A Twenty-Five Year Comparison of Continuous and Rotation Grazing in the Northern Plains[1]

GEORGE A. ROGLER

Agronomist, Bureau of Plant Industry, U. S. Northern Great Plains Field Station, Mandan, North Dakota

A GRAZING experiment was established at the Northern Great Plains Field Station in 1916 to determine the carrying capacity of native range. Pastures of various sizes were grazed with cattle continuously during a 150 day summer season from May 16 to October 13 at intensities that would result in degrees of use from over-grazing to under-grazing. In 1918 additional pasture was established to study a system of deferred and rotation grazing. This deferred and rotation pasture was grazed every year during the period 1918–45. The results obtained on this pasture are directly comparable with those from the continuously grazed pastures.

Sarvis (1923 and 1941) describes the plan of the entire experiment and gives the results from 1916 to 1940. Rogler (1944) gives the results from 1940 to 1943. This paper presents data needed to compare results obtained on the deferred and rotation pasture with those from two of the continuously grazed pastures, one of which was grazed heavily and the other moderately.

[1] Cooperative investigations by the U. S. Dept. of Agriculture, Agricultural Research Administration, Bureau of Plant Industry, Soils, and Agricultural Engineering, Division of Forage Crops and Diseases and the North Dakota Agricultural Experiment Station. J. T. Sarvis of the former Division of Dry Land Agriculture was in charge of the project under which these investigations were carried on from 1915 to 1941, inclusive. Most of the data presented in this paper were collected during that period.

Climate and Vegetation

The climate of the area under study does not differ greatly from that of other sections of the northern Great Plains. Temperatures reach extremes in both winter and summer, rainfall is limited, and high winds are not infrequent. Of all the climatic factors involved, rainfall most influences the production of native forage.

Normally about half of the annual rainfall comes in May, June, and July and the seasonal precipitation from April 1 to September 30 is about three-fourths of the annual. The average annual precipitation at the Northern Great Plains Field Station for the 1918–45 study period was 15.30 inches; the average seasonal precipitation 11.83 inches. For the first study period, 1918 to 1935, the average annual and seasonal precipitation was 14.73 and 11.34 inches. The seasonal precipitation varied from 6.40 inches in 1934 to 16.04 inches in 1927. During the year 1936 when no grazing comparisons were made, the seasonal precipitation was only 2.96 inches, the annual only 6.43 inches. During the second study period, 1938 to 1946, the annual and seasonal precipitation was 17.15 and 13.47 inches. The seasonal precipitation varied from 11.37 inches in 1938 and 1939 to 16.86 inches in 1941. It is evident, therefore, that the second phase of the study was carried on during a much more favorable period than the first.

The mixed prairie native vegetation in the pasture on which these studies were

made is typical of much of the surrounding area. The dominant plant species are blue grama (*Bouteloua gracilis*), western wheatgrass (*Agropyron smithii*), threadleaf sedge (*Carex filifolia*), and needle-and-thread (*Stipa comata*). Other common species are silver sage (*Artemisia frigida*), white sage (*A. gnaphalodes*), green sage (*A. dracunculoides*), silverleaf scurfpea (*Psoralea argophylla*), and prairie junegrass (*Koeleria cristata*).

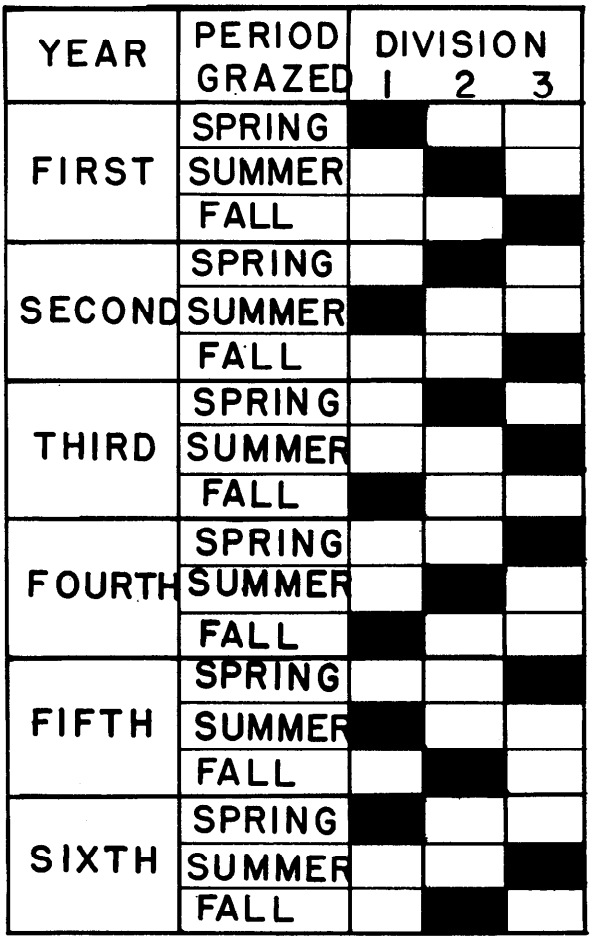

FIGURE 1. Diagram of the order of grazing the three divisions of the deferred and rotation pasture for a complete cycle. Grazing periods are shaded, rest periods unshaded.

PROCEDURE

The deferred and rotation system was set up in a manner similar to that suggested by Jardine (1915) and Sampson (1913). A 70-acre pasture was divided into three divisions and grazed as shown in Figure 1. Grazing on each division was deferred until fall during two successive seasons. This allowed production of seed on the fall-grazed division one year, and protection of the seedlings, if any, until fall of the next. Each division was grazed approximately one-third of the season each year.

The study was divided into two periods. Two-year-old steers were used during the first period from 1918 to 1934, and yearlings during the second, from 1938 to

1945. From 1935 to 1937 rotation and continuous grazing could not be compared because the heavy continuously grazed pasture was not used during that time. From 1918 to 1927 the number of steers on the pasture varied from year to year, averaging five acres per head. It was then determined that this pasture could be grazed at five acres per head without injury to the vegetation. In 1929 the location of the 70-acre rotation pasture was interchanged with a continuously grazed 70-acre pasture. Up to 1934 and during the 1938–45 period five acres per head were allowed until 1941 when the grazing intensity was increased to 3.85 acres per head. The pasture was cut in size from 70 to 50 acres in 1941 with a continuation of the same type of division and rotation grazing.

There were two continuously grazed pastures: one 70 acres grazed moderately and the other 50 acres grazed heavily. The 70-acre pasture was grazed with one head to 7 acres for the 1918–40 period, and with one head to 5.38 acres for the 1941–45 period. The 50-acre pasture was grazed at an intensity of one head to 5 acres from 1918 through 1940, and with one head to 3.85 acres from 1941 through 1945.

The 50-acre continuously grazed pasture did not carry the steers the full season every year. Grade steers were used, branded with serial numbers and weighed individually. Average 3 day weights were used at the beginning and close of the season. The second weighing was always made on May 31, and thereafter, weights were taken at intervals of 30 days to check monthly gains. The average starting weight of the two-year-olds was 748 pounds per head, for the yearlings 480 pounds.

Eighty permanent meter square quadrats were established in each continuously grazed pasture and in each division of the rotation pasture at the beginning of the experiment. Estimates and counts on these quadrats showed the effects of the different intensities and systems of grazing on the vegetation. To determine the amount of forage produced in the various pastures a series of clippings were made in the spring, summer, and fall when the cattle were moved from one division of the rotation pasture to the next, and also when the cattle entered and left each division. In addition clippings were made at 20, 30, and 40 day intervals, annually and biennially. Estimates were also made of the foliage removed by grazing on each pasture and on each division of the rotation pasture during and at the close of each season.

Results

Vegetation

It was evident by 1936 when the shift was made from two-year-olds to yearlings that an intensity of one head to 7 acres was approximately the correct grazing rate for a continuously grazed pasture carrying two-year-olds for the summer season. It provided enough forage to produce the maximum gain per head, and the vegetation was not adversely affected. An average of about 25 percent of the total foliage remained for a forage carryover to the next season. At this rate of grazing changes in the composition of the vegetation were influenced primarily by differences in precipitation. Species that tend to increase with over-grazing such as silver sage and blue grama either decreased or were maintained at about the same level. Species that decrease with over-grazing such as western wheat, needle-and-thread, prairie junegrass and silver leaf scurfpea were still abundant after 34 years of grazing. Much of the needle-and-thread was killed out during the drought years of 1934 and 1936 but was considerably recovered afterwards. Western wheatgrass also came in more abundantly after the drought years.

It was evident by 1940 that yearlings consumed about two-thirds as much forage as two-year-olds. The intensity of grazing was therefore increased by one-third on all pastures in 1941. The 70-acre continuously grazed pasture still provided a maximum of feed with plenty of carry-over forage. On the average only about half of the forage was grazed each year during the 1938–45 period when precipitation was especially favorable for the growth of grass.

The vegetation in the 50-acre continuously grazed pasture was definitely overgrazed at an intensity of one two-year-old to 5 acres for the 1918–34 period. Six times, the steers had to be removed before the end of the grazing season. The over-grazed condition was indicated not only by lower gains but also by an increase in silver sage, and a reduction of needle-and-thread, prairie junegrass, silver leaf scurfpea, white sage, and green sage. The density also decreased from an estimated 50 to 60 percent to 30 to 40 percent.

During the favorable 1938–45 period when yearlings were used, this pasture was in no year considered over-grazed. On the average there was a 30 percent carry-over of forage from one year to the next.

The rotation pasture was grazed at the average rate of one head to 5 acres during the 1918–34 period. The vegetation did not show the adverse effects evident in the pasture grazed continuously at the same rate. Under rotation, grasses benefited by the rest periods when they were periodically allowed to develop a normal growth and mature before being grazed. There was no evidence that the pasture benefited from any natural reseeding that took place in the fall-grazed divisions. The density of the pasture was so high at all times that old plants produced more competition than small seedlings could withstand. The vegetation was not affected when the pasture grazed continuously with one head to 7 acres was interchanged in 1930 with the rotation pasture grazed at 5 acres per head. This was true even though a greater amount of the foliage was utilized during each season in the rotation pasture after the change. The amount of foliage removed from each division of the rotation pasture was approximately the same each year. During the 1918–34 period, grazing removed a yearly average of 92 percent of the herbage; during the more favorable 1938–45 period, only 59 percent of the forage growth.

Gains

Comparative gains per head on the two continuous pastures and the rotation pasture for the 1918–34 period are shown in Figure 2. During this period there were only three years when the steers on the rotation pasture failed to gain more than those on the pasture grazed continuously at the same rate. The average gain of steers on rotation over continuous grazing at the same intensity was 33.9 pounds per head during 1927–34 when the steers on rotation were held at 5 acres per head; and 34.8 pounds for the entire 17 year period 1918–34 (Fig. 2).

In the comparison of the moderate continuously grazed pasture carrying one two-year-old to 7 acres and the rotation pasture grazed with one two-year-old to 5 acres, the continuously grazed steers gained more per head every year of the 1918–34 period—an average of 44.5 pounds per head. The average difference between gains on all pastures was statistically highly significant.

Comparative gains per head for the two continuously grazed and the rotation pasture for the 1938–45 period are shown in Figure 3. Since there was no shortage of forage in any of the pastures during

the period, even though the grazing intensity was increased in 1941, it appears permissible to average gains for all years. During seven of the eight years, gains per head were higher on the 50-acre pasture grazed continuously with 5 acres per head until 1941 and 3.85 acres per head thereafter than on the rotation pasture grazed at the same intensity. The 8-year average gain of 20 pounds per head more for the yearlings grazed continuously was statistically significant. Yearlings grazed continuously at the moderate rate of 7 acres per head for 3 years and 5.38 acres per head for 5 years gained more per head every year than those on the rotation pasture. The advantage for the continuously grazed pasture in this case was highly significant at 28.8 pounds per head over the rotation

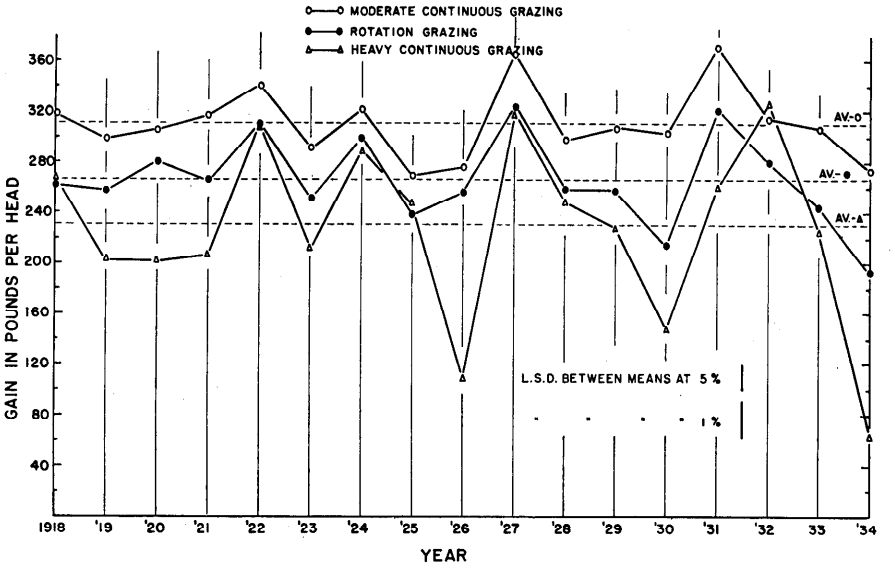

FIGURE 2. Seasonal gain of two-year-old steers on native pastures at the Northern Great Plains Field Station from 1918 through 1934.

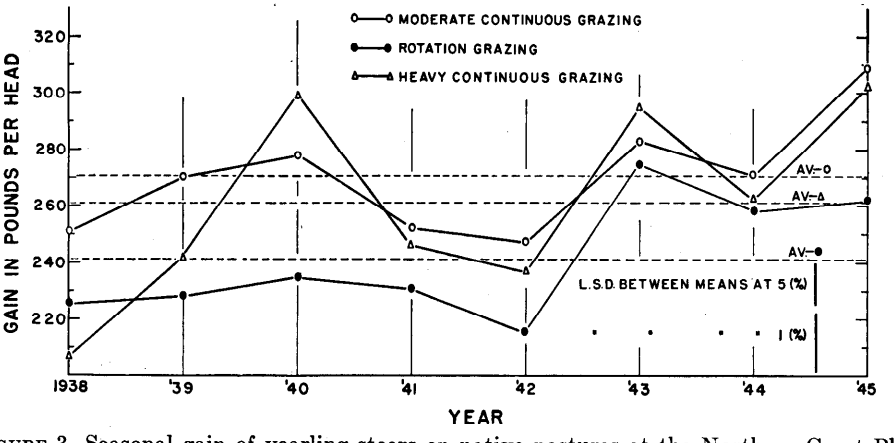

FIGURE 3. Seasonal gain of yearling steers on native pastures at the Northern Great Plains Field Station from 1938 through 1945.

pasture. As would be expected, because of the abundance of forage in both continuously grazed pastures, there was no significant difference in the average gain on these pastures.

Discussion

Under the conditions of the experiment, which are similar to those throughout the northern Plains, moderate continous grazing of native range is conducive to maximum gains per head. It cannot be expected that gains per head can be increased by changing to a rotation system when there is sufficient forage for continuous season-long grazing, with at least 25 percent carry-over of vegetation. Little benefit can be expected from rotation grazing where plenty of range is available. If enough native forage is available for cattle to put on maximum gains, no other system of grazing can be expected to show greater increases.

There would seem to be some merit in a rotation system for improving range that has been damaged by over-grazing. It is likely, however, that complete deferment until the range recuperates would be a more rapid and satisfactory method of improvement. If two-year-olds or older cattle are being grazed, a rotation system might be used when it is necessary to graze heavily during occasional years.

One of the apparent advantages of continuous grazing is that cattle have access to all the plants in the pasture when highest in feed value. Cattle grazed on rotation must crop each division closely before being moved to a new one. During this close grazing, gains are likely to be lower. If gains are lost they are generally not made up later in the season. Young cattle are less likely to gain under a rotation system because they do not utilize as well as older cattle the mature forage present in the summer and fall divisions. This is indicated by the fact that yearlings did not gain as well on the fall division of the rotation pasture as those on continuously grazed pastures during the same period.

Summary

1. A deferred and rotation pasture was established in 1918 as part of the long time grazing experiment at the Northern Great Plains Field Station. Results on the rotation pasture are compared to those on two continuously grazed pastures, one grazed moderately and one heavily.

2. The vegetation in both the continuous moderately grazed pasture and more heavily grazed rotation pasture showed no adverse effects from the cropping. The continuous heavily grazed pasture showed adverse effects of over-grazing.

3. For the 17 year 1918–34 period when two-year-olds were used, gains averaged 34.8 pounds per head more on the rotation pasture than on the continuously grazed pasture with the same grazing intensity. The steers on the moderate continuously grazed pasture during the same period gained 44.5 pounds more per head on the average than those on the rotation pasture.

4. Yearling steers for the 1938–45 period grazed continuously at both moderate and heavy rates gained more per head than those on rotation pasture. At the rate of 5 acres and 3.85 acres per head the continuously grazed yearlings gained 20 pounds more per head on the average than those on rotation pasture at the same intensity. At the rate of 7 acres and 5.38 acres per head the continuously grazed yearlings gained 28.8 pounds per head more on the average than those on the rotation pasture.

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NUTRITIONAL DEFICIENCIES IN BEEF CATTLE

Lack of sufficient total feed is probably the most common deficiency in beef cattle. In limited feeding on farms or overstocked ranges, low energy intake may be the sole deficiency, the results being slowing or cessation of growth (including skeletal growth), loss of weight, reproduction failure, and increased mortality. On ranges, low feed intake also commonly results in increased mortality from toxic plants and from lowered resistance to parasites and diseases. Very commonly, however, underfeeding is complicated by shortages of protein and other nutrients.

Richard T. Allman and T. S. Hamilton
in Nutritional Deficiencies in Livestock.
FAO Agri. Studies No. 3, 1949.