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Effect of nutrition on fine wool production in Merino wethers

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ABSTRACT

The potential to reduce fibre diameter of wool from Merino sheep using feeds that are readily available and cheaply produced in New Zealand was investigated. Two hundred and twenty fine wool two year old and mature Merino wethers were allocated to four feeding treatments for 12 months. The four feeding treatments were 1) silage, 2) silage and grass, 3) grass allocated three times per week, and 4) grass allocated once per week. Monthly liveweight, wool growth rate and fibre characteristics were measured. At the trial conclusion annual fleece production was determined and wool samples from each treatment group combined for line analysis.

Liveweights fluctuated over the trial period indicating the difficulty of controlling feed intake accurately under pasture conditions. Wethers on the silage treatment had significantly lower fleece weights (2.4 kg) and finer fibre diameter (17.0 ± 0.2 and $17.6 \pm 0.3 \mu$ for 2 year old and mature wethers respectively) than other treatments (3.2 kg, 17.6 ± 0.2 and $18.6 \pm 0.3 \mu$ for 2 year old and mature wethers respectively). Staple strength ranged from 17 to 36 N/ktex, with weakest wool from the silage treatments. Bulk values were low, ranging from 24.0 to 27.3 cm³/g.

Wool was processed by a Japanese company for super high grade men's clothing fabric. The treatment groups were processed separately and evaluated at all stages from greasy wool to fabric. Little difference was found between the treatments except for the wool from the young silage treatment which had a superior fabric handle but was inferior at other processing stages.

Keywords: Merino; nutrition; fibre growth; liveweight; processing performance.

INTRODUCTION

Premiums for fine wool, with fibre diameter of 21 microns and under, are well established in the wool industry. Wool under 19 microns attracts premiums which increase exponentially with reductions in fibre diameter. Demand for fine wool increased in the mid-1980's, due to fashion and increased promotion, with a peak in 1988/89 (Wool Report, 1993). Although wool returns have dropped considerably in recent years premiums for fine wool still exist.

It is possible to manipulate fibre diameter in the sheep through environmental factors, such as nutrition. Underfeeding of sheep reduces wool growth, with concomitant reductions in both fibre length and diameter. A previous trial investigating the production of superfine wool (Litherland *et al.*, 1990) found that fibre diameter could be reduced significantly without affecting wool quality by maintenance feeding. However labour, housing and concentrate feed costs meant that indoor feeding was not economic. This trial investigated the potential to reduce fibre diameter of wool from Merino sheep using feeds that are readily available and cheaply produced in New Zealand.

MATERIALS AND METHODS

The trial was undertaken at the Levin Horticultural Research Centre (latitude 40° 16' S, longitude 175° 16' E). After shearing in August 1989, 220 two-year-old and mature Merino wethers were randomly allocated to four feeding treatments: 1) silage, 2) silage and grass, 3) grass - allocated 3 times per week, and 4) grass allocated once per week. The wethers in treatment one were penned, in two pens according

to age, and silage was fed daily. The other treatments were break fed on pasture, with silage being given daily on the break in treatment two. Breaks were allocated three times per week for treatments two and three and once per week for treatment four. Feeding levels were designed to provide maintenance intake. Young and mature wethers were run separately. Wethers were weighed fortnightly and adjustments made to feeding levels.

From November, after an initial adjustment period, midside patches, approximately 15 cm x 15 cm, were clipped every 4 weeks. Wool growth rate on the patch area (mg/cm²/day) was calculated. Fibre length was measured on midside samples after clipping. Samples were alcohol scoured and yield calculated from the ratio of clean to greasy wool. Fibre diameter was measured by projection microscope on 400 fibres from the scoured sample.

At the conclusion of the trial, August 1990, all wethers were shorn. Fleeces were weighed, skirted and reweighed. Individual fleeces were sampled and yield and fibre diameter tested. Samples were also obtained for each treatment and age group and tested for bulk, colour, length and strength. The wool was processed in treatment lines by a wool textile company, Nippon Keori Kaisha Ltd, Osaka, Japan, and evaluated for suitability for super high grade men's clothing fabric. The eight groups of wool were inspected and processes of scouring, combing, spinning, dyeing, weaving and final finishing were performed to each group under the same conditions. The performance of each line was measured during processing.

Liveweight and wool growth data was analyzed using generalised linear models (SAS, 1985). A repeated measures analysis of variance was carried out on liveweight and wool

TABLE 1: Liveweight, fleece weight and fleece characteristics at shearing for each treatment and age group.

	Age								SE
	Young				Mature				
	Treatment				Treatment				
	Silage	Silage & grass	Grass 3x	Grass 1x	Silage	Silage & grass	Grass 3x	Grass 1x	
Liveweight (kg)									
Aug 89	33.9	32.3	35.4	35.2	44.7	44.2	44.1	44.5	0.9
Aug 90	30.7	31.3	30.9	31.4	35.7	36.8	35.8	34.4	0.9
Fleece weight (kg)	2.3	3.1	3.1	3.4	2.6	3.3	3.3	3.1	0.1
Yield (%)	75.4	74.8	75.2	73.9	74.0	71.0	72.8	72.1	1.5
Fibre diameter (μ)	16.6	17.7	17.7	17.6	17.8	18.7	18.1	17.9	0.3
Staple length (mm)	71	83	83	79	63	65	78	74	2
Staple strength (N/ktex)	17	28	32	33	24	36	34	36	-
Bulk (cm^3/g)	26.3	24.0	27.3	24.2	24.7	25.3	26.3	24.2	-
Colour									
Brightness (Y)	67.5	67.5	68.0	67.0	66.0	67.5	68.0	68.0	-
Yellowness (Y-Z)	-0.5	-0.5	0.5	0.0	-0.5	-0.5	-0.5	-0.5	-

characteristics. Line tests and processing evaluation results are presented and discussed.

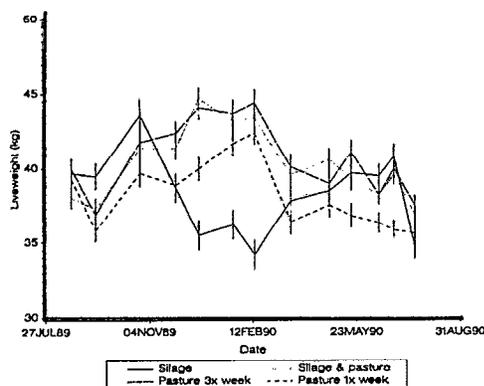
RESULTS

Liveweight, fibre growth and fibre diameter profiles for each treatment are presented in Figures 1, 2 and 3. Mean liveweight, greasy fleece weights and fibre characteristics at shearing for each treatment and age group are summarised in Table 1. There were no significant interactions ($P < 0.05$) between age and treatment.

Liveweight

Liveweight decreased over the trial period for both age groups and all treatments (Figure 1), indicating that the animals were underfed, with below maintenance feed intakes. Liveweight profiles were similar for young and mature wethers, although mature wethers were significantly ($P < 0.05$) heavier than young wethers by 8 - 9 kg.

FIGURE 1: Liveweight for Merino wethers on each feeding treatment over the trial period.



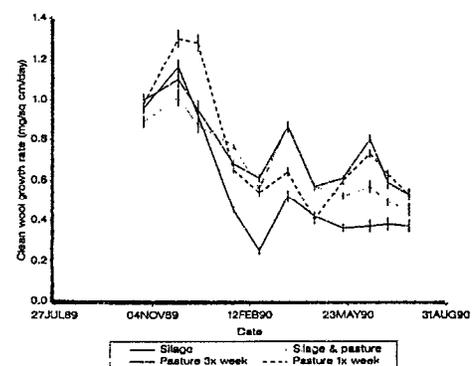
Wethers on the silage and pasture treatment were significantly ($P < 0.05$) lighter than wethers on the pasture only treatments for most trial periods. Wethers on the silage treatment had the greatest liveweight variation. In the middle of the trial, wethers on the silage treatment had a large loss in liveweight and were significantly ($P < 0.05$) lighter than the

other treatments, however this was reversed over the last third of the trial.

Fibre measurements

Young wethers had higher wool growth rates than the mature wethers, although differences were not significant at all sample dates. Wethers on silage feeding treatment had the lowest wool growth rates ($P < 0.001$), the other treatments were variable with none consistently higher (Figure 2). Fleece weights at shearing reflected wool growth rate trends (Table 1), wethers on the silage treatment had significantly ($P < 0.05$) lower fleece weights (mean = 2.5 kg), with no significant differences between the other treatments (mean = 3.2 kg).

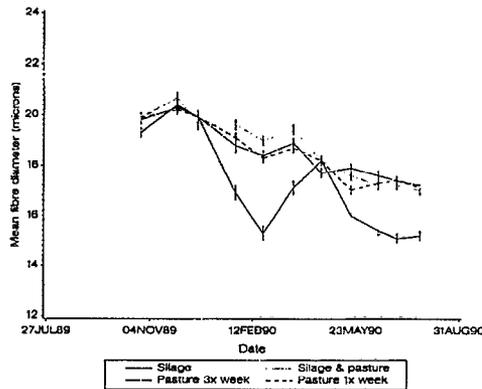
FIGURE 2: Clean wool growth rate for Merino wethers on each feeding treatment over the trial period.



Fibre diameter of wool from the silage treatments was significantly ($P < 0.05$) finer than the other treatments for most trial periods (Figure 3) and at shearing (Table 1). There were no consistent differences in fibre diameter between the other treatments. The effect of liveweight on wool growth and diameter was investigated using liveweight as a covariate, however liveweight and liveweight change effects were non-significant ($P < 0.05$).

Treatment had a significant ($P < 0.001$) effect on staple length growth rate and staple length at shearing (Table 1). Staple length of wool from wethers on the silage treatment was 10 mm shorter on average than other treatments. Age

FIGURE 3: Mean fibre diameter for Merino wethers on each feeding treatment over the trial period.



was also significant ($P < 0.001$), with wool from young wethers 9 mm longer on average than wool from mature wethers.

Staple strength ranged from 17 to 36 N/Ktex. Wool from wethers fed silage was the weakest in both age groups, with little difference between the other treatments. The exception was the young wethers on silage and grass which produced wool which was considerably stronger than the silage but weaker than the grass treatments.

Processing Performance

After combing, wool top evaluation found that wool from the young wethers fed silage treatment was extraordinarily short, 66.8 mm hauteur, compared to the other lots (78.9 ± 1.6 mm). The short fibre content was highest for the young silage treatment with 19.3 % below 40 mm compared to the other lots where only 13.8 % of fibre was below 40 mm. The highest small nep content was found in wool from the silage treatments, with 54 and 24 ± 4 pieces/10 g in silage and other treatments respectively.

Yarn breakage was evident in the wool from the young silage and young silage and grass lots. At the single yarn stage the yarn strength of both silage treatments and the mature silage and grass treatment was lower than the other lots. Yarn faults were highest in the silage treatments with 132 and 92 faults/5 kg for young and mature wethers respectively compared to 39 ± 5 faults/5 kg in the yarn from other treatments.

Fabrics made from the wool lots were evaluated by hand and KES (Kawabata Evaluation System for Fabrics). From the hand evaluation of fabric handle, fabric from the young silage treatment was graded the highest, with no particular differences between the other lots which all received high handle scores. Measurement of fabric handle by KES also found the young silage treatment had the highest performance.

DISCUSSION

Liveweight fluctuated over the trial period indicating the difficulty of controlling feed intake accurately under practical conditions. Feed quality has an important effect on the relationship between feed offered and liveweight change. Pasture and silage quality vary with season and other factors making consistent feeding levels difficult to achieve. Thompson *et al.* (1992) found considerable variation in the

relationships between feed on offer and liveweight change at different times during spring.

Fibre diameter at the end of the trial was finer than at the start of the trial. Young wethers were 0.15 microns finer on average at the end of the trial, even though the fibre diameter would be expected to coarsen between two and three years of age. Older wethers were 0.46 microns finer on average at the end of the trial. Similar reductions in fibre diameter associated with liveweight reductions have been reported (Ritchie and Ralph, 1990; Thompson *et al.*, 1992; Litherland *et al.*, 1993).

Staple length at shearing averaged 81.5mm, ranging from 70 to 90mm between treatments. Staple length desired by wool buyers for fine wools is between 60 and 100mm, with length allowable increasing with fibre diameter (D. Wright pers. comm.). Superfine wool staple lengths of around 70mm are preferable. Staple length of wool in this trial fitted within the desirable range.

The strength of wool fibres is an important raw wool characteristic (Reis, 1992). In this trial staple strength was generally in the sound range (>30 N/ktex) but less than the strength of maximum processing performance (60 N/ktex) observed by Butler and Head (1992). Minimum fibre diameter and the rate of change of diameter along a staple are important determinants of strength (Reis, 1992). Hansford and Kennedy (1990) found that the rate of change in diameter along fibres was more important in determining staple strength than minimum fibre diameter or the range in fibre diameter. Wool from wethers on the silage treatments had the finest fibre diameters and the greatest rate of change in fibre diameter (Figure 3) and hence the lowest staple strength. These results were opposite to the findings of Litherland *et al.* (1990) where wethers fed silage produced stronger wool than the concentrate and pasture feeding treatments.

Bulk values in this trial were considerably lower than expected. Carnaby and Elliott (1980) showed that the crimped wools (Down and Merino types) have a higher loose-wool bulk than the Romney and Leicester/Lincoln types, with loose wool bulk for Merinos at about $33 \text{ cm}^3/\text{g}$ and for Romneys at about $21.5 \text{ cm}^3/\text{g}$. Litherland *et al.* (1990) obtained bulk values of 29.2 - $31.5 \text{ cm}^3/\text{g}$. Sumner *et al.* (1991) evaluated the end-product performance of Perendale hogget wool which differed only in loose wool bulk (low bulk 23.9 vs high bulk $29.1 \text{ cm}^3/\text{g}$). Processing results found the trends expected, as bulk increased worsted fabrics had greater firmness, less sleekness and greater fullness.

Japanese researchers have been instrumental in developing sophisticated objective evaluation procedures for textiles which allow comparisons of subtle differences based on sets of subjective assessments (Kawabata, 1980 in Sumner *et al.*, 1991). These techniques were used to evaluate processing performance in this trial, especially fabric handle. Fineness of the wool is known to be the most important factor affecting fabric handle, resulting in fabrics produced from wool from the young wethers fed silage having the highest handle grade. However, the lower processing performance of this wool, mainly due to the low staple strength, meant it was not economic to process.

CONCLUSIONS

The loss of liveweight in all treatments indicated that wethers intake levels were below maintenance. The fluctua-

tions in liveweight reflected the difficulty of controlling intake in a pasture situation.

The adverse effect on wool production of liveweight loss was clearly shown in the silage treatment, where liveweight loss was highest, fleece and staple length growth lowest and fibre diameter finest. Although the aim was to minimise fibre diameter this treatment was extreme and wool quality adversely affected resulting in poor staple strength and decreased bulk.

Advantages to the silage treatment obtained by Litherland *et al.* (1990) were not repeated in this trial. Liveweight losses were not as great in the other treatments and fibre diameter was decreased without as great a loss in clean wool growth rate and staple strength.

ACKNOWLEDGEMENTS

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