GENETIC CHANGE IN SOUTH AFRICAN MERINO RESOURCE FLOCKS

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SUMMARY

Genetic trends over 17-36 years for two-tooth live weight (LW), clean fleece weight (CFW) and fibre diameter (FD) are reported for three South African Merino resource flocks where these traits were included in the selection objective. The flocks were the Grootfontein Merino stud (GMS), Cradock Fine Wool stud (CMS) and the Tygerhoek Merino flock (TMF). Reproduction, namely number of lambs weaned per ewe mated (NLW) and total weight of lamb weaned per ewe mated (TWW) was reported for the Elsenburg Merino flock (EMF), which was divergently selected for NLW. Selection for overall excellence resulted in moderate positive changes in LW, CFW and FD in the GMF prior to 1986. Responding to a change in selection objective from 1986 to 1999, LW increased by 0.86% of the overall phenotypic mean p.a., while FD decreased at 0.33% p.a. Selection pressure in the CMS was initially to increase LW and CFW, resulting in responses of respectively 1.0 and 1.2% p.a. prior to 1996. From 1996, selection pressure was directed at LW and FD, resulting in respective responses of 0.35 and -0.67% p.a. Selection for CFW with a check on FD since 1969 resulted in a direct response of 0.6% p.a. in the TMF. Divergent selection for NLW resulted in direct responses of 1.5% p.a. in the upward direction (H line) and -0.8% in the downward direction (L line). Corresponding response in TWW were 1.9 (H line) and -1.0% (L line) p.a. Marked genetic progress, consistent with the selection objectives strived for, was thus attainable in all traits that were considered.

INTRODUCTION

Data from the most important Australian resource flocks have recently been utilised for the accurate estimation of genetic parameters for various traits (Safari *et al*. 2007a; b). Accordingly, a number of Merino selection demonstration flocks are maintained in South Africa. These demonstration flocks form a part of the South African ovine genetic resource and were subjected to various selection regimes, based on what is perceived as the most important production traits for Merinos under South African condition. Initially, factors like clean fleece weight (Heydenrych *et al*. 1984) and overall subjective excellence (Olivier 1989) were considered in the selection programme. Modern Merino evaluation schemes depend on an enhanced net reproduction rate, a shorter production cycle, and optimum fibre production (Olivier 1999). This change in strategy has resulted in marked adaptations in the emphasis of selection in some of the resource flocks. This paper presents information on genetic change in these flocks, pertaining to the selection objective strived for.

MATERIAL AND METHODS

The flocks studied were the Grootfontein Merino stud (GMS) and the Cradock Fine Wool stud (CMS) in the Eastern Cape province of South Africa, as well as the Tygerhoek Merino flock (TMF) and the Elsenburg Merino Flock (EMF) in the Western Cape province (Table 1). Details of experimental sites, animal husbandry, statistical modelling and genetic parameters derived from the flocks were published (Olivier *et al*. 1994; 2006; Cloete *et al*. 1998; 2004). The GMS was maintained on extensive pastures, with planted pasture for strategic usage. The CMS was maintained on cultivated lucerne pastures. Dryland lucerne pastures and small grain fodder crops were used to maintain the TMF and the EMF, but the latter flock also utilised irrigated kikuyu pasture. Complete production and reproduction records were kept on all sites. However, this paper concentrates on the traits included in the selection objective for the respective flocks. Therefore results pertaining to two-tooth live weight (LW – kg), clean fleece weight (CFW – kg) and fibre diameter (FD – μm) were reported in the GMS, CMS and EMF. Fasted LW was used in the GMS and CMS, but animals in the TMF were not fasted. Ewe reproduction, namely number of lambs weaned (NLW) and total weight of lamb weaned (TWW – kg) per ewe mated, was reported for the EMF. Data were subjected to single-trait genetic analyses, using ASREML (Gilmour *et al*. 1999). Statistical modelling within flocks was as described in previous papers (Table 1). Direct breeding values were obtained and averaged within birth years. These breeding values were obtained from analyses where selection line (where applicable) and its interactions with other traits were excluded.

Table 1 Description of the resource flocks included in the study

Flock	Site and district	Selection objectives	Time span	References
GMS	Grootfontein, Middelburg EC	< 1986: Overall excellence 1986–1999: LW↑;CFW→; FD↓	1956 – 1999	Olivier *et al.* (1994; 1995)
CMS	Halesowen, Cradock	<1996: LW ↑; CFW ↑; FD → >1996: LM ↑; CFW →; FD ↓	1988 – 2005	Olivier *et al.* (1999; 2006)
TMF	Tygerhoek, Riviersonderend	Lines selected for: CFW Line: CFW ↑; FD → Control: No directed selection	1969 – 2006	Cloete *et al.* (1998)
EMF	Elsenburg, Stellenbosch	Divergent lines selected for: H Line – NLW ↑ L Line – NLW ↓	1986 – 2006	Cloete *et al.* (2004)

RESULTS AND DISCUSSION

Coefficients of variation (CV) were fairly constant across flocks and ranged from 19-28% for LW, 23-42% for CFW and 7.4-13.5% for FD (Table 2). The GMS was subjected to major managerial changes with regard to supplementary feeding in different years, resulting in a higher than expected CV for FD. In the EMF, NLW averaged 0.90±0.66 and TWW averaged 19.6±13.9 kg (n = 3683). All these results are fairly consistent with literature findings (Safari *et al*., 2005; 2007a).

Table 2 Mean ± SD (animals in brackets) for three flocks selected on LW, CFW and FD

Trait	Flock		
	GMS	CMS	TMF
LW (kg)	50.7±14.4 (10008)	61.7±11.7 (6089)	48.3±9.0 (8279)
CFW (kg)	5.1±1.8 (10008)	4.4±1.0 (6089)	3.9±0.0.9 (8788)
FD (μm)	21.9±3.0 (1008)	19.1±1.5 (6089)	20.2±1.5 (8820)

GMS: Selection for overall excellence, as perceived by the classers working on the stud during 1968-1985, resulted in improvements of 0.34% in LW and 0.48% in CFW relative to the overall phenotypic means (Table 3). This selection regime also resulted in the wool becoming broader by 0.19% p.a. in this flock. Genetic trends corresponded with the selection objective strived for during the 1986-1999 period. LW increased by 0.86% p.a. and CFW showed a slight increase of 0.24% p.a. while FD decreased at 0.33% p.a. The direction of change for LW and FD corresponded with the report by Olivier *et al*. (1995) for the 1986-1991 period, but genetic changes were somewhat slower in the present study. In contrast, no response in CFW was reported by Olivier *et al*. (1995).

Table 3 Genetic trends (b±SE) in the GMS, CMS and the TMF, as dictated by the selection strategies implemented over time

Flock	Interval/Line	LW (kg)	R^2	CFW (kg)	R^2	FD (μm)	R^2
GMS	1968-1985	0.172±0.024	0.74	0.024±0.002	0.85	0.042±0.006	0.76
	1986-1999	0.436±0.030	0.95	0.012±0.004	0.37	0.074±0.011	0.78
CMS	1988-1995	0.625±0.069	0.92	0.052±0.010	0.81	-0.015±0.016	0.12
	1996-2005	0.218±0.067	0.57	0.004±0.014	0.01	-0.129±0.025	0.77
TMF	CFW line	0.218±0.008	0.96	0.025±0.001	0.97	-0.002±0.002	0.03
	Control	0.037±0.007	0.17	-0.002±0.001	0.05	0.00±0.001	0.00

CMS: After the establishment of the CMS initial selection during the 1988-1995 period favoured heavier sheep with a higher CFW, with LW increasing by 1.0% and CFW increasing by 1.2% of the overall phenotypic mean p.a. (Table 3). No significant selection pressure was directed at FD during this period, as reflected by a non significant genetic trend (P>0.3). During the post-1995 era, the applied selection pressure to reduce FD resulted in a genetic trend amounting to -0.67% p.a. The response in LW was slower during this period (0.35% p.a.), while CFW was stable. These trends were consistent with the selection objectives being strived for according to Table 1.

TMF: Selection for CFW in the CFW line of the TMF resulted in a correlated response in LW, amounting to 0.4% of the overall mean p.a. (Table 3). The direct response in CFW was 0.6% p.a. There was a suggestion that CFW increased at 0.029±0.001 kg p.a. (0.74% of the overall mean; R^2=0.99) up to 1996, with no subsequent response (0.007±0.011; R^2=0.05). A selection plateau may thus have been reached after approximately 8.9 generations of selection. In contrast, Hatcher and Atkins (1998) reported no evidence of a plateau after 41 years of divergent selection for CFW. FD was not increased in the CFW selection line, in accordance with the selection objective. The TMF control line was fairly stable for CFW and FD, but an increase was observed in LW. The direction of responses in LW, CFW and FD in both the CFW and the Control lines were similar to those reported earlier (Cloete *et al*. 1998), but the magnitude of the changes was generally smaller.

EMF: Direct responses in reproduction were evident in the H line with genetic trends amounting to 0.014±0.001 NLW per ewe mated and 0.370±0.011 kg TWW per ewe mated p.a. Corresponding genetic trends in the L line amounted to -0.007±0.001 NLW and -0.191±0.011 kg TWW p.a. Expressed relative to the overall phenotypic mean, trends in the H line amounted to 1.5% p.a. for NLW and 1.9% p.a. for TWW. Corresponding trends in the L line amounted to -0.80% for NLW and -0.97% p.a. for TWW. Divergent selection for reproduction rate in sheep accordingly resulted in a slower response in the downward than in the upward direction (Burfening *et al*. 1993). The genetic trends for reproductive traits were very similar in direction and magnitude to those reported earlier by Cloete *et al*. (2004), over a slightly shorter period. The realised change in reproduction rate is consistent with previous reports in the literature (Burfening *et al*. 1993; Gates and Urioste 1995; Ercanbrack and Knight 1998; Hanford *et al*. 2002; 2003; 2006) involving both NLW and TWW.

CONCLUSIONS

The study demonstrated marked genetic change in accordance with the selection objectives being strived for in South African Merino resource flocks. These results have supported and lent credibility to the efforts of the South African Small Stock Improvement Scheme for the breed improvement of the Merino on a national basis, and hence contributed to genetic improvements in industry.

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