

## Genetic trends in a South African Mutton Merino nucleus breeding scheme

H.Q. Gray<sup>1</sup>, F.W.C. Neser<sup>2</sup> \*, G.J. Erasmus<sup>2</sup> and J.B. van Wyk<sup>2</sup>

<sup>1</sup>ARC Animal Improvement Institute - Cedara, P.O. Box 342, Pietermaritzburg, 3200 Republic of South Africa

<sup>2</sup>Department of Animal Science, University of the Orange Free State, P.O. Box 339, Bloemfontein, 9300 Republic of South Africa

*Received 1 May 1998; accepted 24 November 1998*

Genetic parameters and trends were estimated for 2296 lambs from a SA Mutton Merino nucleus breeding scheme using multiple trait mixed model procedures. Direct heritability estimates obtained for the traits were 0.32 for weaning weight, 0.03 for post-weaning average daily gain (PWADG) and 0.05 for post-weaning Kleiber ratio (KL). Maternal heritability for weaning weight was estimated as 0.15, while the estimate for permanent maternal environment as a proportion of the total variance was 0.07. The genetic correlations between weaning weight and PWADG and weaning weight and KL were  $-0.12$  and  $0.02$  respectively. The estimated genetic trends for all the traits were disappointingly low, probably owing to the low heritabilities and unfavourable genetic correlations.

Genetiese parameters en tendense is vir 2296 lammers van 'n SA Vleismerino Groepteelskema beraam deur van 'n meer eienskap-gemengde modelprosedure gebruik te maak. 'n Direkte oorerflikheid van 0.32 vir speenmassa, 0.03 vir naspeense gemiddelde daaglikse groei (PWADG) en 0.05 vir naspeense Kleiber verhouding (KL) is onderskeidelik beraam. Die maternale oorerflikheid vir speenmassa is beraam as 0.15, terwyl die beraming vir permanente maternale omgewing as 'n proporsie van die totale variansie op 0.07 te staan gekom het. Die genetiese korrelasie tussen speenmassa en PWADG asook speenmassa en KL was onderskeidelik  $-0.12$  en  $0.02$ . Die beraamde genetiese tendense vir al die eienskappe was teleurstellend en kan moontlik aan die lae oorerflikhede en ongunstige genetiese korrelasies toegeskryf word.

**Keywords:** SA Mutton Merino sheep, genetic parameters, genetic trends, nucleus breeding scheme

\* To whom correspondence should be addressed

### Introduction

The South African Mutton Merino is a dual purpose (meat and wool) breed claimed and mostly accepted to be a good utiliser of low quality roughage. In 1983 the apparent success of Merino nucleus breeding schemes prompted ten SA Mutton Merino breeders to start their own nucleus breeding scheme. After 15 years of operation the most important question is obviously what genetic progress, if any, has been made. Since selection is normally, as in this case, carried out on more than one trait, multivariate analyses should be carried out. Additional information such as estimates of genetic correlations will then become available. This should improve the accuracy of the evaluation (Ducrocq & Besbes, 1993) and hence the trend estimate. The advances in computer technology and software have made multiple trait analyses a viable option, even in complex situations. These

advances invariably lead to a refinement and updating of existing parameter estimates as a by-product of the initial objective of the study.

The objective of this study was primarily to estimate the genetic parameters and genetic trends for some of the traits (weaning weight, post-weaning average daily gain and post-weaning Kleiber (1936) ratio, defined as average daily gain/final weaning weight<sup>0.75</sup>) in this nucleus flock. Nucleus breeding schemes have in the past been widely propagated but little is known about their actual success in bringing about genetic progress and hence this study was undertaken.

## Material and methods

### Animals

Data from the Freelands SA Mutton Merino Group Breeding Scheme were used and consisted of 2 296 weaning weight records, the progeny of 82 sires, collected over a period of 12 years, as well as records of 564 young rams tested in post-weaning growth tests (Phase D of the National Performance Testing Scheme for sheep). This was about 50 % of all ram lambs born in the scheme. Ewes were kept on natural and irrigated pastures. The post-weaning growth tests were conducted on irrigated Italian Ryegrass pastures with additional concentrate feeding (200 g alkali-ionophore treated grain) during the last four years (1992–1995). Young rams were tested for post-weaning average daily gain and Kleiber ratio (since 1992). Rams were selected on weaning weight (Ww), post-weaning average daily gain (PWADG), post-weaning Kleiber ratio (KL) and scrotal circumference applying independent culling levels. Scrotal circumference was, however, not included in the study. Ewes that skip lambing or ewes with very poor weaning performance were culled. A complete description of the breeding and management practices in the scheme was presented by Gray & Van Wyk (1995).

### Statistical analysis

To assess the influence of non-genetic factors on Ww, PWADG and KL, an analysis of variance was done using General Linear Model (GLM) of SAS (1988). Sires were treated as random. Year, sex, birth status and dam age were identified and included as fixed effects, while age at weaning was fitted as a linear regressor.

Estimates of the (co)variance components and breeding values were obtained using the Derivative Free Restricted Maximum Likelihood (DFREML) program developed by Meyer (1995), using a tri-variate analysis with two different models fitted. In the model used for Ww two correlated random factors, direct additive and maternal additive were included, while permanent maternal environment was included as an uncorrelated random factor. For PWADG and KL only the direct additive was fitted as a random factor, while year and dam age were included as fixed effects and days in test and starting weight were included as linear regressors.

## Results and discussion

The heritability estimates for Ww, PWADG and KL are presented in Table 1.

The direct heritability estimate for Ww compares well with published values for the breed (Gray & van Wyk 1995; Naser *et al.*, 1998). The value also compares well with other international published values for sheep (Maria *et al.*, 1993; Tosh & Kemp, 1994; Conington *et al.*, 1995). The maternal heritability estimate also compares well with the results obtained by Naser *et al.* (1998) (0.15 vs 0.18) but is higher (0.07) than that obtained by Gray & Van Wyk (1995) in a previous study undertaken on the flock. It is, however, in line with international estimates (Maria *et al.*, 1993; Tosh & Kemp, 1994; Conington *et al.*, 1995). However, the correlation between direct and

**Table 1** Heritability and variance component estimates for weaning weight (Ww), post-weaning average daily gain (PWADG) and post-weaning Kleiber ratio (KL). (Standard errors in parenthesis.)

	Ww	PWADG	KL
Direct heritability (SE)	0.32 (0.00)	0.03 (0.08)	0.05 (0.09)
Maternal heritability (SE)	0.15 (0.00)		
Permanent maternal environment (SE)	0.07 (0.00)		
Direct additive variance	710.92	20.06	389.86
Maternal additive variance	327.70		
Variance owing to permanent maternal environment	154.89		
Error variance	1330.83	668.21	8323.59
Phenotypic variance	2198.53	688.27	8713.45
Correlation between direct and maternal	-0.68		

maternal effects corresponds with that obtained by Gray & Van Wyk (1995) and Nesar *et al.* (1998)  $-0.68$  vs  $-0.80$  and  $-0.68$ ). The estimate obtained for permanent maternal environment is lower than that obtained by Gray & Van Wyk (1995) and Nesar *et al.* (1998) (0.07 vs 0.14 and 0.085).

The direct heritability estimates for both PWADG and KL are considerably lower than the values in the literature. Badenhorst *et al.* (1991) reported heritability estimates of 0.22 and 0.23 for average daily gain and Kleiber from weaning to year-old in Afrino sheep, respectively. This compares well with results obtained by Mavrogenis & Constantinou (1990) for post-weaning growth rate in Chios sheep (0.26).

The genetic and phenotypic correlation obtained among the traits is presented in Table 2.

The genetic correlation between Ww and PWADG obtained in this study compares well with the results obtained by Badenhorst *et al.* (1991) in Afrino sheep ( $-0.12$  vs  $-0.10$ ). Although the sign of the phenotypic correlation between Ww and PWADG differs in the two studies mentioned, both are low (0.03 vs  $-0.12$ ). There is, however, a difference in both the genetic and phenotypic correlation between Ww and KL (0.02 vs  $-0.55$  and  $-0.04$  vs 0.52) in the present study and Badenhorst *et al.* (1991). The genetic and phenotypic correlation between PWADG and KL also compares well with the results obtained by Badenhorst *et al.* (1991) in Afrino sheep (0.98 vs 0.90 and 0.89 vs 0.98). Since the accuracy of the estimated correlations largely depends on the number of records in the analysis, one should be cautious to make too many inferences since the correlations were estimated from only 564 records. The genetic correlation of  $-0.12$  between Ww and PWADG could be an

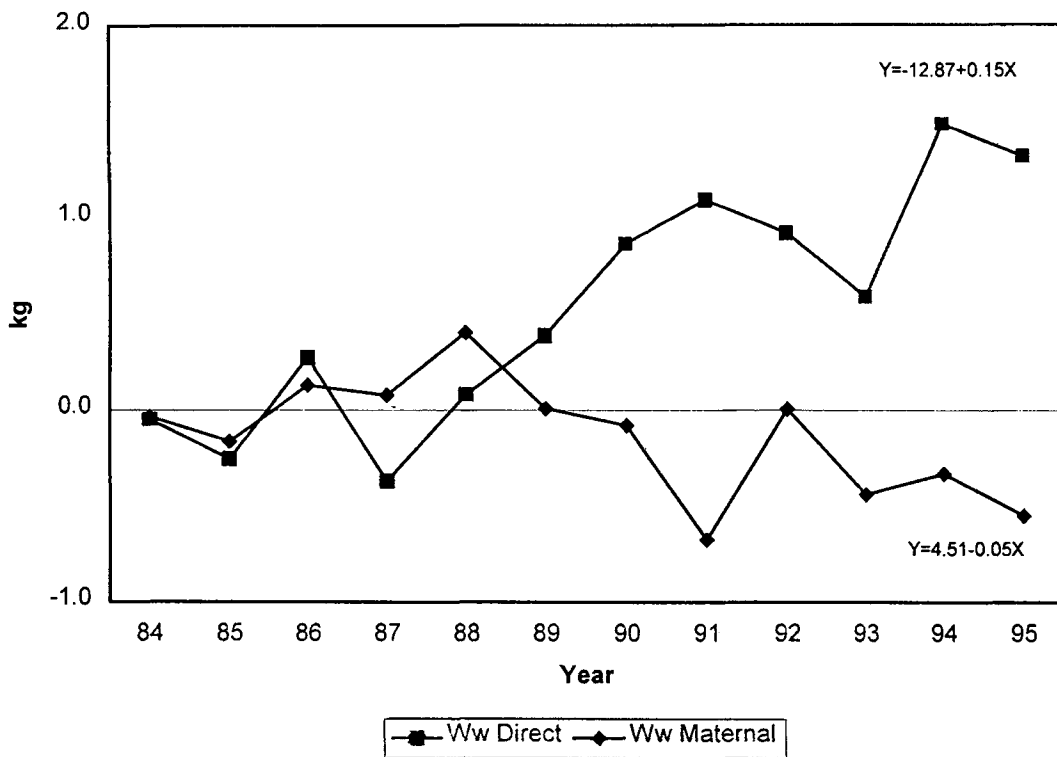
**Table 2** Genetic (above diagonal) and phenotypic (below diagonal) correlations for weaning weight (Ww), post-weaning average daily gain (PWADG) and post-weaning Kleiber ratio (KL). (Standard errors in parenthesis.)

	Ww	PWADG	KL
Ww (SE)	-	$-0.12$ (0.08)	0.02 (0.07)
PWADG (SE)	0.03	-	0.98 (0.06)
KL (SE)	0.04	0.98	-

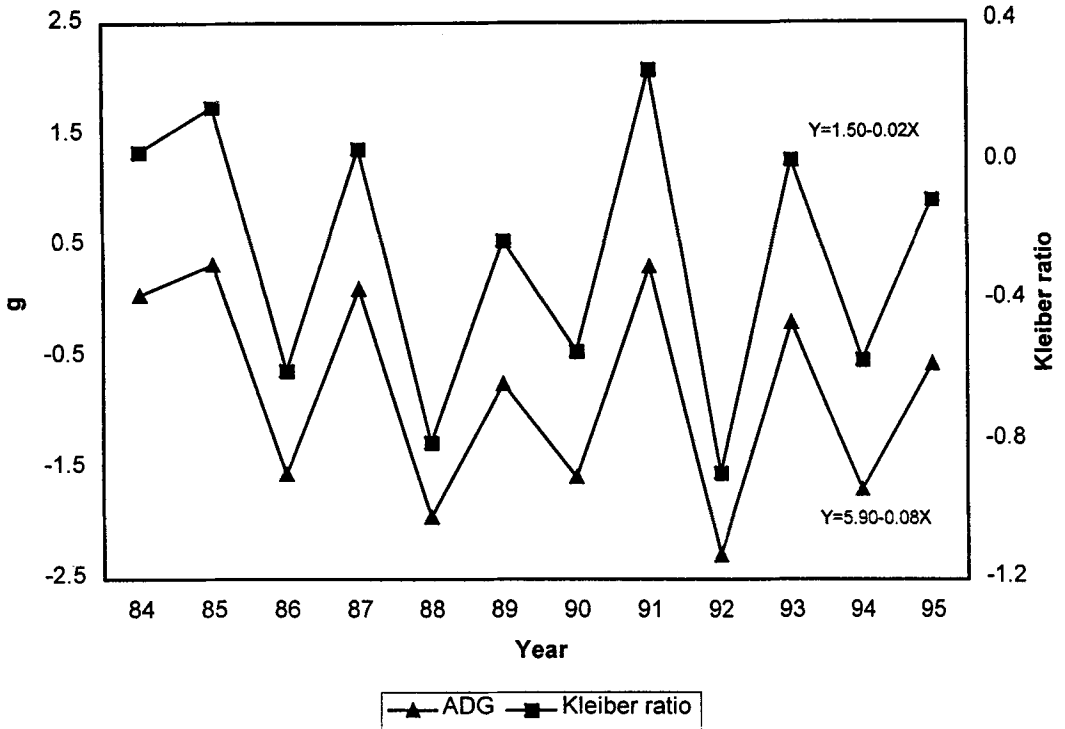
indication that different genes are partially responsible for growth at different stages of development.

A genotype × environment interaction is possible, since the post-weaning growth tests are conducted under a more favourable environment than that in which the ewes are kept. Nesper *et al.* (1998) found a genotype × environmental interaction in the SA Mutton Merino breed for weaning weight. Furthermore, Theron *et al.* (1994) found that, in Bonsmara cattle, the genetic correlation between growth in intensive feeding performance trials and growth under field conditions is negligible. Another reason for the low negative genetic correlation between Ww and PWADG could also be the chronological age differences in growth patterns in males and females (Theron, 1997).

The estimated genetic trends are depicted in Figure 1 and 2. The variation over years could partly be attributed to the fact that a combination of Ww, PWADG and Kleiber ratio was used in the selection program. Nesper *et al.* (1995) showed virtually no selection progress in weaning weight in a selection experiment in Dorper sheep where combined selection for weaning weight under extensive conditions and post-weaning growth under feedlot conditions took place. The negative maternal genetic trend is a result of the high negative correlation (−0.68) between the direct and maternal genetic effects for Ww. Both PWADG and Kleiber ratio (Figure 2) showed virtually no change over time. This could mainly be ascribed to the low estimated direct heritability (0.03 and 0.05) in the two traits.



**Figure 1** Average annual estimated direct additive (Ww direct) and maternal (Ww maternal) breeding values for weaning weight in kg.



**Figure 2** Average annual estimated direct additive breeding values for average daily gain in grams (PWADG) and Kleiber ratio.

## Conclusions

Although  $W_w$  showed a small improvement over time, the response varied, especially during the last four years from, 1992 to 1995. The lack of selection response in PWADG and Kleiber ratio is largely due to their low heritabilities estimated at almost zero. These results obtained in a nucleus breeding scheme are disappointing especially when compared to those obtained in a single closed flock by selecting on BLUP of breeding values (Olivier *et al.*, 1995).

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