
THE PROCEEDINGS OF THE
NEW ZEALAND SOCIETY
OF
ANIMAL PRODUCTION
VOLUME 62 2002

Grazing management strategies for the production of fine Merino wool in North Island conditions

A.J. LITHERLAND, N. HAACK AND D.J. PATERSON

Flock House Agricultural Centre, Private Bag, Bulls, New Zealand.

ABSTRACT

Five treatment groups of 40 fine Merino wethers were offered grazing regimes over 2 treatment periods, to achieve a range of liveweight profiles. The first was from 16 October 1990 to 21 December 1990 while the second continued until 29 August 1991. Treatment period 1 generated significant differences in liveweight (P<0.001) between all groups and thereafter the sheep were grazed in 2 larger mobs consisting of groups 1-3 and 4 and 5. By the end of the first period liveweights were 48±1, 38±1, 33±1, 33±1 and 39±1 kg in groups 1 to 5 respectively (P<0.001) and the end of period two the liveweight of the groups were 40.7±0.9, 39.0±0.9, 40.7±0.9, 39.0±0.9, 38.8±0.0.9, 36±1 and 35.9±0.9 kg for groups 1 to 5 respectively (P<0.001). Fleece weight was similar in Groups 1,2 and 3, despite liveweight differences, however mean fleece weight for Groups 4 and 5 was 0.5 kg lighter (P<0.001) than for Groups 1-3. Groups 4 and 5 also produced a finer fleece (P<0.001) than other groups (17.8 microns and 18.9 microns). Group 1 produced wool which was 7 N/ktex stronger than that produced in Groups 3, 4 and 5 with Group 2 being intermediate (p<0.01) though the position of wool break was similar in all groups. Variation in fibre diameter along the staple accounted for 15% of the variation in staple strength. Estimated finacial returns from wool sales showed that Groups 4 and 5 producedd $10/head and $20/stock unit (P<0.01) more than Group 1,2 and 3.

Keywords: nutrition, fibre diameter, staple strength, wethers.

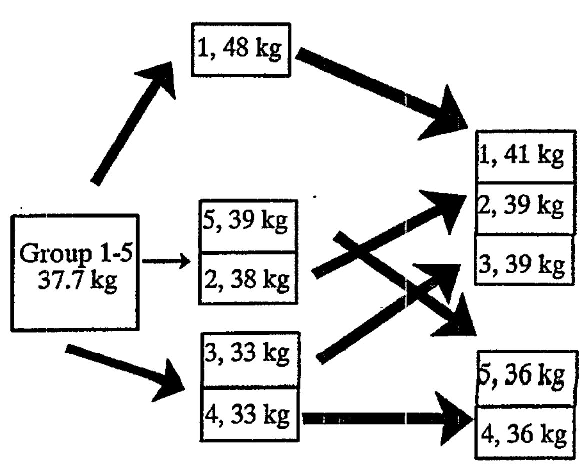
INTRODUCTION

For fine wool, fibre diameter is the main determinant of wool price though staple strength, length, colour and vegetable matter also contribute (Rogan, 1989). From 1983 to 1990 wool of less than 19 microns attracted premiums for fibre diameter which increased exponentially with reducing fibre diameter (NZ Wool Prices 1983-1990) resulting in improvements in wool returns despite associated reductions in fleece weight. With the trend to lightweight clothing and higher wool processing speeds premiums for fibre diameter of less than 19 micron wool remain and are generally expected in the future (Plate *et al*, 1987; Ponzoni, 1992). Restricted feed intakes can potentially reduce fibre diameter in heavier sheep losing weight or lighter sheep maintaining liveweight (Donnelly *et al*, 1983; Langlands *et al*, 1984). However often a reduction in fibre diameter can also be associated with a reduction in wool strength (Hawker and Littlejohn, 1989). The objective of this study was to examine the effects of different liveweight profiles on fibre diameter, fleece weight and wool strength.

METHOD

The experiment was conducted at Levin Horticultural Research Station which is predominantly Levin Silt Loam and has an annual rainfall of 1120 mm. One hundred and ninety mixed age merino wethers with a mean fibre diameter of 18.8 microns and mean liveweight of 37.7 kg were randomly allocated to five treatment groups. Nutritional treatments were applied in 2 periods. In the first period (16 October to 21 December 1990) groups 1, 2 and 5 were grazed separately (Fig 1) and groups 3 and 4 were grazed together. After 21 December 1990 (second period) groups 1, 2 and 3 were grazed together as were groups 4 and 5 (Fig 1). The sheep were weighed at two weekly intervals. Animals were removed from the experiment when signs of stress could be observed. Only data from animals remaining in the experiment to completion is presented. The sheep were drenched with Ivomec and foot bathed in zinc sulphate at four weekly intervals coinciding with paddock shifts. The sheep were dipped for flystrike with Vetrasin in November and January. Faecal samples were collected from all animals on 9 May 1990. On 7 June the animals were tested for drench resistance using faecal egg count (FEC) depression 7 days post drenching with Ivomec and Levamisole.

FIGURE 1: Liveweights, at the beginning (16 October 1990), end of period 1 (21 December 1990), and end of period 2 (29 August 1991), in merino wethers in treatment groups 1-5.



Paddocks were hard grazed with cattle and adult sheep immediately prior entry of the Merinos. Paddock area was calculated using drymatter requirements (Rattray, 1986) for the required group liveweight change and pasture growth predictions based on five year average pasture growth measurements from similar land type. Sheep remained in the paddock for 28 days and small alterations to the paddock size were made in response to deviations from the required liveweight profile based on the two weekly liveweight measurements.

The paddock mean herbage mass was determined at two weekly intervals from one hundred capacitance readings collected diagonally across each paddock. Three quadrats with a capacitance reading equivalent to the paddock mean, 10% higher and 10% lower were cut at two weekly intervals, pooled and used to convert capacitance reading to dry matter per hectare. Ten measurements of average canopy pasture height were made using a ruler in each quadrat.

One month prior to shearing, midside wool samples were collected and tested for yield and fibre diameter by New Zealand Wool Testing Authority. At shearing on 17 September 1991 the fleeces were weighed and treatment groups were baled separately. Core samples from bales were tested for mean fibre diameter, length, colour, bulk, staple strength, position of break (POB) and vegetable matter (NZWTA/AWTA). The predicted hauteur (fibre length in the clean scoured top) was calculated using individual fibre diameter and strength measurements in combination with the staple length and vegetable matter measurements obtained from the bale test (Andrews *et al*, TEAM Report, 1985). Financial returns were calculated using fibre diameter and staple length and strength measurements from individual animals and average wool prices in micron intervals from 1983 to 1990 for New Zealand fine wool. Staple strength premiums used in the calculations were 6c/cflwt <35 N/ktex and 3 c/cflwt >35 N/ktex (Rogan, 1989). These are based on Australian data as such information is not yet available for the New Zealand wool.

In calculating wool income per head it was assumed that skirtings comprised 30% of the fleece weight and were priced at 50% of the full fleece price. Assumed components of the costs of production used in later calculations were animal health ($5/hd); shearing ($2); capital (10% on $80 sheep). The annual drymatter requirement for each treatment group liveweight profile was calculated using theoretical feed requirements of 490 kJME/kg$^{0.75}$ for maintenance and 55 KJME/1 gram gain or loss (Rattray, 1986). These metabolisable energy requirements were then converted to dry matter requirements of pasture by assuming an energy value of pasture of 10.8 MJME/kgDM.

Stock unit (su) equivalents derived from the annual dry matter requirement for each treatment were calculated on the basis that 1 stock unit consumes 550 kg·DM/year. Gross margin per stock unit was calculated from return per head (R), the costs of production (C), and adjusted using the ratio of number of sheep present at the end of the experiment (N^1) versus those present at the start (N^0) using the following equation:

$$GM/su=(R-C)*N^0/N^1)/su$$

A 10 cm strip of wool located on the midside was dye banded using Nako H with the bands being applied on 11 October 1990, 8 November 1990, 4 January 1991, 23 February 1991, 7 April 1991, 19 June 1991, 28 July 1991 and 8 August 1991. At shearing the dyeband was removed and staple length determined on four staples and the length between each band measured on one staple. The linear growth per day was calculated. Four dye banded staples were then used for the determination of individual sheep staple strength using the Instron tensile tester (Orwin *et al*, 1987). The site of breakage relative to the dye bands was noted.

Mean fibre diameter was calculated from 150 fibres measured by projection microscope. Snippets for measurement were selected from dyebands of 15 sheep in the two groups exhibiting the greatest difference in mean staple strength.

Statistical analysis

Analysis was conducted using SAS linear regression analysis to determine whether staple strength was correlated with minimum fibre diameter, coefficient of variation in fibre diameter along the staple, and slope of fibre diameter change (change in fibre diameter from minimum to maximum divided by length or time).

General linear models (SAS) were used to determine treatment effects on wool traits and financial returns. The error variances used in significance testing were the between sheep within group variances. Since there was no replication of paddocks the effect of variation between paddocks could not be accounted for and variances are likely to be underestimated. Absence of significant difference between Groups meant that data from Groups 1-3 were pooled and data from Groups 4 and 5 were pooled. Simple regression analysis was used to describe the nature of the relationships between fibre diameter and fleece weight and annual liveweight change (difference in liveweight at start and finish of the experiment corrected for fleece weight changes). Unless otherwise stated data are presented as ls means and ls standard errors.

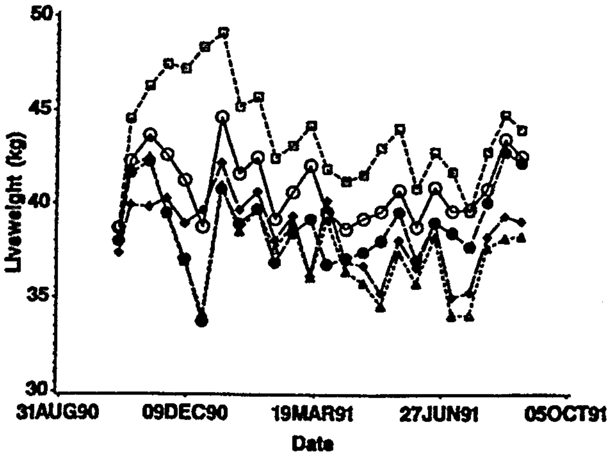
RESULTS

Wool Production and Liveweight

On 21 December 1990 following 9 weeks of differential feeding the mean liveweight of group 1 had increased by 10 kg while groups 3 and 4 had reduced by 5 kg (Fig. 1). At the end of the experiment on 29 August 1991 Groups 1-3 were similar in liveweight and Group 4 and 5 were 3 kg lighter ($P<0.01$) than the mean for Groups 1-3.

Groups 1,2 and 3 fleeces were similar in fibre diameter and weight (Table 1). However Group 4 and 5 had fleeces which were 1.1 micron ($P<0.001$) finer and 510 grams ($P<0.001$) lighter than Groups 1-3 (Table 1). Mean staple strength was 7 N/ktex higher in Group 1 than in Groups 3, 4, and 5 while Group 2 was intermediate ($P<0.01$). Wool yield was similar in all treatment groups and ranged from 76-77%. The position of staple break was similar in all treatments and occurred closest to the dye band applied on 04 January 1991. POB measured on bale lines was predominantly in the middle of the staple with 67-89% of the staples breaking in the mid

FIGURE 2: Liveweight of merino wethers in group 1□--□ 2○—○ 3●--● 4△—▲ 5◇—◇



region of the staple all Groups. The Y-Z wool colour ranged from 0.7 to 1.0, vegetable matter from 0.13% to 1.0% and bulk from 23 to 26 g/cm^2. Hauteur was similar in Groups 1 (55±1 mm), 2 (53.8±0.9 mm) and 3 (53±1 mm) but lower in Groups 4 (48±1 mm) and 5 (48±1 mm) ($P<0.001$).

TABLE 1: Wool characteristics and income from Merino wethers in groups 1 to 5.

Group	Fibre Diameter (microns)	Fleece Weight (Kg)	Staple Strength (N/ktex)	Wool Income ($/head)	Gross Margin ($/su)
1	19.1^{a}	3.5^{a}	39^{a}	44^{b}	51^{b}
2	18.9^{a}	3.5^{a}	35^{ab}	44^{b}	64^{ab}
3	18.7^{ab}	3.4^{a}	31^{bc}	47^{b}	62^{ab}
4	17.7^{c}	2.9^{b}	31^{bc}	58^{a}	82^{a}
5	18.0^{bc}	3.0^{b}	31^{bc}	52^{a}	78^{a}
lse	0.3	0.1	2	4	8
	***	***	**	*	*

Means within a column with the same superscript are not significantly different at the 5% probability level

Ninety seven percent ($P<0.001$) of the variation between groups in mean fleece weight was explained by fibre diameter and 90% ($P<0.01$) of the variation in fibre diameter could be explained by annual liveweight change.

Linear wool growth (mm/day) as measured by dyebanding differed between individual groups on 04 January ($P<0.05$), 19 June ($P<0.05$) and 8 August ($P<0.01$). On 4 January following large reductions in liveweight wool growth was lower in groups 3 (213±12 µm/day) and 4 (216±12 µm/day) than in Groups 1 (255±12 µm/day) and 5 (249±11 µm/day). Wool growth in group 2 was intermediate at 236±11 um/day. On 19 June Groups 1, 2 and 3 had similar wool growth ranging from 250 to 271 µm/day while groups 4 and 5 had lower growth rates at 238±8 µm/day. In August wool growth was highest in Group 3 (259±12 µm/day) and ranged between 188 and 219 um/day in the other four groups.

The percentage of stock removed from the experiment due to ill thrift was 16%, 10%, 23%, 23% and 13% in Groups 1 to 5 respectively with 60% of the cases occurring during autumn. In May the mean FEC was high (1301±133(se)) eggs per gram with no effect of treatment. There was no evidence for internal parasite resistance to anthelmintics.

The mean pre-grazing herbage mass for the first period (16 October-21 December 1990 averaged 840±50 kgdm/ha (3.6±0.4 cm) for Groups 2-5 and 1434±193 in Group 1. In the second period the mean pregrazing herbage mass in all groups was 770±80 kgdm/ha (2.7±0.5 cm).

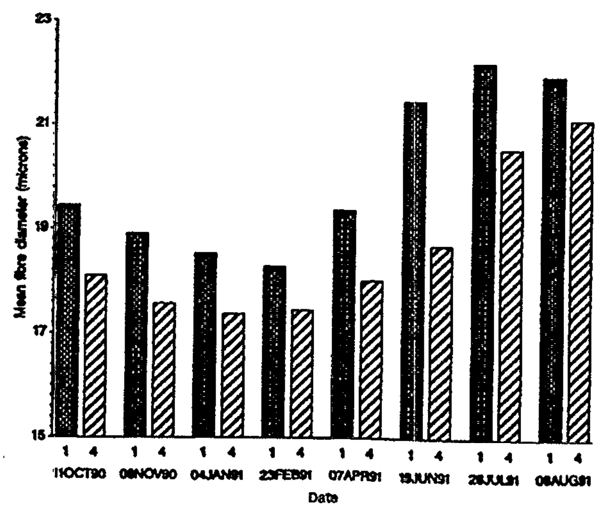
Financial Returns

The finer fleeces in Group 4 and 5 compared to Groups 1-3 produced an additional ($P<0.001$) $10 per head (Table1). The lower feed requirements of Groups 4 and 5 produced an additional $20 per su gross margin ($P<0.001$).

Detailed measurements of wool growth

The mean minimum fibre diameter (Fig. 3) along the staple occurred in Group 1 on 8 February±10 (se) days and in Group 4 on 14 January±15 (se) days. However the mean POB was closest to the dyeband applied on 4 January 1991 in both groups. Individual staple strength either within Group 1 and 4 or pooled across group was poorly correlated with fibre diameter at position of break, minimum fibre diameter, fibre diameter slope by time and length. The coefficient of variation of fibre diameter along the staple was 8.4% in both Groups and described 15% of the variation in staple strength overall ($P<0.05$).

FIGURE 3: Mean fibre diameter of dyebands in merino wethers in group 1 ▩ and group 4 ▨



DISCUSSION

Despite large differences in liveweight profile in Groups 1,2 and 3 fleece fibre diameter and weight were largely unaffected. It was only when final liveweight was reduced by 3 kg as in Groups 4 and 5 that fibre diameter was reduced by 1 micron. Equivalent fibre diameter reductions have been reported (Ritchie and Ralph, 1990) in sheep maintained with a 10 kg difference in liveweight. Group 3 was lower in wool strength than Group 1 despite the similarity of other wool characteristics. It is likely that the low body condition (Saul, 1989; Orwin *et al*, 1988) of Group 3 sheep versus Group 1 and 2 at the time of wool break was a contributing factor to the lower wool strength. However none of the Groups produced tender wool (<30N/ktex) illustrating the practicality of grazing Merinos at high stocking rates behind other stock classes.

Despite differing nutritional treatments, the postion of wool break was similar. Poor parasite control or a decline in summer pasture quality may have contributed to the wool break. In hindsight most of the problems with poor thrift were likely to have been due to grazing of internal parasite contaminated pastures.

Important factors associated with staple strength either within treatments or overall proved to be elusive. A positive correlation existed between the coefficient of variation in fibre diameter along the fibre and staple strength. However in contrast to other experiments (Ritchie and Ralph, 1990) only a small proportion of the variation in staple strength was explained by fibre diameter variation along the staple. In agreement with some experiments (Mata *et al*, 1990) and in contrast to others (Hansford and Kennedy, 1990) the present study found no association between change in fibre diameter and staple strength or between minimum fibre diameter and staple strength (Bigham *et al*, 1983). The mechanisms regulating wool strength in non tender wool may be different to those in tender wool with protein composition of pastures affecting intrinsic wool strength (Mata *et al*, 1990).

While wool strength was reduced by liveweight profile the premiums for wool strength used had negligible effect on wool returns. The successful economic use of grazing strategies to reduce fibre diameter is dependent on the premium for fibre diameter. The premium for fibre diameter used in this paper is high and exponential. Wool prices in 1991 and 1992 have a reduced and more linear premium and fail to show statistical differences in wool income for the nutritional treatments. The toll on the animals from experiencing a rapid liveweight loss can be high as can be seen by the number of the animals removed from the experiment in Group 3 and 4. However the effects of a slow gradual liveweight loss were less severe.

The nutritional conditions used for Groups 4 and 5 in this experiment are not sustainable in practice. The sustainable liveweight profile (Group 1) comprised a short rapid period of liveweight gain followed by a slow loss in liveweight but was not effective in reducing fibre diameter. The results of this study suggests that that the maintenaning Merino wethers at 36 kg with effective animal health regimes is likely to be a highly profitable farming venture.

REFERENCES

Andrews M.W., Douglans S.A.S., Ireland A., Quirk R. and Rottenbury R.A., 1985: *TEAM Final Report,* Australian Wool Corporation, Melbourne.

Bigham M.L., Sumner R.M.W., Hawker H., and Fitzgerald J.M. 1983: Fleece tenderness - a review. *Proceeding of the New Zealand Society of Animal Production* **43:** 73-8.

Donnelly J.R., Morley F.H.W., McKinney G.T., 1983: The productivity of breeding ewes grazing on lucerne or grass and clover pastures on tablelands of southern Australia.II Wool production and ewe weight. *Australian Journal of Agricultural Research* **34:** 537-48.

Hansford K.A. and Kennedy J.P., 1990. Relationship between the rate of change in fibre diameter and staple strength. *Proceedings of the Australian Animal Production* **17:** 415.

Hawker H. and Littlejohn R.P., 1989: Relationships between staple strength and other wool characteristics of Romney wool. *New Zealand Journal of Agricultural Research* **32:** 305-310.

Langlands J.P., Donald G.E. and Paull D.R.,1984. Wool production and quality, lamb growth rate and size and live weight of ewes. *Australian Journal of Experimental Agriculture and Animal Husbandry* **24:** 34-46.

Mata G., Peter D.W., and Purser D.B., 1990: Dietary changes, staple strength and point of break. *Proceeding of Nutrition Society of Australia* **15:** 132.

Orwin D.F.G, Gourdie R.G., Woods J.L., and Geenty K.G., 1987: Measuring staple strength of New Zealand Romney and Corriedale wools. *New Zealand Journal of Experimental Agriculture* **15:** 303-308.

Orwin D.F.G., Ranford S.L. and Geenty K.G., 1988: Relationship of staple strength and other fleece characteristics of romney wool to fibre length after carding. *New Zealand Journal of Agricultural Research* **31:** 409-414.

Plate D.E.A., Robinson G.A., Rottenbury R.A., 1987: The effect of staple strength and position of weakness of greasy wool on worsted spinning. *Journal Textile Institute* **4:** 269-280.

Ponzoni R.W., 1992: Reducing average fibre diameter with wool plan options. Wool Technology and Sheep Breeding Dec/Jan 136-139.

Rattray P.V., 1986: Feed requirements for maintenance gain and production. *In* Sheep Production 2: Feeding, growth and health. NZ Institue of Agricultural Science. 75-109.

Ritchie A.J.M. and Ralph I.G, 1990: Relationship between total fibre diameter variation and staple strength. *Proceedings Australian Society of Animal Production* **18:** 543

Rogan I.M., 1989: High Quality Free contaminant wool: Breeding for improved Wool Quality. *Proceedings Australian Society Animal Production* **18:** 58-60.

Saul G.R, 1989: The effects of season of birth, breed and pasture type on the fibre strength of wool from weaner sheep. *Proceedings of the Australian Society of Animal Production* **17:** 467.