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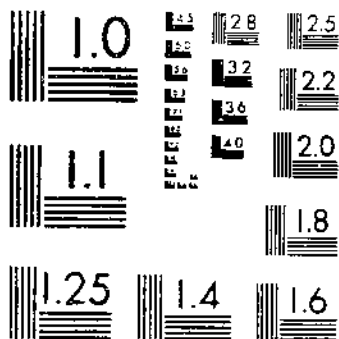
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WINTERING STEERS IN THE NORTH CENTRAL GREAT PLAINS SECTION

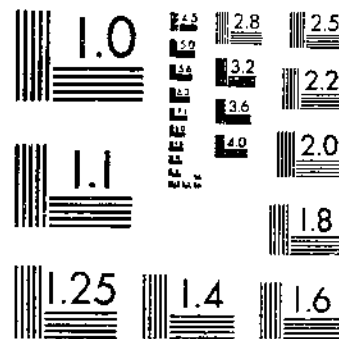
BLACK, W. H.; MATHEWS, O. R.

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NATIONAL BUREAU OF STANDARDS-1963-A

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.WINTERING STEERS IN THE NORTH
CENTRAL GREAT PLAINS SECTION

By W. F. BLACK, Senior Animal Husbandman, Animal Husbandry Division, Bureau of Animal Industry, and O. R. MATHEWS, Associate Agronomist and Superintendent, Ardmore Field Station, Office of Dry-Land Agriculture, Bureau of Plant Industry.

CONTENTS

	Page		Page
The section and its problems-----	1	Experiment 1, 1923-24-----	6
Objects of the experiments-----	2	Experiment 2, 1924-25-----	7
Plan of work and steers used-----	2	Experiment 3, 1925-26-----	8
Feeds used-----	3	Experiment 4, 1926-27-----	9
Summer pastures-----	3	Experiment 5, 1927-28-----	10
Weather conditions during the experi- ments-----	5	Averages of the five experiments-----	11
		Summary and conclusions-----	12

THE SECTION AND ITS PROBLEMS

DEPOSITION

The section to which the results of these experiments are most applicable is composed of western South Dakota, eastern Wyoming, and northwestern Nebraska. In this territory livestock production is still the major industry. Farming on a large scale is practiced on the better types of soil, particularly close to railroads, but immense areas remote from railroads are still in native grass utilized principally as feed for grazing animals and, will probably continue to be so used for years to come. Where farming is practiced, livestock growing is almost always a part of the farm operations.

It is a well-known fact among ranchers that winter feed must be provided if stock are to be carried through the winter without danger of loss from starvation. At the same time it is commonly recognized that the gains made by the animals when grazing are the cheapest. Therefore, the chief problem is to carry the steers economically through the winter in condition to make large gains during the grazing season. In other words, the largest possible gains for the winter and summer combined at the least possible cost per pound are most likely to result in the greatest profit. Stinting the winter feed to cheapen the gains may be carried too far, with the result that the cattle do not make sufficient growth or do not carry flesh enough to command the most favorable returns when marketed. Consequently there is a wide divergence of opinion about the amount of feeding that is necessary, and as to the value of different home-grown feeds for wintering purposes.

¹ V. I. Clark, scientific aide at the Ardmore Field Station, assisted in the preparation of this bulletin and directly supervised most of the details of the experiments.

OBJECTS OF THE EXPERIMENTS

Comparison of four home-grown feeds during a period of five consecutive years was made to determine their value as winter feeds for steers. The experiments were conducted cooperatively by the Bureau of Animal Industry and the Bureau of Plant Industry of the United States Department of Agriculture, at the United States Dry-land Station, Ardmore, S. Dak.

The experiments were planned for the purpose of comparing the relative values of alfalfa hay, western wheatgrass (*Agropyron smithii*) hay, corn silage, and oat straw as roughage for wintering steers. Western wheatgrass has been the standard hay of the region since the country was settled, but of late years the acreage of alfalfa has been considerably increased. The respective merits of the two hay crops have been a subject of much controversy. The prevailing attitude has been a strong prejudice in favor of wheatgrass over alfalfa. Oat straw was brought into the comparison for the purpose of determining whether this by-product of farming operations could be used economically to supplement or replace part of the hay as a winter feed for cattle. The corn silage was introduced to determine whether a feed could be grown that would be more economical than hay.

The quantity of feed received by all the lots of steers was deemed sufficient to produce a gain during the winter period, and to permit the steers to come through the winter in condition to make good gains during the grazing season. The effect of the different winter feeds on the gains made during the summer grazing season was also determined. The effect of overgrazing summer pastures also received incidental study to the extent that one lot of 10 cattle was permitted to overgraze an 80-acre pasture.

PLAN OF WORK AND STEERS USED

Grade Hereford yearling steers, as uniform in size and quality as could be obtained, were used during all the experiments. (Fig. 1.) During the first four years the steers were obtained locally, but in the fifth year they were obtained on the Denver market. As the steers were acquired through exchange in all years, it is impossible to determine their cost accurately.

The steers were branded with individual numbers and were weighed on three consecutive days at the beginning of each experiment. They were then divided into four lots that were as nearly equal in size and quality as could be selected. The animals were weighed at 28-day intervals during the progress of each experiment and on three consecutive days at the end of the experiment. The averages of the three initial and final weighings were taken as the initial and final weights. All weighings began at 1.30 p. m. The feeding period was 168 days during two years, and 196 days in the other three years. The winter feeding period in these experiments ended with the morning feed. The closing date of a period and the beginning of the subsequent period were thus on the same day. Each year at the beginning of the experiment the steers were dipped twice, to kill lice. In all but one year it was necessary to repeat the dipping in the early spring.

The daily rations given the different lots of steers were as follows: Lot 1, 10 pounds oat straw, 5 pounds alfalfa hay; lot 2, 15 pounds

alfalfa hay; lot 3, 30 pounds corn silage, 5 pounds alfalfa hay; lot 4, 15 pounds wheatgrass hay. In the last experiment, the quantity of silage fed to lot 3 was reduced to 20 pounds a head daily.

No charge against the steers was made for labor, and no credit was given for the manure produced.

An open shed 24 feet in depth and 96 feet long provided shelter for the steers. (Fig. 2.) Water was available at all times, tank heaters being used to keep it from freezing. Salt was kept before



FIGURE 1.—Some of the experimental steers on grass, July, 1926. These steers are representative of those used throughout the experiments

the steers at all times. Bedding was used in quantities sufficient to prevent the pens from becoming sloppy.

The steers were fed once a day, feeding beginning at 9 a. m. The feed to be given to a lot was carefully weighed and was then distributed as evenly as possible along the manger. The lots were fed in the same order each day, beginning with lot 1 and ending with lot 4.

FEEDS USED

The oat straw used in the tests was produced at the station. All fields of oats grown were of the Sixty-Day variety, the straw of which is short and fine.

Alfalfa hay was generally purchased, though in some years part or all of it was grown on the farm. None of the alfalfa used would have graded better than No. 2, and in some years the grade would have been lower. Discoloration was generally the principal cause for the alfalfa grading so low. However, the feeding value of the alfalfa was good in all years.

The wheatgrass hay was purchased from neighboring ranchers each year except in 1927, when the grass was purchased standing and was cut, stacked, and baled by station labor. In all years the wheatgrass hay was of fair quality, although in some it was more mature than desired.

The corn silage was grown at the station. In all but one year it was of good quality and contained a relatively high percentage of grain. The kinds of corn used for silage were early maturing dent varieties. During two years sorgo silage was used to supplement the corn silage.

A more detailed description of each year's feed is given in the discussion of each year's test.

The prices of the feeds are not directly comparable, because part was grown at the station and part was purchased. The cost of the purchased feeds depended to a considerable extent on how long a haul was necessary to get them to the feed lot. All straw and hay were baled for convenience in handling, and the baling was an expense not ordinarily experienced by ranchers. For all purchased feed the delivered price was naturally much higher than farm prices.

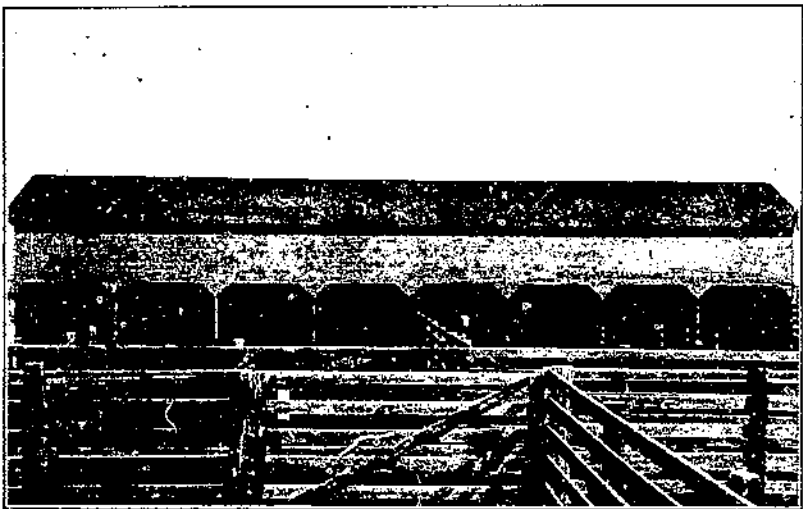


FIGURE 2.—Feeding shed and arrangement of pens for wintering experiments

To make the results of the experiments applicable to farm conditions it was thought best to ascertain as nearly as possible the farm prices of feeds during the five experiments, and to use the average of them as a basis for determining the costs of wintering steers.

During the period covered by the experiments both alfalfa and wheatgrass sold for an average of nearly \$10 a ton in the stack. This is above rather than below the average farm price for a longer period.

A price of \$6 a ton was put on the corn in silage. This price was based on an estimate of the cost of producing corn and converting it into silage at the station.

A price of \$3 a ton was placed on the unbaled oat straw. This was probably higher than farm prices warrant, as the straw was a by-product of farming and was not grown as a cash crop.

SUMMER PASTURES

It was desirable to use as large a number of steers for wintering as the available equipment and feed would accommodate rather than limit the number to those that could be handled on the experimental pastures. The experimental pastures contained 150, 80, and 160 acres, respectively. Ten steers each were used in the 150 and 80 acre pastures. While it was known that 80 acres would not carry 10 head of cattle satisfactorily, it was advisable to use this number of cattle in order to make a study of the effects of overgrazing. The 160-acre pasture was subdivided into two equal areas, 16 steers being kept on one area for half the grazing season and then transferred to the remaining area. The results of the grazing studies are to be combined with other data and published later.

WEATHER CONDITIONS DURING THE EXPERIMENTS

Table 1 shows the maximum, minimum, and average daily temperatures by months during the experiments. When the experiment covered only part of a month the temperatures given are for that fraction only. Table 2 shows the precipitation during the time covered by the experiments. It is to be noted that the first, second, and fourth experiments were begun later in the year than the others; hence, in some cases, there are no data for the months of November and December.

TABLE 1.—Temperature conditions at Ardmore, S. Dak., during the periods of winter feeding

Year	Novem- ber	Decem- ber	January	February	March	April	May
Maximum temperatures:	° F.	° F.	° F.	° F.	° F.	° F.	° F.
1923-24.....		56	48	59	57	80	68
1924-25.....		64	50	55	75	77	88
1925-26.....	63	63	43	62	73	86	90
1926-27.....			56	62	70	85	80
1927-28.....	67	45	60	57	78	80	89
Minimum temperatures:							
1923-24.....		-32	-31	-5	-11	20	24
1924-25.....		-22	-13	-8	-8	20	28
1925-26.....	11	-12	-13	10	5	19	28
1926-27.....			-28	-10	4	6	21
1927-28.....	8	-22	-11	-5	3	8	30
Mean temperatures:							
1923-24.....		21	14	27	23	43	49
1924-25.....		12	15	31	38	50	53
1925-26.....	35	26	22	33	35	47	56
1926-27.....			19	29	34	42	51
1927-28.....	40	14	25	27	37	43	56

TABLE 2.—Precipitation at Ardmore, S. Dak., during the periods of winter feeding

Year	Novem- ber	Decem- ber	January	February	March	April	May	Total
	Inch	Inch	Inch	Inch	Inches	Inches	Inches	Inches
1923-24.....		0.02	0.75	0.70	0.69	0.62	0.62	2.43
1924-25.....		.41	.45	.42	1.34	1.62	1.62	4.86
1925-26.....	0.01	.65	.12	.49	.49	1.79	1.79	4.06
1926-27.....		.22	.31	1.14	4.06	2.01	2.01	7.77
1927-28.....	.20	.27	.28	.28	.40	.27	1.28	3.14

EXPERIMENT 1, 1923-24

The oat straw fed during this winter was of poor quality because of a heavy rust infection of the oats in 1923. The alfalfa was exceptionally good. Silage was of good quality. The quantity fed was approximately 55 per cent sorgo silage, 40 per cent corn silage, and 5 per cent Sudan grass and sunflower silage. Most of the corn silage was fed during the first, second, and sixth periods. The wheatgrass was of good quality.

All rations were palatable and readily consumed, though the oat straw and the wheatgrass were consumed much more slowly than the alfalfa and the silage.

Table 3 summarizes the principal results of the experiment, showing for each of the four lots the gains during the winter and following summer, the cost of the feeds used, and the feed cost per 100 pounds of gain.

TABLE 3.—Summary of Experiment 1, winter period 168 days, December 5, 1923, to May 21, 1924; summer period 130 days, May 21, to September 28, 1924

Item	Lot 1 fed oat straw, 10 pounds; alfalfa, 5 pounds	Lot 2 fed alfalfa, 15 pounds	Lot 3 fed silage, 30 pounds; alfalfa, 5 pounds	Lot 4 fed wheatgrass, 15 pounds
Winter:				
Steers per lot.....	15	15	15	15
Average initial weight per steer.....pounds.....	663.3	658.5	657.3	655.9
Average gain per steer.....do.....	32.9	81.5	187.2	65.7
Winter and summer:¹				
Steers per lot.....	9	9	12	12
Average winter gain per steer.....pounds.....	34.8	68.3	105.0	69.2
Average summer gain per steer.....do.....	77.9	83.2	41.2	96.3
Average total gain per steer.....do.....	112.7	151.5	236.2	165.5
Average cost of feed and pasture per steer ²dollars.....	13.22	19.10	25.82	19.10
Average feed cost per 100 pounds of gain.....do.....	11.73	12.61	10.93	11.54

¹ On account of the limited capacity of the experimental pasture, some of the steers were taken out of the experiment at the end of the wintering period, and the remainder were divided as equally as possible for the grazing experiments. The winter, summer, and total gains are given for those steers carried throughout the wintering and summer-grazing experiments.

² Pasture was charged at the rate of 5 cents per head per day. The winter feed cost may be determined by subtracting from the total feed cost the product resulting from multiplying the number of days on grass by 5 cents.

The steers fed on silage and alfalfa, lot 3, made much the highest gain for the winter. The alfalfa-fed lot made slightly greater gains than the wheatgrass-fed lot. The lot fed oat straw and alfalfa produced a gain of only 32.9 pounds a head during the winter period.

The silage-fed lot, which made the heavy winter gain, made the lowest gain on pasture. The straw-fed lot, with a low winter gain, made the next to the lowest summer gain. The steers fed wheatgrass made a slightly higher summer gain than those fed alfalfa, and the total gain for the year was also a little larger. In this connection it should be stated that the gains during the summer are smaller than those obtained by ranchers, because some of the steers were kept on closely grazed pasture. Approximately the same number of steers from each lot was kept on the different pastures, and the results afford a true comparison of the relative gains of the different lots under the same conditions.

The ration of the steers wintered on straw was much cheaper than any of the others. The cost of wintering steers on alfalfa or wheatgrass was approximately double that of the straw-fed lot, and the cost of the silage-fed lot was nearly triple that of the lot wintered on straw. The real economy of a winter ration, however, would appear to be the feed cost per pound of gain made during the entire year.

The lot fed silage had the lowest feed cost per 100 pounds gain, while the lots fed straw and wheatgrass were about equal in cost, but somewhat higher than the silage-fed lot. The gains made by the alfalfa-fed lot were the most expensive.

The small gains made in the summer of 1924 were a result of the low rainfall and shortage of grass for that season. The total precipitation for the year was 11.74 inches which is 5.12 inches less than the 12-year period 1912-1923. The precipitation during the early spring months was considerably more deficient than it was for the year.

EXPERIMENT 2, 1924-25

The steers used during the 1924-25 test were the lightest in any year. They were obtained from the Pine Ridge in Nebraska about two weeks before the experiment began. The change in water and feed was not to their liking, and they lost approximately 50 pounds a head from the time they were received at the station until they were put on experiment. This may partly account for the high winter gain made by the steers.

The straw produced in 1924 was bright and fine stemmed, but during a portion of the feeding period straw left over from the previous year was used in the test. The alfalfa and the wheatgrass hay were of good quality. The corn silage contained very little grain, and its feeding value was far below that of the corn silage used in other years. Approximately 10 per cent of the silage used during the feeding period was sorgo silage. The results of this experiment are given in Table 4.

TABLE 4.—Summary of Experiment 2, winter period 196 days, November 5, 1924, to May 21, 1925; summer period 130 days, May 21, 1925, to September 28, 1925

Item	Lot 1 fed on straw, 10 pounds; alfalfa, 5 pounds	Lot 2 fed alfalfa, 15 pounds	Lot 3 fed silage, 30 pounds; alfalfa, 5 pounds	Lot 4 fed wheatgrass, 15 pounds
Winter:				
Steers per lot.....	15	15	15	13
Average initial weight per steer.....pounds	550.7	601.0	590.9	610.3
Average gain per steer.....do	112.1	137.3	177.0	126.6
Winter and summer:¹				
Steers per lot.....	8	8	10	10
Average winter gain per steer.....pounds	123.5	144.9	195.7	145.1
Average summer gain per steer.....do	170.6	152.5	130.0	165.4
Average total gain per steer.....do	294.1	297.4	325.7	310.5
Average cost of feed and pasture per steer ²dollars	14.34	21.20	29.04	21.20
Average feed cost per 100 pounds of gain.....do	4.88	7.13	8.89	6.83

¹ See note 1, Table 3.

² See note 2, Table 3.

The lot fed silage produced the highest average total gain, but the increase over the other lots was smaller than in any other year. The lower winter gain of the silage-fed lot as compared to the

previous year was no doubt largely because of the poor quality of the silage. The lowest total gain was made by the lot fed on straw and alfalfa hay, but this was only slightly lower than the gains made by the steers fed alfalfa and wheatgrass.

The lot fed silage made the lowest gains during the grazing period. This is in conformity with the results of the previous year. In direct contrast with the results of the previous year, the lot fed straw produced higher gains during the grazing period than either the alfalfa-fed or the wheatgrass-fed lot. Its total gain was nearly equal to that of the lot fed alfalfa. The gain of the wheatgrass-fed lot during the grazing period was higher than that of the alfalfa-fed lot, which was true also of the total gain for the year.

The feed cost of gains during the year was very much lower for the lot fed straw than for any other. The costs for the alfalfa-fed and wheatgrass-fed steers differed very little, and were about midway between the straw-fed and silage-fed lots. The relation of the total feed costs of the different lots to one another was the same as in the previous year, but the cost of each lot was somewhat higher, because of a longer feeding period.

EXPERIMENT 3, 1925-26

The steers used in the third year's test were obtained locally. They were of exceptionally good quality and were somewhat heavier than those used in the other years of the tests.

The alfalfa hay used in the third year's test was bright and leafy. It contained about 10 per cent of bluegrass, but it is not believed that the bluegrass materially influenced the results. The straw was bright, fine stemmed, and of very good quality. The wheatgrass and silage were likewise good.

One of the steers in the silage-fed lot was killed while being dipped for lice during the winter, and the results for this lot are for the 14 steers that were on hand during the entire test. A summary of the experiment is given in Table 5.

TABLE 5.—Summary of Experiment 3, winter period 196 days, November 6, 1925, to May 21, 1926; summer period 156 days, May 21 to October 18, 1926

Item	Lot 1 fed cut straw, 10 pounds; alfalfa, 5 pounds	Lot 2 fed alfalfa, 15 pounds	Lot 3 fed silage, 30 pounds; alfalfa, 5 pounds	Lot 4 fed wheatgrass, 15 pounds
Winter:				
Steers per lot.....	15	15	14	15
Average initial weight per steer..... pounds.....	672.3	673.5	679.0	672.7
Average gain per steer..... do.....	84.5	82.3	220.4	80.2
Winter and summer: ¹				
Steers per lot.....	8	8	10	10
Average winter gain per steer..... pounds.....	93.2	80.4	231.4	84.7
Average summer gain per steer..... do.....	61.0	73.0	19.0	83.7
Average total gain per steer..... do.....	154.2	153.4	250.4	178.4
Average cost of feed and pasture per steer ²dollars.....	25.34	22.20	36.04	22.20
Average feed cost per 100 pounds of gain.....do.....	9.95	14.47	12.00	12.44

¹ See note 1, Table 3.

² See note 2, Table 3.

The most marked deviation from results in other years is the fact that the average winter gain of the straw-fed lot was slightly more than the alfalfa-fed and the wheatgrass-fed lots. The relatively

better showing of the straw-fed lot was no doubt attributable largely to the exceptionally good quality of the straw. The gain of the silage-fed lot was exceptionally high, being nearly 140 pounds a head higher than that of the other lots.

The summer gains in this year's test were all low because of dry weather and short pastures. The silage-fed lot gained only 19 pounds a head during the 150-day pasture period. The straw-fed lot made lower summer gains than either the alfalfa-fed or wheatgrass-fed lot. The steers fed wheatgrass made a summer gain sufficiently high to make their combined winter and summer gains considerably above those of the oat-straw-fed and alfalfa-fed steers.

The feed cost per pound of gain was again lowest for the lot fed straw, being followed by the steers fed silage and wheatgrass, which were nearly the same.

EXPERIMENT 4, 1926-27

The steers used in the fourth year's test were obtained locally and were nearly all of good breeding and quality. Difficulty in getting the steers delayed the experiment, and the length of the winter feeding period was only 168 days.

The alfalfa used in this feeding test was brown. The straw was clean and fine stemmed, but a small portion of it had been discolored by rain. The silage contained a relatively high percentage of grain and was of uniformly good quality. The wheatgrass was clean and bright but contained sufficient ergot to be injurious to some of the steers. The presence of ergot could not be detected by the appearance of the hay. In consequence, three of the steers became poisoned during the course of the experiment and were removed from the lot. Ergot poisoning is not uncommon in this section.

The results of the experiment are given in Table 6, the three poisoned steers not being included.

TABLE 6.—Summary of Experiment 4, winter period 168 days, December 4, 1926, to May 21, 1927; summer period 150 days, May 21, 1927, to October 18, 1927

Item	Lot 1 fed oat straw, 10 pounds; alfalfa, 5 pounds	Lot 2 fed alfalfa, 15 pounds	Lot 3 fed silage, 30 pounds; alfalfa, 5 pounds	Lot 4 fed wheatgrass, 15 pounds
Winter:				
Steers per lot.....	15	15	15	12
Average initial weight per steer.....pounds.....	629.5	629.7	629.4	646.9
Average gain per steer.....do.....	86.3	89.1	188.6	86.5
Winter and summer: ¹				
Steers per lot.....	8	8	10	10
Average winter gain per steer.....pounds.....	89.7	90.9	194.4	93.0
Average summer gain per steer.....do.....	164.9	220.7	162.3	216.5
Average total gain per steer.....do.....	254.6	311.6	340.7	309.5
Average cost of feed and pasture per steer ² dollars.....	14.22	20.10	26.82	20.10
Average feed cost per 100 pounds of gain.....do.....	5.59	6.45	7.74	6.45

¹ See note 1, Table 3.

² See note 2, Table 3.

As in the previous year's experiment, the winter gains of the straw-fed lot were practically the same as those of the alfalfa-fed and wheatgrass-fed lots. The silage-fed steers gained approximately 100 pounds more per head during the winter period than any of the other lots.

The silage-fed lot made the smallest gain during the grazing season, though the difference was not so great as in some other years. The straw-fed lot made the next to the lowest gain. The gains of the alfalfa-fed and wheatgrass-fed lots were nearly equal, with a slight difference in favor of the alfalfa-fed lot. This is the only year during the experiments in which the alfalfa-fed steers gained more during the summer than steers wintered on wheatgrass hay.

The feed cost per pound of gain for the year was lowest for the straw-fed lot and highest for the silage-fed lot.

EXPERIMENT 5, 1927-28

One material change in the experiment was made in the fifth year. It was recognized from the gains made during previous years that the quantity of silage fed was too great for a wintering ration. A reduction from 30 to 20 pounds per head daily in the silage was therefore made for the purpose of determining whether a smaller winter gain for the silage-fed steers might not be compensated for by a greater gain on pasture.

The straw produced in 1927 was coarse and the oats were heavily infected with rust, so that the quality of the straw was probably the lowest in any year of the experiment. The wheatgrass hay was bright and leafy and was at least equal to any other used in the tests, but the alfalfa hay was badly discolored. The corn silage contained a high percentage of grain.

The steers used were obtained on the Denver market and were received at the station about two weeks before the experiment began. The steers were of good breeding and quality but were the wildest used in any year. The results of the experiment are shown in Table 7.

TABLE 7.—Summary of Experiment 5, winter period 196 days, November 7, 1927, to May 21, 1928; summer period 150 days, May 21, 1928, to October 18, 1928

Item	Lot 1 fed out straw, 10 pounds; alfalfa, 5 pounds	Lot 2 fed alfalfa, 15 pounds	Lot 3 fed silage, 20 pounds; alfalfa, 5 pounds	Lot 4 fed wheatgrass, 15 pounds
Winter:				
Steers per lot.....	10	10	10	10
Average initial weight per steer.....pounds.....	654.8	655.9	654.6	656.1
Average gain per steer.....do.....	48.9	71.1	171.9	71.1
Winter and summer:¹				
Steers per lot.....	8	8	10	10
Average winter gain per steer.....pounds.....	49.6	74.9	171.9	71.1
Average summer gain per steer.....do.....	168.4	149.0	124.2	178.1
Average total gain per steer.....do.....	218.0	223.9	296.1	249.2
Average cost of feed and pasture per steer ² , dollars.....	15.34	22.20	24.16	22.20
Average feed cost per 100 pounds of gain.....do.....	7.04	9.92	8.10	8.91

¹ See note 1, Table 3.

² See note 2, Table 3.

The straw-fed lot, owing partly at least to the poor quality of the straw, produced the lowest winter gain. The gains of the alfalfa-fed and wheatgrass-fed lots were the same and were materially higher than those of the straw-fed lot. In spite of the reduction in the quantity of silage fed, the silage-fed lot produced 100 pounds per head more gain than the alfalfa-fed and wheatgrass-fed lots.

The gain of the silage-fed steers on pasture approached the gains of the other lots more nearly than in other years, though it was still the lowest. The wheatgrass-fed lot made the highest summer gain.

The feed cost of gains in the straw-fed lot was again the lowest. The reduction of the silage in the ration of lot 3 reduced the cost of the gains for that lot and made it less than for either of the lots wintered entirely on hay. Wheatgrass was slightly more economical than alfalfa, largely because of the greater summer gains made by the first-named lot.

AVERAGES OF THE FIVE EXPERIMENTS

The series of experiments here reported is regarded as a completed piece of work.¹ Although differences in feed have caused the results to vary greatly from year to year, the average results should be a valuable indication of what may be expected on most ranches of the northern Great Plains. The proportion of wet and dry years, with the consequent effect on the character of the feed produced, has been about average. The average results of all the experiments, namely, the gains during both the winter and summer grazing periods, the total gains, the winter feed cost, and the feed cost per 100 pounds gain during the year, are shown in Table 8.

TABLE 8.—Summary of winter, summer, and total gains, and cost of 100 pounds of total gain, for the five experiments, 1923 to 1928

Item	Lot 1 fed oat straw, 10 pounds; alfalfa, 5 pounds	Lot 2 fed alfalfa, 15 pounds	Lot 3 fed silage, 28 pounds; alfalfa, 5 pounds	Lot 4 fed wheatgrass, 15 pounds
Average winter gain per steer (all steers).....pounds	74.7	93.8	189.8	85.9
Average winter gain per steer (steers carried through summer).....pounds	77.1	91.3	197.8	91.7
Average summer gain per steer.....do	127.3	134.4	91.7	147.9
Average winter and summer gain per steer ¹do	204.4	225.7	289.5	239.6
Average cost of feed and pasture per steer ¹dollars	14.46	20.93	27.12	20.89
Average feed cost per 100 pounds of gain.....do	7.07	9.27	9.37	8.72

¹ See note 1, Table 3.

² See note 2, Table 3.

The average gain of the silage-fed lot during the winter was 189.8 pounds a head, which was very much higher than that of any other lot. On the other hand, the summer gain of the silage-fed steers was lower than that of any other lot, but because of the extremely high winter gain, the yearly gain of the silage-fed lot was higher than that of any of the others. The average winter gains of the alfalfa-fed and wheatgrass-fed steers carried through the experiment were about the same, but the steers wintered on wheatgrass produced 13.5 pounds a head more gain during the grazing period. The steers fed on straw produced the lowest winter gain, and the next to the lowest summer gain. Their gain for the year was from 21 to 85 pounds a head less than for the other lots.

¹ A series of experiments is now under way at this station to compare three rations for wintering steers, namely, silage and oat straw, alfalfa and oat straw, and Dakota amber sorgo. The cattle are being so fed that they make little or no winter gains, which is in keeping with the practice on most ranches.

The feed cost per pound of gain during the year was slightly higher for the silage-fed lot than for any of the other lots. The feed cost of gain in the alfalfa-fed lot was appreciably higher than in wheatgrass-fed lot. The low cost of straw made the feed cost per pound of yearly gain for the straw-fed lot much lower than for any other.

SUMMARY AND CONCLUSIONS

The results of the five years' work show that oat straw is a valuable supplement to the winter's feed. In years when the quality of the straw was good, the winter gain of the steers fed on straw was satisfactory. However, in years of heavy rust infection the gain of the steers fed on straw was much lower than that of steers fed hay.

Oat straw was the most economical of all the feeds under study, but it must be remembered that oat straw is purely a by-product of producing a crop of oats for grain. The amount of oats grown for grain seldom exceeds the needs of the individual farm, as other grain crops have a higher market value per acre than oats. Certainly no recommendation that oats be grown for the purpose of obtaining straw for feeding purposes can be made. Therefore the quantity of oat straw available is seldom large enough to form more than a part of the winter ration. The experiment has definitely proved, however, that a limited quantity of good-quality oat straw can be fed with alfalfa hay to steers without materially reducing the gain. When used in this way, it materially reduces the wintering cost of the steers.

Alfalfa and wheatgrass have proved to be of about equal value as winter rations. The slightly greater winter gain of the alfalfa-fed steers is more than compensated for by the greater summer gain of the wheatgrass-fed steers. The difference between the two is small, however, and one can safely say that these two crops are so nearly equal that cost rather than feeding value should determine which should be used.

Wheatgrass has been generally accepted as being better than alfalfa, because a specified quantity will last longer. In these experiments the alfalfa-fed steers generally consumed their rations in less than half the time required by the wheatgrass-fed steers. There is no doubt that steers will consume much more alfalfa than wheatgrass if given the opportunity. It is this greater consumption of alfalfa that has given rise to the opinion that wheatgrass is "stronger" than alfalfa, and that less is required for feeding purposes. The experiments indicate that no more alfalfa than wheatgrass is needed for a winter ration.

The gain of the silage-fed steers was always high during the winter period, and that resulted in a low gain during the grazing period. The results in these experiments are in keeping with those obtained in studies of the effect of winter rations upon the subsequent summer gains of steers on pasture, such as the study reported in Department Bulletin 1251, *Effect of Winter Rations on Pasture Gains of 2-Year-Old Steers*. The general conclusion of such studies is that the steers which make the greatest winter gains make the smallest summer gains, but the greatest total gains for winter and summer combined. The silage ration in the beginning was calculated to contain the same quantity of dry matter as the other lots, the quantity

fed being based on a 25.3 per cent dry-matter content. Drying tests made during the experiment, however, showed that the silage generally contained from 35 to 40 per cent dry matter, so that the quantity of digestible nutrients fed was greater than originally intended. In the last year of the test the reduction in the silage fed made the digestible nutrient in the ration less than in the hay rations. In spite of this the silage-fed steers continued to make good gains, and the feed cost per pound of gain for the year was less than for the hay-fed lots. It is believed, and the results of the last year's test substantiate that belief, that when the quantity of silage fed is small enough to keep the winter gain from being too high, silage is as economical a winter ration as hay. Even under the conditions of the experiment the difference is probably less than shown by the cost figures. The silage-fed steers were usually in better condition than the other lots at the end of the grazing season and would probably have sold on the market for enough more to take care of at least part of the higher wintering cost. This can not be definitely proved, however, as the steers were sold as feeders and as one drove of cattle.

The gains made during the wintering experiments show that the feed for all lots was sufficient to bring the steers through the winter in a satisfactory condition. It is probable that had less feed been used during the winter the steers in all lots would have made slightly higher gains during the grazing period.

The cost and quantities of feed consumed were greater than under ranch conditions because the steers were confined in pens and had no feed whatever except their rations. On most ranches winter pasture is available, and steers are able to get a portion of their feed from dried grasses, except during storm periods. This decreases the actual cost of the winter rations but should not materially change the relative value of the different rations.

**ORGANIZATION OF THE
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END