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CARRYING CAPACITY OF NATIVE RANGE GRASSES IN NORTH DAKOTA.¹

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For many years the writer has believed that a large area of land in the western half of North Dakota should be kept in native prairie sod for pasturing live stock and has held that it will produce vastly more return in that way than can be obtained from the same land if plowed and cropped.

The 1908 report of the field operations of the Bureau of Soils of the United States Department of Agriculture, covering a survey of the portion of North Dakota lying west of the hundredth meridian, confirms this view and in its statement lists 6,645 square miles of land which I interpret from their description is adapted only for grazing. The land west of the hundredth meridian in North Dakota constitutes about three-fifths of the area of the State. The rough or grazing land constitutes about 17 percent of the area, and is equivalent to 184 townships of land.

In 1913 an active campaign on the part of the writer resulted in an arrangement for a trial to determine the carrying capacity of a native range pasture of wild grasses to be conducted cooperatively by the North Dakota Agricultural Experiment Station and the United States Department of Agriculture on the Northern Great Plains Field Station at Mandan, N. Dak. John T. Sarvis and the writer, representing

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the two cooperating agencies, have been responsible for the plans and have carried out the details of the experiment.

The land used for this trial is Section 16, Range 81, Township 138. It is within the Williston loam series of soils and located in what is locally called Custer's Flats, 3.5 miles due south of the city of Mandan, N. Dak. The land is on meridian 101 just south of the 47th degree of north latitude. The elevation is 1,929 feet. The following weather data have been recorded:

- The average precipitation for 40 years, 1875 to 1914, is 17.41 inches.
- Greatest annual precipitation was in 1876, 30.92 inches.
- Lowest annual precipitation was in 1889, 11.03 inches.
- Greatest precipitation in one month was in June, 1914, 10.68 inches.
- Mean seasonal precipitation, April 1 to July 31, inclusive, 9.91 inches.
- Month of maximum precipitation, June, 3.5 inches.
- Month of minimum precipitation, February, 0.5 inch.
- The coldest temperature recorded was in January, 1916, -45° F.
- The hottest temperature recorded was in July, 1910, 107° F.
- Average date of last killing frost in spring, May 15.
- Average date of earliest killing frost in fall, September 15.
- Record latest spring frost, June 7.
- Record earliest fall frost, August 23.
- Prevailing wind, north; usual velocity, 5 to 10 miles per hour.

This section of land, with the exception of 50 to 60 acres, is nearly level and while it differs from most grazing land in that particular permits the laying out of more uniform and comparable pastures than could otherwise be had. The soil type is fairly typical of a large area in western North Dakota. The rough land is set off for a reserve pasture and hence does not enter into the trial.

The section of land used for the trial had been a hay meadow for several years previous to 1915. Some portions of it had been mowed in 1914. Where these cut areas occurred the cattle grazed more readily than they did where it had not been mowed, as that operation had removed much dead grass. As prairie grass covers go, this pasture was densely covered with vegetation at the start.

The object of the trial is to determine the carrying capacity of native pastures without regard to their maintenance or improvement. When this factor is worked out consideration can be given to different methods and periods of grazing.

In 1915, the entire 250 acres set aside for the experiment was fenced as one field and pastured on the basis of 5 acres to the steer. This was done to study its carrying capacity and to get the land in uniform condition. In 1916 the grazing land was divided into four pastures, as shown in figure 10. These pastures contain 30, 50, 70, and 100 acres respectively.

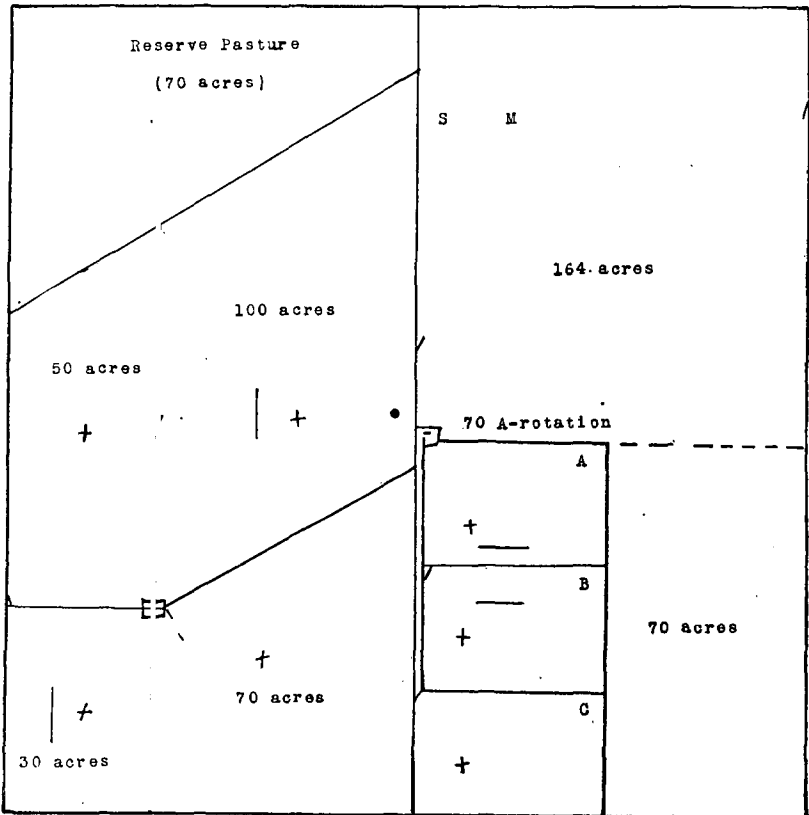


FIG. 10. Plot of the section used in the grazing experiments at Mandan, N. Dak. The corrals and sheds are at the center of the pasture. The straight lines within the various areas represent isolation transects. The crosses show the location of the mapped quadrats. Soil samples are taken around these areas. The dot in the center of the section shows the location of the well. The letters S and M in the northeast quarter of the section represent seeding and mowing experiments respectively.

Corrals, board shelter sheds open on the south, scales, and a squeeze for branding were arranged at the converging corners of the four pastures, and water was provided there for all of the cattle. A 70-acre rotation pasture was begun in 1918 and water was provided separately in the corner of that field.

Ten 2-year-old grade beef-bred range steers are the standard grazing force for each pasture, which makes the pasturing ratio 3, 5, 7, and 10 acres of grass area to the 2-year-old steer.

By correspondence and questionnaires the estimates of about two hundred farmers on the carrying capacities of native and domestic pastures for that region of the State were secured. They range from 6 to 12 acres of native grasses for a 2-year-old steer.

One of the first factors to be determined in this trial seemed to be that of the unit of measure in pasturing with cattle. The 2-year-old beef steer was decided upon as the unit, as (a) he seemed to be the unit most used by ranchmen figuring on this question; (b) he has about the average capacity for consumption between yearlings, cows, and large steers; and (c) he is not disturbed like the heifer by periods of oestrus or by calving during the trial.

The trial calls for 55 head of 2-year-old steers each year. It has been difficult to find suitable animals on the market in the spring, and yearling cattle have had to be used in part for two seasons. Consequently, the comparisons of the consuming and gaining capacity of yearling steers and 2-year-olds are features which have been strongly forced upon us for consideration. This matter has been disposed of by placing approximately a standard weight of cattle per pasture on the land and by comparing the total gains in live weight per pasture and per acre. The weights of the animals when put on the different pastures each year are shown in Table I.

TABLE I.—*Weight and number of cattle per pasture by years.*

Year.	Pasture.	Number of h.ad.	Weight of cattle per pasture.	Days pastured.	Average weight per head.
1915	All as one (250 acres)	53	<i>Pounds.</i> 42,745	109	<i>Pounds.</i> 806.5
1916	100-acre.	14	8,705	149	621.8
	70-acre.	12	7,580	149	631.8
	50-acre.	12	7,310	149	609.2
	30-acre.	12	7,600	149	633.3
	Total or average	50	31,195		623.9
1917	100-acre.	10	7,735	155	773.5
	70-acre.	10	7,800	155	780.0
	50-acre.	10	7,700	155	770.0
	30-acre.	10	7,730	114	773.0
	Total or average	40	30,965		774.1
1918	100-acre.	14	7,090	157	506.4
	70-acre.	14	7,070	157	505.0
	50-acre.	14	6,945	157	496.0
	30-acre.	14	6,970	107	498.0
	Rotation 70-acre.	14	7,020	157	501.4
	Total or average	70	35,095		501.4

It will be seen by Table 1 that 7,000 to 7,500 pounds weight is our approximate standard, or a 700- to 750-pound steer is our approved unit weight when the cattle are placed in the pasture in the spring. In all cases where more than 10 head of steers to the pasture were used some yearlings have been included.

In this discussion thruout I will refer to the cattle on the basis of 10 head of 2-year-old steers per pasture, for convenience in making comparisons. In some cases 14 head of yearling cattle have been used instead of 10 head of 2-year-olds.

The reserve pasture has served a very useful purpose in providing grass for the lot of cattle given 3 acres per 2-year-old steer after their supply of grass was exhausted and also by supplying substitutes when a trial animal was disabled.

Quadrats 20 by 300 feet in area were fenced off early in 1915 in the 30-acre pasture, which it was anticipated would be overgrazed, and in the 100-acre pasture, which it was expected would be undergrazed during the trial. These were isolated for the purpose of making floral population studies. Beginning in 1916, perquadrats 4 meters square have been opened for grazing each year, and a perquadrat of similar size has been taken in from the body of the pasture. If a population study can be made each year for ten years as planned, at the end of that time data will be secured on areas that have been grazed from one to ten years. Quadrats are established at the points marked + on the pasture diagram, these having been laid out by surveying from known points. On these quadrats the grass species population is counted and mapped at intervals during the trial. About 175 different species of plants were collected by Mr. Sarvis during the season of 1915 and made into a herbarium at the Federal station at Mandan for purposes of comparison. A view of a section of the pasture in 1915, when the trial was begun, is shown in Plate 3, figure 1.

Following is a list giving the dominant, primary, and secondary species in the pastures:

Dominant species, *Bouteloua gracilis* (blue grama) and *Stipa comata* (western needle grass).

Primary species, *Stipa viridula* (feather bunchgrass), *Andropogon scoparius* (little bluestem), *Andropogon furcatus* (big bluestem), *Stipa spartea* (porcupine grass), and *Koeleria cristata* (prairie Junegrass).

Secondary species, *Aristida longiseta* (wiregrass), *Agropyron smithii* (western wheatgrass), *Calamovilfa longifolia* (sandgrass), *Agropyron caninum* (bearded wheatgrass), *Bouteloua curtipendula* (tall grama), *Bulbilis dactyloides* (buffalo grass), *Poa palustris* (false redtop), *Agropyron tenerum* (slender wheatgrass), *Elymus canadensis* (Canadian wild rye), and *Sporobolus brevifolius* (prairie rushgrass).

A number of species occur that are not abundant enough to enter into consideration as supplying or hindering pasture.

Blue grama (*Bouteloua gracilis*), typical of the short-grass region, and western needle grass (*Stipa comata*) are the predominating species. Needle grass is representative of the long grass or prairie formation. Apparently the grass land occupants of this pasture would in majority belong to this formation. The blue grama and western needle grass association on these pastures is dominated by the blue grama, which covers approximately twice as much ground surface as the needle grass.

The blue grama from the standpoint of grazing ranks above the needle grass. It stands trampling well and responds to light rains that would not be sufficient to stimulate growth in most other grasses. It is greatly relished by stock. Needle grass furnishes early grazing in the spring and regularly to the time when the needles are formed. When the needles are on, the stock avoid it for a couple of weeks until the needles drop, after which it is again readily eaten for the remainder of the season.

One of the most relished grasses is the big bluestem (*Andropogon furcatus*). It is not plentiful enough to supply much forage, occurring mostly in the ravines. It makes abundant growth, stands drouth well, and recovers rapidly from grazing. It is always grazed closely by the stock and hence has little chance to spread. On these pastures this grass was eaten almost exclusively when the stock were first turned in until it was closely grazed and the new growth has been fed down as fast as it has appeared during the four years of the trial.

Western wheatgrass (*Agropyron smithii*) is one of the best range grasses, but occurs too sparsely in the pastures to be of much consequence. Three grasses of doubtful value and little relished are little bluestem (*Andropogon scoparius*), wiregrass (*Aristida longiseta*), and prairie rushgrass (*Sporobolus brevifolius*). All three furnish some acceptable grazing when young, but soon become harsh and woody. These three are bunch grasses and form dense tussocks. When the 30- and 50-acre pastures grew short the steers left these grasses standing, but when hunger pressed them the tufts were grazed close to the ground. Bunches of wiregrass left by the cattle are shown in Plate 4, figure 1. In figure 2 a portion of the 30-acre pasture is shown in which all grasses are grazed close. Plate 5 shows other views of the pastures.

Plants other than grasses also occur in small percentage and are

allowed to grow by the grazing steers except when necessity forces the cattle to eat them. Their chief importance is that they occupy ground which otherwise might furnish grass and there is a possibility of their affecting the flavor of the flesh of animals when eaten. Most of these plants are eaten to some extent, in the pasture not overstocked, in some stage of their growth.

Following is a list of the plants other than grasses which occur on these pastures.

Dominant species.

Carex filifolia (nigger-wool sedge). It is estimated that this plant covers from 1 to 2 percent of the surface of the ground.

Carex heliophia (sedge). This plant covers less than 1 percent, but a larger area than any of the following.

Primary species.

The following list of primary species is arranged in their order of abundance as based upon actual counts made of 100 quadrats.

	Percent.
<i>Artemisia gnaphaloides</i> (wild sage)	24.0
<i>Solidago rigida</i> (goldenrod)	17.4
<i>Artemisia canadensis</i> (wild sage)	12.5
<i>Psoralea argophylla</i> (silver-leaved psoralea)	12.2
<i>Artemisia frigida</i> (wild sage)	11.6
<i>Echinacea angustifolia</i> (purple coneflower)	8.7
<i>Polygala alba</i> (white milkwort)	6.6
<i>Ratibida columnaris</i> (yellow coneflower)	4.3

Secondary species.

<i>Lacinaria punctata,</i>	<i>Aster multiflorus,</i>
<i>Oxytropis lambertii</i> (loco weed),	<i>Sideranthus spinulosus,</i>
<i>Hedomia hispida,</i>	<i>Lactuca pulchella,</i>
<i>Salsola pestifer</i> (Russian thistle),	<i>Vicia sparsifolia,</i>
<i>Comandria pallida,</i>	<i>Malvastrum coccineum,</i>
<i>Senecio plattensis,</i>	<i>Cherrinia aspera,</i>
<i>Petalostemon purpureum,</i>	<i>Petalostemon candidum.</i>

The percentages of the vegetation removed by the cattle from the various pastures are shown in Table 2.

TABLE 2.—Percentage of vegetation grazed from each pasture yearly.

Year.	Pasture.			
	100-acre.	70-acre.	50-acre.	30-acre.
1916	30	50	70	95
1917	40	60	90	100
1918	55	75	100	100

In the 100- and in the 70-acre pastures the grazing is more patchy than in the 50- and 30-acre ones and was noticeably so from the year 1916 forward.

The pasture ground cover was determined by measurement and count and was found to be about 60 percent. In other words, 60 acres in 100 are covered with vegetation of some kind on these pastures. The grass cover, however, would be called heavy or dense range grass by stockmen.

Two hundred and thirteen head of cattle have been used in this trial during the four years that it has been under way. The fact that they have gained an average of 1.86 pounds per head per day during the time they have been grazed is evidence that they have been thrifty and reasonably well-bred stock.

I find few data covering the carrying capacity of domestic pastures which throw light on gains of cattle or carrying capacity of full-season grazing. Morrow of the Illinois station in the early eighties (1880, 1882, 1883, and 1885) carried on grazing experiments with beef steers. In his experiments, 35 steers pastured for 154 days showed an average gain per day of 1.9 pounds. Morrow does not describe his pasture nor his steers, but I feel safe in assuming that he used grade beef cattle and that he grazed them on the standard domestic or tame grass pastures of Illinois.

Hunt of the Virginia station in the December, 1918, issue of *The Field* reports that he pastured steers in 1915, 1916, and 1917, presumably on bluegrass pasture. He reports that 15 steers averaging 1,100 pounds pastured for 135 days showed an average gain of 2.04 pounds per day. Hunt does not give the area of pasture supplied per steer. He used Shorthorn and Hereford grades in his trial.

Carrier and Oakley at the Virginia station in 1909, 1910, and 1912 carried on a pasturing trial, in which 30 steers pastured for 151 days averaged 2 acres per head and gained an average of 1.52 pounds per day. These steers were on a 12-year-old bluegrass pasture. Carrier and Oakley do not describe their cattle more than to say that 2-year-old steers were used in 1909 and yearlings the other two years.

The Mandan results give an average of 1.86 pounds per head per day and make a reasonably good comparison with the Illinois and Virginia station gains. They may, I believe, be called standard for range-grazed cattle.

Shorthorn, Angus, and Hereford grade and crossbred cattle have been used in the Mandan trial. The majority have been range-bred stock, altho a few farm-bred cattle have been used. Except that



FIG. 1. View showing condition of the pasture in 1915 when the trial was begun.



FIG. 2. Type of cattle used in 1915.

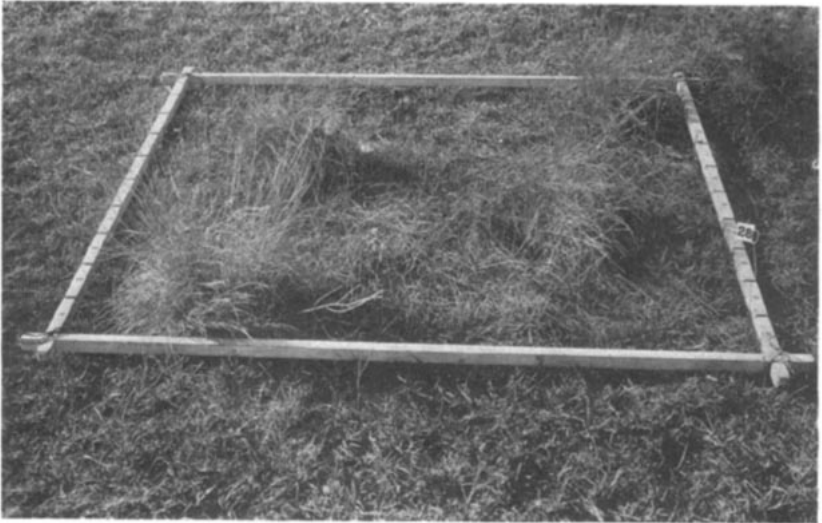


FIG. 1. Close view of the *Aristida* bunches left by cattle. Note close grazing around them. Also compare with Plate 4, figure 2, where scant pasture forced the cattle to eat this forage plant.



FIG. 2. Area in foreground of 3-acre-per-steer pasture is quadrat opened to grazing in 1918. Background shows completeness of grazing, or 100 percent. Note how closely the 3-acre-per-steer cattle grazed a heavy growth the first season it was opened to them. Compare Plate 5, figure 1, where a similar area was opened to the 10-acre-per-steer lot of cattle.

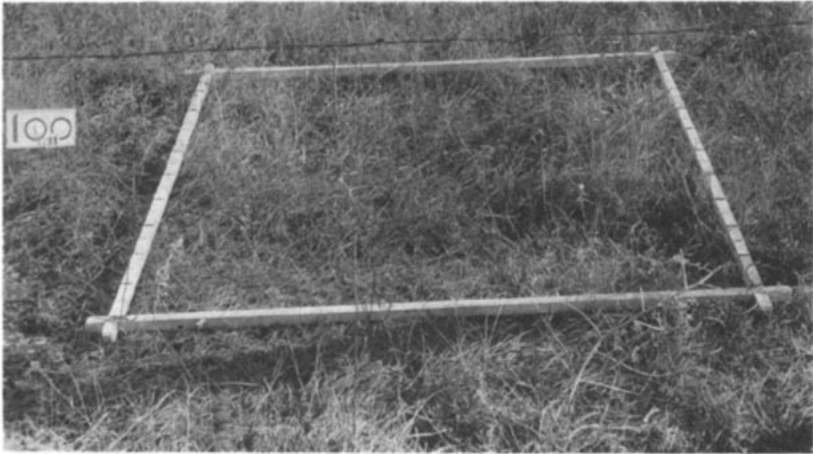


FIG. 1. View of area in 10-acre-to-the-steer pasture opened to cattle in the spring of 1918. Note how little grazed it is compared with Plate 4, figure 2, the 3-acre-to-the-steer pasture opened to grazing at the same time.

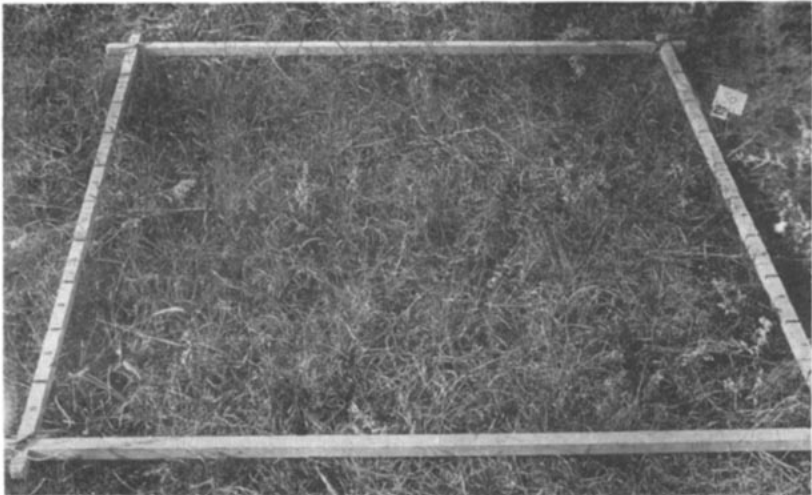


FIG. 2. View of area closed in 1917. Note the thickening of the cover on this 3-acre-to-the-steer pasture with two years' rest period.

they were wild and hard to handle on that account range stock are more satisfactory than domestic cattle. A group of the cattle used in 1915 are shown in Plate 3, figure 2.

Two-year-old steers have been secured in so far as that has been possible, but for two seasons a number of yearlings had to be substituted. In 1918 some heifers were taken. Extra numbers are used when younger cattle are substituted so that the live weight per pasture has been nearly constant at from 7,000 to 7,500 pounds.

The five pastures already described have been pastured by groups of cattle carefully divided into bunches so as to be uniform in type, age, weight, and general character at the beginning of the grazing season. Approximately the same live weight has been placed in each pasture lot at the opening of the pasturing season each year. Beginning with 1916 and from that season on four pastures have been stocked with the same number and approximate weight of cattle or at the rate of 3, 5, 7, and 10 acres to the 2-year-old steer. At the close of the second year (1917) of separate pasture grazing the 3-acre-to-the-steer pasture was exhausted as shown by a shrinkage in weight of the cattle.

TABLE 3.—Results of grazing experiments with steers in 1918 at Mandan (2 two-year-olds and 12 yearlings in each pasture).

30-ACRE PASTURE.

Date of weighing.	Length of period.	Total weight.	Average weight.	Gain or loss per lot.	Average gain or loss per head.	Gain per acre.	Average gain or loss per day.
	Days.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
May 17		6,970	498				
May 31	15	7,390	528	420	30.0		2.0
June 30	30	8,855	633	1,465	104.7		3.5
July 30	30	9,050	646	195	14.0		0.5
Aug. 29 ^a	30	9,150	654	100	7.1		0.2
Total	105			2,180	155.8	72.7	1.5

50-ACRE PASTURE.

May 17		6,945	496				
May 31	15	7,715	551	770	55.0		3.7
June 30	30	9,020	644	1,305	93.2		3.1
July 30	30	9,760	697	740	52.9		1.8
Aug. 29	30	10,280	734	520	37.1		1.2
Sept. 28	30	10,970	784	690	49.3		1.6
Oct. 20	22	10,715	765	-255	-18.2		-.9
Total	157			3,770	269.3	75.4	1.8

TABLE 3.—Results of grazing experiments.—Continued.

70-ACRE PASTURE.

May 17		7,070	505				
May 31	15	7,905	565	835	59.7		4.0
June 30	30	9,380 ^b	670	1,475	105.4		3.5
July 30	30	10,035	717	805	57.5		1.9
Aug. 29	30	10,500	750	465	33.2		1.1
Sept. 28	30	11,190	799	690	49.3		1.6
Oct. 20	22	11,370	812	180	12.9		0.6
Total	157			4,450	318.0	63.6	2.0

100-ACRE PASTURE.

May 17		7,090	506				
May 31	15	7,645	546	555	39.6		2.2
June 30	30	8,580	613	935	66.8		2.4
July 30	30	9,620	687	1,040	74.3		2.5
Aug. 29	30	10,490	749	870	62.1		2.1
Sept. 28	30	11,255	804	765	54.6		1.8
Oct. 20	22	11,390	814	135	9.7		.5
Total	157			4,300	307.1	43.0	1.9

ROTATION PASTURE.

Date of weighing.	Length of period.	Total weight.	Average weight.	Gain or loss per lot.	Average gain or loss per head.	Gain per acre.	Average gain or loss per day.
	Days.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
May 17		7,020	501				
May 31	15	7,800	557	780	55.7		3.7
June 30	30	8,885	635	1,085	77.5		2.6
July 30	30	9,375	670	490	35.0		1.2
Aug. 29	30	10,120	723	745	53.2		1.7
Sept. 28	30	10,690	764	570	40.7		1.4
Oct. 20	22	10,710	765	20	1.4		.1
Total	157			3,690	263.6	52.7	1.7

^a Cattle removed from pasture. This lot of cattle showed a loss in weight of 240 pounds during the last ten days of August, or at the rate of 1.7 pounds per head per day.

^b Weight after substitution, 9,230 pounds.

In the third year the 3-acre-to-the-steer pasture was exhausted August 30, or at the end of 106 days, and the cattle lost weight regularly after that time until removed from the pasture. On September 30, at the end of 137 days, the 5-acres-to-the-steer pasture was exhausted and the cattle began losing weight rapidly. Seven acres to the steer seems to be carrying the cattle satisfactorily. A rotation pasture supplying 7 acres to the steer was started in 1918. This pasture lies adjacent to the original 70-acre pasture and is fenced into

three equal parts consisting of $23\frac{1}{3}$ acres each. The cattle were pastured on A, B, and C sections of it respectively during the first, middle, and latter portions of the grazing season during 1918. In 1919 they will be pastured first on B, second on C, and third on A. In 1920 they will be pastured first on C, second on A, and third on B, and continue in a similar repeating rotative manner thruout the trial. Table 3 gives the detailed results for the cattle in the third year of the trial, 1918.

TABLE 4.—*Summary of results of grazing experiment at Mandan in 1918 with 2 two-year-olds and 12 head of yearling cattle in each pasture.*

Data.	Pasture.				Rotation, 70 acres.
	100 acres.	70 acres.	50 acres.	30 acres.	
Total weight May 16, pounds...	7,090	7,070	6,945	6,970	7,020
Total weight Oct. 20, pounds...	11,390	11,370	10,715	9,150 ^a	10,710
Average weight May 16, pounds	506	505	496	498	501
Average weight Oct. 20, pounds	814	812	765	654 ^a	765
Gain per pasture in 158 days, pounds	4,300	4,450	3,770	2,180 ^a	3,690
Average gain per head, pounds	307	318	269	156 ^a	264
Average gain per day, pounds...	1.9	2.0	1.7	1.4 ^a	1.7
Gain per acre, pounds	43.0	63.6	75.4	72.7	52.7

^a Weight September 1 when 30-acre pasture was exhausted.

Table 5, which gives a summary of the pasturing results for three years, shows similar altho more marked results than those for 1918 as the per acre gain from heavy and light pasturing.

In the summary table for 1918 it will be seen that the added weight or gain per acre of pasture decreases with the acreage of grass supplied per steer. Three acres to the steer in 1918 gave 72.69 pounds of gain per acre or 69 percent more gain per acre than 10 acres to the steer, despite the fact that it had been pastured to exhaustion the previous year and lasted only 106 days, while 10 acres to the steer was grazed 157 days. The increases per acre of grass land were in reverse ratio to the acreage supplied per head.

Carrier and Oakley report results from trials on an old bluegrass pasture as follows:

- 3 steers grazed 151 days on $2\frac{1}{2}$ acres per steer gained 112 pounds per acre.
- 6 steers grazed 151 days on $1\frac{1}{4}$ acres per steer gained 198 pounds per acre.

These gains per acre are naturally much heavier than those secured under range conditions, but show a similar spread in the total gain per acre on heavy and light pasturing. It is interesting to note also

TABLE 5.—Average gain per head for the entire pasturage period, gain per head per day, and gain per head per acre in grazing experiments at Mandan in 1916, 1917, and 1918.

AVERAGE GAIN PER HEAD.						
Year.	Number of days.	Pasture.				
		100-acre.	70-acre.	50-acre.	30-acre.	70-acre rotation.
1916	149	271.1	324.9	321.2	271.7	
1917	155	241.5	213.0	227.0	124.0 ^a	
1918	158	307.1	318.0	269.3	155.8 ^b	263.6
Average.....		273.2	285.3	272.5	183.5	

AVERAGE GAIN PER DAY.						
1916	149	1.82	2.18	2.16	1.82	
1917	155	1.37	1.46	1.46	1.08	
1918	158	1.94	2.00	1.72	1.40	1.70
Average.....		1.71	1.88	1.78	1.43	

GAIN IN WEIGHT OF CATTLE PRODUCED PER ACRE.						
1916	149	37.97	55.71	77.10	108.66	
1917	155	24.15	30.43	45.40	66.66	
1918	158	43.00	63.59	75.40	72.69	52.71
Average.....		35.04	49.91	65.96	82.67	

^a Pasture exhausted September 1 after 106 days grazing.

^b Pasture exhausted September 18 after 123 days grazing.

that Virginia bluegrass sod improved from heavy grazing while the lightly grazed pasture grew weedy. These experimenters report no advantage from rotation pasturing.

The rotation pasture (7 acres to the steer) at Mandan gave only five-sixths the gain obtained from the nonrotated 7-acre-to-the-steer pasture. Five steers from this pasture broke out and were returned after covering 30 miles. They were gaunt and doubtless shrunk considerably during that time. They were turned in on section C of their pasture September 1 and were out September 11 to 14. The grazing was particularly good in division C at that time, but the cattle were nervous and restless when returned. This difference seems to me, however, to be chiefly chargeable to the fact that the rotation 70-acre pasture had not been grazed down in several years and contained much dead grass, which is either not relished, so that the cattle do not eat heavily of it, or is not nutritious and fails to give good

gains when consumed. The other 7-acre-to-the-steer pasture had been grazed regularly for three years and hence was reasonably well pastured down. Further evidence that the fresh grass of early spring gives much more rapid gains than the drier grass of the later season is shown by Table 6.

TABLE 6.—Gains made per day by grazing periods, 1915 to 1918.

Period.	Number of steers.	Inclusive dates.	Length of period, days.	Gains per day per head, pounds
Season.....	53	July 17 to Nov. 3, 1915	109	1.8
1st.....	50	June 1 to July 17, 1916	47	3.4
2d.....	50	July 18 to Sept. 13, 1916	58	2.1
3d.....	50	Sept. 13 to Oct. 13, 1916	30	0.8
4th.....	50	Oct. 13 to Oct. 27, 1916	14	-0.9
1st.....	40	May 26 to June 30, 1917	35	3.6
2d.....	40	July 1 to Aug. 29, 1917	60	1.5
3d.....	40	Aug. 29 to Sept. 28, 1917	30	0.7
4th.....	40	Sept. 28 to Oct. 29, 1917	30	-0.6
1st.....	70	May 16 to July 1, 1918	46	3.0
2d.....	70	July 1 to Aug. 30, 1918	61	1.4
3d.....	56	Aug. 30 to Sept. 30, 1918	30	1.6
4th.....	56	Sept. 30 to Oct. 20, 1918	20	.1

Summary by periods for 3 years, 1916-1918.

1st.....	160		44	3.26
2d.....	160		60	1.64
3d.....	146		30	1.07
4th.....	146		22	.47

Summary entire season for 4 years, 1915-1918.

213 steers 140 days, average gain per day 1.86

It will be noted that for the three years the average gain per day for the first 44 days is double that of the next 60 days, while the gain for the 30 days following the first 104 days of the season is only 1.07 pounds, or less than one-third that of the first 44 days. During the last 22 days of the grazing season in the month of October the cattle sustain a loss of 0.47 pound in weight per day.

The average gain per day secured in a 3-year trial when grazing 44, 104, 134, and 140 days respectively is shown below. This is a summarized comparison of the total gains which may be expected at different dates in the full season.

Period.	Gain per day, pounds.
First period, 160 steers, 44 days	3.26
First and second periods, 160 steers, 104 days	2.33
First, second, and third periods, 157 steers, 134 days	2.06
First, second, third, and fourth periods, 213 steers, 140 days	1.86

Cattle as thin as stocker steers are in the spring naturally gain more rapidly than they do later, but I do not believe that the large and consistent gains here shown can be accounted for in that way.

These results do not bear out the theory that amide substances found in succulent plants have less value in producing gains in live stock than the protein substance found in more mature plant growth.

Four years is too short a time to give conclusive results from a grazing trial, but the evidence seems reasonably conclusive that less than 7 acres to the 2-year-old steer will not carry and that the principal gains are made by cattle during the early part of the season. Also, that late season grazing is done without gains or at an actual loss in weight. They also indicate that the number of acres supplied per steer in practice will depend upon the farm management questions of the cost of supplementing pastures and the price of land used for grazing, as heavy early season pasturing gives maximum per acre yields.