GENETIC PARAMETERS FOR BODY WEIGHT AND CARCASE TRAITS IN AUSTRALIAN BASED SOUTH AFRICAN MEAT MERINO SHEEP

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SUMMARY
To breed for improved growth and carcase characteristics accurate genetic parameters are required. Heritabilities and genetic and phenotypic correlations for weaning weight (Wwt), post weaning weight (Pwt), yearling weight (Ywt), post weaning fat depth (Pfat), yearling fat depth (Yfat), post weaning eye muscle depth (Pemd) and yearling eye muscle depth (Yemd) were estimated for 4,614 South African Meat Merino lambs. These lambs descended from 124 sires and 1326 dams. Heritability estimates for Wwt, Pwt, Ywt, Pfat, Yfat, Pemd and Yemd 0.33 (0.04), 0.38 (0.04), 0.74 (0.06), 0.19 (0.05), 0.32 (0.06), 0.29 (0.05) and 0.35 (0.07), respectively indicate that these traits are moderate to highly heritable. Significant maternal effects were not found for these traits. There was no evidence to suggest that the genetic parameters for South African Meat Merino sheep differ significantly from those estimated in Merino sheep.
Key words: Merino, genetic parameters, body weight, fat depth, eye muscle depth

INTRODUCTION
Historically Australian Merino breeders have selected animals for breeding primarily for wool characteristics. With a decline in sheep numbers across Australia there has been an increase in demand, and therefore price, of Merino sheep. Many of these sheep are now being purchased for breeding lambs for the mutton and lamb markets. As a result many Merino breeders are becoming interested in producing ewes suitable for prime-lamb as well as for wool production. This has led many producers to investigate the potential production benefits of using exotic sheep breeds. The South African Meat Merino (SAMM) is one such breed. Many records are now present in the Merino Genetic Service (MGS) database both from purebred SAMM studs and crossbred animals from SAMM and Merino studs.

At present the SAMM data is analysed separately to the Merino data due to a lack of genetic linkage. However this linkage is increasing with time and breeders require accurate comparisons between animals from each breed. Prior to combining these data knowledge is required of the differences in genetic parameters between the SAMMs and Merinos. Furthermore, both wool and lamb industries are interested in sheep that have a high reproductive performance and are resistant to internal parasites. There is considerable interest in breeding animals for wool, meat, reproductive and disease traits simultaneously. Estimates of variances and covariances are essential for accurate multiple trait prediction of breeding values and index development. There are very few studies that provide good

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*AGBU is a joint venture of NSW Department of Primary Industries and the University of New England information on the genetic parameters in SAMMs. The objective of this study is to estimate genetic parameters for seven body weight and carcase traits recorded in SAMM sheep.

MATERIALS AND METHODS

Variances and covariances were estimated for a number of traits based on data from the Merino Genetic Service (MGS) database. The traits analysed were weaning weight (Wwt), post weaning weight (Pwt), yearling weight (Ywt), post weaning fat depth (Pfat), yearling fat depth (Yfat), post weaning eye muscle depth (Pemd) and yearling eye muscle depth (Yemd).

The data contained information regarding body weights and carcase traits on 4,614 animals born between 1996 and 2003 that descended from 124 sires and 1,326 dams (Table 1). The total number of animals in the pedigree was 6,234.

Variance component estimates were obtained using an animal model in ASREML (Gilmour *et al.* 2002). The model for body weight traits included the fixed effects of age as a covariate within sex, birth type, rearing type, damage (fitted as quadratic polynomial) and contemporary groups. For carcase traits the fixed effects of body weight (fitted as quadratic polynomial) and contemporary groups were fitted. Contemporary groups were defined using breed, flock, year, sex and management group. The additive genetic effects of individual animal, maternal genetic effects and maternal environmental effects were fitted as random effects. Using a series of univariate analyses and log likelihood ratio tests the importance of these random effects (Lynch and Walsh, 1998) was evaluated. The maternal genetic and maternal permanent environment effects did not significantly improve the fit of the model and were therefore removed from further analyses. A complete set of bivariate analyses was then performed for each trait combination.

Table 1. Summary statistics of the phenotypic data

Traits	No. Records	Mean	Std Dev	Minimum	Maximum
Wwt (Kg)	4,582	34.8	8.24	11.2	60.8
Pwt (Kg)	4,614	50.2	10.6	20.0	86.5
Ywt (Kg)	2,588	67.3	14.2	33.0	117.0
Pfat (mm)	2,528	3.35	1.20	0.50	10.0
Yfat (mm)	2,255	4.01	1.37	1.00	11.0
Pemd (mm)	2,537	28.6	4.24	15.0	42.0
Yemd (mm)	2,258	31.3	4.46	16.0	49.0

RESULTS AND DISCUSSION

Solutions and levels of significance of the fixed effects are presented in Table 2. Body weight traits for both males and females (except yearling weight in males) were affected by age ($P<0.001$). These growth rates are similar to those seen in Australian Merino sheep. Twin born lambs had a significantly lower weaning weight (3kg) and post-weaning weight (2.8kg; $P<0.001$) than single born lambs but the difference was not significant for yearling weight ($P>0.05$). There was a significant effect of rearing type only on weaning weight (1.8kg; P<0.01). Weaning and post-weaning weight were affected by dam age (P<0.01) but dam age was not significant for yearling weight (P>0.05). Body weight as linear and quadratic regression had a significant effect on carcase traits. Post-weaning fat was affected by only a linear regression of body weight (P<0.001).

Table 2. Solutions and level of significance for fixed effects on body weight and carcase traits

Traits	Age M	Age F	Birth Type[1]	Rearing Type[1]	Dam Age	Dam Age^2	Wt	Wt^2
Wwt (Kg)	0.108***	0.121***	-3.033***	-1.717**	0.164 ns	-0.105**	-	-
Pwt (Kg)	0.152***	0.132***	-2.761***	-0.362 ns	0.378**	0.040 ns	-	-
Ywt (Kg)	0.196 ns	0.047***	0.986 ns	-2.998 ns	0.086 ns	-0.022 ns	-	-
Pfat (mm)	-	-	-	-	-	-	0.059***	0.000 ns
Yfat (mm)	-	-	-	-	-	-	3.950***	0.053**
Pemd (mm)	-	-	-	-	-	-	0.273***	-0.001*
Yemd (mm)	-	-	-	-	-	-	0.201***	-0.001***

* P<0.05, ** P<0.01, *** P<0.001 and ns P>0.05

[1]The solutions for birth type and rearing type are both related to a single born and raised lambs

Phenotypic variances along with estimates of heritability and genetic and phenotypic correlations are presented in Table 3. The heritability estimates for weaning and post-weaning weight were 0.33 (±0.04) and 0.38 (±0.04) respectively. These values were within the range of estimates found in the literature for Merino sheep (Safari and Fogarty 2003). Neser *et al.* (2000) and Cloete *et al.* (2001) reported estimates of 0.18 and 0.32 for heritability of weaning weight in South African Meat Merino, respectively. The estimated heritability of yearling weight (0.74±0.06) is higher than corresponding estimates found in literature (Safari and Fogarty 2003). Cloete *et al.* (2001) estimates a yearling weight heritability of 0.45 in South African Meat Merino data.

In this study, maternal genetic and maternal permanent environmental effects were not significant for the body weight traits. However, Cloete *et al.* (2001) and Neser *et. al.* (2000) have observed significant maternal effects for weaning weight (0.09 to 0.24). Cloete *et al.* (2001) also observed significant maternal heritability of Ywt (0.12). The structure of the data appeared sufficient to estimate maternal effects with 15 to 31% of animals having a dam also recorded for the trait. Dams had on average 4.3 progeny however the data contained many embryo transfers that would have interfered with the estimation of the maternal genetic and maternal environmental effects.

The estimates of heritability for Pfat, Yfat, Pemd and Yemd were 0.19 (0.05), 0.32 (0.06), 0.29 (0.05) and 0.35 (0.07), respectively. Maternal effects did not significantly improve the model for the carcase traits. Fogarty *et al.* (2003) and Greeff *et. al.* (2003) reported heritability estimates of 0.20 and 0.28 for fat depth and, 0.27 and 0.31 for eye muscle depth measured at hogget age in Merino sheep, respectively. These authors report non-significant maternal effects for these traits.

The genetic correlations of weaning weight with post-weaning weight and yearling weight were highly positive (0.79 and 0.61, respectively). A value of 0.86 was estimated for genetic correlation between post-weaning and yearling weight. These estimates are in agreement with the estimates found in the literature (Safari and Fogarty 2003). The genetic correlations of body weight at weaning and yearling age with Pfat were -0.40 and –0.64, respectively. The genetic correlation between Pemd and Yemd was highly positive (0.82). No previous estimates have been reported for these traits in South African Meat Merinos. All other genetic correlations, mostly involving Yfat, Pemd and Yemd are not significantly different from zero given their standard errors.

Table 3. Estimates of phenotypic variance, heritability, genetic correlation (below diagonal) and phenotypic correlation (above diagonal) with standard errors in brackets

	Wwt	**Pwt**	**Ywt**	**Pfat**	**Yfat**	**Pemd**	**Yemd**
σ^2_p	21.34	31.16	55.5	0.63	0.88	5.3	5.22
h^2	0.33 (0.04)	0.38 (0.04)	0.74 (0.06)	0.19 (0.05)	0.32 (0.06)	0.29 (0.05)	0.35 (0.07)
Wwt		0.72(0.01)	0.55(0.02)	-0.09(0.03)	-0.03(0.03)	0.00(0.03)	-0.01(0.03)
Pwt	0.79(0.05)		0.66(0.02)	-0.03(0.03)	-0.01(0.04)	0.02(0.03)	0.07(0.03)
Ywt	0.61(0.08)	0.86(0.05)		-0.08(0.04)	0.02(0.04)	0.07(0.04)	0.05(0.04)
Pfat	-0.40(0.17)	-0.23(0.16)	-0.64(0.15)		0.25(0.05)	0.16(0.02)	0.08(0.05)
Yfat	0.20(0.13)	0.19(0.14)	0.17(0.13)	0.27(0.21)		0.06(0.05)	0.16(0.03)
Pemd	-0.31(0.15)	-0.03(0.14)	0.15(0.15)	-0.04(0.17)	-0.05(0.19)		0.36(0.04)
Yemd	-0.14(0.14)	0.10(0.15)	0.06(0.13)	0.26(0.22)	0.20(0.15)	0.82(0.14)	

CONCLUSIONS

There was no evidence to suggest that the genetic parameters for South African Meat Merino sheep differ significantly from those estimated in Merino sheep. Until more data are available the recent Merino genetic parameter estimates for use in the ASGD Merino genetic evaluation can also be used for the SAMM evaluation.

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