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EFFECT OF RECOVERY INTERVAL OF IRRIGATED FORAGE ON THE PERFORMANCE OF GRAZING STEERS

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SOUND pasture management must consider the requirements of both plant and animal. Few fields of research involve the careful consideration of plant-animal relationships that is required in grazing management. Two of the most important factors that can be controlled in a system of grazing are the length of the grazing period and the length of the regrowth interval.

Peterson and Hagan (1953) concluded from clipping experiments that a forage recovery interval of 25 to 28 days might give the greatest production from a grass-legume irrigated pasture. However, little information involving measurements on both grazing animals and forage is available. The present experiments were designed to provide such information.

Experimental

A uniform field of orchardgrass *(Dactylis glomerata var. Akaroa)* and trefoil *(Lotus tenuis)* was divided into 36 pastures of approximately 0.4 acre each. Trials were conducted in each of the two years 1957 and 1958 beginning in early May in 1957 and early June in 1958. Forage recovery intervals were obtained by varying the number of pastures per treatment—five, six and seven pastures, with each allowed a six-day grazing period, resulting in respective forage recovery intervals of 24, 30 and 36 days. Approximately equal grazing intensity was obtained on all treatments through the use of an adjustable fence forming the end of each pasture.

Management of the forage included adequate irrigation and fertilization, with 30 units of nitrogen (30 lb. of available nitrogen) applied per acre per month. In the spring the forage was harvested by a field chopper the proper number of days prior to the start of grazing to establish the desired recovery intervals for the treatments. The forage removed was not credited to the experiment. At the end of the 1957 experiment, Ladino clover *(Trifolium repens var. latum)* was seeded into the pastures to increase the proportion of legumes since the number of trefoil plants had been reduced.

The 1957 and 1958 experiments were identical except that one group of steers on each recovery interval in 1957 was supplemented with barley. The barley intake was controlled by varying the salt (sodium chloride) level between 8 and 20% in a barley-salt mixture. An attempt was made to obtain an equal intake of barley on each recovery interval. Actual consumption, however, averaged 5.2, 3.9 and 5.5 lb. per steer per day on the 24-, 30- and 36-day recovery intervals, respectively.

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Each year good to choice Hereford feeder steers were obtained 30 days before grazing was to begin so that 18 steers (three per treatment in each replicate) could be gentled and accustomed to fecal collections. All animals were allotted at random to each treatment. Initial weights were taken after the animals had been on pasture 6 days, all weighings being made after 14 hours without feed and water.

Body composition of all steers was calculated at the end of the experiment from specific gravity determinations made on the right half of the carcass. The empty body composition of the whole animal was calculated from the specific gravity by use of equations developed by Kraybill *et al.* (1952) and Reid *et al.* (1955) according to the method outlined in detail by Lofgreen and Otagaki (1960). Corrected carcass and energy yield were

TABLE 1. THE EFFECT OF RECOVERY INTERVAL ON THE LIGNIN, CRUDE PROTEIN AND TOTAL DIGESTIBLE NUTRIENT CONTENT OF TWO DIFFERENT PASTURE MIXTURES [a]

Mixture	Recovery interval	Lignin	Crude protein	TDN
	days	%	%	%
	24	4.1	17.8	66.6
Trefoil-orchardgrass	30	4.1	16.9	65.2
	36	3.8	15.8	63.9
	24	4.6	17.3	64.4
Trefoil-Ladino clover	30	4.4	17.0	65.1
and orchardgrass	36	4.6	16.9	64.0

[a] Dry matter basis.

determined by the method of Meyer *et al.* (1960). Initial body composition was estimated from a representative group of steers slaughtered at the initiation of the trials.

Production of total forage was estimated by the clipping technique and consumption was measured by the chromogen-chromium oxide technique of Reid *et al.* (1952). Before the steers entered a pasture, 5 to 10 areas of 18 sq. ft. each were clipped at random in each pasture. Dry matter and species determinations were made and the samples composited for chemical analysis.

Digestibility and forage consumption were measured at three approximately equal intervals in each experiment. Chromium oxide was administered daily at a level of 20 gm. at 7 a.m. during a preliminary period of 7 days and a collection period of 6 days. Grab samples of feces were collected twice daily from the rectum of the collection steers during the six-day collection period. All results are reported on a silica-free basis because of dust contamination of the forage. The method of Kimura and Miller (1957) was used for the chromium oxide determination. Total digestible nutrients (TDN) were calculated as described by Lofgreen and Meyer (1956).

Behavior studies were made in the 1957 experiment. Observations were made for 24 hours on the first and fifth days of a six-day grazing period in

August. Each lot, in the same order, was checked every 15 minutes and a record made of the numbers of animals grazing, eating supplement, standing and ruminating, standing idle, lying and ruminating, lying idle, and drinking. Total time spent in a given behavior was calculated by assuming that the number of animals observed in a given behavior continued in that

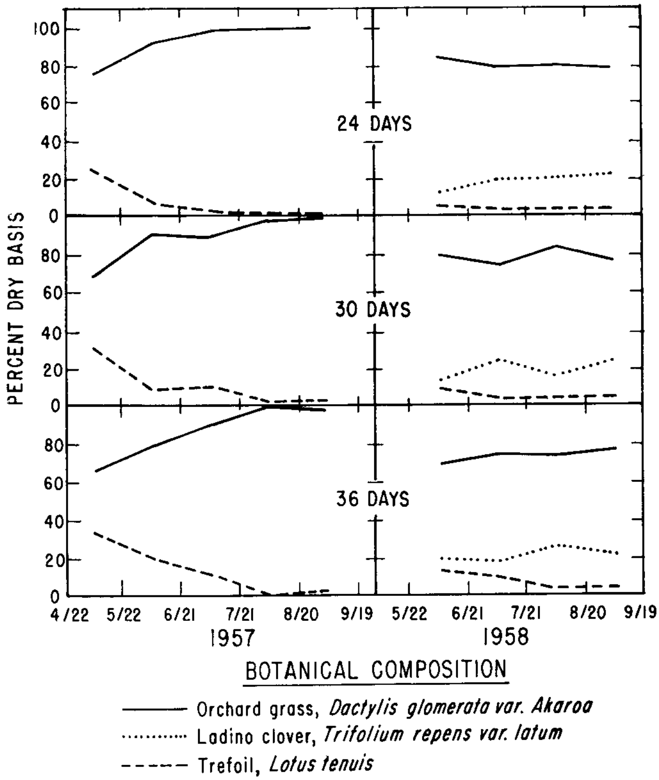

Figure 1. Botanical composition of the forage for the three recovery intervals.

behavior until the next observation. This technique was used in an earlier study (Lofgreen *et al.*, 1957) and has been proven to be valid as a measure of the factors being studied (Hull *et al.*, 1960).

Results and Discussion

The lignin, protein and TDN of the forage are presented in table 1. Protein and TDN decreased only slightly with increasing recovery interval while lignin showed no change.

From the botanical composition of the forage presented in figure 1, it is noted that the persistence of trefoil increased with longer recovery intervals.

As the grazing season progressed, trefoil plants per unit area decreased in all treatments, evidencing that trefoil was a poor competitor under the conditions of these studies. Adding Ladino clover to the pasture in 1958 resulted in a more uniform mixture throughout the season. The forage grazed was always in the vegetative stage. Except for a few plants, trefoil or Ladino clover never flowered, although a few plants of orchardgrass reached the flower stage in the early part of the season.

As shown in figure 2, daily growth was greater with longer recovery intervals, especially during the early season. The seasonal growth trends of daily yield of forage dry matter closely follow the pattern of extensive yield data reported by Peterson and Hagan (1953) for a grass-legume pasture, except that the dry matter production peak for these experiments

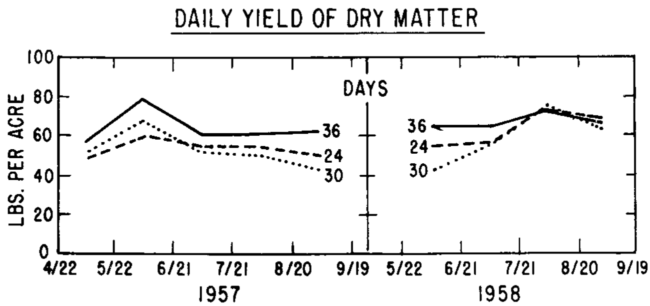

Figure 2. Daily yield of dry matter for the three recovery intervals. (See figure 1 for legend showing botanical composition.)

was later in the 1958 season. Because of environmental differences it is difficult to compare years, but Nelson and Robins (1956) showed that same shift in seasonal peak of forage yield when several light applications of nitrogen fertilizer were used. Since nitrogen was applied to the pasture during the middle of July and again in the middle of August, this could explain the later seasonal dry matter production peaks.

Table 2 contains some the important production data. Although the daily gains are somewhat lower in each experiment on the 36-day recovery interval, this difference was not statistically significant. The increased gain from supplementation was highly significant. The consumption of approximately 5 lb. of barley by steers grazing this pasture resulted in an increased rate of gain of 0.25 lb. per day. This is in good agreement with earlier work from this station in which 5 lb. of a barley and beet pulp mixture stimulated the daily gain of beef steers eating green alfalfa 0.33 lb. per day (Lofgreen *et al.*, 1960). Although the supplemented steers had a higher dressing percent and carcass grade, there was no interaction of supplement and recovery interval, indicating the supplement produced relatively the same effect regardless of the number of days the pasture was

TABLE 2. EFFECT OF RECOVERY INTERVAL AND SUPPLEMENTATION ON DAILY GAINS, FEED CONSUMPTION AND CARCASS GRADE

	1957						1958		
Item of interest	Supplemented			Unsupplemented			Unsupplemented		
Recovery interval of forage, days	24	30	36	24	30	36	24	30	36
Number of animals per treatment	6	7	8	6	7	8	10	12	14
Number of animals per acre	3.5	3.3	3.8	2.8	2.8	2.8	2.3	2.6	2.6
Duration of trial, days	142	142	142	142	142	142	120	120	120
Initial body weight, lb.	634	629	629	642	631	628	541	539	518
Daily body weight gain, lb.	1.88	1.65	1.71	1.52	1.52	1.46	1.61	1.56	1.42
Daily dry matter consumed, lb. per head	....	....	....	22.1	20.3	20.4	20.1	18.6	19.4
Daily TDN consumed, lb. per head	....	....	....	14.7	13.2	13.0	12.9	12.1	12.4
Weight gain per lb. of dry matter, lb.	....	....	....	6.9	7.5	7.2	8.0	8.4	7.3
Dressing percent	60.6	60.8	60.8	58.4	57.7	57.7	53.2	54.2	54.4
Carcass grade, percent of animals in grade:									
Good	67	86	50	0	14	0	0	0	0
Standard	33	14	50	83	86	88	90	100	100
Utility	0	0	0	17	0	12	10	0	0

TABLE 3. EFFECT OF RECOVERY INTERVAL ON PRODUCTION PER ACRE

(Unsupplemented Only)

Item of interest	Recovery interval, days		
	24	30	36
Total live weight gain, lb. per acre	526	541	502
Total dressed weight gain, lb. per acre	324	333	326
Fat in dressed weight gain, percent	25.5	25.7	22.9
Corrected carcass gain, lb. per acre	375	387	353
Energy in live weight gain, mcal.[a] per acre	798	814	696
Energy in dressed weight gain, mcal.[a] per acre	486	502	458
Relative energy gain per acre, percent of 24-day interval	100	103	94

[a] Megacalorie.

allowed to recover. In both years the forage and TDN intake tended to be higher on the 24-day recovery interval than on the 30- and 36-day intervals. These differences, however, were not statistically significant.

Since analysis of the data in table 2 revealed no interactions of year and recovery interval, the effect of recovery interval on production per acre presented in table 3 is based on the means of both years for the unsupplemented treatments. These data cannot be analyzed statistically since only the mean gain per acre for each lot can be calculated. Even though more forage was available per acre on the 36-day recovery interval, there appeared to be a somewhat lowered yield of corrected carcass, adjusted to equal energy and protein content, and energy production. This was due primarily to the lowered fat percentage in the gain produced on this treatment. It may be, therefore, that with the type of pasture studied in these experiments, a 36-day recovery period is approaching that interval which will allow the forage to become too mature for optimum utilization. This, however, cannot be conclusively proven from these studies.

The over-all effects of supplementation on production per acre in 1957 are shown in table 4. Because there was no interaction of recovery interval

TABLE 4. THE EFFECTS OF SUPPLEMENTATION ON PRODUCTION PER ACRE IN 1957 STUDY

Item of interest	Unsupplemented	Supplemented
Total live weight gain, lb. per acre	595	881
Total dressed weight gain, lb. per acre	380	647
Dressed weight gain as percent of live weight gain	63.9	73.4
Fat in dressed weight gain, percent	21.9	33.1
Corrected carcass gain, lb. per acre	401	888
Energy in live weight gain, mcal.[a] per acre	821	1593
Energy in dressed weight gain, mcal.[a] per acre	521	1152

[a] Megacalorie.

and supplement all recovery intervals are combined in these data. The consumption of approximately 5 lb. of barley per head per day or 19 lb. per acre per day resulted in an increase in live beef production of 48%. The dressed beef, however, increased 70%. The dressing percent of the unsupplemented steers was 57.9, whereas the supplemented steers dressed 60.7% (table 2). The dressed weight gain as percent of live weight gain for the two treatments was, however, 63.9 and 73.4%, respectively. A greater proportion of the gain produced from the supplement was therefore distributed in that part of the body retained at slaughter than in the discarded offal.

Because of the difference in the fat content of the gain and the dressing percent, a more valid measure of the effect of treatment is the gain in

TABLE 5. CALCULATION OF THE NET ENERGY OF THE UNSUPPLEMENTED FORAGE

	1957			1958		
Recovery interval, days	24	30	36	24	30	36
NE required for maintenance, mcal.[a] per acre	1965	1966	1946	1227	1351	1309
Energy in body weight gain, mcal.[a] per acre	939	806	719	656	822	673
Total NE, mcal.[a] per acre	2915	2772	2665	1883	2173	1982
Forage dry matter consumed, lb. per acre	8788	8085	8042	5550	5701	5947
NE in forage, mcal.[a] per 100 lb. dry matter.	33.2	34.3	33.1	33.9	38.1	33.3
TDN in forage, lb. per 100 lb. dry matter	66.6	65.2	63.9	64.4	65.1	64.0
NE per lb. of TDN, mcal.[a]	0.50	0.53	0.52	0.53	0.59	0.52

[a] Megacalorie.

corrected carcass (Meyer *et al.*, 1960). Such a measure places the carcass gains on an equal energy and protein basis. The consumption of the supplement resulted in an increase in corrected carcass and in energy of 120% over the production without supplement. Supplementation, therefore, resulted in an increased body weight gain, but possibly more important was the deposition of a greater proportion of the gain in the dressed weight and the deposition of a higher energy gain.

The net energy (NE) of the unsupplemented forage can be estimated from the energy required for maintenance, the energy gain and the forage consumption. The maintenance requirement can be estimated from the equation of Garrett *et al.* (1959) and used with the experimentally measured energy gain and forage consumption. The data are presented in table 5. It is again demonstrated that there is little difference in the value of the forage consumed on the three recovery intervals. It is noteworthy that even though the TDN in the dry matter was relatively high, the NE was low. The mean value of 0.53 megacalories (mcal.) of NE per pound of TDN is what one would expect in a rather low-quality roughage. In earlier studies (Lofgreen *et al.*, 1960) green alfalfa fed to beef steers contained 0.75 and 0.83 mcal. of NE per pound of TDN.

It is possible to estimate the NE value of the barley fed to the supplemented lots if it can be assumed that grazing intensity was equal in the

TABLE 6. CALCULATION OF THE NET ENERGY OF THE BARLEY SUPPLEMENT

Item of interest	Unsupplemented	Supplemented
NE required for maintenance, mcal.[a] per acre	1963	2530
Energy in body weight gain, mcal.[a] per acre	821	1593
Total NE, mcal.[a] per acre	2784	4123
NE from barley supplement, mcal.[a]	....	1339
Barley dry matter consumed, lb. per acre	....	2229
NE of the barley, mcal. per 100 lb. dry matter	....	60.1

[a] Megacalorie.

supplemented and unsupplemented lots. An effort was made to accomplish this by reducing the area available to the supplemented animals so that the forage remaining after grazing appeared to be comparable. Recognizing this technique is subject to the accuracy of the eye in estimating grazing intensity, the data resulting from the assumption of equal grazing intensity are presented in table 6. The value of 60.1 mcal. of NE per 100 lb. of barley dry matter, although low, is in line with the low NE of the forage and indicates that the steers in these studies made inefficient use of the digestible nutrients in both the forage and the barley. This re-emphasizes the importance of using the net energy principle in pasture investigations as earlier work from this station has suggested.

Behavior studies often prove useful in interpretation of results when combined with production data. The results of behavior observations made

TABLE 7. BEHAVIOR OF STEERS IN 1957 STUDY

Behavior	Unsupplemented	Supplemented
	Time spent per day, hours	
Grazing:		
First day	8.8	7.5
Fifth day	10.0	7.0
Means	9.4	7.3
Eating supplement:		
First day	0	0.4
Fifth day	0	1.4
Means	0	0.9
Ruminating:		
First day	7.8	7.7
Fifth day	7.2	6.2
Means	7.5	7.0
Idling:		
First day	7.6	8.2
Fifth day	6.4	9.0
Means	7.0	8.6

during the 1957 studies are presented in table 7. Since there were no differences among recovery intervals, all are combined in presentation of the data. As one would expect, the unsupplemented animals spent more time grazing than those supplemented with barley. This difference was highly significant. When the time spent eating supplement is added to the grazing time, the total time spent eating by the supplemented steers is still less than those receiving no supplement. It is of interest to note that the supplemented animals spent 3.5 times as much time eating supplement the fifth day in the field as on the first day. This difference was statistically significant. This undoubtedly resulted in a greater barley consumption although only total consumption for the period was obtained. The extra time spent grazing by the unsupplemented animals was spent idling by those receiving barley. One might speculate that this difference in activity might tend to magnify slightly the differences in production between these two groups.

Summary

During two seasons studies were made of the performance of beef steers grazing on irrigated grass-legume pasture at different stages of maturity. The maturity stages were controlled by allowing 24, 30 and 36 days for the forage to recover between six-day grazing periods. A study of the effects of barley supplementation was made during the first season.

The data indicated that the forage was grazed when in a vegetative stage. No large differences were noted in TDN, crude protein and lignin content of the grazed forage. Recovery interval did not influence steer response as measured by daily gain, feed consumption, efficiency of feed utilization, live weight, dressed weight or energy gain per acre or in animal behavior. A barley supplement increased daily gains, caused a greater proportion of gain to be distributed in the dressed weight and resulted in deposition of a higher energy gain.

Unsupplemented animals spent more time grazing and less time idling than those receiving a barley supplement. Supplemented steers spent 3.5 times as much time eating supplement during the fifth day in a pasture as during the first day.

The net energy of the forage and the barley supplement, determined from energy gains and estimated maintenance requirements, averaged 33.5 and 60.1 mcal. per 100 lb. dry matter, respectively.

It appears that when the type of forage studied in these trials is grazed at a vegetative stage, factors other than animal response will determine rotational intervals within 24 to 36 days.

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