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The impact of live weight and liveweight change on wool staple tenacity in Romney hoggets

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ABSTRACT

Three lines of Romney sheep were selectively bred over 10 years for high or low staple tenacity, or were bred at random. Each crop of ewe and ram hoggets was weighed at strategic intervals throughout the year and staple tenacity was measured on mid side wool harvested in spring. Relationships of staple tenacity with live weight and liveweight change were examined by single and multiple regression analysis of data from a total of 2696 hoggets. The biggest single influence on staple tenacity in the ram hoggets was selection line, which accounted for 23.3 % ($P<0.001$) of the variation. For the ewe hoggets, selection line accounted for 19.6 % ($P<0.001$) of the variation. The liveweight parameter that accounted for most variation in staple tenacity was liveweight change from autumn to winter. When liveweight gains over this period exceeded 20 g/day, 84 % of the ewe hoggets had staple tenacity values greater than 22 N/mm^2, but only 50 % of those with gains less than 20 g/day achieved that milestone. For the ram hoggets, the corresponding values were 66 % and 38 %. These findings provide a basis for liveweight targets to achieve chosen levels of staple tenacity in Romney hoggets.

Keywords: wool; staple tenacity; live weight; liveweight change; Romney; hoggets.

INTRODUCTION

The strength of wool staples, or staple tenacity, influences the value of wool because of implications at several stages along the processing chain. Fibres from low tenacity wool are more likely to break in the carding process, resulting in greater fibre loss during carding and spinning. This can also lead to more ends-down during spinning, which reduces efficiency, and increased pilling in end-products (Maddever *et al.*, 1994). Wools of higher staple tenacity allow yarns to be spun at higher speeds, which can lead to valuable productivity gains (Maddever *et al.*, 1994).

Staple tenacity or strength is influenced by genetic and nutritional factors. The genetic contribution has been examined in detail in Australian Merinos (Swan *et al.*, 1997; Hill and Ponzoni, 1999) and Romneys in New Zealand (Newman *et al.*, 1991; Bray *et al.*, 1995). Single trait selection for staple strength or tenacity indicated heritabilities of 0.42 ± 0.06 for Merinos (Lewer and Li, 1994) and 0.46 ± 0.03 for Romneys (Bray *et al.*, 1995).

The nutritional influence on staple strength has been well documented with a high correlation between reduced nutrition and low staple strength (Barry, 1969; Hawker and Crosbie, 1985; Fitzgerald *et al.*, 1984; Butler, 1994; Masters *et al.*, 1998). In New Zealand, under-nutrition is most common in winter, and when it is combined with the reduction in wool growth during this period due to photoperiod effects (Geenty *et al.*, 1984; Woods and Orwin, 1988), and the stress of pregnancy in ewes (Bigham *et al.*, 1983), the reduction in fibre diameter can create a weak point on the staple. This weakness often leads to fleeces being classified as tender or cotted, which attracts a price discount. In more extreme cases, some or all of the fleece may be shed.

From this effect of nutrition, it seemed reasonable to expect a link between live weight and staple tenacity. In this study, records were examined to establish the relationship between staple tenacity and live weight and also liveweight change.

MATERIALS AND METHODS

Records were examined from a total of 1324 Romney ewe hoggets and 1372 Romney ram hoggets selected for high or low staple tenacity, or selected at random. These hoggets were born between 1986 and 1995. The annual crop of progeny from all three selection lines was run together from birth in September until hogget shearing the following November. However, the two sexes were grazed separately from lamb shearing in January each year. Normal farm management practices were employed throughout the project. Unfasted live weights were routinely recorded at birth, weaning, lamb shearing, pre- and post-winter, hogget shearing and at other strategic times during the year.

A sample of mid-side wool grown over the 10 months from January to November, was harvested from each animal immediately prior to hogget shearing, for the measurement of staple tenacity and other fleece and fibre characteristics. Staple tenacity was measured on five staples per hogget on an Agritest Staplebreaker as described by Bray *et al.* (1995). Staple tenacity (N/mm^2) was calculated from the peak force required to break the staples and the staple thickness at the point of break. This is distinguished from measurements of staple strength (N/ktex), which are influenced by the amount of wool away from the point of break (Scobie *et al.*, 1995).

Inter-relationships between staple tenacity and live weight and liveweight change parameters were examined by single and multiple stepwise regression analysis to determine the variables exerting the most influence.

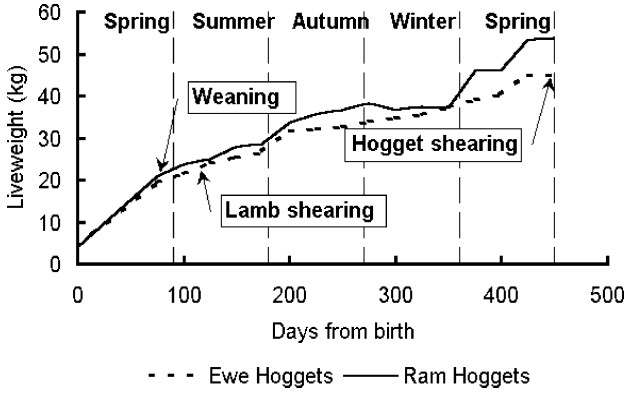
Local animal ethics committees approved all procedures used in this research.

RESULTS AND DISCUSSION

Figure 1 shows the pooled average live weights achieved during the ten years of the project by both the ewe and ram hoggets, from birth in September until hogget shearing the following November. The liveweight pathway followed by both groups was similar in most years, with favourable pre-weaning, summer and autumn growth rates. Liveweight gains reduced over the winter period, particularly in the

ram hoggets, but this was followed by an improvement leading up to shearing in November. The standard error of the means for the liveweight measurements was 0.2 kg with no significant differences between selection lines.

FIGURE 1: Ewe and ram hogget liveweight pathways from birth to hogget shearing. Data from the three selection lines have been pooled.



Wool is considered to be 'sound' at staple tenacity values greater than 30 Newtons/kilotex or 22 Newtons/mm^2. The mean (± s.e.m.) staple tenacity over the ten years for the ewe hoggets was 32.2 (± 0.39) and for the ram hoggets was 26.4 (± 0.35) Newtons/mm^2. Individual staple tenacity values ranged from 3.2 to 78.8 N/mm^2 for the ewe hoggets and from 4.3 to 72.5 N/mm^2 for the ram hoggets.

Multiple stepwise regression analysis revealed that among the traits studied, the main influence on staple tenacity (ST) was selection line. This accounted for 19.6 % of the variation in the ewe hoggets (P<0.001) and 23.3 % in the ram hoggets (P<0.001), as shown in Table 1. Addition of the summer liveweight (LW) of the animals at five months of age, and their subsequent liveweight gains (LWG) over the summer to autumn, autumn to winter and winter to spring periods, improved the variation accounted for another 25.2% and 24.4% for ewe and ram hoggets respectively (see Table 1).

TABLE 1: Proportion of the variation in staple tenacity accounted for by selection line and liveweight parameters.

Parameter	Percentage variation accounted for	
	Ewe hoggets	Ram hoggets
Selection line	19.6	23.3
+ summer live weight	21.1	23.9
+ LWG – summer to autumn	21.1	24.7
+ LWG – autumn to winter	44.8	42.1
+ LWG – winter to spring	44.8	47.7

The overall regression equation for staple tenacity of the ewe hoggets was:

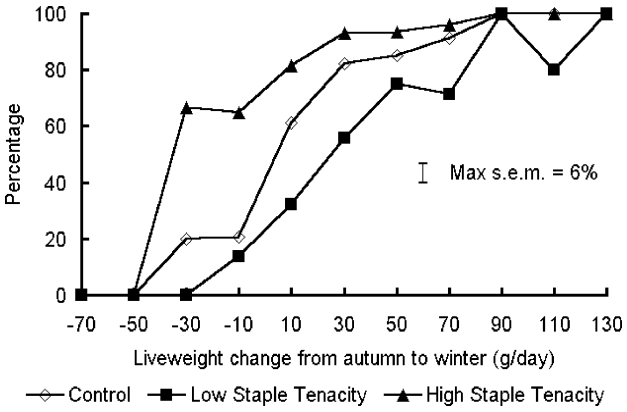
ST = 5.64 + 0.691 * summer LW + 0.080 * LWG summer to autumn + 0.380 * LWG autumn to winter - 0.009 * LWG winter to spring (r^2 = 0.448, P<0.001)

The overall regression equation for staple tenacity of the ram hoggets was:

ST = 14.11+ 0.007 * summer LW + 0.016 * LWG summer to autumn + 0.174 * LWG autumn to winter + 0.092 * LWG winter to spring (r^2 = 0.477, P<0.001)

When the data for the three selection lines were pooled and the liveweight parameters examined singularly, the parameter that accounted for most variation in staple tenacity was liveweight change from autumn to winter, for both the ewe (r^2 = 0.212) and ram hoggets (r^2 = 0.173). Figure 2 indicates the increasing proportion of ewe hoggets with sound wool as liveweight gain from autumn to winter increased. It also shows the magnitude of the difference in staple tenacity between selection lines across the range of liveweight gains during the 10-year period.

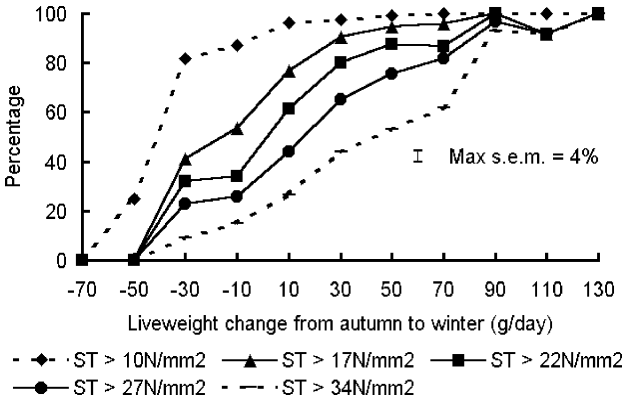
FIGURE 2: Percentage of ewe hoggets from the three selection lines within classes of liveweight change from autumn to winter that had staple tenacity greater than 22 N/mm^2.



In the ewe hoggets, the mean autumn live weight across all three selection lines was 31.0 (± 0.13) kg. Every 10 g/day increase in their liveweight gain from autumn to winter resulted in an increase of 2.90 (± 0.01) N/mm^2 in the tenacity of their staples. For the 34.0 (± 0.13) kg ram hoggets, the same increase in liveweight gain lead to an improvement of 1.32 (± 0.07) N/mm^2. These results are similar to the values reported by Masters *et al*. (1995) and Doyle *et al*. (1995) for young Merino sheep in Western Australian environments.

Figure 3 uses the same data as in Figure 2, with the selection lines pooled. It shows the proportion of ewe hoggets in liveweight change classes that achieved various staple tenacity levels. When autumn to winter liveweight gains exceeded 20 g/day, 84 % of the ewe hoggets had staple tenacity values greater than 22 N/mm^2, but only 50 % of those with gains less than 20 g/day achieved that milestone. For the ram hoggets (not shown), the corresponding values were 66 % and 38 %.

FIGURE 3: Percentage of ewe hoggets within classes of liveweight change from autumn to winter at various staple tenacity levels. Data from the three selection lines have been pooled.



The regression parameters for the relationship between staple tenacity and autumn to winter liveweight change for all three selection lines and for both sexes are shown in Table 2.

TABLE 2: Regression parameters for the relationship between staple tenacity and autumn to winter liveweight change for the three selection lines and both sexes.

Sex	Selection line	Slope	Constant	r^2
Ewe hoggets	Control	0.299	22.24	0.300
	Low Staple Tenacity	0.236	16.99	0.350
	High Staple Tenacity	0.258	31.71	0.191
	Overall	0.264	24.00	0.212
Ram hoggets	Control	0.151	21.88	0.252
	Low Staple Tenacity	0.118	16.03	0.291
	High Staple Tenacity	0.140	30.50	0.162
	Overall	0.138	22.75	0.173

All regressions were significant at the 0.001 level of significance

These results are highly consistent with those reported for Merinos in Western Australia by Doyle *et al*. (1994), who summarised the relationship across several experiments, Doyle *et al*. (1995), who used supplementary feed to manipulate live weight and by Masters *et al*. (1995). The degree of agreement across different genotypes, environments, nutritional treatments, and at different times of year, is remarkable.

Using the "overall" regression equations from Table 2, and assuming starting live weights in autumn of 31 and 34 kg for ewe and ram hoggets respectively, the levels of liveweight change required to produce three levels of average staple tenacity can be calculated (Table 3). This shows that both the ewe and ram hoggets from this study can sustain a slight liveweight loss during this period and still produce wool with staples averaging 22 Newtons/mm^2.

TABLE 3: Estimates of liveweight changes from autumn to winter required to produce various levels of staple tenacity in Romney ewe and ram hoggets. Data from the three selection lines have been pooled.

	Minimum liveweight change from autumn to winter required (g/day)	
Level of mean staple tenacity desired (Newtons/mm^2)	Ewe hoggets	Ram hoggets
17	-26	-41
22	-8	-5
27	11	31

These findings provide a basis for liveweight gain targets to achieve chosen levels of staple tenacity in Romney hoggets.

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