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## BULK: A WOOL TRAIT OF IMPORTANCE TO THE CARPET INDUSTRY

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### SUMMARY

Data are presented which show wide differences in the bulk of wool from sheep breeds in New Zealand. Relationships between raw wool bulk and yarn bulk indicate that significant increases in the bulk of yarns made from a blend containing a high proportion of Romcross wool can result from the addition of a wool component of high bulk. Data are also presented which indicate that there is little phenotypic variation for bulk within the Romney, Coopworth and Drysdale breeds, but that a large variation is evident in Perendales. This has implications for sheep breeding, wool preparation, and marketing.

### INTRODUCTION

About 70% of the wool types grown in New Zealand are commonly used for the manufacture of carpets. This wool is grown predominantly by the Romney, Perendale and Coopworth breeds of sheep and is collectively referred to as Romcross wool (Elliott, 1979). Romcross wools are considered to be among the best available to the world's carpet industry to improve blend colour, to achieve a good spinning performance, and to increase yarn strength (Ince, 1979). However, Romcross wools do have certain deficiencies for some carpet end uses. In particular, they tend to be of low "bulk", due primarily to their fibre-crimp characteristics (Chaudri and Whiteley, 1961). As a result, when wools are blended for the manufacture of carpet yarns a good proportion of crimped wools must be included if a bulky yarn is required.

Carpet manufacturers are very conscious of the commercial significance of yarn bulk, which in part influences the "cover" a yarn will provide in a carpet (Carnaby and Thomas, 1978) and the "apparent value" of the carpet. The latter refers to differences in the amount of pile fibre which the customer considers he is getting for his money. It is commonly accepted that yarn bulk differences greater than 15% are visually significant.

How yarn bulk is affected by factors such as raw material selection, manufacturing system (woollen versus semi-worsted), twist and number of plies, and finishing techniques such as

dyeing, steaming and raising, is a question of vital interest to manufacturers. Such factors are being studied at WRONZ, and some results relevant to the selection of wools and their effects on yarn bulk are presented here.

#### BREED DIFFERENCES

The effect on yarn bulk of various New Zealand wools of known breed type and covering a wide range of loose-wool bulk values has been examined in pilot-plant processing studies. The wools selected were considered typical of the recognized breed types, apart from the Corriedale and Leicester/Lincoln wools. In the case of the Corriedale a "strong" line was chosen because of an interest in determining the suitability of this wool to the carpet industry, and a mixed line of Leicester/Lincoln wools from a woolstore bin for coarse-lustre wools was used. In all cases, well-prepared full-length fleece wools of good style were selected. In addition, a line of Scottish Blackface wool typical of that imported into New Zealand was examined.

#### TRIAL 1

In the first trial each line of wool was processed "straight" (unblended) on the woollen system. The processing conditions were similar for each lot, though slight adjustments to machine settings were required to produce strictly comparable yarns of similar linear density and twist.

The loose-wool bulk of each line and the bulk of the resulting yarns were measured by testing techniques developed at WRONZ (Dunlop *et al.*, 1974; Ross *et al.*, 1977). Essentially, each is a measure of the volume of fibre per unit mass when compressed under a light load (1 kPa; 10 gf/cm<sup>2</sup>). The results are illustrated in Fig. 1 and show that the crimpy wools (Down and Merino types) have a higher loose-wool bulk than the more-planar-crimped Romney and Leicester/Lincoln types. Also of note are the low bulk values for the Drysdale and Scottish Blackface wools.

Figure 1 also shows that differences in bulk between the wools in loose form persist in the yarns; the correlation coefficient was 0.89\*\*\*. Differences in yarn-bulk values can largely be traced to differences in fibre-crimp configuration; an explanation of this has recently been illustrated by Carnaby (1979). The lower bulk values for the yarns relative to the carded loose wool are due to the insertion of twist.

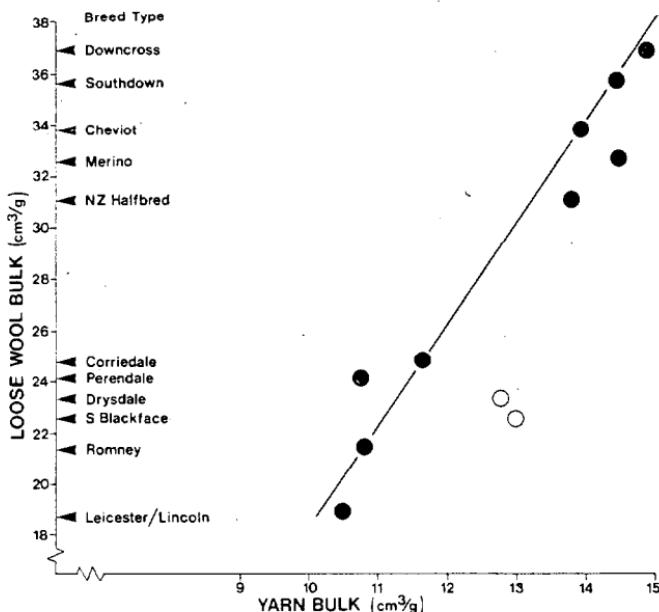


FIG. 1: *Loose-wool bulk for the different breed types and the relationship to woollen bulk. (Note: The line represents the regression equation of yarn bulk on loose-wool bulk when the data for the higher-medullated Drysdale and Scottish Blackface wools are omitted; an improved correlation coefficient of 0.97 results.)*

## TRIAL 2

A special problem faced by semi-worsted yarn manufacturers is that semi-worsted yarns are less bulky than woollen yarns. Because semi-worsted yarn manufacturers are interested in the potential of crimped New Zealand wools as components of their carpet-wool blends, owing to their effect in raising yarn-bulk values, a second trial was undertaken. For this, 30% of each of the 11 wools used in the first trial was blended with 70% of a base-blend of Romcross wools. In addition, a blended line of 30% coarse N.Z. crossbred crutchings (length 75 mm) and 70% of the Romcross base-blend was made, and a line of 100% Romcross base-blend was used as a control. The 13 lines were processed on the semi-worsted system.

The yarn bulk was measured as before and the loose-wool bulk of each blend was calculated assuming that the bulk values of the components are additive. The yarn bulk ( $Y$ ) was plotted

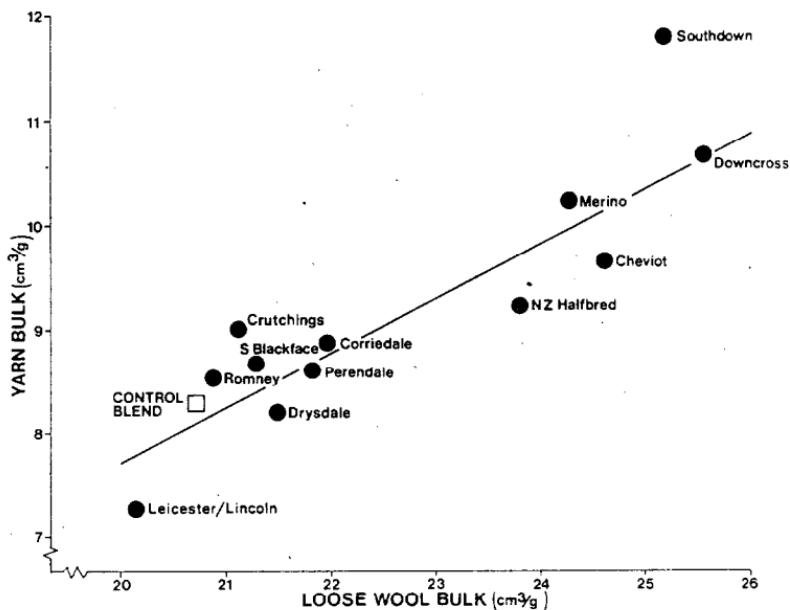


FIG. 2: Relation between semi-worsted-yarn bulk and loose-wool bulk for blended lines.

against the loose-wool bulk ( $X$ ) in Fig. 2 and gave the regression equation

$$Y = 0.55X - 3.31$$

The correlation was again highly significant, 81% of the variation in yarn bulk being accounted for by the differences in loose-wool bulk.

A comparison of Fig. 2 with Fig. 1 shows that semi-worsted yarn-bulk values are lower than respective woollen yarn-bulk values. This is mainly a consequence of the semi-worsted processing system and emphasizes the interest in raising yarn bulk. However, the important result from this study is the indication that significant increases in the bulk of semi-worsted yarns made from a "standard" blend of Romcross wools can be expected from the addition of a wool component with a higher loose-wool bulk.

#### WITHIN-BREED VARIATIONS IN BULK

A meeting at WRONZ between representatives of MAF Research and Advisory Divisions, Massey University, Lincoln College, the N.Z. Wool Board, and WRONZ was held in October

1978 to discuss the breeding of sheep for growing premium carpet wools in New Zealand. The main recommendation from that meeting for future sheep-breeding research with regard to premium-carpet-wool production was to explore the consequences of within-breed improvement of loose-wool bulk in Romcross and Drysdale sheep. As improvement by breeding relies on exploiting the existing variation between animals in a desired characteristic, there was an evident need to determine the phenotypic variation in loose-wool bulk of breeding ewes within a flock.

#### ROMCROSS BREEDS

In 1979, WRONZ determined the loose-wool-bulk values of about 150 midside samples from fleeces of 2- and 3-year-old Romney, Coopworth, and Perendale breeding ewes being run at

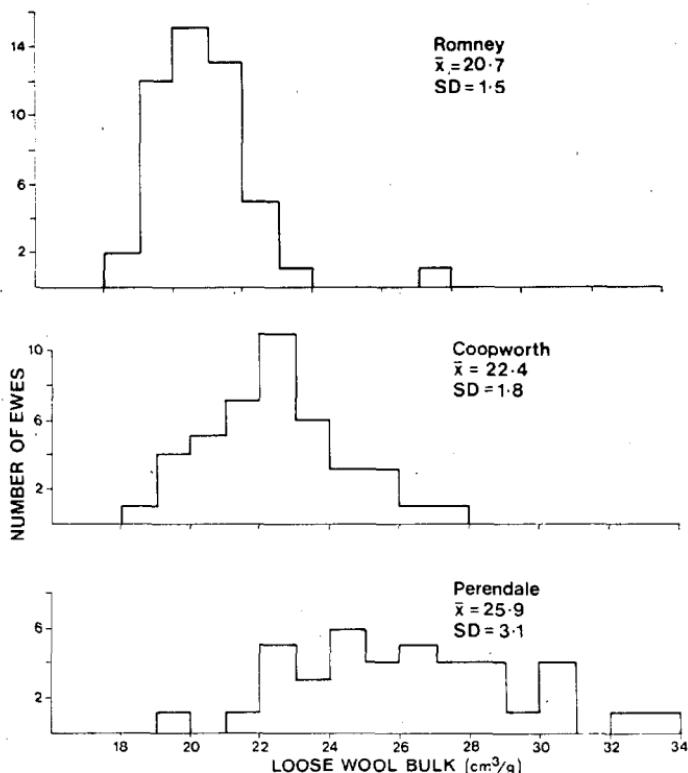


FIG. 3: Distribution of loose-wool-bulk values for Romcross breeding ewes.

one stocking rate (15/ha) in a sheep-breed evaluation trial at Invermay Agricultural Research Centre. The results showed no differences due to age, so the data from both age groups were combined. The distributions of bulk values are shown in Fig. 3. It can be seen that there was little phenotypic variation in bulk with the Romney and Coopworth ewes. However, with the Perendales there was a large variation, ranging from low values of 19 to 22 cm<sup>3</sup>/g typical of the Romney to very high values of 30·5 to 33 cm<sup>3</sup>/g in line with values previously recorded for the Cheviot breed.

#### DRYSDALES

The loose-wool-bulk values of midside samples from 2- and 3-year-old *N<sup>d</sup>*/*N<sup>d</sup>* Drysdale breeding ewes from a flock at Massey University have been determined at WRONZ. Again no differ-

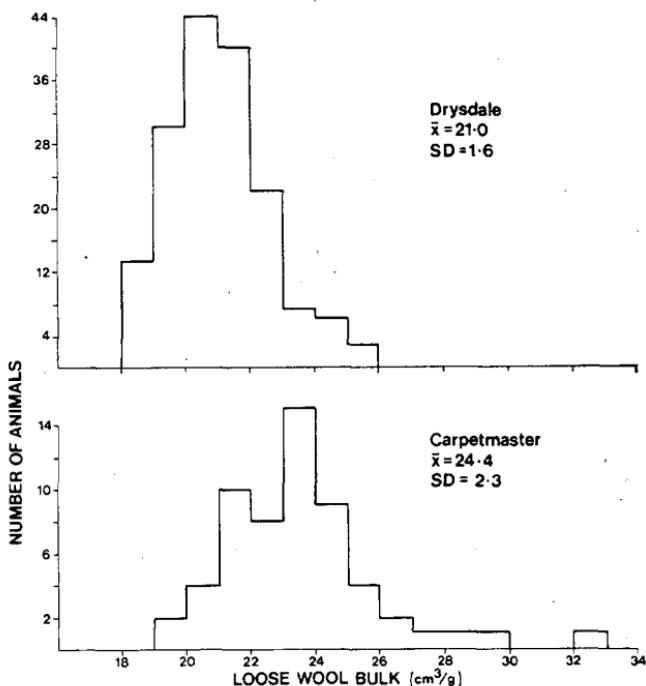


FIG. 4: Distribution of loose-wool-bulk values for Drysdale breeding ewes and Carpetmaster ram hoggets.

ences due to age were found, so the data were combined and are presented in Fig. 4 which shows little phenotypic variation in bulk between the Drysdale fleeces, like the Romney fleeces.

Measurements have also been made on samples from a composite flock of  $N^i/N^i$  and  $N^i/+$  Carpetmaster ram hoggets. (The Carpetmaster is a breed with medullated wool similar to the Drysdale, but unlike the Drysdale which has a Romney base, the Carpetmaster has its origin from crossbreeding a ram with  $N^i$  genes with Perendale ewes (Wickham and Rae, 1977). The distribution of bulk values is also included in Fig. 4, and it can be seen that the mean value for the Carpetmaster fleeces is higher than that for the Drysdales and not too dissimilar to that for the Perendales in Fig. 3. The distribution is also noticeably more spread than the Drysdale distribution.

#### DISCUSSION

It is evident from the results presented on breed differences in loose-wool bulk that there are high-bulk wools produced in New Zealand which, when blended with Romcross wool, will increase yarn bulk. This result has an important application to the expanding New Zealand carpet industry, which by 1978 was exporting carpets and carpet yarn worth in excess of \$40 million a year (Waller, 1978). For a well-planned expansion in these exports, particularly of semi-worsted carpet yarns, and to cater for a growing overseas demand for more bulky Romcross types, it is important to determine the present quantities and seasonal availability of fleece wool, crutchings, and skirted pieces, etc., of these higher-bulk wools in New Zealand. It is also important to be able to recognize any price premium for wool due to this particular property. With this in mind, WRONZ is currently undertaking a project to relate the New Zealand Wool Board's wool-type classification system to objective measures of bulk. The results obtained should assist in the marketing of New Zealand wool.

It would appear from the data presented on within-breed variation in bulk that selection for bulk within Romney or Coopworth flocks could be an unrewarding exercise. In arriving at this conclusion one must consider the selection intensity for bulk that might be expected bearing in mind the dual-purpose nature of these breeds which requires emphasis to be placed on fertility and fleece weight. With the very best of responses the gains in bulk would be of little processing significance in the light of the

results shown in Fig. 2 and the requirement for at least a 15% difference in yarn bulk.

The practical consequences of exploiting the larger variation in bulk within the Perendale breed could be potentially important. Foremost is the immediate need to identify and market separately the high-bulk, sound, vegetable-matter-free Perendale wools from those with lower bulk (including crutchings, bellies and pieces as well as fleece wool). It has been estimated that there were in excess of nine million Perendale breeding ewes in New Zealand in June 1977. Even if the percentage of high-bulk fleeces produced within this breed was only 20%, this could indicate that 5 000 tonnes of the wool currently produced deserves a higher price than is presently being received.

A trial in progress at WRONZ aimed at determining the ability of experienced wool appraisers to subjectively evaluate loose-wool bulk indicates that individual Perendale fleeces can be classed for differences in bulk with sufficient accuracy for most practical purposes. It would thus appear that, with some extension to the requirements to be fulfilled by the present New Zealand Wool Board's Classer Registration Scheme, a suitable marketing arrangement for high-bulk Perendale wool could be implemented within a very short time. It appears that desirable gains could be made by selecting for loose-wool bulk within the Perendale breed. However, the inheritance of bulk and the genetic relationships between bulk and other wool-production traits need to be determined for soundly based selection programmes to proceed.

Using the bulk data reported in this study, the following phenotypic correlation coefficients were calculated between greasy fleece weight and bulk: Romney (-0.02), Coopworth (-0.17), Perendale (-0.25), Drysdale (0.01) and Carpetmaster (0.00). In no case was the coefficient statistically significant ( $P < 0.01$ ). This would suggest that current practices in selecting for fleece weight are unlikely to alter bulk levels to any appreciable extent unless the genetic correlations are very different from the phenotypic correlations.

The limited variation in bulk within the Drysdales suggests that it would be difficult to breed Drysdales with fleeces having higher bulk. Though it is not really valid to compare the Drysdale and Carpetmaster loose-wool-bulk results when little is known about the effects on bulk of age, sex and environmental differences, the higher mean value for the Carpetmasters suggests that crossbreeding Drysdales with higher-crimped breeds may be a

means of improving bulk while retaining a highly medullated fleece. However, these specialty carpet wools normally constitute only 15 to 20% of a carpet blend. Consequently, small improvements in bulk can be expected to have little influence on the overall bulk of a carpet-wool blend.

### CONCLUSIONS

It has been shown that New Zealand wools with high-bulk properties can increase the bulk of carpet yarns from blends containing a high proportion of Romcross wool. Of immediate importance is the need for identifying and marketing high-bulk, sound, vegetable-matter-free Perendale wools and similar wools from other breeds. It appears from the phenotypic data presented here that the chances of improving bulk by selection are limited because of the small variation in bulk within most breeds.

While the results presented are of a preliminary nature, results coming to hand from other studies of carpet blends support the processing data presented in this paper. However, further wool production and processing research is required before sound guidelines can be given to woolgrowers who may wish to influence the bulk properties of their clips by changes in either breeding or management practices.

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