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FURTHER STUDIES ON CONTINUOUS AND ROTATIONAL GRAZING OF IRRIGATED PASTURE BY YEARLING BEEF STEERS AND HEIFERS

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THE method of grazing is one of the most important tools a pasture operator has for controlling animal production on grazed pastures. For many years, rotational, rather than continuous, grazing has been widely advocated in countries where pasture plays a significant role in livestock production (McMeekan and Walske, 1963). However, the claims made by McMeekan and Walske in favor of rotational grazing were based on a study using dairy cows, and were not entirely substantiated by the work of Hull, Meyer and Raguse (1967) using beef steers. They found that rotational grazing was better than, or equal to, continuous grazing in animal days grazing and live weight gain/ha, but only at heavy stocking rates. At a medium stocking rate, continuous grazing was better than, or equal to, rotational grazing when live weight gain/ha, live weight gain/ha per animal day and energy gain/ha were considered.

The species of plant grazed (Meyer, Hull and Lofgreen 1957; Spedding, 1965) may influence production as much as does the system of grazing management. Hull *et al.* (1967) have presented evidence indicating that shifts in botanical composition are related to grazing management. In general, the shift is toward a predominance of grass on rotational grazing, and toward a higher proportion of legumes under continous grazing.

Since uncertainties persist in the literature regarding the comparative advantages of continuous and rotational grazing (Wheeler, 1962; Hull *et al.*, 1967), further studies comparing these two systems were conducted.

Experimental Procedure

Good to choice yearling beef feeder cattle were used in these studies. The cattle were vaccinated against infectious bovine rhinotracheitis, treated for intestinal parasites, and individually number branded. Each year, after an initial adjustment period of 3 to 6 weeks, they were allotted at random to the grazing treatments. All animals were weighed every 28 days during the experiments, after being without feed and water overnight. Stocking rates were the same for all treatments within a year, and were based on previous trials (Hull *et al.*, 1967) for similar pastures. The stocking rates were such that forage availability would allow maximal individual animal performance.

In October 1965, prior to the start of the trials in June, 1966, pastures were seeded with orchardgrass (*Dactylis glomerata L.*), perennial ryegrass (*Lolium perenne L.*), Ladino clover (*Trifolium repens L.*), and strawberry clover (*Trifolium fragiferum* 'Salina'). Pretrial excesses of pasture forage were removed by a separate herd of animals, and were not credited to these trials. The grazing treatments were: (1) one field continuous grazing, in which half the field was flood irrigated every Monday and the other half every Thursday so that the entire field was irrigated weekly; (2) a five-field rotational grazing schedule with 7 days grazing per field and a 28-day recovery period between grazings. These fields were also flood irrigated weekly except for the field being grazed, which was irrigated at 10-day intervals so as not to irrigate under the cattle; and (3) a two-field rotational grazing schedule in which the cattle were rotated weekly. The two-field treatment was begun on pastures also established in October 1965, and used under a five-field rotational system for another experiment during 1966 and 1967 (Hull *et al.*, 1969). This treatment was flood irrigated as in treatment 1.

The areas in treatments 1, 2 and 3 were 1.5, 1.5 and 0.9 ha, respectively. Treatments 1 and 2 were continued for 4 years, and treatment 3 for the last 2 years of the experiment. The number of grazing days per year were 110, 203, 200 and 215, respectively, for 1966, 1967, 1968 and 1969. Steers were used in 1966, 1967 and 1968; heifers were used in 1969. Stocking rates were 5.3, 6.6, 6.6 and 8.6 animals/ha, respectively, for the 4 years.

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The rates remained constant during the grazing season except in the second and fourth years. In midsummer of the second year, when forage growth was judged insufficient to permit maximal live weight gains, the numbers were reduced to 3.3 after 147 days. After 84 days in the fourth year, at which time the first flush of spring growth was over, the numbers were reduced to 7.2.

Body composition of all experimental animals was determined at the end of the grazing period. Composition of a representative group slaughtered before the experiment began also was determined. Carcass density as described by Garrett and Hinman (1969) was used to estimate body composition. Corrected carcass weights and empty body weights were estimated by the methods proposed by Meyer, Lofgreen and Garrett (1960) and Garrett and Hinman (1969), respectively. Energy gain by the animals was calculated by subtracting the average initial body energy from the final body energy. Analysis of variance was used to determine differences among treatments. Years were the replicates, and only main effects were treated statistically.

Botanical composition was determined each year by using a modified step-point quadrat technique (Evans and Love, 1957). These data were compiled as frequency of species occurrence.

TABLE 1. ANIMAL RESPONSE TO GRAZING SYSTEM (MEAN OF 4 YEARS)

Item	Grazing system		Standard error of the mean
	Continuous	5-Field rotation	
Animals carried per ha	6.8	6.8	....
Total animal days grazing	1991	1991	....
Average daily gain, kg	0.683[a]	0.628[b]	0.01
Initial wt., kg	235.3	234.0	5.88
Carcass data			
Final wt., kg	357.8[a]	346.0[b]	5.09
Dressing %	58.9	58.1	3.58
20 % fat corrected carcass, kg	194.6	188.8	5.38
Marbling score	3.3	3.6	0.10
Backfat thickness, cm	0.91	0.96	0.04
Rib eye area, cm²	63.45	62.15	0.63
Final carcass grade[c]	5.4	5.7	0.14
Energy gain/day, Mcal	2.821	2.756	0.10
Energy gain/kg of gain, Mcal	4.258	4.547	....

[a, b] Means on the same line having different superscripts differ significantly ($P<.01$).
[c] 5=low good, 6=average good. U.S.D.A. slaughter grade.

Results and Discussion

The influence of grazing system, i.e., continuous *vs.* five-field rotation, on animals is indicated in table 1. Daily gains and final carcass weights of the cattle were significantly greater in the continuous system. The differences were consistent each year, regardless of yearly variation, and were of the magnitude of 8 to 10%. Where significant differences were found between years they were attributed to different lengths of grazing season (table 2). Under both systems of grazing

TABLE 2. YEARLY PRODUCTION AS INFLUENCED BY GRAZING SYSTEM

Item	Year[a]	Grazing system			Standard error of the mean
		Continuous	5-Field rotation	2-Field rotation	
Animal days/ha	1	583	583	....	....
	2	1159	1159	....	....
	3	1325	1325	1333	....
	4	1677	1677	1766	....
Live wt. gain per animal/day kg	1	0.71	0.69	....	0.03
	2	0.58	0.54	....	0.03
	3	0.80	0.70	0.71	0.02
	4	0.66	0.60	0.65	0.01
Live wt. gain/ha, kg	1	413	402	....	16.91
	2	669	629	....	31.29
	3	1057	921	952	23.90
	4	1100	1001	1148	15.36
Live wt. gain per ha/day, kg	1	3.76	3.66	....	0.15
	2	3.83	3.56	....	0.18
	3	5.28	4.62	4.76	0.12
	4	5.68	5.16	5.78	0.08
Energy gain/ha, Mcal	1	1697	1859	....	117.53
	2	3444	3239	....	167.13
	3	4580	4569	3810	158.96
	4	3989	3480	4126	122.39

[a] Years 1, 2, 3—Steers; Year 4—Heifers.

management the cattle were of a good feeder grade, but had undesirable finish for slaughter, as indicated by the carcass data. Response of the cattle in the two-field rotation treatment (table 2) was intermediate between the continuous and the five-field rotation responses, and not significantly different from either.

Conniffe, Browne and Walske (1970) have stated that animal production in grazing experiments depends both on grazing treatment and on stocking rate, and that production at the optimum stocking rate is the only valid measure of treatment effect. The consistency between years of the carcass and energy gain data indicates that forage availability allowed maximal individual animal performance, even though different stocking rates were used each year.

When considering differences in systems of grazing management, both production per unit area and per animal unit should be assessed (table 2). Animal days/ha varied among years, with less of the pasture growing season being used the first year than in the second, third and fourth years. Differences in animal days per hectare between the two-field rotation and the other two treatments were due to the fixed size of the pastures, which made it impossible to obtain equal stocking rates for this treatment. Live weight gain/ha was quite high each year when the full seasonal pasture growth was utilized. Forage production, based on calculations using the net energy system of Lofgreen and Garrett (1968) for maintenance and gain, was estimated to be 16,000 kg dry matter/ha per season at 75% utilization, using the net energy figures for 28% crude fiber alfalfa hay. Meyer and Jones (1962) have reported production figures for alfalfa of 20,000 kg dry matter/ha under California conditions. Acord (1969) has reported dry matter production in Utah of 30,000 kg/ha, based on similar calculations. Except for the experiment in which heifers were used, and in which the energy gain/ha was greatest for the two-field rotation, there was remarkable consistency within years in live weight and energy gains per hectare for the three grazing systems.

Data from the 2 years when all three grazing systems could be compared, and when the forage was grazed for the entire growing season, are presented in tables 2 and 3. In the criteria used to evaluate the grazing systems continuous was better than rotational grazing. The differences varied from 3 to 8%, depending upon the type of rotational grazing. These

TABLE 3. SEASONAL RESPONSE TO THREE GRAZING SYSTEMS

Item	Continous			5-Field rotation			2-Field rotation			Standard error of the mean
	Steers[a]	Heifers[b]	Mean	Steers[a]	Heifers[b]	Mean	Steers[a]	Heifers[b]	Mean	
Animal carried/ha, (Initial only)	6.6	8.6	7.6	6.6	8.6	7.6	6.7	8.9	7.8	....
Animal days/ha	1325	1678	1501	1325	1678	1501	1325	1678	1501	....
Initial wt., kg	240.4	163.7	202.1	245.4	160.1	202.8	243.1	164.6	203.9	13.00
Initial live wt./ha, kg	1590	1410	1500	1620	1380	1500	1630	1470	1550	....
Avg daily gain, kg	0.80	0.66	0.73[d]	0.70	0.60	0.65[e]	0.71	0.65	0.68[e]	0.01
Daily energy gain (Kcal/wt.$^{3/4}$, kg)	49.7	37.3	43.2	50.4	33.9	41.8	41.9	38.6	40.1	1.23
Final wt., kg	399.9	304.8	352.2[d]	384.2	289.4	336.8[e]	386.0	304.4	345.2[f]	15.30
Final U.S.D.A. grade[c]	5.5	5.5	5.5	6.1	5.2	5.7	4.3	5.6	5.0	0.16
Live wt. gain/ha, kg	1057	1100	1080[d]	921	1001	961[e]	952	1148	1050[d]	27.80
Energy gain/ha, Mcal	4580	3990	4285	4570	3480	4025	3810	4130	3970	29.49

[c] 4.0=High standard, 6.0=Average good U.S.D.A. slaughter grade.
[a, b] Steers (1968) and heifers (1969) grazed during different years.
[d, e, f] Treatment means on the same line having different superscripts differ significantly (P<.01).

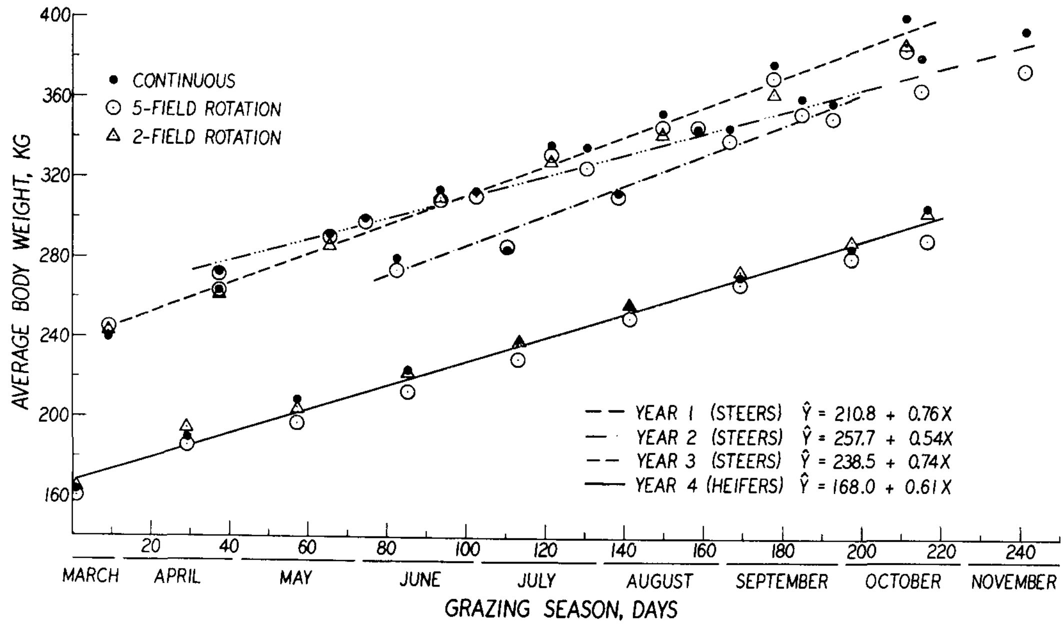

Figure 1. Seasonal responses of beef steers and heifers on irrigated pasture.

results are in agreement with those of Blaser *et al.* (1969), who reported 10% greater live weight gain from continuous grazing, with a medium stocking rate, than from other grazing systems. They attributed this increase to selective grazing. In the trials reported herein, selective grazing was not apparent in the continuously grazed swards.

Data indicating the responses of steers and heifers grazed for a complete pasture season, but in different years, are also presented in table 3. An attempt was made to allow for the smaller initial weight of the heifers by increasing the stocking rate. The average daily gain of the heifers approached that of the steers, but it did not appear that a desirable finish for slaughter could be obtained even over a 215-day grazing season when starting with light weight heifers. As with the steers, daily gain of the heifers was about 10% greater in the continuous system than in the rotational grazing system. Both live weight gain per hectare and energy gain per hectare were also remarkably close to those obtained with steers.

The increase in body weight during each grazing season is shown in figure 1. For this presentation the data for all treatments were combined within years. The slopes of the lines are similar indicating that when light weight heifers are used, results approaching those obtained with steers may be expected. The daily gains of both the steers and heifers were linear for the entire grazing season (200 days, r=0.98). This contrasts with results from previous work by Hull *et al.* (1967) who obtained a curvilinear response. The animal production obtained in the present study appears to indicate that forage growth was very good

TABLE 4. INFLUENCE OF GRAZING SYSTEM ON PERCENT FREQUENCY OF OCCURRENCE OF PLANT SPECIES

	Continuous				5-Field rotation				2-Field rotation			
Year	Orchard grass	Rye grass	Ladino clover	Strawb. clover	Orchard grass	Rye grass	Ladino clover	Strawb. clover	Orchard grass	Rye grass	Ladino clover	Strawb. clover
1	34	25	33	9	35	27	35	4	..	..	..	..
2	41	12	8	39	62	5	26	6	..	..	..	..
3	53	10	4	33	56	10	28	5	59	10	19	11
4	64	11	1	22	78	4	11	6	64	9	9	16
	Grass		Legume		Grass		Legume		Grass		Legume	
Mean	63		37		69		31		71		29	

during the warm months and on into the cooler grazing season.

The percent plant species under the various grazing systems are indicated in table 4. The percentages of legumes were consistently higher in the continuously grazed sward than in those grazed rotationally. 'Salina,' strawberry clover became the predominant legume under continuous grazing, while Ladino clover predominated in the five-field rotation. There were indications that the balance between these two legumes is determined by system of grazing management, as indicated by the reversal of botanical composition trends which occurred under the two-field rotation. However, there was a trend over time toward predominantly grass swards regardless of type of grazing system. The significance of these botanical shifts, in terms of plant nutritive value and productivity, apparently was not reflected in animal performance over the years studied.

From the study reported, and others at this station, it might be postulated that either system of grazing management (rotation or continuous) could have a place in the overall production of livestock, depending upon the desired rate of gain and the size of animal wanted at the end of the grazing season. It can also be postulated that, given good management of both the animals and the pasture sward, light weight beef heifers will perform satisfactorily in terms of average daily gain and beef produced per unit area.

Summary

Continuous grazing was compared to five-field rotational grazing of irrigated pasture over a 4-year period, and to a two-field rotation (following a five-field rotation) for 2 years. Beef steers were used for 3 years and beef heifers for 1 year. Stocking rates were approximately equal within years for each grazing treatment.

Continuous grazing consistently resulted in 3 to 8% higher average daily gains and more beef/ha than rotational grazing. Where the animals were carried for the entire grazing season, it was possible to obtain very good production of beef/ha although the animals were of inadequate finish for slaughter.

Changes in botanical composition differed among the grazing management systems. A higher percentage of legumes persisted in the sward under continuous grazing; but, regardless of the grazing system, there was a trend toward higher percentages of grass over time.

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