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Fleece production responses to Merino fine wool index selection

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ABSTRACT

A fine wool index selection flock (I) was established by screening the Tara Hills Merino flocks in 1988 and 1989. The flock of 200 breeding ewes was formed with equal numbers of four age groups born in 1984 to 1987. A randomly sampled 160 ewes from the same population served as the Control (C). The greasy fleece weights of the I flock were 8.3% (P<0.001), 6.8% (P<0.001) higher than that of C flock in 1988 and 1989 respectively. Spring live weight (P<0.05) and yield (P<0.001) were significantly higher while fibre diameter (P<0.001) was significantly lower for I. Progeny hogget fleece weight, live weight and fibre diameter, however, differed insignificantly between flocks.

Keywords Merino, wool, selection, characteristics, index.

INTRODUCTION

The clean fleece weight and mean fibre diameter of the fleece are the two most important factors determining the fine wool grower's monetary return. Single trait selection for either of these properties has been shown to be effective. Where selection was for high clean weight in medium-fine Merinos the annual gain in clean fleece weight varied between 1.18% to 1.58% over 20-30 years of selection with negligible changes in fibre diameter (McGuirk, 1983; Rogan, 1984). Sheep selected for low fibre diameter had fleeces 4.5 µm finer than the control flock and 8.5 µm finer than the high fibre diameter selection flock after 20 years of selecting from the same original base population (Moore *et al.*, 1989). Selection on an index which combines both traits weighted by the relative economic values (REVs) can be more efficient in increasing profitability. The degree of selection pressure on fleece weight and fibre diameter can then be balanced to suit the sheep strain, environment and profitability. Index selection in three commercial flocks of medium-fine wool South African Merino for four traits, live weight, CFW, FD and skin fold score, gave responses of +12.1%, +14.4%, -1.7% and -29.4% respectively over 7 years (Poggenpoel and van der Merwe, 1987).

The objective of the trial was to examine fleece production and associated wool characteristic responses to index selection for fleece weight and low fibre diameter. This paper presents the production data from a fine wool index selection flock (I) and a control flock (C) and the performance of their progeny born in 1988 and 1989.

MATERIALS AND METHODS

Animal Selection

This trial was initiated by selecting 150 high-index ewes from the Tara Hills fine wool Merino flock (c.3500 ewes) in 1988 and a further 50 ewes in 1989 to form the I flock. Selection was based on an index comprising hogget clean fleece weight (CFW) and mean fibre diameter (FD) assessed from midside fleece samples (Airflow method). The C flock of 160 ewes was established beforehand by random selection from the same population base. Both flocks had four equal sized age groups, comprising animals born in 1984, 1985, 1986 and 1987. From 1990 the flocks were closed and maintained at their current size. Progeny hogget selection was carried out at shearing at 12 months of age.

Flock Management

A different team of five full-mouth sires from untested rams available at Tara Hills was used each year in each

TABLE 1 Mean live weight, fleece weights, yield and fibre diameter of I and C Merino ewes.

Year of Observation	Traits	I	C	Differences	Average SED
1988	Number of animals	149	120	-	-
	Spring liveweight (kg)	48.7	47.0	1.35 ns	0.8
	Greasy fleeceweight (kg)	4.32	4.00	0.32 ***	0.07
	Clean fleeceweight (kg)	3.26	2.92	0.33 ***	0.05
	Yield (%)	75.44	73.23	2.21 ***	0.47
	Fibre diameter (μm)	18.93	19.93	-1.00 ***	0.15
1989	Number of animals	200	160	-	-
	Spring liveweight (kg)	52.0	50.7	1.31 *	0.7
	Greasy fleeceweight (kg)	4.25	4.03	0.22 ***	0.06
	Clean fleeceweight (kg)	3.32	3.06	0.26 ***	0.05
	Yield (%)	78.23	75.96	2.27 ***	0.40
	Fibre diameter (μm)	19.32	20.18	-0.86 ***	0.13

ns : non significant; * : P<0.05; *** : P<0.001.

of the I and C flocks. Index rams were also progeny tested within the C flock using 60 of the 160 ewes in each of two years, and their I x C progeny (P) were retained to measure the response due to selection of sire or dam. Each sire was single sire mated, either naturally or by artificial insemination, to a randomly allocated group within the flocks during May. Flocks were grazed and managed together except that ewes were drafted into their respective sire groups for lambing. All progeny were individually tagged and weighed at birth. Lambs were weaned and weighed at four months of age and shorn as hoggets at 12 months of age. Spring live weight (SLW) prior to shearing and fleece weight were recorded and midside fleece samples were collected for both ewes and hoggets.

Wool Measurement

Fleeces were classed into sale lots according to fineness (as measured from midside patches prior to shearing), and subjectively assessed characters such as tenderness, staple length and visual colour. Fleece samples of ewes in 1988, 1989 and progeny hogget fleeces in 1989 and 1990 were measured for CFW, yield (IWTO @ 16%) and FD (Airflow method). Crimp, scoured wool colour (NZS8787-1984), resistance to compression (RTC), staple strength (SS), position of break (POB) and staple length (SL) (Agritest Ltd, Australia) were measured for the I flock in 1990.

Index Calculations

The selection index was based on hogget FD and CFW. Two versions of the index were used, one to screen in ewes to establish the I flock, and the other for selection within the I flock. The following genetic and phenotypic parameters have been assumed in the construction of the index: heritabilities of 0.35 and 0.50 for CFW and FD respectively, with their genetic correlation being 0.25 and their phenotypic correlation 0.20 (Atkins, 1987). It is assumed that the adult performance of the base flock was 3 kg CFW and 21 μm FD, with CVs of 14% and 8% respectively (corresponding to phenotypic standard deviations of 0.42 kg and 1.68 μm). The relative economic values (REVs) for the traits at this performance level were calculated to be $7.90/kg CFW and -$2.40/μm FD using New Zealand Wool Board data from the 1983/84, 1985/86 and 1986/87 selling seasons.

TABLE 2 Mean live weight, fleece weight, yield and fibre diameter of I, C and P hoggets born in 1988 and 1989.

Traits	Group I	Group C	Group P	I-C Diff	I-C SED	I-P Diff	I-P SED
Number of Animals	229	126	80	-	-	-	-
Spring liveweight (kg)	39.3	38.2	38.5	1.1	0.9	0.8	0.6
Greasy fleeceweight (kg)	3.08	3.01	3.11	0.06	0.08	-0.04	0.06
Clean fleeceweight (kg)	2.32	2.25	2.31	0.07	0.06	0.01	0.05
Yield (%)	75.62	74.72	74.21	0.89	0.88	1.40*	0.56
Fibre diameter (µm)	18.56	18.79	19.08	-0.23	0.23	-0.52*	0.14

Diff : Difference; SED: Standard error of differences; * : P<0.05.

The index for screening was constructed using these parameters and selection coefficients were adjusted by the ratio of the assumed means to the actual means. On average over the four birth years, the index used for screening was:

$$I = 3.03 * CFW' - FD'$$

where ' denotes the deviation from the ewe hogget flock-year mean.

To select replacement females within the I flock, the mean adult performance was adjusted to 20 µm FD with the resulting REVs being $8.8/kg CFW and -$3.20 /µm FD. A further difference was that breeding values (BVs) were estimated for each trait by best linear unbiased prediction (BLUP) which adjusted for sex, birth date, birth rearing rank, age of dam and year, and included information on the performance of all recorded relatives. The genetic and phenotypic parameters were adjusted to take account of the extra genetic information from the relatives. The final index used was equivalent to:

$$I = 2.47 * BV(CFW) - BV(FD).$$

Both these indices are similar to the Merino index used by the Animalplan sheep recording scheme.

Statistical Analyses

The performance of the screened I and associated C flocks were compared by least squares methods. The model included flock and age, with any interaction being discarded after being found to be non-significant for all traits considered. Data for each record year were analysed separately. Litter size was not considered in the model, however the percentage of ewes with multiple births was similar (about 30%) in both flocks. The performance of hogget progeny was analysed by residual maximum likelihood (REML) procedures. Initial models fitted included year born, sex, birth date, birth/rearing rank, age of dam, flock (I or C), sire (as a random effect) and first-order interactions . Interactions which were not significant for any of the traits analysed were eliminated from the final model used, which included year born by sex, birth date by sex, and birth date by birth/rearing rank interactions.

RESULTS AND DISCUSSION

Production Performance of Flocks

The performance of I and C flocks are summarised in Table 1. Fleece weight (P<0.001) and yield (P<0.001) were significantly higher in the I flock in both years. Spring live weight was heavier in the I flock by a similar amount in both years but the difference was significant only in 1989 (P<0.05). Mean FD was 1.0 and 0.86 µm lower in the I flock in 1988 and 1989 respectively (P<0.001).

The performance of hogget progeny followed a similar pattern to the parental flocks, although only

TABLE 3 Mean live weight, fleece weights, yield and fibre diameter of I flock, and other wool characteristics of I flock and hogget progeny at 1990 shearing.

Traits	I flock (n=175)		I progeny (n=117)*	
	Mean	SE	Mean	SE
Spring live weight (kg)	55.7	0.2	39.7	0.5
Greasy fleece weight (kg)	4.72	0.06	3.10	0.06
Clean fleece weight (kg)	3.50	0.05	2.32	0.04
Yield (%)	74.27	0.14	75.14	0.35
Fibre diameter (μm)	19.67	0.08	18.27	0.12
Staple crimp (crimp/cm)	6.12	0.06	6.27	0.08
Staple length (mm)	84.49	0.22	76.73	0.29
Staple strength (N/ktex)	38.23	0.22	27.39	0.06
POB (%)	63.57	0.24	55.76	0.27
RTC (g/cm^2)#	114.21	0.28	71.19	0.34
Colour - X	63.79	0.10	57.23	0.16
Colour - Y	65.71	0.10	58.58	0.16
Colour - Z	67.71	0.11	60.11	0.17
Yellowness (Y-Z)	-2.18	0.05	-1.53	0.07

* : I progeny born 1989 only; # : 1 g/cm^2 = 0.0980 kilo pascals (kPa); POB : Position of staple break; RTC : Resistance to compression.

yield (P<0.05) and FD (P<0.05) differences between I and P were significant (Table 2). Fleece weights and wool characteristics of the I flock and I progeny are presented in Table 3. Some wool characteristics are not available for 1990 C and P hoggets, but they could be expected to be similar to those of I. The I flock SLW, GFW, CFW, yield and FD changed by 6.8%, -1.6%, 1.8%, 3.7% and 2.1% in 1989 from 1988 and similarly by 7.1%, 11.1%, 5.4%, -5.1% and 1.8% in 1990 compared with the previous year.

The phenotypic correlations in both I ewes and hoggets were highly significant for major wool traits (Table 4), namely GFW with CFW (P<0.001), and for fleece weights with FD (P<0.001). These results are similar to previous studies of New Zealand fine and superfine Merino wool (Cottle and Wilkinson, 1989; Wuliji *et al.*, 1990). The correlations measured for the wool traits in hogget progeny were similar to those in the dam flock. However a stronger positive correlation was found for fleece weights with SL and FD and for FD with SL, and a stronger negative correlation for fleece weights with RTC. The correlations between fleece production (GFW, CFW, SC) and FD in the ewe flock could be expected to be lower than in a random population because they have been selected on these traits.

Wool sold separately for each flock indicated that in 1988 the returns from the I flock were $81/hd and the C flock $55/hd whilst in 1989 the returns were $69/hd and $48/hd respectively. There was therefore a net advantage of $26/hd and $21/hd to the I flock for these two years.

Comparison of Predicted and Actual I Progeny Performances

The performance of the I progeny in comparison with the C progeny can be broken into two components, that due to sire selection and that due to dam selection, through the use of the performance of P (Table 5). The dam component (b/2) is the difference between I and P, while the sire component (c/2) is the difference between P and C, and the sum of these (e) is the difference between I and C. The expected performance of the progeny, from the dam selection intensity is given by d. The realised heritability from dam selection is the ratio of b to a, and these results suggest a lower heritability for CFW and a higher heritability for FD than assumed in the index calculations.

TABLE 4 Correlation of fleece weights and wool characteristics within the I flock.

	CFW	FD	SC	SL	SS	RTC	Yield
Ewes:							
GFW	0.90***	0.35***	-0.19*	0.26***	0.06ns	0.00	0.00
CFW		0.35**	-0.16*	0.35***	0.05ns	-0.05ns	0.46***
FD			-0.23*	0.08ns	0.26***	0.24*	0.08ns
SC				-0.25***	0.06ns	0.47***	0.01ns
SL					0.11ns	-0.25***	0.27**
SS						0.08ns	0.01ns
RTC							-0.13ns
Hoggets:							
GFW	0.97***	0.44***	-0.38***	0.46***	0.12ns	-0.37***	0.45***
CFW		0.49***	-0.42***	0.52***	0.19*	-0.48***	0.65***
FD			-0.20*	0.43***	0.29*	-0.04ns	0.51***
SC				-0.38***	-0.04ns	0.44***	-0.36***
SL					0.15ns	-0.34***	0.51***
SS						0.11ns	0.33***
RTS							-0.61***

GFW : greasy fleece weight; CFW: clean fleece weight; FD: fibre diameter; SC: staple crimp; SL: staple length; SS: staple strength, RTC: resistance to comparison; ns: non significant;
* : P<0.05;
** : P<0.01;
*** : P<0.001.

TABLE 5 The comparisons of predicted and actual Index flock progeny performance (Standard errors are given in parentheses).

	Comparisons	Clean Fleece Weight (kg)	Fibre Diameter (µm)
a:	Dam selection Differential	+0.40 (0.03)	-1.16 (0.10)
b:	Dam progeny comparison (x2)	+0.02 (0.10)	-1.03 (0.29)
c:	Sire progeny comparison (x2)	+0.13 (0.15)	+0.58 (0.51)
d:	(a x heritability + C)/2	+0.13 (0.08)	0 (0.26)
e:	(b + c)/2	+0.07 (0.08)	-0.23 (0.32)
f:	Realised heritability (dam selection)	+0.04 (0.11)	+0.89 (0.31)

TABLE 6 Paternal half-sib heritability estimates of fine wool Merinos.

	Heritability	SE
Spring liveweight	0.40	0.21
Greasy fleece weight	0.31	0.19
Clean fleece weight	0.35	0.20
Yield	0.61	0.27
Fibre diameter	0.61	0.27

Heritability Estimates

The estimates of heritability for major production traits were calculated by paternal half-sib analysis (Table 6). These estimates are in good agreement with Australian literature (Davis and McGuirk, 1987), however, they are less precise due to the low sample size. Genetic correlation estimates have not been calculated because of the low sample sizes, but the increase in CFW and decrease in FD due to dam selection (Table 5) is consistent with a low genetic correlation between these traits.

CONCLUSION

Selection for the fine wool index combining CFW and FD weighted on REVs, as indicated in this trial, may be a profitable system for fine wool production in Merinos. Continued selection in the index flock at Tara Hills will allow a detailed analysis of selection responses and heritability estimates in wool characteristics as well as other associated traits.

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REFERENCES

Atkins, K.D. (1987). Potential responses to selection in Merino sheep given current industry structure and selection practices. *Proceedings of a National Symposium: Merino Improvement Programmes in Australia.* Australian Wool Corporation (Ed. B.J.McQuirk). pp 299-312.

Cottle, D.J. and Wilkinson, B.F. (1989). Information from New Zealand and Australian Merino wether trials. *Wool Technology and Sheep Breeding 37(2):* 118-123.

Davis, G.P. and McGuirk, B.J. (1987) Genetic relationships between clean wool weight, its components and related skin characters. *Proceedings of a National Symposium: Merino Improvement Programmes in Australia.* Australian Wool Corporation. (Ed. B.J. McGuirk). pp 189-206.

McGuirk, B.J. (1983). Selection for wool production. *Sheep Production* (Ed: WHaresign). Butterworths, London. pp. 545-566.

Moore, G.P.M., Jackson, N. and Lax, J. (1989). Evidence of a unique developmental mechanism specifying both wool follicle density and fibre size in sheep selected for single skin and fleece characters. *Genetic Research Cambridge. 53:* 57-62.

Poggenpoel, D.G. and van der Merwe, C.A. (1987). Selection response with index selection in three commercial Merino flocks. *South African Journal of Animal Science 17(2):* 70-73.

Rogan, I.M. (1984). Selection for wool production. *Proceedings 2nd World Congress on Sheep and Beef Cattle Breeding.* Pretoria (eds. J.H. Hofmeyer and E.H.H.Meyer). pp 367-378.

Wuliji, T., Land, J.T., Andrews, R.N., and Dodds, K.G. (1990). Fleece weight and wool characteristics of Merino ewes screened into a superfine flock. *Proceedings of New Zealand Society of Animal Production 50:*301-303.