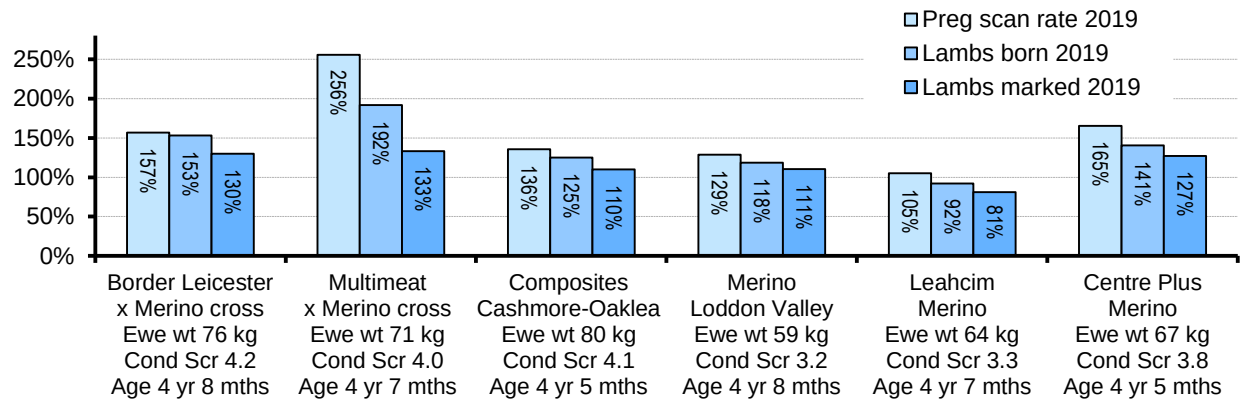
Details at joining: Ewe weight - fleece free, condition score and age at joining

Lambing 2018, joining 1Dec17, preg scan 27Feb18, mid lambing 20May, marking 7 June



Details at joining: Ewe weight - fleece free, condition score and age at joining

Lambing 2019, joining 15Nov18, preg scan 13Feb19, mid lambing 2May, marking 5June



Details at joining: Ewe weight - fleece free, condition score and age at joining

Pregnancy scanning in perspective

During lambing dead lambs were picked up at least daily, this was added to the number of lambs marked to calculate the number of lambs born. It is obvious there are some large differences between the pregnancy scanning rate and the number of lambs born. Discussions with veterinarians and scanners have given possible reasons for these differences, including:

Embryo-foetal mortality between scanning and lambing

Small embryo losses are normal, but embryo losses increase with multiple embryos from twins to higher multiples. They can also increase with low ewe body weight losses, especially ewes with multiple foetuses.
Extract from 'Sheep Medicine' (Scott PR 2007), but edited to reduce technical terms. "However, reduced lamb birth weights can occur when placental development has been limited by competition in the uterus. This situation is not uncommonly encountered in multiple litters and where the birth of twins with disproportionate weights (e.g. 5.5 kg versus 3.5 kg) probably indicates that three embryos implanted and underwent early fetal development but one fetus failed to develop further and was resorbed. The limited number of attachment points available to the remaining fetus results in poor growth and a much reduced birth weight compared to the co-twin, which developed without competition. While the placenta attachment points can increase in size and blood flow, these compensatory mechanisms often fail to overcome their reduced number."
In a New Zealand study on two commercial farms, ewe lambs with fetal losses had a body weight loss(adjusted for fleece and conceptus) difference as small as 80 grams per day compared with those that maintained pregnancy in the 24-30 days leading up to the identification of the fetal loss (Ridler et al 2017).
Campylobacter infection is also a cause of foetal loss but is considered not to be an issue at Elmore. All ewes received the full Coopers Campylobacter vaccine program, a New Zealand developed vaccine to prevent abortions caused by the Campylobacter bacteria, mainly a problem in young ewes. Veterinarians from Coopers that supplied the vaccine followed up with blood antibody tests that confirmed infection was unlikely to be an issue.

Scanning accuracy

Scanning accuracy is affected by several factors, which should be considered when interpreting the results, especially in breeds with high fecundity. In general, the numbers of fetuses are overestimated at scanning and increase gradually with the number of fetuses diagnosed.
Several overseas studies and personal reports from scanning training workshops (Jubb 2019) in Australia indicate that scanning for fertility (pregnant vs dry) is highly accurate, scanning for singles vs twins has very good accuracy, but the accuracy of scanning for triplets or more has average to medium accuracy , around 65 to 70% with highly competent operators. Accuracy also decreases with increasing age of gestation and with increasing ewe fatness. The highest accuracy is obtained with sheep positioned on their backs in a VE machine examined at length with more specialised equipment.
The scanning "window" is critical for accurately counting multiple foetuses. Differentiating single from multiple foetuses is most accurate when pregnancies are between 40 and 90 days; it becomes difficult after 90 days and is impossible for pregnancies greater than 95 days. Differentiating twins from triplets and quadruplets is probably about 60% accurate when scanning a mob of ewes with a pregnancy range of 40 to 90 days with most of the errors occurring in the heavier pregnancies at 75 to 90 days. Some scanners say their accuracy is increased substantially if the scanning window is reduced so they are just scanning pregnancies ranging up to 70 days with the "empties" rescanned two to three weeks later. Operator error does increase if ewes are overly boisterous, overly fat or overly full (ie not curfewed prior to scanning).

Predators

There is a chance of foxes removing lambs before the regular inspection each morning during lambing. However these losses are likely to be low. Alpacas were run with each breed mob in the 2015, '16 and '17 lambings. Dead lambs were picked up and examined for cause of death and up to 30% had some sign of predation.

Elmore experiences

At Elmore the largest differences between scanning and lambs born have been in the Multimeat x Merino cross, the differences have been smaller in the Cashmore Oaklea composites. The Border Leicester x Merino cross ewes and Merinos had low differences.
These differences were present in 2016 and 2017 when the ewes gained condition (see previous graphs) but were higher in 2018 which was very much below average rainfall at Elmore. The ewes gradually lost condition, but were still within 'lifetime ewe' management suggestions. Pasture supply was poor from January 2018 and onwards. Ewes were fed Coprice pellets, 1 kg per week and oaten hay ad lib during pregnancy. Prior to lambing this ration was increased to 3.5 to 4 kg pellets per week plus ad lib oaten hay. Over pregnancy sheep lost about one condition score but lamb survival was excellent at 92%. After lamb marking in 2018 all sheep had ad lib access to lick feeders and oaten hay until weaning.

Seasonality of breeding season

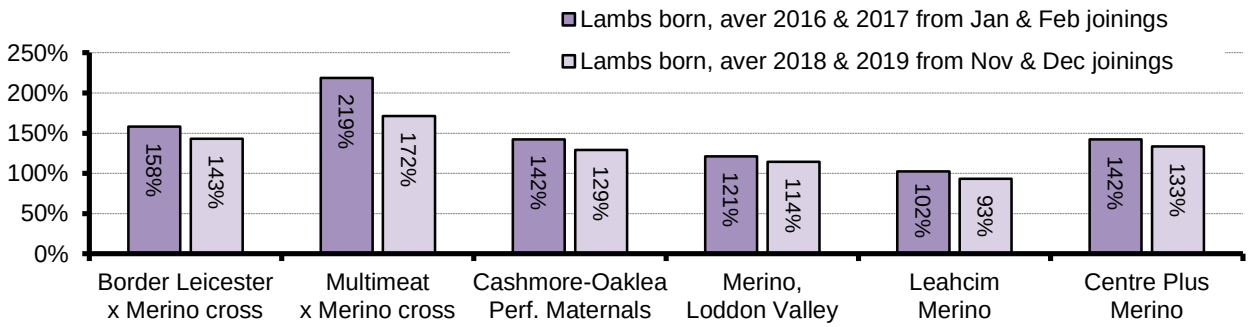
Ewe joining times in northern Victoria are commonly from early November to late January, a few farms may join as late as February. The joining times at Elmore thus reflected local farm management.

Most sheep in Australia are seasonal breeders. They join more readily in the autumn that late spring to early summer. The breeds in this trial differ in their seasonality of breeding. Border Leicester x Merino (BL x M) cross ewes are well known to be more seasonal breeders than merinos. The Cashmore – Oaklea Performance Maternals would also be expected to be more seasonal breeders due to their background that includes Border Leicesters, Coopworths and Romneys.

This study was not designed to compare the seasonality of breeding season between the ewe groups. Lambing percentages are influenced by many factors including ewe condition score, live weight, nutrition around joining time, nutrition 4 to 6 months before joining as well as the seasonality of the breeding season. In this study the numbers of ewes was also limited. Statistical analyses of this trial are not yet available, but we can still look for trends that indicate BL x M and Composite ewes might be more seasonal breeders than the other breeds.

At Elmore the graph below indicates the BL x M cross ewes and Composite ewes averaged 14% more lambs from their later lambings while the three Merino breed types averaged 8% more lambs from their later lambings; compared to their earlier lambings. This trend, though not statistically significant, follows other research that indicates 'British Breed' (BL x M and Composites) ewes reach their full potential with a March – April joining.

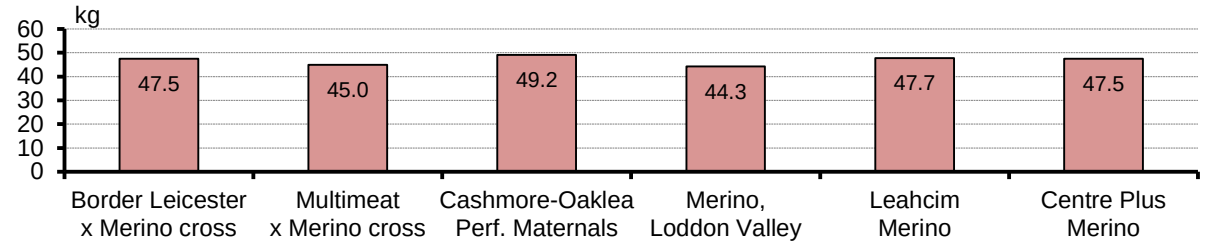
Lambs born per ewe joined



Lambs & carcase

Single lambs grow faster than twins and triplets, especially up to weaning . Thus the lower sale weights of the Multimeat x Merino cross is no doubt due to the higher number of multiples.

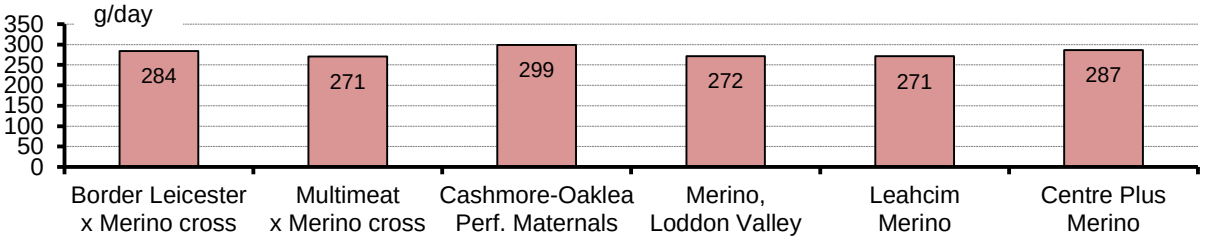
Lamb weight when first batch sold, aver 2016, '17 '18 & '19, ex adult ewes and terminal sires



The components of this weight at first sale have been split into 'early' and 'later' lamb growth.

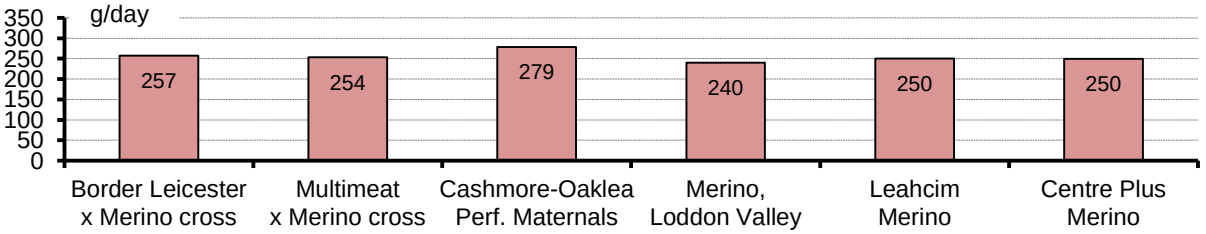
(i) Lamb growth from marking to weaning.

Lamb weight gain, marking to weaning, aver 2016, '17 '18 & '19, ex adult ewes and terminal sires

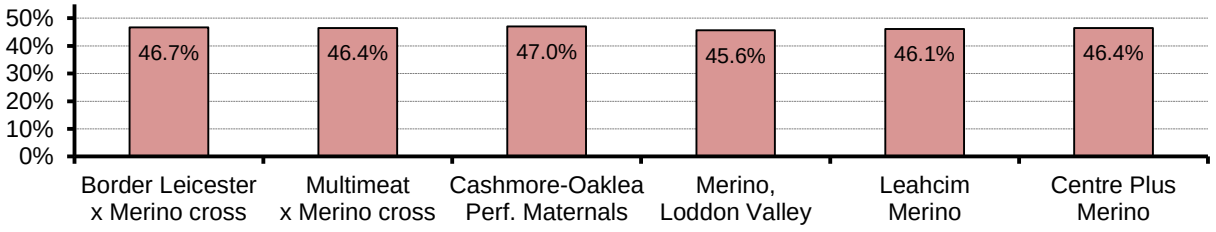


(ii) Lamb growth from weaning to first sale.

Lamb weight gain, weaning to 1st sale, aver 2016, '17 '18 & '19, ex adult ewes and terminal sires

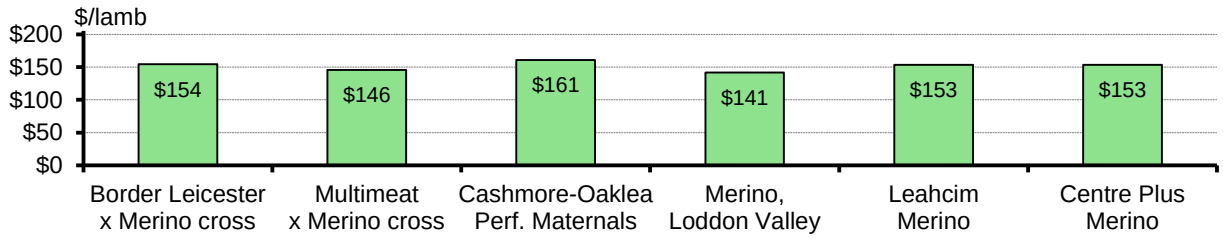


Dressing percent of lambs, aver 2016, '17 & '18 drops, '19 na



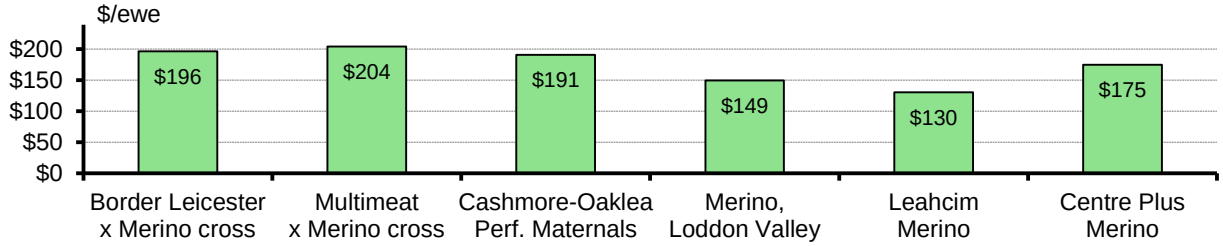
The lamb price – value per head was calculated from their live weights when the first batch was marketed, their dressing percentage, carcase price per kilo and skin value. Skin prices of all lambs, regardless of breed, were given the same price per head.

Lamb price aver 2016, '17, '18 & '19 drops, incl skins, $/lamb



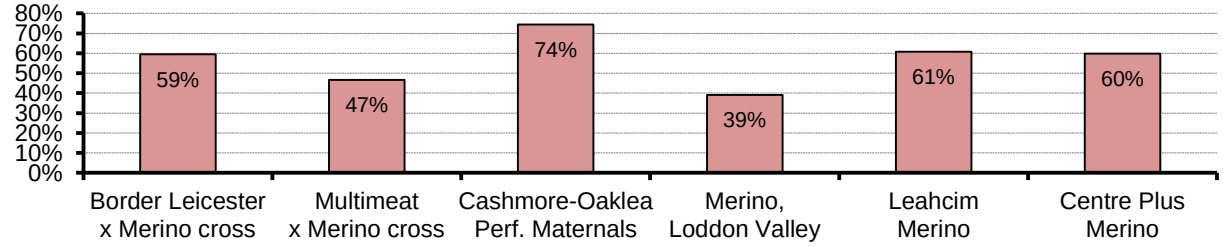
The lamb returns per ewe were calculated from the lamb price per head plus skin value, the percentage of lambs marked and an allowance for lamb deaths between marking and sale.

Lamb returns per ewe, aver 2016, '17, '18 & '19 drops, incl skins, $/ewe



Prime lambs were sold when they reached a target weight regardless of the ewe group. No adjustments have been made to account for more multiple births in some breeds. Cut off lamb live weights for the first draft were 47.0 kg in 2016, 46.5 kg in 2017, 43 kg in 2018 and 49 kg in 2019.

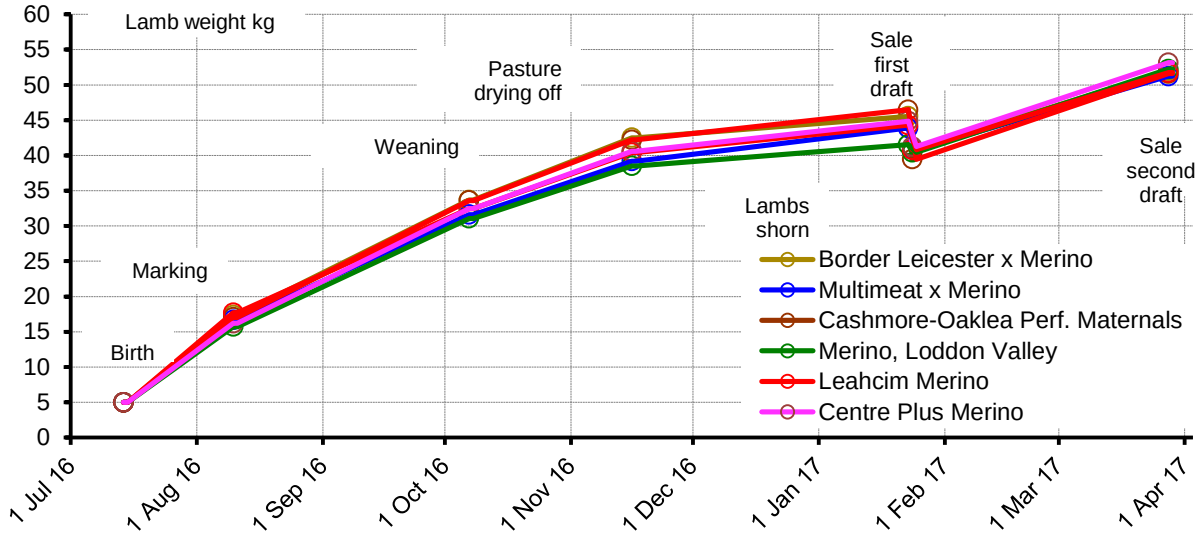
Percent lambs sold in first batch, aver 2016, '17, '18 & '19 drops



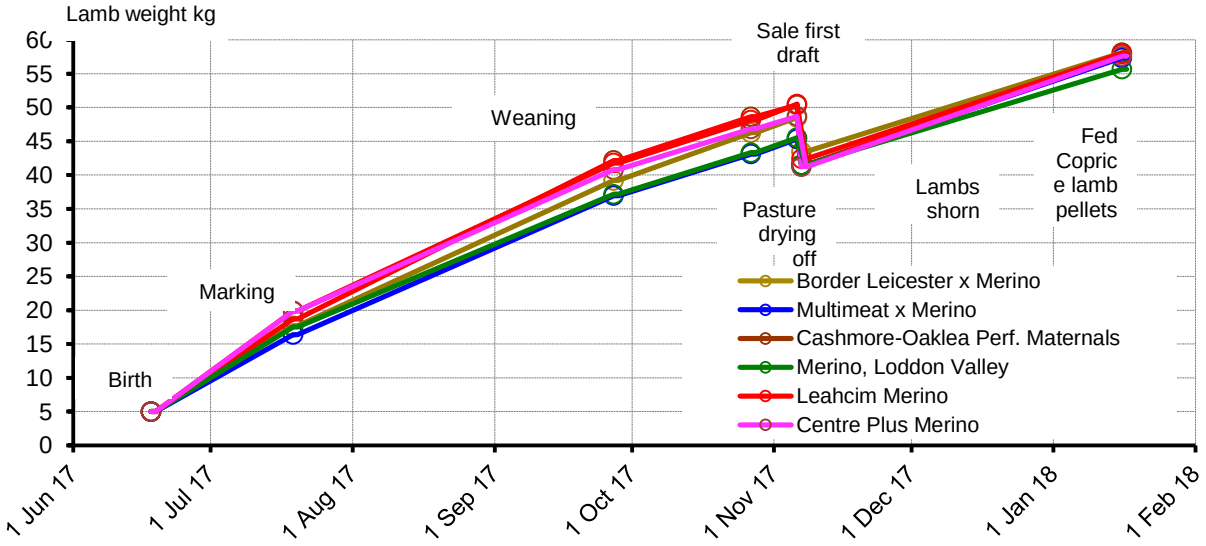
Lamb weight, kg, average all lambs in breed group, when first batch sold

Team	*BL x Merino*	*Multimeat x Merino*	*Cashmore-Oaklea*	*Merino, Loddon V*	*Leahcim Merino*	*Centre Plus M*
2015 drop, (from ewe lambs, new from home farm, range of ages, weights and condition) born on average 15 Aug, weight 11 Dec	*34.4*	*30.6*	*31.0*	*33.4*	*32.9*	*32.5*
2016 drop, born on average 14 Jul, weight 23Jan2017	*45.9*	*44.3*	*46.8*	*41.9*	*44.6*	*45.2*
2017 drop, born on average 18 Jun, weight 6 Nov	*48.5*	*45.3*	*50.4*	*45.5*	*50.5*	*48.7*
2018 drop, born on average 15 May, weight 21 Sept	*41.0*	*38.6*	*43.4*	*39.0*	*39.7*	*40.7*
2019 drop, born on average 5 May, weight 2 Oct	*54.4*	*51.9*	*56.4*	*51.0*	*56.0*	*55.2*

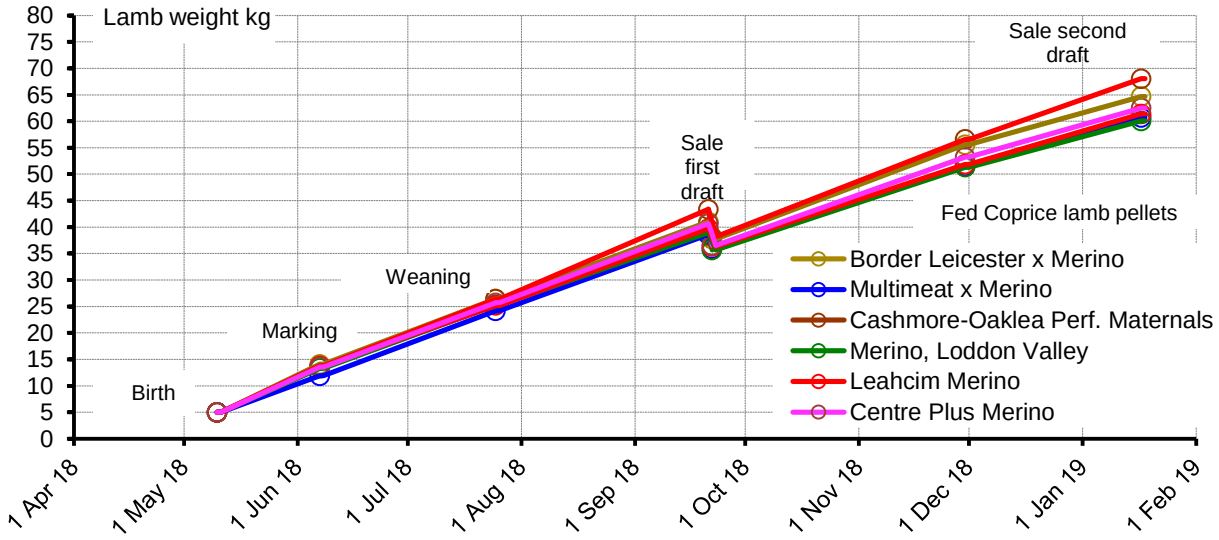
Lamb weights, fleece free, from birth to sale, 2016 drop. Note: All lambs were by White Suffolk rams. Lambs were not weighed at birth, the assumed birth weight was 5 kg. There will be differences between the breeds and birth type (singles, twins or triplets). For example; it was obvious that the Multimeat x Merino cross



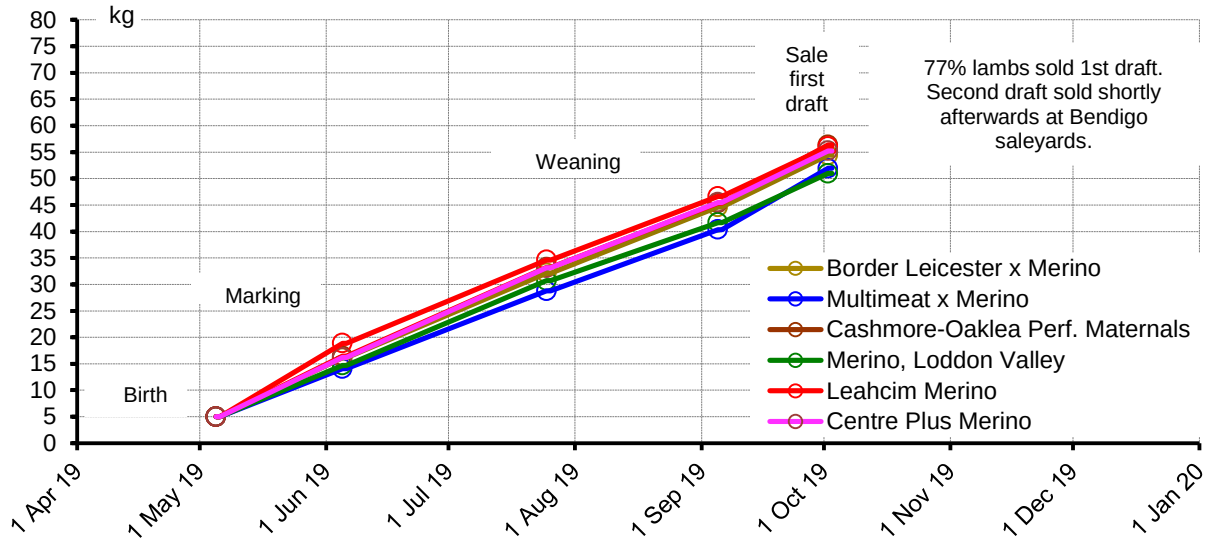
Lamb weights, in wool, from birth to sale, 2017 drop. Note: All lambs were by Poll Dorset rams. Lambs were not weighed at birth, the assumed birth weight was 5 kg. There will be differences between the breeds and birth type (singles, twins or triplets). For example; it was obvious that the Multimeat x Merino cross ewes reared at



Lamb weights, in wool, from birth to sale, 2018 drop. Note: All lambs were by Poll Dorset rams. Lambs were not weighed at birth, the assumed birth weight was 5 kg.

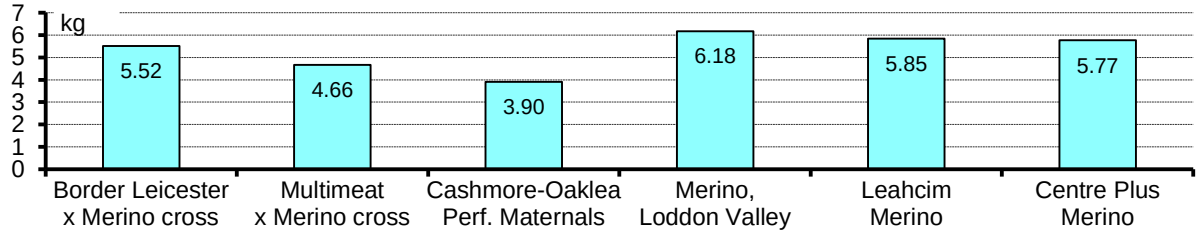


Lamb weights, in wool, from birth to sale, 2019 drop. Note: All lambs were by White Suffolk. Lambs were not weighed at birth, the assumed birth weight was 5 kg.

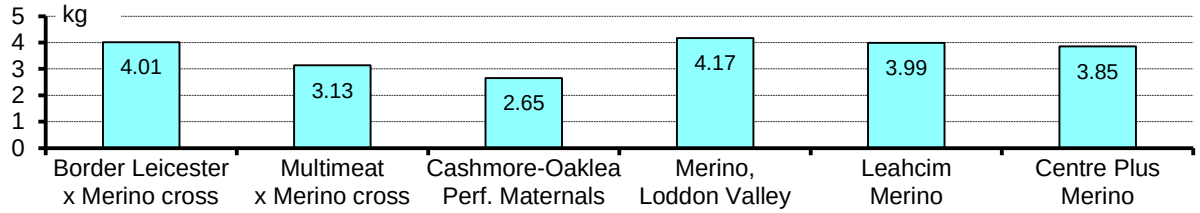


Wool

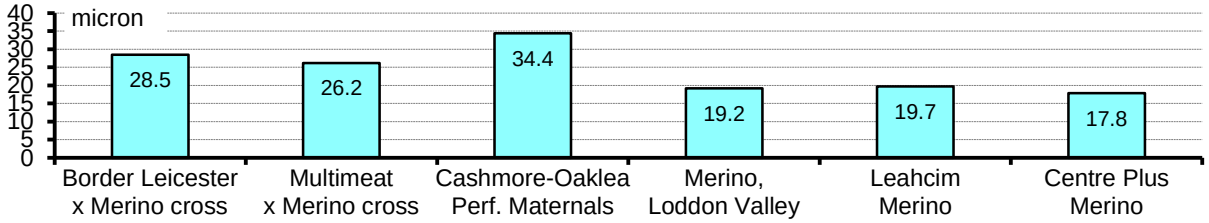
Greasy fleece weight, aver of 2016, '17, '18 & '19 adult shearings



Clean fleece weight, aver 2016, '17, '18 & '19 adult shearings

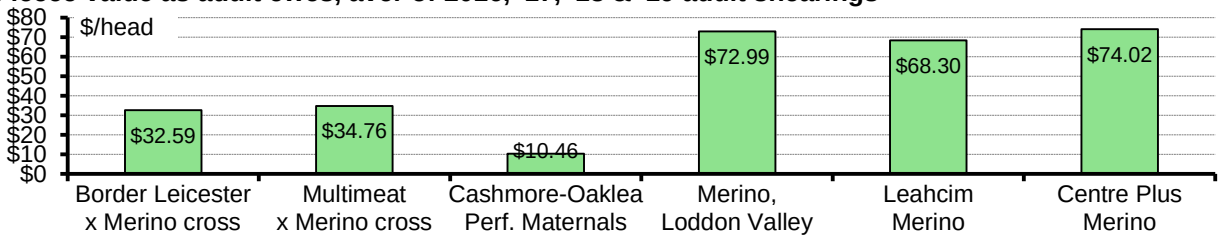


Wool Fibre diameter, aver 2016, '17, '18 & '19 adult shearings



The fibre diameters above are from mid-side wool samples taken prior to shearing. On average these merino mid sides are 0.3 to 0.5 um finer than the bale core test samples (see next page), but the differences are consistent and do not change the relative prices of the wool when fleeces are valued.

Fleece value as adult ewes, aver of 2016, '17, '18 & '19 adult shearings



Calculating wool value

Wool returns were calculated each year using average wool prices for each diameter and type over the 12 months prior to shearing. Discounts or premiums have been applied after bale core measurements of strength or length were available (listed below, full core tests are listed later in this report). The core test visual appraisal (AWEX ID) indicated all fleece wools were of high quality all years, thus no discounts were applied for colour or vegetable matter faults. Pieces and bellies wool were given 12% and 18% yield reductions from the fleece wool yield of each breed. Clean wool prices for pieces and bellies were 11% and 18% below their fleece wool prices.

Bale core tests

Wool was baled and sold in breed lots so the bale core tests and grab sample tests provide additional information on the breed differences. The core tests of fibre diameter and yield closely matched the individual mid side measures while the wool grab sample tests on staples provide additional measures of length and strength.

Bale core test results, average of 2016, '17, '18 and '19 shearings.

Breed	*BL x Merino*	*Multimeat x Merino*	*Cashmore -Oaklea*	*Merino, Loddon V*	*Leahcim Merino*	*Centre Plus M*
Bale brand	*AAAFX*	*AAAFX*	*AAACX*	*AAAM*	*AAAM*	*AAAM*
Fibre diameter						
Micron um	*28.7*	*26.4*	*33.5*	*19.6*	*20.2*	*18.1*
CV %	*21.3*	*21.7*	*22.9*	*18.7*	*18.4*	*18.1*
Comfort factor	*61.8*	*77.7*	*34.9*	*99.1*	*98.9*	*99.5*
Curvature	*59.5*	*69.5*	*64.25*	*59.75*	*52.25*	*59.5*
Yield						
VM %	*0.3*	*0.3*	*0.5*	*0.5*	*0.4*	*0.5*
Sch dry yield %	*75.5*	*68.9*	*67.9*	*71.9*	*70.4*	*68.1*
Staple						
Length mm	*112*	*104*	*109*	*104*	*108*	*111*
CV%	*14*	*14*	*16*	*11*	*15*	*11*
Strength n/kt	*32*	*31*	*26*	*28*	*30*	*33*
Hauteur mm	*94*	*87*	*96*	*78*	*80*	*81*
Position of break						
Tip %	*14*	*4*	*17*	*5*	*11*	*5*
Mid %	*62*	*79*	*59*	*67*	*73*	*74*
Base %	*24*	*18*	*24*	*28*	*17*	*21*

Shearers' wool combing and OHS score

Each sheep was scored by its shearer for wool combing and occupational health and safety (OHS) for the 2016, 2017 and 2019 shearings. Records were incomplete in 2018.

(a) Wool combing; each ewe was scored using the system: 1. Good commercial combing, should be most of sheep 2. Some fault, light dermo, colour, cotted, sticky on points, but still reasonable combing. 3. Very hard to shear, heavy dermo, colour, fleece rot, cotted, flyblown etc, should be very few. The scoring was converted to a scale with 100% being the best.

(b) OHS (Occupation health and safety). Ewes were given a score of either Y – Weight OK or N – Excessive weight. The scoring was converted to a scale with 100% being the best.

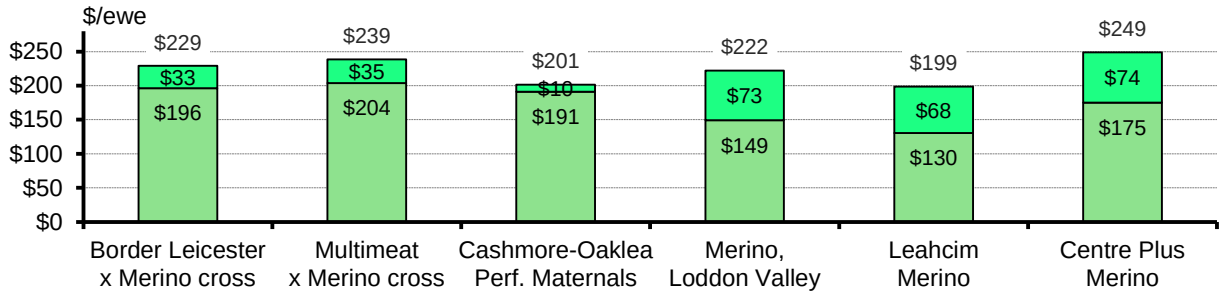
Results are shown below

Breed	*BL x Merino*	*Multimeat x Merino*	*Cashmore -Oaklea*	*Merino, Loddon V*	*Leahcim Merino*	*Centre Plus M*
Shearers wool combing score						
2016 shearing	*94%*	*95%*	*91%*	*90%*	*89%*	*93%*
2017 shearing	*100%*	*100%*	*94%*	*100%*	*92%*	*100%*
2019 shearing	*100%*	*100%*	*100%*	*76%*	*95%*	*100%*
Shearers OHS score						
2016 shearing	*97%*	*98%*	*73%*	*100%*	*100%*	*100%*
2017 shearing	*100%*	*100%*	*82%*	*100%*	*100%*	*100%*
2019 shearing	*52%*	*74%*	*10%*	*100%*	*98%*	*100%*

Total lamb and wool returns per ewe and DSE

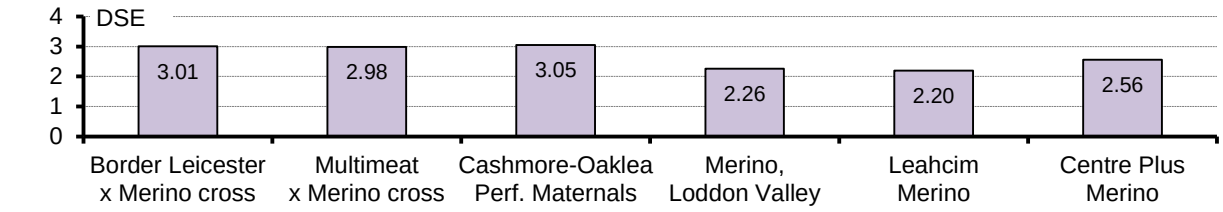
The total lamb and wool returns per ewe were averaged for the adult years 2016, '17, '18 and '19 to give the average total returns per ewe. Lamb returns per ewe were calculated from the lambing percentage and lamb price per head for each breed.

Total lamb and wool returns per ewe, aver of 2016, '17, '18 & '19

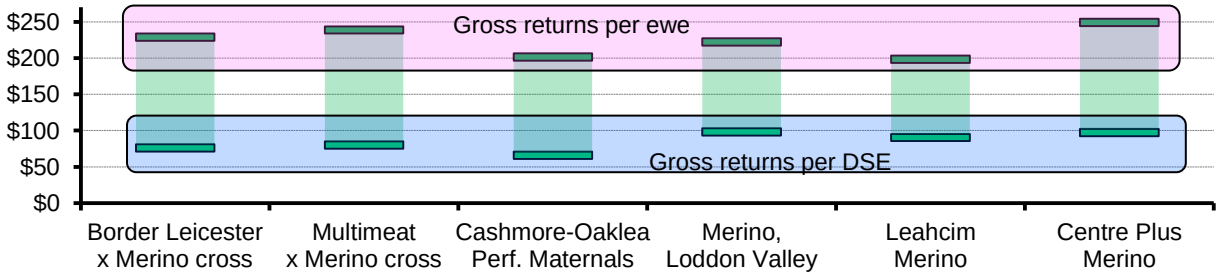


The DSE (dry sheep equivalent) per ewe indicates the feed energy eaten per ewe and lambs marked. This calculation allows for the extra feed needed with higher lambing percentages and higher ewe weights. One DSE is the amount of feed energy needed to maintain a dry sheep at 50kg live weight for one year; it equates to about 310 kg dry matter of pasture eaten. A DSE rating of 2.14 would thus equate to about 650 kg of pasture eaten while a rating of 2.97 would equate to about 900 kg of pasture.

DSE rating per ewe & lambs marked & grown to sale, aver 2016, '17, '18 & '19 seasons



Gross returns from lamb and wool, (i) per ewe and (ii) per DSE, aver seasons 2016, '17, '18 & '19

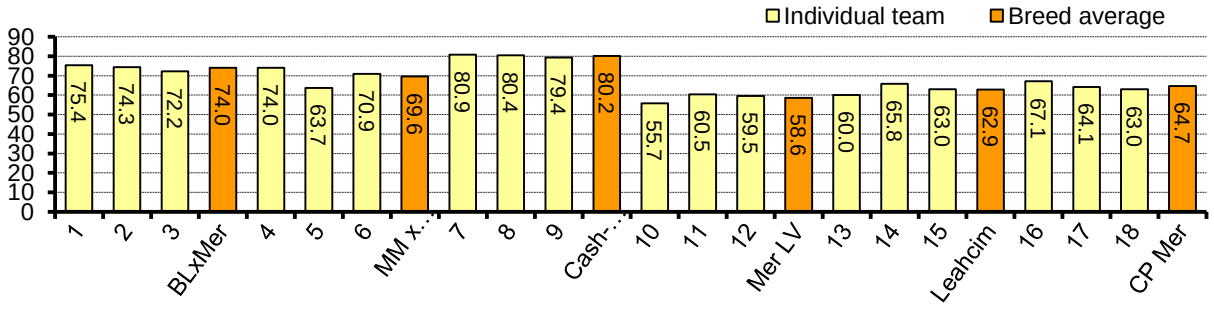


Section 4: Additional details by team and breed

Ewe weight

Ewe weight at joining, kg fleece free, for individual teams within breed

Ewe weight at joining, aver 2016, '17, '18 & '19 adult lambings

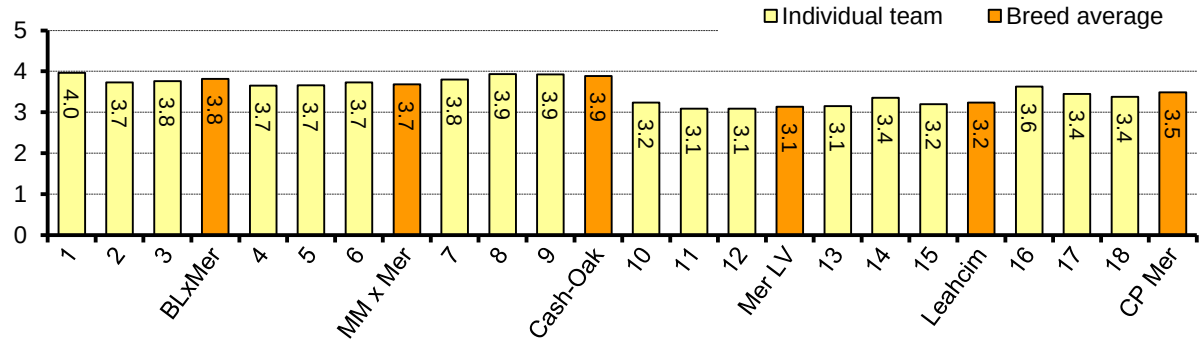


Ewe weight at joining each year, fleece free, kg

	Team	*2015 lambing -ewe lambs*	*2016 lambing*	*2017 lambing*	*2018 lambing*	*2019 lambing*	*Adult ewes, 4 year average*
Date of weighing		*26Feb'15*	*28Jan'16*	*23Jan'17*	*16Jan'18*	*30Nov'18*	
Border Leicester	*team 1*	*63.8*	*64.3*	*75.1*	*85.5*	*76.8*	*75.4*
x Merino XB	*2*	*52.1*	*61.1*	*72.8*	*86.9*	*76.6*	*74.3*
	3	*59.4*	*62.7*	*69.8*	*82.5*	*73.7*	*72.2*
	av	*58.4*	*62.7*	*72.6*	*85.0*	*75.7*	*74.0*
Multimeat	*4*	*54.0*	*63.3*	*72.6*	*84.5*	*75.6*	*74.0*
x Merino XB	*5*	*40.9*	*54.5*	*64.6*	*72.2*	*63.7*	*63.7*
	6	*51.5*	*61.1*	*70.1*	*79.6*	*72.8*	*70.9*
	av	*48.8*	*59.7*	*69.1*	*78.8*	*70.7*	*69.6*
Cashmore-Oakley	*7*	*57.2*	*66.0*	*82.1*	*92.1*	*83.1*	*80.9*
Performance Mat	*8*	*55.5*	*70.7*	*79.0*	*91.8*	*80.1*	*80.4*
	9	*45.2*	*66.1*	*80.6*	*92.9*	*77.8*	*79.4*
	av	*52.7*	*67.6*	*80.6*	*92.3*	*80.3*	*80.2*
Merino,	*10*	*37.5*	*48.5*	*53.8*	*63.1*	*57.5*	*55.7*
Loddon Valley	*11*	*43.0*	*54.0*	*59.2*	*68.6*	*60.1*	*60.5*
	12	*46.0*	*51.8*	*58.0*	*69.0*	*59.2*	*59.5*
	av	*42.2*	*51.4*	*57.0*	*66.9*	*58.9*	*58.6*
Leahcim Merino	*13*	*39.9*	*51.7*	*58.2*	*67.9*	*62.3*	*60.0*
	14	*47.4*	*57.6*	*65.9*	*73.2*	*66.4*	*65.8*
	15	*44.5*	*55.6*	*60.6*	*71.7*	*64.3*	*63.0*
	av	*43.9*	*54.9*	*61.6*	*70.9*	*64.3*	*62.9*
Centre Plus	*16*	*41.2*	*57.3*	*64.5*	*77.7*	*68.9*	*67.1*
Merino	*17*	*43.5*	*53.6*	*61.4*	*73.9*	*67.6*	*64.1*
	18	*39.6*	*53.2*	*60.6*	*73.0*	*65.1*	*63.0*
	av	*41.4*	*54.7*	*62.1*	*74.9*	*67.2*	*64.7*

Condition score

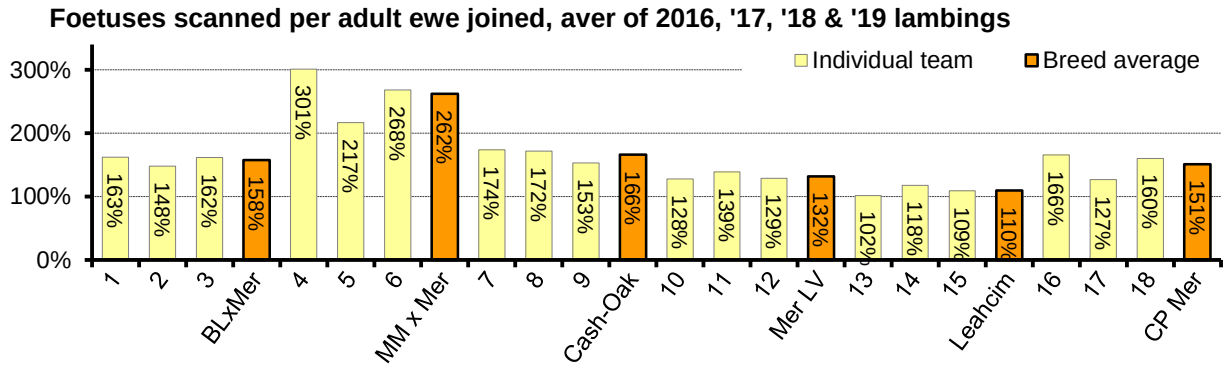
Ewe condition score at joining, aver 2016, '17, '18 & '19 adult lambings



Ewe condition score at joining each year

	Team	2015 lambing -ewe lambs	2016 lambing	2017 lambing	2018 lambing	2019 lambing	Adult ewes, 4 year average
Date of weighing		26Feb'15	28Jan'16	23Jan'17	16Jan'18	30Nov'18	
Border Leicester	team 1	3.89	3.41	3.88	4.23	4.35	3.97
x Merino XB	2	3.08	3.04	3.69	4.12	4.08	3.73
	3	3.62	3.23	3.54	4.15	4.11	3.76
	av	3.53	3.23	3.70	4.17	4.18	3.82
Multimeat	4	2.97	3.04	3.77	3.81	4.00	3.65
x Merino XB	5	2.85	3.25	3.55	3.96	3.88	3.66
	6	3.07	3.14	3.57	4.00	4.21	3.73
	av	2.96	3.14	3.63	3.92	4.03	3.68
Cashmore-Oakley	7	3.15	3.12	3.68	4.21	4.20	3.80
Performance Mat	8	3.03	3.50	3.82	4.30	4.13	3.94
	9	2.59	3.63	3.88	4.28	3.93	3.93
	av	2.92	3.41	3.79	4.26	4.08	3.89
Merino,	10	2.56	3.04	3.08	3.42	3.41	3.24
Loddon Valley	11	2.73	2.86	3.11	3.36	3.04	3.09
	12	2.70	2.54	3.08	3.50	3.23	3.09
	av	2.66	2.81	3.09	3.43	3.23	3.14
Leahcim Merino	13	2.61	2.92	3.13	3.38	3.18	3.15
	14	2.79	3.00	3.32	3.61	3.50	3.36
	15	2.67	3.04	3.00	3.43	3.33	3.20
	av	2.69	2.98	3.15	3.47	3.34	3.24
Centre Plus	16	2.83	3.32	3.38	3.88	3.92	3.63
Merino	17	2.84	3.00	3.21	3.73	3.85	3.45
	18	2.61	2.92	3.25	3.73	3.63	3.38
	av	2.76	3.08	3.28	3.78	3.80	3.49

Pregnancy scanning



Pregnancy scanning rate for individual teams within breed for each lambing with the average adult scanning rate

Ewe scanning rate per ewe joined each year

	Team	2015 lambing -ewe lambs	2016 lambing	2017 lambing	2018 lambing	2019 lambing	Adult ewes, 4 year average
		18May'15	20Apr'16	31Mar'17	27Feb'18	13Feb'19	
Border Leicester	team 1	1.71	1.73	1.64	1.55	1.50	1.63
x Merino XB	2	1.29	1.43	1.69	1.23	1.58	1.48
	3	1.71	1.85	1.54	1.46	1.63	1.62
	av	1.57	1.67	1.62	1.41	1.57	1.58
Multimeat	4	2.43	3.00	3.14	3.00	2.92	3.01
x Merino XB	5	1.70	2.25	1.75	2.50	2.17	2.17
	6	2.50	2.71	2.93	2.50	2.58	2.68
	av	2.21	2.65	2.61	2.67	2.56	2.62
Cashmore-Oakley	7	1.79	1.92	1.71	1.92	1.40	1.74
Performance Mat	8	1.50	1.70	1.67	2.00	1.50	1.72
	9	0.57	1.77	1.58	1.60	1.17	1.53
	av	1.29	1.80	1.65	1.84	1.36	1.66
Merino,	10	0.60	1.31	1.46	1.08	1.27	1.28
Loddon Valley	11	0.75	1.36	1.50	1.36	1.36	1.39
	12	0.93	1.31	1.23	1.38	1.23	1.29
	av	0.76	1.32	1.40	1.27	1.29	1.32
Leahcim Merino	13	0.33	1.08	1.00	1.00	1.00	1.02
	14	0.93	1.64	1.07	0.93	1.07	1.18
	15	0.36	1.07	1.00	1.21	1.08	1.09
	av	0.54	1.26	1.02	1.05	1.05	1.10
Centre Plus	16	0.55	1.64	1.54	1.69	1.75	1.66
Merino	17	0.92	1.08	1.31	1.15	1.54	1.27
	18	0.67	1.64	1.64	1.46	1.67	1.60
	av	0.71	1.45	1.50	1.44	1.65	1.51

Pregnancy scanning 20April2016

Team	BL x Merino	Multimeat x Merino	Cashmore-Oaklea	Merino, Loddon V	Leahcim Merino	Centre Plus M
Ewe age mid joining, months	21.5	20.7	19.1	21.3	21.2	18.3
Ewes scanned as dry	3%	3%	11%	5%	5%	5%
Ewes scanned as carrying singles	32%	13%	8%	58%	66%	49%
Ewes scanned as carrying twins	63%	25%	69%	38%	27%	41%
Ewes scanned as carrying triplets	3%	35%	11%		2%	5%
Ewes scanned as carrying quads		25%				
Preg scan. Foetus per ewe	166%	268%	181%	133%	127%	146%

Pregnancy scanning 31Mar2017

Team	BL x Merino	Multimeat x Merino	Cashmore-Oaklea	Merino, Loddon V	Leahcim Merino	Centre Plus M
Ewe age mid joining	2 yrs 9 m	2 yrs 8 m	2 yrs 7 m	2 yrs 9 m	2 yrs 9 m	2 yrs 6 m
Ewes scanned as dry	3%	3%	0%	3%	13%	3%
Ewes scanned as carrying singles	35%	8%	43%	55%	73%	45%
Ewes scanned as carrying twins	59%	33%	49%	43%	15%	53%
Ewes scanned as carrying triplets	3%	38%	9%			
Ewes scanned as carrying quads		20%				
Preg scan. Foetus per ewe	162%	261%	165%	140%	102%	150%

Pregnancy scanning 27Feb2018

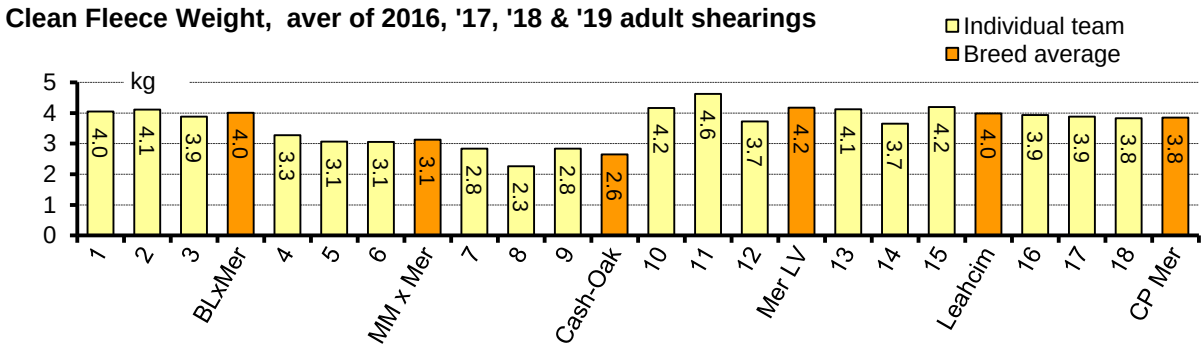
Team	BL x Merino	Multimeat x Merino	Cashmore-Oaklea	Merino, Loddon V	Leahcim Merino	Centre Plus M
Ewe age mid joining	3 yr 8 m	3 yr 7 m	3 yr 5 m	3yr 8 m	3 yr 7 m	3 yr 5 m
Ewes scanned as dry	3%	0%	4%	8%	13%	8%
Ewes scanned as carrying singles	54%	8%	14%	58%	68%	41%
Ewes scanned as carrying twins	43%	35%	79%	35%	20%	51%
Ewes scanned as carrying triplets		41%	4%			
Ewes scanned as carrying quads		16%				
Preg scan. Foetus per ewe	141%	267%	184%	127%	108%	144%

Pregnancy scanning 13Feb2019

Team	BL x Merino	Multimeat x Merino	Cashmore-Oaklea	Merino, Loddon V	Leahcim Merino	Centre Plus M
Ewe age mid joining	4 yr 8 m	4 yr 7 m	4 yr 5 m	4yr 8 m	4 yr 7 m	4 yr 5 m
Ewes scanned as dry	3%	8%	5%	3%	11%	0%
Ewes scanned as carrying singles	47%	11%	55%	66%	73%	38%
Ewes scanned as carrying twins	40%	22%	40%	32%	16%	59%
Ewes scanned as carrying triplets	10%	36%				3%
Ewes scanned as carrying quads		22%				
Preg scan. Foetus per ewe	141%	267%	184%	127%	108%	144%

Clean fleece weight

Clean Fleece Weight (CFW) for individual teams within breed.



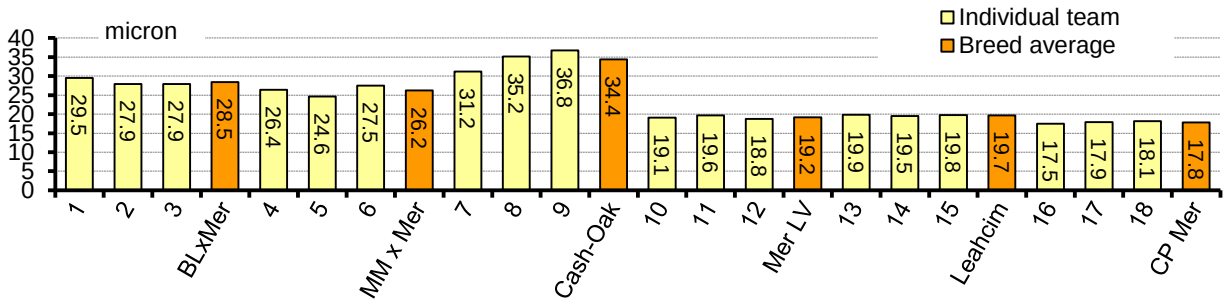
Clean Fleece Weight (CFW) , kg, for individual teams within breed

	Team	2015 shearing -ewe lambs Oct2015	2016 shearing Oct2016	2017 shearing Oct2017	2018 shearing Oct2018	2019 shearing Oct2019	Adult ewes, 4 year average
Border Leicester	*team 1*	*3.44*	*3.93*	*4.37*	3.61	4.27	4.04
x Merino XB	*2*	*3.49*	*3.99*	*4.57*	3.58	4.31	4.11
	3	*3.36*	*3.73*	*4.24*	3.51	4.03	3.88
	av	*3.43*	*3.88*	*4.39*	3.56	4.20	4.01
Multimeat	*4*	*2.83*	*3.32*	*3.54*	2.90	3.33	3.27
x Merino XB	*5*	*2.60*	*3.04*	*3.38*	2.62	3.24	3.07
	6	*2.88*	*3.15*	*3.35*	2.72	3.03	3.06
	av	*2.77*	*3.17*	*3.42*	2.74	3.20	3.13
Cashmore-Oakley	*7*	*2.62*	*3.12*	*3.04*	2.39	2.79	2.84
Performance Mat	*8*	*2.31*	*2.67*	*2.56*	1.73	2.10	2.27
	9	*2.60*	*3.20*	*3.03*	2.42	2.71	2.84
	av	*2.51*	*3.00*	*2.88*	2.18	2.53	2.65
Merino,	*10*	*3.28*	*3.83*	*4.74*	3.77	4.31	4.16
Loddon Valley	*11*	*3.62*	*4.32*	*5.17*	4.22	4.78	4.62
	12	*3.18*	*3.54*	*4.17*	3.29	3.91	3.73
	av	*3.36*	*3.90*	*4.69*	3.76	4.33	4.17
Leahcim Merino	*13*	*3.37*	*3.91*	*4.37*	3.87	4.33	4.12
	14	*3.34*	*3.44*	*4.00*	3.25	3.92	3.65
	15	*3.31*	*3.78*	*4.72*	3.86	4.42	4.20
	av	*3.34*	*3.71*	*4.37*	3.66	4.23	3.99
Centre Plus	*16*	*3.56*	*3.87*	*4.55*	3.58	3.73	3.93
Merino	*17*	*3.37*	*3.46*	*4.29*	3.93	3.86	3.88
	18	*3.38*	*3.59*	*4.24*	3.52	3.97	3.83
	av	*3.44*	*3.64*	*4.36*	3.55	3.85	3.85

Fibre diameter

Ewe wool Fibre Diameter, um, for individual teams within breed

Fibre diameter, aver of 2016, '17, '18 & '19 adult shearings



Wool fibre diameter, micron, for individual teams within breed

	Team	2015 shearing -ewe lambs Oct2015	2016 shearing Oct2016	2017 shearing Oct2017	2018 shearing Oct2018	2019 shearing Oct2019	Adult ewes, 4 year average
Border Leicester	*1*	*29.5*	*29.3*	*29.9*	*28.9*	*30.0*	*29.5*
x Merino XB	*2*	*26.5*	*27.4*	*28.8*	*26.8*	*28.6*	*27.9*
	3	*27.2*	*26.3*	*29.0*	*27.4*	*29.0*	*27.9*
	av	*27.7*	*27.7*	*29.2*	*27.7*	*29.2*	*28.5*
Multimeat	*4*	*26.3*	*25.8*	*27.3*	*26.4*	*26.3*	*26.4*
x Merino XB	*5*	*24.1*	*24.6*	*25.3*	*23.4*	*25.2*	*24.6*
	6	*27.1*	*26.6*	*28.1*	*27.0*	*28.4*	*27.5*
	av	*25.8*	*25.7*	*26.9*	*25.6*	*26.6*	*26.2*
Cashmore-Oakley	*7*	*29.6*	*30.7*	*32.1*	*30.4*	*31.7*	*31.2*
Performance Mat	*8*	*34.0*	*36.8*	*36.3*	*32.9*	*34.7*	*35.2*
	9	*35.3*	*38.2*	*37.9*	*35.6*	*35.2*	*36.8*
	av	*33.0*	*35.3*	*35.4*	*33.0*	*33.9*	*34.4*
Merino,	*10*	*17.7*	*18.8*	*19.6*	*18.7*	*19.1*	*19.1*
Loddon Valley	*11*	*19.1*	*19.3*	*20.2*	*19.3*	*19.8*	*19.6*
	12	*18.2*	*18.4*	*19.4*	*18.6*	*18.7*	*18.8*
	av	*18.3*	*18.8*	*19.7*	*18.8*	*19.2*	*19.2*
Leahcim Merino	*13*	*18.2*	*19.1*	*20.4*	*19.6*	*20.3*	*19.9*
	14	*19.0*	*18.7*	*20.0*	*19.1*	*20.2*	*19.5*
	15	*18.6*	*19.1*	*20.1*	*19.6*	*20.4*	*19.8*
	av	*18.6*	*19.0*	*20.1*	*19.4*	*20.3*	*19.7*
Centre Plus	*16*	*17.5*	*17.5*	*18.0*	*17.2*	*17.2*	*17.5*
Merino	*17*	*17.7*	*17.5*	*18.2*	*17.7*	*18.1*	*17.9*
	18	*17.5*	*17.6*	*18.5*	*18.1*	*18.3*	*18.1*
	av	*17.5*	*17.5*	*18.3*	*17.7*	*17.9*	*17.8*

Section 5. References

The following references discuss aspects of comparing ewe reproduction. They provide background information on (i) the concept of comparing between ewe groups as undertaken at Elmore, (ii) pregnancy scanning accuracy with multiple foetuses and (iii) embryo – foetal mortality with multiple embryos.

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