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Differences in wool characteristics for lines of sheep with high or low levels of backfat thickness.

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ABSTRACT

Relationships between backfat thickness and wool characteristics for lines of Coopworth and Southdown sheep, selected for or against backfat thickness, were studied between years and between different age classes. On average, the lean Coopworth line grew 230 g more greasy wool ($P < 0.001$), which was 1.7 μm finer ($P < 0.001$) and less variable in diameter ($P < 0.05$) than the fat line. Other measured wool characteristics were not affected. The Southdown lines did not differ in fibre diameter, variability of diameter or curvature, within age groups. Southdown lambswool was finer ($P < 0.001$) and less variable in diameter ($P < 0.001$) than hogget or ewe wool (23.6 ± 4.9, 27.0 ± 5.6 and 26.7 ± 5.4). Fibre diameter differences observed in the Coopworth lines may have been a founder effect, as subsequent selection had little impact on it. Selection for leanness increased greasy fleece weight without affecting fibre diameter or staple length.

Keywords: wool; fibre diameter; leanness; Coopworth; Southdown.

INTRODUCTION

The viability of the sheep meat and wool industries is dependent on their abilities to provide products that meet consumer requirements. Since the early 1980s, the sheep meat industry has demanded leaner carcasses. The physiological reasons for differences in backfat thickness, and their effects on meat characteristics have been extensively studied (Purchas *et al.*, 1982; Fennessy *et al.*, 1987; Lewis *et al.*, 1996). Similarly, wool processors have demanded reductions in fibre diameter, and much research has focused on identifying the physiological determinants of fibre diameter (Reis and Schinckel, 1963; Downes and Sharry, 1971; Hawker and Kennedy, 1978; Orwin, 1980). There have been few reports referring to the effects of selection for leanness, on fibre diameter and other commercially important wool characteristics.

This paper describes two experiments, initiated to look at the effects of selection for or against backfat thickness, on the diameter, variability of diameter, curvature and opacity of wool fibres. Effects were studied between years and between various age classes of stock.

MATERIALS AND METHODS

The first experiment utilised hogget wool, harvested from lines of Coopworth ewes established and maintained at Invermay Agriculture Centre (Fennessy *et al.*, 1987). The flock consisted of lines selected for (fat) or against (lean) backfat thickness, using liveweight-adjusted ultrasonic measurements, and a randomly selected control line. Wool was harvested at approximately 12 months of age, from hoggets that had previously been shorn as lambs, at 4 months of age. Fleece weights were recorded at hogget shearing. A total of 477 samples were measured, from animals born in 1981, 1990, 1991, 1992, 1993 and 1996. Each year, each line was represented by between 11 and 35 ewe hoggets, and four sire groups.

For the second experiment, wool was harvested from Southdown sheep, which were selected for or against backfat thickness, at Massey University (Purchas *et al.*, 1982). Lean and fat lines of lambs (6 months), hoggets (18 months) and ewes (mixed age) were sampled on one occasion only, in 1999 after 15 years of selection. The hoggets and ewes were shorn 7 months prior to sampling. The lambs had not previously been shorn. Two sires represented each selection line, for each year of birth. A total of 160 animals were sampled.

All samples were measured for fibre diameter, variability of diameter, fibre curvature and fibre opacity, using an Optical Fibre Diameter Analyser. Additionally, staple length measurements were made on the Coopworth samples. Restricted maximum likelihood procedures were used to obtain estimates of means of the measured characteristics for individual selection lines. Fixed effects were selection line and year of birth (experiment 1) or selection line and age group (experiment 2). Year of birth by sire effect was fitted as a random component.

RESULTS

The lean Coopworth line grew an average of 230 g more greasy wool ($P < 0.001$) than the fat and control lines, over each of the six measurement years. Wool from the lean line was 1.7 μm finer ($P < 0.001$) and less variable in diameter ($P < 0.05$) than the fat line (Table 1). The lean line also exhibited a higher degree of curvature ($P < 0.001$) than the fat line, but had similar levels of opacity and staple length.

Details of the variance in fibre diameter between the selection lines and the control line are presented for each of the six measurement years (Figure 1). The magnitude of the difference in fibre diameter between the lean and fat lines varied between measurement years, ranging from 0.56 μm ($P > 0.10$) to 3.62 μm ($P < 0.001$). The lean line, however, was finer than the fat line in each measurement year. Fibre diameter of progeny from the foundation ewes differed by 1.76 μm ($P < 0.001$) between selection lines, the lean line being finer.

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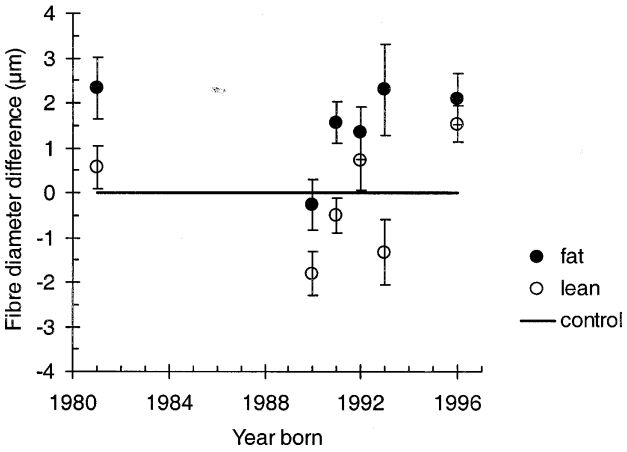
TABLE 1: Average fleece characteristics of hogget wool, from lines of Coopworth sheep selected for (fat) or against (lean) backfat thickness and a randomly selected control line, for six years of measurement.

	Selection line			pooled
	lean	fat	control	s.e.d.
greasy fleece weight (kg)	2.94[a]	2.71[b]	2.75[b]	0.14
fibre diameter (μm)	33.8[a]	35.5[b]	33.9[a]	0.8
fibre diameter variation (sd)	8.5[a]	8.8[b]	8.3[a]	0.4
opacity (%)	56.0[a]	55.8[a]	56.5[b]	0.5
curvature (degree/mm)	49.2[a]	46.9[b]	50.2[a]	2.6
staple length (mm)	116[a]	120[a]	119[a]	5

[a b] within rows, values with different superscripts differ significantly (P<0.05)
s.e.d.; standard error of the difference

FIGURE 1: Differences in fibre diameter (mean ± sem) of hogget wool from Coopworth sheep selected for (fat) or against (lean) backfat thickness, relative to a randomly selected control line (control), for 6 measurement years.



The lean Coopworth line grew 0.24, 0.26, 0.28, 0.22 and 0.49 kg more greasy fleece than the fat line in the 2nd, 3rd, 4th, 5th and 6th measurement years, respectively. These differences were significant ($P < 0.001$) in all except the fourth measurement year. In the initial measurement year, the lean line grew 0.09 kg less than the fat line ($P > 0.10$). Fleece weight data was not available for the Southdown lines.

TABLE 2: Fleece characteristics of Southdown lambs, hoggets or ewes, after 15 years selection for (fat) or against (lean) backfat thickness, harvested on one occasion.

	lamb		hogget		ewe		pooled
	lean	fat	lean	fat	lean	fat	s.e.d.
fibre diameter (μm)	23.7[a]	23.5[a]	27.2[b]	26.7[b]	26.9[b]	26.4[b]	0.3
fibre diameter variation (sd)	4.8[a]	5.0[a]	5.6[b]	5.5[b]	5.4[b]	5.5[b]	0.2
opacity (%)	55.2[a]	56.7[b]	56.6[b]	57.0[b]	56.9[b]	57.0[b]	0.4
curvature (degree/mm)	137[a]	136[a]	128[b]	124[b]	127[b]	126[b]	2

[a b] within rows, values with different superscripts differ significantly (P<0.05)
s.e.d.; standard error of the difference

For the Southdown flock, fibre diameter, variability of diameter and curvature did not differ between selection lines, within age groups (Table 2). As expected, lambswool was finer ($P < 0.001$) and less variable ($P < 0.001$) than wool harvested from hoggets or ewes (23.6 ± 4.9, 27.0 ± 5.6 and 26.7 ± 5.4 μm, respectively (mean ± sd)). Lambswool had a higher degree of curvature ($P < 0.001$), and was less opaque ($P < 0.001$) than hogget and ewe wool.

There was a relationship across all selection lines, age classes and both breeds studied, for finer fibre diameter to be associated with higher degrees of fibre curvature (Tables 1 and 2).

DISCUSSION

Selection for leanness or fatness had little impact on fibre diameter, for either the Coopworth or Southdown lines. The significant difference in fibre diameter observed in the Coopworth hoggets was probably a consequence of a founder effect. Liveweight-adjusted ultrasonic backfat thickness was the sole measurement criteria on which foundation animals were selected (McEwan *et al.*, 1990). Subsequent selection, using the same criteria, increased the separation in backfat thickness of the lean and fat lines (Morris *et al.*, 1997), but there has been little divergence in fibre diameter since their formation. The lean and fat Southdown lines exhibited no difference in fibre diameter after 15 years of selection, despite a similar method of establishment.

The increased greasy fleece production of the lean Coopworth line appeared to be a response to selection, as fleece weights of the foundation animals did not differ significantly between the lean and fat lines. Genetic correlations between fleece weight and backfat thickness have been reported to range from very low to low in Coopworth hoggets (McEwan *et al.*, 1991; Nsoso *et al.*, 1999) and Border Leicester ewes (Nsoso *et al.*, 1999). The magnitude and direction of differences in fleece production between the lean and fat Coopworth lines were consistent in magnitude and direction to the findings of McEwan *et al.* (1991) but contrasted in direction to the those reported by Nsoso *et al.* (1999).

Increases in fleece weight have been shown to produce a corresponding increase in fibre diameter (Slen, 1949; Bray *et al.* 1997). The finer fibre diameter of the lean Coopworth line contrasts with this expectation. The increase in fleece weight, with no corresponding increase in fibre diameter, is a further indication that the differences in fibre diameter between the lean and fat lines resulted from inherent differences in the foundation animals. Staple length was similar between selection lines, which means increased fibre length, increased wax and suint content and a greater number of active follicles remain as possible reasons for the increased fleece production of the lean line. These parameters were not measured.

The relationship between lower fibre diameter and higher fibre curvature, across all groups, was not unexpected. The similarity of fibre diameter and curvature in the lean and control Coopworth lines, suggests that the difference in curvature between the lean and fat lines, was more closely associated with differences in fibre diameter than backfat thickness.

Although there were differences in opacity, the degree of opacity did not exceed the threshold of 80 %, at which the OFDA records fibres as medullated, at any point of measurement for either the Coopworth or Southdown

flocks. Differences in opacity between the lean and fat lines were significant only in Southdown lambswool, and were possibly due to different amounts of medullation in the birthcoat.

In summary, selection for leanness increased the amount of greasy wool grown without affecting fibre diameter or staple length.

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