RESPONSES IN FLEECE CHARACTERISTICS TO SELECTIVE BREEDING IN NEW ZEALAND LONGWOOL SHEEP

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SUMMARY
The major end use of New Zealand longwools is for outer garments and interior textiles. Wool characteristics with the greatest influence on processing for these products are wool bulk, tensile strength and colour. Bulk appears to be controlled by a few genes of major effect in Perendales, and staple tenacity appears to be highly inherited in Romneys. Correlated responses in all three characteristics have been recorded in sheep selected for other productive traits. Genetic parameters from current studies will allow wool characteristics to be included in selection indices for multiple and specialist objectives for New Zealand longwool breeds. However, current premiums for these traits are small relative to the gains to be made from increasing fleece weight and lamb production. Keywords: Sheep, breeding, hogget selection, wool characteristics.

INTRODUCTION
Eighty percent of the New Zealand wool clip is from longwool breeds with mean fibre diameters over 30 µm. Most of it is manufactured into outer garments and interior textiles. Wool characteristics that affect performance during semi-worsted and woollen processing and the performance of the end products include wool bulk, colour, fibre length after carding, diameter and medullation.

New Zealand’s longwool breeds (predominantly Romney, Coopworth and Perendale) are dual purpose. A substantial amount of the selection currently undertaken in breeding programmes is focussed on lamb production traits (reproduction, growth and leanness). Selection pressure exerted on wool traits in recent times has mostly been placed on fleece weight. Increased emphasis on objective measures of product quality indicates a need to review effects of current selection practices and to develop new ones which include objective wool quality traits.

SELECTION FOR GREASY FLEECE WEIGHT AND BODY WEIGHT
Johnson et al. (1995) reported direct selection responses to hogget selection in two single trait lines of New Zealand Romneys established from a common base. Nine generations of selection over more than 20 years accumulated 7-8 phenotypic standard deviations of selection pressure and direct responses corresponding to average heritabilities of 0.28±0.04 and 0.31±0.04 for hogget greasy fleece weight and hogget body weight, respectively. Correlated responses in traits representing the productive performance of adult ewes in the breeding flock were evaluated by Morris et al. (1996), and are summarised in Table 1. While selection for hogget body weight had
no effect on adult clean fleece production, it did increase wool bulk. Selection for greasy hogget fleece weight increased fleece weight, staple length, fibre diameter and its variability and yellow discolouration.

Table 1. Annual percentage rates of response in body and fleece characteristics in adult ewes (from Morris et al. 1996)

<table>
<thead>
<tr>
<th>Selection line</th>
<th>Body weight</th>
<th>Greasy fleece weight</th>
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<tbody>
<tr>
<td>Clean fleece weight</td>
<td>-0.01</td>
<td>1.44</td>
</tr>
<tr>
<td>Body weight</td>
<td>1.18</td>
<td>0.45</td>
</tr>
<tr>
<td>Staple length</td>
<td>-0.03</td>
<td>0.43</td>
</tr>
<tr>
<td>Fibre diameter</td>
<td>0.01</td>
<td>0.28</td>
</tr>
<tr>
<td>Fibre diameter standard deviation</td>
<td>0.03</td>
<td>0.17</td>
</tr>
<tr>
<td>Loose wool bulk</td>
<td>0.43</td>
<td>0.04</td>
</tr>
<tr>
<td>Brightness (Y)</td>
<td>0.02</td>
<td>-0.06</td>
</tr>
<tr>
<td>Yellowness (Y-Z)</td>
<td>-0.11</td>
<td>1.31</td>
</tr>
</tbody>
</table>

Clarke et al. (1995) reported animal model estimates for the heritability of greasy fleece weight that were higher in female (0.48) compared with male (0.32) hoggets. Co-heritability estimates with clean fleece weight in adult sires were nearly half the average magnitude for males (0.21) compared to female hoggets (0.36), a trend also found for Merinos (Atkins et al. 1990). Selection responses for other Romney lines were reviewed by Clarke and Johnson (1993). They provide important evidence for the design of industry selection and flock management strategies for wool production and quality.

SELECTION FOR BULK

Wool bulk is defined as the specific volume of a known mass of fibre under a set load and is expressed as cm³/g. High bulk improves carding performance, imparts increased insulation to knitting yarn and bedding and improves the appearance retention and wearability of carpets (Sumner et al. 1991; Maddever and Wuliji, 1993). The compressional properties of wool are primarily associated with aspects of individual fibre crimp within the fibre mass (Sumner et al. 1993).

Initial studies based on a single generation of selection of Perendale (interbred Cheviot x Romney) sheep indicated the heritability of bulk varied between 0.4 and 0.7 (Bigham et al. 1985). Estimates for Romney sheep were consistently lower at 0.3. Data from 60 sire groups in Perendale and Cheviot high and low bulk lines over six years (Sumner et al. 1995) have shown the initial screening for high or low bulk produced a genetic divergence of 5cm³/g between the lines. Subsequent selection resulted in a slower rate of genetic divergence averaging 0.4cm³/g per year. Combined estimates of realised heritability for bulk over the six years were 0.44±0.07 for the Perendales and 0.32±0.09 for the Cheviots. Estimates for the period after screening were considerably less (0.25 to 0.30, similar to Romneys). Phenotypic and genetic correlations between
wool bulk and clean fleece weight averaged -0.23 and -0.51 respectively for the two breeds. These data provide circumstantial evidence that relatively few genes, each with a large effect, may be involved in the expression of wool bulk in Perendale and Cheviot sheep. It also indicates that these genes may in part be independent of genes involved in the expression of clean fleece weight. In view of the slow gains achievable from selection for bulk in low bulk breeds such as the Romney and Coopworth it will be quicker for growers to introduce high bulk genes by crossbreeding (Sumner 1994). Texel and Poll Dorset breeds are currently being evaluated for their suitability for this purpose (Sumner 1994; Wuliji et al. 1995).

The recent introduction of a standard pre-sale test for core bulk may serve to increase the current premium for bulk from 6.5c/cm³/g (NZ) (Maddever et al. 1991). This premium would need to double for wool growers to derive an equivalent wool return from high and low bulk Perendale and Cheviot sheep.

**SELECTION FOR STAPLE TENACITY**

Improvements in fibre length are being sought through increases in tensile strength which will reduce fibre breakage during processing. Fibres of longwool sheep are most likely to break in the portion grown in winter (Bigham et al. 1983). This is a consequence of the additive effects of short photoperiod and reduced feeding which produce a winter trough in fibre diameter that is 25 to 40% of peak values in summer (Woods et al. 1995).

Selection for high or low staple tenacity (Scoble et al. 1995) at hogget shearing in Romney sheep since 1986 has produced consistent differences in staple tenacity (Bray et al. 1995). Staple tenacity values for progeny born in 1993 in the high, control and low staple tenacity lines were 38, 26 and 17 N/mm² respectively. Divergences from the control line were 1.3 and 0.9 standard deviations for high and low staple tenacity lines, respectively. A preliminary estimate of the heritability of staple tenacity based on 90 sire groups in these lines over a six year period is 0.46±0.03 which compares with published estimates for staple strength, measured by varying methods, ranging from 0.20 to 0.58 (Bray et al. 1995). Associated with increases in staple tenacity have been increases in mean fibre diameter, staple length and fleece weight, and reductions in variation of fibre diameter, length and medullation (Table 2).

Table 2. Hogget wool characteristics of Romney sheep selected for high or low staple tenacity of the hogget fleece (from Bray et al. 1995)

<table>
<thead>
<tr>
<th>Selection line</th>
<th>High</th>
<th>Control</th>
<th>Low</th>
<th>S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staple tenacity (N/mm²)</td>
<td>50.2</td>
<td>33.7</td>
<td>22.1</td>
<td>2.1</td>
</tr>
<tr>
<td>Staple length (mm)</td>
<td>146</td>
<td>135</td>
<td>129</td>
<td>4</td>
</tr>
<tr>
<td>Fibre diameter (µm)</td>
<td>34.7</td>
<td>32.4</td>
<td>29.6</td>
<td>0.7</td>
</tr>
<tr>
<td>Clean fleece weight (kg)</td>
<td>2.27</td>
<td>2.10</td>
<td>1.99</td>
<td>0.09</td>
</tr>
</tbody>
</table>
In parcels of Romney wool selected to be similar for characteristics other than staple tenacity, increased staple tenacity improved performance during processing into knitted fabric and tufted carpet (Maddever et al. 1994). Fibre length after carding and combing yield were increased. End breaks at high spinning speeds were reduced and slight improvements in panel abrasion and piling were achieved. The sum of the benefits of the high and low staple tenacity wools in that study was estimated at 20c/kg (NZ).

CONCLUSIONS
Parameter estimates indicate that for the Romney breed current industry emphasis on lamb and wool production traits will have little correlated influence on wool quality traits apart from yellowness and fibre diameter. Increased fibre diameter would be expected to be associated with improved staple tenacity. High responses to selection for bulk in Perendales are, by contrast, associated with decreased fleece production, and presumably vice versa.

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REFERENCES

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