

Diet and Grazing Habits of Steers on Foothill Range Fertilized with Sulfur

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Availability of nutritious range herbage can be extended well into summer, when the dry vegetation on unimproved annual-type range is of low value, by fertilizing with sulfur. Cattle definitely prefer the dry herbage on fertilized range (Bentley 1946). Its better value has been shown by greater weight gains of steers during the summer in a study at the San Joaquin Experimental Range (Wagon, Bentley, and Green, 1958). As part of this study, observations were made to learn whether the better quality of dry herbage might be due to differences in the species selected by cattle on fertilized ranges. Records of the diet and grazing habits of steers are reported in this paper, while effects of fertilization on herbage production and steer gains have been reported in companion articles.

Methods

In July of 1950 and 1951, two comparable groups of weaner steers were put into pastures that had not been grazed during the main plant growing season in the spring. Records of grazing habits and what the steers ate were made each year. One

¹With the Agricultural Research Service for one year, when this agency cooperated in the grazing trials.

²The Experiment Station is maintained at Berkeley, California, by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California.

pasture of 46.5 acres had been fertilized in January 1949 with a mixture of superphosphate and soil sulfur. The other pasture of 49.6 acres was an unfertilized control. The steers were kept in the pastures through the dry-forage season and into the winter season each year.

To sample vegetation in each pasture, nearly mature ungrazed herbage was clipped to a ½-inch stubble height on about 70 square-foot quadrats located at uniformly spaced intervals along grid lines throughout each pasture. Clipped material from individual quadrats was placed in paper bags, air dried, and weighed. Weight of each species was estimated. These were then totaled and averaged to deter-

mine average production of each plant species.

Additional herbage sampling was done to determine as closely as possible the diet of the grazing steers and to provide opportunity for close observation. Observers circulated among the steers a day or two until they were allowed within a few feet. Then, twice weekly during the summer and fall of 1950 and once weekly in 1951, observers spent the morning and evening grazing periods, from dawn until about 9:30 a.m. and from 4:30 or 5:00 p.m. until dark collecting herbage samples which simulated the livestock diet. At the same time habits of the animals were observed. Steers mostly shaded up during the hot part of the day.

Each animal was approached in turn and its grazing observed from a distance of 5 or 6 feet. Then a sample of the plant species and part that the steer was taking was collected from a nearby spot. In a 3- to 4-hour collection period about 100 grams of herbage, air dry weight, were collected. After additional drying the samples were weighed, and the weight of each species was estimated and composited by 2-week periods.

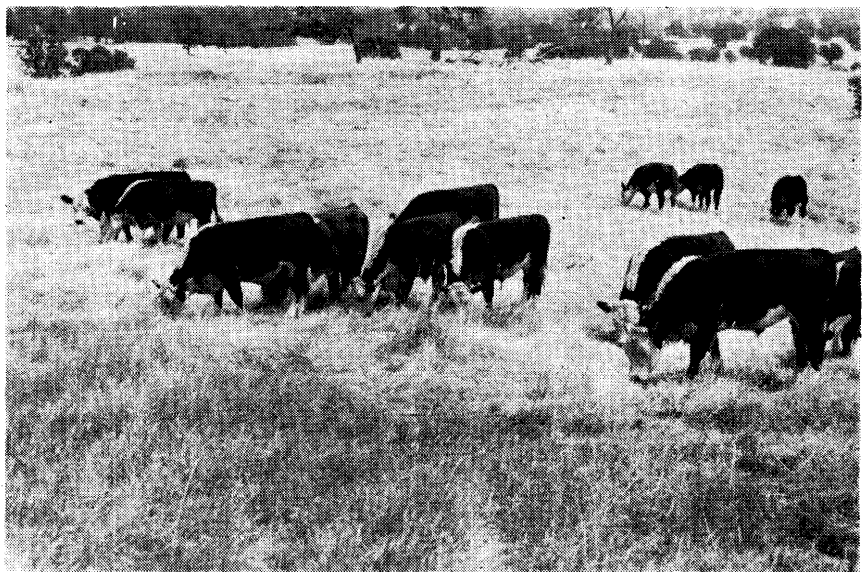


FIGURE 1. Typical group of steers grazing on fertilized range, August, 1954.

At each sampling period the observer noted the movement of the steers over the pasture, the sites on which they grazed, and the manner in which they grazed the different species. In 1951 the activities of all steers in sight were tallied at 15-minute intervals during the sampling periods.

Grazing Habits of the Steers

In the unfertilized pasture the animals scattered widely and grazed in groups of two or three. They wandered about continuously, taking small bites of selected plants and appeared to be searching for something better.

In contrast, on fertilized range in 1950 the steers usually grazed as one group with little wandering. This group was gentler than the other. They grazed greedily and took large bites. Their diet was more easily sampled than the diet of the control group. In 1951 and later years steers on fertilized range were not as gregarious as the 1950 group but they scattered less than those on unfertilized range (Fig. 1). They were less gentle than the 1950 steers and grazed less greedily, apparently because the vegetation contained less clover.

Total time spent grazing and time spent grazing in the swales were less both years on fertilized range. This reflects the increased herbage production on other sites and improved forage quality brought about by fertilization. The difference in grazing time, $\frac{1}{2}$ to 1 hour a day, was spent loafing around salt and water on the fertilized range, as the following tabulation shows:

Activity	Fertilized range		Unfertilized range	
	(Percent of time)			
Grazing in swale	18.6		28.4	
Grazing on slope	47.5		47.8	
At salt and water	25.7		12.8	
Shaded up or lying down	8.2		11.0	
	100.0		100.0	

In 1950, during the dry forage season, cattle spent more than half the grazing time on fertilized

Table 1. Percent of different species in the herbage crop and in the simulated diet of steers during the dry-forage season, July 15 to October 15 on fertilized and unfertilized range.

	1950				1951			
	Fertilized		Unfertilized		Fertilized		Unfertilized	
	Herbage	Diet	Herbage	Diet	Herbage	Diet	Herbage	Diet
Soft chess	9.5	7.7	6.9	28.0	15.3	20.4	11.5	33.3
Australian chess	3.4	.4	5.9	4.5	4.2	.8	4.5	1.7
Red brome	.9	2.3	3.7	7.7	.8	1.9	.2	1.5
Ripgut brome	.8	.7	3.8	10.5	.8	4.4	1.6	1.3
Foxtail fescue	12.4	11.1	8.9	15.2	48.5	46.8	36.6	38.5
Mediterranean barley	.1	1.9	.7	6.5	1.8	2.4	9.7	5.2
Other grasses	.7	.5	1.1	2.2	.1	.1	.1	.6
Total grasses	27.8	24.6	31.0	74.6	71.5	76.8	64.1	82.1
Grasslike plants	.1	1.0	.5	3.1	.8	.1	.9	2.5
Littlehead clover	²	65.5	²	2.1	4.2	3.1	.6	.3
Whitewick clover	²	2.7	²	7.1	5.7	18.4	6.9	11.8
Tree clover	²	1.0	²	2.1	3.6	.9	.5	.1
Total clovers	25.6	69.2	8.2	11.3	13.5	22.4	8.0	12.2
Spanish clover	2.5	1.3	.4	2.1	.6	.4	.7	2.1
Ground lupine	5.8	.5	6.1	.5	.2	.1	.1	.1
Other legumes	.6	.1	.4	.1	.1	.1	.1	.1
Total legumes	34.5	71.1	15.1	13.9	14.3	22.8	8.9	14.3
Broadleaf filaree	33.8	2.8	49.8	5.5	10.3	.2	23.7	.3
Miscellaneous forbs	3.8	.3	3.6	2.1	3.1	.1	2.4	.2
Total forbs	72.1	74.2	68.5	21.5	27.7	23.1	35.0	14.8
Browse	³	.2	³	.8	³	.1	³	.6
Total vegetation	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

¹Less than .1 percent, or not in sample.

²Not differentiated in sample.

³Not sampled.

ized range in selecting littlehead clover (*Trifolium microcephalum*), which had grown luxuriantly over most of the slopes. The coarse stalks were eaten avidly and shattered leaves and stems were licked from the ground. At first some spots were grazed closely, while good clover plants on adjacent spots were ignored. By the middle of October, however, all of the clover had been closely grazed. On unfertilized range, cattle spent little time searching for any certain species on the slopes. At times they wandered about picking out the heads of soft chess.

In 1951, cattle were not selective on the slopes in either pasture, but they concentrated on whitewick clover (*Trifolium variegatum*) in the swales as long as it was available. They spent more time grazing in the swales than in 1950, particularly in the fertilized pasture.

On unfertilized range, acorns were eaten regularly during the fall and winter of 1950. Acorns were available because ground squirrels had been poisoned and did not compete with the steers. All blue oak acorns were taken as they became available, starting in late September, and live oak acorns in November. On the fertilized range the steers ignored the acorns until December and then consumed fewer than on unfertilized range. Consumption of acorns before supplemental feeding was started may have reduced gains of cattle on unfertilized range (Wagon, 1946). A lessened desire for acorns with the dry forage may

They grazed the swales a little closer than did the steers in the fertilized pasture.

be a benefit from sulfur fertilization. In 1951 ground squirrels harvested all acorns as they fell.

From the start of supplemental feeding in October 1950 until adequate green feed became available, cattle on unfertilized range followed the observer, or stood bawling around the pickup truck or feed trough for as much as half an hour. Cattle on fertilized range grazed normally whenever the observer drove his pickup into their pasture.

At the end of October 1950 early rainfall and moderate temperatures combined to produce "once in a lifetime" early winter grazing. Steers in both pastures concentrated on green feed, which after November 15, made up 95 percent of what they ate. In most years range cattle are forced to eat old vegetation longer into the winter season.

Species Grazed

On unfertilized range about the same species were taken each year during the dry forage season, but on fertilized range a big difference between years was noted (Table 1). On the fertilized range, diet depended largely on the relative availability of grasses and clovers. When clover was abundant over the slopes in 1950 it composed a major part of the herbage consumed by the steers.

Grasses, grasslike plants, clovers, and Spanish clover (*Lotus americanus*) were the preferred species that made up a greater proportion of the diet than of the herbage crop. These species produced 56 percent of the herbage, or 1,860 pounds per acre, in the fertilized pasture in 1950, as compared to 40 percent, or 1,140 pounds per acre, in the unfertilized pasture. In 1951, they made up 86 percent, or 3,692 pounds per acre, in the fertilized pasture, and 74 percent, or 1,839 pounds per acre, in the unfertilized pasture. Such an increase of preferred species by sulfur fertil-

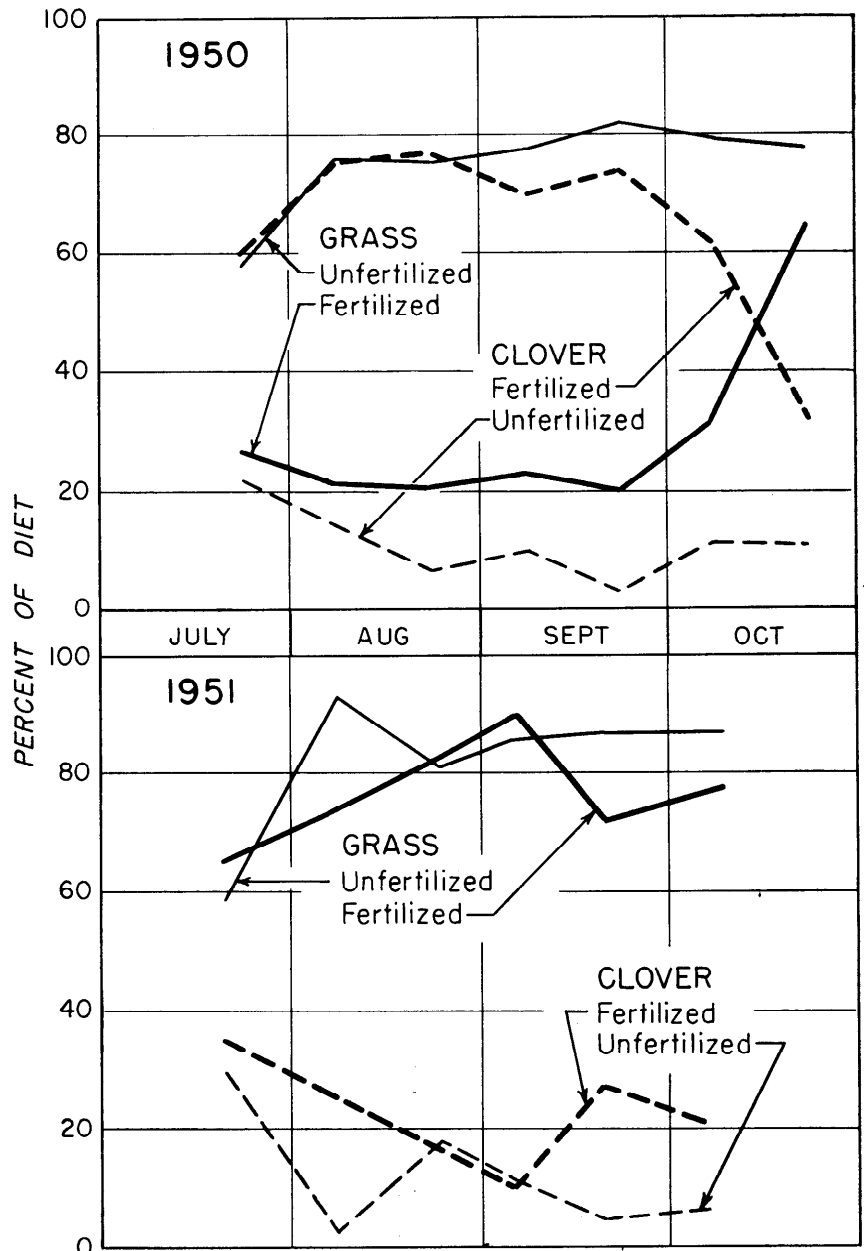


FIGURE 2. Grass and clover in the steers' diet on the fertilized and unfertilized pastures.

ization is worthwhile on foothill ranges grazed during the summer and fall.

Grasses

Grasses, the staple food of cattle during the dry season on unimproved foothill range (Wagon, 1941), ordinarily produce about 60 percent of the herbage (Bentley and Talbot, 1951). The percentage of grass in both pastures was well below this average in 1950 and above average in 1951 (Table 1). Yet, each year in the unfertilized pasture the

grasses made up about 80 percent of what the steers ate during the dry season, after the supply of clovers had been reduced by grazing in July (Fig. 2).

In July, August, and September 1950, grasses made up only about 20 percent of the steers' diet in the fertilized pasture. In October, however, after the abundant supply of clover had been greatly reduced by grazing, more grass was taken. They ate mainly grass after green growth became available.

In 1951 a high proportion of grass was selected on fertilized range throughout the dry-forage season. An extremely large amount was available, 3,089 pounds per acre. Consumption of grass was comparable to, although slightly below, that in the unfertilized pasture.

Soft chess (*Bromus mollis*) was the favored grass, particularly on unfertilized range. It definitely was selected over other grasses until its supply was reduced by grazing.

Foxtail fescue (*Festuca megallura*), the most abundant grass in the pastures, was not preferred when dry. Even so, in 1951 it made up 46.8 percent of the steers' diet in the fertilized pasture and 38.5 percent in the control pasture. Weather that year favored growth of foxtail fescue, and it was stimulated in the fertilized pasture by a high level of soil nitrogen. It was grazed in direct relation to its occurrence in the total herbage crop. Actually, this may indicate some discrimination against this species. If equally palatable with other grazed species, it should have composed a higher percentage in the diet than in the herbage crop because much of the total herbage was non-grazed species.

Some of the so-called undesirable grasses—red brome (*B. rubens*), ripgut brome (*B. rigidus*), and Mediterranean barley (*Hordeum hystrix*)—were grazed along with the other dry grasses. The steers did not discriminate against these species and in some cases appeared to select them. Australian chess (*B. arenarius*) was the only grass present in greater than trace amounts that made up a greater proportion of the herbage than of the diet.

Clovers

The native annual clovers are among the most palatable species

on foothill ranges. They are more nutritious when dry than the annual grasses and the non-leguminous forbs (Gordon and Sampson, 1939). On unimproved range the bulk of the clover selected by cattle during the dry season ordinarily is whitetip clover, which grows in near-pure stands in swales, except during low rainfall years. Littlehead clover and others on slopes seldom grow in concentrated stands and are not definitely selected, but they are grazed along with the grasses.

Grazing of clover on unfertilized range followed this pattern in 1950 and 1951. Steers selected clovers in the swales until the supply was nearly exhausted. Clovers made up 20 to 30 percent

of the diet in July and then dropped to about 10 percent or less (Fig. 2). For the entire dry-forage season, average percentages in the diet were 11.3 in 1950 and 12.2 in 1951 (Table 1).

In contrast, on the fertilized slopes littlehead clover was definitely selected throughout the 1950 dry-forage season. Sulfur fertilization had stimulated growth of this species so that it was abundantly available. This species averaged 65.5 percent of the steers' diet from July until the middle of October. Then consumption dropped because the supply was nearly grazed out (Fig. 2). Dry clover was ignored in November and December when the steers grazed on new green vegetation.

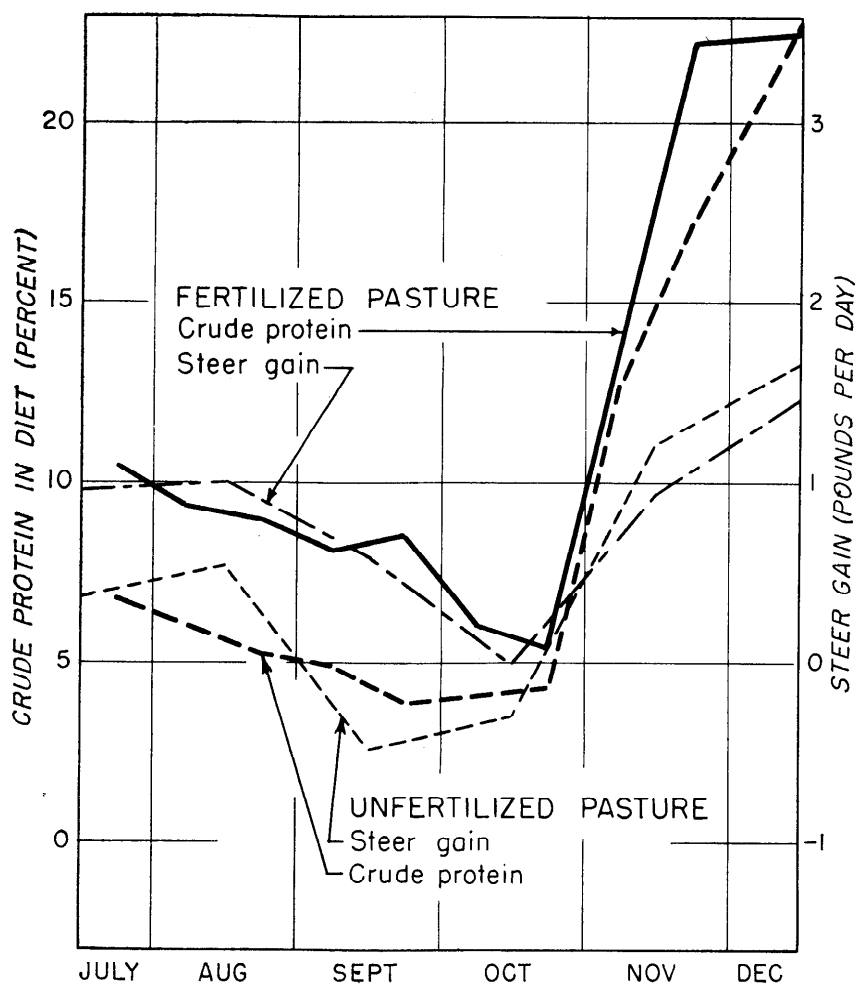


FIGURE 3. Crude protein in the steers' diet and average daily gain of the steers in the fertilized and unfertilized pastures, July-December 1950.

In 1951, the steers grazed about the same species on fertilized as on unfertilized range. Littlehead clover was not selected, but it was not abundantly available because a long spring dry spell had sharply curtailed its growth. Whitetip clover in the swales was the only clover definitely selected. Clovers made up 22.8 percent of the herbage grazed on fertilized pasture but only 14.3 percent on untreated range.

Since then, general observations have shown that cattle selected more littlehead clover on fertilized dry-season range than in 1951. It has been closely grazed whenever abundant on the slopes. In "good clover years" it makes up a major part of the grazed herbage.

Other Legumes

Spanish clover was the only other common legume that the steers preferred. Because it remained green well into the summer, it was selected on both fertilized and unfertilized range.

Ground lupine (*Lupinus bicolor*) and the miscellaneous legumes, mainly species of *Lotus*, were generally avoided but sometimes grazed along with other plants. Therefore these legumes were valuable mainly for nitrogen fixation in the soil rather than for forage.

Bur clover (*Medicago hispida*) was present in only a trace amount. A few plants at one location in the unfertilized pasture were grazed during the first few days.

Forbs

Broadleaf filarees (*Erodium botrys*, *E. obtusiplicatum*) typically produce one-fourth to one-half of the herbage on foothill range, but in these tests filarees averaged not more than 5.5 percent of the cattle diet. The proportion would have been even lower except that plants growing on recently exposed gopher

or squirrel mounds were more attractive, and large coarse plants were grazed to ground level. Broadleaf filaree is valuable as forage during the spring. But for ranges grazed yearlong, a low percentage is desirable. Sulfur fertilization improved the range by lowering the percentage of filaree in the cover.

The miscellaneous forbs were mainly small weedy species relatively worthless as forage on both fertilized and unfertilized range.

Chemical Composition of Grazed Herbage

Herbage selected from fertilized range was more nutritious than that from unfertilized range in both 1950, when clovers were abundant in the fertilized pasture, and 1951, when range herbage on both areas was mainly grass. Thus, the improved value of the diet on fertilized range did not depend entirely on its botanical composition. Instead, the nutritive value of both grasses and clovers was

Table 2. Chemical content of herbage simulating steer diet in the fertilized and unfertilized pastures in 1950 and 1951.

Season and date	Pasture	Ash	Crude protein	NFE-EE	Crude fiber	Calcium	Phosphorus
1950 dry forage season							
7/16-31	Fertilized	10.13	10.46	51.43	27.98	1.43	0.22
	Unfertilized	8.19	6.99	50.22	34.60	1.09	0.13
8/1-15	Fertilized	10.50	9.30	51.97	28.23	1.42	0.24
	Unfertilized	8.63	6.12	52.68	32.57	0.98	0.17
8/16-31	Fertilized	10.00	9.01	52.20	28.79	1.43	0.24
	Unfertilized	7.97	5.35	53.93	32.75	1.04	0.20
9/1-15	Fertilized	9.66	8.01	51.92	30.41	1.43	0.22
	Unfertilized	7.73	4.90	55.06	32.31	0.98	0.17
9/16-30	Fertilized	8.28	8.50	50.66	32.56	1.43	0.20
	Unfertilized	6.14	3.95	50.44	39.47	0.75	0.12
10/1-15	Fertilized	7.00	6.10	53.30	33.60	1.02	0.13
	Unfertilized	6.40	4.00	53.60	36.00	0.86	0.11
10/16-31	Fertilized	6.40	5.40	54.00	34.20	0.98	0.10
	Unfertilized	5.50	4.30	56.90	33.30	0.85	0.11
Average	Fertilized	8.86	8.11	52.21	30.82	1.31	0.19
	Unfertilized	7.22	5.09	53.26	34.43	0.94	0.14
1950 winter season							
11/1-15	Fertilized	9.00	14.00	44.10	32.90	1.80	0.13
	Unfertilized	8.40	12.90	46.80	31.90	1.04	0.33
11/16-30	Fertilized	11.60	22.20	40.50	25.70	1.47	0.29
	Unfertilized	11.30	17.20	45.50	26.00	1.57	0.51
12/1-31	Fertilized	11.70	22.50	43.80	22.00	0.99	0.28
	Unfertilized	11.80	22.80	44.30	21.10	0.95	0.30
Average	Fertilized	10.77	19.57	42.80	26.86	1.42	0.23
	Unfertilized	10.50	17.63	45.54	26.33	1.19	0.38
1951 dry forage season							
7/16-31	Fertilized	6.78	12.07	53.86	27.29	1.22	0.27
	Unfertilized	7.49	9.51	53.38	29.62	1.03	0.18
8/1-15	Fertilized	6.55	9.91	55.08	28.46	0.97	0.25
	Unfertilized	5.52	6.89	56.63	30.96	0.62	0.18
8/16-31	Fertilized	6.32	8.96	54.50	30.22	0.87	0.31
	Unfertilized	6.09	6.72	56.15	31.04	0.73	0.15
9/1-15	Fertilized	6.68	9.35	53.47	30.50	0.88	0.30
	Unfertilized	7.01	6.07	55.92	31.00	0.69	0.16
9/16-30	Fertilized	7.00	8.86	53.37	30.77	1.06	0.23
	Unfertilized	6.96	6.20	55.92	31.00	0.69	0.16
10/1-31	Fertilized	7.39	8.06	53.87	30.68	0.96	0.23
	Unfertilized	6.59	5.84	56.54	31.03	0.61	0.17
Average	Fertilized	6.79	9.54	54.02	29.65	0.99	0.27
	Unfertilized	6.61	6.87	55.69	30.83	0.72	0.17

increased by fertilization (Table 2).

Herbage sampled to simulate the diet of steers on fertilized range during the dry-forage season contained more crude protein and phosphorus than that from unfertilized range at each sampling period in both 1950 and 1951. This is a definite improvement because these are the two items commonly deficient in the dry herbage on unimproved annual-plant range (Guilbert and Hart, 1951).

Calcium percentage was high in samples from the fertilized pasture in 1950, when clovers made up most of what the steers ate. It was lower in 1951, when clovers were reduced, but was still above the calcium level of herbage from unfertilized range. Crude fiber was 5 percent lower and ash was 2 percent higher in samples simulating the predominantly clover diet of the fertilized pasture in 1950. These items were at about the same level for both pastures in 1951 when grass was predominant.

Crude protein in the fertilized pasture dropped to a low level in October 1950, when only dry vegetation from which the choice forage had been previously selected was available. In the unfertilized pasture in both years crude protein was below cattle maintenance needs throughout most of the dry-forage season.

The level of crude protein and phosphorus was well above minimum requirements in the diet in both pastures during November and December when new green vegetation became available.

Differences in crude protein accounted in large part for the greater gains on fertilized pasture. Rate of gain in both pastures closely paralleled crude protein trends in the herbage (Figs. 3 and 4). From July through September 1950, when crude protein in the fertilized

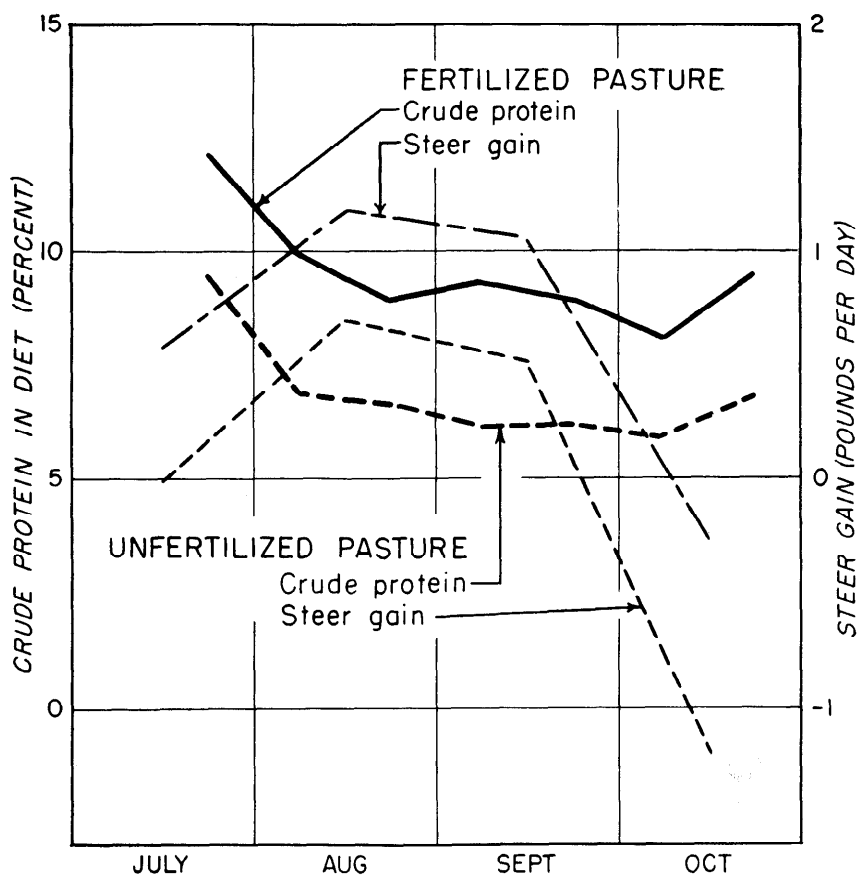


FIGURE 4. Crude protein in the steers' diet and average daily gain of the steers in the fertilized and unfertilized pastures, July-October 1951.

herbage was 3 to 5 percent above that in the unfertilized, about 0.7 pound per steer day greater gain was realized with fertilization. Because new herbage became available in exceptional quantity in November and December 1950, steer gains were better than normal. The thinner steers on unfertilized range started to gain sooner and gained slightly faster than those on fertilized range.

During the dry season in 1951 the crude protein in fertilized herbage paralleled that of the unfertilized herbage but remained about 3 percent higher (Fig. 4). Similarly, animal performance was parallel but about .6 pound gain per day higher in the fertilized pasture. Considerable weight was lost in October in both pastures without a change being shown in crude protein. Much of this loss in weight may have occurred late

in the month after the herbage sampling was completed.

Crude protein of the steer diet was sufficiently high on fertilized range during July, August, and September to promote average daily gains of 0.86 pound in 1950 and 0.93 pound in 1951. In the unfertilized pasture, where crude protein was 3 percent lower, average daily gains were only 0.12 pound in 1950 and 0.40 pound in 1951. Fertilized range produced satisfactory gains during the summer without supplements being fed. Steers in the unfertilized pasture needed supplemental protein concentrates for efficient use of the dry forage.

Summary

A sulfur fertilized and an unfertilized range pasture in the annual plant type were sampled to determine total herbage and species production. During two

dry-forage seasons observations were made of steer grazing habits and the steers' diet was simulated by sampling.

Cattle on fertilized range grazed more as a group, wandered less, took bigger bites, picked up fewer acorns, and satisfied themselves in less grazing time. On fertilized range the abundant clover was grazed, and then grass dominated the diet. On unfertilized range, grass dominated throughout the dry forage season. One abundant plant, broadleaf filaree, was discriminated against. Fertilization reduced the proportion of this and other weedy plants, and thus improved the composition of range vegetation.

Herbage samples simulating diet on fertilized range indicated higher crude protein, phosphorus, and calcium. This was reflected in greater daily steer gains.

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