

## IMPROVING WOOL BULK IN LONG-WOOL SHEEP BY CROSSBREEDING WITH TEXELS

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### SUMMARY

The hogget live weight, fleece weight and wool characteristics of 1259 progeny born in three breeding seasons, sired by 55 sires and comprising seven genotypes were compared. Texel x Romney, Texel x Romney intercross, [Texel x Romney] x Romney, and [Poll Dorset x Romney] x [Texel Romney] significantly outperformed Romneys for live weight traits. The crossbred genotypes had higher fleece weights than random control Romneys by 13 - 23%, but lower fleece weights than Romneys selected for high fleece weight. A major benefit of these crosses was that wool bulk was increased by 22 - 37% and wool fibre diameter was reduced by about 1.5  $\mu\text{m}$  in most crossbred genotypes compared to Romneys.

**Key words:** Crossbreeding, Texel, Romney, bulk, curvature

### INTRODUCTION

High bulk wool is sought after for a number of end uses, particularly in carpets, upholstery, knitwear, and the filling materials in bedding. The bulk characteristic of fleece wool persists through the various processing stages to the finished products. Carnaby and Elliott (1980) showed that about a 15% difference in wool bulk results in a visible difference in yarns and in their final products. Investigations within the traditional New Zealand long-wool sheep have concluded that variation in wool bulk is low (Bigham *et al.* 1985) and the most effective way of increasing bulk is to crossbreed with high bulk breeds (Sumner 1994). Recent comparisons between sire breeds have shown that Texel sheep produce bulky wool but lower fleece weights than other breeds (Wuliji *et al.* 1990, 1995). Single trait selection for fleece weight in Romney flocks (Hawker *et al.* 1988; Wuliji *et al.* 1991) has resulted in an increase of 20 -35% in clean fleece weight over unselected controls. Romney ewes selected for fleece weight were chosen as dams in this trial to crossbreed with Texel and Poll Dorset terminal sire breeds. We discuss the performance of five such crossbred genotypes in comparison with Romneys.

### MATERIALS AND METHODS

**Crossbreeding.** An unselected Romney control flock and a Texel x Romney flock were established in 1991 at AgResearch's Gore Station, as described by Wuliji *et al.* (1995), while a Romney high fleece weight selection flock, established at Woodlands (Hawker *et al.* 1988), was transferred to Gore for comparison. Progeny groups of control Romney (CR), Romney selected for high fleece weight (HR), Texel x Romney ( $\text{TR}_{F1}$ ), Texel x Romney intercross ( $\text{TR}_{F2}$ ), Texel x [Texel x Romney] (TTR), [Texel x Romney] x Romney (TRR) and [Poll Dorset x Romney] x [Texel x Romney] (DTR) were generated over 1 to 3 breeding seasons from 1992 to 1994. Natural

mating, in single sire groups, was used to produce CR, HR, TR<sub>F2</sub>, TRR and DTR; 10 CR rams were joined with 165 CR ewes; 5 HR rams were joined with 125 HR ewes; 5 TR<sub>F1</sub> rams were joined with 70 TR<sub>F1</sub> ewes; 13 TR<sub>F1</sub> rams were joined with 400 HR ewes; and 5 Poll Dorset x Romney (DR) rams were joined with 70 TR<sub>F1</sub> ewes respectively. Ewes for TR<sub>F1</sub> and TTR had oestrus synchronised using intra-vaginal CIDRs (Controlled Internal Drug Releasing Device; Alex Harvey Industries) and were artificially inseminated using frozen semen from 11 Texel sires (260 HR ewes) and from 6 Texel sires (80 TR<sub>F1</sub> ewes) respectively. Ewes and rams for CR, HR and TR were obtained from previous selection trials as described by Wuliji *et al.* (1995) while the 5 DR rams were from AgResearch, Whatawhata Research Station. These matings involved 55 sires and resulted in 1259 (181 CR, 136 HR, 84 TR<sub>F2</sub>, 470 TRR, 90 DTR, 233 TR<sub>F1</sub> and 65 TTR) lambs reared. Ewes and progeny were farmed at the AgResearch Gore Station (Lat. 46°09' S and Long. 168° 56' E) and managed similarly each year.

**Records and measurements.** Birth date, birth-rearing rank, birth weight (BW), weaning weight (WW) and spring weight (SW) were recorded. Greasy fleece weight (GF) was measured at 12 months old (8 months fleece growth excluding belly wool and crutchings) and a midside fleece sample collected. Fleece samples were measured for oven dry yield (%) and colour tristimulus (X,Y,Z) (NZS 8707:1984), where Y is brightness and Y-Z is yellowness. Clean fleece weights (CF) were calculated using yields. Bulk was measured as core wool bulk (cm<sup>3</sup>/g) using a core wool bulkometer (WRONZ Inc.). Average fibre diameter (FD), fibre diameter variation (FDcv) and curvature index (Curv) were measured using OFDA (SGS, Australia Ltd).

**Statistical analysis.** Data were analysed by residual maximum likelihood (REML). Genotype, year, sex, birth rearing rank and age of dam were included as fixed effects, birth day as a covariate and sire as a random effect in the model. The sire variation was fixed as a proportion of the residual variation using previously established estimates for the traits. The models for SW, GF and CF included the interaction between sex and year, while those for FD, FDcv and Curv included the interaction between birth day and sex. Correlations were calculated after adjusting for year effects.

## RESULTS AND DISCUSSION

The highest BWs were for TRR and TR<sub>F1</sub>, being about 14% and 9% ( $P < 0.05$ ) higher than CR and HR respectively (Table 1). The DTR progeny had the highest WW being 21% higher ( $P < 0.05$ ) than CR, but there were no significant differences among HR, TR<sub>F1</sub>, TR<sub>F2</sub> and TTR. The TR<sub>F1</sub>, TR<sub>F2</sub> and DTR progeny remained 20% higher than CR and 8% higher than HR for SW. The crossbred genotypes, particularly TR<sub>F1</sub>, TR<sub>F2</sub> and DTR, consistently outperformed both Romney types for live weight, indicating that crossbreeding has had a favourable effect on growth rate in these crosses. However, TTR was unexpectedly lower than other crosses for SW. HR produced the highest GF and CF, and TRR, TR<sub>F1</sub>, TR<sub>F2</sub> and DTR also produced higher fleece weights ( $P < 0.05$ ) than CR. Yield measurements were higher for both Romney types than all crossbred genotypes although the difference was not significant for HR compared with TTR and TR<sub>F1</sub>. Previous studies have revealed that when long-wool sheep are crossed with Texels there is a substantial loss in fleece weight, which can be up to 30% (Clarke *et al.* 1988; Clarke and Kirton 1990). In the present

**Table 1. Genotype least squares means for live weight, fleece weight and wool characteristics**

| Geno-<br>type    | N<br>o. | BW<br>(kg)         | WW<br>(kg)         | SW<br>(kg)        | GF<br>(kg)         | Yield<br>(%)        | Bulk<br>(cm <sup>3</sup> g) | FD<br>(µm)          | FDcv<br>(%)        | Curv              | Y-Z              |
|------------------|---------|--------------------|--------------------|-------------------|--------------------|---------------------|-----------------------------|---------------------|--------------------|-------------------|------------------|
| CR               | 181     | 4.3 <sup>a</sup>   | 21.5 <sup>a</sup>  | 45.2 <sup>a</sup> | 2.31 <sup>b</sup>  | 65.6 <sup>d</sup>   | 23.7 <sup>a</sup>           | 32.5 <sup>bc</sup>  | 27.2 <sup>d</sup>  | 50.5 <sup>a</sup> | 4.8              |
| HR               | 136     | 4.5 <sup>ab</sup>  | 25.0 <sup>cd</sup> | 50.2 <sup>b</sup> | 3.26 <sup>e</sup>  | 64.7 <sup>cd</sup>  | 25.7 <sup>b</sup>           | 34.0 <sup>c</sup>   | 25.3 <sup>bc</sup> | 52.5 <sup>a</sup> | 4.8              |
| TRR              | 470     | 4.9 <sup>cd</sup>  | 23.2 <sup>b</sup>  | 50.8 <sup>b</sup> | 2.85 <sup>d</sup>  | 62.6 <sup>b</sup>   | 26.4 <sup>b</sup>           | 32.6 <sup>b</sup>   | 26.6 <sup>cd</sup> | 61.2 <sup>b</sup> | 4.9              |
| TR <sub>F1</sub> | 233     | 5.0 <sup>d</sup>   | 25.8 <sup>d</sup>  | 53.6 <sup>c</sup> | 2.66 <sup>c</sup>  | 63.7 <sup>bc</sup>  | 29.1 <sup>c</sup>           | 32.5 <sup>b</sup>   | 24.5 <sup>b</sup>  | 62.5 <sup>b</sup> | 5.1              |
| TR <sub>F2</sub> | 84      | 4.7 <sup>bcd</sup> | 25.9 <sup>d</sup>  | 54.2 <sup>c</sup> | 2.71 <sup>cd</sup> | 60.9 <sup>a</sup>   | 30.0 <sup>c</sup>           | 32.6 <sup>abc</sup> | 24.9 <sup>b</sup>  | 73.7 <sup>c</sup> | 5.1              |
| DTR              | 90      | 4.6 <sup>abc</sup> | 26.1 <sup>d</sup>  | 55.3 <sup>c</sup> | 2.62 <sup>c</sup>  | 62.7 <sup>b</sup>   | 32.5 <sup>d</sup>           | 32.5 <sup>ab</sup>  | 22.9 <sup>a</sup>  | 73.4 <sup>c</sup> | 4.4              |
| TTR              | 65      | 4.5 <sup>ab</sup>  | 24.2 <sup>bc</sup> | 48.9 <sup>b</sup> | 2.06 <sup>a</sup>  | 63.3 <sup>abc</sup> | 29.0 <sup>c</sup>           | 30.8 <sup>a</sup>   | 29.7 <sup>e</sup>  | 70.7 <sup>c</sup> | 5.1              |
| Mean SED         |         | 0.2                | 0.6                | 1.5               | 0.10               | 0.9                 | 0.6                         | 0.7                 | 0.6                | 2.4               | .3 <sup>ns</sup> |

Means bearing a different superscript differ at  $P < 0.05$ ; <sup>ns</sup> denotes no difference within a column.

experiment, crossbreeding HR Romneys with Texel sires reduced GF moderately in relation to HR (e.g. 18% for TR<sub>F1</sub>), but the crossbreds (except TTR) had higher fleece weights than CR, indicating that genetic advantages in HR have compensated for some fleece weight loss in such crossbreeding.

Wool bulk was significantly ( $P < 0.05$ ) higher in all crossbred genotypes and in HR compared with CR. There was a significant ( $P < 0.05$ ) increase in core bulk by 13, 17, 26 and 13% compared with HR, and by 23, 27, 37 and 22% compared with CR for TR<sub>F1</sub>, TR<sub>F2</sub>, DTR and TTR respectively. Earlier studies have shown that hogget wool from first cross Texel x Romney or Texel x Coopworth animals was 23 - 27 % higher for wool bulk than either Romneys or Coopworths (Wuliji *et al.* 1990; Newman and Paterson 1991). Bulky wool is also characteristic of progeny of other down-type sire breeds such as Suffolk, Poll Dorset and Oxford, but the Texel crosses have higher fleece weight (Wuliji *et al.* 1990). DTR showed a substantial boost for bulk, being significantly ( $P < 0.05$ ) higher than any other genotype, although it had a low fleece weight. Bulk in HR showed a two unit increase over CR, which is another benefit to using such animals in a high bulk crossbreeding.

The FD was about 1.5µm finer ( $P < 0.05$ ) in all crossbred progeny except TR<sub>F2</sub>, compared with HR. Of the crossbreds, only TTR was significantly finer ( $P < 0.05$ ) than CR. The lower FD measured in crossbred progeny compared to Romneys agrees with previous studies (Wuliji *et al.* 1990, 1995). The FDcv was similar in HR, TR<sub>F1</sub>, TR<sub>F2</sub> but there was less variation in DTR ( $P < 0.05$ ). Curvature for CR and HR were significantly ( $P < 0.05$ ) lower than for crossbred progeny groups, while TR<sub>F2</sub>, TTR and DTR had higher curvature than TRR and TR<sub>F1</sub>. No significant difference was found in yellowness among the groups but the brightness of TR<sub>F1</sub> (Y= 65.6) and DTR (66.1) was higher ( $P < 0.05$ ) than all other groups (between 63.7 and 64.4).

Males were heavier, and grew more bulkier and yellower wool ( $P < 0.01$ ) than females. Single born and reared animals were heavier ( $P < 0.05$ ) than twin born animals, with twins that were single reared being significantly ( $P < 0.05$ ) heavier at weaning than those that were twin reared. The birth rearing rank did not affect the wool traits, except for yield where twin born and reared animals were higher ( $P < 0.05$ ) than the other rearing types. The effects of sex, birth rearing rank and age of dam (results not shown) on live weights and fleece traits are in agreement with previous work on

Romneys and Texel crosses (Wuliji *et al.* 1991, 1995). Correlations between SW, GF and CF were moderate to high and positive ( $P < 0.001$ ); bulk and curvature were moderately negatively correlated with fleece weights and yield as was curvature and FD ( $P < 0.001$ ). Core bulk was correlated with curvature ( $r = 0.7$ ;  $P < 0.001$ ), with bulk increasing by 0.20 (SE 0.01)  $\text{cm}^3/\text{g}$  for each unit increase in curvature.

The finer fibre diameter and improved bulk in the crossbred wools are characteristics that have demanded an increasing premium in recent years. Assessment of the New Zealand wool auction data from 1984 to 1990 showed that wool bulk has increased in relative economic value over other long-wool characteristics (Maddever *et al.* 1991) and that for bulky wools the premium was \$NZ0.10 per  $\text{cm}^3/\text{g}$  in the early 1990's. Wuliji *et al.* (1995) estimated that there would be about \$2 advantage in the fleeces of these terminal sire crosses compared with HR. Yarn bulk was 14% and 33% higher for  $\text{TR}_{F1}$  and Texel respectively over HR (Maddever and Wuliji 1993). Market trends indicate that New Zealand wool clips will require finer fibres of higher bulk, to meet the demands of the textile market for high quality interior furnishings. This study indicates that crossbreeding HR selected ewes with Texel or other terminal sire breeds will improve wool bulk with only moderate reduction in fleece weight.

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