SUPPLEMENTS OF DIFFERENT PROTEIN AND VITAMIN CONTENT FOR WINTERING BEEF HEIFERS

By

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FOR WINTERING BEEF HEIFERS

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INTRODUCTION

One of th ost i port t it ms of expense in maintaining the cow herd is providing supplemental winter feed The amount of protein supplem nt fed during th winter can gre tly affect the profit of beef c ttle ent rprise. The livestoc producer needs to know w i supple ents containing different amounts of prot in and vitamins can be fed t the low st cost to repl c ment heif rs during the winter without interferring with the animal's productivity.

The protein in the r tion is of great importance in livestock f eding, because it is essential for life and is usually the most costly portion of the ration. Be f cattle wintere on dry cured native grass requir protein to utilize the large amount of rou age, an conomical source of energy. Since protein is the principal co tituent of th organs and soft structures of the animal body, a continuous supply is needed in t e food throughout life for growth and repair of the body tissues.

Heifers bred to calve first s two-year olds may produce an extr calf in their productive lifetime as compared to those calving first s three-year olds. Hov v r, those which calve first as two-y ar-olds ay require incr sed ounts of upplemental fee during this first gestation period to meet th protein requirem nts for maintenance, growth, and reproduction.

One of the objectives of this study was to compare the performanc of bred heifers on the range when fed equal amounts of supplemental

concentrates containing different percentages of protein. A second objective was to study the value of adding a source of several vitamins to the winter supplement of bred yearling heifers allowed to graze the dry cured grass. The value of the various winter rations fed in this study was determined by winter weight change of the young female, rebreeding during the following summer, and birth and weaning weight of offspring.

REVIEW OF LITERATURE

There are many feeding standards which include allowances for growing beef cattle. Armsby (1917) concluded that 1.20 lbs. daily was the digestible protein requirements of a 400-pound growing beef heifer. Mitchell (1929) concluded that a heifer of this size required only 0.62 lbs. of digestible protein per day. The protein allowances recommended by various authors for growing beef cattle are given in Table 1 (Armsby, 1917; Mitchell, 1929; Morrison, 1948; National Research Council, 1950).

Table 1. Daily Protein Requirements of Growing Beef Cattle

Body Wt. (lbs.)	Armsby	Mitchell	Morrison	N.R.C.
200	0.90	0.67		
300	1.07	0.65	0.67	
400	1.20	0.62	0.76	0.90
500	1.32	0.60	0.81	
600	1.40	0.59	0.84	0.90
700	1.40	0.57	0.87	
800	1.37	0.56	0.90	0.90
900	1.30	0.55	0.93	
1,000	1.30	0.54	0.95	0.90

Black et al. (1938) studied the effect of wintering cows on the range with and without a supplement of cottonseed cake. One group of

cows received cottonseed cake as a protein supplement, while the other group depended upon the winter range as the only source of its feed. Calves from the cows fed cottonseed cake weighed an average of 1.9 lbs. heavier at birth and 13.6 lbs. heavier at weaning than calves from the cows not fed a supplement. However, the average feed and range cost per cow, and the cost per 100 lbs. of calf produced were greater for the cows fed the supplement. These workers concluded that feeding of cottonseed cake should be limited to seasons in which winter range conditions are severe.

Daniel (1951) and Fontenot (1953, 1954) conducted an experiment to determine the relative value of 20-, 30-, and 40-percent protein pellets for wintering beef heifer calves. Data were collected from November, 1949, until October, 1953. A total of 259 grade Hereford heifer calves were used with a different group of heifers used each year. The heifers of Lots 1, 2, and 3 were wintered in a small trap and fed prairie hay ad libitum plus one lb. of 20-, 30-, and 40-percent protein supplement per head daily, respectively. The heifers of Lots 4, 5, 6, and 7 were allowed to graze dry cured native grass during the winter. Those of Lots 4 and 5 were fed 1.0 lb. of 20- and 400percent protein supplement, respectively. Those of Lots 6 and 7 were fed 2.0 lbs. of 20- and 40-percent protein supplement, respectively. The heifers of all lots had access to a mineral mixture of one part steamed bone meal and two parts salt. During the summer all the heifers grazed the native grass pasture. The winter gain of the heifers fed one lb. per head daily of 20-, 30-, and 40-percent protein pellets was -11, 34, and 81 lbs. per head, respectively. The heifers wintered on dry grass and fed 1.0 lb. of 20-percent protein pellets and 1.0 lb. of 40-percent protein pellets gained -26 and 15 lbs. per head, respectively, during the winter. The

winter gain of heifers grazing dry grass and fed 2.0 lbs. of 20- and 40-percent protein pellets was 15 and 38 lbs. per h ad, res c ively. The four y ar verage winter feeding period was 154 days. The aver ge y arly gain for the eifers in Lots 1, 2, 3, 4, 5, 6, and 7 was 250, 273, 290, 250, 256, 276, and 268 lbs., respectively.

Arnett (1927) studied the value of cottonseed cake as a supple ent to str w for wintering beef breeding cows. Thirty-six cows were divided into three qual lots. Lot I received straw only; Lot II, straw and 1 lb. of cottonseed cake; Lot III, straw and 5 lbs. of mix h . The results indicated that one lb. of cottonseed cake as equal to 5 lbs. of mixed hay when fed with straw ad libitum for aintaining the weight of cows during the winter. For each pound that the loss was reduced below th t lost by tho fed only straw, Lot II was f d 2.35 lbs. of cotton eed cake and Lot III, 12.2 lbs. of ixed hay.

Vinke (1933) conduct an exp ri nt with be f cows from 1921 to 1932. During this period various winter feeds and rations were test for economy in wintering cow and for their effects upon the calves produced. Also, factors influencing the w ights of calves at birth and weaning were studied. Records taken from total of 419 producing cows during a period of eleven years show a definite relationship b tw en winter gains or losses in weight and summer gains or lo ses. He concluded that the amount of winter gain or loss in weight by breeding cows shoul be only as much as will maintain the weight strength of mature cows from year to year. Records of 250 cows which raised calves during a even-year per'od indicat d no significant relationship between winter gains of th cows an w ights of calves at birth or at weaning ti The calves produced by the cows th t lost 59.7 lbs. during the winter were lighter in weight than the c ves from t

groups of cows which lost less weight or made gains during the winter, but this difference was offset by the fact that this particular group averaged two years younger in age. There was no apparent difference in the vitality and thrift of the calves produced from cows which lost weight during the winter as compared with cows which gained weight.

Brouse (1944) conducted an extensive study in Nebraska on wintering weanling calves on prairie hay and different amounts of grain and protein supplement. The feeding of cottonseed cake, 0.5, 0.75, 1.0, and 1.5 lbs. per head per day, resulted in increased winter and yearly gains. The winter gain increased as the amount of protein supplement increased. The yearly gains were increased as the amount of protein supplement increased in the winter ration except when the supplement intake was raised from 1.0 lb. to 1.5 lbs. per head per day.

Van Horn et al. (1949, 1950, 1951) conducted an extensive experiment with cross-bred ewes. The experimental animals consisted of from 850 to 1000 head in each of three years. The objective was to compare the performance of cross-bred ewes wintered on the range when fed equal amounts of supplemental concentrates varying in crude protein percentage. The control group, which received no supplementation, consisted of an average of approximately 70 head during each of the three years. The ewes in groups 1, 2, 3, and 4 were fed 1/3 pound of 12-, 20-, 30-, and 40-percent protein supplement, respectively, during the winter from December to April. All ewes were grazed together and separated once daily to receive their respective feed allowances. At the end of each winter period the groups receiving no supplemental feed had the greatest loss of body weight. The greatest average gain was in group 4 which gained an average of 12 lbs. per head per winter more than those in the control group. There was no significant difference between the average

birth weight of lambs in all lots. The eaning weights of the lambs in the groups receiving supplements were ap oximately 2 lbs. he vier than in the group which receiv d no supplemental feed. The groups of ewes fed th higher levels of protein gain mo during the wintering period than ewes fed on lower levels of protein. This weig t diff rence w s not reflect d in the production of wool or lambs during the first three years of this experiment, although there as an incre se in the percentage of liv- lambs recorded •f e es t l bing time. The per nt l b crop incr ased by ap oximately 20 to 30 percent from the control group to those groups which r ceived pellets.

Shroder (1954) reported an experiment started in 1948 to determine the effects of age of first alving nd various levels of upplemental eeding during the winter. Ninety head of weanling Hereford calves were divided into six lots of 15 head each. One-half of the heifers, Lots 1, 3, and 5 were bred to drop their first calv s at two years of age while those in Lots 2, 4, and 6 were bred to calve first when thre years old. The cattle of all lot grazed th n tive tall-gr ss p tures y arlong. mineral mixture was fed free choice. The following supplements wer fed during the winter period:

Lots 1 and 2 (Low level) - 1.0 lb. of cottonseed cake.

Lots 3 and 4 (Medi level) - 2.5 lbs. of cottonseed cake.

Lots 5 an 6 (High level) - 2.5 lbs. of cottonseed cake and 3.0 lbs. of oats

The data represent a period from the beginning of the e eriment in Octob r 28, 1948, to tne end of s r ph e on November 3, 1953.

The loss of eight the cows during the winter wa related to the levels of supplemental feeding. During thr•e years of this study, the cows on th low, medi , and high levels of wintering lost an average

of 192, 158, and 125 lbs., respectively. The cows which lost the most during the winter phase gained the most during the summer period while on grass. The cows on the low, medium, and high levels of wintering gained an aver ge of 233, 208, and 167 lbs., respectively, during the summer.

With the exception of Lot 1, there was relatively little difference in the weight of the cows at m turity or in their actual body size as determined from photographic measurements.

There was no significant difference in th weaning weights of calves from the six lots. There was a tendency for co s wintered at the low level to calv about a week later than cows in the medi d high levels. Birth ights of the calves, however, were not ffected by winter tre tments.

Massey and Fisher (1948) reported results of a two-year study on t e value of feeding supplemental protein to bred heifers on summer grass. One group was fed 2.0 lbs. per head per d y of 42-percent protein peanut meal and t e other group was not given supplemental feed. The feeding of the protein supplement increased the average daily gain 0.16 lb. and the calve from these cows gained faster than calves fro cows th t were not fed ditional protein.

Lantow and Snell (1924) conducted an ex riment to determine the comparative feeding values of ground corn, whole corn, cottonse d, and cottonseed cake when fed alon or in combination for maintaining range cows. These worker conclude there was little difference in the feeding value of ground corn, cottonseed cake, or a mixture of the two for ain- t ning range cows during the winter months. The whole corn ration was inferior to any other ration fed. Furthermore, 1 2/3 lbs. of cottonseed, when fed alone, or 1 3/4 lbs. when fed with ground corn, more than

equaled a pound of whole or ground corn, cottonseed cake, or a mixture of ground corn and cottonseed cake.

Stanley (1938) conducted a series of five experiments to compare the relative merits of wintering range cattle with and without the feeding of cottonseed cake. Cottonseed cake was fed at an average rate of 1 to 1.5 lbs. per cow daily for about 100 days each winter season. The results for the five experiments showed that the final weights of cows receiving cottonseed cake were an average of 35 lbs. heavier than those cows not receiving supplemental feed. Out of four experiments on wintering cows with and without cottonseed cake, two experiments showed an advantage in the weaning weights from calves of cows not fed supplement and two experiments showed the calves from the group of cows receiving cake to be heavier than the other calves in the test. Supplemental feeding of range cows with cottonseed cake did not increase the calf birth weight and weaning weight or the percent calf crop sufficiently to warrant the practice when the natural forage was adequate for the production of a living calf and maintenance of health and thrifty condition in the breeding herd in Arizona.

Chittenden et al. (1935) at the Montana Experiment Station compared the feeding value of corn, cottonseed cake, and pellets consisting of dried beet pulp, molasses, and cottonseed meal. Nine hundred and twenty-one grade Rambouillet ewes ranging in age from one to seven years were divided into four uniform lots according to age and weight. Those in Lot I depended on the range for their source of feed, Lot II received corn plus the range, Lot III received cottonseed cake plus the range, and Lot IV were fed pellets plus range. The supplements were fed at the rate of 1/3 lb. per ewe per day. Results indicated there were no significant differences in the number of dry ewes, percentage of lambs dropped,

average birth and weaning weights of the lambs, or amount of lamb or wool produced. Cottonseed cake was more efficient than either corn or pellets in maintaining the weight of the ewes. In conclusion, these workers state that on this particular type of range, the higher the protein content, the more efficient the supplement for maintaining the weight of the ewes.

A protein supplement during the winter is necessary for the economical utilization of dry roughages, but the amount of protein may vary, within limits, without adverse effects upon winter weight change of the young female, birth weight of the offspring, or the weaning weight of the calf.

Burroughs (1950) has conducted several cellulose digestion studies. The purpose of his work was to present evidence that certain grains and protein-rich feeds contributed to the nutrition of cellulose-digestion rumen micro-organisms. Twelve artificial rumens were used simultaneously in two water baths. Filter paper (1 gram) was introduced into each artificial rumen or laboratory flask every 36 hours over a twelve day period. Nine feeds, including cereal grains and protein-rich feeds, were tested with respect to their ability to stimulate rumen micro-organisms in the digestion of cellulose. The results indicated that many feeds influence rumen micro-organisms favorably in cellulose digestion. Dried distillers solubles, soybean oil meal, and linseed oil meal appeared most helpful under the experimental conditions imposed. These were followed by corn and cottonseed meal. Feeds showing little or no favorable influence upon rumen microbiological digestion were meat scraps, fish meal, liver meal, and oats.

Landquist and Phillips (1943) conducted a study at the Wisconsin Station of certain aspects of the nutrition in the very young calf.

The basal diet of all the calves consisted of a skim milk diet from birth without allowing the calf access to colostrum, with a grain mixture and alfalfa hay accessible after the tenth day. Using this diet, experiments were inaugurated to determine: (1) the effect of a vitamin A or carotene supplement; (2) the effect of the vitamin B complex supplements; and (3) the effects of various combinations of these factors. These studies show that vitamin A and nicotinic acid are essential in the diet of the young calf and that they are exceedingly important for the prevention and control of early calfhood diseases. Pantothenic acid with vitamin A was ineffective in the control of scours in contrast to nicotinic acid. On the basis of these data calves can be raised from birth on a diet of skim milk with added amounts of vitamins A, C, D, nicotinic acid, and access to hay and grain.

Bechdel et al. (1928) reported results of an investigation which was designed to determine if the micro-organisms present in the rumen of cows were responsible for the synthesis of vitamin B complex. Three cows that were fed for over 2 years, throughout their growth period, on a ration that was decidely deficient in vitamin B, were used in this study. The ration was demonstrated through rat feeding trials to be devoid of the vitamin B complex. A permanent fistula was made in the rumen of the experimental cows and alcholic extracts of the fer ented rumen contents were proved potent in the vitamin B complex through rat feeding trials. The results of this study showed that the vitamin B complex as produced in the rumen of the cow by bacterial fermentation.

Wegner et al. (1941) conducted a study to determine whether adding urea, linseed oil meal, or both to the grain mixture of a basal ration in varying proportions had any influence on the synthesis of the B complex in the rumen. A 1000-pound Holstein heifer with a rumen fistula

equipped with a rubber plug which insured almost anoerobic conditions in the rumen and prevented leakage or loss of rumen contents was used in this study. The basal ration fed consisted of 15 lbs. of corn silage, 4 lbs. of timothy hay, and 4 lbs. of grain mixture (1/2 ground corn, 1/2 ground oats). The amount of corn silage and timothy hay fed remained constant throughout the duration of the experiment. The only variable was in the grain mixture to which urea or oil meal or both were added. These workers showed that six members of the vitamin B complex were present in the rumen ingesta of a heifer fed a ration composed of natural feeds. In mo t cases higher values for these vitamins were found in the rumen ingesta than in the ration fed. With the exception of flavin, variation of the amount of urea or protein in the grain mixture of the ration had little, if any, effect on the vitamin content of the ingesta.

At least ten B complex vitamins have been discovered thus far, and there is some evidence for the existence of others. So of these vitamins are widely distributed in ordinary livestock feeds, and therefore there is not a lack of them in practical rations. Investigations have shown that the various B complex vitamins are synthesized by the bacteria or other micro-organisms in the paunch of ruminants. Deficiencies of these vitamins are, therefore, not likely to occur in cattle, sheep, or goats; at least not after the animals have reached an age hen the paunch has beco well developed.

EXPERIMENTAL PROCEDURE

In the fall of 1950 an experiment was initiated to study the relative value of supplements of different protein and vitamin content for wintering pregnant beef heifers. The study was conducted at the Lake Carl Blackwell experimental range area near Stillwater, Oklahoma during a four-year period (1950-54). The experimental animals consisted of grade Hereford cattle produced in the experimental cow herd owned by the Animal Husbandry Department at Oklahoma A and M College.

In November of each of the four years of the test bred yearling heifers were allotted equally into four lots on the basis of weight. These heifers were bred during the summer as yearlings so they would calve when they were approximately two years old in March and April. The heifers were allowed to graze in the native grass pastures yearlong. Adequate grass was available at all times. During the winter months the various groups of cattle were fed from 2 to 3 1/2 lbs. of a supplement containing approximately 20-or 40-percent protein, with or without the addition of a vitamin supplement.

The supplements containing different amounts of protein and vitamins were fed in pelleted form. The pellets fed to the heifers in Lot 1 was designated as 20B. They contained approximately 20-percent crude protein (Table 2) and were 34-percent cottonseed meal (41 percent protein) and 66-percent ground yellow corn plus one pound of a commercial vitamin supplement (Table 3) per 100 lbs. of feed. The heifers in Lot 2 (20) were fed the 20-percent protein pellet which did

not contain the vitamin supplement. The supplements fed to the cattle in Lots 3 (40B) and 4 (40) were pelleted cottonseed meal with and without the vitamin supplement, respectively. During the last three years the calcium and phosphorus content of the pellets was approximately equalized by the addition of ground limestone and/or steamed bonemeal where necessary.

The supplements as described were fed in 1950-51, 1951-52, and 1953-54. During the 1952-53 winter feeding period no vitamin supplement was fed, but two lots were fed the 20-percent protein pellet and two lots were fed the 40-percent protein pellet.

The heifers were allowed access to a mineral mixture of 2 parts salt and 1 part steamed bone meal. All cattle were weighed at monthly intervals and on each weigh-day they were rotated among the pastures to reduce the possible variation in performance due to pasture differences.

The experiments were completed in October of each year at which time all the calves and cows were weighed.

Table 2. Chemical Composition of Protein Supplements[1]

Lot	Pellet	Percent dry matter	Percent composition of dry matter						
			Ash	Crude protein	Ether extract	Crude fiber	N-free extract	Ca	P
1	20B	90.69	6.64	22.23	3.55	6.00	61.71	1.19	1.01
2	20	90.78	6.57	22.01	3.48	6.08	61.86	1.20	1.01
3	40B	92.97	8.85	43.07	3.67	13.12	31.29	1.17	0.97
4	40	93.04	8.81	42.40	3.26	13.04	32.49	1.16	0.98

[1]Average of supplements fed during the 1951-52 and 1953-54 winter season.

Table 3. Composition of Vitamin and Mineral Supplement[1]

Feed nutrient	Units per lb.
Vitamin A	995,000 I.U.
Vitamin D_2	299,000 I.U.
Riboflavin	32.23 mg
Pantothenic Acid	40.29 mg
Choline	3074.00 mg
Niacin	1260.00 mg
Potassium Iodine	.10 gm
Cobolt Sulfate	25.00 mg
Iron	5600.00 mg

[1]Actual composition for vitamins A and D_2 and calculated for the other nutrients. Manufactured by Dave's Laboratories, Inc., Chicago, Illinois.

RESULTS AND DISCUSSION

Experiment I (1950-51)

A summary of the weight changes, feed consumption, feed cost and calving data is presented in Table 4. The weight data for the winter phase of the experiment are reported up to March 3, 1951, which was the day before the first cow calved.

The heifers were fed 2 lbs. of protein supplement per head from November 18, 1950 until March 3, 1951 at which time the amount of feed per head daily was increased to 2.5 lbs.

The heifers fed the pellets containing 20 percent protein plus the vitamin supplement (Lot 1) lost an average of 15 lbs. from the beginning of the winter feeding period until March 3. Heifers fed the 20-percent protein pellet (Lot 2) lost an average of 26 lbs. Similar heifers fed 40-percent protein pellets plus a vitamin mixture gained an average of 24 lbs. while those receiving the 40-percent pellets gained 39 lbs. per heifer. Although the differences were small, the feeding of the vitamin supplement resulted in less winter weight loss when fed at the low level of protein supplementation (Lots 1 vs 2) but resulted in smaller gains when added to the ration of heifers fed the 40-percent protein pellet (Lots 3 vs 4).

The cost of the vitamin supplement from November 18 to March 3 (105 days) was $.97 per heifer in Lots 1 and 3.

The heifers in Lots 3 and 4, which were fed the higher protein levels, were noticeably thriftier and in better condition than those

Table 4. Summary of Production Data, 1950-51

	Lot 1 20B	Lot 2 20	Lot 3 40B	Lot 4 40
Heifers per lot	12	12	12	12
Average daily ration (lbs.)				
20-percent protein pellet plus B Vit.	2.24			
20-percent protein pellet		2.24		
40-percent protein pellet plus B Vit.			2.24	
40-percent protein pellet				2.24
Native grass	ad lib	ad lib	ad lib	as lib
Mineral	.13	.13	.13	.13
Average weight (lbs.)[1]				
Beginning winter 11-18-50	696	720	708	715
Before calving 3-3-51	681	694	732	754
Gains from 11-18-50 to 3-3-51	-15	-26	24	39
End of summer 10-4-51	776	773	757	794
Yearly gain	80	53	49	79
Winter feed cost (dollars)[2] 11-18-50 to 3-3-51	$12.06	$11.09	$13.57	$12.60
Calving data (lbs.)				
Average birth wt.[3]	65	61	65	66
Average weaning wt.[4]	349	376	393	377

Feed Prices

	per ton
20-percent protein pellet plus B vitamins	$ 74.37
20-percent protein pellet	66.67
40-percent protein pellet plus B vitamins	87.20
40-percent protein pellet	79.50
Mineral mixture	35.73

[1]Includes only heifers which successfully raised a calf: Lot 1, 10; Lot 2, 11; Lot 3, 9; Lot 4, 9.

[2]Includes only protein supplement and minerals.

[3]Corrected for sex and includes all calves born.

[4]Corrected for sex and age.

in Lots 1 and 2. The average loss of weight during the winter for the heifers fed the supplements containing 20 percent protein (Lots 1 and 2) was 20 lbs. Heifers fed the 40-percent protein pellets gained an average of 32 lbs. Those fed the 40-percent protein pellets produced calves which were heavier at birth than the calves produced in Lots 1 and 2. This difference was statistically significant (P .05) when subjected to the "F" test in an analysis of variance according to the method of Snedecor, 1946 (Appendix Table I).

The cost of supplemental feed during the winter feeding period was $1.21 per head less for the heifers fed the 20-percent protein pellets than for those fed the pellet containing 40-percent protein.

The yearly gains and the weaning weights of the calves in the test probably do not indicate the value of the supplements fed during the winter because supplemental feeding was continued until July 5. This management practice should tend to reduce any differences resulting from winter feeding.

Eight of the 46 heifers in the test were found to be open when examined for pregnancy on October 4, 1951.

Only preliminary estimates of the value of the various supplements should be made from the data collected in this test.

Experiment II (1951-52)

A summary of the weight changes, feed consumption, feed cost and calving data is presented in Table 5.

The weight data for the experiment are reported up to March 8, 1952, which was the last day before the first cow calved. The heifers in all lots were fed an average of 2.5 lbs. of protein supplement per head daily.

During the winter period prior to calving, the heifers fed the 20-percent protein pellets plus the vitamin supplement (Lot 1) lost an average of 1 lb. per head, while those in Lot 2, fed an equal amount of 20-percent protein pellets without additional vitamins, lost 15 lbs. Heifers fed 2.5 lbs. per head per day of 40-percent protein pellets plus B vitamins (Lot 3) gained 67 lbs. per heifer. The heifers of Lot 4 (40-percent protein pellets) gained 63 lbs. during the winter phase. The heifers fed the 20-percent protein supplement plus the vitamin mixture produced calves 5 lbs. lighter at birth than those heifers fed the 20-percent protein supplement. The heifers fed the pellets containing the 40-percent protein plus B vitamins produced calves with an average birth weight 2 lbs. lighter than heifers fed the 40-percent protein supplement. The calves produced by the heifers fed the vitamin supplement were significantly lighter ($P < .05$) at birth than calves produced in Lots 2 and 4 (Appendix Table I).

The weaning weights of the calves in Lots 1 and 2 was approximately the same. When the vitamin supplement was added to the supplement containing 40 percent protein (Lot 3) the cows produced calves which weighed 42 lbs. more at weaning than similar calves in Lot 4.

The cost of the B vitamins in Lots 1 and 3 was $1.23 per head during the winter feeding period. During the winter feeding period the supplemental feed cost per head for the heifers fed 20-percent protein

Table 5. Summary of Production Data, 1951-52

	Lot 1 20B	Lot 2 20	Lot 3 40B	Lot 4 40
Heifers per lot	11	11	11	11
Average daily ration (lbs.)				
20-percent protein pellet plus B Vit.	2.5			
20-percent protein pellet		2.5		
40-percent protein pellet plus B Vit.			2.5	
40-percent protein pellet				2.5
Native grass	ad lib	ad lib	ad lib	ad lib
Mineral	.21	.21	.23	.23
Average weight (lbs.)[1]				
Beginning winter 11-21-51	680	684	684	673
Before calving 3-8-52	679	669	751	736
Gains from 11-21-51 to 3-8-52	-1	-15	67	63
End of summer 10-20-52	813	788	808	802
Yearly gain	133	104	124	129
Winter feed cost (dollars)[2] 11-21-51 to 3-29-52	$19.01	$17.88	$20.60	$19.37
Calving data (lbs.)				
Average birth wt.[3]	62	67	68	70
Average weaning wt.[4]	368	364	408	366

Feed Prices	per ton
20-percent protein pellet plus B vitamins	$ 81.70
20-percent protein pellet	74.00
40-percent protein pellet plus B vitamins	89.70
40-percent protein pellet	82.00
Mineral mixture	45.33

[1]Includes only heifers which successfully raised a calf: Lot 1, 9; Lot 2, 7; Lot 3, 9; Lot 4, 8.

[2]Includes only protein supplement and minerals.

[3]Corrected for sex and includes all calves born.

[4]Corrected for sex and age.

supplement was $1.59 less than the heifers fed 40-percent protein supplement.

The heifers of Lots 3 and 4 fed the 40-percent protein pellets were noticeably thriftier in appearance at the end of the winter feeding period than those of Lots 1 and 2.

The average yearly gain of the heifers fed 20-percent protein pellets was 118 lbs. and those fed 40-percent protein pellets gained an average of 126 lbs. during the year. Prior to calving, the heifers fed the 40-percent protein supplement gained 73 lbs. more per head than those fed the 20-percent protein supplement. However, by the end of the summer grazing period, the difference in average gains of the two groups was only eight lbs.

The average birth weight of the calves of Lots 1 and 2 was 64 lbs. and the average weight for Lots 3 and 4 was 69 lbs. The difference was statistically significant ($P < .05$). The average weaning weight of calves produced by the heifers in Lots 1 and 2 was 366 lbs. and the average weaning weight of calves in Lots 3 and 4 was 387 lbs. This average difference was due to the increased weight of the calves in Lot 3.

Pregnancy examination on October 27, 1952 showed two out of the forty-four heifers to be open.

When supplements of different protein content were fed to heifers at the 2.5 lb. level, the winter gain of the heifers and the birth and weaning weights of the calves was greater when the supplement contained 40 percent protein than when it contained 20-percent protein. The difference in weight of the heifers just prior to calving tends to become small by the end of the summer grazing period.

Experiment III (1952-53)

The weight data for the winter phase of the test are reported up to March 7, 1953, which was the last weight obtained before any calves were born. Supplemental feeding was continued until April 21 at which time adequate green grass was available. In this experiment a vitamin supplement was not included in any of the rations. Lot 2 was a replication of Lot 1 and Lot 4 was a replication of Lot 3.

A summary of the data is presented in Table 6.

From the beginning of the winter feeding period until March 7, the heifers fed the 20-percent protein pellet (Lots 1 and 2) lost an average of 42 lbs. per head, while those fed the 40-percent protein pellet (Lots 3 and 4) gained 30 lbs. per heifer. The supplements were not equal in value as measured by winter weight gains of bred heifers.

The 25 lbs. difference in winter weight loss of two groups of heifers fed similarly (Lots 1 and 2) should be noted. Another example of this variation between animals treated similarly is the 23 lbs. difference in weaning weights of calves in Lots 3 and 4.

The average yearly gains were 30 and 64 lbs. for heifers fed 20- and 40-percent protein pellets, respectively. Thus, the difference in weight gain of 72 lbs. prior to calving was reduced to a difference of 34 lbs. for the entire year.

The average birth weight of the calves was 66 lbs. for heifers fed 20-percent protein pellets (Lots 1 and 2) and 67 lbs. for those fed 40-percent protein pellets (Lots 3 and 4).

The average weaning weights were 398 lbs. for calves in Lots 1 and 2 and 380 lbs. for those in Lots 3 and 4. This is the opposite of results obtained in the previous experiments. Any effect on reproduction

Table 6. Summary of Production Data, 1952-53

	Lot 1 20	Lot 2 20	Lot 3 40	Lot 4 40
Heifers per lot	20	20	20	20
Average daily ration (lbs.)				
20-percent protein pellet	2.5	2.5		
40-percent protein pellet			2.5	2.5
Native grass	ad lib	ad lib	ad lib	ad lib
Mineral	.09	.10	.09	.10
Average weight (lbs.)[1]				
Beginning winter 11-28-52	752	704	709	700
Before calving 3-7-53	723	650	747	721
Gains from 11-28-52 to 3-7-53	-29	-54	38	21
End of summer 10-20-53	790	727	785	753
Yearly gain	38	23	76	53
Winter feed cost (dollars)[2] 11-28-52 to 2-7-53	$15.97	$16.01	$19.79	$19.83
Calving data (lbs.)				
Average birth wt.[3]	69	64	65	69
Average weaning wt.[4]	400	397	368	391

Feed Prices

	per ton
20-percent protein pellet	$87.00
40-percent protein pellet	$108.00
Mineral mixture	$ 48.33

[1]Includes only heifers which successfully raised a calf: Lot 1, 10; Lot 2, 15; Lot 3, 13; Lot 4, 14.

[2]Includes only protein supplement and minerals.

[3]Corrected for sex and includes all calves born.

[4]Corrected for sex and age.

of any protein deficiency during the winter was not apparent after excellent summer grazing conditions.

The feed cost per head for the winter feeding period was $3.82 less for the heifers fed 20-percent protein pellets than those fed the 40-percent protein pellets.

Data on rebreeding of the cows were not available because bulls were not placed with the cows until January 1954 in order that the cows could be used in a fall-calving study.

Experiment IV (1953-54)

The details as to ration composition, weight changes, feed cost and calving data are presented in Table 7.

In this experiment the supplements fed during the winter season were the same as those designated as 20B, 20, 40B, and 40 in Experiments I and II.

The weight data for the winter phase of the experiment are reported up to March 6, 1954, which was the day before the first cow calved. Supplemental feeding was continued until April 24, 1954.

The average winter losses of the heifers fed supplements designated as 20B, 20, 40B and 40 were -12, -54, -10 and -38 lbs. per head, respectively. Less winter weight was lost by the heifers fed the vitamin supplement than by those not fed the additional vitamins at both levels of protein feeding. This advantage for additional vitamins was not apparent in the average birth weights of the calves produced in the different groups.

The cost of the B vitamins from November 10 to March 6 was $1.55 per head for the heifers in Lots 1 and 3.

The average winter loss for heifers fed the 20-percent protein supplement was 33 lbs. and the average loss was 24 lbs. for those fed the 40-percent protein supplement. In Experiments I, II, and III the average gain from November to March was 66 lbs. greater for the heifers fed the supplement containing 40-percent protein than for those fed the 20-percent protein supplement. The difference in average supplemental feed cost per head between the lots of heifers fed the supplement containing 20 and 40 percent protein was small ($.41).

The average birth weight of the calves of Lots 1 and 2 was 62 lbs.

Table 7. Summary of Production Data, 1953-54

	Lot 1 20B	Lot 2 20	Lot 3 40B	Lot 4 40
Heifers per lot	20	20	19	20
Average daily ration (lbs.)				
20-percent protein pellet plus B Vit.	2.5			
20-percent protein pellet		2.5		
40-percent protein pellet plus B Vit.			2.5	
40-percent protein pellet				2.5
Native grass	ad lib	ad lib	ad lib	ad lib
Mineral	.14	.14	.14	.14
Average weight (lbs.)				
Beginning winter 11-10-53	721	719	720	722
Before calving 3-6-54	709	665	710	684
Gains from 11-10-53 to 3-6-54	-12	-54	-10	-38
Winter feed cost (dollars)[1] 11-10-53 to 3-6-54	$16.01	$14.46	$16.45	$14.87
Calving data (lbs.)[2] Average birth wt.	61	64	64	68

Feed Prices

	per ton
20-percent protein pellet plus B vitamins	$ 75.76
20-percent protein pellet	68.06
40-percent protein pellet plus B vitamins	77.70
40-percent protein pellet	70.70
Mineral mixture	38.66

[1]Includes only protein supplement and minerals.

[2]Corrected for sex and includes all calves born.

and the average for Lots 3 and 4 was 66 lbs.

Data on weaning weights of the calves and yearly gains of the heifers are not available at this time.

Average of Experiments

The average winter weight change for the four years of this experiment for heifers fed 20-(Lots 1 and 2) and 40-(Lots 3 and 4) percent protein supplement was -25.8 and 25.5 lbs. per head, respectively. The differences were relatively large in Experiments I, II, and III, but in Experiment IV the difference was only 9 lbs. The supplements containing 20 and 40 percent protein were not equal in value under the conditions of these tests.

The four-year average birth weights of calves produced by cows fed the supplements containing 20 percent protein (Lots 1 and 2) and those fed supplements containing 40 percent protein (Lots 3 and 4) were 64 and 67 lbs., respectively. The average weaning weights in Experiments II and III were 382 and 383 lbs. for the calves in Lots 1 and 2 and Lots 3 and 4, respectively.

The data indicate that feeding a 40-percent protein pellet to bred yearling heifers allowed to graze the dry native grass was more desirable than feeding a supplement containing 20 percent protein as measured by winter weight gain of the heifers and birth weight of the calves. The weaning weights of the calves produced by both groups of cows was nearly the same.

The average winter loss of weight in Experiments I, II, and IV for heifers fed the supplement containing 20 percent protein and a vitamin supplement was 9 lbs. Similar heifers fed the 20-percent protein supplement without added vitamins lost an average of 32 lbs. Much of this average difference in weight change was due to the 42 lbs. difference in gain between the heifers in Lots 1 and 2 in Experiment IV. It should be noted that the difference in weight change of the two

groups of heifers treated similarly (Lots 1 and 2, Experiment III) was 25 lbs. The three-year winter gain of heifers fed the 40-percent protein supplement plus the vitamins was 27 lbs. and the gain of heifers fed the supplement containing 40 percent protein and no added vitamins was 21 lbs.

The three-year average birth weights of calves produced by cows fed the supplements designated as 20B (Lot 1), 20 (Lot 2), 40B (Lot 3), and 40 (Lot 4) were 63, 64, 66, and 68 lbs., respectively. Weaning weights which may be used in a comparison of feeding supplements with and without added vitamins were available only in Experiment II. In this experiment the addition of B vitamins to a supplement containing 20 percent protein was not of value as measured by weaning weight, whereas the addition of the vitamin to the 40-percent protein pellet resulted in a considerable increase in weaning weight.

During the winter feeding periods of Experiments I, II, IV the average feed cost per head for the heifers in the lots fed 20-percent protein pellets plus a B vitamin supplement was $15.69 and those fed 20-percent protein pellets was $14.11. The average winter feed cost for heifers fed the 40-percent protein supplement plus a vitamin mix was $16.87 per head, and those heifers fed 40-percent protein supplement was $15.61 per head.

The data indicate that there apparently was an advantage for adding a vitamin supplement to rations of bred yearling heifers, especially when the supplement contained 20 rather than 40 percent protein. The advantage was as measured by winter weight change of the heifers and not by birth weights of the calves. Satisfactory weaning weight data were not available.

The data reported in this thesis are that collected when cattle were on a particular experimental treatment for one year. The effect of leaving the same cattle on a certain treatment for several successive years in unknown. Such data are desired.

SUMMARY

Four trials were conducted to determine the value of winter supplement containing 20 and 40 percent protein when fed in equal amounts to bred yearling heifers allowed to graze native grass pastures yearlong. The feeding of the supplement containing 40 percent protein resulted in greater winter weight gains of the heifers and slightly greater birth weights of calves. There was no difference in average weaning weight of the calves.

During three of the trials a vitamin supplement was added to the ration of heifers fed both the low- and high-protein supplements. There apparently was an advantage from adding a vitamin supplement to rations of bred yearling heifers. The feeding of additional vitamins resulted in greater winter weight gains of heifers but smaller birth weights of calves. Satisfactory weaning weight data were not available. Additional research is needed on the value of feeding a vitamin supplement.

LITERATURE CITED

Armsby, H. P. 1917. The nutrition of farm animals. New York, New York: Macmillian Company.

Arnett, C. N., and R. C. McCherd. 1927. Winter feeding beef breeding cows. Mont. Agr. Exp. Sta. Bul. 211.

Bechdel, S. I., H. E. Honeywell, R. A. Dutcher, and M. H. Knutsen. 1928. Synthesis of vitamin B in the rumen of the cow. J. Biol. Chem. 80:231.

Black, W. H., V. R. Quesenberry, and A. L. Baker. 1938. Wintering beef cows on the range with and without a supplement of cottonseed cake. U.S.D.A. Tech. Bul. 603.

Brouse, C. M. 1944. Wintering calves in the Nebraska sandhills. Neb. Agr. Exp. Sta. Bul. 357.

Burroughs, Wise, John Long, Paul Gerlough, and R. M. Bethke. 1950. Cellulose digestion by rumen microorganisms as influenced by cereal grains and protein-rich feeds commonly fed to cattle using an artificial rumen. J. An. Sci. 9:523.

Chittenden, D. W., W. F. Dickson, and Frank Barnum. 1935. Supplements on the winter range for breeding ewes. Proc. Amer. Soc. An. Prod. 159.

Daniel, O'dell G. 1951. The relative value of 20, 30, and 40 percent protein supplement for wintering replacement beef heifers. Master of Science Thesis. Oklahoma Agricultural and Mechanical College.

Fontenot, Joseph P. 1953. Supplements of different protein content for wintering beef cattle. Master of Science Thesis. Oklahoma Agricultural and Mechanical College.

———. 1954. Protein and energy studies with beef cattle. Ph.D. Thesis. Oklahoma Agricultural and Mechanical College.

Landquist, N. S., and P. H. Phillips. 1943. Certain dietary factors essentials for the growing calf. J. Dairy Sci. 26:1023.

Lantow, J. L., and M. G. Snell. 1924. Preliminary report on range cow supplemental feeding. N. Mex. Agr. Exp. Sta. Bul. 144.

Lantow, J. L. 1930. Supplemental feeding range cattle. N. Mex. Agr. Exp. Sta. Bul. 185.

Massey, Z. A. and S. W. Fisher. 1948. Supplemental protein and mineral feeding to beef cattle on summer pastures. Ga. Agr. Exp. Sta. Cir. 157.

Mitchell, H. H. 1929. The minimum protein requirements of beef cattle. Natl. Res. Council Bul. 67.

Morrison, F. B. 1951. Feeds and Feeding. 21st. Edition. Ithaca, New York: The Morrison Publishing Company.

National Research Council. 1945. Recommended nutrient allowances for beef cattle. Sub-committee on beef cattle nutrition. Washington, D. C.

Shroder, J. D. 1954. Further studies on effects of age of first calving and level of wintering on productivity of beef cattle. Master of Science Thesis. Oklahoma Agricultural and Mechanical College.

Snedecor, G. W. 1946. Statistical Methods, 4th Edition. The Iowa State College Press.

Stanley, E. B. 1938. Nutritional studies with cattle on a grassland-type range in Arizona. Ariz. Agr. Exp. Sta. Tech. Bul. 79.

Van Horn, J. L., Wm. H. Burkitt, G. F. Payne, G. C. Houghs, and F. S. Wilson. 1949. Nutritional requirements of ewes wintered under range conditions. Mont. Agr. Exp. Sta. Mimeo. Cir. 56.

Van Horn, J. L., G. F. Payne, James Drummond, and F. S. Willson. 1950. Nutritional requirements of ewes wintered under range conditions. Mont. Agr. Exp. Sta. Mimeo. 63.

Van Horn, J. L., O. O. Thomas, G. F. Payne, James Drummond, A. S. Hoversland, and F. S. Willson. 1951. Nutritional requirements of ewes wintered under range conditions. Mont. Agr. Exp. Sta. Mimeo. 68.

Vinke, Louis and W. F. Dickson. 1933. Maintenance of beef cows for calf production. Mont. Agr. Exp. Sta. Bul. 275.

Wegner, M. I., A. N. Booth., C. A. Elvehjem, and E. B. Hart. 1941. Rumen synthesis of the vitamin B-complex on natural rations. Soc. Exper. Biol. and Med. Proc. 47:90.

APPENDIX

TABLE I

ANALYSIS OF VARIANCE

Experiment	Source	Degrees of Freedom	Mean Square	F
I	Total	41		
	Sire	1	476.6	8.84**
	Treatment (3)		(129.0)	(2.39)
	Lots 1&2 vs 3&4	1	351.3	6.51*
	Lots 1&3 vs 2&4	1	30.8	
	Lots 1&4 vs 2&3	1	4.9	
	Treatment X sire	3	0[1]	
	Error	34	53.9	
II	Total[2]	41		
	Sire	3	383.2	13.08**
	Treatment (3)		(135.5)	(4.62)**
	Lots 1&2 vs 3&4	1	152.4	5.20*
	Lots 1&3 vs 2&4	1	184.4	6.29*
	Lots 1&4 vs 2&3	1	69.6	2.38
	Treatment X sire	9	24.1	
	Error	27	29.3[3]	
III	Total	70		
	Sire	5	198.1	4.02**
	Treatment	1	24.9	
	Treatment X sire	5	22.0	
	Error	59	49.3	
IV	Total	75		
	Sire	5	69.3	
	Treatment (3)		(53.7)	(0.75)
	Lots 1&2 vs 3&4	1	93.1	1.29
	Lots 1&3 vs 2&4	1	49.7	
	Lots 1&4 vs 2&3	1	18.3	
	Treatment X sire	15	63.8	
	Error	52	71.9	

* Indicates significant at .05 level.

** Indicates significant at .01 level.

1 This interaction was slightly negative. It is assumed that this was due to unequal subclass numbers and chance association between treatment and sire.

2 Date for one sire were removed because he produced only three calves.

3 It should be noted that the Mean square for error in this experiment was lower than in the other experiments.

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