INDIRECT SELECTION FOR STAPLE STENGTH IN MERINO SHEEP BREEDING PROGRAMS

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SUMMARY
Hogget coefficient of variation of fibre diameter (CVFD) has been shown to be a useful indicator of adult staple strength (SS) in fine wool sheep managed in southern Australia. The correlation between sire estimated breeding values for CVFD, measured at a hogget shearing and SS measured a year later was –0.61. Responses to selection using a number of breeding objectives suggest that decreasing fibre diameter in the breeding objective will lead to decreases in SS. However, the use of direct measurement of SS as a selection criterion will lead to slight gains in SS over one generation of selection.
Keywords: Staple strength, indirect selection, Merino sheep

INTRODUCTION
Staple strength is becoming an increasingly important determinant of price for Merino fleece wool. In the financial year, 1997/98, staple strength accounted for between 9 and 12 % of the total variation in price received for wool at auction (Stott pers. comm.). Nutritional management strategies to improve staple strength have been shown to be variable in their outcome (Scrivener unpublished) and often do not justify their expense (Bowman 1990). In the short term, change of shearing time may be a viable option available to woolgrowers to minimise penalties associated with tender wool. The consequences, and full knowledge and the effects of change in shearing time and its impact on other management practices, such as disease control and chemical residues is unknown. Genetic improvement offers an opportunity for woolgrowers to improve staple strength in the longer term. Staple strength (SS) is heritable and experiments have shown there is a high genetic and phenotypic correlation with coefficient of variation of fibre diameter (CVFD) (eg Greeff *et al.* 1995; Greeff *et al.* 1997; Swan *et al.* 1997).

Most studies to date have measured both SS and CVFD at the same time (within year), and the repeatability of SS across years, and consequently, the use of CVFD measured at hogget shearing to predict adult SS across years is unknown. Also, many ram breeders are using high genetic merit sires, which have been evaluated through central progeny test to improve their Merino flocks. This has been shown to be a good strategy to improve flock genetics, but the consequences on traits such as SS is uncertain. This is especially important where there has been widespread use of individual sires throughout the merino industry.

Central progeny testing has been ongoing in Victoria since 1992. Available data sets provide opportunities to examine relationships between traits and to validate research findings for the local environment. Sheep evaluated in central progeny tests in Victoria have been measured for staple strength as adults in all drops. One of the sites has also evaluated staple strength in sheep at both their first and second measurement shearing. Data from these sheep is used in this paper to validate the findings relating to indirect selection for staple strength.

METHOD

CVFD has been regularly collected and reported at all central progeny test site shearings, while staple strength has been measured at animal's second shearing. In total, since 1992, there have been 8 drops of sheep from 68 sires evaluated in Victoria. Of these, 6 drops have had data recorded on two shearings. At the second shearing, in all these cases, SS has been measured. This paper reports on the results from 5 of these central progeny test drops, namely those occurring at Hamilton, (1993-1994) and those at South Roxby (1995-1997). The sheep managed at Hamilton were measured at their first shearing for the major fleece traits, ie fibre diameter (FD), greasy fleece weight (GFW), clean fleece weight (CFW), CVFD and body weight (BW). At their second shearing, staple length (SL) and SS were also measured. The sheep managed at the South Roxby site were measured for all the above traits at both their first and second shearings. The 1997 South Roxby drop have only been measured once. Table 1 gives the sire numbers and progeny numbers for each of the sire evaluation drops, which became part of this analysis.

Due to the use of link rams between sites, all sites have rams in common and therefore could be used as one data set. At least one sire was used in common with other sites.

Table 1. Numbers of progeny and sires and average FD, SS and CVFD for each of the drops of sheep used in this study

Progeny drop and site	Sire groups	Progeny	FD (μm)		CVFD (%)		SS (N/Ktex)		CFW (kg)	
			1st	2nd	1st	2nd	1st	2nd	1st	2nd
Hamilton 1993	12	318	17.2	18.9	21.8	19.4	-	36.1	1.98	3.36
Hamilton 1994	12	249	18.4	18.7	20.3	18.7	-	32.5	2.36	3.44
South Roxby 1995	12	456	18.2	17.8	18.7	19.5	30.4	40.3	3.12	3.13
South Roxby 1996	12	334	16.2	17.3	20.6	18.1	31.2	51.7	2.50	2.31
South Roxby 1997	12	279	16.3	-	22.3	-	29.0	-	1.70	-

In order to examine the relationships between hogget measurement of CVFD and adult SS, multivariate BLUP procedures were used to calculate EBVs for animals with measurements on all traits used in this study. The EBVs for hogget and adult SS were calculated assuming no correlations with other traits to examine the relationships between traits. To determine whether measurement of SS at a young age was repeatable, two drops were examined – the 1995 and 1996 drop South Roxby site sheep. Apart from this difference, the genetic parameter set used was similar to that used for fine wool Merino sheep. To examine the effect of selection using different objectives on different traits of economic importance, the average progeny values (1/2*EBV) were calculated. These assumed a selection intensity of 60 % of the ewe flock and 2 % of the ram flock. Therefore, they represent the response to selection after one generation.

RESULTS AND DISCUSSION

There were significant sire differences for SS in all of the progeny groups examined in this paper. These findings correspond to previous work examining the heritability of staple strength.

Table 2 shows the correlations between the EBVs for each of the traits examined with adult SS. The correlations between sire EBVs approximate genetic correlations while the correlations between the progeny EBVs approximate phenotypic correlations. Examination of the correlations for other traits (not reported) indicates they are in the same direction and order as the phenotypic and genetic correlations regularly reported, suggesting this approach to determining relationships between characters has merit.

Table 2. Correlation between adult staple strength EBVs and EBVs for other wool traits

	GFW (%)		CFW (%)		FD (μm)		CVFD (%)		BW (%)		SL (mm)	SS (N/ktex)
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	1st
sire EBVs	-0.21	-0.17	-0.14	-0.11	0.25	0.30	-0.61	-0.64	-0.03	0.03	-0.28	0.67*
Progeny EBVs	-0.11	-0.09	-0.06	-0.04	0.22	0.26	-0.40	-0.42	0.01	0.02	-0.31	0.54*

* Calculated using a smaller data set, comprising 834 animals from 24 sires

From Table 2, a slight positive correlation between FD and SS can be observed, which is consistent with literature estimates. This has important implications for selection programs with high emphasis on decreasing FD. A high emphasis on FD is likely to lead to reductions in SS. It is at the finer end of the fibre diameter range that discounts for tender wool are highest.

The responses to selection after one generation using different objectives are shown in Table 3. These show that selection using the standard Rampower indices are likely to lead to (small) decreases in SS. Direct inclusion of SS measurements in the objective is required to maintain this trait.

Selection for CVFD alone will lead to 22 % of the maximum gain to be achieved for SS. If the sheep were selected solely on SS, the maximum response would have been 2.3N/ktex. Selection for CVFD will lead to a 0.5 N/ktex increase in SS.

Table 3. Responses to selection after one generation, using different objectives

	GFW (%)		CFW (%)		FD (μm)		CVFD (%)		BW (%)		SS (N/ktex)	SL (mm)
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	2nd	2nd
3 % index	4.7	4.5	5.4	5.3	0.0	0.0	0.2	0.1	-0.4	-0.5	-0.4	1.1
6 % index	4.0	3.6	4.9	4.7	-0.1	-0.1	0.1	0.1	-0.5	-0.6	-0.4	1.0
12 % index (incl.SS)	2.5	1.7	3.6	3.0	-0.2	-0.2	-0.1	-0.1	0.0	-0.2	0.2	0.9
12 % index no SS	2.6	1.9	3.8	3.2	-0.2	-0.2	-0.1	-0.1	0.1	-0.1	-0.1	0.9
SS only	0.3	0.6	0.9	1.1	0.1	0.1	-0.3	0.3	-0.5	-0.5	2.3	-0.6
CVFD only	-2.1	-2.2	-1.7	-1.8	0.0	0.1	-0.8	-0.8	1.1	1.0	0.5	0.6
FD only	-1.0	-2.0	-0.7	-1.6	-0.4	-0.4	0.0	0.0	0.7	0.7	-0.4	0.0
CFW only	4.9	4.5	5.7	5.2	0.1	0.0	0.2	0.2	0.2	0.0	-0.3	1.1
BW only	-0.1	-0.8	0.3	-0.4	-0.1	-0.1	-0.2	-0.2	4.4	3.8	-0.2	0.2

Table 3 shows the effect of selection on alternative indexes. Using the progeny data, it can be observed that unless SS is directly measured, selection on each of the indices would have resulted in decreases in SS with time. This is an important finding, as the data set is derived from widely used industry sires. Many ram breeders use these sires to improve the overall genetic merit of their flocks.

For fine wool Merino flocks, the discounts for tender wool are high and occur regularly. To avoid this in the future, it will be necessary to undertake a two-stage selection process, optimising accuracy and cost of the measurement.

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