Genetic Parameters for Staple Length and Staple Strength of Merino Wool Produced in Central and North West Queensland

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ABSTRACT: Estimates of genetic parameters are presented for staple length and staple strength for 15 month old, medium Peppin sheep at Longreach and Julia Creek Queensland. The effects of birth type, sex and year of birth are shown. There were significant interactions for sex by site and for sex by year of birth. Heritability of staple length and strength were respectively 0.75 and 0.37 for the Longreach flock and 0.70 and 0.23 for the Julia Creek flock. The heritability of staple strength agrees with other published data however the estimate for staple length is very high. Phenotypic and genetic correlations with greasy fleece weight, yield, clean fleece weight, average fibre diameter and liveweight are in general agreement with other published estimates.

Key Words: Merino Sheep, Staple Length, Staple Strength, Genetic Parameters

INTRODUCTION

Both staple length and staple strength influence the price paid for wool. Staple strength has increased in importance as a determinant in the value of Merino wools and this is especially so in fine wools. The influence of staple strength on the price of fine wools rose from 13% in 1997/98 to 22% in 1998/99, while length accounted for 9% of the variation in prices paid in 1998/99 (The Woolmark Company, 1999).

Between the 1990/91 and the 1994/95 wool selling season, the percentage of tender fault (<30N/ktex) in the Queensland clip varied between 13.4% in 1990/91 and 28.19% in 1992/93 (Wool International, 1996). The percentage of wools <30N/ktex in Queensland was 29.4, 27.4, 31.8, 29.1, and 22.4 for the years 1993/94, 1994/95, 1995/96, 1996/97, and 1997/98 respectively (AWTA, 1999). This is especially a problem for pastoral areas with very seasonal pasture growth and very large differences in conditions between years.

Wool is routinely measured for both length and strength in marketing and increasingly staple strength is being incorporated into breeding programs and performance recording of individual animals for selection. Staple strength has been shown to be moderately to highly heritable in Merino sheep, although there is a wide range of published values, and so would be expected to respond to selection (Greeff *et al.* 1995).

However the high cost of measurement has led to consideration of indirect selection using coefficient of variation of fibre diameter. High phenotypic and genetic correlations have been reported between staple strength and coefficient of variation of fibre diameter (Lewer and Li, 1994; Greeff, 1999; Greeff *et al.,* 1995; 1997). Methods now used to measure fibre diameter, such as the Laserscan, estimate coefficient of variation of fibre diameter as part of the fibre diameter measurement and therefore involve no extra cost to the breeder.

This paper presents estimates of genetic and phenotypic parameters for staple length and strength for two flocks in Longreach and Julia Creek. Estimates derived for these flocks for the characters commonly used in breeding programs (clean fleece weight, yield, clean fleece weight, average fibre diameter and live weight) have been previously reported (Rose and Pepper, 1996; 1999).

MATERIALS AND METHODS

Location and sheep.

The sheep were locally bred, medium Peppin Merinos and were located at two sites, Rosebank Research Station, Longreach and Toorak Research Station, Julia Creek. The management of the sheep has been described (Rose and Pepper, 1996; 1999). There were 18 sire groups, each consisting of 35 ewes, at each site for each year of the three years (1992-94). Sires were replaced each year. However sires used at Julia Creek in 1992 and 1993 were used at Longreach in 1993 and 1994. Ewes were lambed in sire groups and the progeny tagged and sire and dam recorded. Dams were not identified at Julia Creek in 1992. All male progeny were kept entire.

Fleece measurements

All progeny were shorn in July with 12 months wool growth and midside samples taken from the right side of both rams and ewes. Greasy fleece weight (GFW), percentage yield (YLD), clean fleece weight (CFW), and average fibre diameter (DIAM) were measured from these samples. Liveweight (LWT) was recorded annually off-shears. A midside sample, which had been dye-banded in January, was removed from the left side of each animal also and samples of this were used to measure staple length (SL) and staple strength (SS).

Records

Complete records for GFW, YLD, DIAM, LWT, staple length (SL) and staple strength (SS) at 15 months were available for 1754-1795 sheep born in 1992, 1993 and 1994 at two sites. They were the progeny of 72 sires.

Statistical analyses

Analyses were carried out using the program ASREML (Gilmour *et al.,* 1995 and 1998) and the model:

$$Y = X\beta + Z\mu + \varepsilon$$

Where y is a vector of observations

X is a design matrix for fixed effects β

    site (Longreach, Julia Creek)

    year (1992, 1993, 1994)

    sex (male, female)

    birth type (single, twin) and their interactions

Z is a design matrix for random effects $\mu \sim (0, \sigma^2 G)$

      Site.sire

      Site.dam

Residuals $\varepsilon \sim (0, \sigma^2 R)$

RESULTS AND DISCUSSION

Table 1. Effect of birth type on staple length (SL) and staple strength (SS)

Birth type	SL (mm)	SS (N/ktex)
Single	95.58±0.52	24.13±0.32
Twin	94.76±0.83	24.23±0.65

Effects of environmental factors

The means for staple length (SL) and staple strength (SS) are presented for singles and twins in Table 1. There were no significant differences between these means.

There were significant interactions for a number of effects. Table 2 presents the effects of sex by site on SL and SS. Males had shorter wool at Julia Creek than at Longreach while there was no difference between sites for ewes. Ewes at Longreach had much stronger wool than those at Julia Creek but there was no difference between sites for rams' wool.

Table 2. Effect of sex by site on staple length (SL) and staple strength (SS)

Sex	Site	SL (mm)	SS (N/ktex)
Female	Longreach	97.41±0.69	31.89±0.47
	Julia Creek	96.29±1.00	17.50±0.72
Male	Longreach	96.23±0.68	24.26±0.46
	Julia Creek	90.75±0.99	23.06±0.70

Table 3 shows the effects of sex by year of birth on SL and SS. Ewes born in 1992 and 1993 had much longer and stronger wool than ewes born in 1994. Rams born in 1992 had stronger wool than ewes born in 1992 but the difference was reversed for sheep born in 1993. There was no difference between ewes and rams for 1994.

The effect of site by year of birth on SL and SS is shown in Table 4. Since year of birth and year of measurement are confounded, differences in SL and SS reflect the season in which the wool growth took place. The clean fleece weight and average fibre diameters respectively were 2.4, 2.8 and 1.5kg and 21.5, 22.5 and 19.2μm for Longreach for the years 1992, 1993, 1994 and 2.0 and 1.7kg and 21.0 and 19.4μm for Julia Creek

in 1993 and 1994 (Rose and Pepper, 1999).

Better seasonal conditions in some years and better nutritional conditions at Longreach compared with Julia Creek would seem to explain many of the differences involving sites and years although it is difficult to account for the differences in performance of the sexes at the two sites and in some years.

Table 3. Effect of sex by year of birth on staple length (SL) and staple strength (SS)

Sex	Year of birth	SL (mm)	SS (N/ktex)
Female	1992	105.66±1.35	26.90±0.93
	1993	100.04±0.80	30.11±0.57
	1994	84.85±0.83	17.09±0.59
Male	1992	97.16±1.34	31.65±0.91
	1993	98.28±0.78	22.91±0.54
	1994	85.03±0.83	16.42±0.59

Table 4. Effect of site by year of birth on staple length (SL) and staple strength (SS)

Site	Year of birth	SL (mm)	SS (N/ktex)
Longreach	1992	104.25±1.05	35.50±0.68
	1993	102.00±1.03	32.74±0.66
	1994	84.21±1.04	15.97±0.66
Julia Creek	1992[a]	-	-
	1993	96.33±0.98	20.28±0.65
	1994	85.67±1.05	17.54±0.71

[a] Dams were not identified at Julia Creek in 1992.

Phenotypic and genetic parameters

The means and the phenotypic and genetic parameters for SL and SS and a number of fleece and body characters (GFW, YLD, CFW, DIAM, LWT) for medium Peppin Merino sheep measured at 15 months of age are presented in Table 5.

Previously published estimates for the fleece and body characters for these animals (Rose and Pepper, 1999) are included for completeness.

The heritability estimates for staple length of 0.75 (Longreach) and 0.70 (Julia Creek) were high compared with the range of 0.25-0.49 reported in a review of a number of research flocks in Western Australia, South Australia and New South Wales (Greeff *et al.,* 1995; Purvis and Swan, 1999) and at the high end of the range cited by Mortimer (1987) of 0.30-0.70. Estimates of heritability for staple strength of 0.37 (Longreach) and 0.23 (Julia Creek) were high to moderate and in the range of 0.23-0.51 reported for research flocks in other states.

Estimates of phenotypic correlations of staple length with other wool and body characters were of the same order as those reported for a number of research flocks summarised by Greeff *et al.* (1995) and Purvis and Swan (1999). Phenotypic correlations of staple strength with other characters were low to 0 and were consistent with the values reported by these authors.

Table 5. Phenotypic and genetic parameters (±SE) for greasy fleece weight (GFW), yield (YLD), clean fleece weight (CFW), average fibre diameter(DIAM), live weight (LWT), staple length (SL) and staple strength (SS) of 15-month old medium Peppin Merino sheep

		GFW (kg)	YLD (%)	CFW (kg)	DIAM (μm)	LWT (kg)	SL (mm)	SS (N/ktex)
Mean		3.15[a]	64.09	2.01	20.51	31.61	95.17±0.60	24.18±0.42
Heritability	*Longreach*	0.35	0.62	0.34	0.74	0.37	0.75±0.15	0.37±0.10
	Julia Creek	0.23	0.52	0.20	0.67	0.56	0.70±0.20	0.23±0.12
GFW	*Longreach*		-0.10	0.79	0.18	0.31	0.23±0.03	0.07±0.03
	Julia Creek		-0.07	0.82	0.13	0.28	0.22±0.04	-0.07±0.04
YLD	*Longreach*	-0.26		0.44	0.08	0.04	0.34±0.03	0.17±0.03
	Julia Creek	-0.27		0.25	0.03	-0.04	0.17±0.05	0.02±0.04
CFW	*Longreach*	0.65	0.53		0.20	0.29	0.39±0.03	0.15±0.03
	Julia Creek	0.71	0.53		0.15	0.21	0.30±0.04	-0.03±0.04
DIAM	*Longreach*	0.40	0.14	0.47		0.08	0.19±0.03	0.12±0.03[b]
	Julia Creek	0.39	0.10	0.43		0.03	0.24±0.05	0.06±0.05[b]
LWT	*Longreach*	0.16	-0.25	-0.06	0.25		0.12±0.03	0.02±0.03
	Julia Creek	0.53	-0.28	0.20	0.01		0.10±0.05	0.03±0.04
SL	*Longreach*	-0.03±0.19	0.58±0.12	0.41±0.15	0.17±0.16	-0.27±0.17		0.15±0.03
	Julia Creek	0.37±0.23	0.37±0.19	0.53±0.19	0.47±0.17	0.16±0.22		-0.03±0.04
SS	*Longreach*	0.03±0.20	0.28±0.17	0.19±0.20	0.00±0.18[b]	-0.16±0.20	0.01±0.19	
	Julia Creek	-0.64±0.23	-0.05±0.26	-0.38±0.26	-0.04±0.29[b]	-0.13±0.25	-0.07±0.26	

[a] Figures shown in italics from Rose and Pepper (1999).
[b] As the parameters did not converge on the combined site analyses for SS and FD, phenotypic and genetic correlations were estimated from individual site analyses.
Phenotypic correlations are shown above the diagonal and genetic correlations below.

The estimates of genetic correlations of staple length with all characters were within the range of the estimates reported by Greeff *et al.* (1995) and Purvis and Swan (1999). Those between staple strength and the other characters were also in the published range although the estimates with greasy and clean fleece weight at Julia Creek were high and negative.

CONCLUSIONS

This study shows that much of the wool from both sites was <30N/ktex and in some years the staple strength was very low. Improvement in staple strength will result in an overall increase in the value of clips from these areas since staple strength is the second most important determinant after fibre diameter of the price paid for wool.

These results show that staple length and staple strength are both heritable and should respond to selection. However since there is a positive genetic correlation between clean fleece weight and staple length, programs to increase fleece weight should result in an increase in staple length.

Because of the cost of measurement of staple strength, indirect selection for improvement of staple strength based on coefficient of variation of fibre diameter has been investigated by a number of researchers. Lewer and Li (1994) and Greeff *et al.* (1997) showed there was a strong negative relationship between staple strength and coefficient of variation of fibre diameter and that small changes in coefficient of variation resulted in quite large changes in staple strength.

Greeff *et al.* (1997) also showed that sheep with sound wool grew wool with less variation of fibre diameter along the staple than those with tender wool. However they did not find any differences in weight gain or loss. They suggested that the differences may be in feed intake, efficiency of feed utilisation for wool growth and perhaps in grazing behaviour.

Measurement of fibre diameter in these data was carried out using the airflow technique so the coefficient of variation was not available. Further analyses of data from dye-banded samples from these sheep will provide correlations of staple strength with coefficient of variation of fibre diameter. They may also provide elucidation of how some sheep are able to produce more and better quality wool in pastoral Queensland despite the very seasonal availability of feed.

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