

PASTURES AND WOOL QUALITY

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INTRODUCTION

Wool quality may be defined as the various characteristics and defects in the fleece, both inherited and acquired, which influence its end use. Several major quality factors are influenced by pasture consumption or pasture conditions encountered by grazing sheep. They are (i) mean fibre diameter, (ii) fibre length, (iii) fibre strength, and (iv) vegetable matter contamination. Mean fibre diameter and the amount of vegetable matter contamination account for 80-90% of the variations in the price paid for clean merino wool (Whiteley, 1984). Factors (i)-(iii) are influenced by events during the process of fibre growth, whereas (iv) is an external effect. Before discussing these factors in wool quality it is necessary to outline some aspects of the process of wool growth. This is because fibre diameter and fibre length growth determine the amount of wool produced by a sheep, as well as its quality.

WOOL GROWTH**The Process of Wool Growth**

The amount of wool grown by a sheep over a defined period of time depends upon the number of wool follicles actually growing a fibre and the rate of growth of each fibre. Most merino sheep have in excess of 40 million wool follicles (Black and Reis 1979) and virtually all follicles are actively growing a fibre at any given time (Reis 1982). The number of wool follicles on a sheep is determined by its genotype and the nutritional environment before and soon after birth (Black and Reis 1979). The rate of wool growth in an adult sheep can vary over a four-fold range due to various physiological and environmental influences, the major factor being the supply of nutrients to the follicles (Reis, 1982). For example, a high-producing sheep could grow clean, dry wool at rates ranging from 4 g/day to 16 g/day; these rates maintained for a year would produce fleeces of about 1.5 and 6 kg respectively. The main nutritional determinant of wool growth is the amount and amino acid composition of the digestible protein reaching the small intestines (Reis, 1989). For grazing sheep, the peak rate of wool growth during the year is frequently two to three times the minimum rate due to variations in the quantity and quality of feed consumed (Robards, 1979).

The Relationship Between Length Growth Rate and Diameter of Wool Fibres

When the wool growth rate of an individual sheep is altered over a wide range by varying nutrition, the ratio of mean length of fibre grown per day (L) to mean fibre diameter (D) remains almost constant (Downes, 1971). There are, however, quite large variations in the ratio between sheep; L/D values ranging from 10 to 20 have been observed. It should be emphasized that L is fibre length, not staple length. Despite some suggestions to the contrary, Short (1964) showed that the relationship between staple length

and fibre length varied considerably between sheep. Consequently, staple length cannot be used as a reliable indicator of fibre length growth. It is possible to manipulate the L/D ratio by some experimental treatments in research laboratories, but, as suggested by Allden (1979), the ratio for individual sheep can be regarded as relatively constant under natural feeding conditions. This conclusion may need to be qualified for some environments because Purser (1981) found that the ratio appeared to vary over the year for sheep grazing mediterranean type pastures.

PASTURE COMPOSITION AND WOOL PRODUCTION

The subject of pasture composition and animal production, including wool production, was discussed by Dove (1988) at the previous meeting of this Society, and will not be considered in detail here. The main factors which influence the nutrients available to grazing sheep are quantity of feed available, stage of maturity of pastures and plant species. There have been relatively few studies to examine the value of a particular pasture species for wool growth. It has been shown that legumes, such as white clover (*Trifolium repens*) or subterranean clover (*T. subterraneum*), are superior to various grass species for promoting wool growth, due both to higher feed intake and increased post-ruminal supply of protein (Dove 1988). However, it may be unwise to draw general conclusions about clovers vs. grasses from the small number of species studied. For example, Weston and Hogan (1971) found no difference between three grass and two clover species in the amount of protein digested in the intestines per unit of digestible organic matter intake. Differences between various species of grasses in their value for wool growth appear to be small (Gallagher *et al.* 1966; Lloyd Davies and McCluskey 1982), although Axelsen and Morley (1968) found *Phalaris aquatica* superior to several other grasses.

Changing pasture conditions throughout the year result in variations in the nutrients available to wool follicles which produce changes in diameter along wool fibres and in the rate of length growth of fibres. The mean fibre diameter and mean fibre length of a fleece will thus be influenced by the pasture consumed with resultant effects on the quantity and quality of wool.

WOOL QUALITY

Fibre Diameter and Length

Fibre diameter is the most significant property of wool in relation to processing performance (Lipson 1972) and is a major determinant of the price paid for merino wool (Whiteley 1984). Fibre length is ranked second in importance to diameter in determining spinning performance (Lipson 1972). It influences fibre length in the top (hauteur), with lengths below about 60mm incurring a price penalty (Whiteley 1984). Thus, it is apparent that quantity and quality of wool produced cannot be separated because they are both determined by the same components. The mean fibre diameter of a bale of wool encompasses differences between individual fleeces, the variation between fibres on each sheep and variation along fibres. Variation in diameter along fibres may be exaggerated in pregnant and lactating ewes because the growing foetus and the mammary gland compete with the wool follicles for nutrients.

Because of the constancy of the L/D ratio within sheep it is possible to calculate the relative amount of wool grown from mean fibre diameter.

Figure 1 shows that the relative output of wool would increase almost three-fold if mean fibre diameter increased from 19 to 27 μm . This relationship is not influenced by the value of the L/D ratio for a particular sheep. The total amount of wool produced by the same group of sheep will vary from year to year due to differences in the nutrients supplied by the pasture. Consequently, mean fibre diameter will also vary from year to year. By taking account of changes in the price paid for wool as fibre diameter varies, and estimating the output of wool from fibre diameter, it is possible to calculate the relative value of wool grown by a group of sheep as fibre diameter varies. Examples of these calculations are shown in Fig. 2 using average values for combing wools during the year covering the range 19-27 μm , as recorded in the Australian Wool Sale Statistics (Australian Wool Corporation).

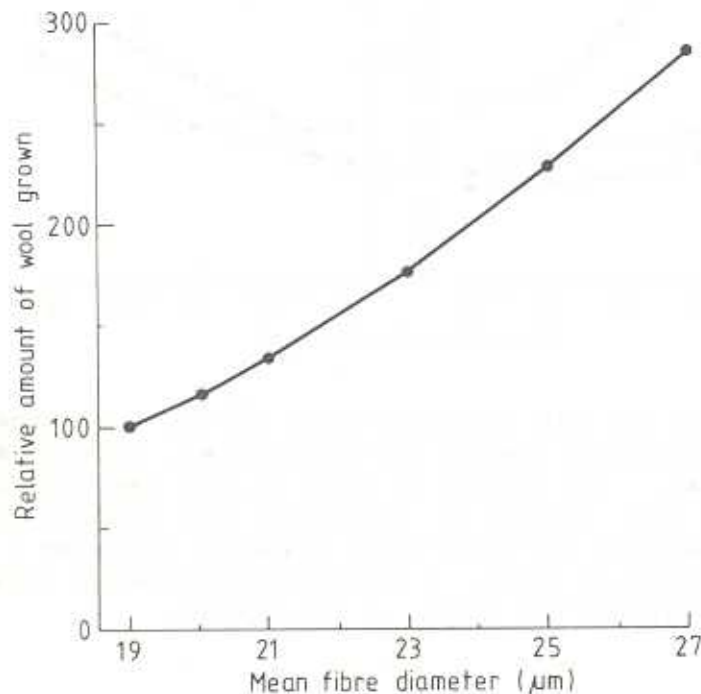


Figure 1. Relative amount of wool grown (calculated from fibre diameter) as fibre diameter increases. (Taking 19 μm = 100).

The price of wool decreases as fibre diameter increases (Fig. 2a), but, commencing in 1987/88 a much greater premium is being paid for finer wools (below about 23 μm). Because about 75% of wool sold falls in the categories 23 μm or finer, this change is of great significance. Prices of merino combing fleeces in 1987/88 indicate the same trend for finer wools, e.g. best top-making 17.5 - 17.9 μm (3173 cents/kg) vs. 18.6 - 19.5 μm (2147 cents/kg). Prices available to date for 1988/89 indicate that the 1987/88 price structure is being maintained but future trends are, of course, unknown. When translated into relative value of wool grown (Fig. 2b), increased wool growth per sheep, and hence fibre diameter, was profitable on 1979/80 and 1983/84 prices. However, the 1987/88 price structure means that as extra wool was grown by a sheep the return to the grower actually dropped (Fig. 2b).

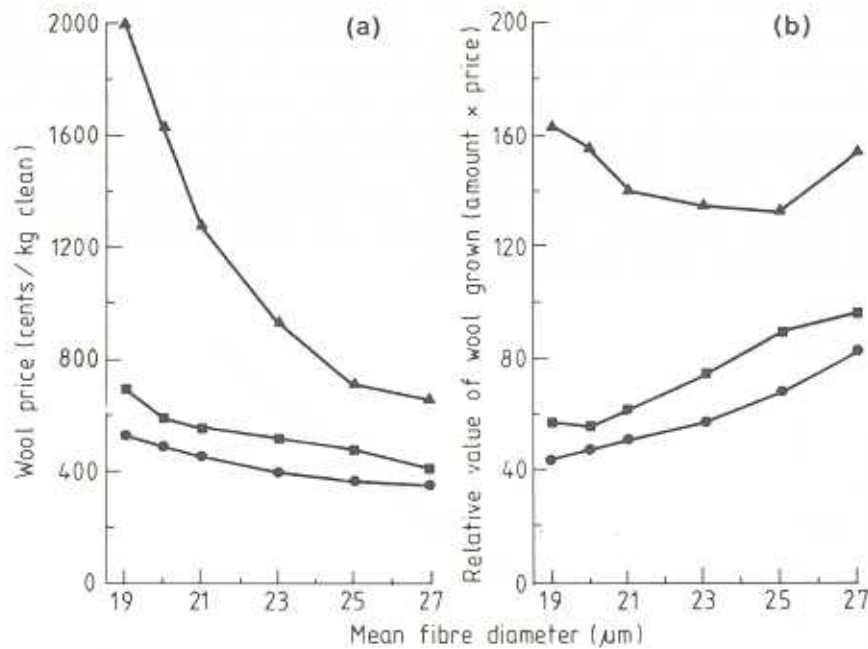


Figure 2. Wool prices (a) and relative value of the wool grown (b) for merino combing fleeces for 1979/80 (●), 1983/84 (■) and 1987/88 (▲). The amount of wool in (b) was obtained by regarding wool fibres as cylinders and calculating the volume grown per day from fibre diameter, assuming a value of 15 for the L/D ratio. A different value would alter the position, but not the shape, of the curves.

Fibre Strength

Fibre strength is closely related to diameter, with weakness being associated with thinner regions of fibres due to the effects of poor nutrition, pregnancy, lactation or disease. Fibres with uniform diameter are usually of normal strength regardless of mean diameter; weakness is frequently associated with a rapid change in fibre diameter due to a sudden change in feed supply (Butcher *et al.* 1984; Hansford and Kennedy 1988). During processing, weak regions in a staple cause breakage which reduces fibre length in the top. If this weakness occurs in the middle regions of the staple there can be a dramatic reduction in fibre length in the top, with a resultant price penalty. A weakness near either end of the fibre is of less significance.

In some situations there can be a large reduction in the intrinsic strength of fibres due to a specific nutrient deficiency. The most notable examples are due to deficiencies of the trace elements copper and zinc, and possibly selenium (Reis 1989). Such deficiencies are not likely to be of widespread significance for grazing sheep, although isolated local problems may exist.

Vegetable Matter Contamination

The presence of vegetable matter adds to processing costs by increasing fibre breakage during processing, thus reducing length in the top. The extent and type of vegetable matter contamination varies considerably in different regions. The amount is generally more important than the type of vegetable matter in influencing the price paid for wool. However, type can also be relevant with grass seeds usually being more difficult to remove than burrs. Contamination of the fleece with burr (e.g. trefoil) only becomes a problem when it exceeds about 3% (Ralph 1984).

PASTURE MANAGEMENT STRATEGIES

What strategies of pasture management are open to the grazier to maximize profits from wool production? If the current price differential for finer wools is maintained, it would obviously be desirable to restrict pasture intake during periods of plentiful feed supply, especially if the wool grown is usually 23µm diameter or finer. A subjective judgement would have to be made by the grazier based on condition of the sheep and an assessment of the feed available. Extended periods of high feed availability should be avoided. For example, if wool growth was increased appreciably over a period of 3 months with a resultant increase of 4µm in fibre diameter, the average effect for the year would be an increase of 1µm in mean fibre diameter. The simplest strategy to adopt would be to adjust stocking rate, but this may not always be feasible within the overall programme of pasture management. Other strategies would be to restrict access to legume-rich pastures when feed supply is plentiful and to utilize any standing feed of poorer quality. Surplus pasture could be conserved as hay or silage where possible.

Grazing management should also attempt to avoid sudden or severe changes of feed supply which could cause fibre weakness. This is especially important for pregnant or lactating ewes. The overall strategy should be to not overfeed sheep and hence increase fibre diameter markedly, and to minimize periods of poor nutrition, especially those due to sudden changes in feed. The grazier may have little latitude to reduce the problem of vegetable matter contamination, but grazing management that avoids the use of pastures containing significant amounts of grasses such as barley grass (*Hordeum leporinum*) or spear grass (*Stipa* sp., *Heteropogon* sp.) during seeding could be financially rewarding.

CONCLUSION

Mean diameter and length of wool fibres are major determinants of the amount of wool grown and of its quality. These components of wool growth vary continuously in grazing sheep due to changes in the nutrients provided by pastures. The price paid for wool declines as fibre diameter increases. Currently this price differential is very steep with increasing diameter up to about 23µm, such that it is unprofitable to grow more wool per sheep because fibre diameter would automatically be increased. Grazing management should therefore aim to minimize fibre diameter increases by restricting feed intake, while avoiding severe restrictions and sudden changes in feed supply which could cause fibre weakness. The long-term aim of research should be to understand the process of fibre production in the wool follicle in more detail with the aim of maximizing length growth relative to diameter as the rate of fibre production changes.

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