THE EFFECT OF PASTURE ALLOWANCE ON THE PERFORMANCE OF DIFFERENT BREEDS OF SHEEP

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Abstract

In a trial conducted at Ruakura over 5 years, mixed-age flocks of Coopworth, Perendale, High Fertility Romney, and Control Romney ewes were run on separate farmlets stocked at 26, 21 or 16 ewes/ha. At any given pasture allowance the Coopworth ate more pasture than the other breeds. Lambing performance, weight of lamb weaned and fleece weight were curvilinearly related to allowance. Lamb production per ewe tended to level out at a DM allowance of 4 kg/ewe/day for the Perendale and about 5 kg/ewe/day for the other breeds. Pasture allowance accounted for an appreciable amount of variation in animal production between years and stocking rates; litter size, 38 to 90%; lambs weaned/ewes mated. 29 to 71%; weight of lamb weaned/ewe mated, 26 to 62%; and fleece weight, 25 to 49%. Pasture allowance accounted for the least variation in all variables in the Perendale compared with the other breeds.

INTRODUCTION

FEEDING levels for the breeding ewe at critical periods of the year and for different levels of performance are well known from intake studies with penned and grazing animals (Jagusch and Coop, 1971; Rattray, 1978). However, the grazing animal does not utilize all the pasture offered to it. Pasture allowance is a measure of the amount of pasture above ground level offered per animal per day. Short-term experiments have shown that animal performance increases with pasture allowance up to an asymptote in quite a precise manner (Rattray and Jagusch, 1978).

This paper examines the animal performance from a 5-year farmlet study conducted at Ruakura with various breeds of ewe, to ascertain the extent to which annual pasture allowance influenced production between years and between stocking rates. Data are presented for the final 4 years for which complete pasture and animal measurements were made. Interim and final summaries of the levels of animal production and pasture production have been given elsewhere (Dalton *et al.*, 1978; Jagusch et al., 1978; Joyce et *al.*, 1976a, 1976b; Rattray et al., 1978).

EXPERIMENTAL

The trial design, grazing management and methods of measurement are given in detail in the above reports, but very briefly they were as follows,

Mixed-age flocks (26.2% two-tooth, 22.6% four-tooth, 20.2% six-tooth, 17.9% 4-year and 13.1% 5-year ewes) of Coopworth (COOP), Perendales (PER), the Ruakura High Fertility Romneys (HFR) and Control Romneys (CFR) were run on separate farmlets at 26, 21 or 16 ewes/ha.

Apart from 1 month of set-stocking over lambing, the ewes were rotationally grazed on a 24-paddock system, reaching a slow 60 to 70 day rotation during winter.

Net pasture production, pasture allowance and pasture intake (pasture "disappearance") were measured using a cutting technique with the use of exclosure cages (Jagusch et *al.*, 1978).

RESULTS AND DISCUSSION

PASTURE ALLOWANCE AND PASTURE PRODUCTION

On an annual basis the major determinants of pasture allowance are the stocking rate and level of pasture production. Changes in allocation of feed, by altering rotation length, can adjust allowance at critical times of the year.

Annual net pasture production and average pasture allowance over all treatments increased during the course of the experiment (Table 1). In general, levels of animal production and amounts of conserved pasture followed a similar trend to net annual pasture production (Table 2). There was a significant effect of stocking rate on pasture production, allowance and

TABLE I: EFFECT OF YEAR ON NET PASTURE PRODUCTION, PASTURE ALLOWANCE, PASTURE INTAKE AND UTILIZATION

Year	*Net Pasture Production (kg DM/ha)*	*Pasture Allowance (kg DM/ ewe/day)*	*Pasture Intake (kg DM/ ewe/day)*	*Utilization per Grazing (%)*
1973-4	11800	3.2	1.5	49.5
1974-5	14 500	3.6	1.8	48.2
1975-6	19 200	4.9	2.0	45.3
1976-7	18 000	4.6	1.9	43.7
SE of Diff. (±)	1340	0.32	0.15	2.52
Sign.	$P<0.001$	$P<0.001$	$P<0.001$	$P<0.05$

TABLE 2: AVERAGE ANNUAL NET PASTURE PRODUCTION, SURPLUS OF HAY AND SILAGE, AND ANIMAL PRODUCTION

Year	Net Pasture Production (kg DM/ha)	Surplus Hay or Silage (kg DM/ewe)	Mating Weight (kg)	Lambs Weaned/ Ewes to Ram (%)	Fleece Weight (kg/ewe)
1973-4	11 800	9	49	94	3.7
1974-5	14 500	16	52	96	4.2
1975-6	19 200	79	61	114	4.4
1976-7	18 000	59	62	114	4.5

TABLE 3: EFFECT OF STOCKING RATE ON NET PASTURE PRODUCTION, PASTURE ALLOWANCE, PASTURE INTAKE AND UTILIZATION

Stocking Rate (ewes/ha)	Net Pasture Production (kg DM/ha)	Pasture Allowance (kg DM/ ewe/day)	Pasture Intake (kg DM/ ewejday)	Utilization per Grazing (%)
26	17 100	3.5	1.7	50.6
21	16 300	4.0	1.8	46.9
16	15 000	4.7	1.9	42.5
SE of Diff. (±)	1 170	0.32	0.13	2.20
Sign.	$P<0.05$	$P<0.001$	$P<0.10$	$P<0.01$

intake (Table 3). There were no significant interactions between stocking rate and year, season, breed, or soil type. Some of the effect on pasture production could be due to the technique of measurement, *i.e.,* greater decay under low stocked pastures. However, there were greater levels of utilization, lower proportions dead material, greater numbers of ryegrass (*Lolium perenne*) tillers, and fewer numbers of browntop (*Agrusfis tenuis*) and Yorkshire fog (*Holcus lanatus*) plants as stocking rate increased (Jagusch *et al.,* 1978; Rattray *et al.,* 1978).

The effect of breed on pasture production, allowance and utilization is shown in Table 4. There was no significant difference between breeds in pasture production or intake. The amount of pregrazing and post-grazing DM/ha was 2900 and 1500 kg/ha for the Coopworths, and 3300 and 1900 kg/ha for the other breeds. This was due to the higher per grazing utilization by the Coopworths, and led to their having lower average pasture allowances than the other breeds.

TABLE 4: EFFECT OF BREED ON NET PASTURE PRODUCTION, PASTURE ALLOWANCE, PASTURE INTAKE AND UTILIZATION

Breed	*Net Pasture Production (kg DM/ha)*	*Pasture Allowance (kg DM/ ewe/day)*	*Pasture Intake (kg DM/ ewe/day)*	*Utilization per Grazing (%)*
HFR	16 200	4.1	1.7	46.6
CFR	15 300	4.2	1.7	43.7
COOP	16 900	3.7	1.9	51.2
PER	16 200	4.3	1.8	45.1
S.E. of Diff. (±)	1 350	0.32	0.15	2.55
Sign.	n.s.	$P < 0.05$	n.s.	$P < 0.01$

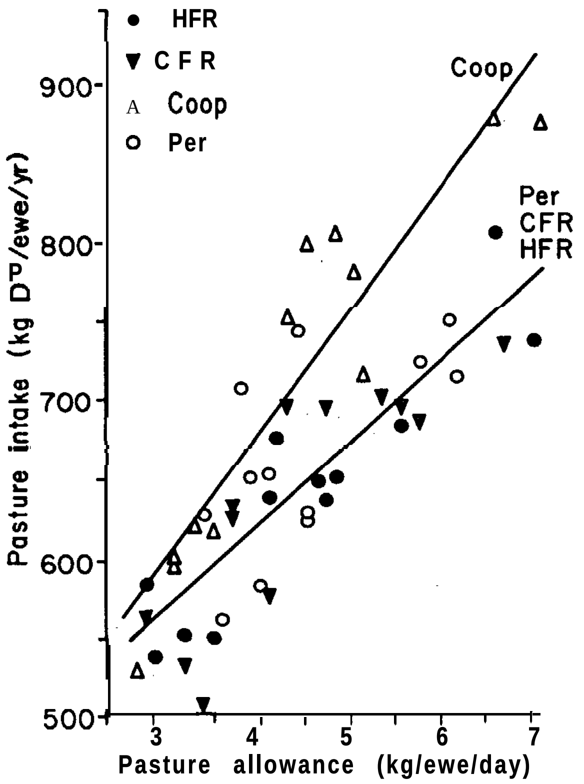

FIG. 1: *Relationship between annual pasture intake and average daily pasture allowance.*

Pasture Allowance and Intake

The relationships betwen total annual pasture intake and average daily pasture allowance across years and stocking rates are shown in Fig. 1. (*N.B.*: In all figures each observation is for 78 to 96 ewes.) The relationships for the HFR, CFR, and PER did not differ, and the overall regression was Y = 53.7 X + 403 (n = 36, r = 0.83, S_b = ± 6.2, Y is annual pasture DM intake/ewe and X is average daily DM allowance per ewe). The slope of the relationship for the COO? (Y = 81.1 + 348, n = 12, r = 0.93, S_b = ±9.9) was significantly different ($P < 0.05$), and showed that at any allowance the Coopworths ate more than the other breeds, and this effect was greater at higher allowances.

Ewe Liveweight

Ewe liveweights were related to annual pasture intake, with pre-lambing liveweight being more closely related than mating liveweight. Pre-lambing liveweight (Y) was closely related to mating liveweight (X) , with no significant difference between the breeds. The overall relationship was: Y = 0.96 X + 10.3 (n = 48, r = 0.92, S_b ± 0.059). Figure 2 shows the relationship between pre-lambing liveweight (Y) and animal DM intake (X) . Breeds did not differ significantly. The regression was: Y =

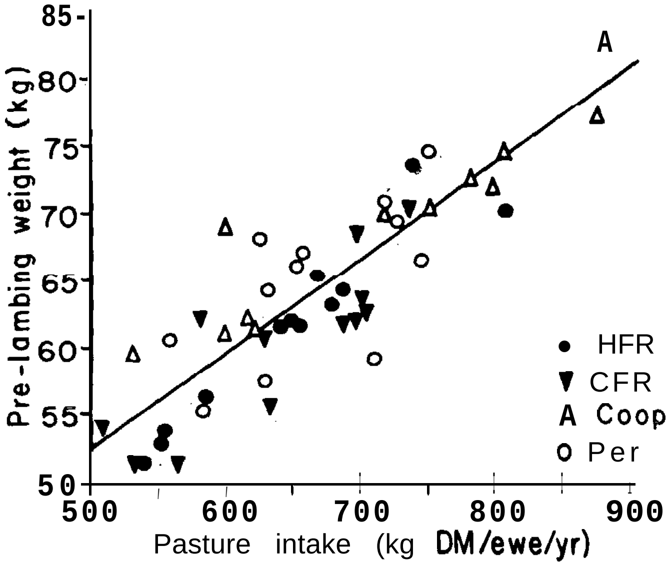

FIG. 2: Relationship between pre-lambing liveweight of the ewes and pasture allowance.

$0.072\ X + 15.8$ ($n = 48$, $r = 0.86$, $S_b = \pm 0.0064$). In spite of there being no significant difference between breeds, most of the COOP and PER observations lie above the line, while the HFR and CFR lie below. Because of this and differences in intake response to pasture allowance, there were breed differences in the relationships between pre-lambing liveweight and allowance (Fig. 3). The regressions were:

COOP $Y = 4.71\ X + 48.2$ ($n = 12$, $r = 0.89$, $S_b = \pm 0.75$, $S_a = 13.54$)

PER $Y = 5.20\ X + 41.1$ ($n = 12$, $r = 0.82$, $S_b = \pm 1.14$, $S_a = \pm 5.34$)

HFR & CFR $Y = 4.81\ X + 39.1$ ($n = 24$, $r = 0.91$, $S_b = \pm 0.46$, S_a = rt2.14)

Although there were no significant differences in slope, the intercepts of the COOP and overall Romney regression differed ($0.05 < P < 0.10$). That for the PER was intermediate between these two but was not significantly different from either.

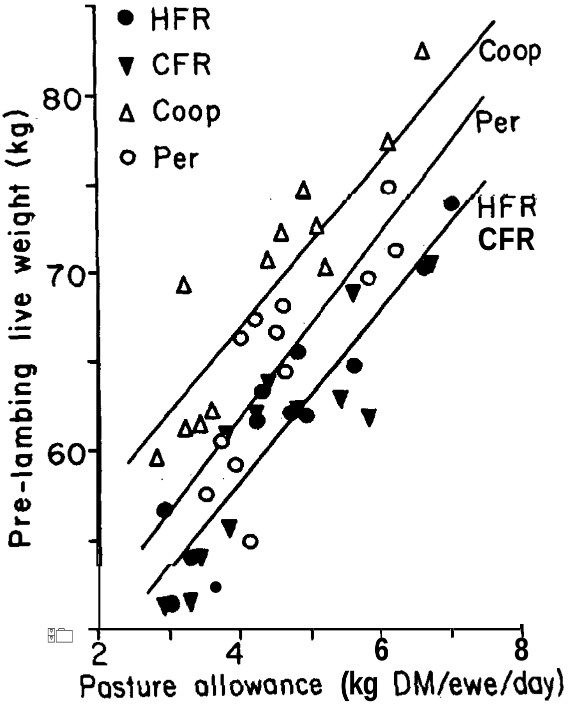

FIG. 3: *Relationship between pre-lambing liveweight and average daily pasture allowance.*

Although the number of twins carried would differ between the CFR and HFR and also with ewe liveweight, short-term trials have shown ewe liveweight gain of single- and twin-bearing ewes to be very similar at the same allowance (Rattray and Jagusch, 1978).

Lambing Performance

The following curvilinear relationships between lambs born/ ewe lambing (Y) and average pasture allowance (X) are shown in Fig. 4.

$$\text{HFR} \quad Y = 2.21 - \frac{2.11}{X} \quad (r = -0.90,\ S_a = \pm 0.079,\ S_b = \pm 0.325)$$

$$\text{CFR} \quad Y = 1.55 - \frac{1.33}{X} \quad (r = -0.95,\ S_a = 20.034,\ S_b = \pm 0.140)$$

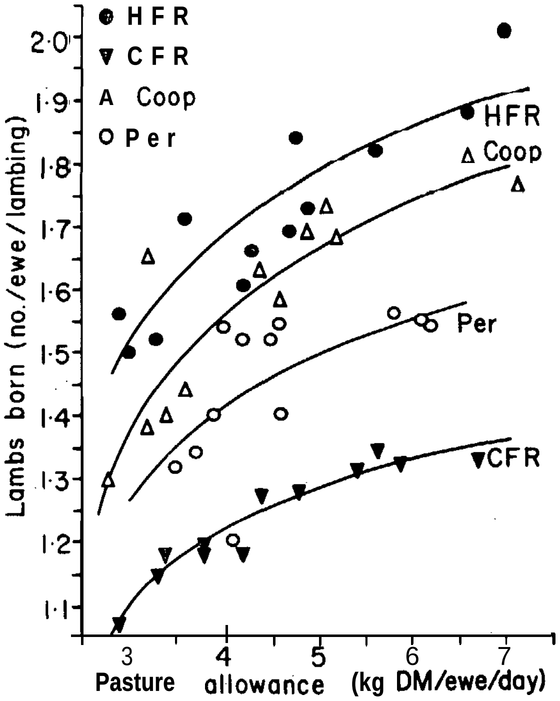

FIG. 4: *Relationships between litter size and pasture allowance.*

$$\text{COOP} \quad Y = 2.10 - \frac{2.15}{X} \quad (r = -0.88,\ S_a = \pm 0.091,\ S_b = \pm 0.364)$$

$$\text{PER} \quad Y = 1.84 - \frac{1.72}{X} \quad (r = -0.62,\ S_a = \pm 0.156,\ S_b = \pm 0.681)$$

The HFR and COOP curves are almost parallel, with the COOP having approximately 0.15 fewer lambs at any given allowance. The CFR responds less than the HFR as allowance increases, and at any given allowance has a lower litter size by 0.4 to 0.55 lambs per ewe lambing. This low litter size is partly due to inbreeding (Clarke, 1978) . The poorest relationship was that of the Perendales. The actual observations were similar to the Coopworths up to an average allowance of approximately 4 kg DM/ ewe/day, with very little response thereafter.

The relationships of lambs weaned/ewe mated (Y) and pasture allowance (X) shown in Fig. 5 are as follows:

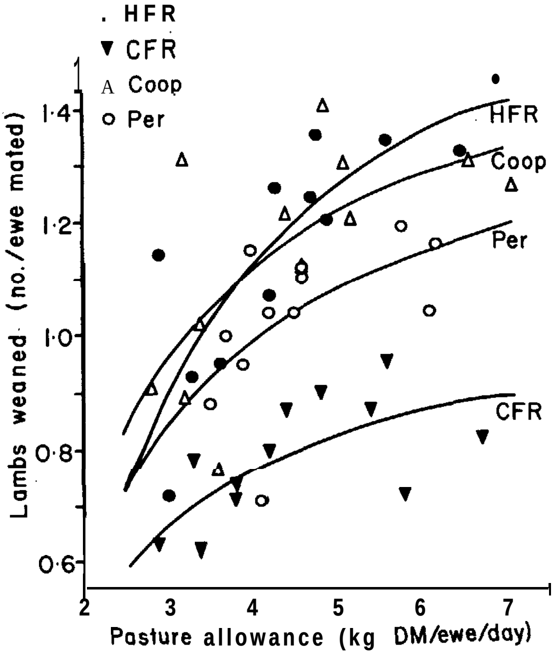

FIG. 5: *Relationships between lambs weaned/ewe mated and average daily pasture allowance.*

HFR $Y = 1.79 - \frac{2.68}{X}$ ($r = -0.84$, $S_a = \pm 0.135$, $S_b = \pm 0.555$)

CFR $Y = 1.06 - \frac{1.19}{X}$ ($r = -0.66$, $S_a = \pm 0.104$, $S_b = \pm 0.430$)

COOP $Y = 1.60 - \frac{1.92}{X}$ ($r = -0.66$, $S_a = \pm 0.172$, $S_b = \pm 0.692$)

PER $Y = 1.42 - \frac{1.71}{X}$ ($r = -0.54$, $S_a = \pm 0.193$, $S_b = \pm 0.846$)

There is no significant difference between the COOP and HFR relationships.

Low lamb survival rates of the HFR, partly associated with inbreeding (Clarke, 1978), are responsible for this breed losing its litter size advantage by weaning at the lower allowances (4 kg). At higher allowances some advantage over the Coopworth is retained. The CFR is the lowest relationship, due mainly to the low litter size but also to higher losses between birth and weaning. The PER is intermediate, mainly because of its failure to respond in litter size to high allowances. However, compared with the other breeds, the proportion of variation accounted for in the PER relationship is the smallest, failing to reach significance at the 5% level.

Weight of Lamb Weaned

Relationships between weight of lamb weaned per ewe mated (Y) and pasture allowance (X) are shown in Fig. 6. These are:

HFR $Y = 36.5 - \frac{62.1}{X}$ ($r = -0.79$, $S_a = 13.67$, $S_b = \pm 15.15$)

CFR $Y = 23.6 - \frac{32.7}{X}$ ($r = -0.73$, $S_a = \pm 2.36$, $S_b = \pm 9.77$

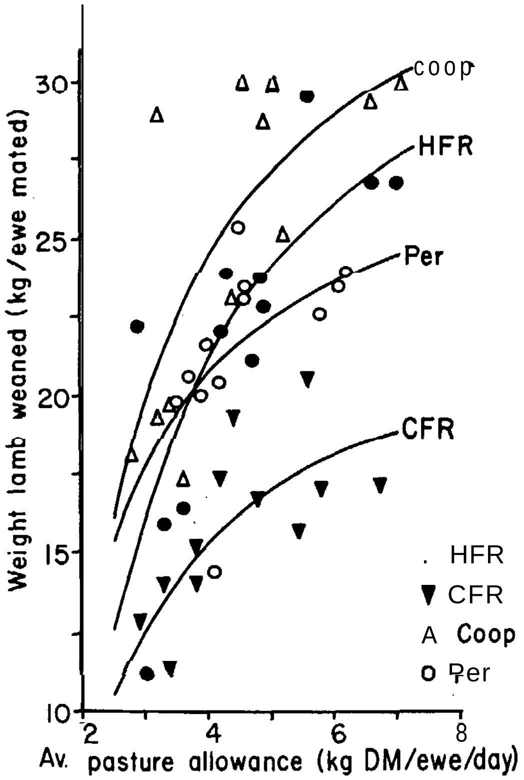

FIG. 6: *Relationship between weight of lamb weaned/ewe mated and average daily pasture allowance.*

COOP $Y = 38.0 - \frac{54.3}{X}$ ($r = -0.73$, $S_a = \pm 4.01$, $S_b = \pm 16.11$)

PER $Y = 29.6 - \frac{35.6}{X}$ ($r = -0.53$, $S_a = \pm 4.12$, $S_b = \pm 18.03$)

The COOP and HFR are the highest and similar, the higher growth rates of the COOP showing to advantage. The CFR are the lowest owing to poor litter size, and the PER are intermediate.

FLEECE WEIGHTS

Figure 7 contains the following relationships between ewe fleece weight (Y) and pasture allowance (X) :

HFR $Y = 5.0 - \frac{4.9}{X}$ (r = -0.70, $S_a = \pm 0.38$, $S_b = \pm 1.58$)

CFR $Y = 5.4 - \frac{4.7}{X}$ (r = -0.70, $S_a = \pm 0.38$, $S_b = \pm 1.53$)

COOP $Y = 5.3 - \frac{3.0}{X}$ (r = -0.65, $S_a = \pm 0.28$, $S_b = \pm 1.11$)

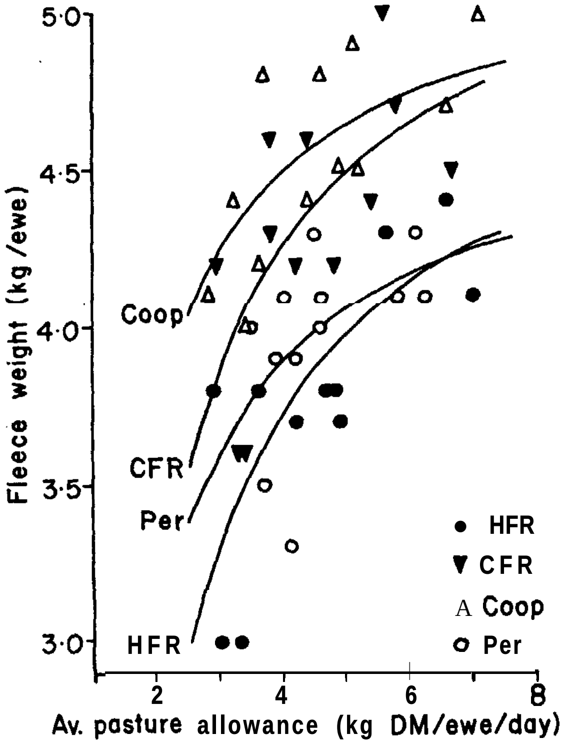

FIG. 7: *Relationships between ewe fleece weight and average daily pasture allowance.*

PER $$Y = 4.7 - \frac{3.4}{X} \quad (r = -0.50, \; S_a = \pm 0.44, \; S_b = 21.90)$$

The HFR and PER relationships are similar, while the CFR and COOP relationships are similar. The HFR has a relatively light fleece compared with the CFR at the same allowance, due in part to a negative genetic link with fertility as well as to the high number of twins carried and suckled by the former (Clarke, 1978; Rattray et al., 1978).

CONCLUSIONS

The relationships between intake and pasture allowance, and ewe liveweight and either intake or allowance, were linear. Pasture allowance accounted for 69 to 86% of the variation in intake between years and stocking rates, and for 67 to 83% of the differences in liveweight.

At any given allowance the Coopworth had a higher intake and liveweight than the other breeds. The higher appetite is probably due to the relatively high liveweight of this breed.

Other measures of performance were related curvilinearly to allowance, which accounted for 25 to 90% of the variation between stocking rates and years. Part of the reason for the poorer relationship would be that average annual allowance is not a good index of allowance at critical periods. It appears that pasture allowance, either directly or via its effect on ewe body weight, does account for a considerable proportion of the variability in performance between years and stocking rates. During some periods (e.g., lactation) there is some mobilization of maternal tissue energy for lamb and wool growth. Liveweight also influences ovulation rate and lambing performance. Liveweight

TABLE 5: PROPORTION OF VARIATION IN PERFORMANCE ASSOCIATED WITH PASTURE ALLOWANCE OR EWE LIVEWEIGHT

	Allowance (%)	*Liveweight* (%)
Litter size (n/ewe lambing)	38-90	62-85
Lambs weaned (n/ewe mated)	29-71	50-87
Weight lamb weaned (kg/ewe mated)	28-62	65-74
Fleece weight (kg)	25-49	35-62

gained at non-critical periods could thus influence performance. Table 5 shows the proportion of variation in performance associated with pasture allowance or body weight (Rattray *et al.,* 1978, unpublished). Multiple regression of performance against both pasture allowance and ewe body weight was not used because of the high partial correlation between bivariates.

The Perendale relationships were lowest in terms of accounting for variability, mainly because this breed failed to respond to allowances greater than 4.0 kg DM/ewe/day. The other breeds also demonstrated curvilinearity in the relationships, tending to level off in terms of lambs weaned/ewe mated and weight of lamb weaned at an allowance of 4.5 to 5 kg DM/ewe/day.

From estimates of intake, ewe liveweight and levels of performance it is possible to predict how these vary with allowance (Table 6). Because the two strains of Romney are atypical of industry sheep, the trends given are for Coopworths and the Perendales. The level of nutrition could be imposed by different stocking rates or different levels of pasture production between years or between districts. For any given level of pasture production, because of their lower appetite and liveweight more Perendale ewes could be carried per hectare. In a previous report from this trial it was shown that similar levels of animal production per hectare could be obtained by 26 Perendales and 21 Coopworths or by 21 Perendales and 16 Coopworths (Rattray *et*

TABLE 6: PREDICTED PASTURE INTAKES, EWE LIVEWEIGHTS AND LEVELS OF PERFORMANCE OF COOPWORTHS AND PERENDALES OVER A RANGE OF PASTURE ALLOWANCES

	Average Pasture Allowance (kg DM/ewe/d)							
	3		4		5		6	
	COOP	*PER*	*COOP*	*PER*	*COOP*	*PER*	*COOP*	*PER*
Pasture intake (kg DM/ewe/yr)	591	564	672	618	754	672	835	725
Ewe mating weight (kg)	54.2	48.3	59.1	53.8	64.1	59.2	69.0	64.6
Ewe pre-lambing weight (kg)	62.3	56.7	67.0	61.9	71.8	67.1	76.5	72.3
Lambs born/ewe lambing (%)	138	127	156	141	167	150	174	155
Lambs weaned/ewes mated (%)	96	85	112	99	122	108	128	114
Weight lamb weaned/ ewe mated (kg)	19.9	17.7	24.4	20.7	27.1	22.5	29.0	23.6
Fleece weight (kg)	4.3	3.6	4.6	3.9	4.7	4.0	4.8	4.1

TABLE 7: LEVEL OF ANIMAL PRODUCTION AND RETURNS FROM COOPWORTH AND PERENDALE EWES

Ewes/ha	*16 COOP*	21 *PER*	*21 COOP*	26 *PER,*
Wool (kg/ha)	96	101	111	117
Meat (kg/ha)	280	281	312	299
Gross returns ($/ha) :				
Wool	173.09	182.11	200.14	210.96
Meot	187.60	188.27	209.04	200.33
Total	360.69	370.38	409.18	411.29
Animal health + shearing ($/ha)	24.00	31.50	31.50	39.00
Difference ($/ha)	336.69	338.88	377.68	372.29

al., 1978); *i.e.,* 1.2 to 1.3 Perendale ewes could be carried per 1.0 Coopworth ewe to give similar levels of production per unit area. This is in part due *to* differences in liveweight between these breeds, as annual feed requirement is linearly related to liveweight.

The average levels of wool and lamb carcass production achieved (Rattray et *al.,* 1978) over the last 4 years of the trial, by both breeds at these stocking rates, are shown in Table 7, together with the gross returns. These are based on last year's schedule prices for lamb (67c/kg) and for greasy wool (180.3 c/kg) (N.Z. Meat and Wool Boards' Economic Service, 1978). The costs for animal health and shearing are assumed to be $1.50/ewe. This is equivalent to the 1975-6 costs (N.Z. Meat and Wool Boards' Economic Service, 1977) with an allowance for inflation of about 12% per annum. The Perendales produced slightly more wool/ha than the Coopworths, but less or comparable amounts of meat, and came out slightly ahead in terms of gross returns per hectare. Because, however, more Perendale ewes are required to achieve these comparable levels of production, when the costs of animal health and shearing are taken into account this advantage is considerably reduced (16 Coopworths/ha. *vs* 21 Perendales/ha) or lost (21 Coopworths/ha *vs* 26 Perendales/ha).

Coopworths respond to high levels of feeding and appear suited to highly productive land or low stocking rates. In contrast, Perendales fail to respond to very high levels of feeding or to mating weights over 60 kg (Rattray et *al.,* 1978), and are more suited to high stocking situations or less productive land such as much of the hill country, where the attributes of this breed are already recognized.

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