GENETIC OPPORTUNITIES TO IMPROVE LAMB WEANING RATES IN MERINOS

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SUMMARY
Opportunities to improve genetic merit for number of lambs weaned (NLW) and scrotal circumference (SC) are relatively untapped by Merino breeders. Data from the Merino Genetic Services (MGS) database was analysed to determine the heritability of yearling and hogget scrotal circumference and number of lambs weaned as well as their genetic correlations. NLW was found to be lowly heritable at 0.06. Scrotal circumference at yearling and hogget ages was moderately heritable at 0.37 and 0.36 respectively. The genetic correlation between yearling SC and NLW was moderately positive at 0.35 (0.30) suggesting that yearling SC may be a useful indirect selection tool for NLW. The standard error associated with these correlations suggests that more data is needed to more accurately describe this relationship.

Examination of the range in estimated breeding values (EBV) within the MGS database illustrates significant genetic variation for these traits. Among the 256,000 Merinos in this database the range in NLW EBV is 77.3%. That is, the daughters of a ram at the high end of the range are expected to wean, on average, 38.6% more lambs than the daughters a ram at the low end of the EBV range. The range in yearling scrotal circumference EBV is 6.3cm. Given the estimated genetic variation in NLW and SC and the genetic parameters derived from this data set there appear to be significant genetic opportunities for improved lamb weaning rates in Merino sheep.
Keywords: number of lambs weaned, scrotal circumference, Merino, sheep

INTRODUCTION
The Australian ewe flock has been contracting in size by an estimated average of 1.8 million head per year since a peak at 73 million breeding ewes in 1989-1990 (Shafron *et al.* 2002). This has significant implications for not only the wool industry but also the sheep meat (lamb and mutton) industries to which Merinos contribute an estimated 59% of the genetics. Over the same period the value of the sheep meat industry has increased over twenty fold from $50M in 1990 to over $1B in 2002 consuming an estimated 18 million lambs. Meat and Livestock Australia estimate that current market demand could absorb an extra 4 million lambs. The declining ewe flock coupled with severe drought conditions in many key sheep producing areas means that sheep meat producers are unlikely to be able to satisfy existing market demands.

The ability to exploit genetic opportunities to increase reproductive performance will contribute to halting the current decline in ewe numbers and increase the rate of flock rebuilding post drought conditions. The opportunity for genetic improvement in number of lambs weaned (NLW), yearling (Y) and hogget (H) scrotal circumference (SC) and their genetic relationship is examined.

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MATERIALS AND METHODS

Pedigree and performance data were extracted from the Merino Genetic Services (MGS) database. This database consists of pedigree and performance records from Australian and New Zealand Merino studs and is used for genetic evaluation purposes. The database currently holds records on over 256,000 animals.

Only data that met the following criteria were used: 1) date of measurement and current owner were recorded, 2) at least sire or dam was known, 3) date of birth was known, 4) the sex was identified as male or female, 5) pure-bred Horn or Poll Merino, and 6) age of dam was less than 12 years. Observations more than 3 standard deviations outside the mean of their contemporaries were also deleted, and all animals in contemporary groups (CGs) with fewer than 10 animals were deleted. The pedigree was built using all available ancestors. A summary of the data used for each trait is shown in Table 1.

Table 1. Description of data used in univariate analysis of scrotal circumference at Yearling (YSC) and Hogget (HSC) ages and bivariate analysis of number of lambs weaned (NLW) and Yearling and Hogget scrotal circumference

	Univariate analysis		Bivariate analysis	
	YSC	**HSC**	**NLW-YSC**	**NLW-HSC**
Pedigree	5036	8264	23775	26183
Data	2935	5100	17658	19823
Sires	168	245	1413	1460
Flocks	14	17	47	48
Years	5	7	18	18

Model for Analysis. Genetic parameters were estimated for each trait by fitting an animal model in ASREML (Gilmour et al. 1999).

$$\mathbf{y} = \mathbf{X}b + \mathbf{Z}_1\mathbf{a} + \mathbf{Z}_2\mathbf{m} + e$$

Where **y** is the vector of observations, b is the vector of fixed effects (means, age, age of dam, birth type, rearing and CG for SC and only means and CG for NLW), **a** and **m** are vectors of direct and maternal genetic effects, **X, Z_1** and **Z_2** are incidence matrices relating observations and effects, and **e** is the vector of random residuals. Also with g = [a m]. Var g (= [a m]) = A * G_o, Var(e) = I * R_o.

The MGS database was also used to determine the genetic variation, expressed by estimated breeding values calculated using OVIS (Brown *et al* 2001), that exists for number of lambs weaned (NLW) and yearling and hogget scrotal circumference (YSC, HSC).

RESULTS AND DISCUSSION

A moderate direct heritability of 0.37 (0.07) and 0.36 (0.05) was estimated for scrotal circumference at yearling and hogget ages respectively (Table 2). This is consistent with estimates by Ponzoni *et al.* (1995) and Duguma *et al.* (2002). Ingham *et al* (2002) estimated the heritability of scrotal circumference at 0.25 and 0.26 (0.01 – 0.09) at ten and sixteen months respectively. The maternal genetic effect on scrotal circumference was significant at yearling age, 0.09 (0.04). With the limited

depth in maternal pedigree and a relatively small number of records currently available (2935 yearling and 5100 hogget) these estimates will require re-estimation when a larger pedigree and data set is available. The effect of birth type and rear type were considered insignificant due to high standard errors.

Table 2. Phenotypic variance (PhenV), direct heritability (h^2) and maternal heritability (m^2) estimated for yearling (Y) and hogget (H) scrotal circumference

	YSC	HSC
PhenV	5.96 (0.21)	5.84 (0.15)
h^2	0.37 (0.07)	0.36 (0.05)
m^2	0.09 (0.04)	0.03 (0.02)

The effect of dam age on scrotal circumference was low and considered insignificant at both yearling and hogget ages. Using dam age and dam age^2 solutions to make quadratic adjustment for dam age influences, an adjustment of up to 1.5cm appears adequate to standardise scrotal circumference of ram lambs from young or old ewes to the 4.5 year old standard used by OVIS. Further scrotal data across all ewe age groups is required to better estimate these effects. Of the current data over half is from the 2001 ram drop. The effect of age on scrotal circumference was low at both yearling 0.02 (0.001) and hogget 0.02 (0.01).

With bivariate analysis of number of lambs weaned (NLW) with yearling (Y) and hogget (H) scrotal circumference (SC) the heritability of scrotal circumference was moderate to high at yearling, 0.42 (0.07) and hogget, 0.39 (0.05) (Table 3). The heritability of number of lambs weaned was low at 0.06 (0.01). A moderate positive genetic correlation of 0.35 (0.30) was estimated between NLW and YSC offering breeders an opportunity to use the readily measured and moderately heritable trait YSC to improve NLW.

Table 3. Phenotypic variance (PhenV), direct heritability (h^2) and genetic correlation (r_g) estimated for number of lambs weaned and yearling (Y) and hogget (H) scrotal circumference

	NLW	YSC	NLW	HSC
PhenV	0.23 (0.01)	5.72 (0.17)	0.23 (0.01)	5.80 (0.13)
h^2	0.06 (0.01)	0.42 (0.07)	0.06 (0.01)	0.39 (0.05)
r_g	0.35 (0.30)		0.15 (0.24)	

The reduction in the genetic correlation between NLW and SC from yearling to hogget ages is not considered significantly different given the standard errors of these estimates. Ingham *et al* (2002) report the genetic correlation between number of lambs weaned and scrotal circumference at 10 months and 16 months at 0.40 and 0.36 (0.14 to 0.18).

The authors suggest that additional repeat scrotal circumference data is required to further investigate the role of scrotal circumference estimated breeding values as a tool to select for number of lambs

weaned. An adequate volume of repeat measurements would also enable better identification of the optimal time of measurement. The Merino Genetic Services genetic evaluation produces estimated breeding values (EBVs) for number of lambs weaned and scrotal circumference. Table 4 shows the genetic range in the database as at February 2003. These relatively large ranges suggest that significant opportunities exist for improvement in these traits in Merinos.

Table 4. Variation in estimated breeding values (EBV) for yearling and hogget scrotal circumference (YSC and HSC respectively) and the number of lambs weaned (NLW) from the Merino Genetic Services database as at February 2003 (n=297,761)

	Low EBV	High EBV	Range
NLW (%)	-27.7	49.5	77.3
YSC (cm)	-3.2	3.1	6.3
HSC (cm)	-4.7	4.2	8.9

CONCLUSIONS

Number of lambs weaned (NLW) is an important trait for breeding flock profitability. NLWis lowly heritable making response to selection from this measure slow. Scrotal circumference at yearling age is moderate to highly heritable and can be readily and cheaply measured on-farm by ram breeders. Yearling scrotal circumference has a moderate positive genetic correlation with NLW offering Merino breeders an additional selection tool. The most effective use of yearling scrotal circumference will come from an EBV that is corrected for maternal and environmental effects. The current data is limited in volume. Further analysis will need to re-estimate the phenotypic and genetic relationships between these traits and with other traits in the genetic evaluation. As Merino breeders include these traits in their breeding objective they will need to go through the process of estimating the economic value for each of these traits.

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REFERENCES

Brown, D.J., Tier, B., and Ball, A.J. (2001). What does OVIS offer the Merino Breeder? *Proceedings of the Association for the Advancement of Animal Breeding and Genetics* 14, 525-528.

Duguma, G., Cloete, S.W.P., Schoeman, S.J. and Jordaan, G.F. (2002) *South African J. Anim. Sci.* **32**:76.

Gilmour, A.R., Thompson, R., Cullis, B.R., and Welham, S. (1999) "ASREML Reference Manual," NSW Agriculture, Orange.

Ingham, V., Pitchford, W. and Ponzoni, R.W. (2002) Genetic Improvement of Merino Sheep Meat Production, unpublished.

Ponzoni, R.W., Grimson, R.J., Jaensch, K.S., Smith, D.H., Gifford, G.R., Ancell, P.M.C., Walkley, J.R.W. and Hynd, P.I. (1995) *Ass. Adv. Anim. Breed. Genet.* **11**:303.

Shafron, W., Martin, P. and Ashton, D. (2002) *Profile of Australian Wool Producers, 1997-98 to 2000-01*, ABARE Research Report 02.7, Canberra.