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Relationship of subcutaneous fat depth and weight changes induced by stocking rate in 4 lines of lambs

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ABSTRACT

Industry Coopworths, industry Perendales and closed lines of Romneys intensely selected for (HFR) or against (LFR) twinning, were raised in individual farmlets with ewe stocking rates of 26 (H), 21 (M) and 16 (L) ewes/ha. Lambs were slaughtered at 16, 20 and 24 weeks of age. The correlated response to selection for twinning was decreased fat depth at equal ewe stocking rates and birth-rearing status. HFR compared to LFR also increased fat depth less when weight was increased by a reduction in stocking rate. Perendales compared to Coopworths had less fat depth and increased fat depth less, when weight was increased by a reduction in stocking rate. The results suggest that fatter breeds will be comparatively leaner at high stocking rates.

Keywords Sheep; carcass; weight; fat; twinning; stocking rate; breed by environment interaction

INTRODUCTION

Heavier carcasses tend to be fatter when weight differences are caused by age, faster growth rate or better nutrition (Burton and Reid, 1969), but not necessarily when caused by sex, breed, or other genetic factors (Fourie *et al.*, 1970). It is important to know if breed fatness differences are affected by nutritionally induced weight differences. If breed differences in fatness change with intake, then this needs to be accounted for when making and interpreting breed comparison trials. The predominant dual-purpose breeds are Romney, Coopworth and Perendale and they will necessarily be the dams of most slaughter lambs. Furthermore, these breeds are grown under many nutritional levels.

Within-breed differences in fatness can be the result of direct selection for or against fatness (Fennessy *et al.*, 1982) or may be the result of selection for a genetically correlated trait (Roberts, 1979). Other important traits are wool weight, fecundity and body weight. Within-breed differences may also vary with intake induced weight differences.

Industry Coopworth (CPW), industry Perendale (PRN) and Romneys from 2 closed lines selected over 25 years for (HFR) or against (LFR) twin-bearing ewes (Clarke, 1972), were evaluated at Ruakura from 1973 to 1978 (Rattray *et al.*, 1978). Each breed group was raised in 3 farmlets with stocking rates of 26 (H), 21 (M) and 16 (L) ewes/ha. Ram lambs, except those saved at random for replacements in the HFR and LFR flocks, were slaughtered at 16, 20 and 24 weeks of age. Carcass composition was not a major objective of the experiment but subcutaneous fat depth over the *m. longissiumus dorsi* at the first lumbar (C) was measured. The purpose of this analysis is to compare breeds and selection differences for C fat depth and for the relationship between C and weight differences induced by different stocking rates.

METHOD

Carcass weight and C measurements from the previously mentioned experiment comparing CPW, PRN, HFR and LFR breed groups at H, M, and L ewe stocking rates were analysed. A statistical model including breed by ewe stocking rate combination, age of dam, birth and rearing rank and individual linear and quadratic slaughter age regressions for each breed by stocking rate combination was fitted to each year's carcass weight and C data. This model was used to estimate mean 16, 20 and 24 week carcass weight and C fat depth for each breed by stocking rate combination for ram lambs born from 1973 to 1977. These estimates and their effective numbers (inverses of the matrix diagonals, Harvey 1977) were then used in further analyses. Numbers of slaughter lambs are summarised by breed and ewe stocking rate in Table 1.

Estimated means were analysed by a split-plot model including year, breed, stocking rate and the interaction

TABLE 1 Number of lambs by breed and ewe stocking rate.

Breed	Ewe stocking rate H	M	L
HFR	177	188	196
LFR	97	119	112
CPW	193	186	242
PRN	167	196	248

of breed and stocking rate as whole plot effects and slaughter age and its interactions with breed group, stocking rate and breed by stocking rate as subplot effects. The variance of each estimated mean was assumed to be inversely proportional to its effective number.

Estimated means were further used to calculate regression coefficients of C on carcass weight within year, breed and age but across stocking rates (60 coefficients). Regression coefficients were calculated by weighting estimated means by their effective number. A statistical model fitted year, breed and age effects to these coefficients, weighting them by the corrected sums of squares for the independent variate carcass weight.

RESULTS

Mean values for carcass weights and C fat depths are shown in Table 2 by breed and stocking rate. Breed

TABLE 2 Breed and stocking rate means for carcass weight and C fat depth.

		Carcass weight (kg)	C fat depth (mm)
Breed†			
	HFR	10.8	0.84
	LFR	11.1	1.04
	CPW	13.5	1.47
	PRN	13.0	1.21
Stocking Rate‡			
	H	11.28	1.01
	M	11.77	1.04
	L	13.97	1.37

† Approximate standard errors are 0.15 kg for carcass weight and 0.05 mm for C fat depth.
‡ Approximate standard errors are 0.13 kg for carcass weight and 0.04 mm for C fat depth.

and stocking rate were significant sources of variation for both carcass weight and C fat depth but their interaction was not significant. Age and its interactions with breed and stocking rate for both carcass weight and C were also significant. These interactions are illustrated in Figs 1 and 2.

Comparisons of breed and ewe stocking rate effects on lamb carcass weight and fat depth must be made within the context of the experimental design. Equal ewe stocking rates do not imply equal lamb stocking rates between breeds or proportional lamb stocking rates across ewe stocking rates. Under the experimental conditions, CPW and PRN ram lambs had heavier carcass weights and greater C fat depth than HFR and LFR ram lambs. CPW lambs had greater C fat depth than PRN and LFR had greater C fat depth than HFR. Interactions of breed and stocking rate with slaughter

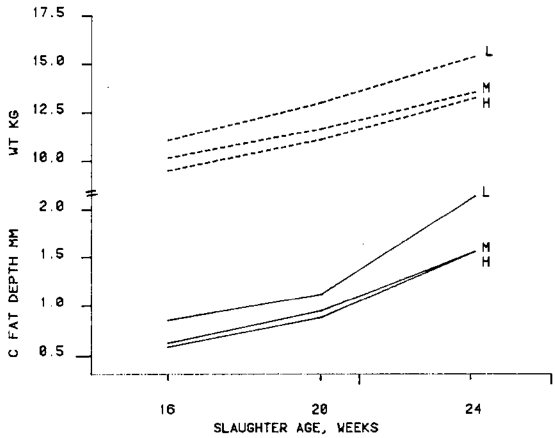

FIG. 1 Stocking rate by slaughter age interactions

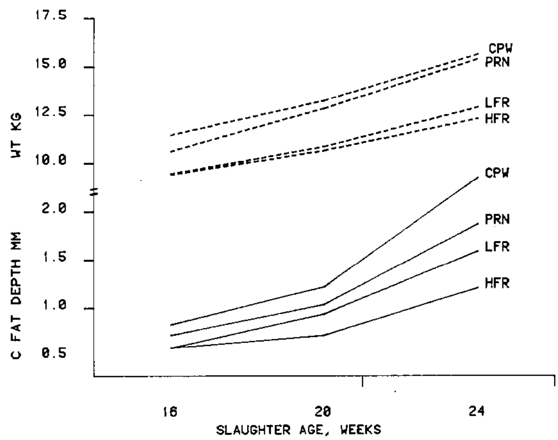

FIG. 2 Breed by slaughter age interactions

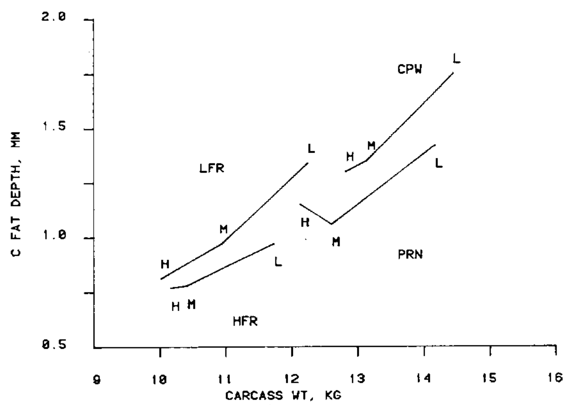

FIG. 3 Average C fat depth and carcass weight by breed and stocking rate

TABLE 3 Stocking rate induced regressions of C fat depth on carcass weight.

		Regression mm/kg	
Breed†	HFR	0.155	
	LFR	0.237	
	CPW	0.264	
	PRN	0.178	
Linear Contrasts	HFR, LFR *v* CPW, PRN	-0.025 ± .032	*P*>.40
	HFR *v* LFR	-0.082 ± .046	*P*<.10
	CPW *v* PRN	0.086 ± .042	*P*<.05

† Approximate standard error = 0.031.

age were primarily the result of increasing differences with age.

Means and linear contrasts among regression coefficients of C fat depth on carcass weight differences induced by stocking rate are shown in Table 3. Fig. 3 shows average carcass weight and C fat depth by breed and stocking rate. HFR fat depth increased less than LFR fat depth and PRN fat depth increased less than CPW fat depth per kilogram of increase in carcass weight.

DISCUSSION

The results presented have been adjusted for birth and rearing rank. This is appropriate for studying the physiological differences between breeds. Actual lamb production differences among breeds would be affected by their litter sizes. In these data the average difference between lambs born and reared as singles and those born and reared as twins was 1.9 kg carcass weight and 0.34 mm C fat depth. Thus the reported differences between HFR and LFR of −0.3 kg carcass weight and −0.20 mm C would widen to about −1.2 kg carcass weight and −0.35 mm C taking into account the difference in reproductive rate between the 2 lines (Clarke, 1972). The correlated physiological response to selection for twinning appears to be decreased subcutaneous fat depth at equal stocking rates and birth rearing status. In addition, HFR lambs appear to deposit less subcutaneous fat per kilogram of increase in carcass weight when the increases are caused by nutritional levels.

Differences among breeds in their propensities for increasing C with nutritionally induced weight increases were unexpected, in light of the low stocking rate by breed F ratios for carcass weight (0.52) and C fat depth (1.33). The only significant orthogonal component of the interaction showed that the differences in both carcass weight and C fat depth between HFR and LFR increased with decreasing stocking rate. Significantly different regression coefficients suggest that weight adjusted fat depth differences between HFR and LFR and between PRN and CPW would increase with decreasing stocking rate. Negligible differences in regression coefficients between HFR and PRN and between LFR and CPW indicate little effect of stocking rate on these breed comparisons for C fat depth although on average there was no overlap in carcass weights.

Lambs fed reduced intakes but still growing have generally been shown to have similar composition to those fed higher intakes when slaughtered at the same carcass weight (Jagusch and Nicol, 1970; Kirton, 1970; Notter *et al.*, 1983). To the extent that C fat depth reflects body composition, the present results show that ewe stocking rate (nutritional level) may influence carcass composition of breeds differently, resulting in a genotype by environment interaction. Kirton *et al.* (1982) have also suggested by indirect comparison that carcass composition of some breeds respond differently to hard hill country than to easier lowland grazing. The interaction of breed and stocking rate found in this experiment can best be characterised as one of increased difference between fatter and leaner breeds with increased nutritional level.

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