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Factors Affecting Wool Quality

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Introduction

A major discussion of factors affecting wool quality can be split into two major sections:

(a) The definition of wool quality and its components.
(b) Factors influencing the various components of wool quality.

Both these sections could be large and complex. To keep the present paper to a reasonable size it will be restricted to a very brief resume of (a) and a limited consideration of the factors affecting the main components of wool quality.

Problems of Defining Wool Quality

In the broad sense wool quality can be defined in terms of its monetary value. This value is fixed by a series of rather complicated procedures but the ultimate set of components determining value are those which affect the end product and the ease with which the raw material is converted into the end product.

The variety of end uses of wool make the definition of wool quality complicated. A major difficulty has arisen in New Zealand since the carpet industry has developed into the main user of Romney type wools. The criteria most commonly used for classifying wools in this country are essentially designed for apparel wools and are not very appropriate when the wool is to be processed into carpets. Recent estimates suggest that far more New Zealand wool is used in carpets than in clothing but knowledge of what features are associated with good performance in carpets is very incomplete (Ross 1978, Story 1978).

Components of Wool Quality

The factor of major importance in determining the value of wools for processing into clothing is fibre fineness. Fineness allows the production of fine yarns and lightweight fabrics and if these fine fibres are incorporated into heavier weight clothing their fineness leads to greater softness and warmth. However fineness is usually no advantage in carpets and may be associated with some features which are undesirable. These factors result in price advantages for increasing fineness when the wool is finer than 33 μm (48/50s) but little effect of fineness on the price of coarser wools which are used mainly in carpets.

The next most important component is fibre length but this only becomes important in the later stages of processing. About 30% of the fibres break in the early stages of processing when the wool is sound and free but 60% or more of the fibres may break when they are tender and/or entangled. Thus tenderness and cotting of wool must be regarded as factors leading to shorter lengths. While a high proportion of short fibres frequently leads to problems there is seldom much advantage in fibres longer than 100-125 mm.

The other important component of wool quality is colour. Pure white fibres can be dyed to any shade. Discoloured wools must be bleached or dyed to dark shades and discolouration is sometimes associated with fibre damage. Discolouration is the main factor affecting the style grade of wool and hence is probably the main factor affecting the price of Romney-type wools.

Most other quality traits seem relatively unimportant. It appears that bulk and medullation are desirable in carpet wools but knowledge of their effects is very limited. Generally carpet manufacturers are unwilling to pay large premiums for better types of wool. This is partly due to the fact that raw material costs make up a far larger proportion of costs of carpet manufacturers in comparison with apparel manufacturers. The other main factor is that the systems used in carpet manufacture can make satisfactory carpets from a wide variety of types of wool. This is less true with the modern carpet-making systems and fibre length and strength requirements are becoming more strict.

Factors Affecting Fibre Fineness

The wool industry is at present changing its system of assessing fineness from the traditional quality number system to the mean fibre diameter (micron) system The approximate relationship between the two systems is shown in Table 1.

Table 1. Mean fibre diameter — quality number approximate equivalents.

Mean diameter μm	Quality number	Mean diameter μm	Quality number
19	70s	29	54/56s (50/52s lambs)
20	64/70s	30	52/54s (50/48s lambs)
21	64s	31	52s (46/50s lambs)
22	60/64s	32	50/52s
23	60s (Merino)	33	50s (44/48s lambs)
24	60s (Quarterbred)	34	48/50s
25	58/60s	35	46/50s, 48s
26	58s	37	44/48s
27	56/58s	40	36/44s
28	56s (52/56s lambs)		

This relationship is far from perfect. At present most of the wool is being bought at auction on the basis of hand and eye appraisal of diameter but more and more wool is being bought on the basis of pre-sale measurements.

Genetic factors are by far the most important causes of variation in fineness. Within breeds the heritability of mean diameter is about 0.5 with the heritability of quality number usually in the 0.3 to 0.4 range. The between breed differences are very marked as a result of generations of selection for fineness in some breeds, the Merino being the prime example. Also there are differences between breeds in the quality number-diameter relationship. For instance Cheviots, and to a lesser extent Perendales, tend to be coarser in diameter than is expected for their quality number.

In most situations there is a tendency for fine fleeces to be light in weight. Both the genetic and environmental correlations between fleece weight and fineness are negative. Selection of fineness tends to lead to lower fleece weights and frequently lower returns to breeders. Fig. 1 illustrates the nature of the relationships:

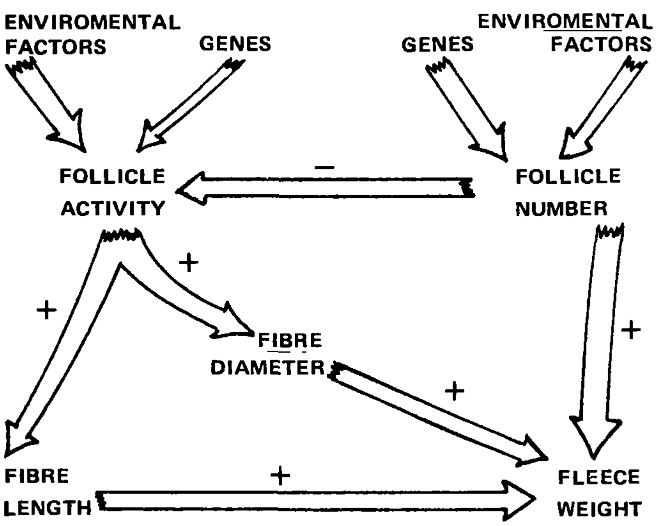

Figure 1. Diagrammatic representation of the relationship between length, diameter and fleece weight.

The number of follicles appears to have a major influence in determining fineness. The fleeces produced by sheep with high follicle numbers tend to be both finer heavier. Follicle number tends to be fixed by gene action during foetal development. Merino sheep and their descendants seem to possess genes for high follicle numbers that are rare in British breeds. The negative association between fleece weight and fineness seem particularly strong in the British breeds making it difficult to achieve a combination of good fleece weights and fine wool. It seems that selection for fineness in British breeds results in reduced fibre weight with little compensatory increase in fibre numbers whereas in the Merino or part Merino breeds selection for fineness results in a marked change in fibre number.

There has been little research on the modification of follicle number. A relatively cheap method of stimulating follicle numbers should offer considerable extra flexibility in changing to a finer type of wool when market conditions suggest this. Presumably this would involve treatment of the foetus *in utero*.

Nutrition can have a considerable effect on fineness. Low nutritional levels reduce the output of fibre from each follicle and this results in finer, shorter wool and lighter fleece weights. Conversely high levels of feeding result in coarser, longer and heavier wool fibres. Quality number tends to show little response to nutritional changes but diameter measurements show the effects of nutrition to a greater extent. This results in well-fed young rams appearing very coarse when diameter measurements are considered in selection.

Factors Affecting Fibre Length

The length of greasy wool is usually expressed in terms of staple length and while this is an approximate guide to fibre length it is far from perfect. Mean fibre length of the raw wool tends to be greater than the staple length. Because of the processing systems used length tends to be more important in fine wools than in coarse wools. However the length requirements of coarse wools for carpet manufacture are tending to become more strict. The major problem is the presence of too many short fibres for efficient processing but very long fibres can also create processing problems. Thus Drysdale sheep usually have to be shorn every 6-8 months or the fleeces get too long and with other coarse-woolled sheep it is frequently beneficial to shear at intervals of about 8 months. However with fine-woolled sheep the price margins for length are usually sufficient to discourage shearing at less than 12 month intervals.

Both genetic factors and nutrition have effects on length. Reduced fibre production results in shorter length as well as finer fibres. However these effects are far less important than the effects of time of shearing.

Fibre breakage during processing is a major cause of problems in processing. While staple unsoundness and cotting create other problems in processing the most important effect of these faults is that they lead to a high proportion of broken and hence short fibres in the wool coming off the card. These short fibres can create a variety of problems depending on the processing systems used and the type of end product.

The basic causes of break, tenderness and cotting are similar. They result from a temporary reduction in the growth rate of the wool fibres, this in turn being associated with a thinning and the shedding of some fibres from the follicles. The fleece can become cotted as a result of the shed fibres migrating through the fleece becoming entangled with the other fibres. This migration results from the felting behaviour of the wool fibres and this seems to be promoted by frequent wetting and drying of the fleece.

Some fleeces become cotted after fibre shredding has taken place but others, while lacking tensile strength, are relatively open and free. The factors which determine whether a fleece becomes cotted after fibre shedding has taken place have not been thoroughly established. Henderson (1955) has shown that fleeces which are coarser in quality number show the highest level of cotting while those that are finest in quality number tend to be more unsound. It may be that the higher crimp frequently of the finer quality wools inhibits the felting that results in cotting.

There are three main factors that lead to the thinning and shedding of fibres which are the causes of unsoundness and are the primary cause of cotting

(a) Winter reduction in wool growth
(b) Pregnancy
(c) Poor nutrition

Some sheep will produce a tender or cotted fleece solely as a result of the winter trough in their inherent seasonal cycle of wool growth but usually two or more factors act together. The so-called lambing break is usually the result of all three factors. The reduction in growth rate of the fibres occurs well before lambing but the thinning only becomes obvious as the fibres start to grow out of the follicle after lambing. Sudden changes in diet can produce severe break both during winter and at other times of the year. In a recent trial pregnant ewes wintered on swedes had thin regions in their wool fibres coinciding with both their entry to and exit from the crop (Horton 1978).

There is no ready solution to these problems. Selection can probably alleviate the winter reduction in wool growth. Recent evidence suggests that susceptibility to cotting is reasonably heritable and that selection for fleece weight will produce sheep that are more resistant to both unsoundness and cotting (Chopra 1978). Improving winter nutrition to the level that will alleviate unsoundness and cotting is likely to be uneconomic for the farmer. Pre-lamb shearing is one solution but this cannot be recommended unless plenty of feed is available at the time of shearing. Shearing ewes as soon as possible after lambing will also alleviate the problems but most farmers are unwilling to try this.

Parasitism is involved in unsoundness and cotting at times and Barger and Southcott's (1975) results suggest that the challenge of resistant sheep with Trichostrongylus larvae may being about a marked reduction in wool growth even though a population of adult worms is not established. If this effect is common to other nematode species then a build up in larvae on pasture may have a greater effect on unsoundness than has previously been supported.

Factors Affecting Wool Colour

White wool has the advantage that it can readily be dyed to any other colour. In New Zealand few sheep produce wool that has melanin pigmentation; most fibres are white when first produced. However while the fleece is on the sheep many fibres become discoloured; yellow discolouration is by far the most common.

A number of causes of yellow discolouration have been listed (Hoare 1968) but the relative importance of the various causes of yellowing has not been thoroughly established. Generally the yellow discolourations are most apparent in fleeces which carry a relatively high content of alkaline salts (secreted from the skin) and which have been continuously wet for three days or more, particularly in periods when temperatures have been relatively high.

The discolouration problem tends to become worse in the more northern areas of the country. This probably reflects the increasing humidity and temperatures. Also fleeces removed from the sheep prior to about late November tend to show less discolouration than those shorn in December and January although this varies greatly from year to year and when winters are warm and wet most fleeces will be yellow by early spring. Sheep grazing in very long pasture tend to produce badly discoloured wool probably due to transference of water from the pasture to the fleece and the belly wool tends to be most discoloured. Also cotted fleeces are usually discoloured as well and it is thought that this is due to slow drying of the entangled wool. It appears far more important that the fleece be fast drying rather than slow wetting to confer resistance.

The usual method of limiting discolouration is by manipulation of shearing times Early shearing (October and early November) will frequently result in better colour. Many farmers in the northern areas of the country have adopted second shearing partly as a method of improving colour. While the extra shearing costs money and shorter wool frequently fetches less than longer wool of the same style the improvement in colour often compensates for these other losses.

Recent evidence suggests that selection can be quite effective in producing sheep that are resistant to discolouration. The heritability of greasy colour is about 0.3 and it has a high genetic correlation with scoured colour. Probably this selection would have its effects through producing less alkaline and faster drying fleeces.

Other Quality Components

Bulk and medullation (hairiness) are of some interest to carpet manufacturers. Both these traits appear to be controlled largely by genetic factors. The hairy shaker syndrome (Durham *et al* 1976, Derbyshire and Barlow 1976) suggests the interesting prospect that if a viral strain could be produced that affected the wool follicles without producing the neurological disorders it might be possible to produce speciality-type carpet fleeces as a result of inoculation of ewes during pregnancy.

Fleece character, which depends mainly on clarity and uniformity of fibre crimp is a trait of some interest because farmers tend to place considerable emphasis on it in ram selection. However recent research indicates that it is not strongly inherited and is controlled by a variety of environmental factors including nutrition and internal and external parasites. A high clover component of the diet has been shown to have a beneficial effect while copper and zinc deficiencies are very detrimental.

Space will not permit coverage of other quality components some of which are thought to be important by farmers. However the main price-determining traits have been covered and the others do not appear to have much effect on prices paid at wool sales.

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