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SOUTH DAKOTA STATE COLLEGE BROOKINGS

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Acknowledgments

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WINTERING BEEF COWS
ON SOUTH DAKOTA RANGES

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Wintering beef cows on the ranges of the Northern Great Plains is a major problem for every cattleman of the area whose production program calls for a beef breeding herd. Proper wintering of beef cows demands a ration and management program that is (1) economical, (2) practically free from death losses, and (3) satisfactory for high production. This is not easy to achieve in a climate as variable as that of the Northern Great Plains.

In the 22 West River counties of South Dakota, there are approximately 22 million acres in farms and ranches. About 80 percent of this is in grass. Beef cows utilize a large portion of this, and if the grass is to be used economically, many of these cows must be wintered in the area. In recent years, more than 400,000 beef cows have been wintered annually on western South Dakota ranges. This research was conducted in order to learn more effective feeding and management practices for wintering these cows. The findings will also apply in part to the cattle operations in the semi-range area east of the Missouri River.

Review of Literature

Wintering experiments with beef cows have been conducted at other experiment stations, but in general, feeds, management and climate have differed so much from those of western South Dakota that the results have limited value in planning wintering practices for South Dakota range cattle.

The experimental wintering trials conducted at the U. S. Range Livestock Station, Miles City, Montana, and reported in USDA Technical Bulletin 603, probably are more nearly applicable to South Dakota conditions than the others. Their results showed that when wintering cows on the open range, it paid to feed cottonseed cake during severe winters but not during open winters. However, feeding the cake always resulted in heavier spring weights of the cows and slightly heavier fall weaning weights of their calves. These experiments also showed that 1 pound of cake fed to cows on the open range gave results similar to feeding 10 pounds of alfalfa hay.

The Montana Experiment Station also wintered cows in corrals for several years. In these trials, 1 pound of cottonseed cake replaced about 5 pounds of alfalfa as a supplement to low-grade roughages. In another set of trials, several kinds of roughages were compared. These ranked in feeding value as follows: (1) oat hay, (2) alfalfa hay, (3) sweet clover hay, (4) blue joint hay, and (5) corn fodder.

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During the winter of 1948-49, deep snow covered the ranges for an extended period. The cows had to be gathered into groups near headquarters and fed approximately 20 pounds of hay daily. This winter each cow required 1½ tons of hay and 200 pounds of soybean cubes to supplement the winter grazing

Experimental Work

Four wintering experiments were conducted. Two of these were conducted at the Range Field Station at Cottonwood, and two at the Reed Ranch at Presho, South Dakota. The wintering rations compared were:

1. Winter grazing plus salt,[4] bonemeal and ground limestone.
2. Winter grazing, salt, bonemeal and ground limestone with (a) cottonseed cubes, (b) soybean cubes, and (c) a mixed protein supplement of soybean oil meal and corn cubes.
3. Winter grazing, salt, bonemeal and ground limestone with (a) windrowed hay, (b) windrowed hay plus stacked hay, (c) stacked hay, and (d) sorghum fodder.

The roughages were all grown at the stations where the trials were conducted. The soybean-corn cube mixture was prepared by a feed company for this experiment, and consisted of soybean oil meal diluted with ground shelled yellow corn so that the mixture averaged 23.6 percent protein.

The trials were conducted during an 8-year period from the winter of 1941 to 1949, inclusive. The snow of 1948-49 forced all trials to be abandoned during that year. In late January after the second bad storm, all of the cows were grouped and fed on harvested feeds. During that winter it took about 1½ tons of hay plus 200 pounds soybean cubes to winter each cow.

In normal winters, one-half ton of hay or 120 pounds of a 40 percent protein supplement with bonemeal, ground limestone and salt, fed free choice, produced good results when

[4]At Reed Ranch, salt containing 25 to 37½ ppm of arsenic was fed to the cattle continually to counteract the effects of selenium poisoning caused by selenium in the soils.

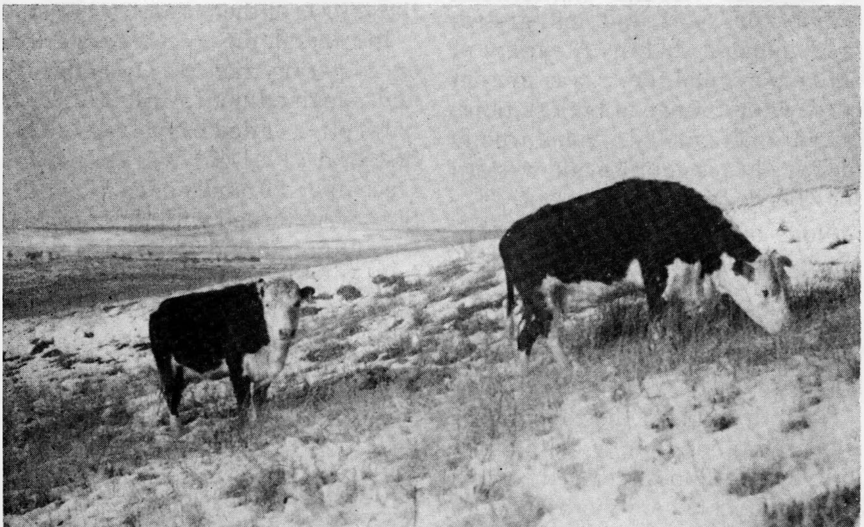
fed to cows grazing on the open range. Ten years of observational studies on South Dakota ranges indicate a hay storage supply of 2 to 2½ tons of hay, or its equivalent, per cow is desirable to take care of winter emergencies and the years of limited hay production.

The Range Field Station where Experiments 1 and 2 were conducted is located just east of Cottonwood, South Dakota. This station is about midway between Pierre and Rapid City in the Bad River watershed. Reed Ranch, where Experiments 3 and 4 were conducted, is an experimental ranch of the South Dakota Agricultural Experiment Station located just west of the Missouri River valley, 35 miles southeast of Ft. Pierre and 20 miles northwest of Presho.

The elevation of the Cottonwood Range is about 2400 feet, and that of Reed Ranch 1700 feet. Long-time weather data for the Cottonwood station show an annual precipitation of 14.7 inches, with only 3.5 inches falling during the 5-month period, December 1 to April 30. The average precipitation for Pierre, South Dakota for the same period was 16.1 inches with 4.4 inches falling during the December 1 to April 30 period. The precipitation at Reed Ranch appears similar to that at Pierre.

The average mean temperatures for the 5-month period, December through April, were 22°, 19°, 22°, 34°, and 46° F. respectively at Cottonwood, and 23°, 18°, 20°, 33°, and 48° F. at Pierre. The lowest recorded temperature at Cottonwood was –42° F., and at Pierre a –40° F.

Cows grazing on snow-covered range in February. As long as the snow did not get any deeper and remained on the ground for only a short time, the cows did well if they received 1 pound of 40 percent protein supplement daily, plus minerals



Warm days are common during the winter months, however, and snow seldom covers all of the range for any extended length of time.

The soils of the winter range land at the Cottonwood station are heavy clays of slow permeability which have been derived from the Pierre formation. Soils of Reed Ranch have also been derived from the Pierre formation. The Reed Ranch soils, however, contain enough selenium to cause selenium poisoning in livestock. Salt containing 25 to 37½ ppm of arsenic was fed continually to cattle grazing on such soils to counteract the poisoning. None of the animals in the wintering experiment showed signs of selenium poisoning.

Mixed prairie vegetation covered the winter ranges of both stations. The principal grasses were western wheatgrass, blue grama, buffalo grass, little bluestem, needle-and-thread, side-oats grama and green needlegrass. At the Cottonwood station the short and mid-grasses predominated slightly. A variety of native perennial forbs[5] was present in the winter range at both stations, but in small amounts. Some woody plants, silver sagebrush and western snowberry, were also present.

None of the winter ranges were grazed during the summer months. The vegetation remained relatively unchanged throughout the experiment and was always strong and vigorous.

At both stations, the topography is gently rolling to hilly, with a majority of the slopes facing the north in the ranges where the trials were run. There was some natural protection, however, in each of the ranges at the Cottonwood station. Board windbreaks were constructed in each of the pastures at Reed Ranch.

The cattle used in Experiment 1 were high-grade Hereford cows bred to purebred Hereford bulls. The ages of the animals in the herd varied. Replacements were added to the lots only when needed due to age of cows. Each cow remained on the ration allotted to her at the beginning of the experiment; thus the results of Experiment 1 show all accumulative effects of the rations and represent expected production from long-time systems of management. During the years that Experiments 2, 3, and 4 were conducted, the herds were being shifted rapidly from grades to purebreds. Although each cow was kept on the ration to which she was randomly allotted in the beginning, the turnover was so rapid that there was little opportunity for the cows to show accumulative effects of the rations.

In general, the cows were started on wintering trials on December 1, and remained until April 30. These dates often varied by one week. The first trial (1941-42) was started on December 29 and ended May 12. Sires were turned with the cows between June 15 and 25, and left there until September 1. About two-thirds of the calves were born preceding April 30. The calves were weaned on approximately November 1 each year.

The supplemental feeds were fed in the afternoons. All cows were watered from tanks.

[5]A forb is any herb other than grass (a weed in the ranch stockman's language).

Results

Experiment 1. Cottonwood Range Field Station

(1941-42 to 1945-46)

The results of cow and calf production when wintering cows on western South Dakota range grasses, salt, bonemeal and ground limestone alone, or with cottonseed cubes, native hay or sorghum fodder,[6] are shown in Table 1. In this experiment the cows were all grazed together during the day and then divided into four lots to permit supplemental feeding of Lots 2, 3, and 4 each evening. Supplemental feeding was done from January 1 to April 30. The cottonseed cubes were fed at the rate of 1 pound per head daily. The western native hay and sorghum fodder were fed at the rate of about 8 pounds per head

[6]Variety 39-30-S, a low prussic acid variety developed by South Dakota Agricultural Experiment Station.

Table 1. Production of Cows Wintered on the Open Range, With Salt, Bonemeal, and Ground Limestone Alone; or With Cottonseed Cubes, Native Hay, or Sorghum Fodder, 1941-42 to 1945-46

	Lot 1	Lot 2	Lot 3	Lot 4
Cows on Winter Treatment 147 Days. Approximately Dec. 1 to April 30	Grazing, Minerals Only	Grazing, Minerals, 1 lb. CSC Daily, 1/1 to 4/30	Grazing, Minerals, Approx. 8 lbs. Native Hay Daily 1/1 to 4/30	Grazing, Minerals, Approx. 8 lbs. Sorghum Fodder Daily, 1/1 to 4/30
Cows started, total	60	60	60	60
Cows died, total	3	3	3	2
Initial weight, lbs., av.	945	955	956	966
March 1 weight, lbs., av.	893	921	950	939
Gain or loss to Mar. 1, lbs., av.	–52	–34	–6	–27
Final weight, lbs., av.	873	900	915	916
Gain or loss to Apr. 30, lbs., av.	–72	–55	–41	–50
Condition of cows, av.*	5.9	6.1	6.2	6.3
Calves born by Apr. 30, total	20	24	27	28
Calves born, total	48	54	57	54
Calves weaned, total	46	50	52	48
Calf crop weaned, %	76.7	83.3	86.7	80.0
Birth weight, lbs., av.	73.2	70.7	70.1	71.1
Weaning weight, lbs., av.	350	382	383	374
Weaning age, days, av.	183	189	191	196
Daily gain (birth to weaning) lbs., av.	1.51	1.64	1.64	1.55
Condition calves at weaning, av.	7.7	8.0	8.1	7.7
Calf wn. wt. per cow, lbs., av.	269	318	332	300
Summer gains per cow, lbs., av.	83	68	50	63
Feeds per cow for winter period				
Acres per cow month	2.3	2.3	2.3	2.3
Cottonseed cubes	—	119	—	—
Roughages	106	99	995	992
Bonemeal	.81	.73	1.72	.86
Ground limestone	.11	.09	.10	.14
Salt	15.9	19.3	10.7	8.5

*The cows and calves were rated in condition from 0 to 14, with 14 being the fattest group. A rating of 7 indicates average condition on good range.

daily. During prolonged storms some hay was fed to those cows getting no roughage (Lots 1 and 2). This amounted to about 100 pounds per cow per year, but most of this was fed during one winter when the range was covered with deep snow for about three weeks.

At the levels fed, all rations were insufficient to maintain the body weights of the cows as pregnancy advanced, which is shown by average March 1 weights. Native hay did the best job of maintaining cow weights, followed closely by sorghum fodder and cottonseed cubes. By April 30 the cows had lost more weight, but this was due in a large measure to the fact that from one-third to one-half of the cows had calved by this time. The rations continued to keep the same rank in maintaining cow weights as existed before calving started.

Figure 1 shows the final winter weights (approximately April 30) for the four lots of cows for each of the five years. There appeared to be an accumulative effect on the cows wintered continually on the open range without supplement other than salt and mineral. The heavy weights for Lot 1 in the spring of 1942 (the first year) were due largely to the fact that only four cows had calved by April 30 in this lot, while Lots 2, 3, and 4 had eight, nine, and nine calves, respectively. This cannot be attributed to treatment, as all cows were allotted at random and had similar treatment prior to December 1, 1941.

Had the same number of cows calved in Lot 1 by April 30 as in Lots

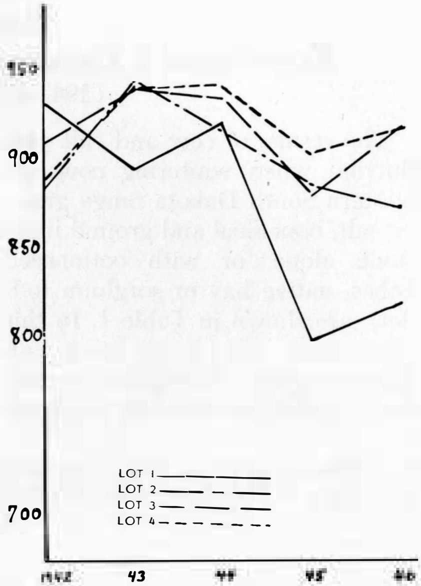


Fig. 1. Average final weights (near April 30) of cows wintered on (1) open range and minerals, (2) open range, minerals, 1 pound cottonseed cubes daily, (3) open range, minerals and 8 pounds native hay daily, (4) open range, minerals, and 8 pounds sorghum fodder daily

3 and 4 during the 5-year period, the average loss for the cows in Lot 1 would have been increased by about 10 pounds; thus making the winter weight loss of cows on range alone about twice that of cows supplemented with one-half ton of native hay or sorghum fodder. Also, cows on range alone never did quite catch up in weight with the others, even though all were grazed similarly during the summers.

The average monthly weights of the four lots of cows throughout the year are shown in Fig. 2. As stated previously, the cows were of similar weight in the fall of 1941 when the experiment was started, but their weights soon became differentiated;

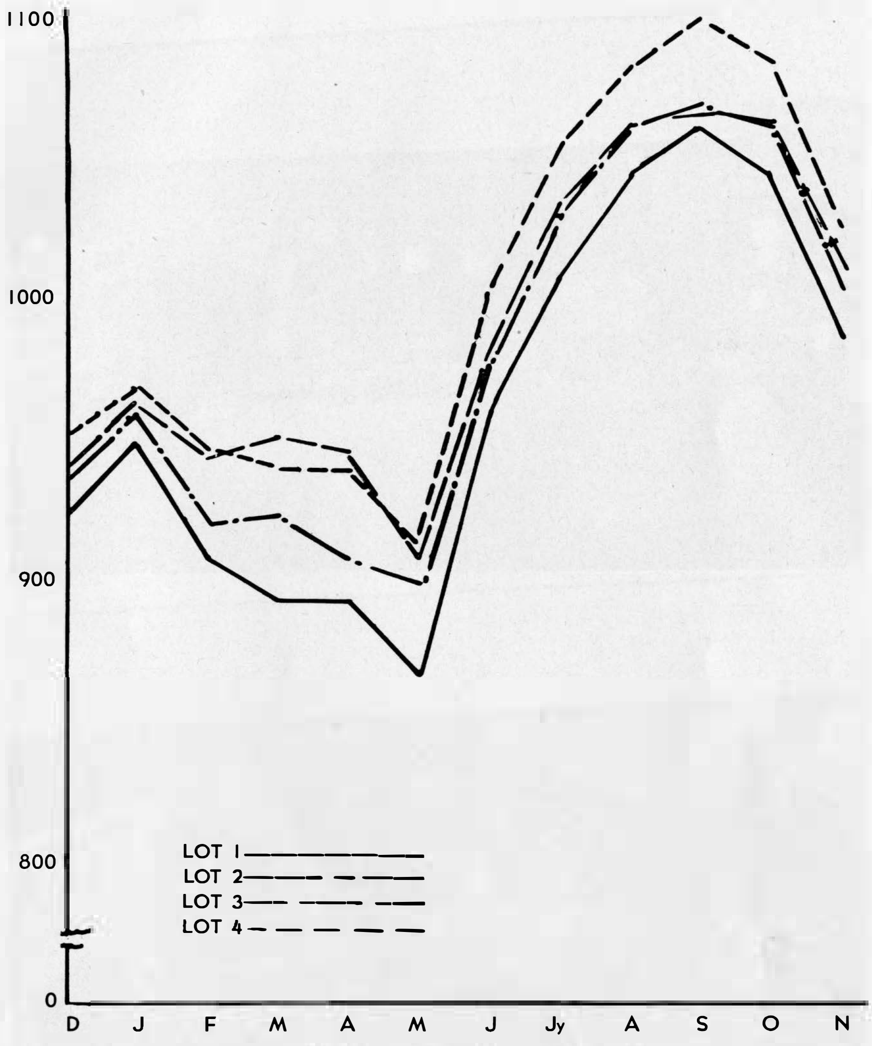
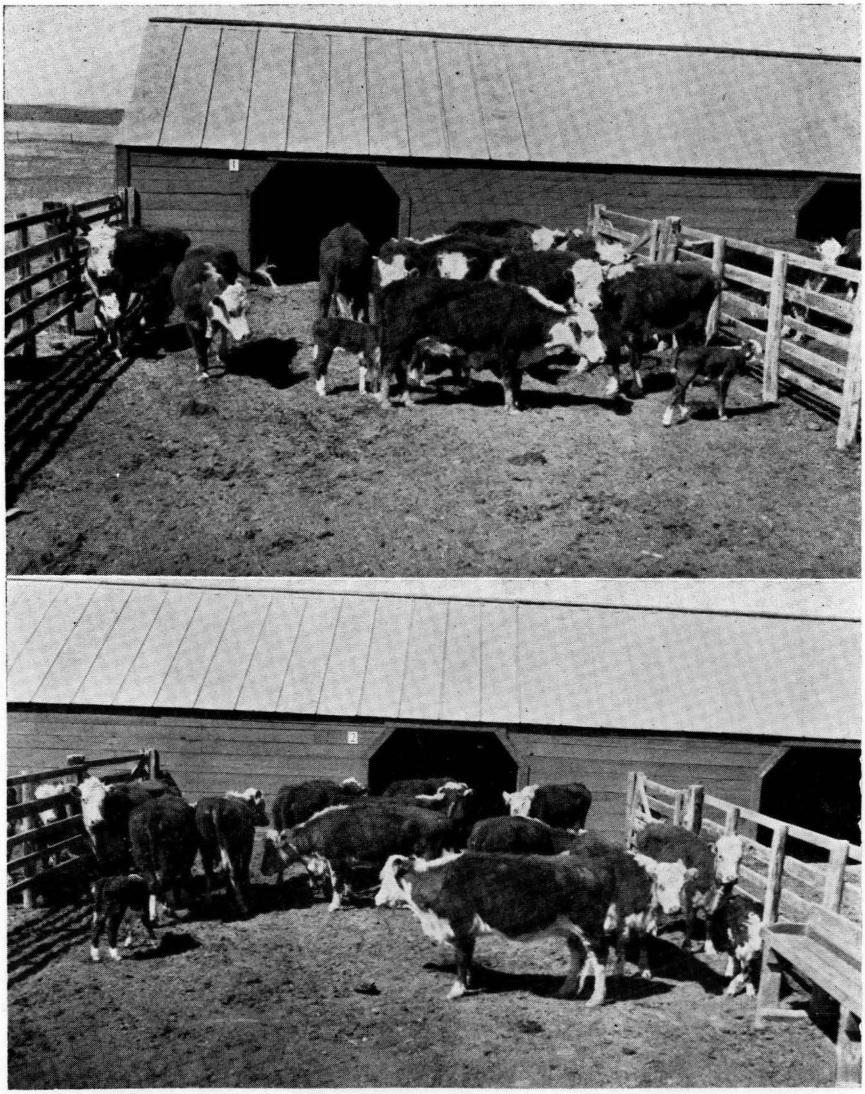


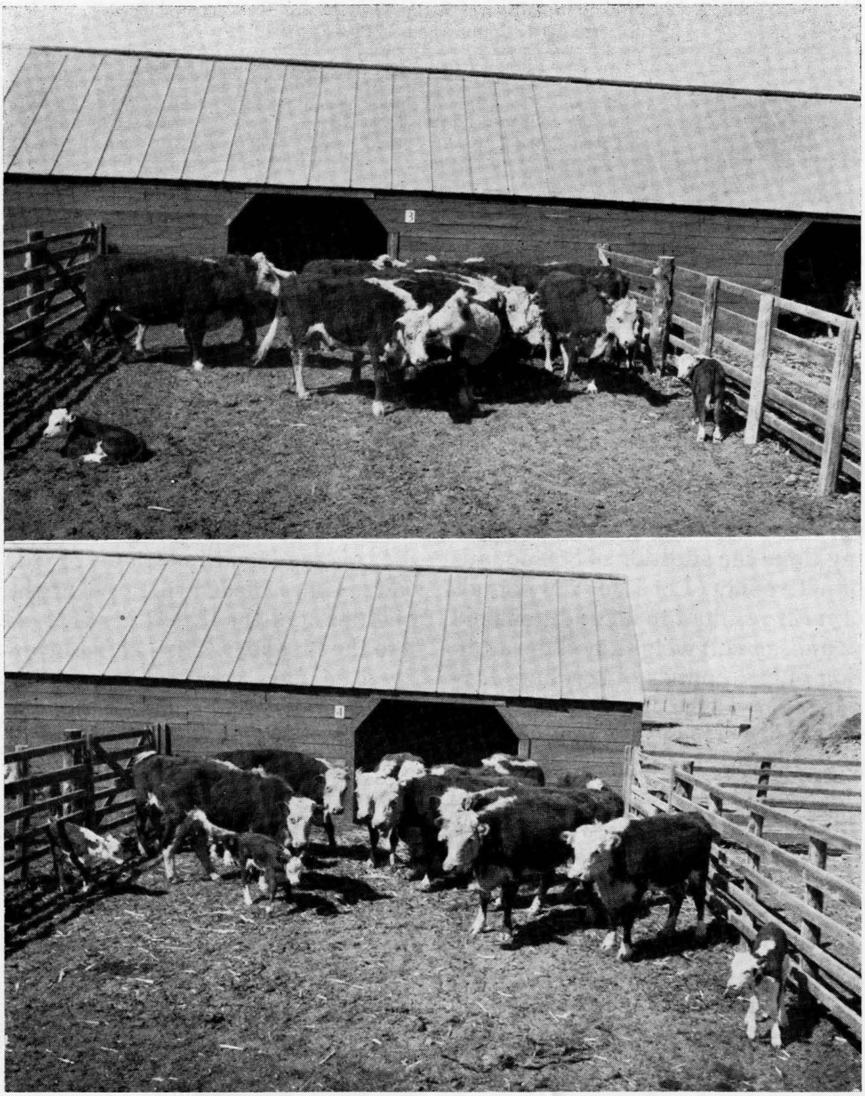
Fig. 2. Average monthly weights of cows throughout the year when wintered on (1) open range and minerals, (2) open range, minerals, 1 pound cottonseed cubes daily, (3) open range, minerals and 8 pounds native hay daily, (4) open range, minerals and 8 pounds sorghum fodder daily

this is shown in the December 1 average weights. The cows getting native hay and sorghum fodder remained the heaviest even after 7 months on summer range. No reason is known why the cows wintered on sorghum fodder did slightly better in the summer than those wintered on native hay, when the winter performance of the two groups was always very similar. There were a few more dry cows in the sorghum



The pictures above and on the right show the cows in Lots 1, 2, 3 and 4 of Experiment 1 at close of the 5-year feeding. The poor condition of the cows on range alone (Lot 1) is very evident, Lot 2 cows (1 pound of cottonseed cake daily) are thin but show much thriftiness

fodder lot, but it appears this would account for only about one-half of the difference shown. The relatively small calf crop weaned in Lot 1 (76.6 percent) still did not allow the cows in this lot to equal the weights of the cows in the other lots by November 1 each year.



Cows in Lots 3 and 4 (those having native hay and sorghum fodder) have lost some weight during the wintering period, but they are in excellent condition to go on summer range

The percent calf crop weaned and weight of calves at weaning were definitely reduced in Lot 1 where no supplemental feeding was done other than salt, bonemeal and ground limestone. Over the 5-year period, Lot 1 cows produced only 48 calves, while the smallest number for the other lots was 54. On the basis of calf weight weaned per cow

Table 2. Chemical Composition of Range Grasses and Supplemental Feeds, Experiment 1, Cottonwood, 1941-42 to 1945-46

	Feeds Fed at Corrals			Grasses Grazed on Range					
	Cotton-seed Cubes*	Native Hay	Sorghum Fodder	Mixed Native† Range Grasses Dec.	Mixed Native† Range Grasses Feb.	Western Wheat-grass Dec.	Blue Grama Dec.	Little Blue-stem Dec.	Side-oats Grama Dec.
	%	%	%	%	%	%	%	%	%
Moisture	....	6.76	7.10	5.63	8.05	5.59	5.68	5.12	5.47
Protein	41.50	7.40	7.71	3.82	3.61	2.70	3.91	1.91	2.58
Crude fat	5.30	3.18	2.01	2.12	2.48	2.36	1.88	1.31	1.60
Crude fiber	13.00	31.72	27.66	31.48	32.76	35.77	27.20	29.19	31.31
Ash	....	8.00	5.48	10.00	9.15	7.65	12.35	7.11	15.02
Crude carbohydrates	24.00	42.94	50.04	46.95	43.95	45.93	48.98	55.36	44.02

*As guaranteed by manufacturer.
†Made up largely of western wheatgrass and blue grama with various amounts of others as indicated in text.

bred the preceding summer, the addition of 119 pounds of cottonseed cubes to the winter grazing, plus minerals, resulted in an additional 49 pounds of calf weight at weaning time; the addition of 889 pounds of native hay (Lot 1 got 106 pounds of hay) resulted in an additional 63 pounds of calf weight; and the addition of 992 pounds of sorghum fodder replaced the 106 pounds of native hay received by Lot 1, and resulted in 31 pounds of additional calf weight at weaning time. Also, the calves from the cows receiving supplemental feeding were generally fatter and would, therefore, have sold for more at the central public markets. Using costs of local feed, labor, risk, and cattle, the financial returns can easily be calculated for any particular set of ranch conditions.

The cows on rations containing no cured roughage seemed to crave salt and ate about twice that consumed by cows getting harvested roughages. None of them ate much bonemeal or ground limestone.

None of the rations were so deficient as to affect birth weights of calves. In fact, calves from cows in Lot 1 (the cows on the most deficient ration) averaged slightly heavier than the others. Also, the rations were not deficient enough to delay the average settling date of the cows. Cows placed in Lot 1 at the beginning of the experiment calved late the first year. Their calves averaged 34 days younger at weaning time than those in Lots 2, 3, and 4 in the fall of 1942. Lot 1 cows on winter grazing, salt, bonemeal and ground limestone only, continued to narrow the spread in weaning age of calves until by the fourth calf crop (three breeding seasons) the calves in Lot 1 average 186 days at weaning time and those in the other three lots averaged 187 days. The following year the calves in Lot 1 were actually two days older than those in any other lot. This difference was not significant, however.

The composition of the supplemental feeds and of the major native grasses and mixed grasses of the Cottonwood ranges is given in Table 2. It will be noted that the protein content of the standing grasses in December and February

is decidedly lower than that of native hay. Digestion trials conducted with steers at this station showed that the protein in good quality native hay was about 42 percent digestible when fed as the only roughage. Similar results were obtained with lambs. When standing grass was cut during the winter and fed to lambs, the protein was only 0.5 percent digestible.

The small percent of protein in the standing grass and its low apparent digestibility indicate that protein must have been a critical nutrient for the Lot 1 cattle that were getting only standing grass, salt, bonemeal and ground limestone. The National Research Council states that a 1000-pound pregnant cow needs a ration containing 4.5 percent digestible protein. The standing grass at the Cottonwood station certainly could not furnish this amount during the winter months when it contained only from 1.91 to 3.82 percent total protein (which must have had a rather low digestibility coefficient), since it was grazed without any supplement other than minerals.

The cows in all lots were also undoubtedly suffering some from lack of total digestible nutrients consumed daily, but those getting the hay and fodder were getting more total digestible nutrients than Lots 1 and 2 and did give higher production. There was always grass on the range, but it was not palatable enough or digestible enough to enable the pregnant cows to consume the amount needed to maintain their body weight.

Experiment 2. Reed Ranch Preliminary Trial
(1945-46)

During the winter of 1945-46, a preliminary winter feeding trial was conducted with pregnant cows at Reed Ranch to determine the practicability of setting up a long-time experiment involving windrowed hay (hay cut at the usual time, raked green, and left in windrows). Three equal areas were fenced (approximately 80 acres each) and were not grazed during the summer. In Lot 1, the grass was allowed to grow and cure standing. In Lots 2 and 3, 20 acres of hay were mowed in each at the "shooting stage" (early July) and the remaining grass was left for winter grazing. In Lot 2 the hay was raked into small windrows and left for winter grazing. In previous observations it had been noted that hay left in large windrows or small cocks tended to mold. The hay in Lot 3 was stacked as soon as cured after mowing and was hand fed during the winter months.

Twelve breeding cows were put in each of the three lots during the first week of December. Cows in Lot 1 had standing grass, a mineral mixture of 3 parts bonemeal and 1 part salt, and salt; all self-fed. Cows in Lot 2 had the same ration plus 20 acres of windrowed hay (approximately 20 tons). Cows in Lot 3 had stacked hay in place of the wind-

Table 3. Preliminary Trial, Production of Cows Wintered on the Open Range With and Without Windrowed Hay and Stacked Hay, Reed Ranch, 1945-46

	Lot 1	Lot 2	Lot 3
	Grazing Only	Grazing Windrowed Hay	Grazing Stacked Hay
Cows started, total	12	12	12
Cows died	0	0	0
Initial weight, lbs., av.	1022	1018	1015
Final weight, lbs., av.	927	954	976
Gain or loss, lbs., av.	–95	–64	–39
Calves born up to May 1	7	5	3
Calves born, total	9	8	8
Calves weaned, total	9	8	8
Calf crop weaned, %	75	67	67
Birth weight, lbs., av.	68	79	70
Weaning weight, lbs. av. (190 days)	334	365	349
Daily gain, lbs., av. (birth to wean.)	1.40	1.51	1.47
Condition calves at weaning, av.*	6.6	8.8	8.9

*The cows and calves were rated in condition from 0 to 14 with 14 being the fattest group. A rating of 7 indicates average condition on good range.

Table 4. Composition of Hay When Cut and of Windrowed Hay and Standing Grass During the Summer and Fall

	Av. of Hay When Cut	Av. of Windrowed Hay				Av. of Standing Grass			
	July 13	July 28	Sept. 6	Oct. 13	Dec. 7	July 28	Sept. 6	Oct. 13	Dec. 7
Protein, %	8.4	8.1	8.1	7.9	7.3	....	5.8	3.6	2.9
Phosphorus, %	.18	.16	....	.15	.15	....	.15	.08	.06
Carotene, ppm	130	75	....	50	40	....	40	20	5

rowed hay fed in Lot 2. The stacked hay was fed from January 1 to April 30 at the rate of 10 pounds per head daily. About 6 tons of the 20-ton stack was fed.

Table 3 gives the production data on the three lots. As this table contains data for only one year, the results should be considered chiefly as indications. However, the winter ration of standing grass, bonemeal and salt only, again is clearly shown to be inadequate to maintain cow weight and calf production. Windrowed and stacked hay gave similar cow-calf production in this comparison. The calves were heavier at weaning time in the windrowed lot than in the stacked hay lot, but this seems likely to have resulted from the cows being slightly higher-producing cows at the start, as indicated by the heavier birth weights (79 pounds) of their calves. The 15 pounds difference between Lots 1 and 3 on the basis of 190-day weaning weights, is similar to the results of the 5-year experiment shown in Table 1.

The composition of the stacked and windrowed hay when cut, and the composition of windrowed hay and standing grass during the summer and fall, was studied. This is shown in Table 4.

It is very evident that windrow-

ing hay preserved the protein and phosphorus content of the feed very well. There was some reduction in the carotene content, but when the cows were turned into the fields in early December the carotene in the windrowed hay was much higher than in the standing grass.

During this experiment all cows lost weight in December. The cows on windrowed hay, however, lost less weight than the others.

Experiment 3. Cottonwood Range Field Station
(1945-46 to 1949-50)

Table 5 shows cow and calf production data resulting from wintering cows on western South Dakota range grasses, salt, bonemeal and ground limestone alone, and from supplementing this ration with windrowed hay, windrowed and stacked hay, a 24 percent protein soybean-corn cube, or a 40 percent protein soybean cube.

Table 5. Production of Cows Wintered on the Open Range, With and Without 40% Soybean Cubes, 24% Soybean-Corn Cubes, Windrowed Hay, Windrowed and Stacked Hay (Three Years' Work, 1946-47, 1947-48, 1949-50)

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5
Cows on Winter Treatment 151 Days. Approximately Dec. 1 to April 30	Grazing, Minerals Only	Grazing, Minerals, Windrowed Hay	Grazing, Minerals, Windrowed Hay and Stacked Hay	Grazing, Minerals, 24% Protein Cubes	Grazing, Minerals, 40% Soybean Cubes
Cows started, total	36	36	36	36	36
Cows died, total	1	0	2	0	0
Initial weight, lbs., av.	990	983	988	983	971
March 1 weight, lbs., av.	970	990	985	1004	1018
Gain or loss to March 1, lbs., av.	–20	7	–3	21	47
Final weight, lbs., av.	885	921	901	938	962
Gain or loss to Apr. 30, lbs., av.	–105	–62	–87	–45	–9
Condition of cows, av.*	5.7	6.1	6.0	6.9	7.0
Calves born by Apr. 30, total	23	21	22	20	20
Calves born, total	31	34	32	30	30
Calves weaned, total	29	27	28	28	27
Calf crop weaned, %	80.6	75.0	77.8	77.8	75.0
Birth weight, lbs., av.	68.2	73.2	68.7	74.3	72.8
Weaning weight, lbs., av. (190 days)	368	363	354	368	378
Daily gain, lbs., av. (birth to weaning)	1.58	1.53	1.50	1.54	1.60
Condition calves at weaning, av.*	6.8	6.2	6.8	6.6	7.0
Summer gains per cow, lbs., av.	83	35	34	15	–1
Feed per cow for winter period					
Acres per cow month	1.8	1.8	1.8	1.8	1.8
Concentrates	—	—	—	105	105
Native hay†	29	29	935	29	29
Bonemeal	3.26	2.31	2.13	2.91	2.37
Ground limestone	.07	.03	.11	.13	.15
Salt	15.2	8.9	11.1	16.4	12.8

*The cows and calves were rated in condition from 0 to 14 with 14 being the fattest group. A rating of 7 indicates average condition on good range.
†Fed only in winter of 1949-50 and fed to all.

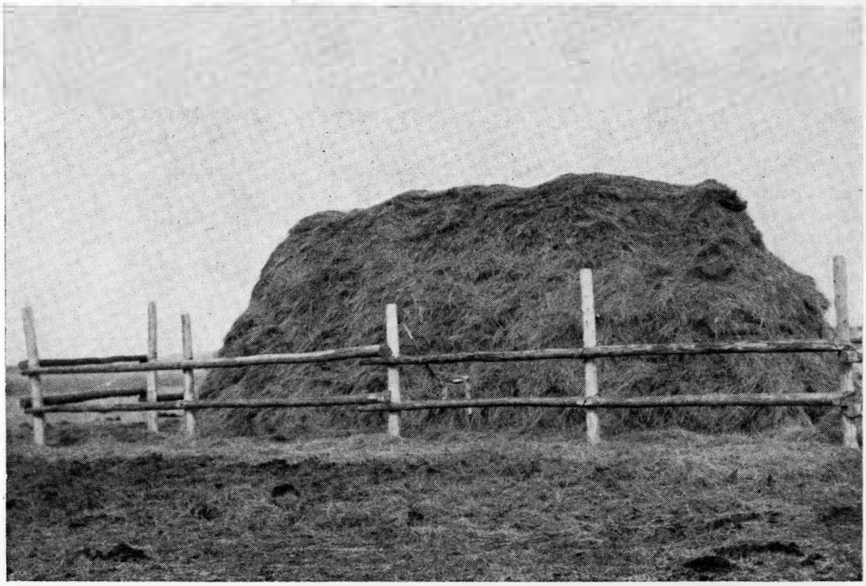
For this experiment, five similar areas were fenced (approximately 105 acres each) and grazed with 12 cows per lot. The range was grazed only during the winter months, which was roughly from December 1 to April 30 each year. The protein supplements were taken to the cows and fed in the afternoon. The windrowed hay was fed in the windrows and the stacked hay was fed in racks around the stacks. All the cows were watered from tanks. Weighing was done once each month.

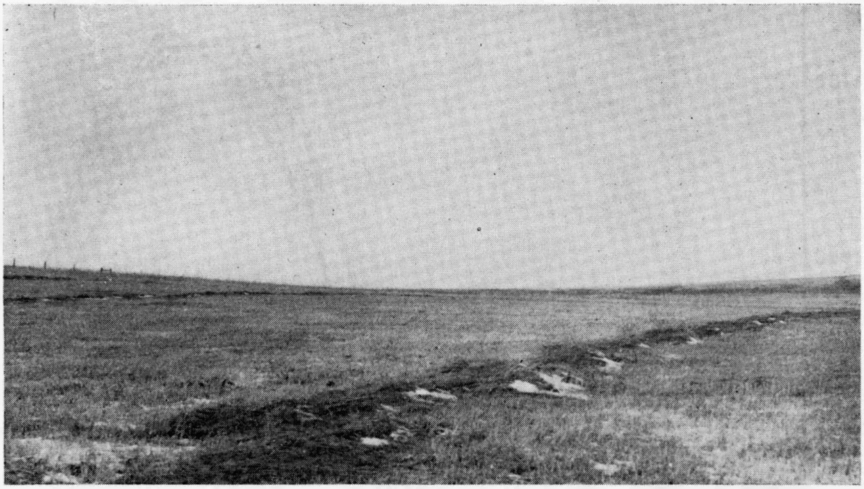
Lot 1 had winter range plus minerals only. Lot 2 cows had winter grazing, minerals, salt and 20 acres of windrowed hay cut in mid-July from within the Lot 2 winter pasture. The hay was raked into small windrows as mowed, allowed to cure, and then was self-fed from the windrows during the winter. During the month of December the cows had access to only 5 of the 20 acres of windrowed hay, plus all of the standing grass. After January 1, the cows were allowed the remainder of windrowed hay.

Lot 3 cows had winter grazing, minerals, and salt, plus windrowed and stacked hay. A total of 20 acres of hay was cut from within the Lot 3 pasture, five of which were left in the windrows and 15 acres stacked soon after mowing. During the month of December the cows had free access to the 5 acres of windrowed hay plus all standing grass. From January 1 to April 30 they were fed 10 pounds per head daily of the stacked hay in addition to the standing grass in their range.

Lot 4 cows had winter grazing,

Seven tons of hay in the stack was satisfactory for wintering 12 bred cows. When self-feeding windrowed hay, 12 bred cows needed from 15 to 20 tons to produce the same results





Windrowed hay remained high in protein and phosphorus throughout the winter months. It was highly palatable to the cows. Though the carotene content deteriorated, in early December it contained eight times the amount of that contained by the standing grasses

minerals and salt, plus 1 pound of 24 percent protein cubes fed daily from January 1 to April 30. The cubes were made from soybean oil meal and ground shelled yellow corn, as previously stated. Lot 5 cows had winter grazing, minerals and salt, plus 1 pound of 40 percent soybean cubes fed daily from January 1 to April 30.

The cows were again kept on their respective winter rations as long as they stayed in the herd, but due to the shifting of the herd from grades to purebreds, few cows were in the experiment more than one year; thus the effect of rations on production are those resulting chiefly from one wintering trial rather than from a lifetime practice.

As in Experiment 1, the cows on winter grazing plus minerals lost the most body weight. The cows getting the protein cubes in this trial did better than those getting the roughages, which is just the opposite of the results in Experiment 1. The cows getting the 1 pound of 40 percent protein cubes definitely did better than those getting 1 pound of 24 percent protein cubes.

The reason for the protein supplements producing better results than the hay in the third experiment may be explained by studying the chemical composition of hays fed in the two experiments, (Tables 2 and 6). In Experiment 1, the hay and sorghum fodder contained 7.40 and 7.71 percent protein, respectively. In Experiment 3, the windrowed hay averaged 6.12 percent protein, and the stacked hay averaged 5.66 percent protein. Undoubtedly the relatively better results from feeding protein supplements in Experiment 3, as compared to Experiment 1, were due to the lower protein

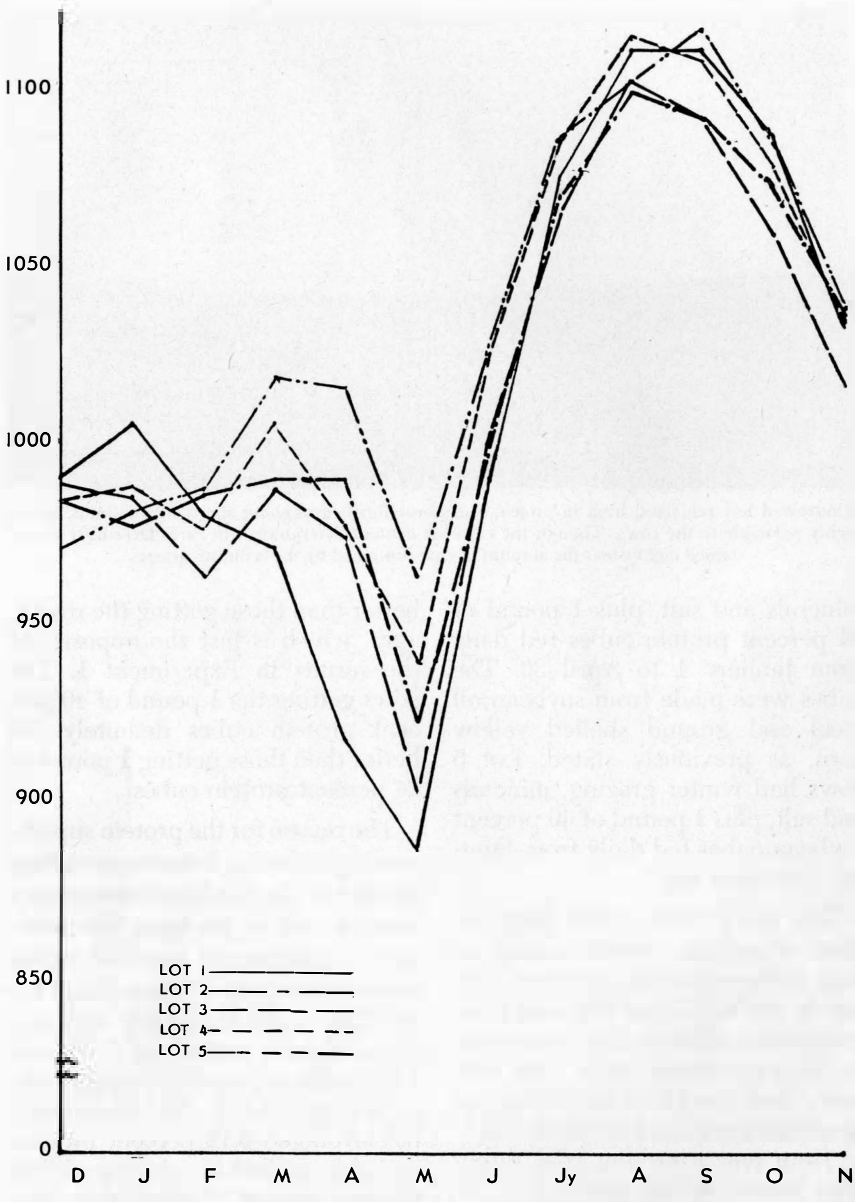


Fig. 3. Average monthly weights of cows wintered on (1) open range, (2) windrowed hay, (3) windrowed hay and stacked hay, (4) 24 percent protein supplement, and (5) 40 percent protein supplement.

Table 6. Chemical Composition of Range Grasses and Supplemental Feeds in Experiment 3, Cottonwood Range Field Station

	Soybean-Corn Cubes	Soybean Cubes	Native Windrowed Hay	Native Stacked Hay	Standing Grass Tall Dec.	Standing Grass Short Dec.
Moisture	7.71	7.67	5.42	5.30	5.44	5.59
Protein	23.57	39.61	6.12	5.66	3.28	4.54
Crude fat	3.89	4.97	2.24	2.10	1.99	1.68
Crude fiber	4.52	6.43	34.31	32.96	35.11	28.38
Ash	9.22	10.13	8.56	8.64	8.50	12.20
Crude carbohydrates	51.09	31.19	43.35	45.34	45.68	47.61

content of the hays fed in Experiment 3, thus putting the cows in Lots 2 and 3 in Experiment 3 on a more protein deficient ration than the cows in Lots 3 and 4 in Experiment 1.

The monthly weights for the five lots of cows during the wintering period and during the following seven months that they were on summer range are shown in Fig. 3. The windrowed hay was made available to cows in Lots 2 and 3 in December, as it was thought this would result in greater gains during the first month and allow the cows to go through the winter in better condition. This did not occur. The cows in Lots 2 and 3 lost on the average a few pounds while those in Lots 1, 4 and 5, with no supplement during the month of December, made from 4 to 15 pounds gain each. Apparently it did not pay to start winter feeding before January 1 under the conditions of Experiment 3.

During the time Experiment 3 was being conducted the rainfall was below normal in two of the three years, and may have accounted for the fact that the standing grass had a slightly higher protein content during this wintering experiment than during the first one as shown in Tables 2 and 6 preceeding.

Following the close of the wintering trials the cows tended to become similar in weight and condition. The cows having the 40 percent protein supplement did maintain a slight advantage during the summer months, but it was very small as compared to the difference that existed on May 1. Apparently the greater difference in summer weights in the lots in Experiment 1 in comparison with those in Experiment 3 was due to the carry-over effect experienced by the cows in Experiment 1. It seems a cow can take rather severe treatment for one winter without greatly affecting her production if plenty of feed is available during the following summer. Production is affected, however, if a poor winter ration is repeated for five consecutive years as was done in Experiment 1.

The weaning weights of the calves from the cows on the five rations ranked in the same order as the body weights of the cows in the spring, except for Lot 1. The differences in weaning weights of the calves in Experiment 3 were not as great as those in Experiment 1, however. Again it appeared the cows had the ability to recover and pro-

duce good weanling calves as long as they had plenty of grass during the summer and were not continually on inadequate winter rations.

Experiment 4. Reed Ranch
(1945-46 to 1949-50)

Experiment 4 was conducted similar to Experiment 3 with two exceptions: Lot 1 (winter grazing, minerals and salt only) was omitted, and the minerals fed consisted of 3 parts bonemeal, 1 part salt, and salt self-fed, instead of bonemeal, ground limestone and salt, each self-fed. Table 7 contains the cow and calf production data for Experiment 4.

As in the other three experiments, all cows lost weight during the wintering period. In all of the trials this loss in body weight of the cows was due partly to the cows becoming thinner and partly to the fact that from one-third to one-half of the group had calved and were being suckled. The 40 percent protein cubes did the best job of maintaining body weight in these trials as they did in Experiment 3. Windrowed hay and windrowed and stacked hay gave similar results in maintaining the body weight of the cows. However, they ranked much closer to the 40 percent protein lot than they did in Experiment 3. In these trials the lot getting 1 pound of 24 percent protein cubes ranked at the bottom, being slightly inferior to the two roughage lots and definitely inferior to the lot getting 1 pound of 40 percent protein cubes daily.

The reason for the windrowed hay and the windrowed and stacked hay ranking higher in Experiment 4 than in Experiment 3 is rather evident when comparing the chemical

Table 7. Production of Cows Wintered on the Open Range With 40% Soybean Cubes, 24% Soybean-Corn Cubes, Windrowed Hay, Windrowed and Stacked Hay, 1945-46 to 1949-50

	Lot 1	Lot 2	Lot 3	Lot 4
Cows on Winter Treatment. Approximately Dec. 1 to April 30	Grazing, Minerals, Windrowed Hay	Grazing, Minerals, Windrowed and Stacked Hay	Grazing, Minerals, 24% Cubes	Grazing, Minerals, 40% Cubes
Cows started, total	31	31	31	31
Cows died, total	1	0	1	0
Initial weight, lbs., av.	1064	1055	1068	1049
Final weight, lbs., av.	970	965	953	970
Gain or loss, lbs., av.	–94	–90	–115	–79
Calves born by April 30, total	13	15	16	12
Calves born, total	27	25	26	21
Calves weaned, total	24	25	24	20
Calf crop weaned, %	77.4	80.6	77.4	64.5
Birth weight, lbs., av.	75.7	77.3	74.9	79.3
Weaning weight, lbs., av. (190 days)	398	382	373	398
Daily gain, lbs., av. (birth to weaning)	1.69	1.60	1.57	1.68
Condition calves at weaning, av.*	8.4	8.0	8.4	8.0

*The cows and calves were rated in condition from 0 to 14 with 14 being the fattest group. A rating of 7 indicates average condition on good range.

Table 8. Chemical Composition of Range Grasses and Supplemental Feeds Fed in Experiment 4, Reed Ranch

	Soybean-Corn Cubes	Soybean Cubes	Native Windrowed Hay	Native Stacked Hay	Standing Grass Tall Dec.	Standing Grass Short Dec.
Moisture	7.71	7.67	5.56	6.23	5.24	4.87
Protein	23.57	39.61	7.42	8.16	4.15	4.97
Crude fat	3.89	4.97	1.67	2.46	2.61	1.37
Crude fiber	4.52	6.43	30.89	30.01	32.54	26.84
Ash	9.22	10.13	10.91	9.87	9.46	14.18
Crude carbohydrates	51.09	31.19	43.55	43.27	46.00	47.77

composition of the hays fed in the two trials (Tables 6 and 8). The windrowed and stacked hay fed in Experiment 4 contained 7.42 and 8.16 percent of protein, respectively. That fed in Experiment 3 contained only 6.12 and 5.66 percent protein, respectively; also, the standing grass in Experiment 4 contained slightly more protein than that in Experiment 3. In all four of the experiments, the quality of the roughage, as measured by protein content, affected the spring weight of the cow and her calf production.

Again the spread in weaning weights of the calves was not as great as in Experiment 1. It must be remembered, however, that these cows were also on their winter rations only one year; thus preventing accumulative effects. However, the lot getting 1 pound of 40 percent protein cubes definitely produced heavier calves than those getting 1 pound of 24 percent protein cubes.

Blood Composition of Cows in Experiment 1

The seasonal variation in the phosphorus, calcium, vitamin A and carotene content of the blood plasma was determined for the cows on each of the four rations in Experiment 1. The cows were bled about December 1, March 20, and August 1 during the first two years and last two years of the 5-year experiment. Venous blood was drawn from the jugular vein for the analyses. Sodium citrate was used as the anticoagulent. All blood samples were drawn in the afternoon, transported to the laboratory in an ice chest, and analyzed the next forenoon. The mean and minimum blood plasma values of phosphorus, calcium, vitamin A and carotene for the three seasons are given in Table 9.

It will be recalled the rations were as follows: Lot 1—grazing plus salt, bonemeal and ground limestone, self-fed; Lot 2—same as Lot 1 plus 1 pound cottonseed cubes daily from January 1 to April 30; Lot 3—same as Lot 1 plus 8 pounds native hay daily from January 1 to April 30; and Lot 4—same as Lot 1 plus 8 pounds sorghum fodder daily from January 1 to April 30.

Although bonemeal was available to all lots during the winter, the cows ate very little of it. In general, the cows in Experiment 1 were at a relatively low plasma phosphorus

Table 9. The Mean and Minimum Phosphorus, Calcium, Vitamin A, and Carotene Values of the Blood Plasma of Cows on the Four Wintering Rations in Experiment 1

	Mean Values			Minimum Values		
		Season			Season	
	Dec. 1	Mar. 20	Aug. 1	Dec. 1	Mar. 20	Aug. 1
Phosphorus—mg. per 100 ml. plasma						
Lot 1	4.64	4.54	5.40	2.73	2.58	3.84
Lot 2	4.70	5.84	5.45	3.05	3.48	3.84
Lot 3	5.06	4.74	5.32	3.19	2.96	3.95
Lot 4	5.04	4.74	5.48	2.64	3.22	3.69
Calcium—mg. per 100 ml. plasma						
Lot 1	9.58	9.58	9.90	7.40	5.67	4.21
Lot 2	9.60	9.88	9.77	7.30	7.10	4.74
Lot 3	9.68	10.10	9.97	8.50	6.00	5.48
Lot 4	9.62	10.00	10.27	8.00	7.00	4.42
Vitamin A—mg. per 100 ml. plasma						
Lot 1	.0236	.0303	.0610	.0031	.0132	.0305
Lot 2	.0240	.0257	.0560	.0035	.0156	.0257
Lot 3	.0252	.0294	.0518	.0084	.0152	.0113
Lot 4	.0246	.0298	.0536	.0143	.0193	.0220
Carotene—mg. per 100 ml. plasma						
Lot 1	.059	.034	.411	.030	.013	.172
Lot 2	.059	.024	.433	.018	.009	.143
Lot 3	.060	.036	.404	.019	.009	.091
Lot 4	.059	.063	.375	.026	.031	.154

level in the fall (December 1) which became lower as the winter advanced with the exception of Lot 2 which was getting the cottonseed cubes. The phosphorus content of the blood plasma of the cows getting cottonseed cubes rose to a high level during the winter, even higher than it was in the summer when the cows were on green grass that was high in phosphorus. This is shown clearly in Table 9 and in Fig. 4.

In one experiment at Reed Ranch a salt-bonemeal mixture was fed. This kept the inorganic phosphorus in the blood plasma at a higher level than when self-feeding bonemeal alone as in Experiment 1. When feeding the bonemeal with salt, all cows were well above the minimum level for safety in phosphorus content of blood plasma.

Apparently, cows grazing on standing grass in the winter in western South Dakota need some additional phosphorus. Bonemeal, self-fed, appears to keep the cows just above the border line of deficiency. Self-feeding a salt-bonemeal mixture results in a margin of safety for the cows. When feeding the salt-bonemeal mixture, salt should also be fed free choice. In general, the rise and fall of the phosphorus content of the blood plasma in Experiment 1 followed the phosphorus content of the grasses grazed by the cows, unless the grasses were supplemented with a palatable high phosphorus feed.

The calcium content of the blood was high at all times, being well within the normal range. It will be recalled, however, that the calcium content of the grasses varied little with maturity and was always high in the standing grasses.

It appears the cattle did not need

Table 10. Protein, Calcium and Phosphorus Content of Western South Dakota Range Grasses at Different Stages of Maturity (12% Moisture Basis)

	Protein	Calcium	Phosphorus
Western wheatgrass			
Shooting	7.87	.31	.18
Seed ripe	5.48	.28	.11
Mature	3.24	.30	.07
Blue grama			
Shooting	6.90	.33	.17
Seed ripe	5.31	.39	.14
Mature	3.68	.38	.09

to be fed ground limestone. Table 10 gives the average protein, calcium and phosphorus composition of many samples of western wheatgrass and blue grama taken from western South Dakota ranges at different stages of maturity. It is clearly evident why the cows need some additional phosphorus, but no calcium, when grazing mature grasses.

The blood vitamin A and carotene values were at a low level in December in all lots and remained so during the winter. By August 1, however, both carotene and vitamin A values were high, due to the plentiful supply of green, growing grasses in May, June and July. There were no visible symptoms of vitamin A deficiency in the cows during the winter months when the blood plasma levels were distinctly low.

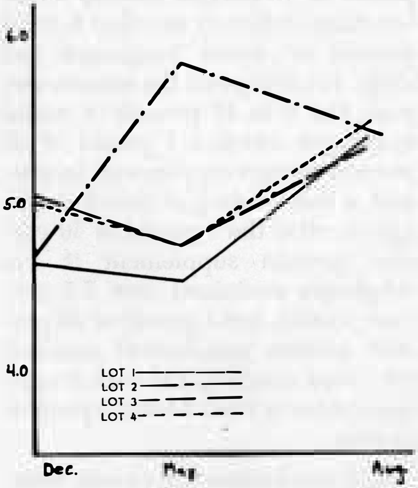


Fig. 4. Inorganic phosphorus in blood plasma of cows wintered on (1) open range and minerals, (2) open range, minerals, 1 pound cottonseed cubes daily, (3) open range, minerals and 8 pounds native hay daily, (4) open range, minerals and 8 pounds soghum fodder daily

Discussion

The four wintering experiments reported in this bulletin show clearly that pregnant beef cows grazing western South Dakota ranges during the winter need supplemental feeds other than bonemeal, ground limestone, and salt, for satisfactory cow-calf production. Protein cubes, early-cut native hay (stacked), early-cut native hay (windrowed) or sorghum fodder, when used as supplements to winter grazing, improved cow-calf production.

The ability of a given amount of any of the four supplements to balance the native range grasses during the wintering period depended upon the quality and amount of the supplement fed and the protein and mineral content of the standing range grasses. The protein content of the hays and grasses varied considerably from year to year. Therefore, it appears that a protein analysis of supplemental feeds and winter range grasses is advisable in or-

der to plan the best wintering rations.

One pound of 24 percent cubes did not do as good a job of wintering the cows as 1 pound of 40 percent protein cubes, in any of the trials. During some of the years, 1 pound of 40 percent protein cubes fed daily definitely excelled 8 to 10 pounds of cured roughages fed daily. In other years the reverse was true: the 8 to 10 pounds of cured roughages excelled 1 pound of 40 percent protein supplement. In general, a half-feeding of cured roughage excelled the 1 pound of 40 percent protein supplement if the roughages contained over 7.5 percent protein, but 1 pound of 40 percent protein supplement excelled the cured roughages if such roughages had only from 5.5 to 6.5 percent protein.

Calf production was closely related to weight of cows at the end of the wintering experiment (approximately April 30 in these trials). In general, the cows that maintained their weights best during the winter (all lots lost some weight between December 1 and April 30) produced more calves and weaned heavier calves in the fall.

The effects of poor and good rations were accumulative if the cows were kept on a given ration over a period of years. Cows that were kept on an inadequate ration for five consecutive years were much lighter in body weight throughout the year and produced fewer pounds of calf per cow bred at the end of five years than they did after one year on the ration, even though all cows had similar treatment during the seven summer months.

Cows whose rations were supplemented adequately with good quality native hay or sorghum fodder (Table 1) were definitely heavier, both summer and winter, and produced more pounds of calf per cow bred than those that had winter range, minerals and salt only. The reduction in pounds of calf weaned per cow in Lot 1, Experiment 1, came from both a reduction in calf crop percentage and from the calves being lighter at weaning.

When the cows were kept on inadequate rations only one year at a time, the differences in body weight between cows on good rations and those on poor rations were not exceedingly large, and these differences were about eliminated by similar grazing during the following seven summer months. Also, calf production and breeding efficiency of the cows were not greatly affected, but the differences that did exist were definitely in favor of supplementation of pregnant cows grazing on winter ranges.

Early-cut windrowed hay, salt, bonemeal and ground limestone proved very satisfactory for supplementing pregnant cows on winter range. The cows did as well, in general, on this feed as on stacked hay and winter range. Using windrowed hay resulted in a considerable saving of labor as compared to feeding stacked hay. It was necessary, however, to have slightly more than twice as much hay in the windrows as in the stack to carry the cows through the winter. Seven tons of

hay in the stack was satisfactory for wintering 12 cows; in the windrows 15 to 20 tons were necessary.

A careful check showed the cows left from 5 to 40 percent of the hay uneaten in the windrows. This did little damage. During some years, more sunflowers grew in the windrow areas, but rank grass growth soon crowded them out.

Some reserve of hay is necessary when windrowed hay is to be the major portion of the winter supplement. During severe winters the windrows may be almost covered with snow, making it difficult to graze. Having some windrows near the tops of the hills on the windward side aids in keeping them from being drifted over. During the winter of 1949-50, the snow was so deep on the open range that it was impossible on most ranges to use any windrowed hay from the middle of January to March. During winters of moderate to heavy snowfall, the cows also tend to favor the windrowed hay over grazing, and may consume all available windrowed hay before the winter is over. This was true in 1950-51, and the cattle on windrowed hay had to be fed some stacked hay during the late winter storms.

Salt was needed by the cows as was indicated by appetite. Cows getting no cured roughage ate about twice as much salt as those getting one-half feed of roughage daily.

Little bonemeal and ground limestone was consumed, even though it was self-fed throughout the winter. Blood plasma studies indicate the cows had plenty of calcium at all times and did not need ground limestone at any time.

The phosphorus content of the blood plasma varied with season, being the lowest during the winter months. During dry years the phosphorus content of the blood plasma was much lower than during the wet years. When self-feeding bonemeal, the cows ate just enough to keep them above the border line of deficiency. It would seem desirable, therefore, to self-feed a salt-bonemeal mixture in order to give the cows a margin of safety. Feeding 1 pound of cottonseed cubes daily furnished a very adequate amount of phosphorus for the cows.

A good mineral mixture for cattle on western South Dakota winter ranges is 3 parts bonemeal and 1 part salt. An inexpensive commercial mineral that is high in phosphorus would also be satisfactory. A commercial mineral should contain at least 10 percent phosphorus for western South Dakota. With any of the above minerals, salt should be self-fed.

The vitamin A and carotene content of the blood plasma was also studied during the winter months. The amount of vitamin A and carotene was low from December to March. During these months all lots were near the minimum level for safety, with the Reed Ranch cattle having a higher carotene content of blood plasma than the Cottonwood cattle, and with the cattle getting harvested roughages at each station having a slightly higher content than those on grazing alone, or grazing plus a protein supplement.

Summary

Standing grasses on ranges of western South Dakota provide valuable winter feed for bred beef cows. For efficient and economical cow-calf production, however, cows grazing winter ranges should receive supplemental feeds.

Standing native grasses are all low in protein, phosphorus and carotene in western South Dakota during the winter months. Bred beef cows cannot get a balanced ration with sufficient total digestible nutrients to maintain cow-calf production from winter grazing, salt and bonemeal alone.

Good quality native stacked hay, windrowed hay, sorghum fodder, or protein concentrates, when fed with bonemeal and salt to cows grazing the range during the winter months, all do a good job of supplementing the cow's ration and maintaining high production.

Eight to 10 pounds of good quality roughage (early-cut native hays or fodders) fed daily excelled 1 pound of a 40 percent protein concentrate for wintering bred cows on winter range, plus bonemeal and salt. If the 8 to 10 pounds of roughage fed was poor in quality (5.5 percent to 6.5 percent protein) 1 pound of protein concentrate fed daily excelled the 8 to 10 pounds of the low protein roughage.

Feeding 1 pound of a 40 percent protein concentrate cube daily to cows on winter range plus bonemeal and salt always produced better results than the use of 1 pound of 24 percent protein concentrate cubes.

Early-cut, windrowed hay, self-fed (hay cut and raked green at shooting stage, and grazed from windrows during the winter months) maintained bred cows on winter range supplemented with bonemeal and salt as efficiently as 8 to 10 pounds of early-cut stacked hay. It was necessary to have from 2½ to 3 times as much windrowed hay available as stacked hay.

A reserve supply of stacked roughage is necessary when depending largely on standing native grasses on the ranges for a large part of the winter feed of beef cows. The supply of stacked roughage should be large enough to full feed the cows for periods as long as three or four months, plus a reasonable reserve for dry years or other emergencies. Bred pregnant cows weighing from 1000 to 1200 pounds need from 18 to 22 pounds of roughage daily if fed in dry lot.