

LEVEL OF PROTEIN SUPPLEMENTATION FOR BEEF CALVES AND
YEARLINGS ON WINTER BLUESTEM PASTURE

by

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INTRODUCTION

Native bluestem pasture provides an excellent diet for beef cattle for three months during the growing season, a diet declining in digestible protein, energy and phosphorus for an additional three months, and a diet deficient in these constituents for the remaining six months. Native bluestem pasture has been used successfully in eastern Kansas as a low cost source of winter roughage for cattle that are to be grazed the following summer and sold off grass.

Every cattleman knows that the cost of the supplemental feed necessary to balance out the nutrient deficiencies in the winter bluestem grazing program is the largest "out of pocket" expense in stocker operations. The nature of this study was to achieve maximum economy without sacrificing performance during the subsequent grazing season. Some of the more profitable systems of beef production are based on the maximum use of native bluestem grasses or other low cost roughages, supplemented with the necessary proteins and minerals.

Experiment I was planned to compare the performance of yearling steers wintered on bluestem pasture and fed two levels of soybean meal. One lot received 1 pound of soybean meal, while the second lot received 2 pounds per head daily. Both lots were summer grazed, with results of the experiment measured by the combined winter and summer performance of the steers.

Experiment II was a comparison of the effect of three levels of winter supplementation for steer calves which were fed per steer daily as follows: 1 pound of soybean meal; 2 pounds of soybean meal; and 1 pound of soybean meal with 1 pound of corn.

Experiment III utilized heifer calves to study two levels of alfalfa hay as a supplement for winter bluestem pasture.

Each experiment contains three trials and a summary of these trials. The object of these studies were to determine the level of protein supplementation most desirable for wintering calves and yearlings on dry bluestem pasture that are to be grazed the following summer and sold off grass.

REVIEW OF LITERATURE

Winter Growth of Cattle on Native Pasture

All experiments on nutrition and production have shown that with animals, as with factories, or other working units, production was most efficient when the operation was proceeding at a rate that approached full capacity. Guilbert et al. (1944) has stated that the greater the rate of production (within certain limits) that was obtained by liberal feeding, the greater was the efficiency from the standpoint of feed required per pound of resulting product. This may be referred to as biological efficiency. Economic efficiency depends upon relative costs of different phases of production--for example, cost of summer gain on range compared with winter gain on hay or concentrate supplements. These considerations modify the degree or approach to the ideal that may be made under any specific situation. Maintenance for short periods may, in some cases, be justified.

Scientists for years have wondered about the nutrient intake and the digestibility of range forage. Cook et al. (1963) reported that esophageal-fistula were used successfully in cattle and sheep to determine the nutrient intake when grazing. In the past there was no definite method of determining exactly what level of winter protein supplementation was most advantageous, except by feeding trials. It is difficult to balance winter rations, as the nutritionist cannot determine the quantity and quality of the grass intake.

Scientists in the future will be able to make faster progress in this field with the esophageal-fistula fed animals.

According to Hobbs et al. (1945), the protein content of native grass, predominantly bluestem, cut at intervals during the grazing season and winter of 1942-43 showed a general decrease in protein with advance in season. The high protein content was 8.97 percent May 18 with 32.7 percent dry matter. The greatest change in the grass occurred between September 14 and October 21. The grass became dry and the protein dropped from 7.58 to 4.31 percent protein. The protein content of the grass continued to decrease during the next four months until in February it reached the low value of 2.56 percent. Changes in other constituents of the grass were small and irregular.

Natural ration restriction occurs normally because of the seasonal variation in the quality and quantity of range forage. Winchester and Howe (1954) have pointed out that restricted growth may be a more economical method of raising beef cattle under some conditions. Their studies indicate that animals retarded in growth respond more rapidly when given adequate rations than do control animals and that only a small difference in body weight exists after a period on a normal ration.

Guilbert et al. (1944) have stated that continuous growth resulted in more efficient and economical gains than occurred if growth was retarded or restricted during the early development of the animal.

Harlan (1960) stated that animals on dry range grass receive neither enough digestible energy nor enough protein for good gains. To supplement dry winter range with enough energy for good gains was generally too expensive to be profitable. A modest wintering level such that yearlings or calves approximately break even or gain no more than 0.5 pound per day appeared to be the most practical. Animals that lost considerable weight during the winter

gained more during the summer but never caught up to those that were wintered at a moderate level. On the other hand, those wintered at high levels gain less during the summer and their advantage in weight seldom pays for the extra costs.

Three sets of monozygous bovine animals were used by Rebhan et al. (1960) to study the relationship between the feed energy required to maintain body weight and the condition of the animal. The total digestible nutrients (TDN) required per unit weight for maintenance increased materially as weight and condition increased. Animals of a set that weighed the same, but differed in condition, the animal that was the fattest required the most TDN per unit weight for maintenance.

Winchester et al. (1957) limited protein intake, together with that of energy, in preference to restriction of some other essential nutrient, because the protein requirement was one that ordinarily could be met under winter range conditions only at a sizeable monetary outlay. The effects of rations of low protein as well as low energy value, fed between the ages of 6 months and one year, were studied with 12 pairs of monozygotic beef-type cattle. During restriction, animals on a ration that contained only 2.5 percent digestible protein, compared to rations of relatively high energy value, liberally supplied with protein, lost weight while those on the other rations gained upward to 1.9 pounds per day. Slaughter of each retarded animal was delayed until its degree of fatness approximated the final condition of its co-twin. In spite of the drastic treatments given some animals, efficiency of feed utilization and carcass and meat quality of co-twins were similar.

As commonly stated in feeding standards, the protein requirement for growth includes the amount needed for maintenance as well. Maynard and Loosli (1962) state that the maintenance component increases with body size,

but the demand per unit of new tissue formed decreases with age and body size because of the decreasing protein content of the tissue. While the total daily requirement increases with age and size, at least during early growth, it decreases per unit of weight and in relation to the energy requirement.

Level of Winter Protein Supplementation

Nelson et al. (1954) compared the value of 20, 30 and 40 percent protein supplements for wintering heifer calves on dry grass in Oklahoma. The results showed that average winter gains of the calves were directly related to the protein content of the supplement. The supplement containing the higher amount of protein promoted the greater winter gain. Feed costs were higher for the heifers fed the 40 percent protein supplement. One pound of 40 percent was equal to the 2 pounds of 20 percent supplement. It may be that when pastures provide only limited amounts of dry cured native grass, the additional energy supplied by 2 pounds of the 20 percent protein supplement would be beneficial. There were only slight differences in yearly gains of heifers grazing the native grass during the winter and fed equal amounts of 20 and 40 percent protein supplements.

Calves wintered on native grass at Spur, Texas, supplemented with 2 pounds of cottonseed cake gained 20 pounds more during the winter, 9 pounds less during the summer than calves fed only 1 pound of cottonseed cake. Calves fed 2 pounds of 41 percent cottonseed cake, 2 pounds of 20 percent range feed or 2 pounds of a cottonseed meal-salt mixture on native grass made approximately the same gain. Marion et al. (1956) in summing up these 14 year reports also stated that the amount and quality of winter forage on native grass pastures in different seasons greatly influenced the gain of calves fed 1 and 2 pounds of cottonseed cake per head daily.

At Woodward, Oklahoma, steer gains during a seven year period fed at a 1-pound winter caking rate were 36 pounds less in winter, 18 more in summer, or 18 less yearlong than for a 2-pound rate. Steers wintered without supplemental protein were 72 pounds lighter in yearlong gain according to McIlvain et al. (1955) than the cattle fed 1 pound of cake in the winter. This study indicated that at least 1 pound of cottonseed cake was needed in winter for normal growth and development of weaner calves on native range in western Oklahoma.

McIlvain et al. (1955) compared 41 percent and 20 percent protein feeds fed during three winters to yearling steers at the rate of 2 pounds per head daily. Steers fed the high-protein cake in winter outgained those fed the low protein by a margin of 14 pounds. The year long difference was 16 pounds in favor of the high protein. This was not a great difference and the practical conclusion was that the lowest cost feed on a protein basis was the most advantageous.

Lofgreen et al. (1951) presented data to show that for Holstein heifers, with the feeds used, the minimum requirements for growth were about 0.80 pound of digestible protein daily from 500 to 700 pounds, 0.90 from 700 to 800, and 1.00 pound from 800 to 1000 pounds.

For wintering weanling calves, a 1 pound daily rate of gain often represents a desirable goal for producers. The National Research Council (1963) recommends 0.7 pound of digestible protein and 5.3 pounds of TDN to promote 1 pound of daily growth for 400 pound weanling beef calves on a wintering program.

Thirty head of yearling Hereford feeder steers were divided to give three levels of winter gain; 1.5, 1.0 and -0.40 pound per head daily.

Hedrick et al. (1954). All cattle were grazed during the summer and finished in dry lot to the choice grade. Analysis of variance showed highly significant differences between lots in percent fat and lean in the 9 - 10 - 11th rib and percent ether extract in the rib eye. Carcasses from cattle on the low plane of winter nutrition had more separable fat, less separable lean and less fat in the rib eye than carcasses from the lots on the higher plane of winter nutrition.

A daily ration of 2 pounds of 41 percent cottonseed cake was compared with a mixture of 1 pound of the same cake and 1 pound of rolled milo grain during 4 winters by McIlvain et al. (1955). In this study the 2 pounds of cake was more profitable than the cake-grain ration, it was not as profitable as 1 pound of cake alone.

Feeding oats in addition to cottonseed meal on native range was not profitable according to Nelson et al. (1960). Although oats helped increase winter gain, the fatter steers in this test did not gain as well on grass during the summer as steers not fed oats. Although the high feeding level increased gains, the gain was not economical. Summer gain on grass was inversely related to winter gain.

Calves wintered on alfalfa hay alone produced the smallest winter gains, the largest summer gains, only 7 pounds less total gain than calves fed alfalfa hay and cottonseed cake. The winter feed cost per calf on alfalfa hay alone was \$1.64 less than the combination of cake and hay. Black et al. (1936) stated that alfalfa hay of good quality when fed alone was a satisfactory winter feed for calves to be turned into native range early in April.

It was demonstrated by Nelson et al. (1954) that 8 pounds of alfalfa could satisfactorily replace 2.5 pounds of cottonseed cake as a winter protein supplement for commercial cows grazed year long on native grass pastures.

Alfalfa hay could profitably be fed if the cost per pound of alfalfa hay was not more than one-third that of cottonseed cake. The value of alfalfa hay relative to cottonseed cake was further increased, since fewer acres of grass per cow were required.

It was observed by Bohman and Torell (1956) that weanling cattle fed either alfalfa or cottonseed meal supplements gained significantly faster during the winter period than non-supplemented animals. The observed differences in rate of gain between the animals fed cottonseed meal and alfalfa was not statistically significant. The following summer the retarded cattle grew faster than the animals supplemented with cottonseed meal. However, for the entire year the cattle supplemented with either protein source produced significantly greater gains than the animals that were fed only hay during the winter. They also noted that when protein intake was restricted during the winter so that only maintenance requirements were met (0.09 pound daily gain) or with slight growth (0.27 pound daily gain) permanent stunting did not occur. The cattle thus tended to compensate for poor winter gains by accelerated growth the following summer.

At the Nebraska Station, Dowe et al. (1957) fed the following three levels of digestible protein per steer calf on a wintering study, 0.60 pound, 0.80 pound and 1.00 pound. These were 75, 100, and 125 percent of the National Research Council's recommendation for wintering weanling calves. The effect of these different levels of protein on gains were 0.94, 1.10 and 1.20 pounds per day.

Clanton et al. (1964) fed wintering heifer calves a high protein and high energy diet to meet the levels recommended by National Research Council. Low protein and low energy levels were calculated to supply 60 and 82 percent, respectively, of the recommended levels. Heifers fed the low protein, low

energy ration gained the least during the winter (0.24 pound per day) and showed less skeletal growth and increase in body condition. Those fed a low protein-high energy and high protein-low energy ration gained at a similar rate (0.44 pound per day).

Matsushima et al. (1958) wintered 4 lots each on the following levels of digestible protein, 0.60 pound, 0.80 pound and 1.00 pound per head daily. The four lots of steers fed the recommended level (N.R.C.) of protein (0.80 pound per head daily) gained 16 percent more than those fed the low level of protein. There was only a slight difference in gains between the groups fed the recommended level and the high level of protein.

Clanton and Zimmerman (1963) reported that production was not impaired when cows were without a protein supplement during the winter--when adequate energy was provided. The protein supplement did increase voluntary intake of brome hay which provided a 39 percent increase in digestible energy. The increased protein and/or energy during the winter probably contributed to improved fertility during the summer.

Black et al. (1939) showed that significantly greater total range and feedlot gains were made by steers wintered on a high plane of nutrition, but that significantly lower cost gains were made by steers wintered on a low plane.

Winter, Summer Gain - A Negative Correlation

Snapp (1959) stated that the amount of gain desired during the winter would depend largely upon the way the cattle were to be handled the next summer. If they were to be fed on pasture they should be wintered better than if they were to be grazed. The amount of gain made in summer varied inversely with the amount of gain made during the winter. Stocker cattle

should be maintained with the minimum outlay for feed consistent with health and vigor. Increase in weight beyond that represented by normal growth was not necessary.

Heinemann and Van Keuren (1956) found a significant negative correlation between winter gains and subsequent pasture gains. Wintering treatment had no significant effect on feedlot performance of the cattle following the grazing season.

Miller and Morrison (1953) found that the addition of 2 pounds of corn to the wintering ration fed to heavy steer calves resulted in greater gain and more fleshing during the winter period, less gain during a 100-day grazing pasture season, and slightly more gain for the entire period. Cost per 100-pound gain was lower for the calves wintered without grain, but they had a slightly lower selling price per pound.

Ruby et al. (1948) found that increased winter gains resulted in increased total gains despite the fact that a negative correlation existed between winter gain and summer gain. In their trials, as the average winter gain of the calf increased by 1 pound, the subsequent summer gain decreased by 0.22 pound.

Potter and Withycombe (1926) in their studies presented results to indicate that for every pound calves gain during the wintering period, they will make from 0.42 to 0.58 pound less gain during the grazing period.

Darlow et al. (1948) stated that the most profitable method of producing stocker yearling steers was to winter the calves at a low level with cured range grasses as the roughage, using cottonseed meal for protein, then provide ample herbage during the summer.

GENERAL METHODS AND MATERIAL

Three experiments were designed to study the level of protein supplementation most desirable for wintering calves and yearlings on dry bluestem pasture. The cattle used in these experiments were grazed a full summer season after the winter treatment and sold off summer grass as stocker or feeder cattle. The results were measured primarily by the combined winter and summer performance of the cattle.

The experimental animals used were good to choice quality Hereford steers or heifers. Native bluestem pasture was used in all the trials. The pastures had been stocked the previous summer, but sufficient grass remained for the wintering experiments. The animals remained on bluestem pasture both winter and summer.

The cattle were divided on the basis of weight and quality into groups of 9 to 11 for their respective treatments. Individual lot treatments will be described within each experiment.

EXPERIMENT I

Yearling steers have been successfully wintered at this station on dry bluestem pasture by feeding 1.50 to 2 pounds of cottonseed or soybean pellets per head daily. The objective of this test was to determine if the level of winter protein feeding could be reduced without affecting the yearly performance of the steers.

Materials and Methods

Three trials were conducted with yearling steers that averaged 687 pounds at the beginning of the wintering phase. The 20 steers used in trial I were

purchased as calves in southeastern Colorado the fall of 1951. They were used in summer grazing tests on bluestem in 1952. From November 1 until the test started December 31, they were fed 1 pound of soybean pellets daily. During the winter test, the steers were moved from pasture to pasture every 15 days to minimize any differences due to pastures.

The 20 steers used in trial II originated at Marfa, Texas. They were handled in the same manner as in trial I before going on their wintering test October 26, 1953.

For trial III, the 20 head of steers were purchased at Carlsbad, New Mexico. The previous treatment of these yearlings was similar to trials I and II before starting their wintering test November 10, 1954.

In addition to dry bluestem, the steers were fed the following amounts of protein supplement in each trial:

Lot 1 - 1 pound of cottonseed or soybean pellets per head daily

Lot 2 - 2 pounds of cottonseed or soybean pellets per head daily.

In trials I and III soybean pellets furnished the protein. Trial II utilized cottonseed pellets as the source of protein. Mineral (bone meal and salt) and salt were fed free choice. Prairie hay was fed when snow covered the grass.

Results and Discussion

In trial I, table I, the steers fed 2 pounds of soybean pellets during the wintering phase gained 46 more pounds during this phase than the 1 pound lot, which was highly significant ($P < 0.01$). During the grazing phase, the 2 pound lot gained 31 pounds less. On the basis of the combined winter and summer gain, the most effective level of protein supplement was 1 pound of soybean pellets per head daily. The feed cost per 100 pounds gain was 11

Table I. Level of winter protein feeding for yearling steers, wintered and then summer grazed on bluestem pasture. (1952-53, 1953-54, 1954-55)
Trials I, II, III and summary for Experiment I

Trial	Trial I		Trial II		Trial III		Summary	
	1 pound soybean pellets	2 pounds soybean pellets	1 pound cottonseed pellets	2 pounds cottonseed pellets	1 pound soybean pellets	2 pounds soybean pellets	1 pound supplement	2 pounds supplement
Lot Number	1	2	1	2	1	2	1	2
Steers per lot	10	10	10	10	10	10	30	30
Phase 1 Wintering								
(Nov.-Apr.) No. days		124		158		147		143
Initial wt. per steer	718	720	743	743	601	597	687	687
Gain per steer	66	112**	95	129**	32	66*	65	102*
Daily gain per steer	0.53	0.90	0.61	0.83	0.22	0.45	0.45	0.71
Feed cost per steer ¹	\$11.31	\$16.36	\$11.47	\$17.13	\$11.22	\$17.24	\$11.33	\$16.91
Phase 2 Grazing								
(Apr.-Aug.) No. days		91		122		118		110
Initial wt. per steer	784	832	838	872	633	663	752	789
Gain per steer	219	188	253	212	243	244	238	215
Daily gain per steer	2.14	2.07	2.07	1.74	2.06	2.06	2.16	1.95
Summary of Phases								
1 and 2 no. days		215		280		265		253
Final wt. per steer	1003	1020	1091	1084	876	907	990	1004
Gain per steer	285	300	348	341	275	310	303	317
Daily gain per steer	1.33	1.40	1.24	1.21	1.04	1.11	1.20	1.25
Feed cost per cwt.	\$9.60	\$10.78	\$7.89	\$9.72	\$11.35	\$12.01	\$9.46	\$10.80

* P < 0.05

**P < 0.01

1. Feed prices per ton: soybean pellets (1952-53 - \$95.00) (1954-55 and summary - \$70.00), cottonseed pellets (1953-54 - \$75.00) and (summary - \$70.00) prairie hay (1952-53 and 1953-54 - \$25.00) (1954-55 and summary - \$20.00). In all years and summary, dry grass per head monthly \$0.75; summer grass \$16.00 per head.

percent less with the steers fed 1 pound of protein. It required 124 pounds of additional protein by those fed the larger amount of protein to produce 15 pounds more total gain for the combined period.

In trial II, table I, the group of steers receiving the 2 pounds of cottonseed pellets daily during the wintering phase gained 26 percent more which was highly significant ($P < 0.01$), however during the grazing phase, they gained 16 percent less. The steers wintered on 1 pound of cottonseed pellets per head daily made 7 pounds more annual gain than those fed 2 pounds of cake during the winter.

In trial III, table I, the steers fed 2 pounds of soybean pellets daily on dry grass, gained 34 pounds more during the wintering phase than the 1 pound group. There was no difference in weight gain during the grazing phase. For the combined wintering and summer phases, the group fed 2 pounds of soybean pellets during the winter increased their yearly gain by 35 pounds, enough to pay for the additional protein fed. The cost of production was lowered slightly where only 1 pound of protein was fed. In this trial, the two pound level might have some advantage if it would give the cattle a better appearance at sale time.

Summary of Experiment I

The steers fed 2 pounds of cottonseed or soybean pellets per head daily gained more pounds during the wintering phase in all trials than the groups fed 1 pound. During the summer phase, the 1 pound group gained more pounds than the 2 pound group in all trials, but trial III. For the combined phase, the 2 pound group produced more pounds in trials I and III. However, the feed cost per 100 pounds of gain was less in all trials for the groups receiving 1 pound of protein per head daily during the wintering phase.

When the three years are combined as shown in table I, the groups fed 2 pounds of cottonseed or soybean pellets produced 36 percent more winter gain, 9.6 percent less summer gain, and only 4.4 percent more yearly gain than the 1 pound group. The three year summary shows the 1 pound level somewhat superior, \$1.34 less per 100 pounds of gain, based on the winter and summer gains combined. The additional 143 pounds of winter protein supplement produced only 14 pounds additional gain. To make the additional pound of supplement pay, it would be necessary to establish that it increases the bloom or condition of the steers so that they would sell for enough more money to pay for the additional supplement fed.

EXPERIMENT II

The objective of this experiment was to study different supplements and level of wintering for steer calves on winter bluestem pasture that are to be sold as stocker or feeder yearlings after the summer grazing season. The calves were wintered on dry bluestem pasture according to their different treatments. They were then grazed together from April until the close of the test, normally the first week of August.

The following comparisons were made:

1. Level of protein feeding on dry bluestem pasture
2. The value of a grain and protein combination fed on dry bluestem pasture.

Results of this experiment were measured primarily by the combined winter and summer performance of the steers.

Materials and Methods

Three trials were conducted with three lots in each trial. The steers in trial I originated near Marfa, Texas, trial II, Medicine Lodge, Kansas, and those in trial III near Lovington, New Mexico.

The calves in trial I were fed prairie hay and 1 pound of soybean pellets until they were placed on test. The wintering phase normally started in November and terminated in April with an average of 125.7 days. During the winter phase, the calves in trial I were rotated every 15 days, while those in trial II were rotated every month to eliminate any differences due to the bluestem pasture treatment. The calves in trial III were pastured together. They were gathered each morning and divided into their respective lots to receive their supplement. Six calves in each lot of trial III were implanted with stilbesterol. The results of this treatment have not been included in this report.

The treatments each lot received, in each of the three trials, were as follows:

Lot 2 - Dry bluestem pasture, 1 pound of soybean pellets per head daily.

Lot 3 - Dry bluestem pasture, 1 pound of soybean pellets and 1 pound of corn per head daily.

Lot 4 - Dry bluestem pasture, 2 pounds of soybean pellets per head daily.

Mineral (bone meal and salt) and salt were fed free choice. Prairie hay was fed when snow covered the grass. The amount fed would average between 1 and 2 pounds per head daily for the wintering phase. All of the steers in each trial were grazed together during the summer. The average length of the

grazing season was 109.3 days, beginning in April and ending in early August.

Results and Discussion

The steers in trial I made above average gains under all methods of winter feeding, due to a mild winter. Table II shows that the steers in trial I, fed 1 pound of soybean pellets and 1 pound of corn gained 16 percent more than those receiving only 1 pound of supplement during the wintering phase and those receiving two pounds of soybean pellets gained 22 percent more than did those at the one pound level. The increased gain paid for the additional 1 pound of corn fed per head daily, but not for the additional 1 pound of soybean pellets fed.

At the end of the 85 day grazing season in trial I, there was less than 6 pounds difference in gain between the 3 treatments. On the basis of winter and summer gains combined, it was more efficient to feed only one pound of supplement per head daily during the wintering phase. Replacing 1 pound of supplement with 1 pound of grain had little effect on yearly gain, and it lowered the cost of production.

In trial II, table II, the steers received 1 pound of soybean pellets and 1 pound corn and the steers receiving 2 pounds of soybean pellets gained significantly more ($P < 0.05$) than did the steers receiving only 1 pound of soybean pellets during the wintering phase. After the 118 day grazing phase, there was less than 11 pounds difference in gain between all lots in trial II.

On the basis of the winter and summer gain combined, lot 3 fed 1 pound of supplement and 1 pound of corn produced 36 more pounds of gain than lot 2 fed 1 pound of supplement at the same cost per 100 pounds of gain. Lot 4, fed 2 pounds of supplement, produced 29 more pounds of gain than lot 2.

In this trial, 1 pound of soybean pellets did not furnish quite enough protein or protein and energy combined for calves wintered on dry grass. One pound of corn and 1 pound of soybean pellets were equal to 2 pounds of soybean pellets. This was also true in trial I.

In trial III, table II, the steers in lot 12B that were fed 2 pounds of protein per head daily gained significantly ($P < 0.05$) more than lot 12A fed 1 pound of soybean pellets during the winter phase. Feeding the 1 pound of corn in addition to 1 pound of soybean pellets was not economical during this wintering test. Gains for the summer phase were nearly the same for all lots. On the basis of gain, apparently 1 pound of soybean pellets did not furnish sufficient protein, the steers in lot 12B gained 29 pounds more year long when fed 2 pounds of soybean pellets as compared with lot 11A where only 1 pound of soybean pellets were fed. However, the cost of producing the gain was about the same in both lots. The steers in lot 12C fed 1 pound of protein and 1 pound of corn gained about the same as those fed only 1 pound of supplement. Since no increase in gain was obtained with the corn, the cost of producing 100 pounds of gain with corn was increased slightly.

Summary of Experiment II

The steers in each trial which were fed 2 pounds of soybean pellets gained more weight during the winter than the lots receiving either 1 pound of soybean pellets and 1 pound of corn or those receiving only 1 pound of soybean pellets. Those receiving the 1 pound of soybean pellets and 1 pound of corn gained more pounds in the wintering phase in each trial than the lots receiving 1 pound of soybean pellets only.

During the grazing phase, there was very little difference in gain between the lots in any trial. For the combined winter and summer grazing

Table II. Level of winter protein supplementation for steer calves both wintered and summer grazed on bluestem pasture. (1952-53, 1954-55, 1955-56).
Trials I, II, III and summary for Experiment II.

Trial	Trial I			Trial II			Trial III			Summary		
	1 pound soybean pellets	1 pound soybean pellets 1 pound corn	2 pounds soybean pellets	1 pound soybean pellets	1 pound soybean pellets 1 pound corn	2 pounds soybean pellets	1 pound soybean pellets	1 pound soybean pellets 1 pound corn	2 pounds soybean pellets	1 pound soybean pellets	1 pound soybean pellets 1 pound corn	2 pounds soybean pellets
Lot Number	2	3	4	2	3	4	12A	12C	12B	1	3	2
Steers per lot	10	10	10	10	10	10	10	10	10	30	30	30
Phase 1 Wintering												
(Nov.-Apr.) No. days		137			147			93			125.7	
Initial wt. per steer	416	416	417	519	520	516	581	585	590	505	507	508
Gain per steer	100	119	128	15	41*	45*	23	35	57*	46	65	76*
Daily gain per steer	0.73	0.87	0.93	0.10	0.28	0.31	0.25	0.37	0.61	0.37	0.52	0.60
Feed cost per steer ¹	\$10.73	\$14.26	\$16.74	\$11.17	\$14.99	\$17.49	\$6.26	\$8.96	\$9.52	\$10.25	\$13.91	\$14.63
Phase 2 Grazing												
(Apr.-Aug.) No. days		87			118			123			109.3	
Initial wt. per steer	516	535	545	534	561	561	604	620	647	551	572	584
Gain per steer	175	182	176	242	252	241	199	187	194	206	207	204
Daily gain per steer	2.01	2.09	2.02	2.05	2.14	2.04	1.62	1.52	1.58	1.88	1.89	1.87
Summary of Phases												
1 and 2 No. days		224			265			216			235	
Final wt. per steer	691	717	721	776	813	802	581	585	590	757	779	788
Gain per steer	275	301	304	257	293	286	222	222	251	252	272	280
Daily gain per steer	1.23	1.34	1.36	0.97	1.11	1.08	1.03	1.03	1.16	1.07	1.16	1.19
Feed cost per cwt.	\$9.72	\$10.05	\$10.77	\$10.57	\$10.57	\$11.70	\$10.47	\$11.69	\$10.56	\$10.02	\$11.00	\$10.94

* $P < 0.05$. (trial II, lots 3 and 4 over lot 2) (trial III, lot 12B over lot 12A) (summary, lot 2 over lot 1)

1. Feed prices per ton: soybean pellets (1952-53 - \$95.00) (1954-55 - \$86.00) (1955-56 and summary - \$70.00) prairie hay (1952-53 - \$25.00) (1954-55, 1955-56 and summary - \$20.00) corn per bushel in all trials - \$1.60. Dry grass, \$0.50 per head monthly. Summer grass per head - \$16.00.

phase, increasing the level of protein feeding from 1 pound of soybean pellets and 1 pound of corn per head daily to 2 pounds of soybean pellets, the gain was increased only 8 pounds as shown by the summary in table II. Apparently 1 pound of soybean pellets furnished adequate protein. The combination of 1 pound of corn and 1 pound of soybean pellets per head daily increased steer gains 20 pounds per head for the winter and summer period over the 1 pound level of soybean pellets per head daily.

The feed cost per 100 pounds of gain were less with the lots wintered on 1 pound of soybean pellets per head daily. Although the differences in cost per cwt. were not large, this experiment demonstrates that the addition of an energy feed, such as corn to 1 pound of soybean pellets fed per head daily during the wintering phase can produce added economical gains for the combined winter and summer grazing program.

EXPERIMENT III

The three trials in this experiment were designed to determine the optimum level of alfalfa hay feeding for heifer calves wintered on dry bluestem pasture. One group of heifers was fed twice as much alfalfa hay as the other, but the supplemental total digestible nutrients remained at about the same level by feeding grain to the heifers on the lower level of alfalfa hay.

After the wintering phase, the heifers were then grazed together, without supplemental feed, from April to August. Results of this experiment were measured primarily by the combined winter and summer performance of the calves.

Materials and Methods

Three trials with two lots each were conducted to compare alfalfa and alfalfa plus grain for wintering heifer calves. The heifers in trial I were

purchased as calves near Lovington, New Mexico. They were placed on the following tests November 15, 1955:

Lot 7. Wintered on dry bluestem pasture, 3 pounds of alfalfa hay, and 1.50 pounds of corn per head daily, grazed on bluestem pasture until August 2.

Lot 8. Wintered on dry bluestem pasture and 6 pounds of alfalfa hay per head daily, grazed on bluestem pasture until August 2.

Both lots had free access to salt and mineral (equal parts of bone meal and salt). Each lot was fed additional prairie hay and alfalfa when snow covered the grass. The average amount of hay for the wintering phase was 0.29 pounds per head daily.

Four heifers in each lot were implanted with 48 mgs. of stilbestrol; results of this test were not included in this report.

Twenty-two head of heifer calves purchased at Melrose, New Mexico, were used in trial II. They were wintered on bluestem pasture with the following treatments:

Lot 8. Fed 4 pounds of alfalfa hay and 2.50 pounds of corn per head daily.

Lot 13. Fed 8 pounds of alfalfa hay per head daily.

In trial II, the average feed cost per heifer for the wintering phase included supplements used until April 20th, 1957. The heifers had free access to salt.

In the third trial, 20 heifers, originating near Clovis, New Mexico, were assigned to the following treatments:

Lot 8. Fed 4 pounds of alfalfa hay and 2.60 pounds of ground corn per head daily.

Lot 13. Fed 8 pounds of alfalfa hay per head daily.

Sufficient old grass was available in both pastures, and the heifers had free access to salt, and a bone meal and salt mixture of equal parts by weight.

Results and Discussion

In trial I, table III, the heifers fed alfalfa and corn gained 8 pounds more during the wintering phase and 11 pounds more during the grazing phase than the lot fed straight alfalfa. Using the current feed prices, the 19 pounds additional gain cost \$0.13 less per cwt. to produce.

Apparently the 3 pounds of alfalfa hay furnished ample protein for calves wintered on dry bluestem pasture, since lot 7, fed alfalfa and grain, gained slightly more during the winter and summer than lot 8, which received only alfalfa hay. The 1.50 pounds of corn fed to lot 7 furnished approximately the same amount of energy as the additional 3 pounds of alfalfa hay fed to lot 8.

In trial II, table III, the heifers fed 2.50 pounds of corn and 4 pounds of alfalfa gained 45 pounds more during the winter than the lot receiving alfalfa hay, which was highly significant ($P < 0.01$). During the grazing phase, lot 8 which received corn and alfalfa, gained 24 pounds less than the straight alfalfa lot. For the combined winter and summer period, the heifers in lot 8 gained 21 more pounds at the same cost per cwt. of gain as lot 13. The increased gain resulting from the replacement of a part of the alfalfa with corn indicates some value of the grain beyond the total digestible nutrient value.

In trial III reported in table III, the heifers in lot 8, which received 4 pounds of alfalfa and 2.60 pounds of corn, made significantly ($P < 0.05$) higher gains at the end of the wintering phase and the combined wintering and

Table III. Feeding two levels of alfalfa hay to heifer calves on winter bluestem pasture. (1955-56, 1956-57, 1957-58)
Trials I, II, III and summary for Experiment III

Trial	Trial I		Trial II		Trial III		Summary	
	3 lbs. Alfalfa & 1.50 lbs. corn	6 lbs. Alfalfa	4 lbs. Alfalfa & 2.50 lbs. corn	8 lbs. Alfalfa	4 lbs. Alfalfa & 2.60 lbs. corn	8 lbs. Alfalfa	3.70 lbs. Alfalfa & 2.20 lbs. corn	7.30 lbs. Alfalfa
Lot Number	7	8	8	13	8	13	2	1
Heifers per lot	9	10	11	11	10	10	30	31
Phase 1 Wintering								
(Nov.-Apr.) No. days	144		109		127		126.7	
Initial wt. per heifer	474	482	473	469	518	525	488	492
Gain per heifer	27	19	81**	36	94*	73	68*	43
Daily gain per heifer	0.19	0.13	0.74	0.33	0.74	0.57	0.54	0.34
Feed cost per heifer ¹	\$14.23	\$12.37	\$18.30	\$15.50	\$11.65	\$8.13	\$14.22	\$11.75
Phase 2 Grazing								
(Apr.-Aug.) No. days	117		115		91		107.7	
Initial wt. per heifer	501	501	554	505	612	598	556	535
Gain per heifer	237	226	176	200	171	164	194	196
Daily gain per heifer	2.03	1.93	1.53	1.74	1.88	1.80	1.80	1.82
Summary of Phases								
1 and 2 No. days	261		224		218		234.4	
Final wt. per heifer	738	727	730	705	783	762	750	731
Gain per heifer	264	245	257	236	265*	237	262*	239
Daily gain per heifer	1.01	0.94	1.15	1.05	1.22	1.09	1.12	1.02
Feed cost per cwt. of gain	\$11.45	\$11.58	\$13.35	\$13.35	\$10.43	\$10.18	\$11.53	\$11.61

* P < 0.05

**P < 0.01

1. Feed prices. Alfalfa hay per ton, (1955-56 and summary-\$20.00), (1956-57 - \$25.00), (1957-58 - \$16.00)
Corn per cwt. (1955-56 and 1956-57 - \$2.86) (1957-58 - \$2.30), (summary \$2.50)
In all years, including summary; dry grass per head monthly, \$0.50, summer grass per head, \$16.00

grazing phase than did the straight alfalfa hay lot. Replacing 4 pounds of alfalfa with 2.60 pounds of corn produced 21 more pounds during the wintering phase and 7 additional pounds during the grazing phase.

For the combined phases, the heifers fed corn and alfalfa gained about 10 percent more than the heifers fed 8 pounds of alfalfa hay. The economy of the two rations would depend on the relative cost of hay and grain. With current prices, the all alfalfa hay ration would be fully as efficient a ration as the alfalfa and grain combined.

Trial III demonstrated how alfalfa hay feeding on winter pasture could be reduced from 8 to 4 pounds per head daily with satisfactory results, if the difference in hay intake was made up by feeding about 2.50 pounds of corn.

Summary of Experiment III

The heifers wintered on corn and alfalfa in this experiment gained more pounds in every phase of each trial than those wintered on straight alfalfa, except the grazing phase of trial II. For the combined wintering and summer phases, the cost per cwt. of gain was essentially the same in all trials.

The three-year summary, table III, shows that the 3.70 pounds of alfalfa hay and 2.20 pounds of corn fed per head daily to the heifers in lot 2 produced 0.20 pound more gain per head daily during the winter, and 9 percent more gain for the winter and summer combined, both significant ($P < 0.05$), than the 7.30 pounds of alfalfa hay fed per head daily. This trend has been the same in each of the three years tested.

Apparently, 3 to 4 pounds of alfalfa hay furnished adequate protein and other nutrients when combined with 2.00 to 2.50 pounds of corn per head daily to equalize the total digestible nutrients supplied by feeding 7 to 8 pounds of alfalfa hay per head daily.

A comparison of costs of production with the two rations would depend on the relative cost of hay and grain. When alfalfa hay is unavailable or high in price, this experiment demonstrates a low level that may be fed with satisfactory results.

SUMMARY AND CONCLUSIONS

The objective of Experiment I was to determine what level of winter protein feeding on dry bluestem grass would be the most economical based on the yearly performance of yearling steers. Steers fed 2 pounds of soybean or cottonseed pellets per head daily during the winter phase produced 36 percent more winter gain, 9.6 percent less summer gain, and only 4.4 percent more yearly gain than the steers receiving the 1 pound level of supplementation. However, the three year summary shows the 1 pound level somewhat more economical, \$1.34 less per 100 pounds of gain, based on the winter and summer gains combined.

To be able to recommend the feeding of an additional pound of cottonseed or soybean pellets during the wintering phase in Experiment I, it would be necessary to establish that it would increase the bloom or condition of the steers so that they would sell for enough more money to pay for the additional protein fed during the winter on dry bluestem.

Experiment II was designed to study different supplements and level of wintering for steer calves on winter bluestem pasture that were to be sold as stocker or feeding yearlings after the summer grazing season. Level of winter protein feeding and the value of a grain and protein combination were compared with the results measured primarily by the combined winter and summer performance of the steer calves.

In the final analysis of Experiment II, additional gain was obtained by increasing the supplemental feed level from 1 to 2 pounds per head daily. For the combined winter and summer phases, an additional 128 pounds of soybean pellets fed per steer during the winter produced an additional 28 pounds of gain compared to the lot receiving 1 pound of supplement. The lot receiving 1 pound of soybean pellets and 1 pound of corn produced 20 pounds more gain than the lot receiving the 1 pound level of supplement.

One pound of soybean pellets and 1 pound of corn produced about the same gain as 2 pounds of soybean pellets per head daily in Experiment II. Apparently, the 1 pound of soybean pellets fed per head daily comes close to meeting the calves' protein needs when combined with an energy feed such as corn for calves wintered and summer grazed on bluestem pasture. Although the differences in total gains were not large, there appeared to be some advantage to increasing the winter supplemental level from 1 to 2 pounds for steer calves on this type program.

Experiment III was designed to determine the optimum level of alfalfa hay feeding for heifer calves wintered on dry bluestem pasture. One group of heifers was fed twice as much alfalfa hay as the other, but the supplemental total digestible nutrients remained at about the same level by feeding corn to the heifers on the lower level of alfalfa hay.

The three trials in Experiment III, demonstrated that 3.70 pounds of alfalfa hay and 2.20 pounds of corn fed per head daily to heifer calves on a wintering program produced 0.20 pound more daily gain during the winter and 9 percent more gain for the winter and summer phases combined than the lot receiving 7.30 pounds of alfalfa hay.

In this experiment, 3 to 4 pounds of alfalfa hay apparently furnished adequate protein and other nutrients, when combined with 2.00 to 2.50 pounds

of corn per head daily to give results comparable to feeding 7 to 8 pounds of alfalfa per head daily during the wintering phase.

In comparing these experiments, it was found that yearling steers could be wintered on a 1 pound level of soybean or cottonseed pellets fed per head daily during the winter. In comparison, heifer and steer calves normally produced higher gains when additional concentrate was added to the protein source. This added concentrate, as supplied by corn, fed with the protein source during the wintering phase provided an economical method of producing additional weight for the combined winter and summer grazing program.

In the future it may be more economical to determine monthly the level of protein needed by actually running chemical analysis of the grass to be pastured. Using the chemical analysis of native bluestem pastures, table IV demonstrates the various levels of 44 percent soybean meal necessary to balance the protein needs for a calf on a winter-summer grazing program. Table IV shows that the amount of soybean meal necessary to balance the protein needs vary from 1.16 pounds per head daily October 1 to 1.95 pounds per head daily April 1.

Table IV. The amount of 44 percent soybean meal necessary to balance the protein of native bluestem pasture as determined by chemical analysis.

Winter grazing phase: Requirement for 500 lb. calf² = 1.3 lbs. crude protein daily.

Date	Protein % ₁ Dry Basis	Daily Lbs. Dry Feed per Animal ³	Total Lbs. Protein Supplied	Amount Lbs. Deficient- Surplus+	Pounds 44% Soybean Meal Required
Oct. 1	5.27	15	.79	-.51	1.16
Oct. 10	4.30	15	.65	-.65	1.47
Dec. 15	4.04	15	.61	-.69	1.57
Jan. 1	2.75	15	.41	-.89	2.02
Feb. 1	3.10	15	.47	-.83	1.89
March 1	3.03	15	.45	-.85	1.93
April 1	2.98	15	.44	-.86	1.95

Summer grazing phase: Requirement for 600 lb. calf² = 1.5 lbs. crude protein daily.

May 10	13.56	18	2.44	+.94	0
May 20	12.10	18	2.18	+.68	0
June 10	10.25	18	1.85	+.35	0
June 20	8.43	18	1.52	+.02	0
July 1	8.58	18	1.54	+.04	0
July 10	9.33	18	1.68	+.18	0
July 20	8.97	18	1.61	+.11	0

1. Chemical analysis of bluestem pastures as recorded in Kansas State College Circular 256. (1949-50).
2. Nutrient requirements of beef cattle, National Research Council publication 1137. (1963).
3. Daily feed required figured on the basis of 3 percent of body weight.

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**LEVEL OF PROTEIN SUPPLEMENTATION FOR BEEF CALVES AND
YEARLINGS ON WINTER BLUESTEM PASTURE**

by

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Native bluestem pasture provides an excellent diet for beef cattle for 3 months during its active growing season, a diet declining in digestible protein, energy and phosphorus for an additional 3 months, and a diet deficient in these constituents for the remaining 6 winter months of the year.

This study was designed to determine the level of winter protein supplementation on bluestem pasture for beef calves and yearlings to achieve maximum economy without sacrificing performance during the subsequent grazing season. The results of each experiment were measured primarily by the combined winter and summer performance of the cattle.

Hereford yearling steers were used in Experiment I to determine the effects of feeding soybean or cottonseed pellets at the rate of 1 or 2 pounds per head daily during the wintering phase. The steers wintered on 1 pound of supplement per head daily made 4.4 percent less yearly gain than those fed 2 pounds of supplement per head daily. However, this group for the combined winter and summer phases, produced 100 pounds of gain for \$1.34 less than the group fed 2 pounds of supplemental protein during the winter.

Level of winter protein feeding and the value of a grain and protein combination were compared in Experiment II with Hereford steer calves. Additional gain was obtained by increasing the supplemental level from 1 to 2 pounds per head daily.

By increasing the level of protein feeding from 1 pound of soybean pellets and 1 pound of corn per head daily to 2 pounds of soybean pellets, the combined winter and summer gain was increased only 8 pounds. Apparently the 1 pound of soybean pellets furnished adequate protein. However, the feeding of some energy feed such as corn seemed desirable since the combination of 1 pound of corn and 1 pound of soybean pellets increased steer gains per head 20 pounds

20 pounds for the winter and summer period over feeding only one pound of soybean pellets per head daily.

In Experiment III, Hereford heifer calves were fed on two levels of alfalfa hay to determine the optimum level necessary for wintering on dry bluestem pasture. One group of heifers in each trial was fed twice as much alfalfa hay as the other, but the supplemental total digestible nutrients remained at about the same level by feeding grain to the heifers receiving the lower level of alfalfa hay.

The results of this experiment demonstrated that 3.70 pounds of alfalfa hay and 2.20 pounds of corn fed per head daily during the wintering phase produced 0.20 pounds more daily gain during this period and 9 percent more gain for the winter and summer combined than the lot receiving 7.30 pounds of alfalfa hay. When alfalfa hay is unavailable or high in price, this experiment demonstrates that a low level may be fed with satisfactory results.

In these experiments, it was found that yearling steers could be satisfactorily wintered on a 1 pound level of soybean or cottonseed pellets fed per head daily. Whereas, heifer and steer calves normally required additional supplementation than that supplied by the 1 pound level of cottonseed or soybean pellets fed per head daily. This additional supplement, as supplied by corn, fed with the protein source was an economical method of producing additional weight gain for the calves on a winter-summer grazing program.