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# Effects of level of nutrition in winter and summer on the wool growth of Romney and Perendale ewes with a history of high or low winter wool growth

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## ABSTRACT

Forty Romney and Perendale ewes with a history of either high (W+) or low (W-) winter wool growth but similar summer wool growth were selected from a large flock. The ewes were not pregnant and were penned individually indoors and offered either 500 or 1500 g/d of a high quality pelleted diet for 8 weeks in both winter and summer.

The 2 breeds had similar intakes and live-weight changes, but the Romneys grew more wool. The W+ and W- ewes had very similar intakes and live-weight changes. Intakes on the low and high plane of nutrition respectively were 420 and 1093 g DM/d in winter and 422 and 1222 g DM/d in summer. Corresponding live-weight changes were -71 and +54 g/d in winter and -112 and +131 g/d in summer.

Summer wool growth rates were on average twice those in winter. Plane of nutrition had a much greater absolute effect on wool growth in summer than in winter (5.5 v 2.3 g/d), but the relative effects were similar (54 v 48%). The W+ ewes grew 38% more wool in winter than the W- ewes (5.8 v 4.0 g/d) and had a 38% higher mean staple strength (2.7 v 1.8 g/tex). Differences between the W+ and W- ewes were similar on the high and low planes of nutrition, and also similar for the Romneys and Perendales.

The variation in winter wool growth and hence in staple strength was evidently due to variation in the partitioning of nutrients to wool growth rather than to variation in feed intake.

**Keywords** Nutrition; season; breed; phenotype; intake; live weight; wool growth; fibre diameter; staple strength.

## INTRODUCTION

Longwoolled breeds of sheep in New Zealand (e.g. Romney, Coopworth, Perendale) grow wool about 4 times faster in summer than in late winter (Story and Ross, 1960; H. Hawker, unpublished). The pronounced seasonality of wool growth occurs because wool growth is controlled by photoperiod (Nagorcka, 1979). The seasonality is accentuated by an interaction between photoperiod and the response of wool growth to the level of nutrition (Sumner, 1979; Hawker *et al.*, 1984).

Seasonal changes in wool growth result from changes of up to 40% in both fibre diameter and fibre length growth rate (Story and Ross 1960). An increase in minimum fibre diameter would lead to an increase in staple strength. This is an important determinant of wool's textile performance (Ross, 1982).

Within flocks, ewes producing wool of low staple strength tend to have lighter fleeces and a much lower rate of wool growth in late winter than do ewes growing sound wool (H. Hawker and K.F. Thompson, unpublished). Whether ewes growing wool of low strength have low intakes in winter, or partition less nutrients to wool growth, is not known. The objective of this experiment was to ascertain the contribution of each of these factors. Therefore the

intakes, live-weight gains, wool growth patterns, fleece weights and staple strength of Romney and Perendale ewes with a history of either high or low winter wool growth were studied on 2 planes of nutrition in winter and summer.

## MATERIALS AND METHODS

Wool growth rates of 280 Romney and 370 Perendale ewes were determined in 8 consecutive 3-month periods (approximating the 4 seasons) from 4 until 28 months of age.

Within each breed 10 ewes which had consistently exhibited high winter wool growth were selected, as were 10 with low winter wool growth (total = 40). These ewes are respectively referred to as W+ and W- ewes or phenotypes. On average the W+ ewes had grown 54% more wool in winter (5.7 v 3.2 g/d, SED 0.51) and 14% less in summer (10.8 v 12.4 g/d, SED 1.18) than the W- ewes. The W+ and W- ewes had exhibited similar patterns of live weight gain or loss.

The W+ and W- ewes within each breed were randomly allocated to a low or high plane of nutrition, namely 500 or 1500 g/d (86.5% DM) of a high quality pelleted diet (20% barley, 40% lucerne, 20% bran, 20% pollard). The design was thus a 2x2x2 factorial with 5 sheep/treatment. The

experiment was run for 8 weeks in *winter* (27 June-22 August 1983) and repeated for 8 weeks in *summer* (19 December 1983-13 February 1984). Before the summer experiment the W+ and W- ewes from each breed were re-allocated randomly to the summer nutritional treatments.

The ewes were not pregnant and were penned individually in a well-ventilated barn exposed to natural lighting. Pellet feeding commenced at least 2 weeks before each experimental period. Digestibility of the pellets was determined *in vivo* with 5 wethers for each plane of nutrition; the values were 74.1 and 71.0%, equivalent to 11.2 and 10.7 MJ ME/kg DM for the low and high planes, respectively.

Live weights (fasted), were recorded on days 0, 28 and 56 of each 8 week experimental period and at shearing on 26 October 1983 and 29 March 1984. Live weights were adjusted for the appropriate weight of fleece and live-weight changes calculated. On days 0, 28 and 56 and 7 days prior to shearing, midside patches were clipped and several staples dyebanded for measurement of length growth. Clean wool growth was estimated as described by Hawker *et al.* (1984). Mean fibre diameters of the midside patch samples were determined by liquid scintillation spectrometry (Andrews and Hawker, 1982) and staple strength for the October fleece samples was measured with an Instron tensile strength tester.

Data were subjected to analyses of variance and regression.

## RESULTS

### Feed Intake and Live-weight Change

The Romney and Perendale ewes had similar mean live weights on 23 June (52.5 kg) and on 19 December (62.5 kg).

DM intakes and live-weight changes (LWC) are shown in Table 1. Results for the Romney and Perendale ewes have been combined, there being no significant breed differences. The intakes of the W+ and W- ewes were very similar in both winter and summer. Average utilisations were 98 and 90% for the low and high feeding levels respectively.

The W+ and W- ewes had similar LWC's on each feeding level and in each season. There was a marked interaction for LWC ( $P < 0.001$ ) between level of nutrition and season (Table 1) with the cumulative effect of differential feeding on live weight in summer nearly double that in winter (13.8 v 7.5 kg).

### Wool Growth

The Romneys and Perendales had mean wool growth rates of 5.5 and 4.4 g/d respectively (SED 0.2) in winter, and 11.5 and 9.2 g/d (SED 0.4) in summer (a difference of 20% in each season). The Romneys also had higher fibre diameters and length growth rates

**TABLE 1** Dry matter intakes (DMI; g/d) and live-weight changes (LWC; g/d) of ewes with phenotypically high (W+) or low (W-) winter wool growth.

Winter phenotype	Level of nutrition			
	Winter		Summer	
	Low	High	Low	High
DMI (SED = 21)				
W-	425	1103	419	1217
W+	415	1083	425	1226
LWC (SED = 20)				
W-	-70	54	-130	134
W+	-71	54	-94	127

**TABLE 2** Wool growth (WG; g/d clean dry), fibre diameter (FD;  $\mu$ m) and staple length growth (LG; mm/d) of ewes with phenotypically high or low winter wool growth.

Winter phenotype	Level of nutrition			
	Winter		Summer	
	Low	High	Low	High
WG (SED = 0.49)				
W-	3.00	4.92	7.83	13.24
W+	4.48	7.21	7.38	13.02
FD (SED = 0.80)				
W-	26.1	29.2	31.6	37.4
W+	30.6	34.9	35.2	38.6
LG (SED = 0.02)				
W-	0.18	0.28	0.39	0.49
W+	0.26	0.40	0.38	0.47

than the Perendales in each season, and a 30% higher mean staple strength in October (2.6 v 1.9 g/tex; SED 0.26). The breeds are combined in all subsequent results because there were no significant interactions of breed with the other main effects.

The effects of season and level of nutrition on the wool growth (WG), fibre diameter (FD) and staple length growth (LG) of the W+ and W- ewes are shown in Table 2.

In summer the ewes on average grew 5.5 g/d more wool than in winter (10.4 v 4.9 g/d; SED 0.24), had a 5.5  $\mu$ m higher mean FD (35.7 v 30.2  $\mu$ m; SED 0.40) and a 0.15 mm/d higher LG (0.43 v 0.28 mm/d; SED 0.01). The seasonal difference of 72% in WG relative to the overall mean can be explained by the differences of 17% in FD and 38% in LG.

Plane of nutrition had a greater *absolute* effect on WG in summer than in winter (5.5 v 2.3 g/d; SED 0.35), but the *relative* effects were similar in the 2 seasons (54 v 48%; SED 12). The significant effects of nutrition on FD and LG in each season explain the effects of nutrition on wool growth. Staple strength of the October fleece was higher for the high than for

the low plane of nutrition (2.5 v 2.0 g/tex; SED 0.26).

Regression relationships between wool growth and metabolisable energy intake (MEI) are shown in Figure 1. The slope was more than twice as steep in summer ( $P < 0.001$ ), but the relative increase in wool growth with increasing MEI was similar in summer to that in winter. It is clear from both Table 2 and Figure 1 that there was a negative relationship between the level of feeding and the proportion of nutrients allocated to wool growth.

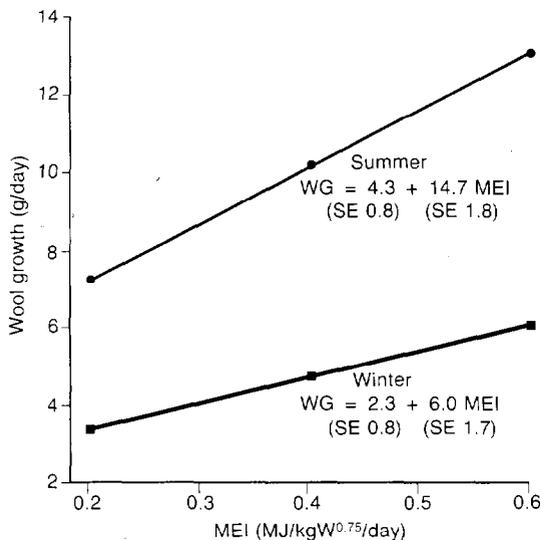


FIG. 1 Relationship between wool growth and metabolisable energy intake.

There was a strong interaction between season and winter phenotype for WG, LG and FD. The W+ ewes grew 38% more wool in winter than the W- ewes (5.8 v 4.0 g/d; SED 0.35) and 3% less wool in summer. There was a similar trend for LG. The W+ ewes had a higher mean FD than the W- ewes in both seasons, but the difference was more pronounced in winter. The low mean FD of the low nutrition W- ewes in summer (Table 2) was due mainly to the Perendale ewes in that treatment having consistently low FD's. The mean staple strength of the October fleece was 38% higher for the W+ than the W- ewes (2.7 v 1.8 g/tex; SED 0.26). There were no interactions between winter phenotype and either breed or level of nutrition. The large difference between W+ and W- ewes in wool growth during winter but not summer meant that the W- ewes had a much more pronounced seasonality of wool growth. In the 10 months from May to March the W+ ewes grew 0.21 kg (SED 0.10) more clean wool than the W- ewes.

## DISCUSSION

The greater response of live-weight change to level of feeding in the summer than in the winter was unexpected because the ewes were on average 10 kg heavier in December than in June. A quicker adaptation to pellets in summer may have been a contributing factor while there might also have been seasonal differences in gut-fill. However, a true seasonal difference in the efficiency of live-weight gain is possible, as a result of differences in body composition.

The negative relationship between the level of feeding and the proportion of nutrients which is allocated to wool growth has been observed previously (Allden, 1979; Butler and Maxwell, 1984) and is due to partitioning of surplus nutrients to tissue deposition on a high plane of nutrition, and tissue catabolism when the level of nutrition is sub-maintenance. The negative relationship can be exaggerated by lag effects of the previous level of nutrition (Allden, 1979).

The marked interaction between season and the response of wool growth to feeding level is consistent with results obtained with wethers (Sumner, 1979) and with breeding ewes (Hawker *et al.*, 1984). In this experiment with non-pregnant ewes the *relative* responses in wool growth to increased feeding were very similar in summer and winter, but the *absolute* response in summer was approximately twice that in winter. The twofold differences between summer and winter in the rate of wool growth and in the amount of wool grown per unit of intake were very similar to those reported by Geenty *et al.* (1984) for non-pregnant Romney ewes. The response of wool growth to feeding level is directly related to the rate of wool growth on a maintenance intake, both being controlled by photoperiod.

The difference in seasonality of wool growth between the W+ and W- ewes that we observed in the grazing situation persisted indoors and was independent of the plane of nutrition. Variation in winter wool growth and hence in staple strength appears to be due to phenotypic (and possibly genetic) variation in the allocation of nutrients to wool growth rather than to variation in feed intake. Selection for higher staple strength should therefore not lead to significant increases in feed intake.

## CONCLUSION

The *response* of wool growth to level of nutrition is determined by the "set" of wool growth, which in summer is approximately twice that in winter.

Phenotypic variation in winter wool growth is highly repeatable, is closely associated with variation in staple strength and is due to differences in the partitioning of nutrients to wool growth rather than to variation in intake. Irrespective of the breed or the

level of winter nutrition there is considerable scope to improve fibre quality by selecting for staple strength and/or winter wool growth.

### ACKNOWLEDGEMENTS

The assistance of D.C. Taylor, R.N. Andrews and M.R. Holmes is gratefully acknowledged.

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