GENETIC RELATIONSHIPS AMONG LAMB SURVIVAL, BIRTH COAT SCORE, BIRTH WEIGHT AND 42-DAY BODY WEIGHT IN A SOUTH AFRICAN FINE WOOL MERINO STUD

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SUMMARY

Lamb and mutton are the most important sources of income for South African Merino farmers. The possibility of genetically improving survival of a Merino lambs was assessed with data from 5769 lambs that were born alive in the Cradock fine wool stud from 1998 to 2003. Three traits can possibly be linked to lamb survival and can therefore be included in selection programs, namely birth coat score, birth weight and 42-day body weight. The aim of this study is therefore to quantify the genetic relationship among lamb survival, birth coat score, birth weight and 42-day body weight in a South African fine wool Merino stud. Direct h^2 estimates were 0.19 for birth weight, 0.19 for birth coat score, 0.06 for 42-day body weight and 0.09 for lamb survival. Corresponding estimates for m^2 were 0.34, 0.18, 0.37 and 0.26 respectively, while c^2 was estimated at respectively 0.06, 0.03, 0.02 and 0.01. Genetic correlations among treats were generally below double the corresponding standard error, and therefore not significant. It was concluded from the results of this study that it would be possible to improve lamb survival genetically, by selection for a related trait, like ewe rearing ability. The scope for successful indirect selection using birth weight, birth coat score or 14-days body weight seems to be limited.

INTRODUCTION

The production of meat is the most important source of income for South African Merino farmers. An increase in meat production can be obtained through selection for increased growth rate or an increase in the number of lambs that survived until weaning as well as a reduction in slaughter age. Increasing the number of lambs that survive until weaning can have a quick and immediate effect on the efficiency of the enterprise.

The survival of Merino lambs is linked directly to its genetic makeup and management factors. Management problems can be rectified with immediate effect, however, the genetic makeup of the lambs is also of utmost importance. Changing the genetic makeup of the lambs will lead to more viable lambs being born.

Three traits can possibly be linked to the postnatal survival of Merino lambs and can therefore be included in selection programs, namely birth coat score (Alexander 1964), birth weight (Morris *et al.* 2000) and 42-day body weight (as an indication of milk production; Brand and Franck 2000). The genetic relationship among these traits and lamb survival must be quantified before they can be included in selection programs. The aim of this study is therefore to quantify the genetic relationship among lamb survival, birth coat score, birth weight and 42-day body weight in a South African fine wool Merino stud.

MATERIALS AND METHODS

Data. The Cradock Fine Wool Merino Stud was established in 1988 as described by Olivier *et al.* (2006). Ewes were bought from 30 Merino farmers with the finest clips throughout South Africa and four fine wool rams were imported from Australia as sires. Since then, another seven rams were introduced into the stud to be used as sires. Data collected on 5769 ram and ewe lambs that were born alive within this stud from 1988 to 2003 were used for the analyses.

The traits included in the analysis were birth weight, birth coat score, 42-day body weight and lamb survival. Lamb survival was defined as the number of lambs born alive that survived until weaning. This trait was coded as a binary trait with two categories, namely lambs born alive that died before weaning (coded as 1) and lambs that survived until weaning (coded as 2).

Birth coat scores were recorded since 1992 and assessed on a scale from 1 to 4 with 1 being woolly and 4 being hairy. All birth weights were recorded within 24 h of birth. The 42-day body weight was measured at an average age (± s.d.) of 47 ± 6 days.

Data analysis. The means, standard deviations, coefficients of variations, minima and maxima for the respective traits were obtained with the PROC MEANS-procedure of SAS, and significance levels for the fixed effects were obtained with the PDIFF-option under the PROC GLM-procedure of SAS (Littell et al., 2002). The effects tested included year of birth, sex, age of dam in years and birth status. The age of the animals (linear regression) at 42 days of age was also tested for significance. Only effects that had a significant effect were included in the final model for each trait.

The estimation of variance components and genetic parameters was done with THRGIBBSF90 (Misztal *et al.* 2002). This software can be used to estimate variance components and genetic parameters in linear-threshold mixed animal models for any combination of categorical and continuous traits (Lee *et al.* 2002). POSTGIBBSF90 was used for Post Gibbs analysis to obtain solutions for the random effects (Misztal *et al.* 2002). A single chain of 150 000 cycles were run and the first 50 000 cycles used as the burn-in period. Every 10^{th} sample after the burn-in period was stored, giving a total of 10,000 samples for the computation of posterior means and posterior standard deviations.

RESULTS AND DISCUSSION

Descriptive statistics for the respective traits are summarised in Table 1. It is evident from these that the average birth weight of the lambs that were born alive was 4.47 kg, with a range from 1.10 kg to 8.00 kg. The average 42-day body weight was 16.09 kg and it ranged from 4.40 kg to 30.20 kg. The average birth coat scores (1 being more woolly and 4 being more hairy) and lamb survival (1 for lambs that died before weaning and 2 for lambs that survived until weaning) on the underlying scale were 1.92 and 1.91 respectively. This can be translated into the fact that more than 90 % (5247 lambs) of the lambs born alive survived until weaning.

Table 1. Descriptive statistics for birth weight, birth coat score, 42-day body weight and lamb survival

	Birth weight (kg)	Birth coat score	42-day body weight (kg)	Lamb survival
Number of records	5769	4456	5352	5769
Mean	4.47	1.92	16.09	1.91
Standard deviation	0.87	0.81	3.69	0.29
Coefficient of variation	19.50	42.12	22.94	15.01
Minimum	1.10	1	4.40	1
Maximum	8.00	4	30.20	2

The point estimates for direct heritability (h^2), maternal heritability (m^2), maternal permanent environment effect (c^2) and the correlation between the direct and maternal genetic effects (r_{am}) on the underlying scale for birth coat score and lamb survival, as well as for birth weight and 42-day body weight are presented in Table 2.

The heritability for lamb survival estimated in this study (0.09) falls within the range of the values cited by Safari *et al.* (2005) that ranged from 0.00 (Olivier *et al.* 1998 – threshold model) to 0.11 (Hall *et al.* 1995 – threshold model). However, Cloete *el al.* (2009) reported a higher heritability of 0.27 for lamb survival obtained with THRGIBBSF90 (Misztal *et al*. 2002). The maternal heritability (0.26) estimated in this study is higher than the estimate (0.14) obtained by Cloete *et al.* (2009), as well as the range of values reported by Safari *et al.* (2005) from the literature. The heritability, maternal heritability, maternal permanent environment effect and the correlation between direct and maternal genetic effect for birth weight falls within the range of values cited for Merino sheep by Safari *et al.* (2005) from the literature. The values estimated in this study for heritability, maternal permanent environment effect and the correlation between direct and maternal genetic effect for 42-body weight is lower than the values reported by Safari *et al.* (2005) from the literature, while the maternal heritability is higher than the reported values (Safari *et al.* 2005). The heritability for birth coat score is lower than values reported in the literature that range from 0.65 (Kemper *at al.* 2003) to 0.70 (Cloete *et al.* 2003). The permanent maternal environment effect estimated in this study is in the same order as the value reported by Cloete *et al.* (2003).

Table 2. The direct heritability (h^2), maternal heritability (m^2), maternal permanent environment effect (c^2) and correlation between direct and maternal genetic effects (r_{am}) for the different traits (± s.e.)

	h^2	c^2	m^2	r_{am}
Birth weight	0.19 ± 0.05	0.06 ± 0.02	0.34 ± 0.08	-0.26 ± 0.12
Birth coat score	0.19 ± 0.02	0.03 ± 0.01	0.18 ± 0.07	-
42-day body weight	0.06 ± 0.06	0.02 ± 0.01	0.37 ± 0.13	-0.04 ± 0.06
Lamb Survival	0.09 ± 0.05	0.01 ± 0.00	0.26 ± 0.16	-0.14 ± 0.10

Genetic and maternal correlations among the different traits are summarised in Table 3. It is evident that all the correlations were low to moderate among the respective traits, with only the maternal correlation between birth weight and 42-day body weight reaching a level of double the corresponding standard error. Cloete *et al*. (2009) correspondingly reported a low negative genetic correlation between birth weight and lamb survival. Sawalha *et al.* (2007) also reported an unfavourable genetic correlation between lamb viability (coded as 0 for survivors and 1 for animals that had died) and birth weight of 0.21. The relationship between lamb survival and birth weight is complicated by the non-linear relationship that exists between these two traits. This relationship suggest that it would be better to produce lambs with intermediate birth weights, as the extreme to both sides, i.e. too low or too heavy birth weights, will reduce lamb survival. Small and ill thrifty lambs will most probably die due to starvation and hypothermia, whereas dystocia is considered as the biggest problem in lambs that are too big and heavy.

The low genetic correlation between 42-day body weight and lamb survival suggest the improvement in the growth rate of lambs would not have a marked effect on the number of lambs that survived until weaning. The effect of the ewe is bigger than the lamb's own performance at this stage of its life. It might be a more viable option to select ewes with better mothering ability at this stage, because lambs still largely depend on the milk production of the ewes. The genetic correlation between lamb survival and birth coat score in this study, support findings in the literature that lamb survival is not highly related to the birth coat score of Merino lambs (Ponzoni *et al.* 1996; Cloete *et al.* 2003).

The low heritabilities for lamb survival in the literature (Olivier *et al.* 1998; Snyman *et al.* 1998; Morris *et al.* 2000) suggested that it would not be possible to improve lamb survival genetically. In contrast, the present study, as well as that of Cloete *et al*. (2009), suggests that it would be feasible to improve lamb survival genetically.

Table 3. The genetic (above diagonal) and maternal (below diagonal) correlations among the different traits (± s.e.)

	Birth weight	Birth coat score	42-day body weight	Lamb survival
Genetic correlations				
Birth weight		0.20 ± 0.26	0.44 ± 0.33	-0.31 ± 0.19
Birth coat score	0.04 ± 0.07		0.35 ± 0.76	0.19 ± 0.38
42-day body weight	0.17 ± 0.07	0.02 ± 0.05		0.11 ± 0.23
Lamb survival	0.03 ± 0.05	0.01 ± 0.05	0.05 ± 0.05	

CONCLUSIONS

It can be concluded that it would be possible to improve lamb survival genetically. This can be achieved by selection for traits directly related to lamb survival in ewes (i.e. rearing ability or multiple rearing ability) by culling of unproductive ewes that failed to rear lambs. The scope for indirectly selecting for lamb survival by considering birth weight, birth coat score or 42-days weight appears to be limited.

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