
VOLUME 62 2002

THE DYNAMICS OF PASTURE PRODUCTION UNDER SHEEP

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SUMMARY

The dynamics of ryegrass-white clover pasture production under sheep were studied on twelve farmlets running Coopworths and Perendales representative of the breeds in New Zealand and Romneys from the Ruakura high-fertility selection flock and its control flock, each at three stocking rates, 16, 21, and 26 ewes/ha, respectively, from 1973 to 1977. Net pasture production over years increased from 12 to 19 t DM/ha. Most of this increase occurred in spring and summer. Both pre- and post-grazing pasture yields increased (2.7 to 3.7, and 1.4 to 2.2 t DM/ha) while utilization of pasture pre-grazing decreased (50 to 44%) with years. Pasture allowance followed the same trend as pasture production and appeared the major factor affecting intake as assessed from differences between pre-grazing and post-grazing pasture cuts. Intake over the 4 years averaged 1.5, 1.8, 2.0, and 1.9 kg DM/ewe/day, respectively.

Pasture production was highest in the spring and lowest in the winter, with pasture allowances and intakes showing similar trends. *In vitro* digestibilities were lower in the summer and autumn than in the winter and spring (71.4 *vs* 79.3%). This appeared to be associated with increased content of dead material in the summer and autumn. The apparent intake of Romneys averaged 1.7, Coopworths 1.9, and Perendales 1.8 kg DM/ewe/day. This was associated with higher levels of utilization and lower pasture yields on the Coopworth farmlets. As stocking rate increased, annual pasture production increased (15.0 to 17.1 t DM/ha), pre- and post-grazing pasture yields decreased, utilization increased (43 to 51%) and pasture allowance and intake both decreased (4.7 to 3.5 and 1.9 to 1.7 kg DM/ewe/day, respectively).

INTRODUCTION

In 1973 a long-term experiment was started to investigate the effects of mature body size and fertility status on the level and efficiency of production in grazing sheep. Interim reports of the levels of animal production achieved were given by Joyce *et al.* (1976a, b). This paper summarizes the pasture measurements recorded.

EXPERIMENTAL

Design

Four genotypes of sheep were each grazed at three stocking rates (16, 21, and 26 ewes/ha). The trial was run at Ruakura on twelve farmlets each with 12 paddocks randomized within soil types (Kaipaki peaty loam, Te Rapa peaty loam, Ruakura peaty loam, and Hamilton clay loam) over a 52 ha area. The sheep were Romneys from the Ruakura high-fertility selection flock and its control flock and Coopworths and Perendales representative of the breeds. Further details on design were given by Joyce *et al.* (1976a, b).

Grazing Management

Ewes were set-stocked according to date of lambing on four of the twelve paddocks for 3 to 4 weeks during lambing. After lambing, ewes and lambs were then moved to a 24-day rotation over 6 to 9 paddocks; approximately 3 to 6 paddocks were saved for silage in spring and hay in summer. After conservation the rotation lengthened to 36 days using all 12 paddocks. During winter each paddock was halved and sheep were block-grazed for 3 days per half paddock (unless it was very wet), thus giving a rotation length of 72 days which continued until lambing.

Pasture Measurement

Pasture production and intake were measured by techniques similar to those of Campbell (1969).

Net pasture production, calculated as the difference between the pasture present pre-grazing (exclosure cages used during grazing) and the residue from the previous grazing, was estimated by taking 4 pre- and post-grazing frame cuts (45.0 × 74.1 cm) from one-third of the paddocks per farmlet with a shearing hand-piece. If paddocks were rested for longer than 30 days, an additional cut was taken. The difference between pasture present pre-grazing and the residue left after grazing (pasture disappearance) was assumed to be the pasture intake of the sheep. *In vitro* digestibility measurements were done monthly on pasture present pre-grazing. During 1977 botanical composition and tiller counts by core analysis were taken.

Pasture Renovation

Grass grub infested pastures were treated with "Dasinit" granules (11 kg/ha). Paddocks needing renovation were undersown with Ariki ryegrass (11 kg/ha) and white clover seed (2 kg/ha).

RESULTS AND DISCUSSION

EFFECT OF YEAR AND SEASON

Total DM production (Table 1) increased over the first 3 years of the experiment, with nearly 80% of the annual yield occurring during spring and summer. Pre- and post-grazing pasture yields increased each year, while "per grazing" pasture utilization decreased. Pasture allowance and intake followed the trend in pasture production.

Prior to this experiment pastures were virtually set-stocked. The actual contribution of the system of grazing management used in the experiment to this increase in pasture production is unknown but the increase does not appear to be solely related to climatic factors some of which are shown in Table 2.

Average lambing percentages during the trial increased from 117 to 144%, while County levels increased from 95 to 100%.

Differences between years in voluntary intake of pasture were due to differences in pasture allowance rather than quality (Table 1). The estimates of annual intake of DM/ewe averaged 640 kg, with year differences ranging from 550 to 730 kg. This illustrates the ability of a well-managed ewe flock at 21 ewe equivalents/ha to buffer yearly fluctuations in pasture production of the order of 4000 kg DM/ha but at the expense (or recompense) of liveweight, wool weight, and lambing percentage.

TABLE 1: EFFECT OF YEAR ON MEAN PASTURE PARAMETERS

	1973-4	*1974-5*	*1975-6*	*1976-7*	*S.E. of diff.*	*Signif.*
Production (t DM/ha):						
Spring	4.4	6.2	8.2	8.8	0.46	***
Summer	3.9	4.4	6.8	6.1	0.41	***
Autumn	1.7	2.9	2.7	1.8	0.28	***
Winter	1.8	1.0	1.5	1.3	0.19	***
Total	11.8	14.5	19.2	18.0	1.34	***
Yield (t DM/ha):						
Pre-graze	2.7	3.1	3.4	3.7	0.15	***
Post-graze	1.4	1.6	1.9	2.2	0.11	***
Utilization (%)	49.5	48.2	45.3	43.7	2.52	**
Allowance (kg DM/ewe/day)	3.2	3.6	4.9	4.6	0.32	***
Intake (kg DM/ewe/day)	1.5	1.8	2.0	1.9	0.15	**
Digestibility (%)	—	75.0	75.6	74.3	0.53	NS

TABLE 2: CLIMATIC DATA[1]

	1973-4	1974-5	1975-6	1976-7
Rainfall (mm):				
Dec.	61	150	54	154
Jan.	15	189	144	128
Feb.	82	18	94	93
Mar.	48	89	47	29
Grass min. temp. (°C):				
Aug.	2.0	0.1	1.2	2.1
Sep.	4.2	2.9	2.8	2.7
Oct.	4.2	3.7	6.5	3.6
Nov.	8.0	5.2	5.2	5.1
Sunshine (h/day):				
Aug.	3.4	4.6	3.8	5.3
Sep.	4.2	5.2	5.1	5.2
Oct.	6.3	6.1	5.1	6.3
Nov.	6.2	7.6	7.1	7.5

[1] N.Z. Meteorological Service records for Ruakura.

TABLE 3: EFFECT OF SEASON ON MEAN PASTURE PARAMETERS

	Season				S.E. of	
	Spr.	Sum.	Aut.	Wint.	diff.	Signif.
Production (t DM/ha)	6.9	5.3	2.3	1.7	1.35	***
Yield (t DM/ha):						
Pre-graze	3.2	3.7	3.5	2.5	0.15	***
Post-graze	1.6	2.3	2.2	1.0	0.11	***
Utilization (%)	51.7	37.5	39.4	58.1	2.55	***
Allowance (kg DM/ewe/day)	5.0	4.4	4.2	2.6	0.32	***
Intake (kg DM/ewe/day)	2.5	1.6	1.6	1.5	0.15	***
Digestibility (%)	80.2	71.4	71.3	78.3	0.55	***

TABLE 4: EFFECT OF MONTH AND STOCKING RATE ON THE PROPORTION OF DEAD MATERIAL (%)

Stocking Rate (ewes/ha)	Sep.	Nov.	Jan.	Mar.	May	Jun.
26	2	4	10	14	24	5
21	3	7	13	26	25	4
16	2	12	14	45	31	5
S.E. of diff.	0.9	2.1	4.8	8.5	5.7	2.5
Signif.	NS	*	NS	***	NS	NS

EFFECT OF SEASON

The effect of season is shown in Table 3. Pasture production was greatest in the spring, and lowest in the winter. The higher pre- and post-grazing yields and the lower per-grazing utilization is a reflection that pasture growth was greater than intake plus losses and also that dead material was accumlating in the pastures during the summer and autumn (Table 4), as ewes selected against dead matter (Rattray *et al.*, 1978). *In vitro* digestibility of the cut pasture samples declined during these perdiods when dead material increased (Tables 3 and 4). These seasonal effects are similar to those reported for other sheep pastures (Rattray, 1978) and dairy pastures (Campbell, 1966; J. B. Hutton and A. M. Bryant, unpublished). It is noteworthy that during lactation in spring sheep ate more pasture at similar levels of allowance than they did during summer and autumn and the dramatic improvement in feed quality during winter was not reflected in higher intakes because ewes were offered less than at other times (Table 3). This is similar to the findings in short-term experiments (Rattray and Jagusch, 1977).

EFFECT OF GENOTYPE OF SHEEP

With the exception of the winter period ($P < 0.05$), "breed" had no significant effect on DM production (Table 5). The greater appetite of the Coopworths had a cumulative effect resulting in lower quantities of pasture pre-grazing and leading to lower allowances per head per day than other breeds, but a higher level of utilization per grazing. Except for intake the differences were significant.

EFFECT OF STOCKING RATE

As stocking rate increased it appears there was an increase in pasture production (Table 6), mainly associated with differences in autumn and winter. As expected, increasing stock numbers resulted in lower pre- and post-grazing yields of pasture, and higher utilization at each grazing. The animals ate less pasture because they were offered less (Table 6). Again the differences were highly significant. There were no significant stocking rate interactions with year, season, genotype, or soil type. Intakes were significantly different only during autumn and winter. During spring and summer, the seasons of highest pasture growth, there was little restriction in allowance or intake at all stocking rates

TABLE 5: EFFECT OF GENOTYPE ON MEAN PASTURE PARAMETERS

	H.F. Romney	*C. Romney*	*Coopworth*	*Perendale*	*S.E. of diff.*	*Signif.*
Production (t DM/ha):						
Spring	7.1	6.7	7.0	6.9	0.46	NS
Summer	5.4	5.2	5.4	5.2	0.42	NS
Autumn	2.3	1.9	2.5	2.3	0.28	NS
Winter	1.4	1.5	1.9	1.8	0.19	*
Total	16.2	15.3	16.9	16.2	1.35	NS
Yield (t DM/ha):						
Pre-graze	3.3	3.4	2.9	3.3	0.15	**
Post-graze	1.8	1.9	1.5	1.9	0.11	***
Utilization (%)	46.6	43.7	51.2	45.1	2.55	**
Allowance (kg DM/ewe/day)	4.1	4.2	3.7	4.3	0.32	*
Intake (kg DM/ewe/day)	1.7	1.7	1.9	1.8	0.15	NS
Digestibility (%)	74.9	74.9	75.9	75.7	0.66	NS

TABLE 6: EFFECT OF STOCKING RATE ON MEAN PASTURE PARAMETERS

	Stocking Rate (ewes/ha) 26	21	16	*S.E. of diff.*	*Signif.*
Production (t DM/ha):					
Spring	6.8	7.2	6.7	0.40	NS
Summer	5.5	5.3	5.0	0.36	NS
Autumn	2.7	2.1	2.0	0.25	**
Winter	2.0	1.7	1.2	0.16	***
Total	17.1	16.3	15.0	1.17	*
Yield (t DM/ha):					
Pre-graze	2.8	3.2	3.6	0.13	***
Post-graze	1.4	1.8	2.1	0.11	***
Utilization (%)	50.6	46.9	42.5	2.20	**
Allowance (kg DM/ewe/day)	3.5	4.0	4.7	0.32	***
Intake (kg DM/ewe/day)	1.7	1.8	1.9	0.13	†
Digestibility (%)	75.8	75.4	74.6	0.57	†

†$0.05 < P < 0.1$.

Digestibility differences were only significant during summer and autumn. This was presumably due to differences in utilization leading to differential accumulation of mature or dead material (Table 4) during these seasons.

The most noteworthy thing is the apparent difference in pasture production. Some of this difference could be explained on the basis of greater decay of ungrazed material under lower grazing pressures because such losses are not estimated with the measurement of net pasture production. However, tiller counts and point analysis (Table 7) showed denser pastures and less bare ground under high-stocked pastures. Botanical analyses carried out during the last year of the trial (Table 8) showed that the high-stocked pastures contained more ryegrass during most of the year and less *Poa*, browntop (*Agrostis tenuis*) and Yorkshire fog (*Holcus lanatus*) during the summer-autumn period than the lower stocking rates. This was probably the effect of

TABLE 7: EFFECT OF STOCKING RATE ON PLANT AND TILLER NUMBERS ($n/10\,cm^2$) (SEPTEMBER 1977)

Stocking Rate (ewes/ha)	*Perennial Ryegrass Tillers*	*White Clover Plants*	*Weeds*
26	28.5	4.8	0.2
21	24.6	3.6	0.5
16	17.6	3.8	0.5
S.E. of diff.	4.13	0.98	0.4
Signif.	**	NS	NS

TABLE 8: AVERAGE BOTANICAL COMPOSITION OF PASTURES FROM DEC. 1976 TO JAN. 1978 (%)

	Ewes/ha	*Dec.*	*Mar.*	*May*	*Jul.*	*Sep.*	*Nov.*	*Jan.*
Lolium perenne	26	59	36	67	74	63	56	41
	21	55	29	70	69	58	54	43
	16	42	44	71	70	42	41	41
Trifolium repens	26	16	31	19	12	11	11	28
	21	27	38	22	15	20	10	32
	16	17	21	21	12	21	16	24
Poa spp.	26	18	1	3	8	20	27	2
	21	11	2	3	9	18	31	4
	16	19	4	20	12	31	38	4
Agrostis tenuis	26	0	1	3	0	3	0	1
	21	2	9	2	0	1	0	2
	16	7	4	3	0	3	0	8
Holcus lanatus	26	0	0	6	0	0	1	0
	21	2	9	3	0	0	1	4
	16	9	4	11	0	0	2	2

grazing management leading to the maintenance of dense ryegrass-white clover dominant pastres, with *Poa* species in the spring. Yorkshire fog made a major contribution in earlier years but later was virtually eliminated from the high-stocked farmlets.

Higher pasture production on the high stocked treatments could be due to the higher levels of utilization leading to an acceleration of the nitrogen cycle through greater returns of dung and urine, greater tillering as a result of more light into the base of the pasture, greater removal of dead, senescent and photosynthetically inactive leaves and encouragement of high-producing pasture species. Some of these factors have been suggested to be responsible for the greater pasture production under sheep as compared with under cattle (Monteath *et al.*, 1977; Scott, 1977).

EFFECT OF SOIL TYPE

Soil type had an overriding influence on pasture production, the drier soils producing less in spring, summer, and autumn but more in winter (Table 9).

EFFECT OF GRASS GRUB (*Costelytra zealandica*)

Compared with non-infested pastures, annual production was reduced by 1200 kg DM/ha. In the face of immediate remedial action, grass grub had a negligible effect on production per farmlet over years.

TABLE 9: EFFECT OF SOIL TYPE ON MEAN PASTURE PARAMETERS

Soil Type	*Production (t DM/ha)*					*Yield (t DM/ha)*		
	Spr.	*Sum.*	*Aut.*	*Wint.*	*Tot.*	*Pre-graze*	*Post-graze*	*Utiln. (%)*
Kaipaki peat	7.1	5.9	2.3	1.5	16.8	3.4	2.0	41.5
Te Rapa-Ruakura peat	7.1	5.6	2.4	1.6	16.7	3.2	1.8	47.6
Hamilton clay	6.5	4.4	2.0	1.9	14.8	3.1	1.5	50.9
S.E. of diff.	0.42	0.38	0.26	0.17	1.22	0.14	0.10	2.30
Signif.	NS	***	NS	†	**	*	***	***

Effect of Conservation

Haymaking reduced subsequent autumn production by 700 kg DM/ha compared with "non-hayed" paddocks. However, winter and subsequent annual production was not affected. More hay was made in the first year than in other years and also on farmlets carrying control Romney sheep. The latter was associated with low demand by this genotype because of lower animal production. Similarly, more hay was made on farmlets carrying fewer stock. Reduced production associated with haying accounts for about 10% of treatment differences associated with year, genotype, stocking rate and soil type.

CONCLUSION

Under the system of grazing management adopted in this experiment, high levels of pasture production were obtained. Pasture production increased dramatically during the course of the experiment. Although much of this may be attributed to climatic factors, it is hypothesized that some of the increase was due to the grazing management adopted. Similar factors were responsible for increased pasture growth at the higher stocking rates in this trial and for the higher production reported under sheep pastures as compared with cattle pastures (Monteath *et al.*, 1977; Scott, 1977). In this experiment, highest grassland production was associated with an average annual manipulation of the canopy between 2800 and 1400 kg DM/ha per grazing.

ACKNOWLEDGEMENTS

Mrs Maree Glass and Miss Robyn Lynch (Sheep Nutrition Records), Dr N. R. Cox (Biometrics) and Sheep Nutrition farm staff. Dr J. N. Clarke was involved in the design of this experiment.

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