THE EFFECT OF PLANE OF NUTRITION ON CRIMP FREQUENCY AND FIBRE DIMENSIONS IN MEDIUM-WOOLED MERINO SHEEP

H. IRAZOQUI* and M. K. HILL*

Summary
Sixteen medium-wooled Merino wethers similar in body-weight, fibre diameter, staple crimp frequency and wool growth rate were randomised into four groups and individually fed indoors at different rates for a period of 11 months.

Wool growth rate, fibre diameter, fibre length, staple length and staple crimp frequency were each significantly affected by plane of nutrition which suggests that wool quality number, judged objectively or subjectively, would be decreased by an elevation in level of feeding.

The data also support the hypothesis that crimp formation is a periodic function of time.

I. INTRODUCTION

The relationship between level of feeding and subjectively assessed wool quality-number has remained a vexed question. The early studies of Ross et al. (1937) and Dumaresq (1938) demonstrated slight reductions in quality-number, but substantial improvements in fleece weight, when fine-wooled Merino grazed "improved" pastures. These observations were supported by the more recent studies of Roberts and Dunlop (1957) who concluded that staple crimp frequency (an important determinant of subjectively-assessed quality-number) was unaffected by variation in nutrition.

These conclusions, however, cannot be satisfactorily reconciled with those of Norris and Van Rensburg (1930) who held that crimp formation was a periodic function of time. Factors capable of increasing staple length might, therefore, be capable of reducing quality-number. This concept is indirectly supported by the flock analyses of Henderson (1953) who reported significant negative phenotypic correlations between fleece weight and quality number within a large number of individual flocks of various breeds of sheep.

It is, therefore, possible that in areas of Merino wool production, pasture improvement programmes could lead to greater financial gains through increased stocking rates, rather than through increased production per head.

* Department of Livestock Husbandry, University of New England, Armidale, New South Wales.
The object of the present study was to ascertain the effects of gross differences in plane of nutrition on staple crimp frequency and fibre dimensions in a group of medium-wooled Merino wethers.

II. MATERIALS AND METHODS

(a) Animals and Rations

Thirty newly shorn, 1½ year-old, medium-wooled Merino wethers were selected from a larger mob on the basis of similarity in bodyweight, staple crimp frequency and fibre diameter. Each was then tattooed on the right and left mid-side positions with a square, approximately 100 cm² in area, placed in a pen and fed a constant ration for a period of eight weeks. At the conclusion of the preliminary period, wool was harvested from within the patches by means of "oster" clippers fitted with a size 40 cutter. Sixteen animals with similar levels of wool growth were then chosen for the experiment. Group mean values for staple crimp frequency and fibre diameter were 4.25 crimps per cm and 20.0 μm, respectively.

The 16 animals were randomised into four groups and were subsequently individually fed lucerne chaff for a period of 11 months. The feeding levels of the four groups were 0.68, 0.90, 1.13 and 1.36 kg/head/day.

(b) Measurement of wool growth rate

At four-week intervals, wool was harvested from within the right mid-side tattoo in the manner described above and clean, dry, wool growth rate was determined by the procedure described by Hill, Watson and McClymont (1968). Wool growth in the first three months of the experimental period was not included in the final analysis since this period was considered necessary for equilibration between food intake and wool growth-rate.

(c) Measurement of fibre dimensions and crimp frequency

Fibre dimensions were measured by methods described below in a Metrology laboratory in which temperature and humidity were standardised.

Mean fibre diameter was determined by an air-flow procedure (Wool Sci. Rev. 1960) using the clean, dry samples obtained at monthly intervals from the right mid-side patches.

At intervals of two to three months, wool was harvested from the left mid-side patch on each animal and these samples were used for measurements of crimp frequency and fibre and staple length.

Measurements of staple length and staple crimp frequency were made on newly-clipped samples using a black velvet board and a white rule.

Fibre length was estimated by a gravimetric procedure. After scouring and drying, wool samples were conditioned overnight in a force-draught oven at ambient temperature (i.e. heating elements turned off). Staples of approximately 40 mg were accurately weighed (to within 0.5 mg) and the number of constituent fibres counted manually. Straight fibre length was derived as follows:

\[ W = \frac{\pi d^2 \times L \times N \times S}{4} \]

\[ L = \frac{KW}{d^2N} \]
where $L = \text{fibre length (mm)}$; $N = \text{number of fibres in staple}$; $S = \text{density (1.31 mg/mm}^3)$; $W = \text{staple weight (mg)}$; $d = \text{fibre diameter (microns)}$; $K = \text{constant (971.936)}$.

**Statistical analyses**

The effect of plane of nutrition on each parameter was evaluated by regression and correlation analyses and, when appropriate, by analysis of variance and Duncan’s Multiple Range Test. Data collected during the first three months of the experimental period were excluded from the analyses.

### III. RESULTS

During the final eight months of the experimental period, wool growth rate, fibre diameter, fibre length, staple length and crimp frequency were each significantly affected by plane of nutrition (Table 1).

The only parameter not significantly affected by plane of nutrition was total number of crimps per staple, though there was a trend for an increase in crimp number with increased plane of nutrition.

It may be noted that in relative terms (group 1 = 100), fibre diameter and staple length responded about equally to increased levels of feeding ($r = 0.90$ and 0.92) but, since fibre weight is proportional to fibre cross-sectional area, the response in diameter was quantitatively much more important than the response in staple length.

### IV. DISCUSSION

In the present study, plane of nutrition was found to have a slight but significant effect on staple crimp frequency. The highest level of feeding was twice that of the lowest and a very similar ratio was observed in wool growth rate, but these groups differed by only 20 per cent in crimp frequency.

Judged on crimp frequency alone, wool from animals on the lowest plane of nutrition could have been regarded as of 64’s quality and that from animals on the highest plane of nutrition, of perhaps 58’s (Lang 1961). If evaluated on the basis of fibre diameter, however, wool samples from the two extreme groups could be expected to approximate 74’s and 60’s quality respectively.

Present results thus tend to confirm the earlier observations of Ross et al. (1937), Dumaresq (1938) and Roberts and Dunlop (1957) that crimp frequency is moderately insensitive to variation in plane of nutrition.

In the present study, nearly two-thirds of the nutritionally-induced variation in wool growth rate came from an alteration in fibre cross-sectional area, the remainder coming from staple length. The relatively slight increments in fibre length with increased levels of feeding could not, therefore, be expected to induce notable changes in crimp frequency.

Though relatively slight, the reduction in crimp frequency which accompanied increased fibre length growth is in accord with the original hypothesis of Norris and Van Rensburg (1930) that crimp formation was a periodic function of time. As shown in Table 1, the total number of crimps was found to be relatively constant. Plane of nutrition was not significantly related to this parameter though crimp number appeared to increase with increasing levels of nutrition.
TABLE 1

Effect of plane of nutrition on wool production of medium-wooled Merino sheep

<table>
<thead>
<tr>
<th>Group</th>
<th>Intake</th>
<th>Wool Production†</th>
<th>Fibre Diam.†</th>
<th>Fibre Length†</th>
<th>Staple Length†</th>
<th>Crimp Frequency†</th>
<th>Total Crimps</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kg/day</td>
<td>mg/patch/day</td>
<td>Microns</td>
<td>mm</td>
<td>mm</td>
<td>crimps/inch</td>
<td>± S.E.</td>
</tr>
<tr>
<td>1</td>
<td>0.68</td>
<td>96.7 ± 4.2</td>
<td>17.6 ± 3.0</td>
<td>67 ± 8.8</td>
<td>49 ± 5.8</td>
<td>11.6 ± 1.9</td>
<td>23.0* ± 2.2</td>
</tr>
<tr>
<td>2</td>
<td>0.90</td>
<td>136.5 ± 4.2</td>
<td>20.0 ± 2.9</td>
<td>76 ± 8.8</td>
<td>55 ± 5.7</td>
<td>10.8 ± 1.9</td>
<td>23.9* ± 1.7</td>
</tr>
<tr>
<td>3</td>
<td>1.13</td>
<td>166.6 ± 4.2</td>
<td>21.6 ± 2.9</td>
<td>86 ± 8.8</td>
<td>61 ± 5.7</td>
<td>10.1 ± 1.9</td>
<td>25.5* ± 1.7</td>
</tr>
<tr>
<td>4</td>
<td>1.36</td>
<td>186.9 ± 4.2</td>
<td>22.6 ± 3.0</td>
<td>95 ± 8.8</td>
<td>67 ± 5.8</td>
<td>9.3 ± 1.9</td>
<td>24.0* ± 1.4</td>
</tr>
</tbody>
</table>

Correlation with intake:

- $r = 0.93^{*}$
- $r = 0.81^{*}$
- $r = 0.90^{**}$
- $r = 0.92^{**}$
- $r = -0.71^{*}$
- $r = 0.32$ n.s.

† Values estimated from regression of parameter on intake ± S.E. of estimate.

** P<0.01.

* Means for total crimps with common letter are not significantly different.
It was concluded that an increase in level of feeding is likely to adversely affect wool quality number, particularly when the latter is determined objectively. Pasture improvement programmes should thus be associated with policies aimed at increasing stocking rates, maintaining production per head within acceptable limits.

V. REFERENCES


