THE EFFECT OF LEVEL OF NUTRITION ON THE PRODUCTIVITY OF SHEEP OF DIFFERENT GENETIC ORIGIN

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INTRODUCTION AND TRIAL DESIGN

THIS is an interim report covering the first 3-year period of a long-term experiment designed to measure:

(1) Genotype × environment interactions in components of lamb production from mixed-age breeding ewes.

(2) The effects of mature body size and fertility status on the level and efficiency of animal production under a grazing system.

The basic trial design is shown in Table 1 and is essentially one of four breeds at three stocking rates run on 12 farmlets with paddocks randomized on a soil type basis over a 52 ha area. Each farmlet has a mixed-age flock (2-tooth to 5-year-old) breeding its own replacements. The experiment examines the lifetime performance of ewes bred and carried at stocking rates aimed at providing levels of nutritional stress ranging from mild to severe. Ewes are culled at 6 years of age. Rams are used for only one mating season and are either supplied by commercial breeders

TABLE 1: TRIAL DESIGN

Breeds	*Stocking Rate (ewes/ha)*	*Area per Treatment (ha)*	*Ewes per Treatment*
Romney[1]			
High fertility (HFR)	26 (H)	3	78
Control (CFR)	21 (M)	4	84
Coopworth (CPW)	16 (L)	6	96
Perendale (PRN)			

Average age structure (% of total flock):

2-tooth	26.2	4-year	17.9
4-tooth	22.6	5-year	13.1
6-tooth	20.2		

[1] High fertility and control Romney flocks — origin described by Wallace (1964) and Clarke (1972).

(Coopworth and Perendale) or are selected at random from within each breed (high-fertility and control Romney).

While the Coopworth and Perendale flocks represent a cross-section of these breeds, the two Romney flocks have been closed breeding units for 28 years and comprise sheep of the Ruakura Fertility Flock described previously by Wallace (1964) and Clarke (1972). Male progeny, other than those kept for breeding purposes, are slaughtered at either 16, 20 or 24 weeks of age for carcass appraisal purposes. All ewe lambs are removed from the farmlets at 20 weeks of age and are carried on a separate area as one composite flock.

Sheep are rotationally grazed on a 24-paddock system with all groups, except possibly those at the highest stocking rate, being self-contained in terms of feed. Conserved supplementary feed is fed back on the same farmlet from which it was harvested.

A pen-mating system (Clarke *et al.*, 1974) is used during the first three oestrous cycles so that the same rams of each breed can be mated each day to teaser-marked ewes from each of the three stocking rates. At the fourth cycle all ewes are paddock mated with Southdown rams. These progeny are excluded from the lamb growth studies.

Measurements include mating and lambing performance, regular liveweights of ewes and their progeny, lamb carcass appraisal, wool production, hogget oestrous activity, milk secretion rates, and pasture growth, availability, utilization and intake.

RESULTS

Although the trial commenced at mating 1973, results presented in this paper, except those of lamb mortality, refer only to the 1974 and 1975 seasons. The 1973 results were excluded as at least 3 to 6 months were needed for stocking rate effects to develop in terms of pasture availability and liveweights and because animals were shorn soon after arrival and just before mating.

Ewe Liveweights

The relative ranking of breeds in terms of their liveweight, averaged over a 12-month period, was Coopworth (CPW) 111, Perendale (PRN) 106, control Romney (CFR) 100, and high-fertility Romney (HFR) 98 (Table 2). Sheep stocked at the lower rates were 11 and 17% heavier than those at the medium and high rates, respectively.

TABLE 2: EWE LIVEWEIGHT (kg)

Breed	*Stocking Rate*			
	High	*Medium*	*Low*	*Mean*
Romney:				
High fertility	49.2	50.8	58.0	52.6
Control	49.4	52.4	58.4	53.4
Coopworth	55.4	58.0	64.7	59.4
Perendale	53.5	56.5	60.6	56.9
Mean	51.8	54.4	60.4	

LAMBING PERFORMANCE

Ewe mortality was similar for all breeds and stocking rates.

Barrenness was greatest for the CFR flocks (22%), least for the HFR flocks (11%), while the CPW and PRN flocks were intermediate (13-14%) (Table 3). Barrenness increased with increasing stocking rate, with the overall level of barrenness being higher in 1975 (18%) than in either 1973 (7%) or 1974 (12%).

All breeds showed decreasing litter size with increasing stocking rate. Increasing the stocking rate from low (L) to high (H) decreased litter size by 13% in 1974 and 14% in 1975. The breed showing the least litter-size response to stocking rate was CFR. Litter size was highly correlated with ewe liveweight at mating (Fig. 1). While a common regression equation was derived relating litter size to mating liveweight for CPW, PRN and CFR, the regression constant associated with HFR was signifi-

TABLE 3: LAMBING PERFORMANCE
(2-year average)

	EP/EJ	*EL/EP*	*LB/EL*	*LW/LB*	*LW/EJ*
BREED					
Romney:					
High fertility	0.97	0.89	1.60	0.75	1.03
Control	0.97	0.78	1.18	0.85	0.75
Coopworth	0.97	0.86	1.48	0.85	1.06
Perendale	0.97	0.87	1.37	0.84	0.97
STOCKING RATE					
High	0.97	0.82	1.31	0.82	0.84
Medium	0.97	0.87	1.38	0.82	0.97
Low	0.98	0.88	1.52	0.83	1.07

EJ: No. ewes present at mating (joined)
EP: No. ewes present at lambing
EL: No. ewes lambing
LB: No. lambs born
LW: No. lambs weaned

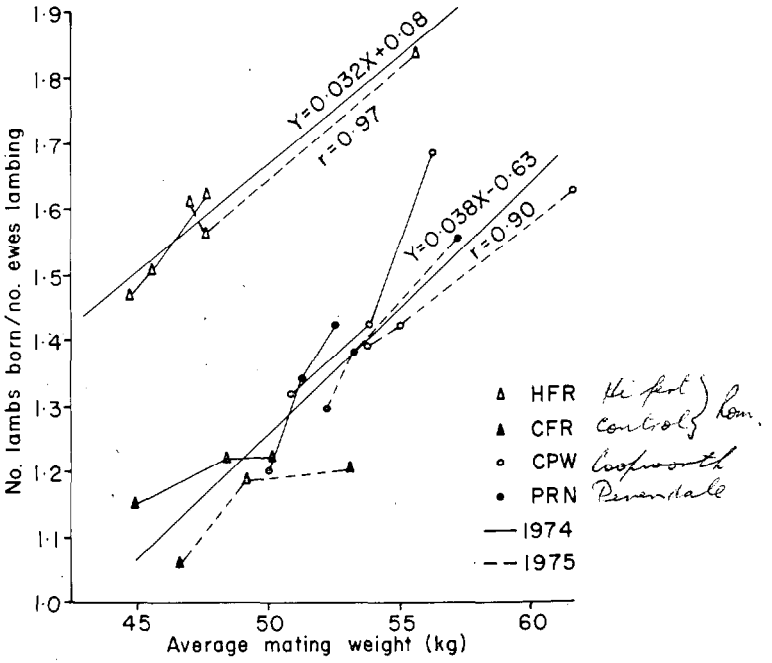

FIG. 1: *The effect of average mating weight on lambing performance.*

cantly greater. At similar mating weights HFR produced an average of 0.4 more lambs per ewe lambing than either of the other three breeds. Most of the differences in litter size betwen the CFR, CPW and PRN breeds were related to differences in mating liveweight.

Lamb survival was not affected by either stocking rate or breed except for HFR in which only 75% of lambs born survived until weaning, compared with 85% for the other breeds.

Lambs weaned as a percentage of ewes mated was highest for CPW. The relative ranking was CPW 141, HFR 137, PRN 129 and CFR 100. Stocking rate effects on the number of lambs weaned were consistent between years and on average lambs weaned per ewe mated decreased by 0.023 for every additional ewe carried per hectare.

LAMB BIRTH WEIGHTS AND MORTALITY

Multiple-born lambs were on average 16% lighter at birth than single lambs (Table 4). Increasing stocking rate from (L)

TABLE 4: LAMB BIRTH WEIGHTS (kg)
(2-year average)

	Singles	*Multiples*
BREED		
Romney:		
High fertility	4.47	3.78
Control	4.88	4.20
Coopworth	5.11	4.23
Perendale	4.79	3.94
STOCKING RATE		
High	4.74	3.93
Medium	4.78	3.99
Low	4.91	4.23

to (H) reduced lamb birth weight by 5%, the effect being more marked for multiple-born lambs than for those born as singles. The relative breed rankings for birth weight were CPW 103, CFR 100, PRN 96 and HFR 91.

There was little difference between breeds other than HFR in the mortality of lambs born as singles (Table 5). The major mortality diagnosis of single-born lambs was dystocia for CFR and PRN and exposure/starvation for HFR and CPW. While dystocia and exposure/starvation accounted for 53% of single lamb deaths at high stocking rates, this figure increased to 80% at low stocking rates with both being of similar importance.

TABLE 5: PERCENTAGE LAMB MORTALITY BIRTH — WEANING (3-year average) AND ITS RELATION TO BIRTH RANK (2-year average)

	Breed				*Stocking Rate*		
	HFR	*CFR*	*CPW*	*PRN*	*H*	*M*	*L*
Lambs dying:							
All lambs born	23.0	13.8	13.3	15.2	16.0	16.2	16.8
BORN SINGLE:							
Mortality	22.3	12.7	13.9	14.0	14.9	16.0	13.6
Deaths due to:							
Dystocia	12.2	45.5	27.8	52.4	27.3	40.0	39.0
Exposure and starvation	39.0	29.5	36.1	14.3	25.5	23.7	40.8
BORN MULTIPLE:							
Mortality	25.4	15.7	10.1	18.4	20.0	16.5	19.1
Deaths due to:							
Dystocia	19.1	25.0	36.8	25.5	18.1	20.0	27.9
Exposure and starvation	47.8	50.0	39.5	38.2	43.1	50.0	42.3

For lambs born as multiples exposure and starvation were more important (average 44%) causes of death than dystocia (27%). While dystocia increased with decreasing stocking rate there was no clear effect of stocking rate on deaths due to exposure and starvation. The survival of CPW multiple-born lambs was considerably better than that of any other breed, a result reflected in part also in single-born lambs.

Milk Secretion Rate

The relative rankings for milk secretion rates were CPW S 119, T 128; PRN S 116, T 121; HFR S 101, T 115; and CFR S 100, T 100 (Table 6). Twin-bearing ewes secreted 30% more milk

TABLE 6: MILK SECRETION RATES (0-10 weeks) (l/day)
(2-year average)

	Single-suckled Ewes	*Twin-suckled Ewes*
Breed		
Romney:		
High fertility	1.13	1.57
Control	1.12	1.37
Coopworth	1.33	1.75
Perendale	1.30	1.66
Stocking Rate		
High	1.12	1.54
Medium	1.17	1.43
Low	1.37	1.79

than single-bearing ewes. Ewes at the low stocking rates secreted more milk than those at the highest stocking rates (single-bearing ewes + 22%, twin-bearing ewes + 16%). Lamb growth rate was highly correlated with milk secretion rate ($r = 0.74$).

Lamb Weaning Weight and Growth Rate

The relative ranking of breeds in terms of lamb weaning weight was CPW 107, PRN 103, CFR 100 and HFR 88 (Table 7). These results are influenced by the ratio of single to multiple-born lambs for each breed. Comparable lamb growth rate ranking was CPW 109, PRN 104, CFR 100 and HFR 87. Lambs reared at higher stocking rates were lower in weaning weight and rate of growth than those born at the lower stocking rates.

TABLE 7: LAMB WEANING WEIGHT[1] AND GROWTH RATE (BIRTH-WEANING)[1]

	Weaning Weight (kg)	*Growth Rate (Birth-weaning, g/day)*
BREED		
Romney:		
High fertility	17.7	161
Control	20.1	185
Coopworth	21.6	202
Perendale	20.8	193
STOCKING RATE		
High	19.0	175
Medium	19.4	179
Low	21.8	205

[1] Not corrected for birth rank, weaned at 12 weeks of age.

TABLE 8: WOOL PRODUCTION
(2-year average)

	Fleece Weight (kg)	*Staple Length (cm)*	*Quality No.*	*Style Grade*	*Colour Grade*	*Character Grade*
BREED						
Romney						
High fertility	3.04	12.3	47.6	2.8	3.6	3.6
Control	3.48	13.3	46.9	2.9	3.7	3.6
Coopworth	3.77	14.2	46.0	3.0	3.8	3.8
Perendale	3.33	12.6	48.6	3.2	3.8	3.8
STOCKING RATE						
High	3.26	12.8	47.3	2.9	3.7	3.6
Medium	3.29	12.8	47.8	3.0	3.6	3.7
Low	3.67	13.7	46.8	3.0	3.9	3.8

WOOL PRODUCTION

Fleece weights and staple length followed the same trends as liveweight for both breeds and stocking rates, with CPW producing most wool and HFR least (Table 8). Sheep stocked at the highest rate produced 11% less wool than those at the lowest rate; PRN and HFR fleeces were slightly finer than those of CPW and CFR. While stocking effects were apparent they were small. There were no significant effects between either breeds or stocking rates in style, colour or character grades.

TABLE 9: PASTURE DRY MATTER INTAKES (kg DM/ewe/year)
(2-year average)

	1973-4	*1974-5*	*Mean*
BREED			
Romney			
High fertility	636	693	665
Control	563	688	626
Coopworth	744	816	780
Perendale	682	755	719
STOCKING RATE			
High	567	620	594
Medium	622	740	681
Low	779	854	817

PASTURE DRY MATTER INTAKE AND EFFICIENCY OF PRODUCTION

The average level of pasture production during the 1974 and 1975 seasons was 13 600 kg DM/ha. The ranking of dry matter intakes was CPW 125, PRN 115, HFR 106 and CFR 100 (Table 9). Ranking for the three stocking rates was Low 138, Medium 115 and High 100. The higher intakes of CPW and PRN are reflected in both heavier liveweights and in higher levels of production — *i.e.,* similar response as shown in stocking rates. Ewe liveweight appeared to have a more significant effect on dry matter intake than fertility status since the HFR flocks consumed only 6% more feed than the CFR flocks. In these latter flocks HFR weaned 33% more lambs while being only 2% lighter in liveweight.

TABLE 10: EFFICIENCY OF PRODUCTION

	kg Lamb Weaned per 1000 kg DM Intake	*kg Wool Produced per 1000 kg DM Intake*	*Per ha Production (kg)* *Lamb Weaning Weight*	*Wool*
BREED				
Romney				
High fertility	27.0	4.59	390	63.9
Control	24.1	5.60	314	73.1
Coopworth	29.2	4.84	481	79.2
Perendale	27.9	4.65	427	70.0
STOCKING RATE				
High	26.2	5.47	412	84.8
Medium	26.6	4.80	390	69.0
Low	27.8	4.49	370	58.8

Feed intakes and levels of production have been used to calculate the efficiency indices shown in Table 10. Those breeds and stocking rates shown to be most efficient in terms of lamb weaning weights tended to be least efficient in terms of wool production. Breed efficiency ranking for weaning weight was CPW 121, PRN 116, HFR 112 and CFR 100. The comparable ranking for wool production was CPW 86, PRN 83, HFR 82 and CFR 100. The low ranking of HFR for weaning weight is a reflection of low lamb survival. The high efficiency of CFR for wool production appears to be a result of the proportion of dry-dry sheep compared with the other three breeds.

The efficiency of producing lamb weaning weight decreased with increasing stocking rate while that of wool production increased with increased stocking rate. However, stocking rate effects were more marked for wool production than for weaning weight.

CPW produced more wool and weaned more weight of lamb per hectare than either of the other three breeds. The least efficient breed in terms of lamb weaning weight was CFR and of wool production HFR. The production of lamb weaning weight and wool per hectare increased with increasing stocking rate.

While these trends were consistent in both 1974 and 1975, they represent the results of only two years of a long-term experiment. A final assessment should not be made until the experiment has continued for sufficient years to encompass a wide range of yearly fluctuations in pasture production.

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