GENETIC PARAMETER ESTIMATES FOR EWE LIFETIME PRODUCTIVITY IN A MERINO SHEEP FLOCK

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INTRODUCTION

Improved ewe productivity is a major objective in the local sheep industry. This could be achieved in part by increasing the number of lambs born and weight of lambs weaned per ewe per year. In South Africa, though Merino sheep are pre-eminently wool producers, 50 to 60 % of income is generated through mutton production (Snyman *et al*., 1998b). Until recently emphasis has mostly been given to the individual component traits of reproduction such as fertility, litter size, etc. Ewe productivity, defined as total weight of lambs weaned per ewe joined, which comprises several component traits has received less attention (Fogarty, 1995) and only a few estimates of genetic parameters are available. Total weight of lamb weaned per year is the best single measure of a flock's productivity (Snyman *et al*., 1997). There is relatively large phenotypic variation in total weight of lamb weaned regardless of the reproductive rate of the flock and could therefore be exploited to genetically increase lifetime reproductive efficiency in any flock. Total weight of lamb weaned is determined by litter size, survival rate as well as several other factors such as mothering ability, milk production of the ewe and growth potential of the lamb (Snyman *et al*., 1997).

The objective of this study was to estimate genetic parameters for ewe lifetime productivity in a Merino flock at the Tygerhoek Experimental Farm. Genetic correlations between total weight weaned in the first parity and total lifetime production of ewes were also investigated.

MATERIALS AND METHODS

Production records for number born, number weaned and weight of lambs weaned were obtained. After editing, 818 ewes with 3272 lambing records from 1971 to 1999 were used. The ewes were the progeny of 689 dams and sired by 371 rams. Traits studied were total number of lambs born per ewe lambing over four lambing opportunities (TLB), total number of lambs weaned per ewe lambing over four lambing opportunities (TLW), total weight of lambs weaned per ewe lambing over four lambing opportunities (TWW) and total weight of lambs weaned per ewe lambing at first parity (TWW1). The first four lambings of a ewe were taken as an indication of lifetime reproduction. Thus, only data of ewes with four consecutive lambings (only those ewes which gave birth for four consecutive lambings) were used in this analysis. Weaning weight of lambs was recorded at about 100 to 120 days of age and it was adjusted to 100 days. The traits TLB and TLW were considered as continuous for this study. All ewes were bred to lamb for the first time at 2-yr of age. Ewe ages ranged from 2 to 6 year.
Different models were used depending on the parameters being estimated. The General Linear Models of SAS (1996) were used to model fixed effects on ewe productivity. The fixed part of

the model for TLB and TLW included ewe type of birth and ewe birth year as fixed effects. For TWW, ewe birth year was fitted as fixed effect. The model for TWW1 included group (selection and control group), ewe birth year and type of lambing as fixed effects. In all cases, ewe two-tooth liveweight was fitted as a covariable.

Variance components were estimated by REML procedures applying the VCE 4.2.5 package of Groeneveld (1998) to an animal model. Following completion of the unitrait analysis, two-trait pairwise analyses were conducted to estimate genetic correlations between traits. The model fitted was :

Y = X**b** + Z**a** + **e**
where
Y = vector of observations ; **b** = vector of fixed effects ; **a** = vector of random animal effects ; X = the matrix that associates **b** with Y ; Z = the matrix that associates **a** with Y ; **e** = vector of random residual effects.

RESULTS AND DISCUSSION
The overall means, analyses of variance and significance of the fixed effects for reproduction traits are shown in table 1. The analyses of variance showed that the fixed models accounted for about 14.4 to 17.5 % of the variances in TLB and TLW and 13.9 % in TWW. Of the different effects considered, two-tooth liveweight of the ewe was of paramount importance for TWW, TLB and TLW followed by ewe type of birth for the latter two traits. Multiple born ewes bore 7.6 % (0.40) more and weaned 7.4 % (0.30) more lambs than singles.

Table 1. Overall means and analysis of variance for TLB, TLW and TWW

		Mean square and level of significance		
Variables	df	TLB	TLW	TWW
Overall mean		5.23 (n)	4.05 (n)	92.55 (kg)
Ewe type of birth	1	23.914***	13.549***	
Ewe birth year	23	2.863***	7.816***	2763.597***
Ewe two-tooth liveweight	1	54.024***	23.251***	43686.485***
Error degrees of freedom		737	737	738
Error mean square		1.03	1.31	725.59
R^2 (%)		14.43	17.48	13.91
C.V. (%)		19.41	28.24	29.11

*** $p < 0.001$

Estimates of direct heritabilities and variance components are presented in table 2 and estimated genetic correlations among the different traits are presented in table 3. Standard errors of heritability estimates ranged from 0.06 to 0.07. The estimated heritabilities for lifetime ewe reproduction traits were moderate and ranged from 0.17 to 0.23. Genetic correlations between ewe reproduction traits obtained in this study were high positive.

Table 2. Variance components and heritability estimates for TLB and TLW, TWW

Trait	σ^2_a	σ^2_e	σ^2_p	h^2
TLB	0.24	0.80	1.04	0.23
TLW	0.22	1.09	1.31	0.17
TWW	141.89	571.86	713.75	0.20
TWW1	0.43	29.30	29.73	0.02

σ^2_a , direct additive variance ; σ^2_e , residual variance ; σ^2_p , phenotypic variance ; h^2, direct heritability.

Table 3. Genetic correlations among the different traits

	TLB	TLW	TWW
TWW1	-0.10 ± 0.24	0.57 ± 0.23	1.00
TLB		0.62 ± 0.16	0.61 ± 0.17
TLW			0.92 ± 0.04

The TWW obtained in the current study was in agreement with those reported by Snyman *et al.* (1997) and Herselman *et al.* (1998) for the Grootfontein Merino flock over three lambing opportunities. Snyman *et al.* (1998b) reported 52.4 kg of weight of lambs weaned per ewe joined over three lambing opportunities for the flock used in the current study. It has been reported that Merino ewes weaned only 37.8 to 91.1 kg of lambs over three lambing opportunities compared to 116.8 kg for Afrino ewes (Herselman *et al*., 1998). Snyman *et al.* (1998a) estimated negative genetic correlations ranging for –0.32 to –0.52 between clean fleece weight and the reproduction traits. This suggested that increasing litter weight puts an added burden on the ewe's metabolic system and results in phenotypic decreases in fleece weight (Ercanbrack and Knight, 1998).

The TLB and TLW obtained in the current study were higher than those reported for the Carnarvon Merino flock (Snyman *et al*., 1997). They reported 2.22 and 1.88 total number of lambs born and weaned per ewe joined over three lambing opportunities, respectively. Multiple born ewes were superior to single born ewes in both the TLB and TLW. This was in agreement with previous results (Cloete and Heydenrych, 1986 ; Kritzinger *et al*., 1984). In the current study, ewe type of birth, however, did not affect TWW ($P > 0.05$). The significant influence of two-tooth ewe liveweight on reproduction traits obtained confirmed an earlier suggestion by Cloete and Heydenrych (1987) whom indicated that selection for an increased two-tooth ewe liveweight (at about 1.5 yrs of age) may probably be associated with an increase in reproduction rate. Heritabilities obtained for TWW were in the range reported in most of the literature cited for Merino sheep (Snyman *et al*., 1997 ; Olivier *et al*., 2001). The heritability values of 0.22 and 0.26 for TWW (for total weight weaned over three and four lambing opportunities, respectively) reported by Snyman *et al*. (1997) were, however, higher than those of this study. Heritability values for TLB and TLW obtained in the current study were in close agreement with those reported by Olivier *et al.* (2001) but higher than most of those reported elsewhere (Burfening *et al*., 1993 ; Brash *et al*., 1994). Cloete and Heydenrych (1987) reported estimates ranging from 0.29 to 0.36 for total number of lambs born and weaned per ewe conceived over four lambing opportunities in the same flock using half-sib analysis. Fogarty (1995) whom reported an average lifetime heritability estimate of 0.14 for total number of lambs born per lambing opportunity indicated that REML estimates of heritability from an animal model were lower, but might be regarded as more reliable than earlier estimates for these traits. In general, the heritability estimates obtained in the present study indicate that there is scope for genetic improvement if selection is based on either of the traits considered.

The estimated genetic correlation between TLW and TWW was very high and positive. This estimate was slightly lower than those estimates ranging from 0.97 to 0.98 reported between the same traits by Olivier *et al*. (2001) for the Grootfontein and the Carnarvon Merino flocks but slightly higher than the estimate of 0.84 reported by Snyman *et al.* (1998a) for Afrinos. The genetic correlations obtained between TLB and TLW and between TLB and TWW were lower than those reported for Afrinos (Snyman *et al*., 1998a).

CONCLUSIONS

Prediction of breeding values of sires for TWW in the South African merino sheep industry should thus be considered.

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