INFLUENCE OF WINTER NUTRITION ON REPRODUCTION, COW WEIGHTS AND CALF GAINS FOR SPRING-CALVING BEEF COWS

by

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Literature Review

Because of its economic implication nutritional requirements of beef cows are of obvious interest to the producer. While cow weight changes are a direct result of varying nutritional factors, reproductive performance and calf gains are of more immediate economic importance.

The relationship between feeding level and reproduction in the bovine has been the subject of reviews by Reid (1960); Wiltbank *et al*. (1965); Baker (1969) and Lamond (1970a).

The mechanism of the effects of feed intake on reproduction in the cow has not been established. Bellows *et al*. (1963) found grain feeding increased total pituitary gonadotropins in the ewe but not the response of the ovary to pregnant mare's serum (PMS) and Lamond (1970b) has shown the ovaries of heifers on a low nutritional plane are responsive to PMS.

Wiltbank *et al*. (1964) observed cows full-fed during the post-partum period had larger follicles and greater ovarian volume during the 5 week period prior to estrus. Folman *et al*. (1973) found cows maintained on a high level of nutrition required fewer services per conception, conceived earlier and had a high plasma progesterone level 23 days earlier in the post-partum period than cows maintained on a standard level of nutrition.

Hill *et al*. (1970) found reduced plasma progesterone levels and unaltered plasma luteinizing hormone (LH) levels within 5 days after feed restrictions. Others (Donaldson, Bassett and Thorburn, 1970 and Gombe and Hansel, 1973) observed increased plasma progesterone during the first estrual cycle of feed restriction but decreased levels thereafter. Gombe and Hansel (1973) found these lower progesterone levels were accompanied by an increase in plasma LH. These results suggest feed restrictions decrease ovarian sensitivity to LH.

Howland *et al*. (1966) suggested that in the ewe persistently elevated plasma glucose levels, via hypothalamic stimulation, lead to greater gonadotropin production and subsequently greater ovarian activity. Similarly Howland and Ibrahim (1971) found ovarian atrophy in underfed rats is associated with reduced levels of plasma LH. When glucose was supplied *ad libitum* body and organ weights were maintained and plasma LH levels were maintained near control levels although pituitary LH levels were lowered.

McClure (1965b) observed blood glucose levels were rising at the time of mating for fertile cows but were lower and falling for infertile cows. In later work, first in mice (McClure, 1967) and later with cows (McClure, 1968) lowering blood glucose with insulin injections produced reproduction failures similar to those of fasting animals. In the cow, four daily insulin injections beginning on day 17 of the estrous cycle significantly lengthened the cycle. However, prolonged nutritional extremes have been reported not to alter cycle length (Joubert, 1954b; Wiltbank *et al*., 1965).

In fasting mice it is possible to restore fertility with human chorionic gonadotropin (HCG) injections (McClure, 1967). Ovaries of underfed rats and guinea pigs are responsive to pituitary hormones (Mulinos and Pomerantz, 1941; Stephens and Allen, 1941). Oxenreider and Wagner (1971) also found evidence of the importance of blood glucose levels. They obtained a significant negative correlation between blood glucose concentration and the post-partum interval to a follicle larger than 10 mm ($r = -.50$) and first ovulation ($r = -.62$). These differences were due to the nutrition and lactation treatments employed since within group correlations for these parameters were near zero. They were able to overcome part of the lactational depression on reproductive function by increasing energy intake. Lactation in this study depressed plasma glucose even though feed intake was adjusted to meet NRC requirements for lactating cows. Jordan, Lister and Rowlands, (1968a) reported cows provided an ad libitum roughage ration of corn silage plus one pound of mixed hay per 100 kg of body weight did not consume enough nutrients to meet NRC requirements for lactation. However, McCartor (1972), working with Hereford heifers, did not find an effect on blood glucose due to suckling.

Beef Cow Nutrition

Two major goals in beef cow reproduction are that a cow calve every year and that she calve early in the calving season. Wiltbank (1970) described three major problems associated with long breeding and calving seasons:

(1) At weaning calves from late calving cows are younger and consequently lighter than calves from cows that calve early in the season; (2) Factors such as nutrition, losses at calving and calfhood diseases cannot be controlled adequately and (3) The opportunity for individual cows to have calving intervals longer than 12 months is greater in long breeding periods than in short breeding periods.

The amount and composition of rations are important considerations. Wiltbank et al. (1965) compared energy and protein in rations for beef heifers. Their work shows all heifers fed adequate protein and high (ad libitum) or medium (66% of the high level) energy exhibited estrus but maintenance levels of energy were too low to initiate estrual cycles. Both they and Bond et al. (1962) observed decreased feed intake when protein was restricted. Jordan et al. (1968a) reported no difference in consumption of an all roughage ration whether or not linseed oil meal was supplied.

Wiltbank et al. (1965) found cows did not show estrus following calving unless they were supplied enough energy, regardless of the level of protein fed. They noted a trend for heifers fed higher energy and protein levels to show estrus sooner than those fed lower levels. In another report (Wiltbank, 1970) two-year-old heifers were fed 8 lb TDN prior to calving. Post-calving energy levels were then compared; only 81% of the heifers receiving 7 lb TDN post-calving had shown estrus by 100 days after calving compared to 97% and 98% of the heifers which received 13 lb and 22 lb TDN, respectively.

Wiltbank *et al.* (1965) found if heifers showed estrus and ovulated, conception rate was not affected by the rations fed. This agrees with Joubert's (1954b) conclusions.

This is not in agreement with the report of Zimmerman, Clanton and Matsushima (1961) who found 38% and 83% first service conception rates for heifers fed maintenance protein requirements and 150% of maintenance respectively. They also supplied maintenance and 150% of maintenance energy requirements and all combinations of the two levels of energy and protein. Restricting energy intake significantly increased the interval from calving to first heat (142 and 148 days for the low energy groups vs. 54 and 51 days for the high energy groups.)

Immature growing animals are more sensitive to nutritional restrictions than mature animals (Wagnon, Guilbert and Hart, 1959). For both supplemented and non-supplemented animals conception rates were lower for the second calving than the first and there was a carry over effect on the third calving in the non-supplemented group.

Jordan, Lister and Rowlands (1968a) found pregnant cows could successfully be wintered within the range of 0.050 to 0.065 kg DP and 0.50 to 0.65 kg TDN per 100 kg of fall weight, daily. They also found an increase in reproductive failure associated with the addition of 0.45 kg linseed oil meal to the ration.

An important consideration is the interval from calving to first estrus. Cows that are allowed two chances to conceive and still calve at yearly intervals must show estrus by approximately 60 days post-partum.

Wiltbank et al. (1962) supplied high and low energy levels pre-and post-calving (9 lb and 4.5 lb TDN pre-calving and 16 lb and 8 lb TDN post-calving). Their results indicate low levels of pre-calving energy can be compensated for by high post-calving levels; however, there is a delay in the interval to first estrus. Four and one-half pounds of TDN were inadequate to allow estrus in a majority of the cows by 60 days post-calving even when 16 lb TDN were provided after calving. Eighty percent of the high pre-calving energy group had been in heat by 60 days post-partum. It was 70 days after calving before a majority (70%) of the low-high group had been in heat and 80 days before 80% had shown estrus. Most of the cows maintained on the low level failed to show estrus and high levels of post-calving energy resulted in improved conception at first service and fewer services per conception. Also significantly fewer cows on low energy levels after calving became pregnant, but as reported by others (Joubert, 1954b; Wiltbank et al., 1965) this was related to differences in the occurrence of estrus.

Wiltbank et al. (1964) have shown the intervals to first post-partum estrus and conception decrease when high levels of nutrition are provided earlier. When 16.5 lb TDN were provided daily following calving conception occurred an average of 67 days post-partum. If only 8.6 lb TDN were supplied the first 4-5 weeks after parturition and then either 16.4 lb or 25.2 lb TDN fed the respective intervals to conception were 86 and 87 days. Conception rates were highest in the groups receiving 25 lb TDN during the breeding period. It seems that conception depends on the level of nutrition at breeding while the occurrence of estrus is influenced by feeding levels over a longer period.

Feeding either more or less than 16.5 lb TDN significantly delayed estrus. This opposes the results of two experiments using heifers (Wiltbank et al., 1965, Pinney et al., 1960) who show no adverse effects on the interval to first estrus due to full feeding. Wiltbank et al. (1965) also found no problems in this respect due to full feeding through the second calving.

Working with heifers, Dunn et al. (1969) found 17.3 megcal energy daily pre-calving resulted in more than half the heifers showing estrus by 60 days post-partum. While more than half the heifers fed 8.7 megcal pre-calving did not show estrus by 60 days post-calving, feeding 48.2 megcal per day after calving resulted in 88% showing estrus by 80 days post-partum. It appeared that by 80 days post-calving the energy level fed after calving was influencing the occurrence of estrus and that by 100 days post-calving pre-calving energy was no longer affecting the occurrence of estrus. Intervals from calving to conception were 83 and 77 days for cows fed low and high pre-calving energy respectively. Again energy levels during the breeding season influenced conception rates. Pre-calving feeding influenced conception at first service, but not at subsequent services.

Range Cow Nutrition

Low quality roughages are a frequent component of beef cow rations and it is common for management systems to include grazing dormant range grasses during the winter feeding period. Establishment of supplementation recommendations under these conditions is particularly difficult because of uncertainty regarding the amount and composition of forage consumed.

California workers (Wagnon, Guilbert and Hart, 1959) found supplementation during annual periods of scarce forage availability increased the pregnancy rate 15%, lowered the percentage of calves dying between birth and weaning and resulted in heavier calves at weaning.

The importance of energy under these conditions has been shown by Nevada research (Speth *et al.*, 1962). No supplement (controls), 1 lb barley, 1 lb commercial protein and 3 lb alfalfa hay were compared on a semi-desert range. All dietary supplements significantly increased calving percent; however, significantly more calves died at birth or shortly thereafter in the commercial supplement group. Knox and Watkins (1958) also found indications that calf losses are increased when cows are fed a protein supplement. Cows in the barley group had the highest calving percent and weaned significantly more calves, partially due to higher death losses in other groups.

Several reports from the Fort Reno Experiment Station in Oklahoma have dealt with the supplemental feeding of range beef cows (Pinney et al., 1960; Turman et al., 1964; Smithson et al., 1966; Holloway et al., 1973). They indicate that smaller winter weight losses obtained by higher levels of feeding decrease the post-partum interval to conception. One of these (Smithson et al., 1966) found that extremely high levels adversely affected longevity and milk production while low levels resulted in poor reproductive performance, decreased milk production and lowered weaning weights. McClure (1965a) found providing hay ad libitum significantly improved the fertility of a pastured dairy herd.

Supplementation does not always improve reproductive performance. Providing 2.5 kg ground corn daily for 30 days beginning 15 days prior to a 60 day breeding season to cows grazing bermuda grass increased cow weights, but not calving percent (Loyacano et al., 1973). Stanley (1938), wintering cows on Arizona range land found no increase in percent calf crop when cows were provided 1 to 1.5 lb cottonseed cake daily for about 100 days each winter.

Protein Content of Rations

Many studies have compared different amounts of protein supplementation. When pangolagrass hay was provided free choice (Witt et al., 1958) providing cows with supplemental protein to meet requirements resulted in a shortened post-calving period to first breeding and conception when compared with cows restricted to 50% of protein requirements. A reduced feed intake was noticed on the low protein diet.

Foster, Biswell and Hostetler (1945) fed different protein levels to cows on forest range of the southeastern coastal plane. While not consistant, their results indicate a higher percent calf crop for cows receiving increased protein. Lantow (1930) working in New Mexico found providing cottonseed cake during the winter months resulted in a slightly larger calf crop and that unsupplemented groups were more erratic in their calf crop percentages from year to year.

Differences in fertility from year to year are well documented. Baker and Quesenberry (1944) found a highly significant yearly variation in calf crop percent for cows under range conditions. Other reports (Brown _et al_., 1954; Lasley _et al_., 1961; Koger _et al_., 1962; Wiltbank _et al_., 1967) have made similar observations. In contrast, relatively few reports have found no year effect (Lindley _et al_., 1958; Warnick _et al_., 1967). Some of these yearly variations are undoubtedly due to variations in the type and amount of forage available. Reports of lowered fertility in drouth years support this contention (Baker and Quesenberry, 1944; Knox and Watkins, 1958; Carroll and Hoerlein, 1966). Knox and Watkins (1958) found supplemental feeding in normal years did not improve the percent calf crop the following year. However, under drought conditions the percent calf crop was increased and corn was as good a supplement as higher protein feeds. Similarly, Marsh *et al.*, (1959) found cows on heavily grazed pastures had poor calf crops.

Cow Weight Changes

A California report by Wagnon, Guilbert and Hart, (1959) shows young cows that rebred were always 30-80 lb heavier than those that did not. Lamond (1969) found high fertility was associated with high condition score and McClure (1965a and 1965b) found fertile cows were gaining weight at the time of breeding and infertile cows were losing weight. Several others have found higher pregnancy rates in cows that are rapidly gaining weight (Wiltbank *et al.*, 1962; Wiltbank *et al.*, 1964; Wiltbank *et al.*, 1965). Warnick *et al.*, (1967) found higher pregnancy rates in Brahman and Santa Gertrudis cows that were gaining the most weight. Apparantly this relationship was not found in the Angus, Brangus and Hereford cows they studied. When adequate amounts of feed are provided after a prolonged period of feed restriction weight gains precede the initiation of estrous cycles (Bond, Wiltbank and Cook, 1958; Wiltbank *et al.*, 1962; Wiltbank *et al.*, 1965).

Bellows (1972) found heifers gaining 0.6 lb/day during a wintering period were 22 and 45 days older at puberty than heifers gaining 1.0 and 1.5 lb/day during the winter when all heifers were placed on the same summer range. Their data also indicate an earlier conception date and significantly lower early embryonic mortality for the faster gaining heifers. Oklahoma workers (Smithson *et al.*, 1966) recommend a moderate level of feeding which results in a gain of 97 lb the first winter as weaner calves and losses in the following winters of approximately 10-15% from fall weight including weight lost at calving.

Many reports indicate free access to summer pasture results in compensatory gains with cows losing the most or gaining the least weight during the winter feeding period gaining more weight the following summer (Arnett, Baker and Vinke, 1926; Lantow, 1930; Vinke and Dickson, 1933; Foster, Biswell and Hostetler, 1945; Joubert, 1954a; Wagnon, Guilbert and Hart, 1959; Pinney et al., 1960; Speth et al., 1962; Jordan, Lister and Rowlands, 1968a; Hironaka and Peters, 1969; Bellows, 1972). These reports are in agreement with the general concepts of compensatory gains (for a review see Wilson and Osborne, 1960).

Apparently beef cows can lose substantial weight during the winter and recover on pasture the next summer. However, recovery is not complete in all cases (Wagnon, Guilbert and Hart, 1959; Bellows, 1972).

Protein supplements provided on winter pasture seem to result in greater winter weight gains (Knox, 1932; Knox and Watkins, 1958; Speth et al., 1962). Jordan, Lister and Rowlands (1968a) found adding 0.45 kg linseed oil meal to the daily ration decreased weight losses during pregnancy although it did not affect weight changes during the lactation period which preceded pasture grazing.

Calf Growth

The effect of dam's nutrition on calf growth is an important consideration. Cows receiving more feed during pregnancy give birth to heavier calves (Black, Quesenberry and Baker, 1938; Stanley, 1938; Pinney et al., 1960; Wiltbank et al., 1962; Turman et al., 1964). Wiltbank et al. (1965) found differences in birth weight resulted from cows on low levels of feed giving birth to lighter calves but high feeding levels did not increase birth weights. Similarly Knapp et al. (1942) observed a drop in birth weights following drought years.

Jordan et al. (1968b) found 0.033 kg DP and 0.36 kg TDN per 100 kg initial weight adversely affected body weight and measurements at birth when compared with higher levels. Hironaka and Peters (1969) observed no effect on birth weight when the dams nutrition was severely restricted and Rust, Meiske and Goodrich (1970) reported no effect on birth weights when pregnant cows were provided 15.2, 17.9 and 18.9 megcal per day.

Weaning weight is not consistantly altered. Wagnon, Guilbert and Hart (1959) found unsupplemented cows had less udder development at partuirition and their calves grew slower the first few months after birth. After 4 months calf gains were similar for both groups. Some reports have shown an effect on weaning weights due to winter feeding (Foster et al., 1945; Pinney et al., 1960; Speth et al., 1962). Others have found no relationship (Arnett et al., 1926; Vinke and Dickson, 1933; Holloway et al., 1973). One Oklahoma report (Turman et al., 1964) shows no effect of winter nutrition on weaning weights although there was a tendency for cows on higher winter nutrition to produce more milk. Range conditions may influence this relationship since winter feeding increased weaning weights when cows were maintained on semi-desert range (Speth et al., 1962). Flushing cows on bermuda grass pasture for 30 days beginning 15 days before a 60 day breeding season did not affect weaning weights (Loyacano et al., 1973).

A Canadian report (Jordan et al., 1968b) found no adverse effects on calf growth or survival due to restricting feed during pregnancy and early lactation. Other Canadian work (Hironaka and Peters, 1969) under short grass range conditions, found low levels of digestible energy restricted calf gains to weaning. They reported the cows studied did not begin the winter carrying an excess of flesh and suggested the extra feed required to restore the body weight of cows wintered on low levels of digestible energy reduced the amount available for milk production and thus weight gain of calves.

Summary

Winter nutrition requirements for beef cows grazing dormant winter range in the Kansas Flinthills were studied from 1968 to 1973 (three-two year trials). Milo (1.36 kg) was superior to soybean meal (0.68 kg) in improving reproductive efficiency when added to a basic ration of 1.36 kg alfalfa hay. Additional response was obtained when the amount of milo was doubled. When a part of the winter feed was delayed until after calving conception occurred later in 2-and 3-year-old cows but mature cows reproduced efficiently when daily feed was increased either at calving or 30 days before the average calving date.

Increasing the amount of winter feed increased cow weight during the feeding period and the following grazing period. Cows which rebred were significantly heavier during both periods than those which did not. In general, calf birth and weaning weights increased when larger amounts of winter feed were provided the dam.

Introduction

Beef cows are frequently expected to utilize dormant range during winter. The purpose of supplemental feeding during these periods is to obtain optimum reproductive efficiency and calf gains consistant with economic considerations. Several reports have considered supplemental nutrient requirements for range beef cows, (Knox and Watkins, 1958;

Speth *et al.*, 1962; Smithson *et al.*, 1966). The objective of this research is to consider the effect of various energy and protein levels on cows grazing dormant winter range.

Experimental Procedure

Supplemental energy and protein requirements for beef cows on dormant winter range pasture were studied in three 2 year trials from 1968 to 1973. No attempt was made to measure winter pasture consumption. Rations are given by trial in Table 1. Ration 1 was included in all trials to aid comparisons between trials.

Trial 1 was designed to compare energy and protein after 1.36 kg alfalfa hay was fed daily and included rations 1 through 4. Ration 2 supplied crude protein in excess of National Research Council (NRC, 1970) requirements and ration 4 provided approximately half crude protein requirements. Rations 1 and 3 were formulated to be relatively high energy-low protein and low energy-high protein rations, respectively.

Trial 2 included rations 1, 5, 6 and 7. Ration 5 was primarily a grain mixture which included urea and was formulated to approximate ration 1 (Table 2). Ration 6 supplies twice the milo in ration 1. Cows on ration 7 were fed 1.36 kg alfalfa hay daily until calving and within one week post-partum their daily feed was increased by 2.72 kg milo.

Trial 3 investigated the possibility of delaying a part of the winter feed until February 10 and included rations 1, 8, 9 and 10. Ration 9 was a grain-soybean meal mixture similar to ration 5. Rations 8 and 10 provided 1.36 kg alfalfa hay and 1.36 kg of a grain-soybean meal mixture respectively until February 10 when daily feed was increased by 2.72 kg milo and 1.81 kg grain-soybean meal mixture, respectively.

Spring calving Polled Hereford and commercial horned Hereford cows were allotted randomly by age to winter rations at the beginning of each 2 year trial. Most cows remained in the herd both years of the trial and remained on the same winter ration both years; others were included in only one year.

Breeding was predominantly by natural mating and occurred during a 65-day breeding period beginning approximately May 25 each year. Cows were allotted randomly by winter ration to breeding groups and each breeding group exposed to one Polled Hereford or Angus bull. Twenty-one cow years in trial 1 and 37 cow years in trial 3 involved a period of artificial insemination, and 34 cow years in trial 3 were exposed to a bull within one week after calving. Statistical corrections were made for differences in bulls and breeding techniques with winter rations approximately equally represented in all breeding groups.

Cows were weighed at monthly intervals and feed was provided daily from approximately November 1 to April 20. Available forage was dormant during the feeding period and consisted predominantly of Big and Little Bluestem, Indian grass and Switch grass. During periods of prolonged snow cover grass hay was fed, however this was rarely necessary. During the summer abundant good quality forage was available.

Calving dates were used to determine conception dates the previous year with the exception of the second year of trial 3 when bulls were equipped with chin ball markers[1] and daily observations made to determine time of estrus. During this year cows were rectally palpated at two week intervals during the breeding period, at the end of the breeding period and 60 days later to determine conception and date of conception. Conception date was considered the first day marks were observed if conception occurred at that estrus. In other years a 283 day gestation period was assumed and conception date calculated from the following years calving date.

For statistical analysis cows were divided into 3 age groups; 2-years-old, 3-years-old and 4-years-old and older. Cow age was calculated on January 1 of the year of breeding and rounded to the nearest year. All age groups were represented in all trials with the exception of trial 3 which did not include 2-year-old cows. For analysis of cow weight, cows were assigned to one of three rebreeding groups; group 1 rebred the first 31 days of the breeding period, group 2 rebred during the remainder of the breeding period and group 3 failed to rebreed.

Data were analyzed by least squares analysis of variance

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[1]American Breeders Service, De Forest, Wisconsin 53532.

TABLE 1. WINTER RATIONS

	Trial 1				Trial 2				Trial 3			
Ration no.	1	2	3	4	1	5	6	7	1	8	9	10
Soybean Meal, kg	---	0.68	0.68	---	---	---	---	---	---	---	---	---
Milo, kg	1.36	1.36	---	---	1.36	---	2.73	2.73 after calving	1.36	2.73 after Feb. 10	---	---
Alfalfa hay, kg	1.36	1.36	1.36	1.36	1.36	---	1.36	1.36	1.36	1.36	---	---
Mix, kg	---	---	---	---	---	2.27[1]	---	---	---	---	2.27[1]	1.36[1] before Feb. 10 3.18 after Feb. 10

[1]Mix in table 2.

TABLE 2. MIXES FED IN TRIALS 2 AND 3

Feed	Ration 5 Mix		Ration 9 Mix
	Year 1	Year 2	
	%	%	%
Soybean meal	---	---	7.0
Wheat	---	15.0	30.0
Milo	85.5	70.5	53.0
Dehy alfalfa	9.5	---	10.0
Alfalfa hay	---	9.5	---
Urea	1.0	1.0	---
Limestone	2.0	2.0	---
Molasses	2.0	2.0	---

(Kemp, 1972) and when significant differences were detected means were compared by Duncan's New Multiple Range Test (Steel and Torrie, 1960).

Results

Conception date, percent conception and cow weights are given in table 3. Conception data were analyzed by trial and adjusted to a trial 2 basis.

In trial 1 rations including milo (rations 1 and 2) resulted in significantly earlier conception dates than providing only 1.36 kg alfalfa hay daily (ration 4). Adding 0.68 kg soybean meal to the basic alfalfa hay ration (ration 3) resulted in an earlier conception date which approached significance. The earlier conception dates for rations including milo vs. soybean meal (rations 1 and 2 vs. ration 3) also approached significance. The age by nutrition interaction was not significant, however most of the difference between rations 1 and 2 and ration 3 occurred among 2-and 3-year-old cows. Restricting energy and/or protein did not lower conception rate for cows 3-years-old and older but conception rate was low for 2-year-old cows fed only 1.36 kg alfalfa hay daily (ration 4).

In trial 2 cows fed the milo-urea mixture (ration 5) and those fed 1.36 kg alfalfa hay, 2.73 kg milo the entire period (ration 6) conceived significantly earler than cows that had a part of their winter feed delayed until after calving (ration 7, $p < .05$). Cows fed 1.36 kg alfalfa hay, 1.36 kg milo (ration 1) conceived significantly later than cows fed twice this amount of milo (ration 6, $p < .05$). This effect was primarily on 2-and 3-year-old cows with little response observed for older cows.

Ration did not significantly affect conception date in trial 3 ($p > .15$) but the age by nutrition interaction approached significance ($p = .07$). Three-year-old cows seemed to rebreed late on the milo-soybean meal mixture (ration 9).

Rations significantly affected cow weights both in winter (December and February, $p < .001$) and summer (May and September, $p < .05$). Since November weight was included as a covariate in the model, weights within treatments are a measure of weight changes. Cows that rebred weighed more in both winter and summer than those that did not ($p < .05$). Month weighed also significantly affected weight ($p < .001$). Cows lost weight from December to May and gained weight from May to September. The age by ration by month and age by pregnancy classification by month interactions were not significant ($p > .2$).

Winter cow weights increased with increased winter feed except for cows fed ration 7 which were heavier than would have been expected. Rations which delayed a part of the winter feed (rations 7, 8 and 10) had not been increased by the February weight.

Summer weights also responded to increased winter feed.

Delaying a part of the winter feed seemed to decrease cow weights the following summer (ration 1 vs. ration 8 and ration 9 vs. ration 10).

Pregnant cows weighed 20.9 kg more than open cows during the winter ($p < .001$) and dry cows weighed 36.2 kg more than cows who lactated during the summer ($p < .001$).

Rations significantly affected calf weight at birth and weaning ($p < .03$, table 4). Cows fed 1.36 kg alfalfa hay daily until late in the winter (rations 7 and 8) had lighter calves at birth and weaning than the average and cows fed only 1.36 kg alfalfa hay daily throughout the feeding period (ration 4) also weaned light calves although birth weights for these calves were relatively high. Adding 0.68 kg soybean meal (ration 3) did not significantly increase either weight. Feeding 1.36 kg alfalfa hay plus 1.36 kg milo daily (ration 1) and the grain-urea mixture (ration 5) resulted in similar weaning weights while the grain-soybean meal mixture (ration 9) tended to increase weaning weights. Adding 0.68 kg soybean meal to ration 1 (ration 2) also tended to increase weaning weight. Cows fed ration 6, which provided more energy than any other ration, weaned the heaviest calves and cows fed ration 10 weaned the next to heaviest calves.

Day of calving significantly affected conception date in all trials ($p < .03$, regression coefficients of .32; .38 and .22 for trials 1, 2 and 3 respectively). The day calved by age of cow interaction significantly affected conception date in trial 2 (p=.01) and approached significance in trial 1 (p=.27) with the most effect on young cows.

Discussion

Earlier conception for cows fed higher energy vs. higher protein (ration 1 vs. ration 3) indicates energy's importance for reproductive function. This agrees with Wiltbank et al. (1965) and Speth et al. (1962). Most of the response to energy occurred in 2-and 3-year-old cows however 1.36 kg alfalfa hay was inadequate even for mature cows as indicated by the delayed conception date. Both winter and summer cow weights responded to the amount of winter feed however protein increased cow weight as effectively as energy (ration 1 vs. ration 3). Knox (1932), Knox and Watkins (1958) and Speth et al. (1962) have also reported proteins effectiveness in supporting cow weights. Weight changes have been proposed as an evaluation of nutritional adequacy for beef cows (Smithson et al., 1966; Wiltbank, 1973). The data reported here suggest weight changes are associated with reproductive functions; however, earlier rebreeding for higher energy (ration 1) and similar cow weights for rations providing either higher energy or protein (rations 1 and 3) suggest weight changes as they affect reproduction can only be compared at similar protein levels.

The earlier conception date for the highest energy (ration 6) occurred almost entirely among 2-and 3-year-old cows. Although weights were increased for mature cows conception date was not improved. Apparently additional energy was not required for reproductive function of mature cows.

Delaying a part of the winter feed until after calving delayed conception (ration 7 vs. ration 1) especially among younger cows. Similar results have been reported by Wiltbank _et al_. (1962) and Dunn _et al_. (1969) who found low pre-calving energy levels delayed the first post-partum estrus even when high levels of energy were fed post-calving. Neither cow weights nor reproductive parameters for mature cows were adversely affected.

Delaying a part of the winter feed until February 10 (approximately 30 days before the average calving date) did not significantly alter rebreeding (rations 1 and 9 vs. rations 8 and 10) however cow weights in December and February were lower. No 2-year-old cows were fed rations 8 - 10 and 3-year-old cows did not give consistant results but reproduction for mature cows was not adversely affected.

Since the feeding period before February 10 is 33 days longer than the feeding period after, ration 8 required 45 kg less milo than ration 1 and ration 10 required 30 kg less grain-soybean meal mixture than ration 9 per cow per winter.

Concentrate mixtures tended to improve cow weights and reproduction when compared to the alfalfa hay-milo rations they were intended to approximate. Since consumption of dormant range is an unknown variable increased grazing for cows fed these concentrate mixtures is a possible explanation.

Calf weaning weights, in general, increased when greater amounts of winter feed were provided the dam. Heavier calf weaning weights for cows fed the grain-soybean meal mixture vs. those fed similar alfalfa-milo rations again indicate superiority for concentrate rations. However the milo-urea mixture (ration 5) did not follow this trend. Delaying a part of the ration did not adversely affect weaning weights for concentrate rations however delaying a part of the alfalfa hay-milo ration decreased weaning weight.

TABLE 3. LEAST SQUARE MEAN CONCEPTION DATE AND RATE AND COW WEIGHTS BY RATION AND AGE

	RATIONS[1]									
	1	2	3	4	5	6	7	8	9	10
Cow age										
Two year olds (no.)	20	11	9	12	10	10	8	0	0	0
Dec. wt[2]	403	407	405	396	404	414	397			
Feb. wt	391	404	386	386	391	399	391	---	---	---
May wt	355	376	361	364	366	374	360	---	---	---
Sept. wt	440	441	436	423	447	446	435	---	---	---
conception date[3]	Jun 21	Jun 18	Jul 3	Jul 10	Jun 23	Jun 9	Jun 30	---	---	---
conception (%)[3]	83	87	80	56	100	100	81	---	---	---
Three year olds (no.)	33	13	8	10	12	8	7	9	9	9
Dec. wt	428	430	420	412	427	439	427	412	435	418
Feb. wt	410	428	411	403	415	422	411	403	409	403
May wt	390	404	396	389	396	401	390	388	396	388
Sept. wt	472	482	470	464	488	488	472	463	470	468
conception date	Jun 16	Jun 20	Jun 29	Jul 10	Jun 6	Jun 2	Jun 23	Jun 24	Jul 1	Jun 4
conception (%)	93	88	98	99	85	100	88	100	98	100
Four years & older (no.)	60	8	15	9	26	25	23	25	25	28
Dec. wt	440	458	441	433	445	451	441	433	439	432
Feb. wt	431	433	423	415	431	443	431	416	438	421
May wt	407	417	404	399	423	422	407	398	404	403
Sept. wt	484	499	490	484	491	495	485	483	491	483
conception date	Jun 13	Jun 9	Jun 14	Jun 27	Jun 9	Jun 10	Jun 14	Jun 8	Jun 9	Jun 10
conception (%)	99	93	100	100	100	94	96	91	94	88
All ages (no.)	113	32	32	31	48	43	38	34	34	37
Dec. & Feb. wt	406^{bc4}	413^{ab}	406^{bcd}	398^{def}	407^{bc}	414^{a}	401^{cde}	393^{f}	405^{bcd}	396^{ef}
May & Sept. wt	416^{ab}	425^{a}	418^{ab}	411^{b}	426^{a}	425^{a}	412^{b}	411^{b}	419^{ab}	416^{ab}
conception date	Jun 17	Jun 18	Jun 27	Jul 7	Jun 13	Jun 7	Jun 22	Jun 19	Jun 24	Jun 10
conception (%)	92	89	100	88	98	100	88	94	87	99

[1]Rations given in table 1. [2]Weight in kg.

[3]Conception data are analyzed by trial and adjusted to a trial 2 basis.

[4]Means in the same line with different superscripts differ significantly ($p < .05$).

TABLE 4. LEAST SQUARE MEAN CALF BIRTH AND WEANING WEIGHTS

	RATIONS[1]									
	1	2	3	4	5	6	7	8	9	10
Cow age										
Two year olds										
no.[2]	9	6	4	5	8	6	5			
birth wt (kg)	32	32	27	29	28	32	30			
weaning wt (kg)	163	176	139	165	156	167	154			
Three year olds										
no.	26	11	6	6	9	6	5	3	7	5
birth wt (kg)	33	35	33	37	31	34	31	30	31	34
weaning wt (kg)	178	184	151	186	177	198	174	157	173	186
Four years & older										
no.	51	6	12	6	22	17	18	19	23	27
birth wt (kg)	35	35	34	34	35	36	34	33	35	34
weaning wt (kg)	194	179	171	173	200	202	189	179	204	204
All ages										
no.	86	23	22	17	39	29	28	22	30	32
birth wt (kg)	$33^{ab\,2}$	34^{ab}	32^{bcd}	33^{abc}	32^{cd}	34^{a}	32^{bcd}	30^{d}	32^{bcd}	32^{abc}
weaning wt (kg)	178^{ab}	180^{ab}	154^{d}	175^{ab}	178^{ab}	189^{a}	172^{bc}	160^{cd}	181^{ab}	188^{a}

[1]Rations given in table 1.
[2]Calves for which both weaning and birth weights were available.
[3]Means with different superscripts differ significantly ($p < .05$).

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INFLUENCE OF WINTER NUTRITION ON REPRODUCTION, COW WEIGHTS AND CALF GAINS FOR SPRING-CALVING BEEF COWS

by

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Winter nutrition requirements for beef cows grazing dormant winter range in the Kansas Flinthills were studied from 1968 to 1973 (three-two year trials). Milo (1.36 kg) was superior to soybean meal (0.68 kg) in improving reproductive efficiency when added to a basic ration of 1.36 kg alfalfa hay. Additional response was obtained when the amount of milo was doubled. When a part of the winter feed was delayed until after calving conception occurred later in 2-and 3-year-old cows but mature cows reproduced efficiently when daily feed was increased either at calving or 30 days before the average calving date.

Increasing the amount of winter feed increased cow weight during the feeding period and the following grazing period. Cows which rebred were significantly heavier during both periods than those which did not. In general, calf birth and weaning weights increased when larger amounts of winter feed were provided the dam.