LONG TERM SELECTION FOR CLEAN FLEECE WEIGHT IN AUSTRALIAN MERINO SHEEP

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SUMMARY

Responses to selection for high and low clean fleece weight in two closed selection flocks compared to a randomly selected control over a period of 41 years were used to test for asymmetry in response in the up and downward direction. Similar rates of response were observed in both directions although at a lower rate than predicted from base population heritabilities. Genotype by environment interaction may have contributed to this lower response rate as judged by heritabilities expressed in good and poor production years.

Keywords: *heritability, asymmetry, selection, Merinos, fleece weight.*

INTRODUCTION

In the early 1950's a selection experiment aimed at determining the long term response to selection for clean fleece weight was initiated. The last comprehensive analysis of this experiment, covered the period 1950 - 1966 (Pattie and Barlow, 1974) and found evidence of asymmetry in response between the up and downward selection directions. The flock selected for high clean fleece weight showed an initial increase which then appeared to plateau with time, whilst the flock selected for low clean fleece weight showed a consistent downward trend.

The selection flocks at Trangie were continued for a further 18 years after the analysis of Pattie and Barlow, until selection was suspended following the 1992 progeny measurements. This paper describes the long term responses to selection for clean fleece weight in terms of the base population heritability and tests for asymmetry in the up and down direction occurring after 41 years of selection.

MATERIALS AND METHODS

Two closed selection flocks of Merino sheep were set up by F.H.W Morley in 1951 at Trangie Agricultural Research Station, located on the central western plains of New South Wales. The development of each selection line, their management and measurement up to 1966 was described by Pattie and Barlow (1974). Briefly, the sheep in each flock were drawn from a base population comprising 1700 ewes born between 1944 and 1951 and 150 rams born in 1949 and 1950. One flock was selected for high clean fleece weight (Fleece Plus) and the other for low clean fleece weight (Fleece Minus). Each flock was maintained at approximately 100 ewes mated to 5 rams. A randomly selected control flock (Random) was established to measure contemporary responses. This flock initially comprised 100 ewes but increased with time to more than 200. Substantially more rams (up to 25 per year) were used in an attempt to minimise genetic drift. In 1983, due to severe drought conditions at Trangie, the Fleece Plus and Fleece

Minus ewes were agisted and not mated. There were no measurements on the Random flocks in 1992 and selection ceased in all lines in 1993.

Fleece weights were adjusted to 365 days wool growth. Cumulative selection differentials were calculated for each line using the method described by Atkins and Thompson (1986). Responses in each selection line were measured as a deviation from the contemporary control line. Realised heritability was calculated as the regression of response on cumulative selection differential. ASREML (Gilmour, 1997) was used to estimate base population heritabilities in the data following the procedure described by Thompson and Atkins (1994).

RESULTS AND DISCUSSION

Realised responses to selection. Changes in the phenotypic variance with selection were small although the variance in both the Fleece Plus and Minus selection flocks tended to be higher than in the Random flock (Table 1). The regression of standard deviation on average clean fleece weight both within and across flocks indicated no need for data transformation.

Table 1. Heritability, standard error and phenotypic variance estimates

	Heritability (h^2)	Standard error (s.e.)	Information (I)*	Phenotypic variance (Vp)
Flock combinations				
Random (R)	0.412	0.027	1332	0.1957
Fleece Plus (P)	0.280	0.042	566	0.2809
Fleece Minus (M)	0.520	0.043	536	0.2470
R + P	0.356	0.021	2246	0.2568
R + M	0.410	0.020	2403	0.2208
R + P + M	0.369	0.017	3586	0.2453
P + M	0.363	0.022	2029	0.2951
Between flock				
(R + P - R - P)	0.263	0.054	348	
(R + M - R - M)	0.297	0.043	535	

* Information is expressed as the inverse of the sampling variance.

Over the 41 years of selection, the average clean fleece weight in the Random flock fluctuated with seasonal conditions but overall showed a consistent downward trend in response to the environment (Figure 1). Increases in stocking intensity and a decline in age at hogget shearing (from 18 to 14 months) are the likely contributing factors to this environmental trend. Responses in the Fleece Plus flock increased over time with substantial variation in response during the period of greatest between year variation (1964-72). In comparison, the response in the Fleece Minus flock showed a steady downward trend. The realised heritabilities were 0.226

and 0.254 for the Fleece Plus and Minus flocks respectively. With a probable standard error of about ± 0.05 after accounting for likely genetic drift, no significant asymmetry of response was apparent.

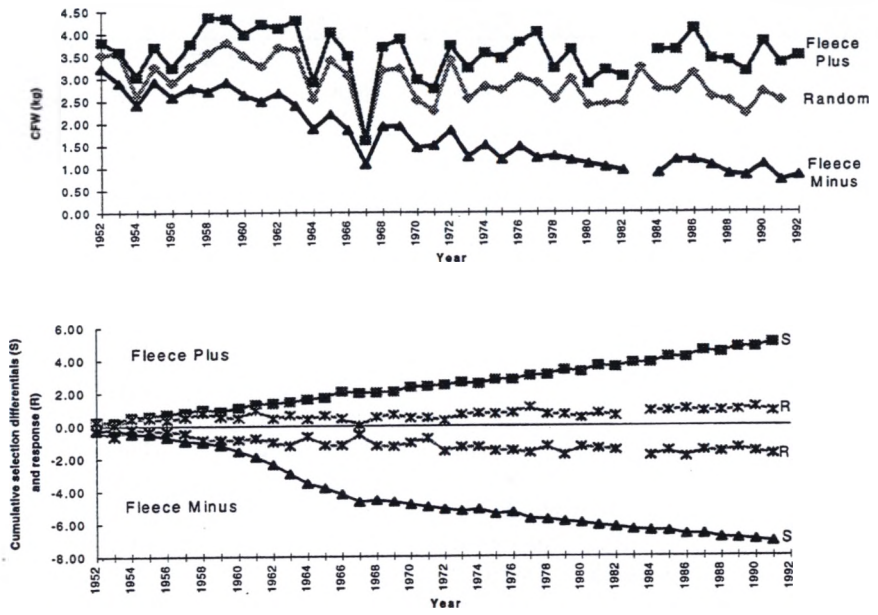

Figure 1 Average clean fleece weights (kg) for the Fleece Plus, Random and Fleece Minus flocks along with cumulative selection differentials (S) and responses (R) for the Fleece Plus and Fleece Minus flocks.

Base population heritabilities. Base population heritabilities were consistently in the range of 0.36 to 0.41 (Table 1) for all combinations of lines, except for the Fleece Plus line (significantly lower) and the Minus line (significantly higher). An alternative estimate of the realised heritability was derived from the difference between flocks (Table 1). The estimates of 0.26 for the upward response and 0.30 for downward response were marginally higher than the corresponding realised heritabilities since the latter do not account for inbreeding and linkage disequilibrium. Both sets of estimates indicate that the base population heritability within the lines overestimated the achieved responses.

Genotype by environment interactions. The pattern of responses in Figure 1 suggests that the expression of genetic superiority may be sensitive to the level of nutrition. For example, in 1967, when severe drought conditions prevailed, there was no difference in clean fleece weight between the Fleece Plus and Random flocks which produced only 0.5kg more than the Fleece Minus flock. By grouping pairs of years into good and poor based on the Random flock mean

(so as not to bias grouping with years of selection) heritabilities were re-estimated in flock combinations (Table 2). Heritabilities in all flock combinations were lower (but not significantly) in poor years compared with good years, as was the phenotypic variance.

Table 2. Heritability estimates from good and poor years.

	Good years		Poor years	
Flock combination	$h^2 \pm$ s.e.	Mean (Vp)	$h^2 \pm$ s.e.	Mean (Vp)
R	0.40 ± 0.04	2.96 (0.22)	0.37 ± 0.04	2.55 (0.16)
P	0.29 ± 0.06	3.86 (0.32)	0.20 ± 0.06	3.20 (0.22)
M	0.60 ± 0.06	1.94 (0.29)	0.44 ± 0.07	1.60 (0.20)
R + P	0.35 ± 0.04	3.24 (0.26)	0.33 ± 0.04	1.60 (0.18)
R + M	0.44 ± 0.04	2.66 (0.24)	0.38 ± 0.04	2.24 (0.17)
R + P + M	0.40 ± 0.03	2.94 (0.26)	0.34 ± 0.03	2.47 (0.19)

In conclusion, long-term selection for clean fleece weight in Merino sheep has produced consistent responses in both directions although at a somewhat lower rate than predicted from base population heritabilities. Genotype by environment interactions may have contributed to this lower response rate although the magnitude of these effects were not large. Finally, the higher heritability within the downward line together with significant skewness in the phenotypic distribution may indicate the presence of a gene of large effect in the Fleece Minus line but further analyses are required to verify its presence.

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