PROTEIN LEVEL FOR HEIFERS ON WINTER BLUESTEM PASTURE

by

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INTRODUCTION

The cost of supplemental concentrates fed during the winter is one of the major items of expense in a commercial cow herd operation. Reducing this cost in the first two years of age before the cow begins to produce a return can increase profit if future production is not adversely affected.

This experiment was designed to study the effects of substituting sorghum grain in place of all or part of the protein supplement normally fed. Parameters studied were: weight gains, conception percentages, percentage of live calves born, calving ability, and changes in blood plasma protein content.

LITERATURE REVIEW

Since the end of the Open Range Era, commercial cow herd operators have been aware of the necessity of providing some kind of supplementation to a ration of native grass fed cows in the winter period. Hultz (1930) stated the feeding of cows in the range country (primarily the seventeen western states) was generally confined to the times when the natural forage was scarce or covered with snow. He further stated that feeds used for winter maintenance varied in different sections of the range country. In the northern sections, a ton of hay per cow was considered a standard allowance. Foreshadowing later recommendations, Hultz (1930) said that range cows and heifers will go into the winter fat and come out thin in the spring. According to Hultz (1930) "This is as it should be, but avoidance must be made of too thin a condition."

Ross et al. (1951) reported on a study that originated in Oklahoma in 1948. One of the objectives was to study the effect of wintering at different levels of supplementation upon the subsequent performance of the animals. Six lots of 15 Hereford heifer calves were grazed on native grass pastures near Stillwater from November, 1948 to June, 1949. From November, 1948 to mid-April, 1949, the following levels of supplementation were fed:

Low level (two lots)-0.93 pounds of cottonseed cake per head daily.

Medium level (two lots)-1.97 pounds of cottonseed cake per head daily.

High level (two lots)-1.98 pounds of cottonseed cake and 2.69 pounds of oats per head daily.

Bulls were placed with one lot of each level May 1, 1949, and were removed September 1, 1949. In June, 1949 all lots were moved to the Fort Reno Experiment Station, El Reno, Oklahoma, and grazed on comparable native pastures. The principle grasses in these pastures were bluestems (Andropogon sp.), indian grass (Sorghastrum nutans), and switch grass (Panicum virgatum).

During the 1949-1950 wintering period (November, 1949 to mid-April, 1950) the dry native grass was supplemented as follows:

Low level-0.93 pounds of cottonseed cake per head daily.

Medium level-2.32 pounds of cottonseed cake per head daily.

High level-2.32 pounds of cottonseed cake per head daily and 2.69 pounds of oats per head daily.

Bulls were placed with all lots on May 1, 1950, and removed September 1, 1950. Blood samples were taken at intervals of about one month.

Ross et al. (1951) made the following observations on the heifers that calved as two-year olds:

At the end of the first winter period, the heifers gained an average of 28, 58, and 85 pounds each for low level, medium level and high level respectively.

At the end of the summer period, 1949, the heifers had gained an average of 329, 339, and 360 pounds each for low level, medium level, and high level respectively since November, 1948.

The heifers of all lots lost weight from the start of the winter period to time of calving. The low level heifers weighed slightly lower at time of calving than any other lot. Although the low and medium level heifers weighed less than the high level heifers, they were not materially smaller or less thrifty in appearance.

The low level of wintering did not adversely effect the number of calves weaned.

There was no difference in the number of heifers in each lot requiring assistance at time of calving.

Ross et al. (1951) further observed that of the heifers exposed to bulls in the summer of 1950 only, the medium and high level heifers made greater winter gains than the low level lot, but those of the low level made the greatest summer gains.

During the winter and early spring months, the low level heifers of both groups tended to have lower blood plasma protein levels than the heifers wintered on the medium and high levels.

Pope et al. (1952) reporting on the same groups of cows, handled in the same manner as in the preceding year, observed that the low and medium level cows, calved as 2-year olds, lost slightly more weight than the comparable high level cows during the winter period, an average of 214, 194, and 161 pounds per head respectively. The low and medium level cows also gained more than the high level cows through the summer grazing season, an average of 259, 266, and 203 pounds per head. The same weight gain and loss pattern was noted for the corresponding lots calved as three-year olds.

Although only slight changes in blood constituents occurred during the 1951-1952 season, it appeared that the period extending from December to April was the most critical period for blood constituents. Plasma protein levels averaged lower for the heifers wintered at the low levels than at the high level from December to April.

Pope et al. (1953) noted that after continuing the same groups of cows on the same treatments for another year the total number of calves dropped and weaned favored the low level of wintering within each calving group. He also observed that the average plasma protein level was higher for the cows in the high level lot as compared to those on the low level, indicating a better nutritutional status. The differences approached equal values in July and August. However, none of the average values observed for the low level were outside the range considered normal for beef cows.

Reid et al. (1957) commented on three groups of Holstein heifers fed three different levels of total digestible nutrients (TDN) based on the Morrison Feeding Standards. A level of 65% of the upper limit of the Morrison Feeding Standards was considered low level. Similarly a level of 100% was considered a medium level and a level of 140% was considered a high level. The heifers were bred at 18 months of age. Reid et al. (1957) noted there was a considerable difference in size at time of first calving. The average weights at time of first calving were 964, 1184, and 1353 pounds per head for the low, medium, and high levels respectively. The low level of feeding delayed puberty but had no definite effect on conception.

Knox and Watkins (1958) reported on a series of experiments conducted on a semi-desert grassland in New Mexico. The principal grass was black grama with a considerable amount of dropseed. The cows were kept in one pasture and supplements fed in pens. The feeding period was from about February 10 to "the time when an appreciable amount of green forage was available but not later than June 1." All lots received bone meal and salt free choice.

The cows were fed as follows:

No additional supplementation,
1.0 pound of ground sorghum grain per head daily,
1.0 pound of cottonseed pellets per head daily.

These were doubled after calving started.

Knox and Watkins (1958) found that the loss of weight by cows during the calving season was influenced significantly by the supplements fed. Grain lessened the loss compared to the animals fed no supplement. The cottonseed pellets increased weights over those fed grain. Over an eight year period, Knox and Watkins (1958) concluded that young cows benefit from supplemental feed in both average and drought years, but mature cows only in drought years. With mature cows, grain produced substantially as good results as cottonseed cake when fed with a suitable mineral supplement. However, protein supplements were superior to grain for young cows.

Pope et al. (1956) reported on a repetition of the 1948 study using three lots, low level, medium level, and high level, receiving respectively, 1.0 pounds of cottonseed pellets, 2.5 pounds of cottonseed pellets, and 2.5 pounds of cottonseed meal pellets plus 3.0 pounds of ground milo per head daily. At the end of the first summer there was only an average of 68 pounds difference between the low and high levels and only 36 pounds between the medium and the high. Weight losses as bred yearlings (November, 1955 to April, 1956) were more severe for the low level, however they remained in strong, thrifty condition. About 70% of all the heifers required assistance in calving. The low level heifers experienced less calving difficulties, apparently due to lighter calf weights and the fleshier condition of the other two lots of heifers.

A third repetition was begun in October, 1955. As reported by Zimmerman et al. (1957), it consisted of three lots of 14 heifers each. The management was identical to that of the second trial, with the exception that the level of supplementation was varied to produce the following gains during the wintering period (early November to mid-April):

First winter as calves

low level-no gain during wintering period
medium level-gain 1/2 pound per head per day
high level-gain 1 pound or more per head per day

Second winter as bred yearlings

low level-no gain to calving-loss of body weight after calving to total approximately 250 pounds per head loss from fall to spring
medium level-moderate gain to calving (50 pounds)-approximately 150 pounds loss from calving to end of wintering period
high level-high gain to calving (100 pounds) no loss to end of wintering period.

During the first winter as calves, the low level heifers gained 21 pounds per head more than was intended on an average of .42 pounds of cottonseed cake per head daily. During the second winter, they lost an average of 7 pounds per head up to February, 1957, with no supplemental feed. The medium level required an average of 1.85 pounds of cottonseed meal per head daily to gain an average of .47 pounds per head per day the first winter. They gained an average of 37 pounds from November to February the second winter on about 2 pounds of cottonseed meal per head daily. The high level required 2.05 pounds cottonseed meal and 3.33 pounds of milo per head daily the first winter to gain an average of .93 pounds per head per day. Supplementing dry grass with 2.5 pounds of cottonseed meal and 4 pounds of milo resulted in an 80 pound gain from November to February of the second winter. Zimmerman et al. (1957) observed the low level lots made the highest summer gains and the high level lots the lowest. There was no significant difference between lots in difficulty of calving. Zimmerman et al. (1958) reported there were no definite trends established in the number of calves born or number weaned in the third trial.

This trial marked the start of a departure from winter supplementation of dry grass based on amount of supplement fed per head per day to a basis of weight gain or loss per head over the wintering period.

Zimmerman et al. (1959) summarized the results of four trials initiated at Fort Reno, Oklahoma in 1956, 1957, 1958 and 1959 respectively. These trials were planned to critically evaluate the effects of different levels of wintering on the growing and developing heifer. Each fall, three lots of 14 or 15 weanling Hereford heifers were selected and handled similar to the earlier experiments at Fort Reno, Ross et al. (1951), Pope et al. (1952), Pope et al. (1953), Pope et al. (1956), Zimmerman et al. (1957), and Zimmerman et al. (1958). They were grazed year long on native grass pastures, pasture-mated between May 1 and August 15 and calved first at two years of age. Supplemental amounts of cottonseed meal and milo were varied to obtain the following gains from early November to mid-April.

First winter as calves-
- low level-no gain during winter period
- medium level-0.5 pound gain per head daily
- high level-1.0 pound gain per head daily

Second and subsequent winters
- low level-200 pounds loss per head
- medium level-100 pounds loss per head
- high level-no loss in weight

Zimmerman et al. (1959) noted no consistent differences have been observed in difficulty at first calving or percent calf crop weaned. Body measurements taken in the fall indicated the winter treatments did not greatly affect the skeletal size of the heifers. Low level heifers have calved an average of about 1 week later than the medium level heifers and 2 weeks later than the high level heifers.

Pinney et al. (1961) reported on a similar study which was started in 1957 and 1958. Four groups of 15 Hereford heifer calves were selected each fall and started on the following supplementation treatments:

First winter	Second winter
low-no gain	loss of at least 20% of body weight as bred yearlings
medium-gain 1/2 pound per head per day	loss of less than 10% of body weight
high-gain 1 pound per head per day	no loss
very high-full fed 50% concentrate ration to gain as rapidly as possible	

The supplementation period was the same as in the previous studies as was the general management throughout the year. Daily supplement fed during the first wintering period for each lot averaged as follows:

Low-less than 1 pound per head cottonseed oil meal
Medium-2 pounds cottonseed oil meal plus 1 pound milo per head
High-2 pounds cottonseed oil meal plus 5 pounds milo per head
Very high-25 to 35 pounds 50% concentrate ration per head self fed.

The average gain per head the first winter was:

Low-loss of 13 pounds
Medium-97 pounds
High-145 pounds
Very high-274 pounds

This gave an average of 285 pounds difference between the low and very high levels. The low level heifers were confined to dry lot and fed wheat straw several weeks at the beginning of the winter period to initiate the desired weight loss. The summer gains were the inverse of the winter gains with the low level gaining highest. This resulted in reducing the difference in weight between the low and very high levels to an average of 110 pounds per head. This illustrated the tremendous recovery power of the low level heifers on good natural grass.

At the end of the second winter, following calving, the low level heifers had lost an average of 27% of their body weight at the start of the winter, while the very high gained 20% additional body weight. The other groups gained or lost between the two extremes. The difference in average weights between the low group and very high group was 502 pounds at the end of this winter.

Pinney et al. (1961) reported that for the first calf crop the very high level heifers lost more calves at birth, resulting in a 63% calf crop. There was only a slight difference in calf crop between the other three groups (low, medium and high). Average calving date was delayed slightly in the low and medium groups as compared to the high group. Birth weights were depressed by the low level.

Pinney et al. (1961) in summarizing the results at 2 1/2 and 3 1/2 years of age for the heifers, stated that too low a plane of nutrition resulted in delayed growth and body development, retarded calving date, smaller, weaker calves at birth, poor milking heifers, and decidedly lighter calves weaned. A very high level hastened maturity, led to large stores of body fat, depressed fetal growth, and milk production. Medium and high levels of supplementation were most desirable in terms of growth and development of female and size of calf weaned. The medium level was considered to be more desirable and profitable in terms of percent calf crop, weaning weight, and development of female. Pinney et al. (1961) noted high quality native grass permitted remarkable recovery during the summer grazing season.

Pinney et al. (1963) commented on two trials in which a total of 150 beef heifers maintained on native grass year long were subjected to different wintering levels by varying the intake of supplemental feed (cottonseed meal and milo) at two week intervals according to body weight gains. As weaner calves, the heifers were subjected to low, moderate and high feed levels from November to mid-April, and during the second winter one-half of the heifers from each of the low and high groups were reversed. First winter gains were -0.16, 0.58, and 0.92 pounds per head daily for the low, moderate, and high levels respectively. Weight losses as bred yearlings were 156, 115, and 36 pounds per head for the continuous treatment groups. Shifting the wintering levels from low to high resulted in gains of 26 pounds per head as yearlings; the reverse treatment caused an average loss of 230 pounds per head. At two and one-half years of age only slight differences were apparent in height, weight, or width measurements. Body weights were significantly different only for the low and high continual treatment groups. The low plane of nutrition resulted in delayed calving, reduced percent calf crop, and depressed birth and weaning weights as compared to the moderate or high levels. Low-high treatment heifers tended to calve later than moderate and high heifers, but were not otherwise affected. High-low treatments proved more severe, reducing birth and weaning weights and delaying rebreeding. Both alternate treatments were inferior to the high level and approached, but were not superior to, the moderate plane of nutrition.

As a result of the Fort Reno studies, Turman <u>et al</u>. (1964) suggested that a low level of nutrition for heifers up to two years of age may be a false economy. It is invariably associated with delayed breeding of yearling heifers, lighter weaning weights of calves, and delayed rebreeding of two-year old heifers, with a higher percent of open heifers at both ages. Turman <u>et al</u>. (1964) commented that there is a need for additional information as to what is the best level of winter feeding consistent with maximum production at the most economical cost.

Durham et al. (1963) reported on four lots of 20 bred heifers fed silage ad libitum. Two lots of 20 head were fed 1 pound of milo plus 1 pound of cottonseed meal in addition to the silage for five months. Two groups of 20 were fed 2 pounds of milo plus two pounds of cottonseed meal and the silage. The groups receiving 2 and 2 gained 1.24 pounds per day. The group receiving 1 and 1 gained 0.60 pounds per day. During the last period of gestation one 2-2 group was fed 2 pounds of milo and one pound of cottonseed meal. One (1-1) group was raised to 2-2 and one was changed to 1 pound of milo and 1/2 pound of cottonseed meal. The restriction in cottonseed meal in the last period had a restricting effect on gains during that period. The 1-1 group followed by the 1-1/2 group had lighter calves and no calving difficulty. Both groups getting 2 pounds of cottonseed meal during the last period experienced some calving difficulty.

Waldrip and Marion (1963) compared continuous grazing at three stocking rates, light, moderate and heavy with 2-pasture and 4-pasture deferred-rotation grazing systems stocked at the moderate level. All pastures were stocked with 3 year old cows and their calves in 1959. Cottonseed cake was fed at levels of 0, 1.5, and 3.0 pounds per head daily on the continuously grazed pastures during the winters of the 4-year period. Cows fed these three levels of winter supplement gained 2, 47, and 26 pounds respectively. The percent of calves weaned was 84.0, 90.5, and 90.5. No significant difference in weaning weights of the calves was attributable to the levels of winter supplement. Climatic conditions were favorable during the test period for grass production and supplemental feeding during the winter did not prove beneficial.

Marion et al. (1964) compared two groups of 34 cows each. One group was maintained on a silage ration in drylot from May 1959; the others on native pasture. Each group was subdivided into three lots which were fed the following amounts of cottonseed meal and sorghum grain per head daily during the winter months:

Low level-1 pound cottonseed meal plus 1 pound sorghum grain
Medium level-0.75 pounds cottonseed meal plus 2 pounds sorghum grain
High level-0.25 pounds cottonseed meal plus 4 pounds sorghum grain

The drylot cows received 40-50 pounds per head of sorghum silage plus the supplement while the pasture cows were fed only the supplement. Four calf crops had been weaned which averaged 87%, 81%, and 91% for the cows on pasture and 81%, 86%, and 92%, respectively for the cows in the drylot fed the low, medium, and high levels of energy. Weaning weights on pasture averaged 466, 447, and 463 pounds compared with 489, 488, and 474 pounds for the drylot cows. Marion et al. (1964) observed the drylot cows appeared to mature earlier, reaching maximum weight at 4 years of age, whereas the pasture cows were 5 years of age at maximum weight.

Hobbs et al. (1965) reported on a study involving 105 Angus heifers, 8 months of age, weighing approximately 466 pounds. Three similar groups were assigned to the following treatments in each of 4 years:

Ration I-corn silage ad libitum plus 4 pounds alfalfa hay per head daily
Ration II-same as Ration I with the addition of 6 pounds corn, cob, and shuck meal per head daily.

The heifers were fed approximately 136 days (November 15-April). After the first winter the heifers were bred to calve at 2 years of age. They were summered on orchard grass-ladino clover pastures. Each subsequent winter all the heifers were treated identically and fed limited hay and corn silage. Hobbs et al. (1965) observed that the treatment II heifers had a significantly ($P < .05$) higher average daily gains (1.39 vs. 0.99) during the winter period and higher condition scores at the end of the winter test (9.8 vs. 8.7). No significant treatment effects were observed for birth weight, number of calves born and weaned, or performance of calves to preweaning (120 days) and to weaning (240 days).

Harris et al. (1965) allotted 20 first-calf cows and 10 bred heifers to the following treatments:

> Optimum-fed (OF)-access to warm season permanent pasture sod plus good quality grass hay and were hand fed 2 pounds per head daily of cottonseed meal
>
> Restricted-fed (RF)-confined to lot and fed poor quality grass hay, block salt, and water.

The cows were grazed together from April 1 to October 31. Groups were separated and fed the treatment rations from November 1 to March 31. Cows were bred for fall calves.

Reporting six year's results, Harris et al. (1965) noted the average winter weight losses were 67 pounds and 129 pounds per head respectively for the OF and RF cows. Average adjusted weaning weight (250 days) was 32 pounds less for calves from RF cows (416 vs. 488). Only 3 of 14 RF heifers calved at 2 years of age, compared with 17 of 22 OF heifers. Heifers from both lots were essentially the same size at four years of age.

Speth et al. (1962) observed 48 Hereford cows of similar ages over a 5 year period allotted to treatments in a 2 x 4 factorial design. Each year, the oldest animal in each treatment was replaced with a 2 year old cow. All the cows grazed the same open range throughout the year. All cows were exposed to the same bulls for any given year. The treatments consisted of the following supplements:

None (controls)
1 pound barley per head daily
1 pound soybean or cottonseed oil meal per head daily
3 pounds alfalfa hay per head daily.

In addition one-half of the cows in each group received 8 grams of phosphorus daily in the form of bone meal or bone meal mixed with the other supplements. When only supplemental bone meal was fed, it was mixed with a limited amount of wheat bran as a carrier. The supplemental phosphorus was fed throughout the year. Speth et al. (1962) commented that the cows receiving barley, protein, and alfalfa supplements lost significantly ($P < 0.05$) less weight during the winter period (177 days) than the controls. During the summer the non-supplemented cattle gained more. The weight changes for the entire year were similar. The percent of cows calving was as follows: None-48.2%, Barley-72.5%, Protein-63.9% and Alfalfa-66.7%; the percent of cows weaning calves was as follows: N-44.9%, P-72.5%, P-47.2%, and A-65.0%; the percent calf death loss at parturition was as follows: N-3.3%, B-0.0%, P-16.7%, and A-1.7%; and six month weaning weights in pounds as follows: N-264, B-298, P-289, and A-288. Dietary phosphorus had no significant effect on the above observations.

Joubert (1954) noted a low level of nutrition could greatly delay the onset of estrus, but not adversely effect the conception rate. Fourteen half-sister or dizygotic twin heifer pairs were used. One of each pair was placed on a "low level of nutrition," the other heifer on a "high level of nutrition." Joubert (1954) suggested that with the approach of favorable nutritional conditions, animals in a low condition first restored depleted body tissues before the sexual cycle returned to normal activity.

Wiltbank et al. (1957) studied the effect of various levels of energy and protein on reproductive phenomena in beef heifers. Fifty-four Angus heifers were divided into three groups fed as follows: full-fed, two-thirds of full-fed group, and fed to maintain body weight. Each of these groups was sub-divided into three groups fed 0.23 pounds of digestible protein (Groups I, IV, and VII), 0.15 pounds of digestible protein (Groups II, V, and VIII), and 0.06 pounds of digestible protein (Groups III, VI, and IX) per head daily. The proportion of heifers showing estrus for groups I through IX respectively was: 100%, 100%, 67%, 100%, 100%, 67%, 50%, 83%, and 33%. The low levels of feeding also resulted in a delayed onset of puberty.

Wiltbank et al. (1962) observed the effects of differing energy levels on the reproductive performance of 88 pregnant Hereford cows ranging in age from 6 to 10 years of age. They were divided into four treatment groups designated as high-high, high-low, low-high, and low-low. Prior to calving, the high-high and high-low groups received approximately 9.0 pounds of TDN per head daily, and the low-high and low-low groups received approximately 4.5 pounds of TDN per head daily. Following calving, which occurred from February through April, the high-high and low-high groups received approximately 16.0 pounds of TDN per head daily, and the high-low and low-low groups received approximately 8.0 pounds of TDN per head daily. All other nutrients were supplied in sufficient amounts to meet the National Research Council requirements (1958). Prior to calving the cows in the high-high and high-low groups gained weight, while the cows in the low-high and low-low groups lost weight and were thin at calving time. Level of energy following calving had a marked effect on changes in body weight.

Calving difficulty was not influenced by treatment prior to calving. The average birth weight of calves from cows in the low-low and low-high groups was 11 pounds less than those from cows in the high-high and low-high groups ($P \angle .01$). The occurrence of estrus after calving was significantly influenced by feeding level. The level of energy provided before calving seemed to be relatively more important. A higher proportion of the cows had cycled by 90 days past calving and estrus was exhibited sooner after calving in the cows receiving the high level ration prior to calving. The proportion of cows diagnosed pregnant was 95%, 77%, 95%, and 20% for the high-high, high-low, low-high, and low-low groups respectively. Wiltbank et al. (1962) commented that the energy level recommended by the National Research Council (approximately 9.0 pounds of TDN per head daily prior to calving and 16.0 pounds of TDN per head daily after calving) is adequate to promote a reasonably high level of reproductive performance in mature beef cows nursing calves.

In regard to the effects of low levels of dietary protein on plasma protein levels, Klosterman et al. (1950) stated ewes fed rations low in protein had lower serum albumens than those fed a liberal amount of protein. Protein sources used were dried skim milk and linseed oil meal.

Wright et al. (1962) found that level of total plasma proteins could be lowered or raised by decreasing or increasing respectively, dietary protein content in pregnant and lactating ewes. They found this was due to changes in plasma albumens.

Carroll et al. (1964) reported on pairs of heifers maintained on isocaloric diets with different protein levels. One heifer of each pair was fed a maintenance level of energy and a submaintenance level of protein; the other was fed a maintenance level of energy and a liberal allowance of protein. Heifers maintained body weights on the restricted protein ration, but they had lower plasma protein and plasma albumin levels than the controls. Within 35 days differences in level of plasma protein between paired mates were no longer significant, but this was not true for plasma albumen levels until the 60th day. When the 16 pairs of heifers were weighed at the end of the period, the average live weight gained on the low-protein and control maintenance rations were 0.6 pounds and 27 pounds per head respectively. Carroll et al. (1964) stated that since the energy consumed by each heifer was estimated to be adequate for maintaining body weight, the larger live-weights gains by controls have to be attributed to the extra protein in the control ration.

METHODS AND MATERIALS

Experiment I

This experiment was designed to study the effects of various levels of winter protein supplementation on the performance of heifers grazed on bluestem pasture.

The sixty-six heifers used were good to choice Herefords purchased near Fort Davis, Texas. They were located at the Animal Husbandry Experimental Range Unit, near Manhattan, Kansas, for the duration of the experiment. Anderson and Fry (1955) stated that the pastures at the range unit were dominated by mid-grasses such as little bluestem (*Andropogon scoparius*), sideoats ramma (*Bouteloua curtipedula*), and Kentucky bluegrass (*Poa pratensis*); together with tall grasses including big bluestem (*Andropogon furcatus*), indiangrass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*).

The heifers were split into six lots of eleven head each on a random weight basis. They were approximately 9 to 11 months of age and averaged 431 pounds in weight.

This experiment began December 6, 1963, and terminated November 2, 1965. The heifers were fed the following experimental rations during the first wintering period (December 6, 1963, to May 1, 1964):

Lots 1 and 3-two pounds of ground sorghum grain plus 0.1 pound of dicalcium phosphate per head daily

Lots 2 and 4-one pound of ground sorghum grain plus one pound of soybean oil meal plus 0.075 pound of dicalcium phosphate per head daily

Lots 5 and 6-two pounds of soybean oil meal plus 0.05 pound of dicalcium phosphate per head daily.

All animals were fed 15,000 International Units of vitamin A per head daily, and had access to loose salt. The varying amounts of dicalcium phosphate were designed to provide approximately the same level of phosphorus for all lots. The heifers were fed three times weekly, receiving 2 to 2 1/2 days supplement at one time.

The six groups of heifers were grazed on five pastures through June, 1964. Four lots (two treatment groups) were grazed on four 60 acre pastures. The remaining two lots (one treatment group) were grazed together in a 140 acre pasture. The lots were rotated at approximately two months intervals. The supplement was fed in feed bunks located in the pastures.

All of the heifers were placed in a 139 acre pasture July 1, 1964. They were placed in drylot at night and checked for estrus in both the evening and morning. Heifers found in heat in the evening were then artificially inseminated the following morning; those exhibiting estrus in the morning were bred that evening. Semen from a Hereford bull was used. Artificial insemination was discontinued August 15, 1964. A Hereford bull was with the heifers from August 15, 1964, to October 1, 1964.

All lots of heifers were placed in a 60 acre pasture August 20, 1964. They were moved to another 60 acre pasture September 1, 1964, and moved to a third 60 acre pasture September 26, 1964. The six lots were separated October 26, 1964; four lots (two treatment groups) were placed in four 60 acre pastures; two lots (one treatment group) were placed in the 139 acre pasture. All heifers were examined for pregnancy on November 20, 1964. All open heifers were culled in addition to a heifer which calved July 10, 1964. The remaining 58 heifers were continued on experiment. All lots were moved to different pastures November 30, 1964. Three lots (2, 3, and 6) representing three treatment groups, were placed in a 190 acre pasture and wintered there. The remaining three lots (1, 4, and 5) were each placed in a 60 acre pasture and wintered there.

Supplemental winter feeding began December 3, 1964. The three treatment groups wintered together were marked with a black dye to facilitate separation into different lots prior to feeding. The marks were placed on the forehead, a stripe over the shoulders, and one group was not marked. The same experimental rations were fed the second winter, however vitamin A and dicalcium phosphate supplementation was discontinued. A small amount of monosodium phosphate was fed starting March 23, 1965 to standardize phosphorus intake. Supplemental feeding was discontinued April 23, 1965.

The first calf was born April 9, 1965. The heifers were checked at least twice daily, morning and evening, and assistance rendered if necessary. The calves were weighed and a birth weight recorded within twelve hours of birth. Calves which were dead at birth were not weighed. Calving difficulty was scored on a scale ranging from 1 to 10. A score of 1 indicated the cow required no assistance; a score of 5 indicated some assistance was necessary; and a score of 10 indicated a Caesarean section was required. Calves were tattooed at birth and sex of calf recorded. The last calf was born July 4, 1965.

All the heifers with the exception of two which had not calved were placed in the 139 acre pasture June 18, 1965, and two Hereford bulls were placed with them. The bulls were removed September 2, 1965, and the heifers moved back to the pastures they occupied from December 2, 1964, to June 18, 1965.

A final weight was obtained November 2, 1965, and the experiment terminated. Throughout the experiment, the heifers were weighed at approximately 28 day intervals following an overnight stand in a dry lot. The heifers were pregnancy examined October 30, 1965.

Blood samples were obtained by jugular puncture, January 29, 1964, March 23, 1964, June 19, 1964, and August 25, 1964. Approximately 25-30 ml. was collected directly into a 50 ml. centrifuge tube which contained a small amount of heparin.

The heparinized blood in the 50 ml. centrifuge tubes, previously described, was centrifuged at 3000 rpm for 30 minutes. The plasma was poured into small (100 ml.) Erlenmeyer flasks or test tubes, tightly stoppered, and stored at 4°Centigrade. Plasma protein was determined using Miller's (1959) modification of Lowery, Rosebrough, Farr, and Randall's method. All spectrophotometric readings were obtained using the Evelyn photoelectric colorimeter. Plasma protein determinations were carried out from June 20, 1965, to July 2, 1965.

Experiment II

This was a small pilot study to determine the effects of wintering heifers on bluestem pasture without additional supplemental feed. Two sets of identical twins, one set of Angus and one set of Hereford were used. The experiment began December 13, 1963. The heifers were approximately 18 months of age at this time. All four animals had received identical treatment up to this time. The heifers were bred to a Hereford bull during the summer of 1963. One heifer of each pair was fed one pound of soybean oil meal and one pound of sorghum grain per head daily through the wintering period (December 13, 1963-May 1, 1964). The remaining two heifers received no supplemental feed. All heifers were on bluestem pasture together with differing groups of heifers involved in Experiment I. Salt was provided free choice for all heifers.

Through the summer grazing period 1964, the four heifers were handled in the same manner as the heifers in Experiment I. The four heifers in this experiment were together except at feeding when the two receiving supplemental feed were fed alone. The heifers were rebred using artificial insemination with the other heifers in July, 1964.

The heifers were pregnancy examined November 20, 1964. Blood samples were obtained by jugular puncture January 29, 1964, March 23, 1964, June 19, 1964, and August 25, 1964. Blood was analyzed for plasma protein using the same procedure as used in Experiment I. The two sets of twins were treated in the same manner during the winter of 1964-65, as in the winter of 1963-64. They were scored for calving difficulty and the calves weighed and identified in the same manner as those in Experiment I.

All four heifers were grazed together through the 1965 summer grazing season. A Hereford bull was with the heifers from June 18, 1965, to September 2, 1965. The twins were pregnancy examined October 30, 1965. Throughout the experiment, weights were obtained after an overnight stand in dry lot at approximately 28 day intervals. The calves were weaned and a final weight obtained November 2, 1965.

RESULTS AND DISCUSSION

Experiment I

Weight Changes. Changes in body weights were separated in the following manner: Changes occurring during the first wintering period (December 6, 1963-March 30, 1964), changes occurring during the first summer grazing period (March 30, 1964-December 3, 1964), and changes occurring during the second wintering period (December 3, 1964-April 5, 1965). These changes are shown in Table 1.

The two groups of heifers receiving sorghum grain only lost weight during the first wintering period; Lot 1 lost an average of 39 pounds per head and Lot 3 lost an average of 29 pounds per head. The remaining groups gained in weight; Lot 4 (sorghum grain plus soybean oil meal) gained an average of 17 pounds, Lot 6 (soybean oil meal) gained 28 pounds, Lot 2 (sorghum grain plus soybean oil meal) gained 39 pounds, and Lot 5 (soybean oil meal) gained an average of 53 pounds per head. Averaging the lots within treatments results in an average loss of 34 pounds per head for the heifers fed only sorghum grain, an average gain of 28 pounds for the heifers receiving sorghum grain plus soybean oil meal, and average gain per head of 40.5 pounds for the heifers supplemented with soybean oil meal alone. The differences between treatments were found to be very highly significant (at the .025 level). Differences between the lots within treatments were even more significant (at the .005 level).

Through the summer grazing season (March 30, 1964-September 26, 1964) the heifers in Lots 1 and 3 gained more than the heifers

Table 1. Weight changes - Experiment I.

Treatment	Sorghum grain		Sorghum grain Soybean oil meal		Soybean oil meal	
Lot	1	3	2	4	5	6
Number of heifers						
Dec. 6, 1963 to Nov. 20, 1964	11	11	11	11	11	11
Nov. 20, 1964 to March 5, 1965	8	10	11	11	8	10
March 5, 1965[1] to Nov. 2, 1965	8	9[2]	10[3]	11	8	10
Average body weights (lbs)						
Dec. 6, 1963	433	424	436	427	426	438
March 30, 1964	394	395	475	444	479	466
Average gain first 115 days[4]	-39	-29	39	17	53	28
Sept. 26, 1964	653	675	711	710	697	690
Average gain March 30, 1964-Sept. 26, 1964	259	280	236	266	218	224
Average gain first 293 days[5]	220	251	272	283	281	252
Dec. 3, 1964	646	667	687	694	699	678
April 5, 1965	562	602	723	707	754	741
Average gain Dec. 3, 1964-April 5, 1965	-84	-65	36	13	35	63
Average gain first 484 days[6]	129	178	292	280	328	303
Nov. 2, 1965	761	754	786	834	781	742

[1]Pregnancy examined November 20, 1964 and open heifers removed.

[2]One cow died following Caesarean section.

[3]One cow died from complications resulting from calving paralysis.

[4]Significant at .025 level between treatments and between lots within treatments at the .005 level.

[5]Significant at .05 level between sorghum grain treatment and sorghum grain and soybean oil meal treatment.

[6]Significant at .05 level between treatments.

receiving soybean oil meal; an average of 259 and 290 pounds per head respectfully. Heifers in Lots 2 and 4 (soybean oil meal plus sorghum grain) gained an average of 236 and 266 pounds per head, and the heifers in Lots 5 and 6 (soybean oil meal) gained least, an average of 218 and 224 pounds per head respectfully. The practice of penning the heifers overnight to facilitate observance of estrus probably reduced gains in this period somewhat. The gains obtained show evidence of the potential for recovery from the effects of low planes of nutrition inherent in heifers which are grazed on good quality pasture through the following summer. Even though the heifers in Lots 1 and 3 gained more through the summer grazing season, they did not gain as much overall from December 6, 1963 to September 26, 1964. This parameter gives a truer measurement of the overall growth relationships between groups of heifers. During this period (the first 293 days of the study) Lots 1 and 3 gained an average of 220 and 251 pounds, Lots 2 and 4 gained an average of 272 and 283 pounds, and Lots 5 and 6 gained an average of 281 and 252 pounds per head. These differences were found to be significant (at the .05 level) between the sorghum grain treatment and the other treatments. The overall gain in body weight resulted in an average weight of 656.5 pounds per head for heifers in the sorghum grain treatment, 690.5 pounds per head for heifers in the sorghum grain plus soybean oil meal treatment, and 688 pounds per head for the heifers in the soybean oil meal treatment as of December 3, 1964.

The pattern of weight changes through the second wintering period paralleled that of the first winter. The heifers in Lots 1 and 3 lost an average of 84 and 65 pounds per head, those in Lots 2 and 4 gained an average of 36 and 13 pounds per head, and the heifers in Lots 5 and 6 gained an average of 35 and 63 pounds per head. Average weight changes per treatment were: sorghum grain alone, a loss of 74.5 pounds per head, sorghum grain plus soybean oil meal, a gain of 24.5 pounds per head, and soybean oil meal, a gain of 49 pounds per head. Average body weight gains through the first 484 days of the experiment (December 3, 1963-April 5, 1965) were: Lots 1 and 3, an average of 129 and 178 pounds per head, Lots 2 and 4, an average of 292 and 280 pounds per head, and Lots 5 and 6, an average of 328 and 303 pounds per head. These differences are significant (at the .05 level) between treatments.

Body weight relationships became variable after April 5, 1965, due to the onset of calving. This resulted in part of the heifers in each lot having calves at side while at the same time others in the same lot had yet to calve or had lost their calves. Average weights of lots of cattle thus became meaningless. The final average weights were taken November 2, 1965, and are as follows: Lots 1 and 3 - 761 and 754 pounds per head, Lots 2 and 4 - 786 and 834 pounds per head, and Lots 5 and 6 - 781 and 742 pounds per head. These weights reflected the number of dry cows within the lot, age of calves, and number of pregnant cows within the lot. The average weights for pregnant cows with calves per lot were: Lots 1 and 3 - 716 and 736 pounds, Lots 2 and 4 - 782 and 766 pounds, and Lots 5 and 6 - 781 and 739 pounds per head. Treatment averages were sorghum grain - 726, sorghum grain plus soybean oil meal - 774, and soybean oil meal - 760 pounds per head.

Reproductive Performance. The reproductive performance of the heifers is summarized in Table 2. The heifers were pregnancy examined

Table 2. Reproductive performance - Experiment I.

Lot	1	3	2	4	5	6
Number of cows pregnant[1]						
Nov. 20, 1964[2]	8	10	11	11	8	10
Percent	80	90.9	100	100	72.7	90.9
Oct. 30, 1965	7	6	9	11	8	9
Percent	87.5	66.7	90	100	100	90
Calving Data						
Number of calves born	8	9	11	11	8	10
Number of live births[2]	5	8	9	5	8	9
Percent of live births	62.5	88.9	81.8	45.5	100	90
Number of calves weaned	5	7	8	5	8	9
Average weaning weight	229	247	293	318	274	299
Average calving date	5/5	5/20	5/6	4/30	5/17	4/28
Average calving difficulty	3.1	5.2	3.4	4.2	3.9	2.6
Average live birth weight (lbs)	58	67	66	69	65	65

[1]See Table 1 for total number of heifers. One heifer in Lot 1 calved 7/10/64 and was not pregnancy examined.

[2]Not significant

November 20, 1964. The results showed all heifers on the sorghum grain plus soybean oil meal treatment (Lots 2 and 4) were pregnant. Eighteen of the twenty-one heifers on the sorghum grain only treatment were pregnant. The smallest number (18 out of 22) pregnant occurred on the soybean oil meal treatment. These differences were tested statistically and were found to be not significant, however, it was felt the limited numbers involved reduced the accuracy of the statistical test.

The first calf was dropped April 9, 1964. The average calving date per lot was as follows: Lot 1 - May 5, Lot 3 - May 20, Lot 2 - May 6, Lot 4 - April 30, Lot 5 - May 17, and Lot 6 - April 28. Treatment averages were: sorghum grain alone - May 12, sorghum grain plus soybean oil meal - May 3, and soybean oil meal - May 8. Thus, the sorghum grain plus soybean oil meal treatment calved, on the average, five days earlier than did the heifers receiving soybean oil meal and a week earlier than those receiving sorghum grain alone. There were wider differences between lots within treatments. Lot 1 calved 15 days earlier than Lot 3; Lot 4 calved 6 days earlier than Lot 2; and Lot 6 calved 19 days earlier than did Lot 5.

The percentage of live calves at birth varied from 100% - Lot 5 to 45.5% - Lot 4. Treatment averages were as follows: sorghum grain - 76.5%, sorghum grain plus soybean oil meal - 63.6%, and soybean oil meal - 94.4%. These differences were tested statistically and were found to be not significant, however, the accuracy of the test was limited by the small numbers involved. Part of the high percentage of dead calves at birth in Lot 4 can probably be attributed to poor management. Several of the heifers in that lot apparently started calving at night and required assistance although they were not discovered until the next day (approximately 8-10 hours after they began to calve). It was felt some of these calves could have been saved had assistance been forthcoming sooner.

Calving difficulty was scored on a scale ranging from one to ten (a score of 1 indicating no assistance, a score of 5 indicating some assistance required, and a score of 10 indicating a Caesarean section required). The average calving difficulty score per lot was as follows: Lot 1 - 3.1, Lot 3 - 5.2, Lot 2 - 3.4, Lot 4 - 4.2, Lot 5 - 3.9, and Lot 6 - 2.6. Treatment averages are as follows: sorghum grain treatment - 4.2, sorghum grain plus soybean oil meal - 3.8, and soybean oil meal - 3.3. Once again statistical analysis, limited by the small numbers involved, failed to indicate any significant differences. The data indicated that there was more difference between lots within a treatment than existed between treatments.

Average birth weights of calves born alive were: Lot 1 - 58 pounds, Lot 3 - 67 pounds, Lot 2 - 66 pounds, Lot 4 - 69 pounds, Lots 5 and 6 - 65 pounds. With the exception of Lot 1 (8 pounds lighter than the average of the other five lots) there was essentially no difference in the average live birth weight between lots or treatments. Apparently average live birth weights did not influence calving difficulty scores.

The heifers were pregnancy examined October 30, 1965, to determine how many had conceived during the previous summer. The percentage of heifers diagnosed as pregnant per lot were as follows: Lot 1 - 87.5%, Lot 3 - 66.7%, Lot 2 - 90%, Lot 4 - 100%, Lot 5 - 100%, and Lot 6 - 90%. Both lots in the sorghum grain group were lower in heifers diagnosed pregnant than the remaining four lots. The sorghum grain treatment averaged 77.1% pregnant while the other treatment groups averaged 95% pregnant. The evidence indicated that the heifers in the sorghum grain group were harder to settle during the second breeding season as compared to the other treatment groups.

The average weaning weights per lot were: Lots 1 and 3 - 229 and 247 pounds, Lots 2 and 4 - 293 and 318 pounds, and Lots 5 and 6 - 274 and 299 pounds. Heifers in the sorghum grain plus soybean oil meal group weaned the heaviest calves, an average weight of 306 pounds, followed by the soybean oil meal heifers, an average of 287 pounds, and the sorghum grain heifers, an average of 238 pounds per calf.

Plasma Protein Content. The results of the plasma protein analyses are shown in Table 3. The individual samples varied from 2.5 to 20.4 grams per 100 ml of plasma. The average normal range for bovine blood is listed by Albritton (1952) as 7.4 to 10.2 grams per 100 ml of plasma and the average as 8.32 grams per 100 ml. Several of the average values in Table 3 are outside the normal range as listed by Albritton (1952). The large discrepancies between the values obtained in this experiment and the normal values as listed in Albritton (1952) can be largely attributed to sample deterioration in storage. The samples were stored in 100 ml Erlenmyer flasks or test tubes at 4°C. which allowed a small amount of evaporation and subsequent concentration of protein in the samples so affected. The samples were also affected with varying degrees of coagulation, microbial and mold growth, and some samples were hemolyzed to an extent which influenced the accuracy of the colorimetric method used.

Table 3. Plasma protein content - Experiment I.

Lot	1	3	2	4	5	6
Average plasma protein[1] g/100 ml. plasma						
Sampling date						
Jan. 29, 1964	8.3	7.7	9.3	8.8	8.6	9.3
March 23, 1964	8.6	8.6	7.5	8.3	8.0	6.9
June 19, 1964	10.7	8.6	9.8	10.9	11.2	8.1
Aug. 25, 1964	10.2	9.6	12.7	10.7	11.9	9.0

[1]Not significant between treatments, lots within treatments, or animals within lots within treatments. Very highly significant between individual readings (.025 level).

The plasma protein values obtained were statistically tested and no significance was found in the differences between lots within treatments or between treatments. Differences between individual values were very highly significant (at the .025 level). No trends were apparent over the period of time encompassed by the sampling period. Due to the large range of values obtained, no definite conclusions could be drawn from this data.

Experiment II

Weight Changes. The results of this experiment are shown in Table 4. During the first winter period (December 13, 1963-March 30, 1964) both treatment groups lost weight, however the cows receiving supplemental feed lost an average of 88 pounds less per head than the two cows receiving only grass and salt through the winter.

Through the first summer grazing period (March 30, 1964-September 29, 1964) the group receiving only grass and salt gained an average of 13 pounds more than the supplemented group. The supplemented cows gained an average of 73 pounds from December 13, 1963, to September 29, 1964, while the non-supplemented group lost 2 pounds during the same period. The data showed that although the non-supplemented cows outgained the supplemented group through the summer, they did not gain enough to offset the greater losses the non-supplemented group suffered during the first wintering period. As one cow in the supplemented group lost her calf during the summer of 1964, the average weight of this group on September 29, 1964, was higher than it would have been had both cows nursed calves.

Table 4. Results of Experiment II.

Treatment[1]	Supplemental feed	No supplementation
Average body weights (lbs)		
December 13, 1963	825	825
March 30, 1964	728	640
Average loss Dec. 13, 1963 to March 30, 1964	-97	-185
September 26, 1964	898	823
Average gain March 30, 1964 to Sept. 26, 1964	170	183
Average gain Dec. 13, 1963 to Sept. 26, 1964	73	-2
Dec. 3, 1964	885	815
April 5, 1965	845	710
Average loss Dec. 3, 1964 to April 5, 1965	-40	-105
Average gain Dec. 13, 1963 to April 5, 1965	20	-115
Nov. 2, 1965	888	880
Average gain April 5, 1965 to Nov. 2, 1965	43	170
Average gain Dec. 13, 1963 to Nov. 2, 1965	63	55
Number of live calves born		
1964	1	2
1965	2	1
Average live birth weight (lbs) 1965	68.5	71
Average calving date 1965	April 28	May 1
Average weaning weight 1965	360	355

[1]One of each set of identical twins per treatment.

As the cows started the second wintering period (December 3, 1964) the average weight for the supplemented lot was 885 pounds compared to an average weight of 815 pounds in the non-supplemented group. Through this period (December 3, 1964-April 5, 1965) the supplemented cows lost an average of 40 pounds per head and the non-supplemented cows lost an average of 105 pounds per head.

Through the second summer grazing period (April 5, 1965-November 2, 1965) the cows in the supplemented group gained an average of 43 pounds per head while the non-supplemented cows gained an average of 170 pounds per head. Part of the large difference can be attributed to the loss of one calf at birth in the non-supplemented group. Thus again there was one dry cow in one group resulting in an elevated average weight as compared to the weight which would have been observed had both cows nursed a calf.

Over the period December 13, 1963, to November 2, 1965, the supplemented group gained an average of 63 pounds per head and the non-supplemented group gained an average of 55 pounds per head. These gains resulted in average weights per head of 888 pounds in the supplemented group and 880 pounds in the non-supplemented group. It appears that although the non-supplemented cows make greater gains during the summer grazing season, these gains do not completely compensate for the larger losses suffered by the non-supplemented group through the winter period. These results also show that one dry cow in a group of two cows can raise the average weight of that lot significantly through a summer grazing season.

Reproductive Performance. The four cows gave birth to four calves in February and March, 1964, however the Angus twin in the supplemented lot gave birth to a dead calf. The three calves were weaned in October, 1964. Following rebreeding in July, 1964, the cows were pregnancy examined November 20, 1964, and all were diagnosed pregnant. The Hereford twins calved within 3 days; the non-supplemented heifer April 20, and the supplemented heifer on April 23, 1964. The Angus twins calved within 9 days;

the supplemented twin May 2, and the non-supplemented on May 11, 1964. Again there were three calves born alive as the non-supplemented Hereford cow gave birth to a dead calf. The four cows were bred during the summer of 1965 and were diagnosed pregnant October 30, 1965. Apparently there was little difference between treatments as far as reproductive performance was concerned.

Plasma Protein Content. The samples in this experiment deteriorated in storage as did those in Experiment I so that no valid conclusions can be drawn. The results are shown in Table 5.

Table 5. Plasma protein content - Experiment II.

Treatment	Supplemental feed	No supplementation
Average plasma protein g/100 ml. plasma		
Sampling Date		
Jan. 29, 1964	8.6	7.6
March 23, 1964	9.7	6.9
June 19, 1964	10.6	6.8
Aug. 25, 1964	11.3	8.7

GENERAL DISCUSSION

The heifers receiving only sorghum grain supplementation lost weight, on the average, during both the first and second wintering periods (-34 pounds per head during the first winter and -74.5 pounds per head through the second winter). At the same time the heifers receiving sorghum grain plus soybean oil meal gained a moderate amount (28 pounds per head and 24.5 pounds per head) while those supplemented with soybean oil meal alone gained an average of 40.5 pounds the first winter and 49 pounds per head through the second winter. Summer gains were in inverse order; the sorghum grain group gained an average of 269.5 pounds per head, the sorghum grain plus soybean oil meal group gained an average of 251 pounds per head and the group supplemented with soybean oil meal gained an average of 221 pounds per head. The pattern of weight changes was similar to those observed in experiment II. The cows receiving no supplementation lost an average of 185 pounds per head through the first winter and 105 pounds during the second winter while supplemented cows lost an average of 97 pounds per head the first winter and 40 pounds per head the second winter. Through the summer, the non-supplemented group outgained the supplemented group an average of 183 pounds to 170 pounds per head. The non-supplemented group also outgained the supplemented twins through the second summer (April 5-November 2, 1965) by an average of 170 pounds to 43 pounds per head, however during the first summer one cow in the supplemented group was dry while one cow in the non-supplemented group was dry through the second summering period. The pattern of weight changes observed, groups on a higher plain of nutrition gained most during the wintering period and those on a lower plane of nutrition gained more through the summer grazing period, was similar to that observed by Ross et al. (1951), Pope et al. (1952), Pope et al. (1956), Zimmerman et al. (1957), Zimmerman et al. (1959), Pinney et al. (1961), Pinney et al. (1963), and Speth et al. (1962). Knox and Watkins (1958) found that young cows responded to supplemental feed in both average and drought years, but mature cows only in drought years. They further concluded that protein supplements were superior to grain for young cows but grain plus a suitable mineral supplement produced as good results as cottonseed cake when fed to mature cows. Waldrip and Marion (1963) observed that over a four year period, cows supplemented at the levels of 0, 1.5, and 3.0 pounds per head daily of cottonseed cake gained 2, 47, and 26 pounds per head, respectively, over the winter periods.

A smaller percentage of heifers in the sorghum grain group were diagnosed pregnant as compared to the sorghum grain plus soybean oil meal following the initial breeding season, however the sorghum grain group had a slightly higher conception percentage compared to the soybean oil group. Following the second breeding period the sorghum grain group had a substantially lower percentage diagnosed pregnant (77.1%) compared to the other two groups (95%). Reid et al. (1957) noted that a low level of feeding (65% of the upper limit of the Morrison Feeding Standards) had no effect on conception. Turman et al. (1964) stated that a low level of nutrition for heifers up to two years of age was associated with delayed rebreeding of two-year old heifers and a higher percent of open heifers. Harris et al. (1965) observed that fewer restricted fed heifers calved at two years of age compared to optimal-fed heifers. Speth et al. (1962) noted that of cows supplemented with one pound of barley per head daily 72.5% calved compared with 66.7% of those fed three pounds of alfalfa hay per head daily, 63.9% of those fed one pound of protein supplement per head daily, and only 48.2% of those receiving no supplemental winter feed over a five year period. Joubert (1954) noted that a low level of nutrition did not adversely effect the conception rate of heifers. Wiltbank et al. (1957) observed that energy levels affected conception percentages more than protein levels.

Average calving difficulty scores per treatment, sorghum grain - 4.2, sorghum grain plus soybean oil meal - 3.8, and soybean oil meal - 3.3, although not statistically significant, indicated the heifers in the sorghum grain and sorghum grain plus soybean oil meal treatments experienced more difficulty in calving than did the heifers in the soybean oil meal group. All heifers in experiment II calved without difficulty. Ross et al. (1951), Zimmerman et al. (1957), Zimmerman et al. (1959), and Wiltbank et al. (1962) observed no differences in calving difficulty resulting from differing nutritional levels prior to calving. Pope et al. (1956) reported low level heifers experienced less calving difficulties attributable to lighter calf weights and less flesh on the low level heifers. Durham et al. (1963) noted that two groups of heifers fed silage and two pounds of milo and two pounds of cottonseed meal per head daily experienced some calving difficulty, at the same time a comparable group receiving one pound of cottonseed meal per head daily experienced little or no calving difficulty.

Average live birth weight was depressed in one lot of sorghum grain heifers. Lot 1 had an average live birth weight of 58 pounds compared to a range of 65 to 69 pounds for the other five lots. The average live birth weight for the non-supplemented group in experiment II was 71 pounds compared to 68.5 pounds in the supplemented group. Pope et al. (1956), Pinney et al. (1961), Pinney et al. (1963), Durham et al. (1963), and Wiltbank et al. (1962) observed birth weights of calves were depressed if their dams were on a low level of nutrition prior to calving. Hobbs et al. (1965) noted no significant treatment effects were observed for birth weight.

Zimmerman et al. (1959) observed low level heifers calved an average of one week later than medium level heifers and two weeks later than high level heifers. Pinney et al. (1961) reported that average calving date was slightly delayed in low and medium groups compared to high level heifers. Average calving dates delayed by low levels of nutrition were also reported by Pinney et al. (1963), Reid et al. (1957), and Joubert (1954). Wiltbank et al. (1962) observed that a low level of nutrition delayed puberty in heifers. Wiltbank et al. (1962) also reported that the level of energy provided prior to calving seemed to be relatively more important than energy level after calving in influencing the date of occurrence of estrus after calving. The heifers receiving sorghum grain plus soybean meal supplementation calved an average of five days earlier than did the heifers in the soybean oil meal group and a week earlier than the heifers in the sorghum grain group. Actual differences due to treatment effects were obscured by the relatively large differences between lots within treatment groups. There was no apparent treatment differences in average calving dates in experiment II. It was probable that most of the lack of greater variation in average calving date between treatments was caused by the delayed breeding period. As the heifers were on good pasture from May to July, 1964, the sorghum grain group and the non-supplemented group had an opportunity to compensate for the lower nutritional plane they had suffered through the winter. All groups were apparently ovulating in July, 1964, when breeding commenced.

The heifers in the sorghum grain group weaned the lightest calves, an average of 238 pounds per calf, the sorghum grain plus soybean oil meal group weaned the heaviest calves, an average of 306 pounds and the soybean oil meal group was intermediate with an average of 287 pounds per calf. Pinney et al. (1961), Pinney et al. (1963), Turman et al. (1964), and Harris et al. (1965) found that low levels of supplementation depressed weaning weights. The results obtained in experiment I failed to agree with the observations of Waldrip and Marion (1963) and Hobbs et al. (1965). They observed no significant differences in weaning weights attributable to the levels of winter supplement. The results of experiment II show essentially no difference (5 pounds) in average weight of calves weaned from the supplemented and non-supplemented groups. Limited numbers were undoubtedly a factor in this study, however, the results agree with the observations of Waldrip and Marion (1963) and those of Hobbs et al. (1965).

No valid conclusions could be drawn from the results of the plasma protein content analyses made as a part of these experiments. The samples of plasma deteriorated greatly in storage between collection and analysis. As mentioned in the results, some of the factors involved were evaporation losses, coagulation, microbial and mold growth, and hemolysis. Ross et al. (1951) reported heifers receiving low levels of protein supplementation tended to have lower blood plasma protein levels than comparable groups fed higher levels of protein in the winter and early spring. Pope et al. (1952) observed lower average plasma protein levels in heifers wintered at the low level than at the high level from December to April. Pope et al. (1953) noted the average plasma protein level for cows in the high level groups was higher in the winter and early spring, although the average plasma protein level for cows in the low level groups approached that of the high level groups in July and August. He observed no average values outside the range considered normal for beef cattle.

Klosterman et al. (1950) and Wright et al. (1962) observed low levels of dietary protein resulted in lowered plasma albumen levels in ewes. Carroll et al. (1964) reported finding lower plasma protein and plasma albumen levels in heifers fed maintenance energy levels and submaintenance protein levels as compared to heifers receiving the maintenance energy level and a liberal allowance of protein. He observed the differences in plasma protein levels were no longer significant after 35 days; the same was true of the plasma albumen levels after 60 days.

SUMMARY

The heifers in the sorghum grain treatment group lost an average of 34 pounds per head during the first wintering period (first 115 days of the experiment); the heifers in the sorghum grain plus soybean oil meal treatment group gained an average of 28 pounds per head, and the heifers in the soybean oil meal treatment group gained an average of 40.5 pounds per head. These differences were statistically significant at the .025 level between treatments and significant at the .005 level between lots within treatments.

Although the sorghum grain group made the largest gains during the following summer grazing season, an average of 269.5 pounds per head as compared to an average gain of 251 pounds per head in the sorghum grain plus soybean oil meal group and an average gain of 221 pounds per head in the soybean oil meal group, their average gains over the first 293 days of the experiment (first winter and first summer) were lowest, an average gain of 235.5 pounds per head as compared to an average gain of

277.5 pounds per head in the sorghum grain plus soybean oil meal group and an average gain of 266.5 pounds per head for heifers in the soybean oil meal treatment group. These differences in gain over the first 293 days of the experiment were statistically significant at the .05 level between the sorghum grain treatment group and the sorghum grain plus soybean oil meal treatment group (lowest and highest gains respectively over the first 293 days of the experiment).

Through the second wintering period the sorghum grain treatment group lost an average of 74.5 pounds per head, the sorghum grain plus soybean oil meal group gained an average of 24.5 pounds per head, and the soybean oil meal group gained an average of 49 pounds per head. Average gains over the first 484 days of the experiment were sorghum grain group - 153.5 pounds per head, sorghum grain plus soybean oil meal group - 286 pounds per head, and soybean oil meal group - 315.5 pounds per head. These differences were statistically significant at the .05 level between treatments. The average weights of pregnant cows with calves at the end of the experiment (after the second summer grazing period) were sorghum grain group - 726 pounds, sorghum grain plus soybean oil meal group - 774 pounds, and soybean oil meal group - 760 pounds.

Following the first breeding season (July 1-October 1, 1964), a pregnancy examination disclosed that 100% of the sorghum grain plus soybean oil meal group were pregnant as compared to 85.7% pregnant in the sorghum grain treatment and 81.8% pregnant in the soybean oil meal group. These differences were not statistically significant.

The sorghum grain plus soybean oil meal treatment group calved, on the average, five days earlier (May 3) than did the soybean oil meal group (May 8) and seven days earlier than did the sorghum grain group (May 12). Wider variation existed between lots within treatment groups, however none of these differences were statistically significant.

The percentage of live calves at birth was as follows: sorghum grain group - 76.5%, sorghum grain plus soybean oil meal group - 63.6%, and soybean oil meal treatment group - 94.4%. These differences were not statistically significant.

Average calving difficulty scores per treatment were as follows: sorghum grain group - 4.2, sorghum grain plus soybean oil meal - 3.8, and soybean oil meal - 3.3. Wider variation existed between lots within treatments than did between treatment groups. These differences were not statistically significant.

Heifers in Lot 1 gave birth to calves which had an average live birth weight 8 pounds lighter than the average of the other five lots in which there was only a four pound range in average live birth weights. Apparently average live birth weights did not influence calving difficulty scores.

Following a second breeding period (June 18-September 2, 1965) a pregnancy examination October 30, 1965, disclosed that a smaller percentage of heifers in the sorghum grain group were pregnant (77.1%) compared to 95% for each of the other two treatment groups. The results indicated that the sorghum grain treatment depressed the conception rate during the second breeding season.

The average weaning weights per treatment were: sorghum grain group - 238 pounds, sorghum grain plus soybean oil meal - 306 pounds, and soybean oil meal group - 287 pounds per calf. Although the heifers in the sorghum grain and soybean oil meal group weaned calves which averaged 19 pounds heavier than those weaned by the heifers in the soybean oil meal group; the soybean oil meal group weaned 17 calves compared to 13 weaned by heifers in the sorghum grain plus soybean oil meal treatment group. The sorghum grain treatment group weaned lightest calves, on the average, as well as the fewest calves (12).

The weight change pattern of the cows in experiment II was similar to that observed in experiment I. The non-supplemented cows lost more body weight through the wintering periods than did those in the supplemented group. The non-supplemented group made large gains during the summer grazing period compared to the supplemented group. Through each summer grazing season one cow was dry as a result of giving birth to a dead calf (supplemented Angus in 1964 - non-supplemented Hereford in 1965). This increased average weights per cow in the lots containing the dry cows. No treatment effects were apparent in any of the parameters concerned with reproductive performance.

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APPENDIX

Table 6. Calf weaning weights.

Age in days Nov. 2, 1965	Sex	Weaning weight (lbs.)	Adjusted weaning weight[1] (lbs.)
Lot 1			
199	Male	245	227
196	Female	315	305
177	Female	250	264
163	Male	215	231
147	Male	120	132
Lot 2			
200	Male	365	335
199	Male	360	332
199	Female	310	298
195	Male	295	277
185	Female	275	280
184	Female	295	301
170	Male	255	266
159	Female	190	220
Lot 3			
187	Male	270	278
185	Female	230	246
183	Male	260	263
180	Male	245	245
167	Male	250	264
159	Male	250	275
121	Female	225	307
Lot 4			
201	Male	345	316
187	Male	325	316
187	Female	395	394
159	Male	265	293
153	Male	260	293
Lot 5			
207	Female	340	215
202	Female	320	303
185	Male	290	284
169	Male	285	299
156	Female	235	286
151	Male	275	315
143	Female	240	296
138	Female	205	260

Table 6. (cont.)

Age in days Nov. 2, 1965	Sex	Weaning weight (lbs.)	Adjusted weaning weight[1] (lbs.)
Lot 6			
206	Female	330	307
202	Male	345	315
199	Male	360	332
197	Female	345	332
189	Male	325	313
185	Female	210	217
182	Female	245	254
180	Male	310	310
141	Male	220	263

[1]The weights are adjusted to 180 days or 6 months and to a steer equivalent.

PROTEIN LEVEL FOR HEIFERS ON WINTER BLUESTEM PASTURE

by

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This experiment was designed to study the level of winter protein supplementation for heifers on bluestem pasture.

The sixty-six heifers used were separated into six lots of eleven head each on a random weight basis. Two lots were fed each of the following experimental winter supplement rations: 2.0 pounds of ground sorghum grain per head daily, 1.0 pound of ground sorghum grain plus 1.0 pound of soybean oil meal per head daily, and 2.0 pounds of soybean oil meal per head daily.

The average weight changes per head over the first 115 days (first wintering period) were: sorghum grain group - loss of 34 pounds, sorghum grain plus soybean oil meal group - gain of 28 pounds, and soybean oil meal group - gain of 40.5 pounds. These differences were highly significant between treatments and between lots within treatments.

The groups receiving sorghum grain made large compensatory gains during the summer grazing period, however, the average gains over the first 293 days (first winter and first summer) were: sorghum grain - 235.5 pounds, sorghum grain plus soybean oil meal - 277.5 pounds, and soybean oil meal - 266.5 pounds. The difference between the sorghum grain group and the sorghum grain plus soybean oil meal group was significant at the .05 level.

The average gains over the first 484 days (first winter and summer plus second winter) were: sorghum grain - 153.5 pounds, sorghum grain plus soybean oil meal - 286 pounds, and soybean oil meal - 315.5 pounds per head. These treatment differences were significant at the .05 level.

All of the heifers in the sorghum grain plus soybean oil meal group were diagnosed pregnant after the first summer compared with 89% in the sorghum grain group and 81.8% in the soybean oil meal group. The sorghum grain plus soybean oil meal group calved, on the average, five days earlier than the soybean oil meal group and a week earlier than the sorghum grain group although wider variation existed between lots within treatments. The highest percentage of live calves born occurred in the soybean oil meal group (94.4%) compared to sorghum grain - 76.5% and sorghum grain plus soybean oil meal - 63.6%. Average calving difficulty scores (based on a scale of 1 to 10 with 10 representing extreme difficulty) were: sorghum grain - 4.2, sorghum grain plus soybean oil meal - 3.8, and soybean oil meal - 3.3, however, wider variation existed between lots within treatments than between treatments. Average live birth weights in one of the sorghum grain lots were 8 pounds lighter than the average of the other lots. The soybean oil meal group weaned more calves (17 vs. 13) which were lighter (287 vs. 306 pounds) compared to the sorghum grain plus soybean oil meal group. The sorghum grain group weaned fewer, smaller calves (12, 238 pounds) than did the other groups.

The sorghum grain group failed to rebreed as well as the other groups during the second summer (77.1% vs. 95%).

Two sets of identical twins were used in a small pilot study to determine the effects of feeding no supplemental feed to cows wintered on bluestem pasture. One twin of each set was fed 1.0 pound of sorghum grain plus 1.0 pound of soybean oil meal per head daily during the wintering periods. The remaining twins received only grass and salt. The non-supplemented group lost more weight through the winters, however, they compensated by large gains through the summer grazing seasons compared to the supplemented group. There were no apparent treatment effects in regard to reproductive performance.

Sample deterioration prevented drawing any valid conclusions from the plasma protein analyses.