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MEASURING PRODUCTIVE CAPACITY OF PASTURES THROUGH MAINTENANCE STUDIES
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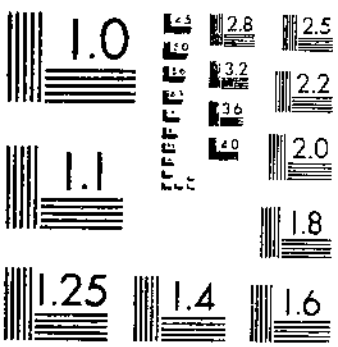

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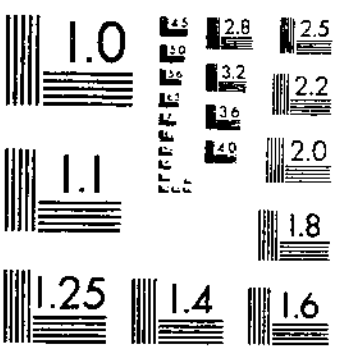

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NATIONAL BUREAU OF STANDARDS-1963-A

Steers

Technical Bulletin No. 890 • *April 1945*

UNITED STATES
DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

Measuring Productive Capacity of Pastures Through Maintenance Studies With Mature Steers [1]

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CONTENTS

INTRODUCTION

Productive capacity of pastures is generally measured by determining the amount and quality of the botanical cover and of animal products resulting from grazing the pastures. Sometimes one or the other of the two methods is employed.

The techniques used in pasture investigations in this country have been the subject of considerable study in recent years (*1*) [2] [3]. The object has been to bring about universal standardization of the procedures and the methods of reporting the results in order that a more adequate evaluation of pastures may be made.

Some of the complexities of pasture evaluation revolve around the use of animals as measures of production. Gain in live weight of beef steers is generally considered to be the most satisfactory measurement. Gain in live weight, however, may be an expression of an increase in growth, fatness, or fill or a combination of these factors. Because of the complex nature of live-weight gains, an experimental error is involved in any computation of herbage production or nutrients consumed when based on the reverse use of feeding standards related to gains in live weight.[4] This is referred to as the animal-requirement

[1] Submitted for publication September 18, 1944.

[2] Italic numbers in parentheses refer to Literature Cited, page 20.

[3] REPORT OF THE CONFERENCE ON ENERGY METABOLISM. Committee on Animal Nutrition, Natl. Res. Council, Washington, D. C., 93 pp. 1935. [Processed.]
ROUND-TABLE DISCUSSION, THE COMPARATIVE NUTRITIVE VALUE AND RELATIVE COST OF FORAGE (PASTURE AND HAY) AND OTHER CROPS. Amer. Soc. Agron., Crops Sect. Program, Subsection 3, Washington, D. C., 22 pp. 1938. [Processed.]

[4] The reverse use of feeding standards involves the determination of yields of pastures by calculating the amount of total digestible nutrients required in maintaining weights of animals or from observed gains in weight, and in dairy cattle from observed milk production.

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method of determining yield of pastures. In spite of the error involved, however, the feeding standards are considered to be sufficiently accurate to justify their use in reverse.

The quantity and quality of herbage produced are usually determined by the agronomic method, that is, by clipping and chemical analyses of the pasture samples. Various experiments (*4,6,7*) have shown, however, that yields obtained by clipping are 15 to 40 percent more than yields calculated by the animal-requirement method. These differences have been attributed to too low nutrient requirements of feeding standards for grazing animals, selective grazing, and differences in the nutritive content between pasture clippings from protected areas and the herbage consumed by the experimental animals. An apparently large part of the differences in yield is attributed by Forbes (*3*) to the reverse use made of feeding standards in computing consumption of herbage. An accurate determination of the amount of forage consumed can be obtained only under controlled conditions of experimentation. By an ingenious method of gathering fecal samples from grazing steers, Garrigus (*5*) developed a technique that greatly increased the accuracy.

OBJECT OF EXPERIMENT AND SCOPE OF WORK

The main object of the present study was to eliminate some of the experimental error inherent in the animal-requirement method of measuring productive capacity of pastures. Mature steers were used to eliminate weight changes due to growth, and the weights of the animals were kept at maintenance to reduce changes due to fill and condition. Part of the experiment involved controlled feeding of herbage in dry lot to determine actual amounts consumed rather than computing the amounts from the reverse use of feeding standards. Published digestive coefficients were used, however, in determining the total digestible nutrients consumed.

Concurrently with the animal-requirement method the agronomic method of determining pasture yields was followed, in which no modification of standard procedure was employed. By maintaining the initial weights of mature steers when placed on pasture it was possible to make a more accurate comparison of the efficiency of the animal-requirement and agronomic methods of determining pasture yields than had previously been made.

In this experiment, conducted at the Iberia Livestock Experiment Farm, Jeanerette, La., during the grazing seasons of 1939, 1940, and 1941, three pastures, the productiveness of which had previously been determined, were used. As the productiveness was measured during 1932 to 1938 by the established procedure (*2*) of grazing for maximum steer gains, it was believed that the present experiment would indicate the advantages, if any, over the established procedure.

WEATHER CONDITIONS

Jeanerette, La., is located in the heavy-rainfall area of the Gulf coast. The average annual rainfall of 57 inches is fairly well distributed throughout the year. Owing, however, to the flat topography and clay soils the runoff is slow, so that for most of the year the water

table is high. The main drainage ditches constantly carry some water. The region is less than 50 feet, and most of it less than 20 feet, above sea level. Summer temperatures and humidities are high. The average frost-free period is 261 days. Table 1 gives the mean monthly temperatures and rainfall for the region during the period of this experiment, as well as the long-time average.

TABLE 1.—*Mean monthly temperatures at Abbeville, La.,*[1] *and monthly rainfall at Jeanerette, La., 1939–41, and long-time averages at Jeanerette*

Month	Mean temperature in—					Rainfall in—				
	1939	1940	1941	1939–41	1904–30[2]	1939	1940	1941	1939–41	1918–38
	°F.	°F.	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
January	56.2	42.0	55.8	51.3	54.3	2.26	3.23	3.15	2.88	5.21
February	57.2	53.0	52.0	54.1	56.4	3.39	5.94	2.43	3.92	3.42
March	62.5	62.0	56.1	60.2	62.4	.74	3.08	6.24	3.35	2.95
April	66.0	67.2	69.6	67.6	68.8	3.21	6.18	4.74	4.71	3.60
May	73.4	73.0	74.2	73.5	74.3	6.57	1.55	8.96	5.77	4.39
June	80.2	78.6	80.6	79.8	80.6	2.41	12.06	10.36	8.28	5.84
July	81.4	81.3	82.4	81.7	81.9	10.00	8.69	12.61	10.43	6.80
August	81.0	80.4	83.8	81.7	81.7	3.64	15.07	2.53	7.08	5.62
September	78.0	76.2	80.1	78.1	78.3	2.31	2.65	6.37	3.84	4.54
October	67.5	70.0	76.1	71.2	68.9	.83	0	4.03	1.62	4.05
November	(3)	61.2	58.6	59.9	61.2	5.25	4.56	2.94	4.25	4.20
December	(3)	58.1	57.6	57.9	54.7	2.34	12.19	3.27	5.93	4.90
Average or total	70.3	66.9	68.9	68.1	68.6	43.25	75.40	67.57	62.06	55.52

[1] Because of incomplete temperature records at Jeanerette, the records filed at Abbeville, La., are given. Abbeville is about 25 air miles from the Iberia Livestock Experiment Farm at Jeanerette. Both places are about the same distance from coastal marshes and open Gulf waters.
[2] At Jeanerette.
[3] Records incomplete.

EXPERIMENTAL PROCEDURE

PASTURES USED AND METHODS OF GRAZING

Four pastures, each approximately 210 by 1,245 feet in size, equivalent to an area of 6 acres, were used in this experiment (fig. 1). From a larger area, known as pasture 10, the herbage was mowed and fed to the steers in the dry lot (both also shown in figure 1). The earlier history of pastures 2, 6, and 8, their fertilizer treatment, botanical composition, and productive capacity measured in steer gains per acre have been reported elsewhere (*2*)[5]. Briefly, the treatments were as follows: Each pasture received 4,000 pounds of ground oystershell per acre in the fall of 1931. Pasture 2 received, in addition, 200 pounds of superphosphate per acre annually during 1932–36; pasture 6, 400 pounds of superphosphate and 75 pounds of muriate of potash annually during 1932–36 and 200 pounds of nitrate of soda during 1932–38. No fertilizer was applied to any of the pastures during 1939–41, the period of the experiment. At least once each season during 1939–41, the pastures were clipped to control weeds and were harrowed to scatter the droppings. During the 6 years preceding the experiment, the average annual steer gain per acre was 292 pounds on pasture 2, 312 pounds on pasture 8, and 351 pounds on pasture 6. These pastures were selected for this work as representative of low, medium, and high fertility.

Pastures 2, 6, and 8, as well as the dry lot, were enclosed with a woven-wire fence with three strands of barbed wire on top. In

[5] ROUND-TABLE DISCUSSION. THE COMPARATIVE NUTRITIVE VALUE AND RELATIVE COST OF FORAGE (PASTURE AND HAY) AND OTHER CROPS. Amer. Soc. Agron., Crops Sect. Program, Subsection 3, Washington, D. C., 22 pp. 1938. [Processed.]

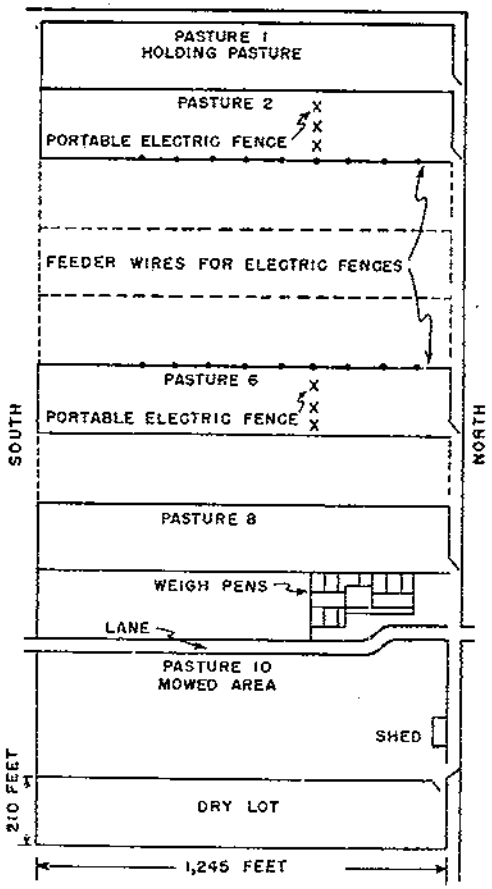

FIGURE 1.—Arrangement of pastures and facilities, Iberia Livestock Experiment Farm, Jeanerette, La. Dots on sides of pastures 2 and 6 indicate positions, at various times, of portable electric fences across the pastures. Dash lines inclose pastures not used in present experiment.

addition, along one side of pastures 2 and 6 an electrically charged wire was strung on top of the fence posts as a feeder for the movable electric fence that divided the pastures into north and south sections. The areas of these two sections could then be increased or decreased. Shade, water, and salt were available in both sections as well as in pastures 1 and 8 and the dry lot.

Pastures 2, 6, and 8 were grazed at a rate that would, as nearly as possible, maintain the weights of the steers. Pasture 1 was set aside as a holding pasture for the experimental animals when they were not grazing the other three pastures. The weights of the steers in pasture 1 were likewise kept at maintenance level in order that, when necessary, these animals could be returned to pasture 2, 6, or 8 without significant change in weight. No effort was made to place the steers on the same pastures from which they were removed. During most of the season the shifting of steers from one pasture to another was the usual procedure.

Six steers were placed in the south section of each of pastures 2 and 6, and their weights controlled by increasing or decreasing the area over which they grazed. Changes were made at ½-acre intervals. Six steers were used in the south section of each pasture as it was thought that at no time would the pastures be so poor that they could not maintain the weights of at least this number of mature animals. These steers remained in the pasture throughout the grazing season.

The north section of pastures 2 and 6 were grazed at a rate that would keep the herbage in the same stage of growth as in the south sections and that would also merely maintain the weights of the steers. When the size of the south sections was increased, one or more steers were removed from the north sections, and when the size of the south sections was decreased, steers were added to the north sections.

In pasture 8 enough steers were used to make it possible only to maintain their weights, but the animals were free to graze over the entire 6 acres.

The dry lot was kept fallow and free of all herbage by periodic cultivation. Six mature steers were placed in it, and their weights were kept as nearly as possible at maintenance on a ration of freshly cut herbage. This was cut on pasture 10 late in the afternoon with a horse-drawn mowing machine. Although the herbage on this pasture was somewhat more mature than on pastures 2, 6, and 8, all four pastures had about the same botanical composition. Half of the ration was weighed out and fed shortly after mowing; that is, about 4 p. m. The other half was weighed out, kept under shed, and fed the following morning at 6 a. m.

Determining Pasture Composition and Production

Two methods were used in determining the botanical composition of the pastures. Every 28 days during the 1939 and 1940 seasons the percentage of ground covered was determined for each species; in 1941, the relative frequency of each species in the pasture sward (*1*). The former data were obtained on representative 4- by 4-foot areas, subdivided into sixteen 1- by 1-foot squares, in each pasture. To obtain the frequency of each species the inclined point quadrat was used, and determinations were made at 10 points in each six representative 250-square-foot areas in each pasture.

As a means of measuring the forage production on the grazed pastures by the agronomic method, two open-mesh wire cages, 4 feet square and 18 inches high, were placed on representative areas in both the north and the south sections of each pasture. These cages were used in pairs for the purpose of obtaining yields from (1) an area that was left uncut and protected for 28 days and (2) an area that was cut at the time the cage was set for the 28-day period.

The cages were set for the first forage determinations each season at the time the steers were turned on the pastures. By the end of the first 28-day period in 1939, the pastures were so closely grazed that it was impossible to obtain, by either clipping or plucking, accurate forage yields. The method of forage determination then became a routine procedure of setting four cages on representative areas at the beginning of each 28-day period and clipping and weighing the growth

at the end of the period. The result was converted to an acre basis and represents the pasture production in green forage.

These forage samples were dried at 65° to 70° C. in an oil-heated oven for 2 to 4 days. They were later dried in an electric oven at 90° to 110° for at least 72 hours and were then considered moisture free. Samples from pastures 2 and 6 were sent to Washington, for chemical analyses. Because of the large number of samples involved in this study the forage samples from pasture 8 were not analyzed.

For making chemical analyses, a 1-pound sample of the fresh herbage fed to the steers in dry lot was weighed out each evening and hung in a wire basket in the shed to be air-dried. At each weekly cattle weigh day, the seven samples were placed in one sack and further dried in an electric oven. Samples of this dried material were forwarded to the U. S. Department of Agriculture, Beltsville Research Center, Beltsville, Md., for analysis.

The total digestible nutrients of the forage fed in dry lot were obtained from the chemical analyses. Use was made of the following digestive coefficients by Morrison (*8*) for "pasture grasses and clovers, mixed, from closely grazed, fertile pastures": For protein, 77 percent; fat, 56; fiber, 76; and nitrogen-free extract, 78. These were used from the beginning of the grazing season to the first of July, which is about the time that the clovers disappear and the pastures become covered predominantly with grasses for the remainder of the season. For the later half of the season use was made of the following digestive coefficients by Morrison for "grasses, mixed, immature": For protein, 70 percent; fat, 62; fiber, 66; and nitrogen-free extract, 75.

Cattle Used and Methods of Handling

The experimental steers were grade Herefords purchased on the Fort Worth market in the spring of 1937 when they were about 1½ years of age. They had been used for 2 years, 1937 and 1938, in experiments on the same area as that of the present experiment and were about 4-year-olds in 1939, when they were placed on the maintenance experiment. They finished the latter in the fall of 1941 as 6-year-olds. When taken off the experimental pastures in the fall of 1939 and 1940, they were placed on a general pasture supplemented with home-grown grass hay and a 50-50 bonemeal and salt mixture. The object was to have the steers in thrifty condition and in medium flesh when they were placed on the pastures in the spring.

All steers were weighed once a week, and allotments to the various pastures were made in accordance with the gain or loss in live weight, current condition of the pastures, and the estimated pasture growth during the week ahead, consideration being given to the season of the year and prevailing weather conditions. To eliminate the factor of water fill in individual animals on the day of weighing, all steers were gathered at 7 a. m. and held at the water troughs before being driven from the pastures to the pens, where they were weighed beginning at about 8 a. m.

The electric fences were moved to increase or decrease the areas thought necessary to maintain the six steers in the south sections of each of pastures 2 and 6. Estimates as to the herbage requirements for the steers in dry lot were also made at this time, consideration being given not only to the gain or loss in live weight of the animals but also

to the area from which the herbage was cut. As far as possible, only young growing herbage high enough for the mower to cut and be caught in the grass-catcher attachment was used. When it was necessary to move to another area this was done at the weekly weigh period.

All groups began grazing on the same date each year and finished, with one exception, on the same date. In 1939 the season extended from February 23 to October 26, or 245 days. The steers in pasture 2, however, were removed 14 days earlier. In 1940 the season extended from March 28 to October 10, or 196 days, and in 1941 from March 27 to October 23, or 210 days. The average grazing season for the 3 years was 212 days for pasture 2 and 217 days for pastures 6 and 8.

RESULTS OF EXPERIMENT

Composition and Production of the Pastures

Table 2 shows the botanical composition of pastures 2, 6, and 8. From the table it is evident that for the most part each pasture was composed of clovers and grasses throughout the seasons. The clovers predominated during the spring and the grasses during the summer and fall. In 1940, however, because of the excess rainfall—17 inches above average from June through September—the clovers persisted through the summer, whereas the grasses, especially Bermuda grass were less abundant during that year.

Although the species composition of the pastures (determined in 1941) was similar, pasture 2 had less clover and more grasses, especially carpet grass, than either pasture 6 or 8. In all three pastures, however, carpet grass progressively increased from 1939 through 1941 and crowded out to some extent the Bermuda and Dallis grasses.

Table 2.—*Botanical composition of pastures 2, 6, and 8 as measured by percentage of ground cover in 1939 and 1940 and percentage of species in 1941*

Year and season	Pasture No.	White clover	Bermuda grass	Dallis grass	Carpet grass	Vasey grass	Hop clover	Miscellaneous grasses and weeds
1939		*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Spring (Feb. 23–May 17)	2	12.1	39.2	30.2	10.4	0.8	.....	7.9
	6	52.9	29.8	9.0	.....	.....	.....	7.8
	8	44.3	26.3	10.2	.....	.....	.....	7.5
Summer (June 15–Aug. 10)	2	.....	66.3	23.7	8.8	1.1	.....	.....
	6	4.2	63.3	31.7	.4	.....	.....	.....
	8	1.7	41.7	22.5	.....	.8	.....	.....
Fall (Sept. 7–Oct. 30)	2	.....	62.6	22.9	11.3	2.1	.....	.8
	6	.....	70.3	29.6	.....	.....	.....	.....
	8	2.1	49.1	43.9	.4	1.7	.....	2.1
1940								
Spring (Mar. 28–May 22)	2	37.1	27.3	8.1	8.8	.....	.6	6.0
	6	51.3	30.6	5.9	.....	.....	1.3	3.7
	8	44.4	40.0	0.8	.....	.....	.....	1.1
Summer (June 20–Aug. 14)	2	32.5	40.4	7.9	12.0	4.6	.....	2.1
	6	25.8	50.8	10.0	6.7	2.0	.....	4.2
	8	18.6	49.2	17.9	3.5	4.0	.....	5.0
Fall (Sept. 11–Oct. 9)	2	13.7	37.5	22.5	20.0	.6	.....	4.8
	6	10.6	45.0	18.2	15.6	1.3	.....	8.8
	8	9.4	38.8	21.9	6.3	1.9	.....	21.9
1941								
Spring (Mar. 26–May 22)	2	51.7	18.2	4.2	19.6	.....	2.1	3.6
	6	59.6	25.9	3.7	5.8	.....	.5	4.6
	8	53.1	20.6	7.0	2.8	.....	.3	9.9
Summer (June 14–Aug. 13)	2	9.6	27.7	4.7	52.2	.....	.....	5.3
	6	6.8	46.8	17.1	15.6	.....	.....	14.1
	8	7.5	37.4	32.4	10.6	.....	.....	11.6
Fall (Sept. 11–Oct. 29)	2	2.6	24.4	7.8	61.7	.....	.....	3.1
	6	2.7	50.6	14.9	16.2	.....	.....	15.8
	8	2.4	54.0	25.0	10.6	.....	.....	8.2

TABLE 3.—*Percentage of dry matter and of chemical constituents in clippings from pastures 2 and 6 and in forage cut from pasture 10 for feeding steers in dry lot*

Year and season [1]	Pasture No.	Dry matter	Crude fiber	Ash	Crude protein	Nitrogen-free extract	Ether extract	Calcium	Phosphorus	Total digestible nutrients
1939		*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Spring	2	24.36	29.51	11.26	13.86	46.35	2.00	0.51	0.31	68.10
	6	20.25	25.45	10.46	17.93	44.17	1.90	.88	.37	68.71
	10	23.18	24.96	10.71	19.81	42.21	2.31	1.04	.36	68.44
Summer	2	27.31	31.50	9.46	10.48	46.65	1.91	.24	.34	66.87
	6	27.49	30.67	8.91	11.41	47.05	1.96	.29	.34	67.31
	10	26.87	29.11	9.96	15.31	43.58	2.04	.96	.36	66.50
Fall	2	30.97	27.34	9.70	11.45	49.59	1.92	.33	.35	64.44
	6	28.45	27.30	9.84	10.32	50.59	1.95	.27	.35	64.39
	10	36.93	30.32	8.93	8.55	50.55	1.60	.39	.31	64.00
1940										
Spring	2	22.33	24.78	12.46	16.00	44.65	2.11	.93	.39	67.16
	6	21.33	23.98	12.21	18.32	43.31	2.18	1.00	.40	67.33
	10	19.25	26.65	10.96	19.07	41.08	2.24	1.16	.34	65.24
Summer	2	21.20	28.68	9.45	14.27	45.38	2.22	.49	.36	66.59
	6	22.09	28.21	9.32	14.02	46.35	2.10	.48	.37	67.05
	10	24.13	30.07	9.14	13.00	45.86	1.93	.73	.29	67.12
Fall	2	20.64	29.19	9.36	10.41	48.58	2.46	.27	.35	64.52
	6	25.22	27.38	9.50	11.72	48.73	2.07	.28	.36	64.48
	10	33.52	31.75	9.26	7.42	49.81	1.76	.38	.28	64.60
1941										
Spring	2	18.90	25.96	10.60	22.17	39.15	2.12	1.12	.38	68.52
	6	19.94	25.77	11.51	22.68	38.04	2.00	1.16	.40	67.84
	10	20.73	28.79	10.71	15.24	43.30	1.96	.92	.34	68.43
Summer	2	18.06	31.29	9.37	12.23	45.21	1.90	.30	.36	66.93
	6	20.02	31.21	9.06	14.82	45.44	1.87	.32	.35	66.74
	10	21.51	32.79	10.51	11.70	43.29	1.71	.72	.37	66.02
Fall	2	19.50	29.07	10.34	11.02	46.92	2.15	.24	.32	63.69
	6	18.64	28.76	10.74	14.61	43.39	2.30	.32	.35	63.33
	10	30.20	34.06	10.09	7.34	46.81	1.50	.30	.32	63.80
3-year average [2]	2	22.59	28.36	10.22	13.61	45.72	2.09	.49	.35	66.35
	6	22.60	27.64	10.21	14.76	45.25	2.11	.56	.37	66.35
	10	26.26	29.83	10.04	13.07	45.17	1.89	.73	.33	66.46

[1] For the period of each season, see table 2.
[2] For each of pastures 2 and 6, 24 monthly samples taken; for pasture 10, 93 7-day composite samples.

TABLE 4.—*Forage production of pastures 2, 6, and 8 computed from pasture clippings for both seasonal and daily grazing periods*

Pasture No.	Grazing season	Grazing period	Forage production per acre			
			Seasonal		Daily	
			Green	Oven dry	Green	Oven dry
		Days	*Pounds*	*Pounds*	*Pounds*	*Pounds*
2	1939	231	21,931	5,849	93.03	25.32
	1940	196	16,772	3,027	85.67	15.51
	1941	210	36,073	6,452	171.78	30.72
	Average	212	24,770	5,309	116.79	24.85
6	1939	245	30,094	7,681	122.83	31.35
	1940	196	16,884	3,784	86.14	19.31
	1941	210	46,204	8,566	220.02	40.79
	Average	217	31,061	6,677	143.00	30.48
8 [1]	1939	245	23,172	5,916	94.58	24.15
	1940	196	18,810	4,086	95.97	20.85
	1941	210	37,104	6,359	176.97	30.28
	Average	217	26,362	5,454	122.51	25.09

[1] On the last day of the grazing periods ending July 13, 1939, and Apr. 23, 1941, all the cages in this pasture were disturbed by the steers, a fact that prevented the accurate measurement of the herbage production for these periods. Production was estimated on the basis of the carrying capacity of pasture 8 in relation to that of pastures 2 and 6 and the known herbage production of pastures 2 and 6 for the same periods.

Table 3 gives the chemical analyses of clippings from pastures 2 and 6 and of herbage fed to the steers in dry lot. The table shows that the clippings and the herbage fed in dry lot had about the same nutritive value. The greatest differences were in the fall samples, the clippings during this season being considerably lower in dry matter and in crude fiber and higher in protein and ether extract than the mowed herbage.

Table 4 shows the forage production of pastures 2, 6, and 8, as computed from clippings taken from these pastures every 28 days.

For the 3-year period the production, on the daily basis, was less for pasture 2 than for either pasture 6 or 8, and pasture 6 produced the most. For all pastures, production was greatest in 1941 and for the most part was lowest in 1940. For all pastures also, the 1940 production was about half as great as that for 1941.

Maintenance of Live Weight

Owing to individuality of the steers or miscalculations on the part of the experimenters in estimating the carrying capacity of the pastures, or both, it was not possible to maintain absolute control of the weights of the animals. Each week varying numbers of steers gained or lost in weight. The gains of some usually offset the losses of others. When the total of the gains and losses on any pasture resulted in a net gain for the entire group, one or more steers were added to the pasture. On the other hand, when the total of the gains and losses resulted in a total net loss, one or more steers were removed. However, as already stated, in the south sections of pastures 2 and 6, where the number of steers was held constant, their weights were controlled by increasing or decreasing the area over which they grazed. Weights of the steers in dry lot were controlled by increasing or decreasing the daily ration of freshly cut herbage.

The purpose of these procedures was to control as far as possible group weights rather than individual weights. However, because of the varying number of steers in each pasture and methods of control, results per steer are recorded. Thus, for example, from July 31 to August 7, 1941, 14 steers were on pasture 8. On July 31, the weights of all steers totaled 13,738 pounds; on August 7, 13,698 pounds. These represent average steer weights of 981.3 and 978.4 pounds, respectively. Of these 14 steers, 1 made no gain or loss in weight during the week; 6 made individual gains of 5, 8, 10, 5, 5, and 15 pounds, or a total of 48 pounds; and the remaining 7 steers made individual losses of 20, 15, 20, 10, 8, 10, and 5 pounds, or a total of 88 pounds. The group therefore made a net loss of 40 pounds, which was 2.9 pounds per steer.

Table 5 shows the average weights, at various times, of the six steers in the south sections of each of pastures 2 and 6 and of the six steers in dry lot. The 3-day average initial and final weights for each year and for the 3 years agreed within reasonable limits. In two instances they agreed within 1 pound, only three groups exceeded 30 pounds, and in only one instance was the difference as much as 51 pounds.

For the six steers in the south sections of pastures 2 and 6, the greatest difference between the average weight throughout the grazing season and the initial weight occurred in 1939, the first year of the experiment. This is attributed to the lack of experience by those in

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TABLE 5.—*Average weights of steers in the south sections of each of pasture 2 and 6 and of steers in dry lot*

Item	1939	1940	1941	Average 3-year
	Pounds	*Pounds*	*Pounds*	*Pounds*
PASTURE 2				
Average 3-day initial weight	1,037	972	1,025	1,011
Average 3-day final weight	1,045	973	1,018	1,012
Average weight during grazing season [1]	1,070	985	1,052	1,040
Difference between grazing-season and initial weights [2]	+39	+13	+27	+29
PASTURE 6				
Average 3-day initial weight	1,049	975	1,027	1,017
Average 3-day final weight	1,086	944	1,011	1,014
Average weight during grazing season [1]	1,119	967	1,051	1,051
Difference between grazing-season and initial weights [2]	+70	−8	+24	+34
DRY LOT				
Average 3-day initial weight	1,037	992	1,024	1,018
Average 3-day final weight	1,088	1,011	1,044	1,048
Average weight during grazing season [1]	1,033	982	1,024	1,015
Difference between grazing-season and initial weights [2]	−4	−10	0	−3

[1] Weighted average.
[2] +indicates gain; −, loss.

charge in estimating the week-to-week carrying capacity of the pastures to the precision necessary in this experiment. As experience was gained, greater control of live weight of the steers was obtained.

The average weights throughout the grazing season in relation to the initial weights are, however, more important. Of the nine average weights during the grazing season (table 5) for the 3 years, five exceeded the initial weights, three were lower, and one was the same. For the steers in dry lot the average weights throughout the grazing season and the initial weights were remarkably close, the former weights being only 0.3 percent less than the latter. In pastures 2 and 6 the 3-year average weights during the grazing season were 2.9 and 3.3 percent greater, respectively, than the average initial weights. It is evident, therefore, that the three six-steer groups were held within reasonable limits of maintenance weights.

Figure 2 shows the week-by-week average fluctuation in weight throughout the three grazing seasons. As the first 5 weeks of 1939 and the last 2 weeks of 1939 and 1941 had no corresponding data for the other years, they were not included in this figure. The average per-steer weights for pastures 2 and 6 fluctuated almost in parallel lines throughout the seasons. The steers in dry lot, on the other hand, had a more irregular week-by-week variation in weight but there was no pronounced seasonal influence. From figure 2 and table 5 it is evident that the weights of steers were more easily kept at about maintenance level by hand-feeding than by controlling the area over which they were permitted to graze.

Inasmuch as adding or removing one or more steers on the north sections of pastures 2 and 6 and on the entire pasture 8 changed the 3-day average initial weight of the group, a comparison of the average initial weights, final weights, and weights during grazing could not be made, as was done when the number of steers was held constant. In-

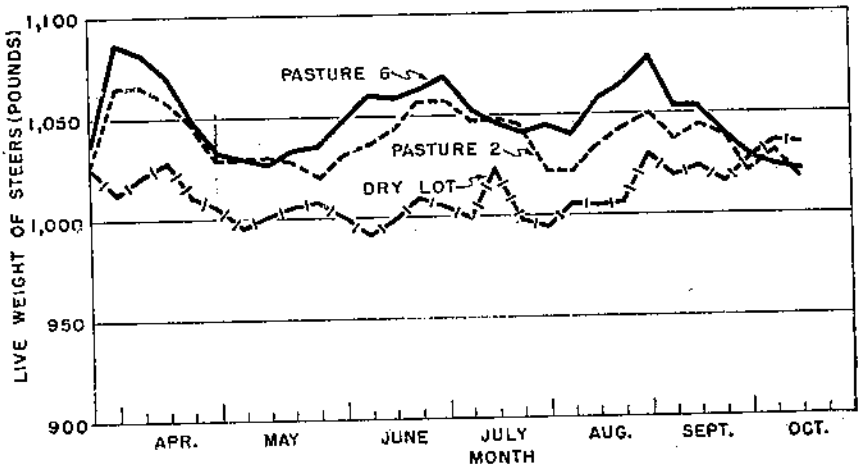

FIGURE 2.—Average weekly per steer weight of the three six-steer groups during the experiment.

stead, in the studies involving the entire pastures, the average weekly changes in weight per steer were obtained. The data on these weights are recorded in table 6.

From this table it is evident that during 1939 all three pastures were slightly undergrazed [6] as there was a net gain in weight per steer. During 1940, pasture 2 was slightly undergrazed, whereas pasture 6 and especially pasture 8 were somewhat overgrazed as in these pastures there was a net loss in weight. The nearest approach to holding the steers at maintenance weight was in 1941, when only a minor net loss was sustained by the steers in each pasture. The pastures were slightly overgrazed, therefore, during 1941. Over the 3-year period pasture 2 was slightly undergrazed, whereas pastures 6 and 8

TABLE 6.—*Gains or losses in weight per steer during the 3 years on pastures 2, 6, and 8*

Pasture No.	Year	Length of time cattle—		Yearly gain (+) or loss (−) in weight
		Gained weight	Lost weight	
		Weeks	*Weeks*	*Pounds*
2	1939	16	17	+34.8
	1940	13	15	+10.4
	1941	13	17	−7.3
	Total or average	42	49	+37.9
6	1939	18	17	+35.4
	1940	14	14	−32.9
	1941	13	17	−18.4
	Total or average	45	48	−15.9
8	1939	15	20	+11.1
	1940	17	11	−69.0
	1941	11	19	−5.6
	Total or average	43	50	−63.5

[6] In this study a pasture was considered to be undergrazed when the steers made a net gain in live weight and overgrazed when they made a net loss in live weight.

were overgrazed. Table 6 shows further that for the 3-year period weights of the steers on pasture 6 were more nearly maintained than those of the steers on pasture 2 or pasture 8.

In spite of the gains or losses in weight per steer, it is considered that the animals were held reasonably close to maintenance; for a difference of 10 pounds in weight represents only 1.009 percent of the average initial weight of all steers over the 3-year period. Differences, therefore, up to 20 pounds come within 2-percent effective control of weight. In field experiments 2 percent is considered very good control. As shown in figure 3, in 220 of the total of 277 weeks—93 weeks

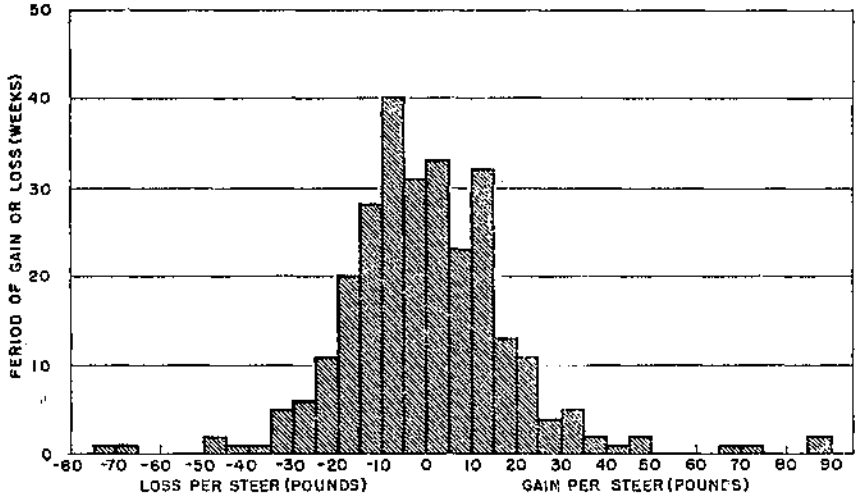

FIGURE 3.—Distribution of average weekly gains or losses per steer in the 277 weeks of grazing during the experiment on pastures 2, 6, and 8 (distribution at 5-pound intervals).

for each of pastures 6 and 8 and 91 weeks for pasture 2—the differences in weight were 20 pounds or less. This represents control of weight within 2 percent during 83 percent of the 3-year period. The weighted-average control is 1.6 percent.

It is evident, therefore, that weights of mature steers can be effectively controlled by the methods used in this experiment.

CARRYING CAPACITY OF PASTURES

The acreages necessary to hold the six steers at maintenance weights in the south sections of each of pastures 2 and 6 for the grazing period used in this experiment are shown in table 7. When the carrying-capacity averages for the south section of each of the two pastures are converted into number of acres per 1,000 pounds of live weight of the animals carried, the results are 0.57 and 0.50 acre, respectively.

Figure 4 shows in graphic form the average acreage occupied by these steers during the 3-year period. The fact that late in the summer the south section of pasture 2 had a greater carrying capacity, and that as a result less of its area was occupied by the six steers than of the south section of pasture 6, is attributed to the rapid invasion

of carpet grass in pasture 2 during 1940 and 1941. This grass has a high carrying capacity late in the summer. Pasture 6 had only small areas of this grass, as shown in table 2.

Table 8 gives the daily carrying capacity in pounds of steer weight per acre for each year and for the 3-year period, for pastures 2, 6, and 8. When the carrying-capacity averages for each of these pastures are converted into number of acres per 1,000 pounds of live weight of the animals carried, it is found that 0.55, 0.49, and 0.60 acre, respectively, are necessary to hold the steers at maintenance weights.

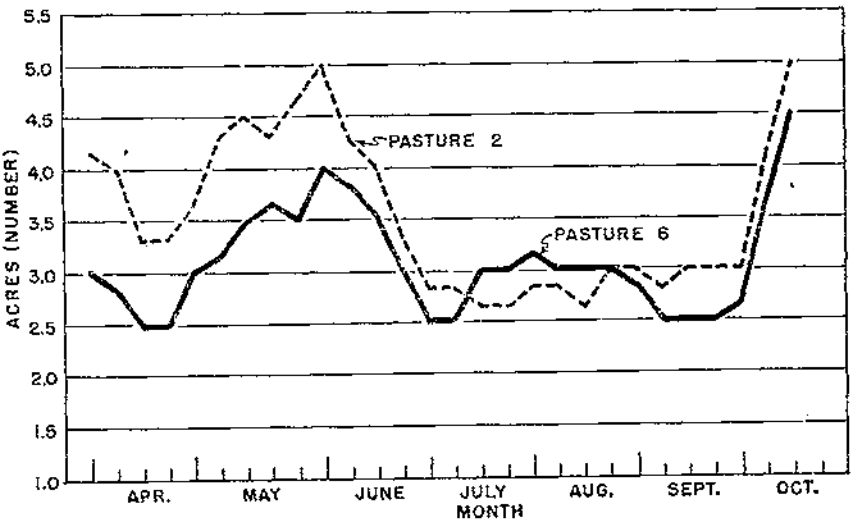

FIGURE 4.—Average acreage occupied by the 6-steer groups in the south sections of each of pastures 2 and 6, during the experiment.

TABLE 7.—*Acreages required to hold six steers at maintenance weights in the south sections of each of pastures 2 and 6*

Year	Pasture 2	Pasture 6
	Acres	*Acres*
1939	4.03	3.44
1940	4.03	3.77
1941	2.77	2.38
3-year average	3.61	3.20

TABLE 8.—*Daily carrying capacity of pastures 2, 6, and 8 in terms of steer weight per acre supported by entire area of each pasture*

Year	Pasture 2	Pasture 6	Pasture 8
	Pounds	*Pounds*	*Pounds*
1939	1,634	1,813	1,499
1940	1,430	1,625	1,503
1941	2,322	2,636	1,958
3-year average[1]	1,798	2,022	1,650

[1] Weighted average.

The differences in carrying capacity of the pastures are actually greater than given in table 8, for it is shown in table 6 that during the 3-year period pasture 2, with a net gain of 37.9 pounds per steer, was undergrazed and pastures 6 and 8, with net losses of 15.9 and 63.5 pounds, respectively, were overgrazed. On the basis that a 10-pound difference in weights of steers is equivalent to 1-percent control of weight, as already indicated, pasture 2 should have carried 3.79 percent more weight and pastures 6 and 8, 1.59 and 6.35 percent, respectively, less weight. During the 3-year period, therefore, pasture 2 should have supported 68 more pounds daily to the acre; pasture 6, 32 pounds less; and pasture 8, 105 pounds less. The corrected 3-year average daily carrying capacity per acre would then be 1,866 pounds for pasture 2, 1,990 for pasture 6, and 1,545 for pasture 8.

The greater carrying capacity of pasture 6 over pastures 2 and 8 agrees with the results obtained by the agronomic method (table 4) in determining the productiveness of these pastures. With pastures 2 and 8, however, the two methods gave different results. Measured by carrying capacity, pasture 2 is superior to pasture 8 by 9.0 percent and by 17.2 percent when the data are corrected for undergrazing of pasture 2 and overgrazing of pasture 8. On the other hand, by the agronomic method pasture 2 produced 3.9 percent less green herbage daily than pasture 8.

The week-by-week fluctuation in carrying capacity in pastures 2, 6, and 8 is shown in figure 5. The seasonal trend is clearly evident. The May decline is due to the rapidly disappearing clovers and the decreased rate of growth of the grasses as a result of low average rainfall during this month. As a result of rains late in June and July and the consequent renewed growth of cover and the increased density of Bermuda grass and other grasses, the carrying capacity increased. During August the three pastures were more alike in cover and carrying capacity than at any other time of the year. Fall rains and the heading-out of the grasses in early September again brought about a slight increase in carrying capacity, but it quickly decreased with the almost complete cessation of growth late in September and

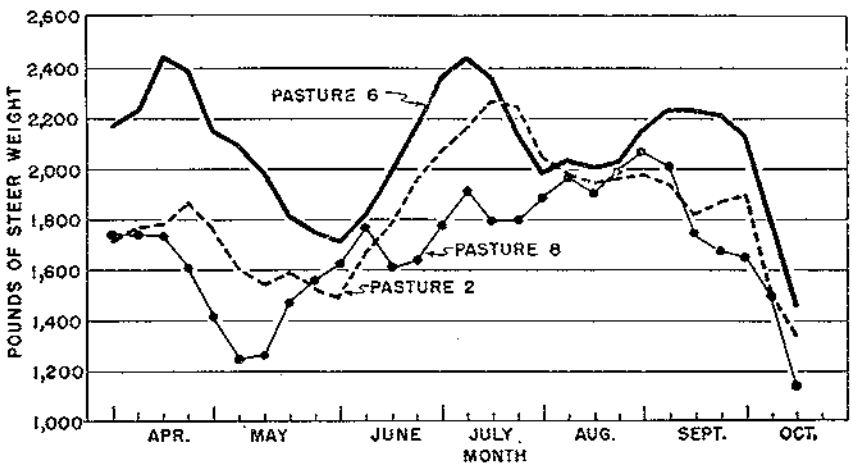

FIGURE 5.—Average carrying capacity per acre of pastures 2, 6, and 8 during the experiments.

early in October. The greatest differences in carrying capacity between the pastures occurred when the environmental factors favored rapid growth of the cover. During the periods of less favorable growth the carrying capacities of the three pastures were more nearly equalized. The rate of grazing necessary to maintain the weights of the steers produced a very short cover. In appearance, the pastures approximated well-kept lawns.

Nutritional Requirements of the Animals

Table 9 gives the average daily consumption of herbage and total digestible nutrients per 1,000 pounds of live weight, by weeks, for the steers in dry lot. As the ration was changed almost weekly to correct for increases or decreases in live weight or because of change in area from which the herbage was cut, there was no seasonal trend in consumption of herbage. In total digestible nutrients consumed, there was a slight seasonal upward trend toward the end of the grazing season. This was due to the marked change in the composition of the herbage during the fall months, as shown in table 3.

Table 10 shows the 3-year average daily consumption of herbage, dry matter, digestible protein, and total digestible nutrients per 1,000 pounds of live weight for the steers in dry lot. The 3-year average of 8.77 pounds of total digestible nutrients per 1,000 pounds of live weight obtained in this study agrees remarkably well with the theoretical maintenance requirement of 7 to 7.93 pounds given by Morrison (*8*) as the feeding standard value for a 1,000-pound dry cow plus 25 percent for the "activity factor." Such close agreement between the observed and the feeding-standard values indicates that a large experimental error was not introduced.

As pointed out earlier, the weights of the steers on pasture and in dry lot were held, within reasonable limits, at maintenance. To determine whether there was any marked difference in the activity of the two groups, 3-day observations for 12-hour daylight periods of the steers on pasture 8 and in dry lot were made. These observations

Table 9.—*Average daily consumption per 1,000 pounds of live weight of freshly cut herbage and total digestible nutrients, by weeks, for steers in dry lot*

Month	Week No.	Herbage	Total digestible nutrients	Month	Week No.	Herbage	Total digestible nutrients
		Pounds	*Pounds*			*Pounds*	*Pounds*
March	1	52.8	6.30	July	19	50.4	9.77
	2	50.3	6.72		20	54.3	9.95
	3	51.3	8.10		21	56.6	9.02
	4	50.9	9.35		22	50.0	8.55
	5	47.3	6.78		23	55.0	8.47
April	6	46.2	5.55		24	54.4	8.69
	7	47.5	7.07	August	25	51.8	9.66
	8	45.0	7.31		26	52.0	9.78
	9	44.3	6.98		27	50.8	11.13
May	10	46.3	6.48		28	51.5	10.68
	11	47.8	6.86	September	29	49.2	11.26
	12	48.4	7.56		30	50.1	9.90
	13	46.3	8.38		31	50.5	10.99
June	14	52.0	6.76		32	47.7	11.12
	15	51.0	7.61	October	33	45.1	10.42
	16	49.7	6.81		34	44.0	11.52
	17	54.1	7.64		35	42.2	11.53
	18	50.8	9.24				

TABLE 10.—*Daily consumption of herbage, dry matter, digestible protein, and total digestible nutrients per 1,000 pounds of live weight of steers in dry lot*

Year	Herbage	Dry matter	Digestible protein	Total digestible nutrients
	Pounds	*Pounds*	*Pounds*	*Pounds*
1939	46.3	13.15	1.35	8.95
1940	51.9	13.18	1.16	8.85
1941	51.9	12.70	.98	8.42
Average [1]	49.7	13.02	1.17	8.77

[1] Weighted average.

included time spent by the animals in grazing or at the feed trough, lying down, and standing. Ten steers in pasture 8 spent 59.8 percent of the daylight hours in grazing, 24.3 percent in lying down, and 15.7 percent in standing. The six steers in dry lot spent 27.9 percent at the feed trough, 12.9 percent in lying down, and 59.1 percent in standing. Although the steers in dry lot had 6 acres of fallow ground over which to roam, they moved about very little and could be found, usually standing, at one end or the other of the dry lot. The activity of the steers in dry lot, therefore, was apparently somewhat less than that of the steers on pasture.

As has also been pointed out, nutritional requirements varied with individual steers. Some steers maintained their weights without difficulty, whereas others on the same pasture lost much weight. In the 3 years of the experiment, two steers were removed because they could not maintain their weights except on pastures that would materially increase the weights of others. As a group, however, the steers on pastures 2, 6, and 8 shed their winter coats and maintained a generally healthy condition throughout the various seasons. The steers in dry lot, however, each year shed their winter coats later than the steers on pasture and had poorer coats of hair throughout the seasons. All steers finished the grazing season with trim middles, a fact which indicated little fill. It was several months after going into winter quarters before most of them acquired a fill normal to that of mature steers with ample roughage available.

PRODUCTIVE CAPACITY OF THE PASTURES

The results obtained with the group in dry lot were used in determining the daily production of pastures 2, 6, and 8, in terms of forage and total digestible nutrients per acre. The latter was computed by multiplying the total digestible nutrients given in table 9 by the number of 1,000 pounds of live weight of animals per acre maintained on each pasture for the corresponding weeks. These data are shown in graphic form in figure 6.

As shown by figure 6 the within-season variation in daily production of total digestible nutrients per acre closely corresponds to the within-season variation of carrying capacity for each pasture (fig. 5), but it also shows a definite seasonal trend upward in production from the early spring months through the summer, after which production drops off rapidly, not to return until the following spring.

Table 11 presents a summary of the productive capacity of pastures 2, 6, and 8 based on the animal-requirement and agronomic methods

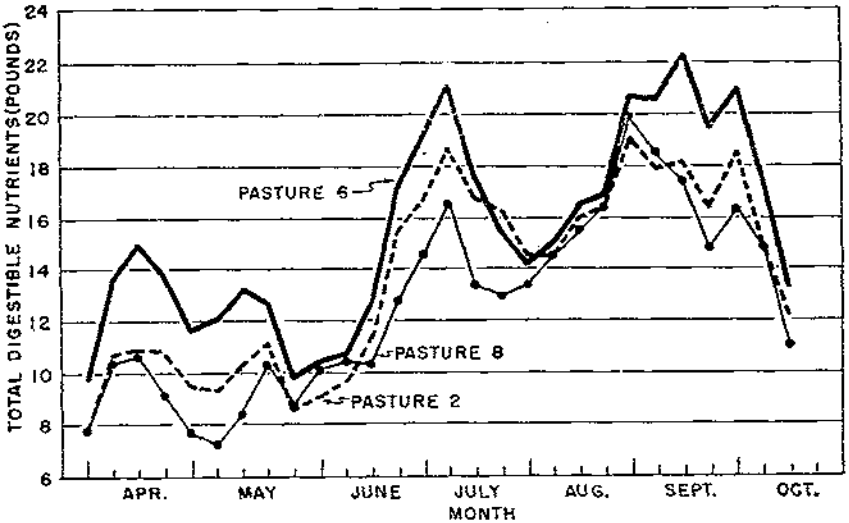

FIGURE 6.—Computed daily production of total digestible nutrients per acre on pastures 2, 6, and 8, by weeks, during the experiment.

TABLE 11.—*Comparison of productivity of pastures 2, 6, and 8 computed by method A (controlled feeding in dry lot) and method B (periodic pasture clippings)*

DATA UNCORRECTED FOR UNDERGRAZING AND OVERGRAZING

Pasture and method	Average grazing season	Animal weight per acre maintained daily	Herbage yield per acre each season (green weight)	Difference in yield	Herbage yield per acre daily (green weight)	Herbage consumed daily per 1,000 pounds of live weight	Total digestible nutrients consumed daily per 1,000 pounds of live weight	Total digestible nutrients produced per acre daily	Area required to produce 100 pounds of total digestible nutrients daily
Pasture 2:	*Days*	*Pounds*	*Pounds*	*Percent*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Acres*
Method A	212	1,798	18,944		89.3	49.7	8.77	15.76	6.34
Method B	212	1,798	24,779	30.8	116.9	65.0	9.74	17.50	5.71
Pasture 6:									
Method A	217	2,022	21,806		100.5	49.7	8.77	17.73	5.64
Method B	217	2,022	31,048	42.4	143.1	70.8	10.61	21.45	4.75
Pasture 8:									
Method A	217	1,660	17,794		82.0	49.7	8.77	14.47	6.91
Method B	217	1,660	26,382	48.3	121.6	73.7			

DATA CORRECTED FOR UNDERGRAZING AND OVERGRAZING

Pasture 2:									
Method A	212	1,866	19,661		92.7	49.7	8.77	16.36	6.11
Method B	212	1,866	24,779	26.0	116.9	62.6	9.38	17.50	5.71
Pasture 6:									
Method A	217	1,990	21,461		98.9	49.7	8.77	17.45	5.73
Method B	217	1,990	31,048	44.7	143.1	71.9	10.78	21.45	4.75
Pasture 8:									
Method A	217	1,545	16,662		76.8	49.7	8.77	13.54	7.38
Method B	217	1,545	26,382	58.3	121.6	78.7			

of determining yield. In the data obtained during the experiment the greater productive capacity of pasture 6 than of pastures 2 and 8 is consistent throughout the 3-year period whether based on carrying capacity, herbage yield, or total digestible nutrients per acre determined from controlled feeding or from pasture clippings.

There are, however, wide differences between herbage yield for each pasture as determined by methods A and B in table 11. The seasonal yields per acre computed from pasture clippings in the agronomic method (method B) are considerably greater than the yields computed from observed animal requirements (method A). The differences varied from 30.8 percent for pasture 2 to 48.3 percent for pasture 8. These differences are further widened when corrections are made for undergrazing and overgrazing. These findings verify those of other workers (*4, 6, 7*) that herbage yields computed from periodic clippings frequently exceed by 40 percent the yields computed from observed animal requirements.

In the present experiment pasture 2 was superior to pasture 8 in carrying capacity with mature steers at maintenance. This reverses the results obtained in the previous 6-year experiment (*2*), when production was measured in steer gains per acre. An explanation for this reversal cannot be found in the 1939 to 1941 herbage yield obtained by the agronomic method because pasture 8 produced slightly more herbage than pasture 2. An explanation may be found in the botanical composition of pastures 2 and 8, as shown in table 2. The rapid invasion of carpet grass in pasture 2 to comprise, by the fall of 1941, more than 60 percent of the species in contrast to only 10 percent for pasture 8, is a possible explanation. The low-growing, creeping nature of this grass, forming a very dense sward when closely grazed, apparently caused the experimenters to underestimate its carrying capacity and also made it difficult to obtain clippings. As chemical analyses of the clippings from pasture 8 were not made, a comparison of the nutritional value of the herbage from this pasture with that from pasture 2 is not available as a possible explanation for the observed differences.

In this experiment the animal-requirement method of determining productivity proved to be more accurate than the agronomic method, because it is based on (1) the observed requirements as determined from controlled feeding and (2) the observed carrying capacity. The animal-requirement method, moreover, agrees closely with the established feeding-standard normals. The agronomic method, on the other hand, is based solely on pasture clippings obtained from four 4- by 4-foot sample areas in each of the 6-acre pastures. Any errors in obtaining the samples, therefore, are multiplied when converted to the acre basis.

As the requirements for total digestible nutrients for mature steers at economic maintenance, obtained in this experiment from observed consumption in dry lot, are within the theoretical requirements for physiologic maintenance of the feeding standards plus 25 percent for the activity factor, the use of theoretical requirements in computing total digestible nutrients produced in pasture experiments would not normally involve experimental errors as large as those computed from pasture clippings.

The fact that corrections can be made for undergrazing and overgrazing when the live weights of mature animals are held at main-

tenance is an advantage that is not possible in pasture experiments in which productivity is measured from maximum steer gains. It is assumed in the latter type of experiment that the two or more pastures compared are all grazed at an equal rate. It is evident from the present experiment how difficult this is to accomplish in fact.

SUMMARY AND CONCLUSIONS

The experiment reported in this bulletin was designed to develop a procedure for evaluating the productiveness of pastures that would reduce the experimental errors inherent in current procedures, especially the computation of yields from periodic clippings of protected herbage and by the reverse use of feeding standards applied to animal gains.

In this experiment, conducted at the Iberia Livestock Experiment Farm, Jeanerette, La., during the grazing seasons of 1939, 1940, and 1941, three pastures, the productiveness of which had previously been determined, were used. For purposes of comparison, pasture clippings were obtained from these pastures by the usual technique every 28 days. Chemical analyses of the samples from two of the pastures were made. Mature steers were placed on the pastures, and the rate of grazing was controlled in a manner calculated merely to maintain the weights of the animals.

By feeding freshly cut pasture grasses and clovers daily to mature steers in dry lot at a rate calculated to maintain their weights, information was obtained on the nutritional requirements for maintenance of mature steers on pasture. The acreage requirements for this purpose were obtained by adjusting, at weekly intervals, (1) the areas on which two groups of six steers each were permitted to graze and (2) the number of steers on the pastures.

It was found that the weights of the steers could be maintained, within reasonable limits, by these methods. For the steers on adjusted pasture areas, the 3-year mean weights throughout the grazing season differed from the 3-year average initial weights by only 2.9 percent on pasture 2 and 3.3 percent on pasture 6. For the steers in dry lot, the difference was only 0.3 percent. In the 277 group weighings, the weekly weights per steer were controlled within 1.6 percent of their average initial weights. The sum of the weekly gains and losses in weight resulted, during the 3-year period, in a net gain of 37.9 pounds per steer in pasture 2 and net losses of 15.9 and 63.5 pounds per steer in pastures 6 and 8, respectively. These results indicated, therefore, that pasture 2 was undergrazed and pastures 6 and 8 were overgrazed.

The observed carrying capacity was 1,798 pounds of animal weight per acre on pasture 2, 2,022 pounds on pasture 6, and 1,650 pounds on pasture 8. Corrected for undergrazing and overgrazing, the carrying capacity was 1,866 pounds per acre on pasture 2, 1,990 pounds on pasture 6, and 1,545 pounds on pasture 8.

The steers in dry lot consumed 49.7 pounds of herbage daily per 1,000 pounds of live weight. By the use of Morrison's digestibility coefficients (*8*), this amount of herbage, containing 13.02 pounds of dry matter, was found to furnish 1.17 pounds of digestible protein and 8.77 pounds of total digestible nutrients. This value is within the range of the theoretical requirements of American feeding standards for the maintenance of a 1,000-pound dry cow plus 25 percent for the "activity factor."

From computations based on the forage consumption in dry lot, it was found, after making corrections for undergrazing and overgrazing, that pastures 2, 6, and 8 produced an average of 19,661, 21,461, and 16,662 pounds, respectively, of herbage to the acre per grazing season. These figures represent daily yields of 92.7, 98.9, and 76.8 pounds of herbage per acre and are equivalent to a daily production of 16.36, 17.45, and 13.54 pounds of total digestible nutrients per acre.

On the basis of pasture clippings, the computed seasonal yields were 24,779, 31,048, and 26,382 pounds of green herbage per acre for pastures 2, 6, and 8, respectively. These figures are 26.0, 44.7, and 58.3 percent greater than those computed from observed consumption by steers in dry lot. Therefore, herbage yields computed from observed consumption in dry lot and carrying capacity of pastures result in a truer evaluation of the productiveness than those computed from pasture clippings.

The chemical analyses indicated that the steers on pasture consumed herbage of about the same nutritive value as that consumed by the steers in dry lot.

It is concluded, from the results of this experiment, that productiveness of pastures may be computed on the animal-requirement basis, carrying capacity of the pasture, and the chemical analyses of pasture clippings, without introducing large experimental errors.

Considerably more attention and skill on the part of experimenters are required to keep, at maintenance level, the weights of experimental animals on pasture than to obtain maximum steer gains. This disadvantage is offset, however, by the ability to correct for undergrazing and overgrazing by the former method.

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U. S. GOVERNMENT PRINTING OFFICE: 1945

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