WOOL GROWTH AND LIVEWEIGHT GAIN DURING SPRING IN A SEASONAL ENVIRONMENT

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SUMMARY

Although liveweight gain and wool growth are both strongly dependent on feed intake, the 2 characteristics are not well related during spring in Western Australia. This study compared sheep that differed in liveweight at the beginning of spring, or in their inherent capacities to grow wool (high vs low producers), to seek an explanation for this dissociation. Sheep on restricted feed the preceding winter ate more pasture and gained more weight during spring than sheep fed well during winter, but wool growth during spring was similar in both groups. High wool-producing sheep had similar liveweight gain to low wool producers at all times. There was no significant interaction between nutrient supply and the capacity to grow wool, although high-producing sheep tended to respond less to winter feed.

In this experiment, increased feed intake during the spring feed flush was partitioned to liveweight gain rather than wool growth, regardless of the capacity of the animal to grow wool. Improved annual wool growth therefore depended upon increased feed availability during winter, rather than spring.

Keywords: liveweight, wool growth, partitioning, spring.

INTRODUCTION

Factors controlling wool growth under steady-state conditions are relatively well defined, but it is often difficult to apply this knowledge in mediterranean environments such as Western Australia (WA), where the level of nutrients available to the animal is constantly changing. The cool wet winters and hot dry summers that characterise this environment result in an abundance of green feed in spring, but sparse, poor quality feed in autumn. Purser and Southey (1989) calculated that efficiency of wool growth is extremely variable between seasons in these environments, for reasons that are largely unknown. For example, in spring the rate of growth of wool is poorly correlated with increase in liveweight (Purser and Southey 1984), even though studies in sheep under more constant conditions indicate that both should reflect intake (White *et al.* 1979; Allden 1979).

There are a number of possible reasons for this. A limiting nutrient may affect partitioning of nutrients between wool and body growth (Purser and Southey 1989). Partitioning may also be affected by the ability of animals to undergo compensatory gain in liveweight during spring (Thornton *et al.* 1979) without a similar effect on wool growth (Butler-Hogg 1984). Alternatively, animals may vary in their inherent capacity to partition nutrients to wool growth in response to a sudden increase in feed without similar differences in liveweight gain (Pritchard and O'Rourke 1992).

This paper examines the role of 2 possible contributors to variation in partitioning, the level of feeding through winter and the capacity to grow wool, to clarify which factors are important under field conditions in determining spring wool growth in WA.

MATERIALS AND METHODS

At shearing in autumn, liveweights and fleece weights were recorded from 120, 2-year-old Merino ewes that had never been mated, and the 14 highest and 14 lowest fleeceweights were selected. The 2 groups had similar mean liveweights. These ewes were then stratified on liveweight and fleeceweight, and sub-divided into 2 treatment groups that were given restricted or abundant pasture during winter. After rainfall at the break of season (Day 0; end of April) dyebands were applied to the fleece. On Day 14 the restricted group (7 high producers and 7 low producers) was moved to a 1 ha plot, and the remaining sheep (abundant group) to an adjacent 4 ha plot. The high stocking rate was sufficient stocking pressure to maintain short, green pasture over winter and maintain the ewes at constant liveweight, whereas the low stocking rate allowed rapid liveweight gain over winter (Figure 1). The sheep were inspected regularly by a veterinarian to ensure they maintained good health. Dyebands were applied again in mid-winter, on Day 78.

Pasture growth rate increased at the beginning of spring, so that the high stocking rate was no longer sufficient to restrict gain in liveweight. At this time (Day 129), another dyeband was put on, and both groups of ewes were moved to run together on another paddock with abundant green pasture at low stocking rate. An intra-ruminal device releasing a constant amount of chromium sesquioxide (Captec chrome, Nufarm, Laverton North, Vic) was placed in the rumen, and 10 days later faecal sampes were collected daily for 3 days to be analysed for chromium. The sheep were injected with selenium and vitamin B12, and drenched with ivermectin.

Another dyeband was placed on the sheep in mid-spring (8 October; Day 161), and again when the pasture dried off (Day 203). The ewes continued to run on the pasture, which supplied abundant dry feed. Dyebands were collected and the ewes shorn on Day 323, at the beginning of March, and the unskirted fleeces weighed. Fleece yield and fibre diameter were measured by SGS Australia (Bibra Lake, WA), and staple strength by an Agri-test machine.

Results were analysed statistically by ANOV, and dyeband measurements by repeated measures ANOV with effects of treatments on patterns of wool growth being detected as an interaction between time and the factor of interest.

RESULTS

Sheep maintained in low body condition during winter gained weight rapidly in spring, while sheep fed well in winter gained little additional weight during spring (Figure1). Within each feeding treatment, high and low wool producing sheep had similar liveweights throughout the study after adjustment for wool growth.

In contrast to the differences in liveweight gain, the maximal rate of wool growth during spring was independent of the previous feeding regime (Figure 1), so that the period of increased weight gain was not accompanied by a similar increment in wool growth. The pattern of wool growth, as derived from the dyebands, was affected by the grazing treatment (Figure 1; $P < 0.05$), and by the inherent capacity of the ewes to grow wool ($P < 0.01$). However, the interaction between time, feeding regime and the inherent capacity to grow wool was not significant ($P = 0.17$). For example, the ratio of the rate of growth of wool in spring vs autumn was similar in both the restricted group (high vs low producers, 1.80 vs 1.83) and the abundant group (high vs low, 2.31 vs 2.18; Figure 1).

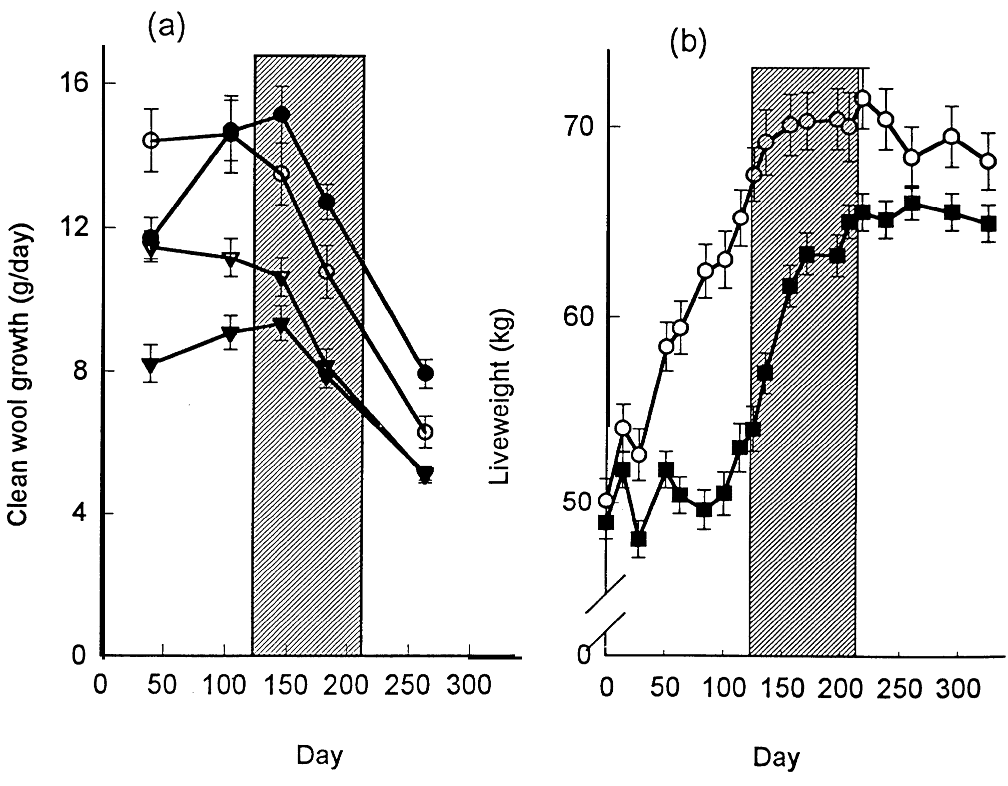

Figure 1. Rates of wool growth (a) and liveweight gain (b) for sheep fed well (open symbols) or poorly (closed symbols) during winter and given common grazing during spring (shaded areas). Figure l(a), points placed in centre of dye-banding period, for sheep with high (circles) or low (triangles) capacity to grow wool.

Table 1. Mean wool characteristics and faecal chromium (Cr) during spring in high and low producing sheep offered restricted or abundant feed during winter

	Restricted feed		Abundant feed			Probability	
	High	Low	High	Low	s.e.m.	Feed	Group
Greasy fleece wt (kg)	5.9	3.9	6.0	4.6	0.1	0.05	0.001
Clean fleece wt (kg)	4.2	2.8	4.1	3.2	0.1	0.16	0.001
Fibre diameter (μm)	24.8	23.1	23.9	23.6	0.3	0.69	0.07
CV diameter (%)	21.9	20.2	21.3	19.5	0.4	0.39	0.02
SS (N/kt)	37.5	41.4	38.0	44.5	1.5	0.53	0.07
Cr conc (ppm)	625	806	851	882	101	0.02	0.11

Over the course of the year, high producing ewes grew more wool than low producers ($P < 0.001$), and sheep offered additional feed during winter grew more wool than restricted sheep (Table 1; $P < 0.01$). These factors tended to interact, such that high producers responded less to winter feeding than low producers ($P = 0.08$). Low producers had a marginally lower fibre diameter ($P = 0.07$; Table 1), accompanied by a reduced coefficient of variation (CV) in fibre diameter ($P = 0.02$; Table 1) and a tendency to a greater staple strength ($P = 0.07$).

Ewes fed well in winter had a higher concentration of chromium in faecal samples collected in spring ($P < 0.05$), but the capacity to grow wool had no significant effect on chromium concentration (Table 1).

DISCUSSION

The results show that flow of nutrients to liveweight gain was relatively independent of the flow of nutrients to wool growth during spring. Sheep offered restricted pasture during winter gained weight rapidly in spring, but grew wool at a rate similar to sheep that gained little weight during this period (Figure 1). Conversely, the inherent capacity to grow wool affected the amount of wool growth during spring, but had no effect on the rate of body growth.

The intra-ruminal device releases chromium at a constant rate, so a lower concentration of chromium in faeces indicated a greater faecal output. Assuming that digestibility was similar in the 2 groups, the sheep that gained weight during spring had a greater feed intake than those that did not (Table 1). In most circumstances, wool growth is linearly related to feed intake (eg, Schinckel 1960; Allden 1979), so it would be expected that the animals eating more would also grow more wool. Since this did not happen, there must have been some limitation to wool growth. The limitation was probably not the animals' genetic capacity, because even the high producers grew only 15 g clean wool/day (Figure 1), somewhat less than that reported elsewhere for sheep of this type (16 to 20 g clean wool/day; Hogan *et al.* 1979). Possibly, wool growth was limited by lack of a specific nutrient such as sulphur, as suggested by Purser and Southey (1984). Interestingly, there appeared no lag effect of previous low nutrition in winter on wool growth during spring, as might have been predicted from the work of Butler-Hogg (1984).

This work indicates that the sheep partitioned spare nutrients to liveweight during spring, making it difficult to increase wool growth during this time. Thus, a micron "blow-out" is unlikely to be related to the magnitude of the spring flush of feed. Similarly, total annual wool growth depended more on the amount of feed during winter than on feed available during spring.

The low wool producers had wool with a lower CV of diameter and a tendency to greater staple strength (Table 1). An association between staple strength and CV of diameter has been reported by other workers (Ritchie and Ralph 1990). In the present study the nutritional regime did not affect the CV of diameter, even though the degree of fluctuation in rate of wool growth between seasons depended more on nutrition than on the capacity to grow wool. These results are surprising, because staple strength is strongly affected by nutrition, and it has been believed that the effects of the nutritional regime may be, mediated by changes in growth rate of wool that may be reflected in the CV of diameter. The present results suggest that the relationship between CV of diameter and staple strength depends more on the characteristics of the sheep than the nutritional regime to which it had been subjected. Clearly, there is more to be learnt about relationships between wool growth rate, variation in fibre diameter and staple strength.

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