

## EVOLUTION OF SHEEP BREEDS WITHIN LAMBPLAN AND THE RISE OF THE COMPOSITES

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### SUMMARY

The LAMPLAN – Terminal and Maternal analysis are large and contain multiple breeds. Over the last 20 years there has been an increase in cross breeding in seedstock flocks and thus the number of composite animals in these analyses, especially in the Maternal analysis and an overall reduction in the number of breed pure animals. The increase in crossbred animals will require some development to ensure that breed and heterosis effects are being modelled accurately. Further use and reporting of breed composition via genomics and pedigree methods should be considered. However, composite animals provide the comparisons needed for an accurate multibreed LAMBPLAN analysis allowing selection of animals across breeds for the industries diverse needs.

### INTRODUCTION

Sheep Genetics (SG) has made significant advancements to the Australian national sheep genetic evaluation since its inception in 2005. Combining multiple database (for Merinos) and developing a uniform “language” to describe genetic evaluation for Australian sheep has proven extremely successful and allowed a more streamlined pipeline for delivery of genetic tools and extension activities (Collison *et al.* 2018). Much research has focused on the technical advancements to the genetic evaluation, with the main development work, first outlined by Brown *et al.* (2007), being completed and implemented into the current genetic evaluation. Advances in genomic technologies and development of resource populations (Brown *et al.* 2018) have seen changes to the analyses and these are incorporated as key component in the evaluation and in many breeding programs.

This paper examined the occurrence of the major contributing breeds and/or composites within the SG population and examine utilisation of pure animals and composite animals over time.

### MATERIALS AND METHODS

Data for this analyses was obtained from the Terminal and Maternal LAMBPLAN database from the February 2023 routine analyses. Table 1 below shows a summary of pedigree related data for these two analyses. The breed of animals is assigned based on the flock of origin with animals within that flock being designated a breed. This included a number of breed codes specifically for composite animals (CT; Terminal, CM; Maternal).

As part of the routine analyses a pedigree-based breed composition matrix for all animals was calculated along with both generalised direct heterosis and maternal heterosis which was calculated across all breeds but not accounting for specific breed combinations (Brown *et al.*, 2016). Flock and breed level trends were calculated for the following statistics breed purity (animals which have 90% or greater of assigned breed proportion), homebred (proportion of animals where the sire’s flock code is the same as to progeny’s flock code), outside sire breed (proportion of animals where sire type does not match the flocks breed code), direct heterosis and maternal heterosis.

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**Table1. Data summary of LAMBPLAN pedigree for the February 2023 Analyses**

	<b>Animals</b>	<b>Sires</b>	<b>Dams</b>	<b>Flocks</b>	<b>Breeds</b>
Maternal	2,671,734	35,484	608,956	2,635	65
Terminal	3,726,242	54,788	958,806	4804	73

**RESULTS AND DISCUSSION**

The LAMBPLAN analysis contains many breeds however for this study we focus on the major breeds with minor breeds grouped into an “Other” category. The number of minor breeds contributing has declined from 39 breeds in 2000 to 19 breeds in 2020 for the Maternal analysis and from 42 in 2000 and to 28 in 2020 for the Terminal analysis (Table 2).

Within the Maternal analyses the major difference in breed contribution between 2000 and 2020 can be associated with a 7,000% increase in the number of CM animals due to large increases in the use of composite sires and dams as well as a substantial increase in number of composite stud flocks. Furthermore, it is worth noting that there was a significant proportion of CM animals in 2000 were missing pedigree, a likely by-product of the development of composites from non-SG sources. Excluding the CM breed all other breeds have exhibited a reduction in flock numbers since. The number of Border Leicester and Booroola animals in the analysis has increased while the Coopworth and White Suffolk have maintained similar number of animals. The Corriedales and minor breeds (other) have seen reductions in the number of animals and flocks.

In the Terminal analysis the use of a composite breed (CT) has significantly increased in both the number of animals and flocks, although not to the same extent as observed in Maternals. White Dorper, Dorper, White Suffolk, Poll Dorset, Suffolk and Southdown all show large increases in animals. With the Texel and the minor breeds (other) breeds having a reduction in numbers.

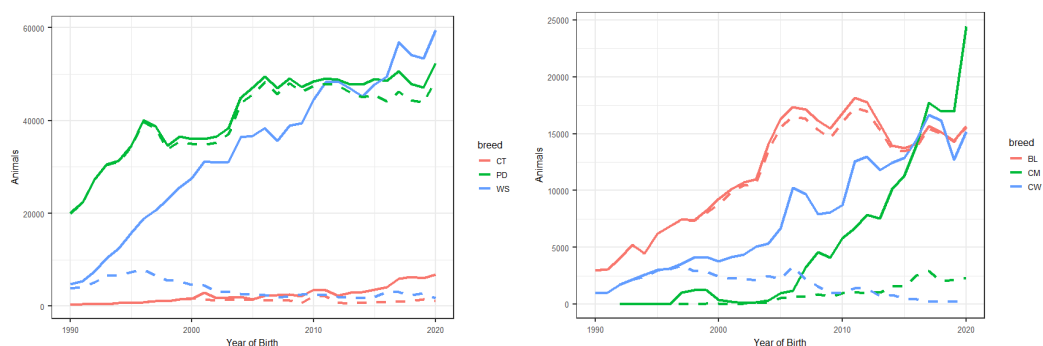
**Table 2. Summary of the major breed contributions in the LAMBPLAN analyses in 2000 and 2020**

<b>Breed</b>	<b>Animals</b>		<b>Sires</b>		<b>Dams</b>		<b>Flocks</b>	
	2000	2020	2000	2020	2000	2020	2000	2020
<i>Maternal Analysis</i>								
Border Leicester	8,130	15,341	277	292	5,319	9,114	53	45
Corriedale	9,462	5,520	177	116	5,781	3,506	25	21
Coopworth	35,095	32,371	406	417	18,922	17,561	52	35
White Suffolk	2,282	2,444	212	94	1,618	1,597	81	17
East Friesian	885	798	47	12	454	446	12	1
Booroola	224	625	6	10	111	322	2	1
Composite	345	25,096	19	365	12	12,771	3	39
Other	1,914	684	595	64	1,559	490	229	22
<i>Terminal Analysis</i>								
White Dorper	831	6,394	89	142	285	4,180	25	18
Dorper	494	4,056	46	108	113	2,271	15	14
White Suffolk	24,995	58,053	663	1,102	16,647	36,794	166	193
Suffolk	3,144	6,369	172	220	2,224	4,073	49	62
Texel	4,123	1,302	192	48	2,975	919	63	10
Poll Dorset	37,595	55,662	1,034	1,049	24,847	35,477	199	152
Southdown	483	2,204	33	85	362	1,345	8	15
Composite	1,164	8,791	51	311	683	5,292	21	34
Other	5,269	4,466	619	172	3,541	2,983	196	41

Figure 1 below summarises the trend in animal number for the two most populous breeds along

with the composite breed for their respective analyses. The terminal analyses showed a rise in the composite animals, but they remain below the number of Poll Dorset (PD and White Suffolks (WS) within the analysis. In comparison the Maternal composites have had a marked rise in popularity since the mid-2000s. Equalling the top two breeds Border Leicester (BL) and Coopworth (CW) for animals born in 2015 and increasing rapidly to almost 25,000 animals in 2020.

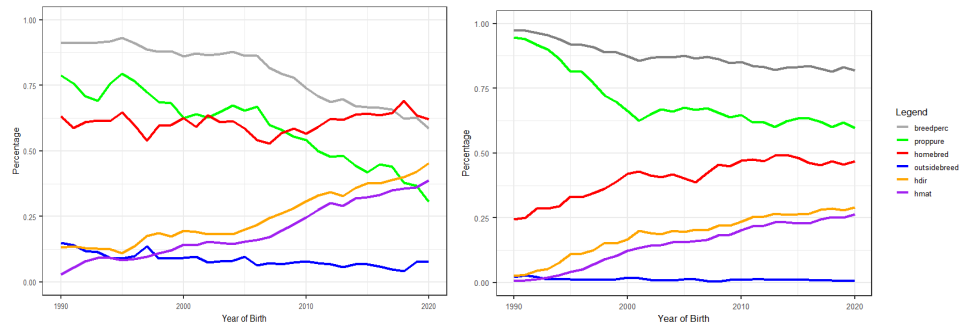
Whilst the popularity of developing a composite line has increased the desire to maintain purity varies across breeds, most likely due to breed society convention and capacity to achieve desired genetic gains with the breed population. For example, the Poll Dorset and Border Leicester breeds which have remained largely pure with only small influence from outside breeds. This contrasts with the White Suffolk in Terminals and Coopworth in Maternal which show only a small number of animals born per year which could be considered pure. Unsurprisingly the composite animals in both analyses have considerable influence from outside breeds.



**Figure 1. Breed contributions within the LAMBPLAN of the two largest breeds and composites, Maternal (left) and Terminal (right), databases from 1990-2020. Solid lines are counts of animals with dotted lines being counts of pure (>90%) animals**

The LAMBPLAN Terminal and Maternal analysis are large multibreed analysis when we look at trends overtime for statistics relating to breed some interesting differences were observed between the two analyses. Figure 2 presents for both analyses the proportion of animals which are pure of designated breed or above 90 percent of that breed via the black and green lines, respectively. The reduction in purity across the analyses is greatest in the Maternal analysis, where there is a stronger willingness from breeders to look at individual animals from outside their breed rather than limiting sire uses to their breed. Thus, allowing maternal breeders to take advantage of across breed and within breed genetic variation and potential heterosis effects. The red lines (Figure 2) represent the proportion of animals which are the progeny of a homebred sire, this has increased overtime in both analyses and approaching 50% in Terminals and almost 70% in Maternal. The proportion of progeny born to outside breeds is significantly higher in Maternals compared to Terminals, suggesting an increased willingness from breeders to look to capitalise on high merit animals from outside breeds. However, the trend to use and outside breed remains proportionally relatively constant (Figure 2, blue line). Direct and Maternal Heterosis levels increase to around 25% in the Terminal analysis and approaching double that in the Maternal analysis however the level of heterosis looks to be stabilising in the Terminal analysis while the Maternal animals are continuing to trend towards higher levels of heterosis. Overall the trends across both analyses are for less pure and more cross bred animals with Maternal analysis showing this trend much more strongly than the Terminal analysis.

## Breeding Plans A



**Figure 2. Breed purity, sire selection and Heterosis trends within the Sheep Genetics Maternal (left) and Terminal (right) databases from 1990-2020. The mean percentage of pure breed (grey), proportion of animals who are > 90% of their assigned breed (green), proportion of homebred animals (red), proportion of outside breed sires (blue), Direct Heterosis (orange) and Maternal Heterosis (purple)**

## CONCLUSIONS

This study showed the change overtime in the breed structure of the LAMBPLAN Terminal and Maternal analysis. In general, the number of flocks and breeds represented in the analysis has reduced overtime, while the overall animal numbers have increased. Both analyses have also had an overall reduction in breed purity and a consequent rise in composite animals, this is especially prominent in the Maternal analysis where composites are now the largest “breed” represented. These changes provide both opportunities and challenges for the evolution of the analysis. Future challenges included modelling of more heterosis effects and providing information around the breed proportion of these composites. Also, with the number of breed crosses and composites and large number of animals and pedigree in common could provide the possibility of a future joint Maternal and Terminal Analysis.

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