A Comparison of Continuous and Rotational Grazing

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Abstract

Continuous and rotational grazing of a brome-alfalfa-creeping red fescue pasture was compared at the University of Alberta Ranch in 1975, 1976, 1977, and 1978. Productivity, in terms of animal weight gain and dry-matter consumption, was studied together with changes in the sward composition. In 1977 and 1978 the weight gains from the rotationally grazed areas were nearly double those obtained from continuous grazing (218 vs 119 kg/ha). The percentage by weight of alfalfa in the sward increased under rotational grazing from 23 to 47%. The herbage in the rotationally grazed field was more digestible and contained more calcium, magnesium, copper, and crude protein than did that in the continuously grazed area. Animals in the continuously grazed fields spent 2.4 hours longer per day grazing than did the animals which were rotationally grazed.

Grazing systems must be adapted to local conditions, and comparisons of trials carried out by different workers in different areas should be made only with caution. Heath, et al. (1973) indicated that in the North American continent rotational grazing favoured legume persistence and improved yields. They regarded rotational grazing as being essential to achieve maximum production per hectare and for the efficient use of management inputs. These conclusions agree with results obtained in Europe (Peter 1929), but are not in agreement with conclusions drawn from trials carried out in the northwestern United States and in western Canada.

Hodgson et al. (1934) found that rotational grazing did not improve pasture quality, and they doubted if rotational grazing was economical in western Washington. Rogler (1951), working in North Dakota, showed that steers on moderately but continuously grazed pasture gained more per head than animals which were maintained under a rotational grazing management system. Campbell (1961) at Swift Current, Saskatchewan, concluded that continuous grazing was to be preferred over more intensive management systems. Hybbard (1961) also stated that for conditions at Manyberries, Alberta, "conservative continuous grazing was the most practical method of pasture use." Cooke et al. (1965) presented data from Melfort, Saskatchewan, which indicated that over a 7-year period rotational grazing did not increase beef production over that obtained where continuous grazing was practiced. In spite of these conclusions in the literature, the extension services of Alberta Agriculture have recommended rotational grazing; and farmers, in some parts of western Canada, have used that system.

It is evident that either conditions in western Canada and northwestern United States differed from those in the rest of the North American continent and in Europe in some way that favours continuous rather than rotational grazing, or that the rotational grazing system practiced by research workers had not been satisfactorily adapted to local conditions. The object of the study reported here was to compare continuous and rotational grazing in central Alberta in terms of pasture composition and productivity as well as beef production.

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Materials and Methods

The experiment consisted of three replications, each of which contained a continuously grazed, 2-hectare plot and four rotationally grazed ½-hectare plots. The continuously grazed plot always contained animals; for the rotationally grazed area, animals were placed in each plot in turn while the other three plots were rested. Two replications were established in 1974 and a third was added in 1975. The test was located at the University of Alberta Ranch at Kinsella, which is situated in the thin black soil zone of Alberta and is classified as a glacial loam of the Viking moraine. The mean annual precipitation (1931-60) was 40.6 cm with the maximum precipitation in the first half of July. The whole of the experimental area was uniformly seeded with a mixture of 1.65 kg/ha of alfalfa, 6.7 kg/ha of bromegrass, and 2.75 kg/ha of creeping red fescue between June 5 and 7, 1972. Grazing commenced in replication one and two in late May 1975 and in the third replication at about the same time in 1976.

The stocking rate was determined by pasture conditions and the "put and take" method was used. The stocking rate was changed from time to time as indicated by the forage available in each pasture. Animal numbers were also reduced when weight losses occurred. The average stocking rate for the experiment as a whole was slightly over two steers per hectare and was higher for rotational than for continuously grazed areas towards the end of all grazing seasons and throughout 1977 and 1978 (Table 1). When the animals were first introduced to a pasture area, 10 cages (each enclosing 1.5 × 1.5 m) were placed at random in the same field. When the animals in the rotational treatments were moved to the next pasture, an area 50 × 100 cm was, in all cases, clipped to ground level, both inside the cage and in an adjacent area outside the cage. The mathematical difference between these two values was used to determine forage consumption. The cages were relocated in the continuously grazed field whenever the animals, which

Table 1: Average annual stocking rate per grazing season in animals per hectare.

	1975	1976	1977	1978
Continuous	2.00	2.42	1.74	1.71
Rotational	2.24	2.58	2.42	2.45

Table 2: Forage consumed and the weight gains under continuous and rotational grazing, Kinsella.

	Forage consumed		Weight gain	
	Continuous	Rotational	Continuous	Rotational
1975	2554	2703	266	318
1976	2291	2173	166	275
1977	1012	2045[1]	119	235[2]
1978	1015	2081[1]	118	202[3]

[1]Unpaired t test (d.f. = 4) shows significant differences between continuous and rotational grazing at the 5% level of probability.
[2]Significant at 1% level of probability.
[3]Significant at 0.1% level of probability.

Table 3: Conversion ratio and average daily gain per animal under continuous and rotational grazing.

	Conversion ratio (kg of forage per kg of beef)		Average daily gain (kg per day)	
	Continuous	Rotational	Continuous	Rotational
1975	9.6	8.5 n.s.[2]	1.36	1.23 n.s.
1976	13.8	7.9 n.s.	0.73	1.18[1]**
1977	8.5	8.7 n.s.	0.86	1.13[1]**
1978	8.6	10.3 n.s.	0.68	0.82[1]*

[1]Unpaired t test shows significant differences between continuous and rotational grazing at 5% (*) and 1% (**) levels of probability.
[2]n.s. = not significant

were grazing rotationally, were moved. The clipped material collected from inside the cage during June of each year (1975, 1976, 1977, and 1978) and in September 1975 was sorted by species, dried, and weighed (Table 3). Fertilizer was not applied during the time period reported here. To evaluate weight gains all animals were weighed at the beginning of the season and at the time of each rotational move. The animals were held in an enclosure without food or water for 12 hours before weighing. Their weights varied from 300 to 410 kg. The animals remained in one of the rotational fields for 7–10 days and it was possible to complete about two and a half rotations each summer. During the summer of 1978 the scope of the experiment was extended to study herbage quality. In vitro dry matter digestibility was determined in the way described by Tilley and Terry (1963) on samples obtained from steers with esophageal fistulae. Two fistulated animals were placed in each replication for a 5-day period in the months of June, July and August. At these times the activities of the animals (grazing ruminating, walking, standing, and bedding) were recorded for a 24-hour period each day. Samples from the fistulated steers were oven dried and ground. Rumen inoculum was obtained obtained from a rumen-fistulated steer fed on brome-alfalfa hay for 8 days prior to sampling.

The percentages of crude protein and phosphorus were determined by placing material collected from the steers with esophageal fistulae in a Coleman 29A nitrogen analyzer and a Technichon autoanalyzer II, respectively. A 10-gm sample of the same material was ashed, mixed with normal hydrochloric acid and analyzed by tomic absorption spectrophotometry (Pye Unicam 2900) to determine the calcium, magnesium and copper concentrations. The data were analyzed using the t-test method for unpaired values set out by "Student" (1908).

Results and Discussion

Production

Under the two grazing management systems studied, neither the amout of forage consumed nor the cattle weight gains obtained (Table 2) showed significant differences during the first 2 years. In 1977 and in 1978 the forage consumed under rotational grazing was double that consumed where continuous grazing was practiced. Animal weight gains showed the same trend, rotational grazing giving values double that from continuous grazing in 1977 and nearly double in 1978. When these same data were studied as cumulative results increasing at each time of weighing, the differences between the forage consumed under continous and rotational grazing in 1977 and 1978 were significant at the 1% and 0.1% levels of probability, respectively. For the animal weight gain data, the differences between the two treatments were significant at the 1% level in 1976 and at the 0.1% level in 1977 (Fig. 1) and 1978.

Frequently, steer weights gains per hectare are achieved at the expense of reductions in average daily gains per animal. In this experiment, with the exception of the first year, the average daily gain per animal was higher for rotational than continuous grazing (Table 3). The forage conversion ratio differed little between the treatments so that improved beef production was associated with

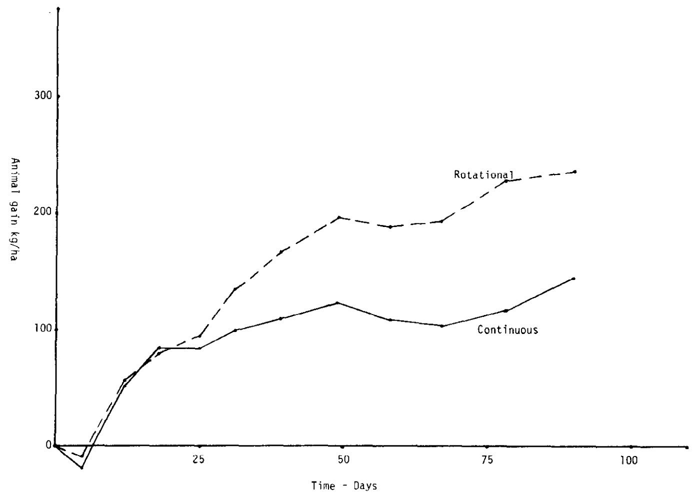

Fig. 1. *Continuous versus rotational grazing, Kinsella, 1977. T tests show all differences to be significant at 0.1% level after day 28.*

higher forage production.

The first study of the species composition of the sward was made in June 1975, shortly after grazing started. There were no significant differences between the weights of alfalfa, bromegrass, or creeping red fescue in the plots which had been allocated to rotational and to continuous grazing, respectively. The species proportion by weight was 23.0% alfalfa, 52.3% bromegrass, and 24.7% creeping red fescue. By September 1975 the amount of material clipped from the sample area for all three species showed significant weight differences between treatments (Table 4). Under rotational grazing the proportion of alfalfa in the sward was 32% in 1976 and subsequently increased to 47% in both 1977 and 1978. While this is a much higher proportion of alfalfa than is normally recommended, there was no evidence of bloat. Conclusions should be drawn from this only with caution since the ranch is normally relatively bloat free. Bromegrass, in the same treatment, declined to 45% by June 1976, to 41% by June 1977, and reached 31% in June 1978. For continuous grazing the proportion of creeping red fescue had increased to 41% by 1978, which is not surprising since this species is of low stature with a substantial proportion of the plant below the bit level (Table 4). The most striking difference was in the magnitude of total forage production under the two management systems.

Forage Quality

As might be expected, the changes in species composition (Table 4) were reflected in herbage constituents and digestibility of the sward as determined in 1978 (Table 5). In vitro dry matter digesti-

Table 4: Mean species yields from samples in 10 cages for continuous and rotationally grazed areas, grams per sample.

		Mean plant production		
	Grazing	Alfalfa	Bromegrass	Creeping red fescue
September 1975	Continuous	2.0	8.6	10.1
	Rotational	19.8[1]***	15.9[1]***	22.6[1]***
June 1976	Continuous	7.1	21.7	14.5
	Rotational	21.2[1]***	30.0[1]*	d14.8 n.s.[2]
June 1977	Continuous	6.5	11.4	6.5
	Rotational	30.7[2]***	26.7[1]***	7.8 n.s.
June 1978	Continuous	6.8	12.4	13.5
	Rotational	33.8[1]***	22.3[1]**	15.9 n.s.

[1]Unpaired t test shows significant differences between continous and rotational grazing at 5% (*), 1% (**) and 0.1% (***) levels of probability.
[2]n.s. = not significant

Table 5: Seasonal mean values for herbage constituents and digestibility under continuous and rotational grazing (Kinsella 1978).

	Grazing system	
	Continous	Rotational
Calcium (%)	0.70	1.69[1]***
Magnesium (%)	0.07	0.11[1]***
Copper (ppm)	4.95	5.98*
Phosphorus (%)	0.31	0.29 n.s.
Crude protein (%)	11.4	15.3[1]**
In vitro digestibility %	58.1	66.4[1]**

[1] *t* test significance level:-*** = 0.1%; ** = 1.0%; * = 5%.

bilities decreased successively in June, July, and August for both continuous and rotational grazing. This decrease was more marked for continuous grazing (66.6 to 53.7%) than for rotational (79.7 to 61.3%). Throughout the season crude protein values were higher for the herbage in the rotationally grazed area than in that which was grazed continuously. This difference increased as the grazing season progressed, being 1.7% in June, 5.5% in July, and 8.5% in August.

The levels of calcium, magnesium, and copper were significantly lower in the herbage from the area grazed continuously than in that which was grazed rotationally (Table 5). There were no significant differences between the levels of phosphorus found in the two treatments. The higher calcium level found under rotational grazing was associated with a higher proportion of alfalfa than under continuous grazing (Table 4). The magnesium level was low for both treatments. Hypomagnesamia has been known to occur at levels below 0.2 per cent. For copper, levels of 4-5 ppm are considered marginal, so that the figures in Table 5 are low. Again, higher levels are usually found in legumes rather than in grasses (Ammerman 1970 and Suttle 1976), thus explaining the significantly higher proportion of copper found under rotational grazing.

Animal Behaviour

There were no significant differences between the time which the animals spent ruminating under the two grazing systems (Table 6). The hours spent grazing were substantially greater under continuous rather than under rotational grazing. This difference increased as the season progressed; the animals under continuous grazing spending 0.8, 1.5, and 1.8 hours longer grazing in June, July, and August, respectively, than did the rotationally grazed animals. A linear relationship between increased grazing time and decreased forage availability has been reported for both sheep (Arnold 1960) and cattle (Lofgreen et al. 1957). The increased grazing time found for continuous grazing no doubt accounts in part at least for the lower animal weight gains obtained from that treatment. Osuji (1975) estimated that sheep expended 0.54 K. cal for each grazing hour for every kilogram of body weight. Graham (1964) reported a higher value 0.43 K. ca./hour/kg of body weight. The extra time spent grazing by the animals on the continuously grazed area could represent a significant expenditure of energy.

Rotational grazing, when compared with the standard continuous grazing method widely practiced in Alberta, had a marked

Table 6: Animal behaviour (mean annual hr/day and standard error) under continuous and rotational grazing (Kinsella 1978).

	Animal behavior	
Grazing system	Grazing	Ruminating
Continuous	10.3 ± 0.70	5.4 ± 0.57
Rotational	7.9 ± 0.61	6.1 ± 0.59
t test significance	1%	n.s.

Table 7: Additional costs of fencing and water supply for rotational grazing compared to continuous grazing for a 20-ha field in 1977.

	Cost per ha ($)
(a) Materials only	
Fencing	32
Water supply	35
Total	$67
(b) Materials and labour	
Fencing	65
Water supply	70
Total	$135

effect on sward composition and productivity. By the third and fourth years, forage consumption from rotationally grazed areas was double that from continuous grazing. The forage from the rotationally grazed fields contained more crude protein, calcium, magnesium, and copper, and was also more digestible than that found where continuous grazing was practiced. This, combined with the animals' shorter daily grazing period, resulted in the live weight gains obtained from rotational grazing being double those under continuous grazing. At existing beef prices in western Canada, the additional cost of fencing and providing water for livestock (between $67–$135/ha, Table 7) which rotational grazing required in this experiment, was recovered by the end of the second year. Further, a rotationally grazed pasture might be expected to be more productive of green material which was more digestible, contained a higher proportion of alfalfa and gave substantially higher animal weight gains than a continuously grazed field. In general, areas with lower productivity levels have been managed using extensive rather than intensive methods. This trial shows that even under short seasons, low rainfalls, and poor soil conditions the additional cost of rotational grazing and a higher level of management required will give an economic return.

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