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Wool staple strength

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By I. G. Ralph, Research Officer, Sheep and Wool Branch

The staple strength of Western Australia’s wool has come under scrutiny since additional wool measurements to those of yield, fibre diameter and vegetable matter began throughout the Australian 1985-86 wool selling season.

In 1980, the Sale by Additional Measurement Trial conducted on the September-October wool sales at Fremantle showed a range in staple breaking forces from 10 to 70 Newtons per kilotex, with an average breaking force of between 30 and 35 N/ktex. A third of the lots offered for sale had a staple breaking force of less than 26 N/ktex, a value which, according to the Australian Wool Testing Authority, marks the level of strength below which wool buyers in the past began imposing a price discount for poor staple strength.

Based on the 1986-87 price discounts which are included in the Australian Wool Corporation Minimum Reserve Price Schedule, this third of the Western Australian wool clip could have incurred a price penalty of 24¢/kg clean or more. The normal annual loss of revenue to the State’s wool producers incurred by low wool staple strength is likely to be at least $2 million.
Without measurement, wool is assessed as “sound” or “tender” depending on whether or not the wool staples selected can be relatively easily broken by hand. Translating this into the current terms of measurement for staple strength, it has been found that wool classifiers exert a force of about 30 Newtons (about three kilograms) on a staple when they apply the traditional test for tenderness, and that they commonly select a staple size of about two kilotex (a 100 mm long staple weighing 0.2 g or one about as thick as a pencil). Thus, by calculation, wool is classed as being tender when it has a staple breaking force of 15 N/ktex (30 / 2) or less. The wool buyer then assesses the amount of price discount which will apply according to his estimation of the proportion of tender fleeces in the lot.

However currently with a measurement for staple breaking force, the Australian Wool Corporation applies a discount for reduced staple strength on a sliding scale from about 30 N/ktex downwards. This discount for 22 micron wool ranges from 24/kg clean at 32 N/ktex to 96/kg clean at a staple strength of 7 N/ktex. It has also been reported that at least one wool buyer in Western Australia is paying a premium for staple strength on a scale above 40 N/ktex.

Therefore, in the future, wool growers who produce wool of superior strength have the possibility of gaining financial benefits from this quality product over and above that obtained by just avoiding tender wool.

**Measured staple strength**

The staple strength is derived by a measure of the maximum pulling force (in Newtons) required to break the staple divided by the staple size or thickness (in kilotex which is a measure of the weight of staple per unit length). Staple strength can vary from zero to 90 N/ktex.

Normally wool fibres have the same intrinsic strength. Variations in the measured staple breaking force, therefore, occur through changes in the fibre diameter along the staple’s length. The greater the variation, the lower the strength. The position in the fibre of this thin weak portion determines whether or not the wool has low staple strength or is tender. If the thin portion is in the central region then the wool has a high chance of being classed as tender; if it is at either end, the wool has little chance of being classed tender.

Changes to fibre diameter are caused by variations in the rate of wool growth as a result of nutritional stress or poor health throughout the year. In the State’s...
agricultural areas, wool growth rate is lowest in autumn when paddock feed has dried off. It is the ratio of this autumn growth rate to the average for the year which determines the measured staple breaking force. Several conditions can influence the measured staple breaking force.

Time of shearing

Time of shearing does not affect the strength of wool but it does control the position where staple breakage occurs and hence mean fibre length in the top.

The top is one of the early wool processing products after greasy wool has been scoured and combed. The top is a continuous untwisted strand of combed wool in which the wool fibres lie parallel to one another. It is the raw material for worsted wool products. The short or wasty fibres that are removed by combing are known as noil.

Wool buyers and manufacturers, therefore, pay a lower price for wool of low staple strength because of the lower average fibre length in the top, greater variation in fibre length, a higher percentage of noil and greater combing cost. Even if the wool is not classed as tender, the presence of a thin or weak portion in the centre of the fibre impairs manufacturing performance.

If the region of low wool production (thinner fibres) along the staple is bisected by shearing then the measured staple breaking force may be higher than that which would have been obtained from another time of shearing.

Regardless of the effect of time of shearing on measured staple breaking force, research by the Department of Agriculture in conjunction with the CSIRO Division of Textile Industry has shown that wool shorn in autumn, when processed, produced a much longer fibre length in the top than that from wool shorn in spring (Table 1). This is because autumn shearing results in the thinnest part of the fibre being at the end of the staple. This results in a considerable increase in the value of the wool to buyers and processors.

However, autumn shearing generally increases the amount of vegetable matter in the wool, the amount and type depending on stocking rate, season and district. In the time-of-shearing experiment at Mt Barker (Table 1), sheep shorn in autumn had a whole clip average vegetable matter content of up to 4 per cent, while the spring-shorn wool had an average vegetable matter content of 1 per cent or less.

This means that although autumn shearing produced a far superior fibre length to spring shearing, the increased vegetable matter content caused an even greater problem than short fibre length in the top. In the 1986-87 Australian Wool Corporation Minimum Reserve Price Schedule, a 4 per cent vegetable matter contamination if shive (i.e. seeds of barley grass, spear grass and silver grass), which can become parallel to the wool fibre in combing, carries a penalty of about 49¢/kg clean.

Ewe nutrition

In 1982 the Department of Agriculture started investigating the influence of feeding supplements in autumn on the wool growth of lambing ewes.

Researchers believed that the problem of low staple strength in Western Australian wools was likely to increase because of an increase in the proportion of autumn lambing ewes within the State flock, and the poorer pastures resulting from an increased proportion of the farm being sown to cereals.

They considered that wool growth was largely determined by the nutritional status of the animal and in the field the main limitation to this growth was likely to be the level of metabolisable energy. However it was known that if protein could be passed through the rumen undergraded then, within the range of 20 to 80 g of protein per day, wool growth increased at the rate of about one gram more for each 10 g increase of protein. Lupin seed could be used as a supplementary supply of protein by-passing the rumen, with some 35 per cent of the protein passing through the rumen undegraded in comparison with barley grain in which about 10 per cent of the protein remains undegraded. Therefore it was thought that while cereal grain supplements fed in autumn should stimulate wool growth and thus increase staple strength, the addition of lupin seed might promote wool growth even further.

Table 1. Effect of time of shearing on mean fibre length in the top of wool from wethers at Mt Barker

<table>
<thead>
<tr>
<th>Shearing date</th>
<th>Fibre length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971 April 14</td>
<td>84</td>
</tr>
<tr>
<td>June 5</td>
<td>79</td>
</tr>
<tr>
<td>July 27</td>
<td>73</td>
</tr>
<tr>
<td>September 17</td>
<td>65</td>
</tr>
<tr>
<td>November 11</td>
<td>66</td>
</tr>
<tr>
<td>1972 February 21</td>
<td>82</td>
</tr>
</tbody>
</table>

A 2 mm snippet of wool is cut from within each dye band and measured in a Fibre Distribution Analyser.

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Graphs and results from the Fibre Distribution Analyser appear on a VDU screen.

Wool fibres, as seen under an electron microscope.

**Cereal stubbles plus supplements**

At Newdegate Research Station ewes were mated to lamb over a ten-day period starting mid-March in 1983 and 1984. Supplements with similar metabolisable energy content but different protein levels in the form of 500 g oats, 480 g oats/lupins (70:30) and 450 g lupins per head per day were fed to the ewes eight weeks before lambing until 12 weeks after lambing.

Supplementary feed and the inclusion of lupin seed did not influence wool growth during pregnancy. The addition of lupin seed increased wool growth during lactation and this increased wool growth resulted in a stronger staple (Table 2).

Although feeding lupin seed improved wool growth and increased staple breaking force, feed costs were not recouped by the value of the extra wool produced and its improved strength.

**Pastures plus supplement**

The trial at Mt Barker Research Station investigated interactions between supplementary feeding during pregnancy and during lactation, as well as production feeding during lactation on improved wool growth.

Ewes were mated to lamb during a confined period starting mid-April. Pre-lambing supplements fed were: 500 g oats per head per day, 430 g oats/lupins (50:50) per head per day or a 50:50 mixture of oats/lupins freely available. One third of each group of ewes was subsequently fed one of these post-lambing supplements: 500 g oats per head per day, oats *ad libitum* or a 50:50 mixture of oats and lupins *ad libitum*, a total of nine feeding treatments.

There was no added effect of the pre-lambing feeding on changes to wool growth to the post-lambing supplements, and it appeared that the wool growth response to supplementation was greater in lactation than during pregnancy.

Feeding supplements increased staple strength, but the experimental design did not allow us to associate the change in staple strength with a level of feeding (Table 3).

**Further research**

Feeding supplements to pregnant and lactating ewes in autumn can increase wool staple strength. However, short-term fluctuations in fibre diameter during the feeding period may negate this benefit.

Information is also needed on the amount of feed required to elicit a given response in wool production, and the effect of this increased autumn wool production on the staple breaking force. Research has started at Mt Barker Research Station to test the response of wool growth of ewes fed at various levels during pregnancy and lactation as compared with that of unmated ewes.

Feeding levels have been chosen according to the requirements of dry, pregnant and lactating ewes to generate a range of liveweight change from a steady loss to a steady gain throughout the trial.

Short term wool growth is being monitored by measuring periodic fibre diameters with a Fibre Fineness Distribution Analyser at specified points along the staple. These points are associated with specific dates by laying skin level bands of dye in the mid-side wool of each ewe. These variations in fibre diameter will be compared with measured staple breaking force.

The outcome of this research should allow us to define the best feeding strategies for autumn lambing ewes and to determine the costs and benefits of feeding lambing ewes for wool production.

<table>
<thead>
<tr>
<th>Supplement</th>
<th>Staple breaking force (N/ktex)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1983</td>
</tr>
<tr>
<td>No supplement</td>
<td>17</td>
</tr>
<tr>
<td>500 g oats per head per day</td>
<td>20</td>
</tr>
<tr>
<td><em>ad libitum</em> oats/lupins</td>
<td>29</td>
</tr>
</tbody>
</table>

Table 3. Effect of feeding during pregnancy and lactation on measured staple breaking force

**Table 2. The staple breaking force of wool from March lambing ewes grazing cereal stubble and fed grain supplements**

<table>
<thead>
<tr>
<th></th>
<th>Staple breaking force (N/ktex)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1983</td>
</tr>
<tr>
<td>Oats</td>
<td>25</td>
</tr>
<tr>
<td>Oats/lupins (70:30)</td>
<td>30</td>
</tr>
<tr>
<td>Lupins</td>
<td>27</td>
</tr>
</tbody>
</table>

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