1951

The Effect of Supplementing Winter Range Grazing on Beef Cow Body Weights, Calf Production, and Calf Gains

James Joy Kiser

THE EFFECT OF SUPPLEMENTING WINTER RANGE GRAZING ON BEEF COW BODY WEIGHTS, CALF PRODUCTION, AND CALF GAINS

By

James Joy Kiser, B. S.

A thesis submitted
to the faculty of South Dakota
State College of Agriculture and Mechanic
Arts in partial fulfillment of the requirements for
the degree of Master of Science
September 1951

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This thesis is approved as a creditable independent investigation by a candidate for the degree, Master of Science, and acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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INTRODUCTION

South Dakota is one of the more important beef cattle producing states in the nation, ranking fifth on the average for the period 1943-1947. The number of beef cattle in South Dakota has been increasing during the past several years. Most parts of the state are well adapted to beef production, especially the range area in the western part where extensive grass lands are available.

The twenty-two western counties of South Dakota, the portion of the state generally considered as the range area, comprise 37,130 square miles or forty-eight per cent of the total acreage of the state. On January 1, 1941, there were 308,900 head of cattle, other than milk cows, within this area, and on January 1, 1947, there were 701,700 head of cattle, other than milk cows, within this area, an increase of 392,800 head of cattle in six years. Anonymous (1940 and 1947).

The success of the beef cattle enterprise in western South Dakota depends largely upon the economical use of supplemental feeds for wintering of breeding and stocker cattle, proper stocking of ranges for summer grazing, and the development and maintenance of good quality

breeding herds. Many cattle raisers in western South Dakota have varying amounts and types of supplemental feeds available for wintering beef cows.

The experiment reported in this thesis was designed to study the effects of various winter rations on cow weights, calf production, and calf weaning weights. Wintering experiments have been conducted at other experiment stations, but until this study was initiated there had not been a study of wintering beef cows under South Dakota climatic conditions using feeds produced in this state. There have been some experiments conducted on wintering steers in South Dakota.

This study was made with four kinds of winter rations suitable to western South Dakota to determine their effect on cow weights during the wintering period, the number and weights of calves produced at birth, and the number and weights of calves at weaning time. The purpose of the experiment was to obtain information for use in planning a ration for wintering beef cows which would result in greater beef production for the ranchers of western South Dakota, as wintering of breeding cows constitutes one of the major problems of the beef cattle industry in this area.

REVIEW OF LITERATURE

Research in the northern great plains area dealing directly with the effect of various wintering rations for range beef cows on the subsequent calf production is quite limited. Wintering experiments with range beef cows have been conducted at several state and federal experiment stations. However, most of the studies were conducted under vastly different climatic conditions and with feeds not native to the northern great plains area. Therefore, only a few of the findings are of value when determining satisfactory and efficient practices for the wintering of range beef cows in western South Dakota.

Black, Quesenberry, and Baker (1938) conducted an experiment at Miles City, Montana, to determine the value of feeding cottonseed cake as a supplement when wintering beef cows on the open range. The study involved 542 cows and was conducted over a five year period. Of these 542 cows, 276 received cottonseed cake and 266 were wintered without any protein supplement. The results of this study indicated that a profit could be realized when cottonseed cake was fed during severe winters, but not during open winters. During severe winter 1 lb. of

cottonseed cake replaced 10 lbs. of alfalfa hay. The cows fed cottonseed cake also consistently produced the heaviest calves at birth and at weaning time. Calves produced from cows receiving the cottonseed cake averaged 1.9 lbs. heavier at birth and 13.6 lbs. heavier at weaning time.

At the San Joaquin Experimental Range, California, Hutchinson and Freeborn (1940) report that the annual addition of 250 - 300 lbs. of cottonseed cake and barley to the ration of each cow increased calf crops and the weaning weight of calves. It was reported to have reduced death losses and the number of retained placentas.

Lantow (1930) states that beef cows during the winter period should be supplemented with cottonseed cake. He states that one pound of cottonseed cake per head daily should be fed after the start of the winter feeding period. Also, he states that while such feeding may not have much effect on the weight of the cow, or the calf when dropped, it enables the cow to produce considerably more milk, which results in rapid gains for the suckling calf.

Guilbert and Rochford (1940) state that pregnant cows must gain about 100 lbs. in weight between weaning time and calving time in order to maintain their flesh

or condition. They report that if cows or heifers just maintain their weight they lose about 100 lbs. in condition and are thin after calving. Below a certain plane of nutrition, either lactation or reproduction, or both, are impaired.

Ross, Van Arsdell, Nelson, Mac Vicar, Cambell, and Darlow (1951a) report that approximately 8 lbs. of alfalfa hay satisfactorily replaced 2½ lbs. of cottonseed cake as a protein supplement for commercial cows grazing dry native grass pastures during the wintering period.

Experiments by Ross, Van Arsdell, Nelson, Mac Vicar, Cambell, and Darlow (1951b) in Oklahoma indicate that a system of management in which beef cows are grazed year-long and fed alfalfa hay during the winter months was more desirable for a commercial cow herd than a system of grazing cows seven months of the year and feeding alfalfa hay and prairie hay in a trap during the winter months. These findings were based on the results of a four year study.

Arnett and McChord (1927) found that there was no apparent difference in the weaning weights of calves from cows wintered on various rations in Montana. The winter rations of the cows consisted of straw alone,

straw plus various amounts of alfalfa and timothy hay, and straw plus cottonseed cake.

Vinke and McChord (1927) reported that in a number of trials in Montana that neither the rations fed nor the gains made by cows the previous winter had any effect upon the strength and vigor of calves at birth or their weights the following fall. They state that their experiments indicate that there are only two requirements of a winter ration for beef cows - (1) to maintain the weights of the cows from year to year, and (2) to have the cows vigorous, strong, and healthy at calving time. Thirty-six cows with an average winter gain of 99.9 lbs. did not produce as large calves as did 35 cows that made an average winter gain of 31.8 lbs. The kind of winter ration fed to beef breeding cows did not seem to have any effect upon the calves produced. Cows which received alfalfa hay and cottonseed cake in their winter rations made an average winter gain of 90.7 lbs. and produced calves averaging 352 lbs. at an average age of 161.2 days. Cows which were limited during their winter feeding to cheap roughages such as corn fodder, corn silage, and straw made an average winter gain of 54.4 lbs. and produced calves averaging 385.5 lbs. at an average age of 171.2 days. Considering the difference in age, no effect of the

higher protein rations upon the weaning weight of the calves could be noticed in these trials.

Arnett, Baker, and Vinke (1926) reported that studies in northern Montana indicated that no protein-rich feeds are necessary for wintering beef breeding cows. Maintenance and good gains have been made when winter rations consisted largely of corn fodder or corn silage and straw. Regardless of the kind of ration fed, greater gains were made by thin cows following a dry summer than by cows in good condition following a wet summer. They state that in winter feeding of mature cows it is not necessary to produce any greater gains than just enough to maintain the weights from year to year.

The above experiments indicate that if enough gains can be made on summer grass, winter losses probably will not do any harm to breeding cows. Cows that made the greatest winter gains did not produce any larger calves at weaning time than did the cows that made the smallest winter gains. The rations fed did not make any difference on the year to year weights of the cows or the weights of the calves produced. Highly carbonaceous rations such as silage, corn fodder, and straw probably are the most economical to

use in wintering cows, and the above workers found no advantage from adding high protein feeds to such rations as far as the objective product, calves, are concerned.

Vinke and Dickson (1933) found that records of 250 cows raising calves in Montana over a seven year period indicated that there is no significant relationship between winter gains of cows and the weights of calves at birth or at weaning time. There was not any apparent difference in the vitality and thrift of the calves. One group of cows (called the protein group) was wintered on rations of alfalfa hay only or alfalfa hay with corn silage or corn fodder and some straw. Another group of cows (called the carbonaceous group) was wintered on corn fodder or bluejoint, or straw in abundance with corn silage or corn fodder. There was not an important difference in the weaning weights of calves from either group. From this information it was concluded that the amount of protein in a winter ration for beef breeding cows has no effect on the weights of calves produced provided the cows are kept in a thrifty condition.

Orcutt (1944) reported that at the North Montana Branch Station at Harve, efforts have been made to determine the most practical methods of wintering

beef cows taking into consideration weight, condition, calf crop, and cost. The results did not show any advantage in feeding high protein rations to wintering beef cows, neither was there any advantage in high winter gains of cows. If cows lose very much weight or become very thin during the winter months the birth weights of the calves will not be affected, but the calves out of very thin cows will not make normal growth unless their mothers have sufficient feed for milk production. From these studies Orcutt made the following conclusions: (1) feed very thin cows enough to gain 100 to 150 lbs. during the wintering period, or enough to offset calving loss, (2) cows in fair condition need to be fed only enough to maintain body weight, (3) fleshy cows may lose considerable weight during the winter without harm, and (4) thin cows produce as large calves at birth as fat cows. Thin cows produce as large calves at weaning time as fat cows, provided feed or grass is plentiful enough during the spring and summer to insure sufficient milk.

Morrison (1948) states that commonly only enough supplemental feed is furnished in addition to winter range to keep the cattle from being seriously reduced in condition. Often a supply of hay or silage is kept

on hand to meet shortages of feed on the range during the winter. Some beef producers supplement the winter range with cottonseed cake or some other protein supplement, when necessary. He states that Montana trials show if mature beef cows have been separated from their calves by mid-October and have made good gains before cold weather, they may lose from 50 to 125 lbs. in weight during the winter months and still produce normal calves the following season. In the Montana trials, cows fed one to two lbs. of cottonseed cake per head daily during the winter, in addition to range pasture, maintained their weights better than did the cows that received no supplement. However, the weaning weights of the calves the next season were not enough greater to cover the cost of feeding the cottonseed cake to all of the cows.

In Oklahoma trials (Morrison, 1948), the calf crop was equally as good when cows were wintered on a supplement of 2.2 lbs. of cottonseed cake with winter range, as when they were wintered on prairie hay and one lb. of cottonseed cake a day. In some areas it does not prove economical to supply supplemental feed to winter grazing under usual conditions. In other districts supplemental feeding of cows being winter

grazed greatly increased the percentage of calf crops, reduced the death losses, and increased the weaning weights of the calves.

Black and Mathews (1937) found it is more economical to winter steers on range and supplement the range with concentrates or dry roughage in extremely bad weather or when the vegetation is covered with snow, than it is to carry them through the winter in the feed lot. The studies were made at the Ardmore, South Dakota station and are not of too much value in determining wintering rations for beef breeding cows.

Hargrave (1949) reports that beef cows may be wintered successfully on grass without any supplemental feeding at the Manyberries experiment station, Alberta, Canada. Cows that were in good condition in the fall lost as much as 350 lbs. in weight during the wintering period, and although thin, they were strong and able to make rapid recovery of weight on new grass. Such great losses in weight had no apparent effects on the subsequent weights and condition of the cows or of the calves that they raised. With adequate pasture during the summer the cows were able to regain all winter losses in weight by the following fall and were able to raise normal calves while doing so.

Several studies have shown that winter grazing

such as used in the experiments reported herein has considerably less protein, phosphorus, and carotene than summer grazing or hay cut at an early stage of maturity. Moxon, Gastler, Staples, and Jordan (1951) found that standing grasses in central South Dakota contained over 8 per cent protein in July, but only about 3 per cent in December. On the other hand windrowed hay that had been cut in July contained over 7 per cent protein in December. The phosphorus content of the standing grass was about 0.18 per cent in July, but only about 0.06 per cent in December, while windrowed hay that had been cut in July contained about 0.15 per cent phosphorus in December. The carotene content of the windrowed hay in December was about one-fourth the amount found in July, while standing grass had lost practically all of its carotene by December.

Smuts and Marais (1940) in studies concerning the nitrogen balance with Merino wethers found that during the winter grazing season when the nitrogen content of the grass is low, the total nitrogen intake is low and in four out of five sheep more nitrogen appeared in the feces than intake. During the summer grazing when the nitrogen content of the grass is higher,

the sheep were in positive nitrogen balance. These studies were conducted on representative grazing lots of Merino wethers during different seasons of the year and were fed without access to any form of supplementation except minerals. The workers found that sheep lose weight on winter grazing alone.

In digestion trials at the South Dakota station, lambs were fed prairie hay handled as shown in table I. The apparent digestibility of the dry matter and crude protein is shown in table I (Embry, 1951).

Table I.

Coefficients of Digestibility of Dry Matter and Crude Protein

	Dry Matter	Crude Protein
Standing grass (cut in Feb. and Mar.)	43.04	0.50
Stacked hay	46.17	22.67
Windrowed hay (hauled in Nov.)	39.02	27.86

The South Dakota work (Moxon et al., 1951) shows that winter forage is very low in protein, phosphorus and carotene. Cutting as hay at an early stage and only windrowing greatly reduces the loss of these nutrients, but standing grass provides much cheaper feed than the

harvested hay, provided additional supplements are not required.

The protein, phosphorus, and carotene contents of the winter grazing shown above are decidedly deficient. It has been shown by several workers that cattle are able to store enough vitamin A to last several months even when fed a ration extremely low in carotene. Phosphorus supplements are cheap. Therefore, protein is the most important supplement to consider under winter grazing conditions when the total feed available is plentiful. The studies with sheep (Smuts and Marais, 1940; Embry, 1951) show that the protein content of winter grazing will not supply the maintenance needs of this species. Comparable studies with cattle were not found. However, the several feeding trials reviewed show that feeding protein supplements with winter grazing or poor quality roughages aids materially in preventing losses in weight. In general, the balance of evidence indicates that winter loss does not appear to have any effect on condition or birth weight of the calves provided the cows do not become seriously run down in condition. Neither does it appear to have much effect on the weaning weight of the calves provided that good grazing is furnished during lactation.

Most of the above studies were conducted under conditions quite different from those encountered in South Dakota. Thus, it seemed desirable to determine the value of various supplements to winter grazing in this state.

OBJECTIVES

The objectives of this study were as follows: (1) to compare the efficiency of different concentrates and roughages for supplementing winter grazing for beef breeding cows, (2) to compare the efficiency of different intensities of summer grazing (under, normal, and over) for beef cows and their calves, (3) to study the effects of the above intensities of summer grazing with various winter rations and vice versa, and (4) to develop a practical index for the selection of efficient range beef breeding stock. Only the data from those parts of the project dealing with the comparison of the efficiency of different concentrates and roughages for supplementing winter grazing of beef cows, and calf production, were used in the study reported herein.

MATERIALS AND METHODS

A. Location and Conditions

All data used in this study were obtained with range cows and calves at the Cottonwood Range Field Station, Cottonwood, South Dakota, from December 1941 to November 1946.

The Range Field Station, a cooperative unit of the South Dakota State College Experiment Station and the Soil Conservation Service, is located in the south central section of the range area of South Dakota. The land at this station is typical of the central range area of South Dakota, being moderately rolling and free from brush. It was estimated that between 96 and 99 per cent of the forage found on the Cottonwood range was grasses and grasslike plants. The principal short grasses were blue grama and buffalo grass, with occasional amounts of threadleaf sedge, needleaf sedge, and inland saltgrass. The principal mid-grass found was western wheat grass. Small amounts of needleandthread, red three-awn, sideoats grama, sand dropseed, little bluestem, and prairie muhly were also present. A small amount of tall grasses in the form of feather bunchgrass was found on the grazing range. Small amounts of annual grasses such as sixweeks

fescue, japanese brome, common witchgrass and little barley were observed. The remaining small percentage of the range forage was composed of perennial weeds, annual weeds, and perennial shrubs. The forage composition of the range was determined by Leslie R. Albee, Range Conservationist, Soil Conservation Service, United States Department of Agriculture. According to Johnson, Albee, Smith, and Moxon (1951) the average annual precipitation for the period 1942-50 in this area was 14.3 inches with 11.4 inches or 79.7 per cent falling in the growing season, April 1 to October 1.

B. Animals

In the late summer and fall of 1941, forty-eight grade Hereford cows of good to choice quality were obtained from ranches in the surrounding area. Insofar as possible only range-bred cows were selected for the project. These cows were taken to the Range Field Station where they were placed on experiment.

Two registered Hereford bulls were used in the herd each year. These bulls were selected on the basis of type, quality, and pedigree and were classified as considerably above average in beef type. The sires were used for a period of two years except that one

of the bulls used the first year was sold at the end of the breeding season. One-half of the cows in each winter and summer treatment were bred to each sire. These sires were turned in with the cow herd about June 20, and removed about September 30, each year. During the balance of the year the cows were maintained by themselves on the range with the necessary supplemental feeds to keep them in good breeding condition.

Depletions in the cow herds because of death or accident which impaired the future usefulness of the individuals necessitated cow replacements. Initial cow replacements were made by the purchase of cows of the same type and quality as those used at the start of the project. Later replacements were made available by saving a few of the best heifer calves each fall.

C. Management and Procedure

This experiment was conducted over a period of five years with each year having a winter feeding and summer grazing period. With this system of management a division of the lots of cows was necessary in order to obtain the data required for the winter feeding and the summer grazing periods. The original forty-eight cows were allotted into four groups as equal as possible for the winter feeding period considering

weight, type, age, condition, origin, and color. Treatments were assigned to the various groups at random. After allotment each cow was numbered in order to maintain identification throughout the experiment. The cows in lot 1 were given numbers 1 to 12 and the cows in lots 2, 3, and 4 were numbered from 13 to 24, 25 to 36, and 37 through 48, respectively. After the winter feeding period, the four lots of cows were redivided into six lots for the summer grazing period. The allotment of cows for the summer grazing period was made in such a manner that representatives from each of the winter feeding lots received under, normal, and overgrazing treatments. The under, normal, and overgrazing treatments were duplicated as indicated in table II.

Table II.

Allocation of Cows on Summer Pasture

Cows from	Type of Grazing	Series 1 Lot 1 Under	Series 1 Lot 2 Normal	Series 1 Lot 3 Over	Series 2 Lot 1 Under	Series 2 Lot 2 Normal	Series 2 Lot 3 Over
Lot 1	Number of cows	2	2	2	2	2	2
Lot 2	Number of cows	2	2	2	2	2	2
Lot 3	Number of cows	2	2	2	2	2	2
Lot 4	Number of cows	2	2	2	2	2	2

Each year of the five-year period, the cows remained in their respective winter and summer treatment groups unless replaced because of death or accident that impaired the future usefulness of an individual.

The first winter feeding trial started December 29, 1941, and ended May 12 of the following year. The second trial started December 4, 1942 and was finished May 1, 1943. The third trial started December 2, 1943 and ended May 2, 1944. The fourth trial started November 30, 1944 and was finished May 1, 1945. The fifth trial started December 3, 1945 and ended May 1, 1946. Supplemental feeding was administered during all winter feeding periods but was generally confined to the last four months of the periods. During the time that supplements were being fed, the cows were left on the open range in one pasture during the day and divided into their respective lots at night for feeding. During the night the cows had access to an open shed (18' x 100') which was divided to house the four lots. There were four corrals each measuring 25' x 50' located on the south side of the shed.

The winter range consisted of essentially the same grasses and other vegetation as described previously for the summer range with the exception of the

annual grasses and other forage that had been killed by freezing. In addition to the winter range and minerals salt, ground limestone and bonemeal, each being self-fed in the dry form in separate containers, all lots received supplemental feed as follows: the cows in lot 1 received wheat grass hay if climatic and weather conditions were such that grazing on the open range was not possible, the cows in lot 2 received 1 pound of cottonseed cake per head daily in addition to the supplemental feeding of wheat grass hay which was provided when the same conditions as described above existed, the cows in lot 3 received approximately one-half feed of wheat grass hay daily, and the cows in lot 4 received approximately one-half feed of sorghum fodder daily. During the winter feeding period all cows had access to well water.

The cows and their calves were pastured approximately seven months during the summer. In order to have duplicated treatments of under, normal, and overgrazing, it was necessary to have six pastures of various sizes. On the basis of eight cows per pasture, the cows receiving the undergrazing treatments were allowed approximately 24 acres of pasture per individual, the animals in the normal grazing treatments were allowed

approximately 17 acres of pasture per cow, and the animals in the overgrazing treatments were allowed approximately 10 acres of pasture per cow. The above acreage allowances were in accordance with the carrying capacity of the range. Salt was self-fed to each group during the time the cattle were on the summer range and water was provided from shallow wells.

In order to obtain material for statistical analysis of the problem, it was necessary to keep the following records on all cows:

1. Weight. The average of three consecutive daily weights was taken as the true weight of each individual at the beginning and end of the winter and summer feeding periods. During the winter feeding period, one-day weights were also taken on each individual each month in order to determine the monthly gain or loss.
2. Breeding condition. The average of three condition ratings, each rating made individually by a different worker, was considered as the true condition of each cow. Condition ratings were made at the beginning and end of each winter and summer feeding period. The condition

standard was composed of five main classes with each class being further divided into a high, medium, and low subclass. The following grading standards were used:

a-excellent breeding condition.

b-above average breeding condition.

c-good or average breeding condition.

d-below average or fair breeding condition.

e-poor or inferior breeding condition.

The above letter grades were subdivided and given a numerical value as follows: a+ = 14, a = 13, a- = 12, b+ = 11, b = 10, b- = 9, c+ = 8, c = 7, c- = 6, d+ = 5, d = 4, d- = 3, e+ = 2, e = 1, and e- = 0.

3. Breeding. Service dates, insofar as possible, and calving dates were kept on all cows.

Many of the calves were calved during the latter part of the winter feeding period each year. The calves were allotted with their dams for the summer feeding periods. The following records were kept on all calves:

1. Age, ancestry, and sex.
2. Weight. Weights were taken at birth and at weaning time. A single weight was considered

as the true birth weight. The average of three consecutive daily weights was used as a true weaning weight.

3. Condition score. Condition ratings were made on all calves at weaning time. These ratings were made in the same manner and given the same values as those reported for the cows.

Additional data were collected on these cows and calves for other experiments but only those itemized above apply to the study reported in this paper.

RESULTS AND DISCUSSION

The five winter feeding trials were not carried out over equal periods. During the first year the cows were put on the winter feeding treatment December 29, 1941 and removed May 12, 1942. The second year the cows were started December 4, 1942 and removed May 1, 1943. The third year started December 2, 1943 and finished May 2, 1944. The fourth winter trial lasted from November 30, 1944 to May 1, 1945. The fifth year the cows were put on the winter feeding treatment December 3, 1945 and removed May 1, 1946. This meant that the winter feeding periods were 135, 149, 153, 153, and 150 days in length for 1942, 1943, 1944, 1945, and 1946 respectively.

Forty-eight cows were started on the experiment and were to remain in the same treatment groups for five years. However, many cows were sold, or died, and were replaced by other individuals before the winter feeding phase started the next year. If a cow was removed from a lot during a winter season, her weight and feed consumption were deducted from the averages.

Not all of the cows produced calves every year. Some calves were born during the winter feeding periods

and some were born after the winter feeding periods had ended. Therefore, the total gain or loss in weight of the cows as recorded in the various winter treatment groups was not accurate and was not used to give an indication of the relative merits of the treatments. Some calves were born dead. Their weights were disregarded and not considered as birth weights.

During the winter of 1942, one cow in lot 1 died. She was thought to be too old to survive under winter range conditions. Also the same year, a cow in lot 2 died of pneumonia after calving. Another cow in lot 2 refused to eat cottonseed cake during the entire winter season. A cow in lot 3 died of pneumonia. Two cows in lot 4 died during the winter season, however, both had calved previous to death. The calves from the cows that died were considered in the average birth weights and then removed from the experiment. One calf in lot 2 came prematurely and was dead at birth. Another calf in lot 2 died of exposure two days after birth. One cow in lot 3 produced twin calves. During the fall of 1942, four cows, one out of each lot, were sold because they were very old and had very short teeth.

In the 1943 winter feeding trials a cow in lot 4 produced a normal size calf that was dead at birth. Four cows, one from each lot, were sold during the fall of 1943. The cow in lot 1 had an ulcered tooth. The cow in lot 2 was sold because of old age. The cow in lot 3 had cancer eye, and the cow in lot 4 was very lame.

During the 1944 winter feeding trials two cows in lot 1, two cows in lot 2, and two cows in lot 4 did not produce calves. The calf of a cow in lot 1 died five days after birth. A cow in lot 4 produced a calf that died shortly after birth. Another cow in lot 4 produced a normal calf that died when it was about four months of age. There was no apparent cause for these deaths. During the fall of 1944 there were six cows removed from the experiment. A cow in lot 1 had a bad udder. One cow was removed from lot 2 because she was very old. Two cows in lot 3 were culled, one because she was very wild and another because she had cancer eye. Two cows were removed from lot 4, one had crooked feet and another was infested with lice.

During the 1945 season there were two cows in lot 1 that died, one of the cows fell into a creek

and drowned. These two cows and four others in lot 1 did not produce calves. There were two cows in lot 2 that died, one of which was very weak and thin and fell into a ditch. These two cows and one other did not calve. Another cow in lot 2 produced a calf that died four days after birth. Two cows in lot 3 died. One cow fell over a bank, while the other died of unknown causes. These two cows and one other did not produce calves. Another cow produced a calf that was dead at birth. Another cow in this lot produced a normal calf that died about three months after birth. There was no apparent cause for the death. A cow in lot 4 produced a calf that died about two and one-half months after birth. There was no apparent cause for the death.

There were five cows that did not produce calves in 1946. Two cows were from lot 1, one cow from lot 2, and two cows were from lot 4. One cow in lot 1 produced a calf that was dead at birth, and another produced a fall calf that was not considered in the averages. One calf produced in lot 3 died the next day after birth and another calf became blind the third day after birth and died on the fourth day after the mother had refused to claim it. One of the cows in

lot 3 produced a dead calf. A calf in lot 4 probably starved to death when it was ten days old as the mother had a bad udder. One calf in lot 4 was not considered in the averages as it was a fall calf.

Table III shows the number of cows that produced calves during the winter feeding trials and the number of cows that produced calves after the winter feeding periods had ended.

Table III

Cows Calving During and After Winter Feeding Periods

	No. cows calving during winter feeding period	No. cows calving after winter feeding period
1942		
Lot 1	6	5
Lot 2	11	1
Lot 3	9	2
Lot 4	12	0
1943		
Lot 1	3	9
Lot 2	1	11
Lot 3	1	11
Lot 4	1	11
1944		
Lot 1	1	9
Lot 2	5	5
Lot 3	5	7
Lot 4	5	5
1945		
Lot 1	4	2
Lot 2	4	5
Lot 3	4	5
Lot 4	9	3
1946		
Lot 1	8	1
Lot 2	7	4
Lot 3	9	3
Lot 4	7	2

In view of the fact that cows lose considerable weight at calving time and also that some of the cows calved during the winter treatment periods while others did not the cow gains or losses can not be entirely attributed to the various winter rations. The cow gains or losses are shown in tables IV, V, VI, VII, and VIII for the years 1942, 1943, 1944, 1945, and 1946, respectively. They are merely informative and can not be used as a true value of the various winter rations. However, observations made by L. E. Johnson indicate considerable differences in appearance of the cows in the various lots.

On May 1, 1943 the cows in lot 1 were described as being in fair condition but lousy and having the roughest hair coats of the four lots. Lot 2 cows were in good condition, fairly free from lice, and had the best hair coats. The cows in lot 3 were the fattest and had the fewest lice, but did not have quite as good hair coats as lot 2. Lot 4 cows were similar to the ones in lot 2 in condition, had smoother hair coats and did not have as many lice as the cows in lot 1.

On May 2, 1944 the cows in lot 1 were thin in flesh, lousy, but had a fair hair coat. Lot 2 cows were fair in condition, had the longest hair of any of the lots,

and were free from lice. Lot 3 cows ranked low-good in condition, had a good hair coat, and were free from lice. The cows in lot 4 were thin, but not quite as thin as those in lot 1, had a fair hair coat, and were lousy, but did not seem to have as many lice as the cows in lot 1.

On May 1, 1945 the cows in lot 1 appeared to have wintered the poorest of the lots. They were very lousy and had the poorest hair coats. Lot 2 cows had the best hair coats and were not very lousy. They appeared to have wintered better than lot 1. The cows in lot 3 were very lousy, did not have as good hair coats as lots 2 or 4, but appeared to have wintered better than lot 2. Lot 4 cows appeared to have wintered the best of the lots, although their hair coats were not as smooth as the cows in lot 2.

By April 30, 1946, the cows in lot 1 were very thin, however, they had a fairly good hair coat. Lot 2 cows carried more condition than the cows in lot 1. The cows in lot 3 appeared to carry the most condition of the four lots. Lot 4 cows did not have as much condition as the ones in lot 3 but carried more condition than the cows in lot 2. This indicates that cows receiving some type of supplemental feeding will winter better than will cows not receiving any supplemental feeding.

The true weaning age of the calves varied somewhat. In order that the weaning weights could be correctly compared, the true weaning weights were adjusted to a constant age of 190 days (Johnson and Dinkel 1951). Tables IV, V, VI, VII, and VIII show the average weaning age, the average weaning weight, and the average weaning weight corrected to 190 days for the years 1942, 1943, 1944, 1945, and 1946 respectively. Using the corrected weaning weights as a measure, the calves in lot 1 were the lightest in weight during the years of 1943, 1944, and 1945. The calves in lot 2 were the heaviest in 1942 and 1944. Lot 3 calves were lightest in 1942, but heaviest in 1943 and 1946. Calves in lot 4 were heaviest in 1945 but lightest in 1946. This might indicate that calves from cows wintered by grazing only will be lighter at weaning time than calves from cows receiving supplemental feed. It may be noted that the calves produced in 1942 were the heaviest and the 1944 calves were the lightest.

The feed cost per cow, exclusive of grazing, for the winter feeding periods is shown in tables IV, V, VI, VII, and VIII. Naturally, the cows that received only salt and minerals in addition to grazing were

wintered with the least cost. The cows that received the cottonseed cake were wintered at the highest cost. Wheat-grass hay cost nearly as much as cottonseed cake as a wintering supplement for beef cows, while sorghum fodder was a cheaper supplement than wheat-grass hay.

Table IV

Beef Production Under Different Wintering Treatments
(December 29, 1941 - May 12, 1942 -- 135 days)

	Lot 1 Grazing plus wheat-grass hay if necessary	Lot 2 Grazing plus cottonseed cake plus wheat-grass hay if necessary	Lot 3 Grazing plus 1/2 feed wheat-grass hay	Lot 4 Grazing plus 1/2 feed sorghum fodder
Cow data				
No. starting trial	12	12	12	12
No. finishing trial	11	11	11	10
Ave. initial wt. per cow finishing trial, lbs.	1034	1040	1038	1035
Ave. wt. gain or loss, lbs.	-104	-155	-128	-150
Ave. init. condition score (Dec. 29)	7.16	6.81	9.60	7.13
Ave. final condition score (May 12)	7.15	5.94	7.60	5.63
Supplemental feed per cow finishing trial				
Cottonseed cake, lbs.		126		
Wheat-grass hay, lbs.	44	43	1020	
Sorghum fodder, lbs.				1060
Salt, lbs.	12.0	12.2	4.1	7.6
Bonemeal, lbs.	.48	.39	.43	.78
Ground limestone, lbs.	.13	.34	.39	.43
Feed cost per cow (not including grazing)	$0.23	$3.74	$3.10	$2.20
Calf data				
No. born	11	12	12	12
No. born alive	11	11	12	12
Ave. birth weight of live calves, lbs.	81	72	71	71
No. weaned	11	9	12	10
Ave. weaning age, days	165	192	196	205
Ave. weaning weight, lbs.	370	416	407	425
Ave. weaning weight, corrected to 190 days, lbs.	408	417	403	412
Ave. weaning condition score	8.04	8.54	7.63	8.57

Table V

Beef Production Under Different Wintering Treatments
(December 4, 1942 - May 1, 1943 -- 149 days)

	Lot 1 Grazing plus wheat-grass hay if necessary	Lot 2 Grazing plus cottonseed cake plus wheat-grass hay if necessary	Lot 3 Grazing plus 1/2 feed wheat-grass hay	Lot 4 Grazing plus 1/2 feed sorghum fodder
Cow data				
No. starting trial	12	12	12	12
No. finishing trial	12	12	12	12
Ave. init. wt. per cow finishing trial, lbs.	961	972	953	969
Ave. wt. gain or loss, lbs.	-65	-31	-16	-32
Ave. init. condition score (Dec. 4)	6.84	6.04	6.14	6.44
Ave. final condition score (May 1)	6.32	7.08	6.68	6.92
Supplemental feed per cow finishing trial				
Cottonseed cake, lbs.		121		
Wheat-grass hay, lbs.	8	8	922.2	
Sorghum fodder, lbs.				901
Salt, lbs.	17.5	19.2	9.3	7.5
Bonemeal, lbs.	.21	.25	1.88	.71
Ground limestone, lbs.	.04	.08	.02	.17
Feed cost per cow (not including grazing)	$0.21	$3.47	$3.02	$2.45
Calf data				
No. born	12	12	12	12
No. born alive	12	12	12	11
Ave. birth weight of live calves, lbs.	73	73	74	72
No. weaned	12	12	12	11
Ave. weaning age, days	177	183	186	185
Ave. weaning weight, lbs.	348	373	382	371
Ave. weaning weight corrected to 190 days, lbs.	364	380	384	375
Ave. weaning condition score	7.09	7.69	8.08	6.84

Table VI

Beef Production Under Different Wintering Treatments
(December 2, 1943 - May 2, 1944 -- 153 days)

	Lot 1 Grazing plus wheat-grass hay if necessary	Lot 2 Grazing plus cottonseed cake plus wheat-grass hay if necessary	Lot 3 Grazing plus 1/2 feed wheat-grass hay	Lot 4 Grazing plus 1/2 feed sorghum fodder
Cow data				
No. starting trial	12	12	12	12
No. finishing trial	12	12	12	12
Ave. init. wt. per cow finishing trial, lbs.	974	987	962	984
Ave. wt. gain or loss, lbs.	-53	-73	-28	-44
Ave. init. condition score (Dec. 2)	7.09	6.51	6.55	6.61
Ave. final condition score (May 2)	7.42	6.90	6.33	7.39
Supplemental feed per cow finishing trial				
Cottonseed cake, lbs.		117		
Wheat-grass hay, lbs.	442.3	410.1	1267.2	
Sorghum fodder, lbs.				1188.2
Salt, lbs.	14	15.2	9.1	5.8
Bonemeal, lbs.	1.83	1.17	2.25	1.25
Ground limestone, lbs.	.17	.00	.00	.00
Feed cost per cow (not including grazing)	$1.97	$5.62	$5.24	$3.67
Calf data				
No. born	10	10	12	10
No. born alive	10	10	12	10
Ave. birth weight of live calves, lbs.	76	72	70	76
No. weaned	9	10	12	8
Ave. weaning age, days	188	194	194	201
Ave. weaning weight, lbs.	305	355	348	342
Ave. weaning wt. corrected to 190 days, lbs.	305	352	346	334
Ave. weaning condition score	7.37	8.73	8.42	8.00

Table VII

Beef Production Under Different Wintering Treatments
(November 30, 1944 - May 1, 1945 -- 153 days)

	Lot 1 Grazing plus wheat-grass hay if necessary	Lot 2 Grazing plus cottonseed cake plus wheat-grass hay if necessary	Lot 3 Grazing plus 1/2 feed wheat-grass hay	Lot 4 Grazing plus 1/2 feed sorghum fodder
Cow data				
No. starting trial	12	12	12	12
No. finishing trial	10	10	10	12
Ave. init. wt. per cow finishing trial, lbs.	848	861	860	912
Ave. wt. gain or loss, lbs.	-49	24	19	-11
Ave. init. condition score (Nov. 30)	5.90	7.03	10.28	7.62
Ave. final condition score (May 1)	4.49	5.42	9.24	5.65
Supplemental feed per cow finishing trial				
Cottonseed cake, lbs.		116.6		
Wheat-grass hay, lbs.	16.2	16.8	930.9	
Sorghum fodder, lbs.				952.2
Salt, lbs.	25.4	32.3	25.2	14.6
Bonemeal, lbs.	1.18	1.83	1.93	1.31
Ground limestone, lbs.	.25	.04	.12	.00
Feed cost per cow (not including grazing)	$0.35	$4.52	$4.04	$3.05
Calf data				
No. born	6	9	9	12
No. born alive	6	9	8	12
Ave. birth weight of live calves, lbs.	68	67	68	68
No. weaned	6	8	7	11
Ave. weaning age, days	186	182	184	196
Ave. weaning weight, lbs.	349	352	358	370
Ave. weaning wt. corrected to 190 days, lbs.	355	362	363	365
Ave. weaning condition score	7.90	7.28	7.86	7.33

Table VIII

Beef Production Under Different Wintering Treatments
(December 3, 1945 - May 1, 1946 -- 150 days)

	Lot 1 Grazing plus wheat-grass hay if necessary	Lot 2 Grazing plus cottonseed cake plus wheat-grass hay if necessary	Lot 3 Grazing plus 1/2 feed wheat-grass hay	Lot 4 Grazing plus 1/2 feed sorghum fodder
Cow data				
No. starting trial	12	12	12	12
No. finishing trial	12	12	12	12
Ave. init. wt. per cow finishing trial, lbs.	907	914	968	933
Ave. wt. gain or loss, lbs.	-89	-42	-53	-18
Ave. init. condition score (Dec. 31)	6.56	5.97	6.71	5.36
Ave. final condition score (May 1)	4.23	5.18	6.09	5.82
Supplemental feed per cow finishing trial				
Cottonseed cake, lbs.		114.8		
Wheat-grass hay, lbs.			863.4	
Sorghum fodder, lbs.				866.0
Salt, lbs.	11.9	19.4	7.8	6.8
Bonemeal, lbs.	.38	.17	2.04	.25
Ground limestone, lbs.	.00	.00	.00	.17
Feed cost per cow (not including grazing)	$0.14	$4.22	$3.61	$2.70
Calf data				
No. born	9	11	12	9
No. born alive	8	11	11	9
Ave. birth weight of live calves, lbs.	70	69	67	66
No. weaned	8	11	9	8
Ave. weaning age, days	198	196	192	190
Ave. weaning weight, lbs.	380	413	421	364
Ave. weaning wt. corrected to 190 days, lbs.	374	408	420	362
Ave. weaning condition score	8.01	7.85	8.34	7.60

Table IX shows the averages of the five years winter feeding. The cows in lot 1 lost the most weight and the cows in lot 3 lost the least amount of weight, however, as previously stated, these losses do not give a true picture as some of the cows produced calves during the winter treatments while others did not calve until the winter periods had finished. The calves in lot 1 were the youngest while the ones in lot 4 were the oldest at weaning time. When the weaning weights were corrected to the constant age of 190 days, the calves in lot 1, which were the lightest in weight, averaged about 20 pounds less at weaning than the calves in lots 2 and 3, which were the heaviest. However, lot 1 calves were the heaviest at birth.

Table IX

Beef Production Under Different Wintering Treatments
Five Year Summary
(December 29, 1941 - May 1, 1946)

	Lot 1 Grazing plus wheat-grass hay if necessary	Lot 2 Grazing plus cottonseed cake plus wheat-grass hay if necessary	Lot 3 Grazing plus 1/2 feed wheat-grass hay	Lot 4 Grazing plus 1/2 feed sorghum fodder
Cow data				
No. starting trial	60	60	60	60
No. finishing trial	57	57	57	58
Ave. init. wt. per cow finishing trial, lbs.	947	957	958	964
Ave. wt. gain or loss, lbs.	-72	-56	-42	-48
Ave. init. condition score (Beginning)	6.73	6.45	7.74	6.62
Ave. final condition score (Ending)	5.95	6.13	7.11	6.28
Supplemental feed per cow finishing trial				
Cottonseed cake, lbs.		119		
Wheat-grass hay, lbs.	105.8	98.9	994.6	
Sorghum fodder, lbs.				992.3
Salt, lbs.	15.9	19.3	10.7	8.5
Bonemeal, lbs.	.81	.73	1.72	.86
Ground limestone, lbs.	.11	.09	.10	.14
Calf data				
No. born	48	54	57	55
No. born alive	47	53	55	54
Ave. birth weight of live calves, lbs.	74	70	71	71
No. weaned	46	50	52	48
Ave. weaning age, days	181	190	191	195
Ave. weaning weight, lbs.	350	383	383	376
Ave. weaning wt. corrected to 190 days, lbs.	363	384	383	372
Ave. weaning condition score	7.64	8.02	8.07	7.63

The feed prices that were used to determine feed costs for the different years of the experiment are shown in table X. The actual costs of the cottonseed cake, salt, bonemeal, and limestone were used. The prevailing prices of wheat-grass hay and sorghum fodder were determined and used in calculating the yearly feed cost.

Table X

Feed Prices

	1942	1943	1944	1945	1946
Cottonseed cake, per ton	$56.00	$53.50	$64.75	$70.00	$70.00
Wheat-grass hay, per ton	6.00	6.00	8.00	8.00	8.00
Sorghum fodder, per ton	4.00	5.00	6.00	6.00	6.00
Salt, per cwt.	0.66	1.05	0.95	0.95	1.00
Bonemeal, per cwt.	3.00	3.00	3.80	3.80	4.00
Limestone, per cwt.	0.85	1.00	1.00	1.00	1.00

In a statistical analysis (Snedecor, 1946) of corrected calf weaning weights for the five years in the four lots, there was a highly significant difference between years but not a significant difference in corrected weaning weights between treatments at the five per cent level (table XI). However, the difference in corrected weaning weight between treatments did approach significance at the five per cent level. Differences in corrected weaning weights between years may have been due to the unequal length of the winter feeding periods for the cows, and differences in climatic conditions. In this discussion the words "highly significant" or the double asterisk (**) have been used to indicate a difference that would occur by chance in less than 1 per cent of similar trials.

Table XI

Analysis of Variance of Corrected Calf-Weaning Weights

Source of Variance	D/F	Sums of Squares	Mean Squares
Total	195	551,448	2,827.94
Treatments	3	13,995	4,665.00
Years	4	127,760	31,940.00**
Treatments x Years	12	21,712	1,809.33
Error	176	387,981	2,204.44

SUMMARY AND CONCLUSIONS

The results of five years' wintering trials with beef cows and the effects upon calf production at the Cottonwood Range Field Station are presented. The cows remained on the same treatment for the full five years unless culled. The cattle in this experiment were all winter grazed together and were divided into four lots at night for feeding. Each lot consisted of twelve cows. Lot 1 received no supplemental feed except wheat-grass hay as was needed during adverse weather conditions. Lot 2 received one pound of cottonseed cake per head daily plus wheat-grass hay during storms. Lot 3 was fed about eight pounds, or approximately one-half feed of wheat-grass hay per head daily. Lot 4 received about eight pounds, or approximately one-half feed, of sorghum fodder per head daily. The supplemental feed was usually given during the last four months of the winter feeding periods.

1. All cows lost weight every winter of the five year period with the exceptions of the cows receiving cottonseed cake and wheat-grass hay as they made slight gains during the

winter of 1945. The cows receiving winter grazing only averaged the most loss in weight for the five year period while the cows supplemented with wheat-grass hay averaged the least loss in weight. Cow gains or losses can not be directly attributed to the various rations in this experiment as some cows produced calves during the winter feeding treatments while others did not calve until the winter periods had finished.

2. Winter supplementation apparently did not affect the number of calves born or their birth weights. However, the cows receiving winter grazing only produced the fewest number of calves, but they were the heaviest at birth.
3. During most winters any supplement fed to the cows increased the weaning weights of the calves the following fall. The cows receiving cottonseed cake and the ones receiving wheat-grass hay apparently produced the heaviest and fattest calves. However, the differences were not great enough to be significant when tested statistically.

4. There was a great difference in the weaning weights of the calves during the various years of the experiment. These differences were found to be highly significant when tested statistically. The yearly differences in calf weaning weights were apparently due to the unequal lengths of the winter feeding periods of the cows, climatic conditions, and perhaps grazing conditions during the summer months.
5. Any supplementation increased the costs of wintering the cows. It cost more to winter cows on cottonseed cake than on wheat-grass hay. The cows that were fed sorghum fodder were wintered more cheaply than the ones that received wheat-grass hay. From the information reported in this experiment, not considering cow gains or losses, the economical use of winter supplementation for range beef cows seems to be influenced by climatic conditions, the condition of the winter range, and current prices of calves at weaning time.

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ACKNOWLEDGMENT

The author wishes to express his sincere appreciation to Dr. R. F. Wilson, Dr. K. Rasmussen, and Dr. L. B. Embry for helpful suggestions and criticisms during the preparation of this manuscript. Acknowledgment is also made to Prof. Ellis Pierce for assistance in writing materials and methods, and to Dr. L. E. Johnson for planning and conducting the experiment.

Appreciation is expressed to other members of the Animal Husbandry Department for suggestions and criticisms.