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## CONCLUSIONS

Although there is no one ideal test, objective measurements of wool length/strength are essential for our research. All the methods available can provide useful information about the length/strength attributes

of wool although their limitations need to be recognised. Direct tests such as fibre length after carding are particularly important in enabling our wool production work to be more closely allied to wool manufacturing performance and end uses.

# Implications of objective measurement of wool for sheep breeding

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## ABSTRACT

The implications for sheep breeding of objective measurement of the wool characteristics fibre diameter, medullation, length after carding, loose wool bulk, colour, and vegetable matter are discussed. For the purposes of this discussion breed differences are categorised into fine, medium, Romcross, higher-bulk, crimp, lustrous, and medullated wool types.

## INTRODUCTION

For a character to be incorporated into a breeding programme, it should be economically important, heritable, and measurable. Objective measurement of wool for trading purposes has a bearing on the first and third of these criteria by giving clearer price signals for some wool characteristics and providing measurement methods that are suitable for use on individual animals.

The processing performance of wool can be largely predicted from the measurement of 6 characteristics:

- fibre diameter;
- medullation;
- length after carding;
- loose wool bulk;
- colour; and
- vegetable matter (VM) content.

Variations of these 6 characteristics cause variations in the prices paid for wool and so have some degree of economic significance in determining the merit of individual sheep. In this paper the consideration of wool quality properties will be confined to these 6 characteristics.

At the outset it is acknowledged that fleece weight is the most important criterion when selecting for improved wool production (Wickham, 1985). As a consequence, when consideration is given to improvement in wool quality the correlated responses arising from fleece weight selection need to be appreciated. But more importantly, if direct selection is brought to

bear on wool quality, the consequences of this on fleece weight improvement and the possible degree of loss of selection pressure on other sheep production traits need to be taken into consideration.

Fibre diameter has long been recognised as the most important of the wool quality characteristics in determining price. The relative importance of this property compared with fleece weight in determining fleece value is dependent on the actual mean fibre diameter of the wool. The relative emphasis which should be placed on each has been discussed by Turner (1973) and is well illustrated by Figure 11 (adapted from Turner).

Research shows that equal selection pressures could result in responses of half a kilogram of fleece weight or 2 microns of fibre diameter. Figure 11 shows that the choice of objective for single-character selection depends on the current fibre diameter of the flock. For flocks coarser than 21  $\mu$  it pays to select for fleece weight rather than finer diameter. For flocks finer than 21  $\mu$  it pays to select for fineness rather than fleece weight. An index approach combining some pressure on both characters will lead to greater financial gain but the relative pressure applied to weight and diameter will still change at about 21  $\mu$ .

Because of the overwhelming importance of rams in generating long-term genetic improvement in commercial flocks (Callow, 1985) this paper addresses genetic improvement in sire-breeding flocks only. Furthermore, Wickham (1985) points out that even

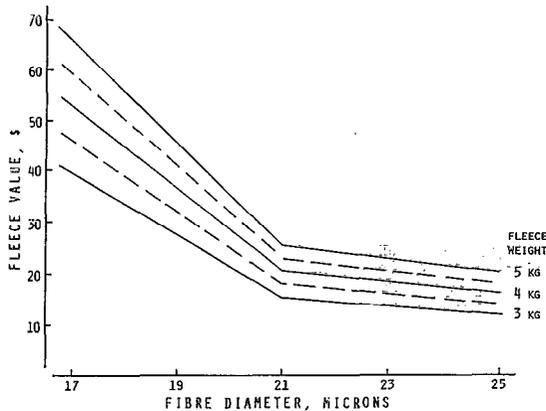


FIG. 11 Relativity of fleece value, fleece weight, and fibre diameter.

within sire-breeding flocks the costs of objective measurement of wool traits are justifiable only for rams.

**TEST MEASUREMENTS**

Of the above list of wool properties, sheep breeders currently have access to objective test measurements of mean fibre diameter, scoured colour and bulk for midside samples of individual fleeces via the Lincoln College Wool Measurement Service and the New Zealand Wool Testing Authority. (Yield testing is also available to enable a calculation of the clean fleece weight.) Testing costs /sample are sufficiently low to be acceptable for carefully selected ram hogget samples, such as from top-index and above-average-fleece-weight animals. In addition, a predictive test for susceptibility to fleece yellowing and measures of medullation are available from the Lincoln College Service which is currently testing more than 5000 samples involving 16,000 measurements annually. A breakdown by breed shows that breeders using the service comprise Merino (45%), Corriedale/Halfbred (23%), Perendale (15%), Romney (9%) and others (8%).

Missing from this list of objective measurements are those for VM content and 'length after carding'. The most serious omission is the length after carding test. As it appears unlikely that a suitable objective test for fleece subsamples from individual animals will be available in the near future, breeders can at present only measure staple length and must then resort to a questionable subjective assessment of staple strength (Orwin and Geenty, 1986). In view of this, of the varying end-uses for wools differing in length after carding, and of the complexity of determining price differentials for this property (Elliott, 1986b) breeders must be warned to enlist expert assistance before embarking on any attempts at breeding to improve the fibre strength component of this trait.

**BREED DIFFERENCES**

To illustrate fundamental differences between wools in their processing performance and suitability for particular end products, New Zealand's breeds of sheep have been categorised as shown in Figure 12 (Elliott, 1985b). Wools from these categories show broad differences in fibre fineness, medullation, lustre, and bulk which are sufficient to influence processing performance as well as the appearance and handle of the end product, and hence suitability for particular end products.

By selective breeding the breeder has the power to move in either of the directions shown. He can do this by direct selection or by crossbreeding. But it is more probable that the breeder's objective will be to maintain the wool type in the relatively distinct category in which it currently exists. In addition to these alternatives, the breeder has the power to influence the sheep's genetic response to management practices which affect colour and length after carding.

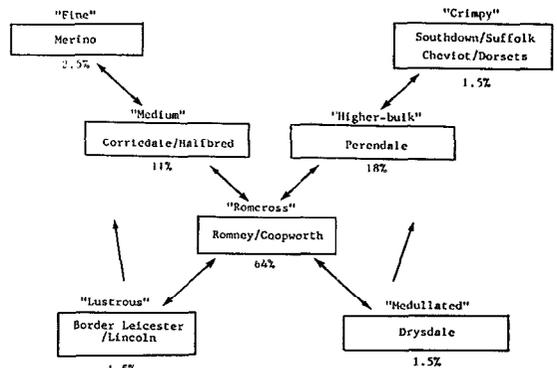


FIG. 12 Composition of New Zealand's sheep flock.

The objective measurement of wool for sheep-selection purposes will be discussed for each of these categories. In line with market-oriented production and the need to produce what the consumer wants, breeders need to question and financially justify the optional sheep-selection practices open to them. In so doing account will need to be taken of the accuracy of assessment (objective v subjective recording) and the likely realised genetic responses in conjunction with the historical trends or stability in price relativities between wool types and/or individual wool properties. Based on processing technical considerations (Elliott, 1986b), likely genetic responses, and general breeding objectives (e.g., Whiteley and Jackson, 1982; Ross *et al.*, 1982; Wickham, 1985) an attempt has been made to illustrate in Table 4 the relative importance of wool properties and the direction for selection for the various breed categories of wool. Clear market signals are required to support decisions on relative emphasis and direction.

The property VM content is ignored in Table 4 as this is essentially environmental rather than genetic in origin.

### Fine

These wools receive high prices because of their fineness and softness of handle and as a consequence their ability to be made into high quality apparel. Fineness is their most distinguishable feature and commands most attention. Any emphasis on selection for wool quality should be directed at decreasing fibre diameter with possibly some attention to improving length after carding and colour as these properties affect the fineness and quality of woven and knitted fabrics.

Superfine Merino breeders may find that selecting for lower bulk is a desirable objective because of the consequential softening of the wool's handle. In this respect trade opinion on any correlated increase in lustre would need to be sought.

Measurement of yield has been included as an indicator of clean fleece weight only. It is somewhat questionable (Wickham, 1985) whether grease content is reduced and susceptibility to fleece rot increased as a consequence.

### Medium

With these wools, holding fibre fineness at the current levels while improving fleece weight is the main challenge. Improvement in length after carding and colour are both important wool quality criteria as variation is marked within this particular wool type. As a consequence these 2 properties can be expected to account for a large proportion of the variation in wool

prices due in particular to the limitations of poorer quality wools for worsted processing. Testing for susceptibility to yellowing of greasy wool (Wilkinson and Aitken, 1985) seems desirable for the Corriedale breed. Selection for or against bulk could both prove to be desirable depending on the wool's end-use, increased bulk being desirable for knitwear end-uses while decreased bulk is possibly desirable for worsted cloth end-uses.

### Romcross

New Zealand's reputation as a producer of quality crossbred carpet wool is based on wool from the Romney breed or breeds of Romney origin such as the Coopworth. Relative to other carpet wools in the world this reputation has been acquired because of the wool's good colour, freedom from pigmented fibres, and an ability to improve processing efficiency and yarn strength when blended with other carpet wools. This reputation needs to be maintained. Improvements in colour and length after carding are of major interest.

A close watching brief may need to be kept on the influence of fibre diameter and loose wool bulk on wool's felting propensity (Elliott and Lohrey, 1983), fleece cottedness (Bigham *et al.*, 1978), and proneness to discolouration. Increases in bulk may be favoured by the carpet trade as well as buyers of lambs and hogget wools destined for knitwear. Unfortunately an ability to make improvements that are of practical significance is questionable (Carnaby and Elliott, 1980; Bigham *et al.*, 1983a). On the other hand a decrease in bulk may prove more profitable owing to an expected increase in lustre and hence movement to a wool more desirable as a base component for wool-mohair blends and Persian-style hand-knotted rugs

**TABLE 4** Relative importance of, and direction for selection according to breed category of wool.

	Fine	Medium	Romcross	High-bulk	Crimpy	Lustrous	Medullated
Fleece weight	+	+	+	+	+	+	+
Yield	?	?					
Fibre diameter	-	0					
Medullation			-? 0 or +?				0
Length after carding	+	+	+	+			+?
Bulk	-?	+or-	-?	-0	0		
Colour	+	+	+	+		+	+

Key: ( ) indicates relative importance; (+) positive selection pressure;  
 (-) negative selection pressure; (0) hold at current level; and  
 (?) indicates where the direction of selection is questionable.

(Elliott, 1983). In many instances increasing lustre will conflict with carpet end-use requirements.

Increasing medullation, while favourable for the carpet trade, may be undesirable overall because of the consequential loss of end-use flexibility due to the wool becoming less desirable in apparel and upholstery. It is for this reason that the recommendation is to hold medullation at its present level. Clearer price signals are required to support this recommendation.

### Higher Bulk

Higher bulk is the distinguishing characteristic of these wools when compared with Romcross wools. Their suitability for semi-worsted processing and manufacture to bulky hand-knitting yarns and knitwear end-uses as well as a high-bulk blend component in carpets (Elliott, 1982b) is a major determinant of price. The challenge to Perendale breeders will be to account clearly for price premiums for bulk and possibly lower fibre diameter (Elliott, 1984) and, if considered sufficiently worthy to warrant attention in selection, to then devise selection programmes to maintain the present bulk levels for the breed or bring about slight improvements while not sacrificing improvements in fleece weight. The genetic associations between these traits have been estimated (Bigham *et al.*, 1985) and the desired objective could be achieved.

The question of whether to attempt to shift bulk levels to those of the crimp-wool category will depend on the price differential between the 2 wool types. Variation within the breed (Elliott, 1981; Bigham *et al.*, 1984) and heritability estimates for bulk (Bigham *et al.*, 1985) suggest that screening of sheep for high-bulk wools combined with direct selection for bulk could quickly achieve such a goal.

### Crimpy

These extremely high-bulk wools with their low propensity to felt (Elliott and Lohrey, 1983) have proven suitability for use in wool-filled products (Watt, 1985) and the manufacture of bulky apparel. The consequences for processing or end-use performance of variation in bulk within these wools have not been determined. It is probable that objective measure-

ments of bulk will highlight even further the speciality of these wools and indicate minimum bulk values. The influence of fibre diameter on price is of interest with finer wools being desirable for apparel end-uses, while a higher fibre diameter to maximise resistance to felting is more desirable for those wools to be used as filler wools in quilted products.

Consideration of other properties such as length after carding and colour seems unimportant and allows full attention to be focused on increasing fleece weight.

### Lustrous

High lustre, which is associated with low bulk, is the most distinguishable feature of these wools. They are currently in demand as a base for wool-mohair blends, where a silky soft-handling wool blend showing a marked sheen and an ability to be dyed to bright colours is desired. Hence, along with low bulk, good coloured (bright and white) wools are required and this probably presents the main challenge to breeders of these wools. The importance of fibre diameter within this wool category is not known. Finer lustrous wools could have a particular speciality. Clearer price signals on this aspect are required.

### Medullated

Drysdale wool is a speciality wool because of its high medullation content. It is used almost exclusively as a component in a carpet blend of wools and its most significant attribute is its medullation content. As this is determined by the N gene (Wickham, 1978) the recommendation is to hold medullation at the current level, realising that blend component substitution can be used to achieve the desired and often varied medullation content in a blend. This allows selection pressure to be focused on other attributes such as wool colour and perhaps improving length after carding.

## CONCLUSION

Increased use of objective measurement in wool trading should enable clearer price signals to be obtained on the particular merits of the different wools which New Zealand is currently producing. Opportunities do exist for selective breeding to bring greater speciality to wool production should markets require this to happen.

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