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Comparison of growth and carcass traits of ram lambs of three breeds from a flock screened for prolificacy and a Romney control flock

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ABSTRACT

Relative to an industry Romney control line, three lines derived from screening for high prolificacy, consisting of Romneys, Perendales and Coopworths had significantly heavier weaning weights after adjustment for non-genetic factors with weights of 19.9 (100), 22.3 (112), 24.0 (121) and 23.9 (120) kilograms (percentage relative to the Romney controls) for the respective flocks. The differences increased post-weaning and when slaughtered, between 175 and 219 days of age, the carcass weights (kg) were 12.0 (100), 14.3 (119), 16.1 (134), 15.7 (131) respectively for the different strains. Although the base populations of Romneys are not genetically comparable the results suggest that the intensive screening for prolificacy has indirectly resulted in animals capable of more rapid growth to slaughter. The differences between strains in their carcass weight adjusted subcutaneous fat depths were minor except that the high prolificacy Perendales had lower increases in fat depths with increasing carcass weight and had the lowest subcutaneous fat depths at heavy weights. Additionally the high prolificacy Perendales had 2 to 6 percent larger estimated *L. dorsi* areas than the other genotypes.

Keywords Sheep, breeds, Coopworths, Perendales, Romneys, prolificacy, liveweights, carcass, fat depths, *L. dorsi* area.

INTRODUCTION

The low reproductive performance of New Zealand sheep breeds is a major constraint in improving the productivity of New Zealand farming systems. For the total New Zealand flock, lambs tailed to ewes mated has been consistently below 100 percent (Anon, 1986) and has shown little apparent improvement over the last twenty years.

One approach to improving reproductive performance has been to screen the New Zealand sheep population for highly prolific animals from the major industry breeds (Parker and Rae, 1982). Romney, Coopworth and Perendale flocks resulting from such a programme are presently located at Woodlands Research Station in Southland. The initial phase of this high prolificacy trial was described by Kelly *et al.*, (1983) while the ovulation rates and litter sizes of the 1979 to 1984 progeny were described by Davis, *et al.*, (1987).

As well as providing an immediate lift in reproductive performance, it was considered that this screening technique could hasten subsequent responses to selection for prolificacy by capturing and increasing the frequencies of rare desirable genes, some of which could have major effects on this trait. Unfortunately in

both this trial and comparable overseas programmes where intensive initial screening for prolificacy has taken place (Hanrahan, 1983; Hanrahan and Owen, 1985), no comparable control flocks were set up at the initiation of these projects, so that definitive information on the size of the initial lift in prolificacy or the correlated changes in other productive traits is not available. At present comparisons of these flocks with the literature suggest a 0.3 to 0.4 increase in lambs born per ewe lambing compared to commercial flocks after adjustment for ewe mating liveweight (Davis *et al.*, 1987).

Therefore to overcome this problem, and provide more accurate information on the productive traits of the high prolificacy lines at Woodlands the Romney control line from the Romney selection project (Tait 1983) was used as a control with which to compare the growth, carcass traits, wool production and prolificacy of the selected animals.

This paper is concerned with the effects of screening for fecundity on growth and carcass traits. These traits are particularly important in the New Zealand sheep industry where dual purpose breeds are producing both wool and meat.

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TABLE 1 Genotype estimates for liveweights and carcass weights (kg)¹.

	High prolificacy		Coopworth	Romney control	Average SED
	Romney	Perendale			
Birth	4.2	4.1	4.4	4.1	0.16*
December	22.3	24.0	23.9	19.9	0.63***
January	28.2	29.9	29.8	24.6	0.71***
February	31.8	33.9	33.6	26.6	0.74***
Pre-slaughter	35.6	37.6	37.2	29.6	0.79***
Hot carcass weight	14.3	16.1	15.7	12.0	0.39***

¹Adjusted for year born, birthday, birth/rearing rank, docking group and also slaughter group nested within year where appropriate.

METHOD

The trial was conducted during 1984 to 1986. The ewes in the high prolificacy experiment consisted of progeny from the original donated ewes, although some donor ewes were still present. The programme involves 3 breeds, namely Romneys (HPR), Perendales (HPP) and Coopworths (HPC). In each of the three years of the trial the high prolificacy ewes were randomly allocated to five or six rams of their own breed which had been selected on the basis of their dams prolificacy (Davis *et al.*, 1987). All but twelve of the rams used as sires originated from within the lines. These twelve rams were hired or purchased from farmers and were used in the 1984 year only. Romney control line (RC) ewes were grazed and managed as part of the same flock in 1985 and 1986. They were derived from surplus animals from the control line of a separately managed Romney Selection experiment (Tait, 1983). The RC ewes were mated to rams chosen at random from the control line of the Romney Selection experiment.

All ram lambs from the RC flock were included in the trial and 4 to 6 ram lambs per sire from the high prolificacy lines were selected randomly, after the best and worst three animals per sire (based on dams prolificacy records) were removed. Actual numbers of progeny per sire included in the analysis ranged from 1 to 9 with 47 of the 55 sires being represented by 4-6 progeny each.

The trial ewes were run together except during

joining and after lambing, when they and their lambs were allocated by lambing date to four or six similarly managed pre-weaning grazing groups (docking groups). From weaning all lambs were grazed and managed together until slaughter. Liveweights were recorded straight off pasture with pre-slaughter liveweights being taken 1 to 3 days before slaughter.

The lambs were slaughtered on 12 March 1985 (a mean age of 175 days), 26 March (192 days) or 22 April 1986 (219 days), and 7 April 1987 (201 days). The carcasses were dressed by conventional methods. Hot carcass weights (minus kidneys and kidney fat) were recorded. After chilling overnight the *L. dorsi* width (A), depth (B) and backfat depth (C) from the cut face of the 12th rib (Palsson 1939) and the tissue thickness GR (Kirton *et al.*, 1978) were recorded.

The data were analysed by residual maximum likelihood procedures (Thompson, 1977) treating genotype, birth/rearing rank and year born as fixed effects, sires within genotype and docking group as random effects, and birth date as a covariate. Carcass traits were also adjusted for variation in carcass weight and the effect of slaughter group nested within year. First order interactions were included in initial models and were subsequently eliminated if the effects were non-significant. Best linear unbiased estimates were calculated for the traits and adjusted to the respective covariate mean. Sire variation within genotype was used to test significance of genotype differences. Genotype contrasts were calculated where appropriate.

RESULTS

Dam age, birth/rearing rank, year born, docking group and birthday all had significant effects on the liveweights recorded. The absolute size of these effects were generally largest at weaning and were similar to those reported from much larger data sets (Baker *et al.*, 1979, Tait, 1983). No first order interactions were significant for the liveweight data and so the data presented are obtained from reduced models which included main effects only.

The HPR were 3 percent heavier at birth than the RC (NS) and the difference increased to 12 percent ($P < 0.001$) by weaning at approximately 80 days of age in December. The liveweight differences continued to increase with age and had reached 19 percent ($P < 0.001$) prior to slaughter. The HPC and HPP had similar liveweights, except at birth when the Perendale was lighter ($P < 0.05$). Both breeds were heavier than the Romney lines after weaning, both in liveweight and hot carcass weight ($P < 0.05$ to $P < 0.001$). The HPP had 34 percent higher adjusted carcass weights than the RC and 12 percent higher than the HPR. Corresponding figures for the Coopworths were 31 and 10 percent respectively.

The fat depth C, measured over the *L. dorsi* muscle, was positively related to carcass weight and the slope of its regression on carcass weight was significantly different between strains (Table 3).

Similar results were observed for the GR values (Fig. 1).

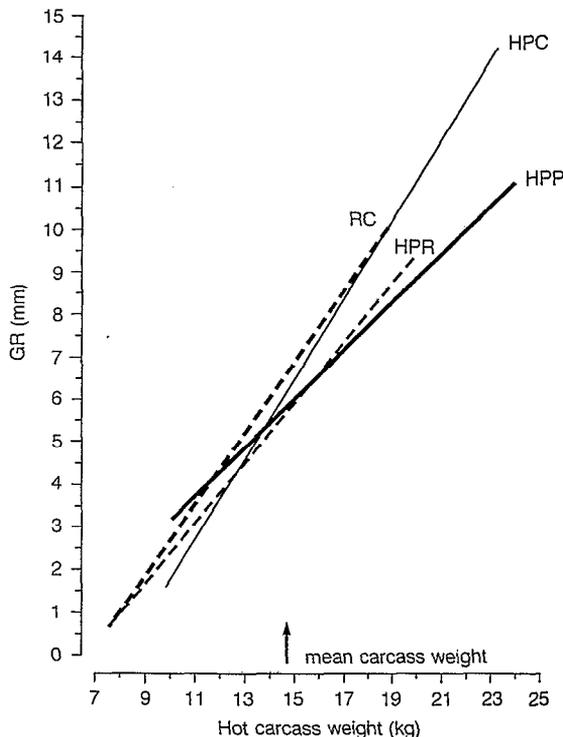


FIG 1 Effect of breed and carcass weight on measurement GR tissue depth. The beginning and termination of each line is determined by lowest and highest carcass weights observed for that strain. The mean carcass weight at which the comparisons are made in Table 2 is also shown.

TABLE 2 Genotype estimates for carcass traits at the mean carcass weight of 14.72 kg¹.

	Romney	High prolificacy Perendale	Coopworth	Romney control	Average SED
Fat depths (mm)					
C ²	2.25	2.06	2.35	2.26	0.209
GR ²	5.61	5.76	6.11	6.53	0.369*
L. dorsi measurements (mm)					
A	52.8	53.8	53.0	53.0	0.54*
B	23.6	24.5	23.7	24.1	0.45*
L. dorsi ³ (cm ²)	9.65	10.21	9.74	9.82	0.226*

¹ Means adjusted as for previous table except that hot carcass weight and interactions of hot carcass weight with breed, year born and slaughter group nested within year born were included in the model.

² Hot carcass weight by breed interactions significant see text and Figure 1.

³ Estimated L. dorsi area obtained by the equation $0.77A \cdot B / 100$.

TABLE 3 Individual genotype regressions of C and GR with hot carcass weight.

Regression mm/kg		C	GR
Strain:	Romney Control (RC)	0.308	0.827
	High Prolificacy Romney (HPR)	0.247	0.696
	High Prolificacy Perendale(HPP)	0.107	0.573
	High Prolificacy Coopworth(HPC)	0.403	0.936
Approx. SE		0.048	0.085
Linear contrasts:	HPR v RC	-0.061 ± 0.078 NS	-0.132 ± 0.120 NS
	HPC v HPP	0.296 ± 0.058***	0.363 ± 0.102***
	HPR v HPP	0.140 ± 0.058*	0.123 ± 0.102 NS

DISCUSSION

The HPP genotype had the lowest increase in the fat depths with increasing carcass weight and many of the comparisons with other genotypes were significant. Within the Romney breed the HPR genotype had a lower increase than the RC in fat depth with increasing carcass weight, but the differences were not significant in GR or fat depth C. The HPR genotype also had a significantly lower GR than the RC when compared at the average carcass weight.

The effect of carcass weight did not differ significantly between the genotypes for muscle measurements with slopes of 0.74 (± 0.19) and 0.66 (± 0.15) mm/kg for A and B, while estimated L. dorsi area increased by 0.38 (± 0.08) cm²/kg. Strain differences in the muscle measurements were significant with the HPP having the highest A and B muscle measurements and estimated L. dorsi area. At the average carcass weight the HPP estimated L. dorsi area was 6 percent larger than the HPR (P < 0.01) and 5 percent larger than the HPC (P < 0.05). After adjustment for hot carcass weight, effects of birthday, age of dam, docking group and birth/rearing rank on the carcass traits were not significant. In contrast, fat depth C differed significantly between both year and slaughter group within year (P < 0.001) with the carcass weight adjusted estimates ranging from 1.44 to 2.92 mm. The GR measurements varied in the same way as the fat depth C for birth year and slaughter group although the differences were smaller in percentage terms and were not significant.

The important information relating to the growth and carcass traits arising from this work comes from a comparison of the differences between the HPR and RC (ie, an identification of the differences associated with screening for prolificacy) and secondly the comparisons between the three high prolificacy strains.

The validity of using the RC line to compare the HPR to determine the results of screening for prolificacy depends upon how representative these sheep are of the Romney base from which the HPR were selected. The RC line was representative of New Zealand Romneys when established in 1969 with animals obtained from over 60 different sources and maintained subsequently in a way to minimise change and inbreeding (Tait, 1983). Recent evidence also suggests that "traditional" Romneys have changed little in their productive characteristics between 1948 and 1979 (Baker et al., 1987). These features and the wide sample of flocks contributing to the high prolificacy Romneys suggest that the use of the RC line as a basis for comparison is reasonable.

The comparison between the two Romney lines (Table 1) suggests that screening for high prolificacy has resulted in improved growth rate and consequently in carcass weight. The 19 percent increase in carcass weight of the HPR compared to the RC is particularly notable due to its magnitude and economic implications.

Although a weak genetic correlation exists be-

tween prolificacy and liveweight, a change of this extent would not be predicted. For example, 30 years of selection for either high or low numbers of lambs born has resulted in no change in weaning weight and only a 4 percent increase in 12 month body weight in the line selected for high reproductive performance compared with controls after adjustment for non-genetic effects (Clarke, 1972).

Several factors could be involved in the apparent improvement in liveweight and carcass weight in the HPR progeny derived from intensive screening for prolificacy. Firstly, the donated animals to the high prolificacy lines were old and had reared large numbers of lambs. The mean age at selection was 6.25 years (range 1 to 13) and the mean number of lambs born per year prior to donation was 2.66. These performance figures suggest that for the animals to survive to this age under such stress, they needed considerable buffering ability and this may have resulted in such animals being genetically heavier than average. A second possibility is that the HPR animals originated from flocks with genetically heavier sheep than the RC, especially as most animals were obtained from flocks which had been recorded on Sheeplan for several years. However it is unlikely that the observed responses could be accounted for solely by this factor (Baker *et al.*, 1987). The Sheeplan breeding values for liveweights of the rams used (in all high prolificacy lines) also were not of a magnitude to account for the differences, explaining at most several percentage units.

Selection for fecundity has been associated with reductions in subcutaneous fat depths in the Woodlands Romney selection project from which the RC line was derived (McEwan *et al.*, 1984). The present work revealed consistent but not significantly lower rates of increase in subcutaneous fat depths with carcass weight in the HPR compared to the RC (Table 3; Figure 1) and a significantly lower GR at the average carcass weight in the HPR (Table 2). At best one could conclude that this experiment only provides limited and qualified support for the previous observation of a genetic relationship between subcutaneous fat depth and fecundity.

When the high prolificacy "breeds" are compared with previous experiments, which have reported carcass weights; for the interbreeds (Meyer and Kirton 1984; Bennett *et al.*, 1984; Kirton *et al.*, 1982), or the equivalent F1 crosses (Carter *et al.*, 1974; Walker, 1949),

the rankings between the "breeds" and the magnitude of the differences are similar.

Carcass fatness parameters showed little difference between the high prolificacy "breeds" at the mean carcass weight but the HPP strain was the best for the production of lean heavy carcasses due to its significantly lower rate of increase of subcutaneous fat depths with increasing carcass weight. This characteristic of Perendales has been previously reported by Bennett *et al.*, (1984) and Rattray *et al.*, (1976) but contrasts with the results of Kirton *et al.*, (1974 and 1982) where the Romney breed was leaner than the Perendale even at heavy carcass weights.

The evidence from this study suggests that the intensive screening for prolificacy has indirectly resulted in animals capable of more rapid growth to slaughter. The differences in the estimated carcass fatness traits were minor except that the HPP may be more suitable for lean heavy lamb production due to its fast growth, slightly larger eye muscle parameters and its slower increase in fat depths with increasing weight.

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