THE INFLUENCE OF POSTPARTUM PLANE OF NUTRITION AND WEANING AGE OF THE CALVES ON COW BODY WEIGHT, COW BODY CONDITION, ESTRUS, CONCEPTION RATE, AND PERFORMANCE OF THE CALVES IN FALL-CALVING BEEF COWS

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PREFACE

This study was concerned with the effect of two levels of nutrition fed cows from calving to breeding and the weaning of their calves at 7 months or 9-10 months of age on the reproductive performance of fall-calving beef cows. The primary goal was to determine how the nutritional regimes and the two calf weaning ages affect cow weight and body condition change, estrus, conception rate, and performance of their calves when these cows calved from September to mid-December.

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CHAPTER I

INTRODUCTION

Two of the most important traits in any beef cow-calf operation are the reproductive performance of the cows and the weaning weights of the calves. Since these traits are the keys to profitability, cows and calves must be managed so that these economically important traits can be optimized.

The level of winter nutrition plays an important role in the reproductive performance of spring-calving cows. Cows that are wintered on an adequate plane of nutrition and calve in good body condition have shorter postpartum anestrous periods and higher conception rates than cows fed lower planes of nutrition during the winter and calve in poorer body condition.

Approximately 30 to 40 percent ot the beef cows in Oklahoma calve in the fall (September-December). Fall-calving cows are typically in better condition going into the calving season than spring-calving cows as a result of summer grazing. Little is known about the combined effects of condition at calving and postpartum level of nutrition on the reproductive performance of fall-calving cows, especially when the availability and quality of forage are decreased. While it may be possible to increase weaning weights of calves by extending the suckling period to 9-10 months, the effect on cow condition and reproductive performance is not clearly understood.

Therefore, the purpose of this study was to determine the influence of level of nutrition from calving to breeding and weaning age of calves on cow body weight, cow body condition, postpartum interval to first estrus, conception rate and calf performance of fall-calving beef cows.

CHAPTER II

LITERATURE REVIEW

Factors Influencing Reproductive Performance

The single most economically important factor in the efficiency of beef production is reproductive performance. Many factors, including plane of nutrition, cow body condition, milk production, suckling stimuli of the calves, dystocia, breed, and age of female have been shown to have marked influence on postpartum interval to first estrus, cycling activity, and pregnancy rate.

Since this topic has been extensively reviewed by numerous workers (Velasco, 1962; Furr, 1962; Kropp, 1972; Cantrell, 1982) this review will serve as an overview of the factors influencing the reproductive performance of beef cows.

Prepartum Nutrition

The prepartum nutritional status of beef cows varies considerably depending on the amount and quality of available forage and time of year when calving occurs. Native range in Oklahoma is typically dormant from early November (first frost) to late April. Therefore, during the winter months, the available forage is low in quality and digestibility. Cows calving in January through April are typically deficient in protein and energy for several months prior to calving unless supplemental protein and energy are furnished. In contrast, fall calving beef cows usually graze high quality warm season grasses high in protein and energy prior to calving. Therefore, the prepartum nutritional level of fall calving beef cows is quite high depending on availability of forage.

Numerous workers (Wiltbank et al., 1962; Dunn et al., 1969; Corah et al., 1975; Bellows and Short, 1978; Holness and Hopley, 1978; Wettemann et al., 1980; Bellows et al., 1982; Wettemann et al., 1982) have reported that prepartum energy levels had their greatest influence on the occurrence of the first postpartum estrus, especially in spring calving cows. Low prepartum nutritional levels reduced estrus activity and lengthened the days from calving to first observed estrus.

Postpartum Nutrition

The postpartum nutritional status of beef cows, even more critical than the prepartum nutrition due to the daily demands for milk production, also varies considerably depending on the availability and quality of forage as well as the calving date. Cows calving early in the spring must depend heavily on supplemental energy and protein, while cows calving later in the spring are able to graze spring growth of grass shortly after calving. With fall-calving cows, the situation is reversed. Those calving early can still graze pastures before the grass becomes dormant, while those calving later must depend heavily on supplemental energy and protein.

Wiltbank et al. (1962) showed that the reproductive performance of spring-calving beef cows was influenced by both the pre- and postpartum energy level, but that the response of cows to postpartum energy level appeared to be conditioned by prepartum energy level. Postpartum energy level had little effect on days postpartum to first estrus in cows fed a high prepartum energy level, but had a marked effect on postpartum interval to first estrus in cows fed a low prepartum energy level. Postpartum energy level had its greatest influence on conception rate. A low prepartum energy level had no affect on conception rate when cows were well fed following calving (Wiltbank et al, 1962; Wiltbank et al., 1964; Hight, 1968). Hodgson et al. (1980) reported that a low portpartum energy level did not reduce pregnancy rate; however, the breeding season lasted 90 days.

Somerville et al. (1979) fed 76 fall-calving Blue-Grey and Hereford x British Friesian cows one of three energy levels following calving (175%, 125%, or 90% of maintenance). Cows calved in good body condition. Following calving, H, M, and L cows lost 8%, 16%, and 21%, respectively, of their post-calving weight by 100 days postpartum. Pregnancy rates for the groups were not statistically different, but the pregnancy rate of the L cows was considerably lower than the pregnancy rates of the M and H cows (84%, 80%, and 66% for the H, M, and L cows, respectively). The month of calving had a greater affect on pregnancy rate than did the plane of nutrition (P<.001 vs. P<.10). More cows calving in November and December (26%) failed to conceive than cows calving in September (6%) or October (4%). However, the breeding season started on November 22 causing an overlap of this season with the calving season; and therefore, cows calving in November and December would have had fewer days to recover and successfully rebreed. The most striking feature of this study was the detrimental affect of the combination of the L plane of nutrition and late calving (November and December). Forty percent of these cows failed to conceive.

Fall-calving Hereford cows in good body condition were allotted to one of three nutritional treatments at the time of calving (Rakestraw et al., 1983). The treatments were (1) maintain weight from calving through breeding, (2) lose 10% of post-calving weight by the start of breeding, and (3) maintain weight from calving to the start of breeding and then lose 10-15% of their body weight during breeding. A significant year x treatment interaction necessitated presentation of the data by year. In the first year of the study, weight and condition losses from calving to breeding were similar for the three groups. During the breeding season, however, group 3 cows lost more weight and condition than either group 1 or 2 cows (-149 lbs. vs. -51 and -67 lbs., respectively; -0.93 vs. -0.36 and -0.20 condition score unit where 1 = very thin to 9 = very fat, respectively; both, P<.01). Treatment did not significantly affect the postpartum interval to first estrus, but the interval to first estrus was longer in group 2 cows (70, 52, and 58 days for groups 2, 1, and 3, respectively). Group 3 cows had a significantly lower pregnancy rate than the other groups (50% vs. 79% and 88% for groups 3 vs. 1 and 2, respectively).

In the second year of the study, weight loss from calving to the start of breeding was different between the groups (-45 lbs. vs. -175 lbs. vs. -69 lbs. for groups 1 vs. 2 vs. 3, respectively; P<.01). During breeding group 3 lost the most weight and group 2 lost the least weight (-106 lbs. vs. -86 lbs. vs. -4 lbs.; P<.01). In year 2, as in year 1, body condition changes paralleled weight changes before breeding (-1.4 vs. -0.4 and -0.3 for group 2 vs. 1 and 3, respectively; P<.01) and during the breeding (-1.37 vs. -.37 vs. .05 for 3 vs. 1 vs. 2, respectively; P<.01). Treatment did not significantly affect the postpartum interval to first estrus, but again, the interval to first estrus was longer in group 2 (61, 46, and 45 days for groups 2, 1, and 3, respectively). In contrast to year 1, conception rates in year 2 did not differ (87%, 53%, and 65% for groups 1, 2, and 3, respectively).

The authors concluded that good condition at calving does not guarantee optimum reproductive performance. Severe weight loss prior to breeding can delay the first postpartum estrus and reduce the number of cows that exhibited estrus by the start of breeding. Severe weight loss during breeding can reduce conception rates and is even more detrimental to fertility if coupled with weight loss prior to breeding.

Angus and crossbred cows were maintained to calve in moderate to good condition (4 to 7) where 1 = thin to 9 = fat (Richards and Spitzer, 1983). Cows were stratified by calving date, breed, parity, condition at calving, and previous year's nutritional group to one of the following postpartum nutrition groups: 25.8 Mcal ME/day (H), 20.7 Mcal ME/day (M), 14.7 Mcal/day (L), and 14.7 Mcal ME/day until 14 days before the start of breeding and then 36.0 Mcal ME/day through the first 30 days of breeding (LF - low flush). Treatment did not affect the postpartum interval to first estrus or the percentage of cows that had exibited estrus by 20, 40, or 60 days of breeding. Neither were days to conception nor percent pregnant by 20, 40, or 60 days of breeding affected by treatment. However, when the data was analyzed based on the allotment of cows into two body condition score groups ($\geq$5 and $\leq$4), the cows in the $\geq$5 group exhibited first postpartum estrus earlier (50 days vs. 63 days; P<.01) and tended to have a greater percentage that had exhibited estrus by day 20 of the breeding season (87% vs. 79%; P<.10). Cows in the $\geq$5 group also had a shorter interval from calving to conception (85 days vs. 93 days; P<.01), a higher pregnancy rate by day 20 of breeding (50% vs. 39%; P <.07), and a higher pregnancy rate by day 40 of breeding (77% vs. 68%; P<.07). Cows in the $\geq$5 group did not have a greater percent that had exhibited estrus or pregnant by day 60 of breeding, however.

Rutter and Randel (1984) studied the effects of postpartum nutrition on pituitary function and onset of first postpartum estrus using Brangus cows and heifers. These females were fed either a L - 90% of NRC, M - 100% of NRC, or H - 110% of NRC level of metabolizable energy and digestible protein. All cows received an intramuscular injection of 100 ug of GnRH on day 21 postpartum. The postpartum interval to first estrus was significantly affected by treatment (57.7 days vs. 40.3 days vs. 34.7 days for L vs. M vs. H, respectively; P<.01), but treatment did not affect endogenous, GnRH-released, and overall LH release. When the data was analyzed on the basis of maintenance or loss of body condition during the first 20 days postpartum, regardless of dietary treatment, the postpartum interval to first estrus was significantly shorter for cows maintaining condition (31.7 days vs. 60.0 days; P< .005). The cows maintaining condition also released more endogenous LH (P <.025), had a greater GnRH-induced LH surge (P<.001), and tended to have a higher GnRH-induced LH peak (P<.10). In addition, cows maintaining condition had greater release curve areas for endogenous LH release (P<.025) and tended to have greater release curve areas for the GnRH-induced ($P<.10$) and total LH ($P<.10$) release.

Bartle et al. (1984) allotted 4- to 9-year-old Hereford cows, 3-year-old Hereford x Angus cows, and 2-year-old first-calf Hereford heifers to two levels of protein (150% or 85% of NRC crude protein requirements) from 60 days prepartum to calving. After calving, females were reallotted to two energy levels (100% or 85% of NRC), remaining on these treatments for 13 weeks. The low protein diet caused greater weight loss during the prepartum period (-75 kg vs. -45 kg; $P<.01$) and the low energy level caused a more rapid weight loss during the 13 week, postpartum, treatment period (-.30kg/day vs. -.07 kg/day; $P<.05$). The postpartum interval to first estrus was not affected by either the prepartum protein level, postpartum energy level, or cow age. While changes in body composition during the 30 days prior to breeding also did not affect the postpartum interval to first estrus, the estimated percent body fat (EPBF) did account for 36% of the variation in the interval.

The following regression equation accounts for 71% of the variation ($P<.01$) in the postpartum interval to first estrus (PPI):

$$PPI = 5.3 - 9.6\,(EPBF) + .187\,(EPBF)^2 + 384.4(REI) - 216.0(REI)^2$$

where REI = relative energy intake.

Through the use of this equation, the authors estimated that cows with $\geq$20% EPBF reached first postpartum estrus within 60 days after calving, even at energy levels below their requirements. They noted that the PPI could be shortened with energy intakes above maintenance. Finally, due to the highly significant affect of cow age on EPBF (6.5% vs. 14.5% and 15.5% vs. 22.8% for 2-year-olds vs. 3- and 4-year-olds vs. 7-year-olds, respectively) and the low numbers of 2- to 4-year-old cows, cow age did not affect the PPI and was not used in the regression analysis.

Suckling Stimulus

Suckling stimulus has been shown to have a significant affect on the reproductive performance of cows. Several researchers have shown that suckling lengthens the postpartum interval to first estrus and that removing the suckling stimulus can have beneficial results on the rebreeding performance of beef cows.

Cows exhibited first postpartum estrus within 39 days after calving when calves were permanently removed from birth to 48 hours after birth, while first estrus did not occur for as long as 15 weeks in cows that continuously nursed their calves (Saiduddin et al., 1967; Oxenreider, 1978; Radford et al., 1978; Carruthers and Hafs, 1980; and LaVoie et al., 1981). Removing calves for a short period from 50-58 days postpartum increased the percentage of cows that had exhibited estrus by 60 days postpartum by 25% over continuously suckled controls (Holness and Hopley, 1978).

Varying the suckling intensity without removing the calves has also been shown to affect the postpartum interval to first estrus. Once daily suckling by one calf vs. ad libitum suckling by one calf reduced the postpartum interval to first estrus by 99 days ($P<.005$) in first-calf Brahman x Hereford heifers (Randel, 1981) and by 20 and nine days, respectively; ($P<.05$) in experiments 1 and 2 in Angus cows (Reeves and Gaskin, 1981). Wettemann et al. (1978) reported a significant delay (average of 29.5 days) in postpartum interval to first estrus and a significant reduction (average of 37.3%) in the percentage of cows that had exhibited estrus by 90 days postpartum when cows suckled their own plus a foster calf compared to a foster calf or their own calf. In contrast, Wheeler et al. (1982) reported that the postpartum interval to first ovulation in Angus, Hereford, and Hereford x Angus cows and heifers was not influenced when cows calved twins and suckled their twins (TT), calved twins and suckled singles (TS), or calved and suckled singles (SS).

Lusby et al. (1981) reported that the interval from calving to conception was 17.5 days shorter ($P<.01$) and conception rate was 36.6% higher ($P<.05$) in first-calf Angus x Hereford heifers that had their calves removed six to eight weeks postpartum vs. heifers where calves suckled for seven months. However, these heifers had previously been in a nutritional study and were in thin condition (3 to 4 on a scale of 1 to 10) which many have influenced the results.

Reeves and Gaskin (1981) reported no effect of suckling intensity on interval from calving to conception in Angus cows.

In a study by Wettemann and Lusby (1983), Hereford cows, calving in moderate body condition (5.1 where 1 = very thin to 9 = very fat) and gaining 0.5 of a condition score unit to the end of breeding, were flushed (an additional 4.5 kg of 20% protein supplement for 28 days starting 30 days postpartum) and calves were separated for 48 hours at 14 and 28 days after the beginning of flushing (FNS), were flushed only (FS), were separated from calves only (NS), or were non-flushed and non-separated from calves (S). The conception rates and percentage of cows with ovarian activity during the breeding season as measured by serum progestrone levels, were not influenced by treatment. Only when cows were flushed and separated from their calves were the days from calving to ovarian activity influenced (2.3 weeks vs. 6.8, 7.0, and 7.3 weeks for the FNS vs. S, FS, and NS, respectively; $P<.01$).

Other Factors Affecting Reproductive Performance

Other factors shown to influence reproductive performance are dystocia, caesarean section, vaginal or uterine prolapse, and presence of the male. Dystocia reduced the percentage of cows detected in estrus during the 45 day AI period by 14.4% ($P<.005$), the percent pregnant to

AI by 15.6% ($P<.01$), and overall percent pregnant (natural mating for an additional 3 to 4 weeks) by 15.9% ($P<.005$) in Hereford and Angus cows (Laster et al., 1973). Conception rates during a 63 day breeding season in spring-calving Simmental (64.6% vs. 73.7%), fall-calving Simmental (70.1% vs. 79.3%) and fall-calving Angus (75.3% vs. 84.3%) heifers were also reduced by dystocia (Bolze et al., 1983). Caesarean deliveries reduced conception rates (52.4% vs. 79.4%, $P<.01$), and only 28.0% and 57.9% of heifers and cows, respectively, were pregnant after calving caused vaginal or uterine prolapse (Patterson et al., 1981). On the other hand, bull exposure form three to 85 days vs. 53 to 85 days postpartum reduced the postpartum interval to first estrus from 62 days to 41 days (Zalesky et al., 1983).

The Influence of the Dam's Nutrition Level and Milk Production on Calf Performance

Researchers have previously reported significant relationships between the dam's nutrition and milk production, and calf performance. These relationships, however, have been highly variable and dependent on many factors.

Drewry et al. (1959) reported increasing correlations (-.15, .35, and .48) between gain to sampling and average daily milk production as lbs. of milk per lb. of calf gain declined (12.5, 10.8, and 6.3 lbs. milk/pound gain). The samples were taken at one, three, and six months after calving. Calves suckling heavier producing dams gained more weight from birth to weaning (P<.01).

Valesco (1962) fed 4- and 5-year-old Hereford dams so that they lost 28% (L) or 18% (H) of their November weight by mid-April (trial 1). The greater stress in the L cows was reflected in the daily milk production of the cows (6.25 and 8.12 lbs. for L and H cows, respectively) and correspondingly, the ADG's of the calves (1.37 and 1.56 lbs. for L and H cows, respectively). Daily milk production and ADG's of calves were highly correlated in both the L cows (.76; P<.01) and the H cows (.55; P<.05). When H cows received the L energy level and visa versa the following year (trial 2), respective November to mid-April weight losses were more similar (16.0% and 20.5%) and daily milk production levels were also more similar (10.31 and 9.6 lbs., respectively). The ADG's of calves (1.58 and 1.48 lbs., respectively) reflected the small difference in level of milk production. However, the correlation between milk production and ADG of calves was not significant for the H cows (-.01) as a result of a large negative correlation (-.26) in the fourth month while the correlation in the L cows was highly significant (.71).

Furr (1962) and Furr and Nelson (1964) conducted three trials with 4-, 3-, and 2-year-old fall-calving Hereford cows in trials 1, 2, and 3, respectively. Cows were fed a Low (5.0, 5.0, or 2.8 lbs. of cottonseed meal) or High (13.2, 12.5, or 14.7 lbs. of cottonseed meal) level of supplementation in trials 1 through 3, respectively. In trial 1, L and H cows lost 28.1% and 25.0% of their mid-October weights by late April and produced an average of 5.92 and 6.4 lbs. of milk daily over the last 172 days of lactation. The spring weights of the calves reflected the level of milk production and were heavier for calves suckling H cows (233 lbs. vs. 201 lbs.; $P<.05$). Correlations between daily milk production and ADG of the calves were highly significant (.81 and .85 for L and H cows, respectively). In trial 2 the correlations between daily milk production and ADG's of the calves were not significant (-.31 and .53 for L and H cows, respectively); yet weaning weights of the calves were highly significantly different (392 lbs. vs. 331 lbs. for H and L cows, respectively) indicating again that higher levels of winter supplement affected calf performance. In trial 3, cows were fed the L or H levels of supplement in traps or on range pastures. Level of supplementation caused only small differences in milk production (6.88 vs. 6.82 and 6.34 vs. 5.33 for H vs. L cows in traps and on range, respectively) and did not affect calf weaning weights (371 lbs. vs. 357 lbs. and 343 lbs. vs. 337 lbs. for H and L cows in traps and on range, respectively).

Harris et al. (1962) reported a large difference in the daily milk production of cows fed two levels of winter nutrition (6.02 lbs. and 9.18 lbs. for L and H cows, respectively). However, 56 days after all cows were turned out onto lush pasture comparable milk production levels were 9.0 and 8.9 lbs. daily, indicating the ability of the L cows to respond to lush grazing. Despite the rebound in milk production, calves suckling L cows averaged 43 lbs. less at weaning over the three years of the study. In later work, Harris et al. (1963) reported that restricted plane of nutrition post-calving reduced milk production in beef females.

In another three year study, fall-calving Hereford cows were fed three levels of winter nutrition from November until calves averaged four months of age (Neville, 1962). Daily milk consumption influenced (P<.01) calf weight and gains to 240 days postpartum, but as level of nutrition improved and with it milk production (1944-2520 lbs.), within-year correlations between milk production and ADG's of the calves declined (.90-.69). As indicated by the decrease in the correlation, calves suckling the highest plane of nutrition cows required 23.5 lbs. of milk/1 lb. increase in calf gains compared to a 12.5 lb. average for the other two nutrition groups.

Christian et al. (1965) reported highly significant correlations (.46-.50) between milk production from 0-60 or 60-240 days postpartum and weaning weights or ADG's from birth to weaning in 2- to 4-year-old Hereford cows. The correlation between milk production from 0-60 days and ADG of the calves from 0-60 days was even greater (.77; P<.01) and indicates the importance of milk production as a factor affecting calf gains early in the postpartum period.

Klett et al. (1965) reported highly significant correlations between daily milk production of spring-calving Angus cows producing 3.9 kg of milk daily and calf weights at sampling (.67-.81), but correlations were not significant for Hereford cows which produced only 2.92 kg of milk. This suggests that the Angus cows provided a greater proportion of nutrients to their calves in the form of milk. In agreement, Melton et al. (1967) reported that spring-calving Angus cows in this study produced highly significantly greater total lbs. of milk than Hereford cows, yet 175 day weaning weights of the calves were similar.

In Hereford cows and heifers; Galloway, Angus, and Charolais x Angus cows; and Angus x Galloway heifers, correlations between monthly milk yields and ADG's of calves from birth to weaning ranged from .73 to .83 ($P<.01$). As indicated by the high correlations in this study, daily milk consumption (3.8-8.5 kg) closely paralleled ADG's of the calves (.57-.94) (Gleddie and Berg, 1968). Serwanja et al. (1969), however, reported significant correlations between monthly milk production and monthly calf gains for the fourth (.48) and fifth (.60) months of lactation only.

Bond and Wiltbank (1970) fed 7-month-old Angus heifers a 3x3 factorial arrangement of three energy and three protein levels until 180 days after their first calf was born. Heifers fed the lowest energy level produced the least milk (3.0 and 3.0 kg vs. 1.5 kg for H and M heifers vs. L heifers, respectively; P<.01) and heifers fed the lowest protein level produced highly significantly less milk than heifers fed the other two protein levels (2.6 and 2.9 kg vs. 2.1 kg for H and M heifers vs. L heifers, respectively). Calf weights were not affected by protein level in either lactation, but gains were faster in the higher protein fed heifers. Calves suckling the higher energy heifers gained faster (P<.01) but were less efficient in converting milk to gain.

Rutledge et al. (1971) reported that 60% of the variation in 205-day weaning weight of calves was explained by the milk production of the Hereford dams. In addition, milk production in months 1 through 4 of lactation affected weaning weights (P<.01). Similarly, Reynolds et al. (1978) reported highly significant correlations between monthly milk production and early weight gain of the calves (.35 to .60) in Angus, Brahman, Brangus, and Africander x Angus cows.

Kropp (1972) and Kropp et al. (1973) fed fall-calving Hereford and Hereford x Holstein heifers two levels of winter nutrition (H and M) and Holstein heifers three levels of winter nutrition (VH, H, and M) in drylot or on range. Within breed, heifers fed the higher energy levels were in better condition (P<.05) in mid-lactation. Only the daily milk production of Hereford x Holstein heifers on range (8.78 kg/day vs. 7.85 kg/day for H vs. M, respectively; P<.05) and drylot Holstein heifers (9.98 kg/day vs. 11.34

and 11.74 kg/day for M vs. H and VH, respectively; P<.05) were affected by nutritional level. Calf weaning weights were not affected by the reduced milk yield; however, the difference in the Hereford x Holstein cows was small compared to the amount of milk produced and milk may not have been a limiting factor on calf gains in the high producing Holstein cows.

Hodgson et al. (1980) fed spring-calving Hereford x Friesian and Blue-Grey cows two levels of energy prior to summer grazing. The H cows produced more milk than L cows from calving to six weeks post-calving (9.5 kg/day vs. 8.1 kg/day; P<.01). At turn-out to grass the difference was even greater (9.4 kg/day vs. 7.2 kg/day; P<.01). These milk production differences were reflected in calf weight prior to turn-out (86 kg vs. 80 kg; P<.01), but weaning weights of calves did not differ. However, L cows produced more milk after turn-out (11.6 kg/day vs. 10.1 kg/day; not significant).

CHAPTER III

MATERIALS AND METHODS

Animals, Treatments, and Procedures

In the summer of 1980, 135 fall-calving Angus x Hereford cows, ranging from two- to five-years of age, were assembled at the Southwestern Livestock and Forage Research Station at El Reno. One hundred eleven of these cows calved and were used in the first year of the study. In the second and third years of the study, 120 and 90 of these cows were used, respectively. During the experimental period, all cows were maintained on tallgrass native range. The range on the Research Station, classified in excellent condition, is typified by little bluestem (*Andropogon scorparius*) as the predominant species and has a carrying capacity of approximately one cow-calf unit per seven acres on a yearlong basis. The range forage is normally dormant from early November (first frost) to late April.

At calving (September 1, 1980 to November 5, 1980) each female was assigned by calving date and age to a level of postpartum nutrition to equalize these effects within treatment. Two levels of postpartum nutrition designated as Moderate and Low were fed. The Moderate level consisted of that amount of supplemental feed necessary for fall-calving cows to maintain their post-calving weight from parturition to the start of the breeding season. To achieve this level of postpartum nutrition, the Moderate cows were maintained on native pasture at a stocking rate of one cow-calf unit per 12 acres and fed 7 lbs. of cottonseed meal (41% crude protein)/head/day from calving to the start of the breeding season. The forage was not limiting at any time. Even though the Moderate cows were able to maintain their post-calving weight and condition to the start of the breeding season, 7 lbs. of cottonseed meal were deemed excessive and impractical. Therefore, the Moderate level was adjusted in subsequent years to that level necessary to maintain Moderate cows in good breeding condition (body condition scores 5.5 to 6.0). To achieve this desired body condition level, the Moderate cows were fed 4 to 5 lbs. of cottonseed meal/head/day depending upon their body condition at biweekly intervals from calving to the start of the breeding season.

The Low level of nutrition consisted of that amount of supplemental feed necessary to achieve a weight loss of approximately 10% from calving to the start of the breeding season. To achieve this level of postpartum nutrition, the cows were maintained on native pasture with the same stocking rate as Moderate cows and fed 1/2 lb. of cottonseed meal/head/day until November 25 and 3 1/2 lbs./head/day to December 15, 1980. Since the Low cows only lost 3.9% of their initial post-calving weight in year one, the Low level cows were placed in one pasture as they calved so that at the end of the calving season the stocking rate was approximately one cow-calf unit per two acres and received 0 to 2 lbs. of supplemental protein from calving to the start of the breeding season in subsequent years.

At the start of the breeding season, all cows were maintained at a stocking rate of one cow-calf unit per 12 acres and received 5 lbs. of cottonseed meal/head daily to April 30. Throughout the study, all cows were fed three times per week [(daily allowance X 7)/3]. After April 30, all cows grazed common pasture through weaning.

Initial cow weights and body condition scores were taken within 5 to 12 days post-calving. Subsequent cow weights and body condition scores were taken once every two weeks until the end of the breeding season and monthly thereafter. Body weight was measured to the nearest pound and body condition score was based on a scale of 1 (very thin) to 9 (very fat) (Table VIII, Appendix).

All calves were weighed and identified by ear tag within 24 hours after birth. Birth weights were adjusted for age of dam based on Beef Improvement Federation Guidelines (Hubbard, 1981) (Table IX, Appendix) and heifer birth weights were adjusted to a steer equivalent by multiplying by 1.07. At birth, bull calves were castrated and horned calves were treated with dehorning paste. The calves remained with their dams on nature pasture until weaning and did not receive creep feed. Calf weights were obtained, after a 6-hour shrink, once every two weeks until the end of the breeding season and monthly thereafter.

To determine the effect of weaning age of the calf on calf and cow performance, calves were weaned from their dams at 210 or 285 days of age (± 7 days). Assignments to weaning age within postpartum nutrition level were made on the basis of birth date and age of dam to equalize these effects within treatment groups. The age-corrected weaning weights were adjusted for age of dam by Beef Improvement Federation Guidelines (Hubbard, 1981) (Table IX, Appendix). Heifer calf weaning weights were corrected to a steer equivalent by multiplying by 1.05. Calves weaned at 210 days were fed a high roughage weaning ration (ad-libitum) for two weeks to reduce weight loss associated with the stress of weaning. After the two-week period, the weaned calves were placed on native pasture similar to that grazed by the nursing calves and were run as stockers, receiving no additional feed to 285±7 days of age. Steer calves were implanted with Ralgro in February and reimplanted in June.

From calving to the start of the breeding season, surgically altered intact bulls, equipped with chin-ball markers, were placed with the cows. Marker bull activity and visual observation twice daily were used for estrus detection. During the breeding season, the cows were divided into four breeding groups on the basis of postpartum nutrition level and weaning age of the calf. All cows were purchased bred to Charolais and Hereford bulls. During subsequent breeding seasons, the cows were exposed to Beefmaster (years 1 and 2) and Charolais (year 3) bulls which were rotated biweekly among the breeding groups. Cows were observed for breeding activity twice daily and herd bulls were equipped with chin-ball markers to assist in determination of breeding dates. Breeding lasted from December 15, 1980 to February 20, 1981 in year 1, December 31, 1981 to March 3, 1982 in year 2 and December 18, 1982 to February 21, 1983 in year 3.

Statistical Analysis

Both the cow and calf data obtained in this study were analyzed by the method of least squares. Differences between individual means were analyzed by the students "t" test (Steele and Torre, 1980).

The cow data can be described by the following model:

$$Y_{ijklmn} = u + T_i + A_j + C_k + R_l + W_m + TR_{il} + TW_{im} + AW_{jm} + CR_{kl} + CW_{km} + RW_{lm} + E_{ijklmn}$$

In this model, Y_{ijklmn} represents cow body weight on a specific date, cow body condition on a specific date, postpartum interval to first estrus, pregnancy status, cow body weight change on a specific date, or cow body condition change on a specific date; while u represents a common constant, T_i represents treatments, A_j represents age of dam, C_k represents calving month, R_l represents year, W_m represents weaning age of the calves, and E_{ijklmn} is the random error term. The factors T_i, A_j, C_k, R_l, and W_m were assumed to be fixed effects. Other two way interactions were deemed unimportant (P>.20) so were not included.

The calf data in this study can be described by the following model:

$$Y_{ijklm} = u + T_i + B_j + W_k + S_l + WS_{kl} + E_{ijklm}$$

In this model, Y_{ijklm} represents the adjusted 210 day weight or adjusted 285 day weight; while, u represents a common constant, T_i represents temperature, B_j represents birth month, W_k represents weaning age, S_l represents sire breed-year, and E_{ijklm} is the random error term. The factors T_i, B_j, W_k, and S_l are assumed to be fixed effects. Other two-way interactions were tested, but not found to be important (P>.20) so were not included.

CHAPTER IV

RESULTS AND DISCUSSION

Body Weight and Condition of Cows

At calving, cows assigned to both postpartum levels had nearly identical body weights and body condition scores (Table I). The Moderate cows lost 4.2% of their initial post-calving weight and 0.4 body condition score unit from calving until the start of the breeding season even though the total daily crude protein requirement of the Moderate cows was supplied by cottonseed meal (41% crude protein). However, it should be noted that the Moderate cows were still in good breeding condition (5.5) entering the breeding season. Feeding 0 to 2 lbs. of supplemental protein to the Low cows and restricting the available forage from calving to the start of the breeding season resulted in double the weight (8.2% of post-calving weight) and body condition losses (.9 condition score unit) of the Moderate cows. This reduction of body weight and body condition meant that the Low cows entered the breeding season with a condition score of 4.9, 0.6 condition score unit below the goal for good breeding condition. Greater weight loss (Dunn et al., 1969; Somerville et al., 1979; Hodgson et al., 1980; Bartle et al., 1984) and greater weight loss paralleled by greater condition loss (Wiltbank et al., 1962; Wiltbank et al., 1964; Rakestraw et al., 1983; Rutter and Randel, 1984) associated with poor levels of nutrition during the postpartum period, have previously been reported.

TABLE I

EFFECT OF POSTPARTUM NUTRITION ON COW WEIGHTS, WEIGHT CHANGE, AND BODY CONDITION SCORES FROM CALVING TO THE END OF THE BREEDING SEASON[a]

	Postpartum nutrition levels	
	Moderate	Low
No. cows	161	150
Initial wt., post calving	1020±12.0	1021±11.3
Wt., start of breeding season	977±11.5[c]	937±10.9[d]
Wt., end of breeding season	886±10.8[c]	866±10.1[d]
Wt. change		
Initial to start of breeding	-43±5.8[c]	-84±5.5[d]
Initial to end of breeding	-134±6.4[c]	-155±6.0[d]
Condition score[b]		
Initial	5.9±.08	5.8±.07
Start of breeding	5.5±.08[c]	4.9±.08[d]
End of breeding	5.3±.07[c]	4.9±.07[d]

[a]Weights are in pounds ± standard error.

[b]Body condition scores, ± standard error, are based on a scale of 1 = very thin to 9 = very fat.

[c,d]Means in the same row with different superscripts differ significantly (P<.01).

The use of 5 lbs. of cottonseed meal to supply the daily crude protein requirement of all cows during the breeding season was insufficient to maintain the weight of either nutritional group. The Moderate cows lost 8.9% of their calving weight during the breeding season while the Low cows lost 7.0%. The additional protein supplement fed the Low cows during the breeding season allowed the Low cows to maintain their body condition. The maintenance ot body condition score observed in the Low cows during the breeding season could possibly be a result of increased forage intake and digestibility due to the improved dietary protein content of the diet. However, the Low cows were still lighter in weight and thinner in condition at the end of the breeding season than the Moderate cows. With the advent of warm season grass growth in April and May, all cows were able to regain weight and condition to weaning.

Grazing warm season grasses allowed the Low cows to gain weight and condition faster than the Moderate cows, and therefore, by 210 days postpartum, Moderate and Low cows were similar in weight and condition (Table II). The weight and condition score patterns for the Moderate and Low cows continued to 285 days postpartum regardless of weaning age of calves. However, cows weaning calves at 210 days post-partum gained more weight ($P<.01$) and condition ($P<.01$) from 210 to 285 days postpartum. A significant treatment x weaning group interaction, that persisted from calving as a result of treatment allotments, prevented a significant weight difference at 285 days between Low cows weaning calves at 210 and 285 days postpartum, but increased the weight difference between the weaning groups in Moderate cows. Even though cows weaning calves at 210 days postpartum were in better condition at 285 days postpartum than cows weaning calves at 285 days postpartum, cows weaning calves at 285 days postpartum were still in very acceptable condition (5.9 and 6.0 for Low and Moderate cows, respectively).

TABLE II

EFFECT OF POSTPARTUM NUTRITION AND WEANING AGE OF CALVES ON COW WEIGHTS AND BODY CONDITION SCORES AT 210 AND 285 DAYS POSTPARTUM

Days Postpartum	Postpartum nutrition levels: Moderate	Low
210 days		
Weight[a]	940±11.5	935±10.9
Condition score	5.4±0.07	5.3±0.06
285 days		
Calves weaned at 210 days		
Weight	1147±14.4[b]	1114±14.0[bc]
Condition score	6.7±0.08[b]	6.6±0.08[b]
Calves weaned at 285 days		
Weight	1069±14.7[c]	1082±14.3[c]
Condition score	6.0±0.08[c]	5.9±0.08[c]

[a]Weights are in pounds ± standard error.

[b,c]Means in the same row or column for 285 days postpartum with different superscripts differ significantly ($P<.01$).

Other factors that affected weight and condition scores include cow age (Table III) and calving month (Table IV). Older cows lost less weight ($P<.01$) and condition ($P<.05$) from calving to the start of the breeding season, were in better condition ($P<.05$) at the start of the breeding season, lost less condition ($P<.01$) from calving to the end of the breeding season, were in better condition ($P<.01$) at the end of the breeding season, and were in better condition ($P<.01$) at 210 days postpartum. Cows calving later in the fall were in poorer condition ($P<.01$) at calving, lost less weight ($P<.01$) and condition ($P<.01$) from calving to the start of the breeding season, lost less condition ($P<.05$) from calving to the end of the breeding season, and were heavier ($P<.01$) and in better condition ($P<.01$) at 210 days postpartum.

Figures 1, 2, and 3 show the mean cow weights and condition scores by calendar date for each year of the study divided into the two postpartum energy levels within each year. Only cows that had calved were included in the means. The general trend for both the weight and condition scores in each of the three years is quite apparent. Although there was year to year variation, cows in both postpartum nutrition levels lost weight and condition rapidly from calving to the middle of the breeding season. Low cows lost weight and condition more rapidly, and then tended to level off, but reached a minimum weight and condition near the end of April just prior to spring grass growth. With the advent

TABLE III

EFFECT OF COW AGE ON WEIGHT AND CONDITION

	Cow age in years					
	2	3	4	5	6	7
Weight loss, lbs.[b] (calving to breeding)	-73±12.2	-88±7.4	-70±6.3	-57±6.6	-48±8.5	-46±12.9
Condition loss[a] (calving to breeding)	-.9±.14	-.9±.08	-.7±.07	-.5±.07	-.5±.09	-.5±.14
Condition score[a] (start of breeding)	4.8±.17	5.0±.10	5.3±.09	5.4±.09	5.3±.12	5.4±.18
Condition loss[b] (calving to end of breeding)	-.9±.16	-1.0±.09	-.8±.08	-.6±.08	-.5±.11	-.3±.16
Condition score[b] (end of breeding)	4.7±.16	4.8±.09	5.2±.08	5.2±.08	5.3±.11	5.6±.16
Condition score[b] (210 days)	5.0±.14	5.3±.08	5.3±.07	5.5±.07	5.5±.10	5.6±.15

[a]Cow age effect significant ($P<.05$).

[b]Cow age effect highly significant ($P<.01$).

TABLE IV

EFFECT OF MONTH OF CALVING ON WEIGHT AND CONDITION OF COWS

	Month of calving[c]		
	September	October	November
Condition score[b] (calving)	6.1±.15	5.7±.05	5.7±.1
Weight loss,lbs.[b] (calving to breeding)	-68±11.2	-82±4.0	-42±8.2
Condition loss[b] (calving to breeding)	-.9±.12	-.6±.04	-.5±.09
Condition loss[a] (calving to end of breeding)	-.8±.14	-.7±.05	-.6±.10
Weight, lbs. (210 days)	886±22.2	922±8.0	1006±16.2
Condition score[b] (210 days)	5.2±.13	5.3±.05	5.6±.09

[a]Calving month effect significant (P<.05).

[b]Calving month effect highly significant (P<.01).

[c]Cows calving in August were combined with cows calving in September and cows calving in December were combined with cows calving in November.

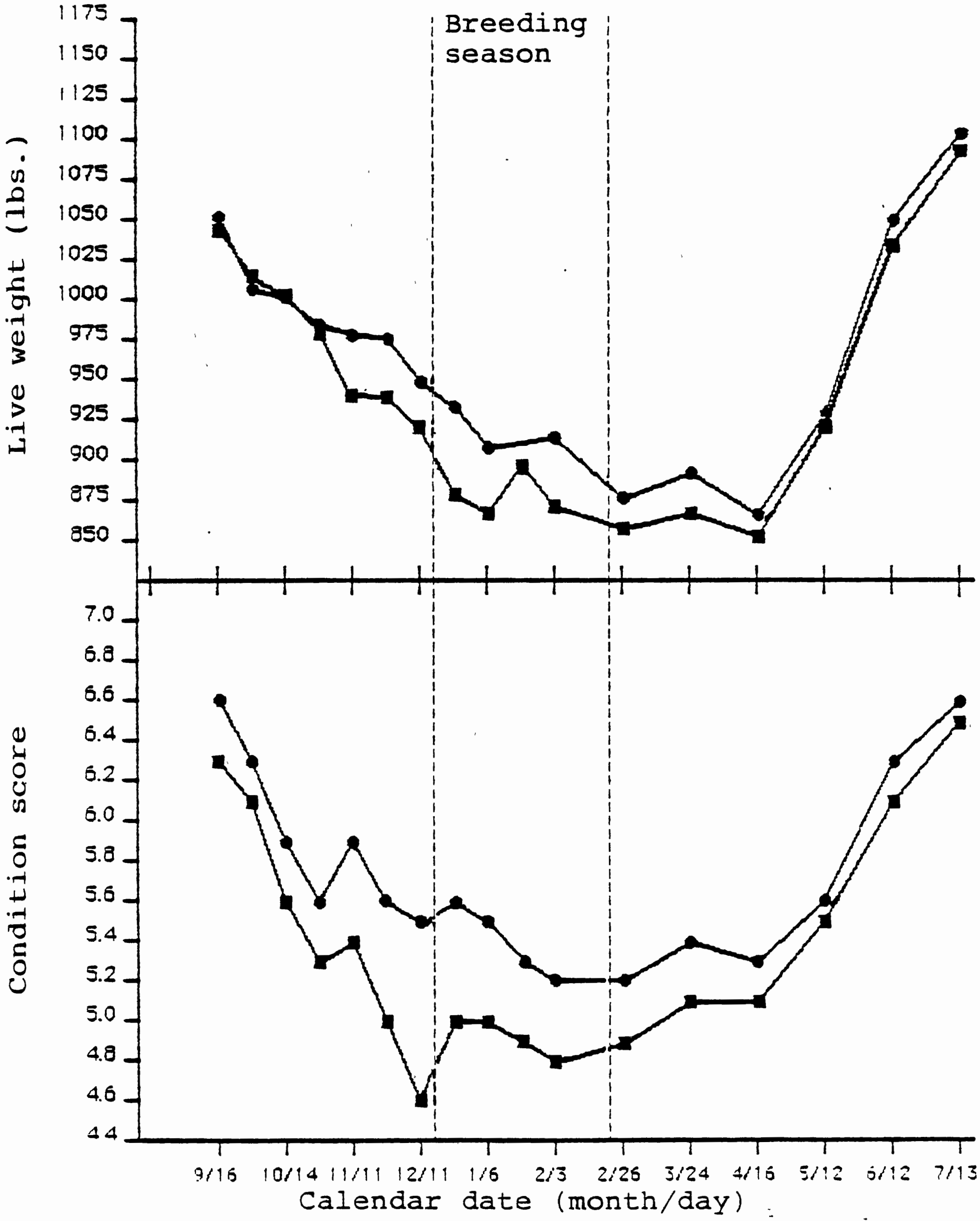

Figure 1. Mean Cow Weights and Condition Scores by Date in Year 1 for Moderate (●—●) and Low (■—■) Cows That Have Calved

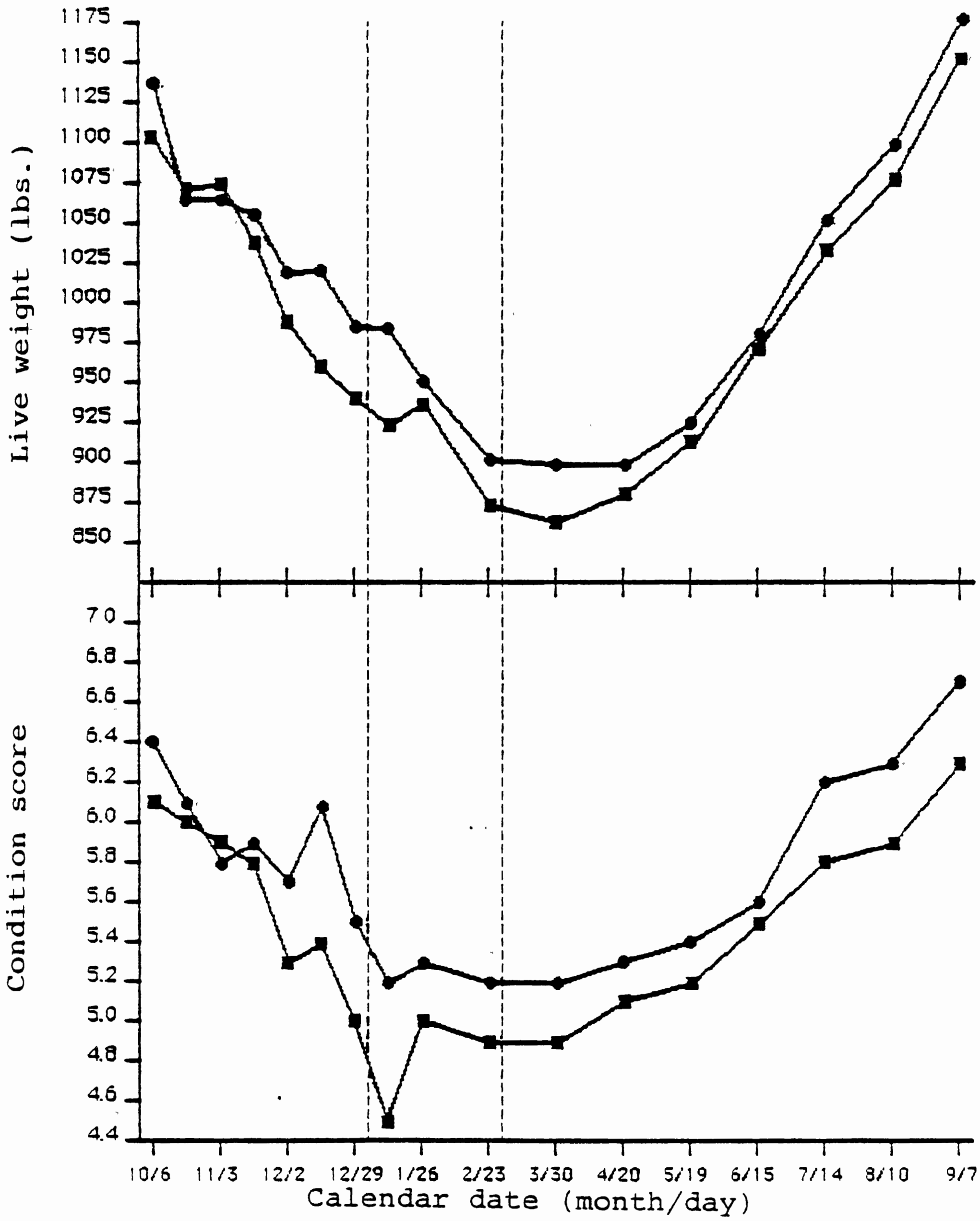

Figure 2. Mean Cow Weights and Condition Scores by Date in Year 2 for Moderate (●—●) and Low (■—■) Cows That Have Calved

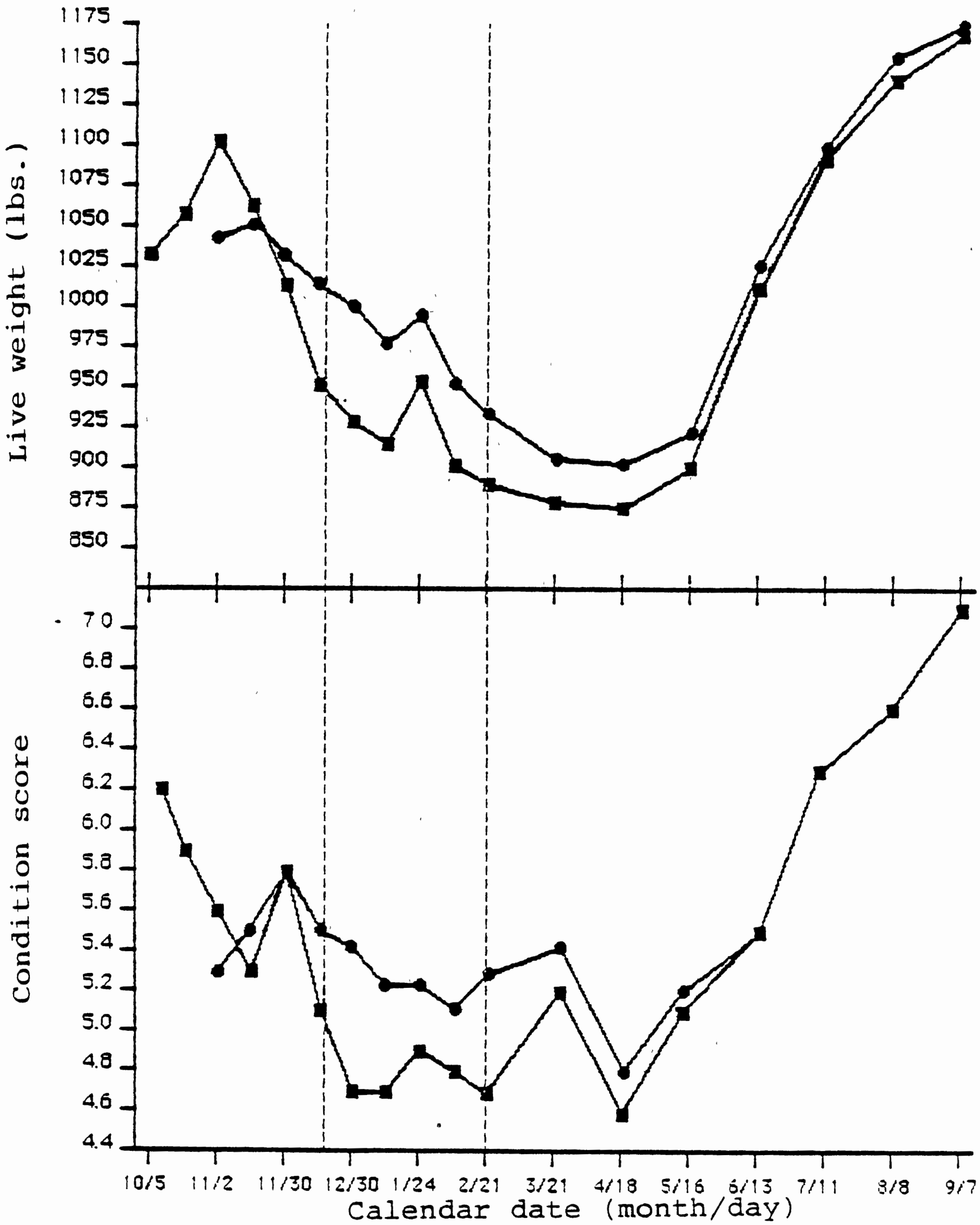

Figure 3. Mean Cow Weights and Condition Scores by Date in Year 3 for Moderate (●—●) and Low (■—■) Cows That Have Calved

of spring grass growth, cows in both postpartum nutrition levels began to gain weight and condition slowly and then more rapidly as the weather warmed and the quality and quantity of grass improved. Weaning the calves from one-half the cows in each treatment was also a factor in greater weight and condition gain. Low cows gained weight and condition more rapidly during the early summer and then paralleled the weight and condition gain of the Moderate cows to the last weighing and condition scoring date.

Although weight and condition as a whole paralleled each other throughout the entire period between calving and the last weighing and condition scoring date, there was considerable variation from one observation date to the next. Many times the condition change from one observation date to the next did not parallel the weight change. Prior to the breeding season, cows of various weights and conditions were being added as they calved and therefore, is a factor in the cause of the variation prior to the breeding season. In addition, weight can fluctuate from one observation to the next due to differences in fill while condition score will often show less fluctuation than weight causing nonparallel changes in weight and condition.

Reproductive Performance

The yearly mean calving dates for each postpartum nutrition level, the yearly breeding dates, and the mean number of days from calving to breeding by year and

TABLE V

YEARLY MEAN CALVING DATES, BREEDING DATES, AND MEAN INTERVAL FROM CALVING TO THE START OF THE BREEDING SEASON

Year	Postpartum nutrition level	Mean calving date[a]	Breeding dates	Interval calving to breeding[b]
1	Moderate	October 3±2.5	Dec. 15, 1980- Feb. 20, 1981	73
	Low	October 5±2.4		71
2	Moderate	October 17±2.2	Dec. 31, 1981- March 3, 1982	75
	Low	October 19±2.6		73
3	Moderate	November 6±2.1	Dec. 18, 1982- Feb. 21, 1983	42
	Low	November 2±3.5		46

[a]Mean ± standard error.

[b]Mean in days.

treatment are presented in Table V. The mean calving date, within year, and therefore, the mean interval from calving to breeding, within year, did not differ among postpartum nutrition levels; however, the mean interval from calving to breeding was considerably shorter in year 3 of the study than in the previous two years of the study.

The effect of postpartum nutrition level on the reproductive performance of cows is presented in Table VI. Moderate cows exhibited estrus 15.0 days earlier ($P<.01$) than Low cows. These results are in agreement with earlier results by Wiltbank et al. (1964) and Rutter and Randel (1984). Holness and Hopley (1978) also reported that well fed cows had a shorter postpartum interval to first estrus than did poorly fed cows, but that a short term switch in the feed level (25 days) did not have an effect. Rakestraw et al. (1983) reported increases in the postpartum interval to first estrus of 18 days (year 1) and 16 days (year 2) in cows fed to lose weight from calving to breeding vs. cows fed to maintain weight; however, these differences were not significant because only a small number of cows were used in each year.

The results of this study disagree with the results presented by Wiltbank et al. (1962). These researchers reported that postpartum energy level had little effect if cows were fed high levels of prepartum energy. The Low cows in this study were well fed and in good condition at calving, but exhibited first postpartum estrus later as a result of the poor nutritional level that was fed after calving. The spring-calving cows fed the Low level of energy in their study, however, were still in good breeding condition (5.6 where 1 = very thin to 9 = very fat) at 56 days postpartum while the Low cows in this study had a body condition score of only 4.9 at an average of 64 days postpartum (start of breeding). The condition score of the Low cows in their study is similar to the condition score of the Moderate cows at the start of breeding in this study. Therefore, the condition of the cows at this time may influence their return to estrus.

TABLE VI

EFFECT OF POSTPARTUM NUTRITION ON THE REPRODUCTIVE PERFORMANCE OF FALL-CALVING BEEF COWS

	Postpartum nutrition levels	
	Moderate	Low
No. cows	161	150
No. exhibiting estrus	156	140
Days postpartum to first estrus[a]	52.1 ± 3.0^{c}	67.1 ± 2.9^{d}
No. cows bred[b]	151	119
Percent cows exposed actually bred	94.0^{c}	79.1^{d}
Percent cows serviced that settled	96.1^{c}	83.8^{d}

[a]Mean ± standard error.

[b]Determined by rectal palpation approximately 90 days after the end of the breeding season.

[c,d]Means in the same row with different superscripts differ significantly ($P<.01$).

Richard and Spitzer (1983) reported no effect of plane of postpartum nutrition on postpartum interval to first estrus; however, the cows used in their study had previously been in a nutritional study and had a much larger variation in body condition score at calving (4 to 7 where 1 = very thin to 9 = fat) which may have influenced the results. All cows in this study were above a condition score of 5.0 at calving.

Bartle et al. (1984), as well, reported no effect of plane of postpartum nutrition on interval to first estrus. However, the Low cows in their study lost only 55 lbs. from calving to 13 weeks postpartum while the Low cows in our study lost approximately 120 lbs. during the same time interval (calving to the middle of the breeding season). Therefore, a much greater stress was placed on the Low cows in this study.

As a result of the delayed return to estrus, a 3.6% lower return to estrus, and only a 65 day breeding season, Low cows had a 14.9% lower conception rate overall and 12.3% fewer Low cows than Moderate cows that were serviced during the breeding season conceived (both, $P<.01$). Even though the overall effect of treatment on conception rate was highly significant, treatment did not elicit an effect on conception rate in the third year of the study, despite delaying estrus 9.0 days. The lack of a treatment effect in the third year of the study may have resulted from the fact that the Low cows were stressed for a much shorter period of time. The mean interval from calving to the start of breeding (Table V), mean interval when cows were on treatment, was approximately 30 days shorter than in the previous two years of the study. In addition, the pattern of body condition loss from calving to the end of breeding of the Low cows in the third year was very similar to the pattern of body condition loss from calving to the end of breeding of the Moderate cows in each of the first two years of the study.

Wiltbank et al. (1962) reported an 11% reduction in conception rate in High-Low cows compared to High-High even though the High-Low cows were in good breeding condition (5.6) at 56 days postpartum. However, the High-Low cows were fed the Low level of postpartum energy until they were diagnosed pregnant. Rakestraw et al. (1983) reported that even when cows calved in good body condition (6.2-6.5), were well fed from calving to the start of breeding, and entered the breeding season in good body condition (5.9-6.1), conception rates could be reduced if cows were poorly fed during the breeding season. In addition, these researchers (Rakestraw et al., 1983) reported a reduced conception rate in cows that lost considerable weight (-175 lbs.) and condition (-1.4) from calving to the start of breeding (year 2); however, when cows were fed the same, but mild weather prevented large weight (only -32 lbs.) and condition loss (only -.25) conception rate was not reduced (year 1). These results are consistent with the results in the present study.

The results by Dunn et al. (1969) are also consistent with the results in this study. Heifers fed a Moderate level of digestible energy for 120 days after calving (27.3 Mcal) had a 15% lower conception rate than heifers fed a High level (48.2 Mcal). Conception rate was reduced even further (8% less than Moderates) when heifers were fed a Low level of digestible energy (14.2 Mcal).

Somerville et al. (1979) reported trends for both month of calving and plane of nutrition to affect fertility, independently, as both resulted in more rapid weight loss during the mating period. Hight (1968), on the other hand, reported a decrease in conception rate only in cows fed both Low pre- and postpartum planes of nutrition. The High prepartum - Low postpartum cows, however, gained an average of .05 g/day from calving to 131 days postpartum, which approximates the interval from calving to the end of breeding in this study.

Hodgson et al. (1980) reported no effect of level of postpartum nutrition on conception rate, even though the Low cows in their study lost 88 lbs. more between the mean calving date and 60 days after the mean calving date, when cows were turned onto lush pasture. However, the Low cows were 66 lbs. heavier at calving and the weights and condition scores of the two treatment groups did not differ when cows were turned onto pastures. Richards and Spitzer (1983) also reported no plane of nutrition effect on conception rate; however, as reported earlier, the cows in their study varied widely in condition at calving and were in a previous nutritional study which may have influenced their results.

Calf Performance

The overall effect of dam's postpartum nutrition level, and overall effect of weaning age of calves, on adjusted calf weights at 210 and 285 days postpartum are presented in Table VII. Calves suckling Moderate cows were 15 and 19 lbs. heavier than calves suckling Low cows at 210 and 285 days postpartum, respectively. Calves weaned at 285 days postpartum were 189 lbs. heavier than they were at 210 days postpartum and 69 lbs. heavier than calves weaned at 210 days postpartum, creep fed for 14 days, and run as stockers on native pasture for 61 days. These results indicate that the dam's postpartum level of nutrition affected the dam's milk production and that the milk production of the dam can influence calf growth until calves are at least 285 days of age.

Previous research has reported that calves suckling heavier producing dams gained more weight ($P<.01$) from birth to weaning (Drewry et al., 1959) and that milk production during the first four months of lactation affected weaning weights (Rutledge et al., 1971). Similarly, Reynolds et al. (1978) reported significant correlations (.35-.60) between monthly milk production and early calf gains. Milk production from 0-60 days and calf gains from 0-60 days were even more highly correlated (.77; P<.01) (Christian et al., 1965). Furthermore, fall-calving cows fed Low levels of winter nutrition produced less milk and had slower gaining calves (Velasco, 1962). All of these studies show the importance of milk production as a factor affecting early calf gains and how these gains can be influenced by the dam's level of nutrition.

TABLE VII

EFFECT OF DAM'S POSTPARTUM NUTRITION AND EFFECT OF WEANING AGE OF CALVES ON ADJUSTED CALF WEIGHTS AT 210 AND 285 DAYS OF AGE[a]

	No.	Adjusted 210 day wt.	Adjusted 285 day wt.
Dam's postpartum nutrition			
Moderate	161	443±9.4[c]	601±10.8[e]
Low	150	428±9.6[d]	582±11.1[f]
Weaning age			
Weaned at 210 days[b]	161	433±9.3[c]	557±10.7[d]
Weaned at 285 days	150	437±9.8[c]	626±11.3[e]

[a]Calf weights are in pounds ± standard error.

[b]Calves weaned at 210 days were creep fed for 14 days and run as stockers on native range for 61 days.

[c,d,e,f]Means within dam's postpartum nutrition or weaning age with different superscripts differ significantly (P<.01).

Milk production over the last 172 days of lactation was less in fall-calving cows fed a Low level of winter nutrition, thus resulting in lighter calves at weaning (Furr, 1962; Furr and Nelson, 1964). The dam's level of nutrition during the first four months of lactation has also been reported to influence weaning weights and gains to weaning in late weaned calves (240 days) (Neville, 1962). These studies show that early restrictions on nutrient intake in the dam, which do affect milk production, can affect the calf late in its suckling life and may explain why this study showed differences in 285 day weights between calves suckling cows fed Low and Moderate levels of postpartum nutrition and why calves weaned at 285 days of age were so much heavier than calves weaned at 210 days, creep fed for 14 days to reduce stress, and run as stockers for 61 days until they were 285 days of age.

While it is not known exactly what the pattern of milk production was for the cows in each treatment in this study, the treatment effects on calf weaning weights in this study reflect closely those reported by Harris et al. (1962). These researchers reported a large decrease in milk production in cows fed a low level of winter nutrition vs. cows fed a High level (6.02 lbs. vs. 9.18 lbs.), and even though the level of milk production of the Low cows rebounded to the level of the High cows 56 days after the cows were turned-out to lush pastures, weaning weights averaged 43 lbs. less over the three years of the study for calves suckling Low cows.

In contrast, Hodgson et al. (1980) reported no effect of dam's level of nutrition on weaning weights of spring-born calves; however, milk production was reduced for only six weeks (8.1 kg/day vs. 9.5 kg/day), the levels of milk production for the two treatments were reversed after cows were turned-out to pasture (11.6 kg/day vs. 10.1 kg/day), and Low cows produced the greater amount of milk for 122 days on pasture. In addition, it has been reported that calves suckling lower producing cows are more efficient converters of milk to gain (Bond and Wiltbank, 1970). Therefore the large increase in milk production of Low cows after turn-out may have been enough to boost calf gains above the gains of the calves suckling the High cows.

Kropp (1972) and Kropp et al. (1973) reported level of winter nutrition effects on milk production in Holstein x Hereford heifers on range (8.78 kg/day vs. 7.85 kg/day for H vs. M heifers) and Holstein heifers in drylot (11.74 and 11.34 kg/day vs. 9.98 kg/day for VH and H vs. M). Calf weaning weights were not affected by the level of milk production in either of these breeds. However, the difference in the Holstein x Hereford heifers was small; therefore increased efficiency of gain may have compensated, and in the Holstein heifers milk production was so high that even in the M cows milk production may not have been a limiting factor on calf gains. In addition, an increase of as much as 23.5 lbs. of milk has been reported to be necessary to increase ADG's by 1 lb. in high producing cows (Neville, 1962).

Conclusions

The results of this study show the substantial effect that postpartum weight and condition loss has on reproductive performance of fall-calving beef cows. Cows that lose considerable amounts of body weight and condition during the postpartum period between calving and breeding will exhibit significantly longer postpartum anestrous periods. These cows will also have reduced conception rates, even though they are well fed during the breeding season.

Although considerable postpartum weight and condition loss from calving to breeding may not permanently reduce milk production, milk production (not measured in the present study) appears to be reduced enough during this time period to significantly reduce the weaning weights of calves.

Allowing calves to suckle their dams for nine to 10 months versus only seven months significantly improved the weaning weights of calves. While extending the suckling period did prevent cows from gaining as much condition over the summer grazing period as cows nursing calves for only seven months, it did not prevent these cows from reaching very acceptable body condition scores.

CHAPTER V

SUMMARY

Data combining the first three years of a four-year study were collected, utilizing a total of 311 fall-calving Angus x Hereford cows, to determine the influence of postpartum nutrition on cow and calf performance. The cows, ranging in age from two to seven years, were assigned to either a Moderate (maintain a body condition score of 6 to the start of the breeding season) or a Low (lose 10% of postcalving weight by the start of the breeding season) level of postpartum nutrition. From the start of the breeding season until warm season grasses began to grow, all cows received the Moderate level of supplementation. Their calves were weaned at 210 or 285 days of age to determine the effect of weaning age of the calf on calf weights as well as cow condition and reproductive performance.

The Moderate level of supplementation was not adequate to maintain post-calving weight and a body condition score of 6 to the start of the breeding season for Angus x Hereford cows. However, the Moderate cows lost less body weight and remained in better condition to the start of the breeding season than the Low cows which received little, if any, supplemental protein. The reduction in body condition of the Low cows prior to the start of the breeding season proved to be reproductively harmful. The Moderate cows had a 3.6% higher return to estrus (96.9 vs. 93.3%), exhibited postpartum estrus 15.0 days earlier (52.1 vs. 67.1 days) and had a 14.9% higher conception rate (94.0 vs. 79.1) than Low cows. In addition, 12.3% more Moderate cows than Low cows that were serviced during the breeding season settled (96.1% vs. 83.8%).

Even though the Low cows were in good body condition at calving, restricted protein and energy supplementation prior to the start of the breeding season resulted in significantly greater body weight and condition loss. An increase in protein supplementation to the Low cows at the start of the breeding season tended to improve their nutrition status (maintaining body condition), but did not result in acceptable rebreeding performance. The results of this study indicate that fall-calving cows calving in good body condition must be supplemented so that they enter the breeding season in good breeding condition (5.5) for acceptable rebreeding performance.

Postpartum nutrition level of the dam and weaning age of the calves significantly affected adjusted calf weights. Calves suckling Moderate cows were 15 and 19 lbs. heavier at 210 and 285 days postpartum, respectively, than calves suckling Low cows. However, the additional weight of the calves did not pay for the additional supplement cost of the Moderate cows prior to the breeding season unless reproductive performance of the cows is considered.

Calves weaned at 285 days of age were 189 lbs. heavier at weaning than calves weaned at 210 days. In addition, calves that remained on their dams for 285 days were 69 lbs. heavier than calves which suckled their dams to 210 days, were creep fed for 14 days, and run as stockers on native range for 61 days. Cows weaning calves at 285 days were lighter in weight and thinner in condition at 285 days postpartum than cows weaning their calves at 210 days; however, their body weight and condition were still acceptable.

Extending weaning resulted in large increases in calf weaning weights and had no detrimental effect on the cows. Therefore, in fall-calving cows delaying the weaning of calves until they are nine to 10 months of age can be a very important management tool to increase the profitability of a cow-calf herd providing that the additional forage consumed by the calves does not hamper the weight and condition gain of the cows during the summer grazing period and does not limit the availability of dormant grasses following calving.

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APPENDIX

TABLE VIII

SYSTEM OF BODY CONDITION SCORING (BCS) FOR BEEF CATTLE

Group	BCS	Description
	1	EMACIATED - Cow is extremely emaciated with no detectable fat over spinous processes, transverse processes, hip bones or ribs. Tail-head and ribs project quite prominently.
Thin Condition	2	POOR - Cow still appears somewhat emaciated but tail-head and ribs are less prominent. Individual spinous processes are still rather sharp to the touch but some tissue cover exists along spine.
	3	THIN - Ribs are still individually identifiable but not quite as sharp to the touch. There is obvious palpable fat along spine and over tail-head with some tissue cover over dorsal portion of ribs.
Borderline Condition	4	BORDERLINE - Individual ribs are no longer visually obvious. The spinous processes can be identified individually on palpation but feel rounded rather than sharp. Some fat cover over ribs, transverse processes and hip bones.
	5	MODERATE - Cow has generally good overall appearance. Upon palpation, fat cover over ribs feels spongy and areas on either side of tail-head now have palpable fat cover.
Optimum Moderate Condition	6	HIGH MODERATE - Firm pressure now needs to be applied to feel spinous processes. A high degree of fat cover is palpable over ribs and around tailhead.
	7	GOOD - Cow appears fleshy and obviously carries considerable fat. Very spongy fat cover over ribs and over and around tailhead. In fact "rounds" or "pones" beginning to be obvious. Some fat around vulva and in crotch.

TABLE VIII (Continued)

Group	BCS	Description
	8	FAT - Cow very fleshy and over conditioned. Spinous processes almost impossible to palpate. Cow has large fat deposits over ribs, around tail-head and below vulva. "Rounds" or "pones" are obvious.
Fat Condition	9	EXTREMELY FAT - Cow obviously extremely wasty and patchy and looks blocky. Tail head and hips buried in fatty tissue and "rounds" or "pones" of fat are protruding. Animal's mobility may even be impaired by large fatty deposits.

TABLE IX

BEEF ADJUSTMENT FACTORS

Birth weight (BW)

sex adjustment - adjustment of females to a male basis

multiply female birth weight by 1.07

age of dam adjustment - adjustment to mature dam basis

age of dam	additive adjustment (lbs.)
2	+8
3	+5
4	+2
5-10	+0
11+	+3

Weaning weight (ww)

adjustment to 210- and 285-day basis

$$210\text{- or }285\text{-day weight} = \frac{\text{actual ww} - \text{BW}}{\text{age in days}} \times 210 \text{ or } 285 + \text{BW}$$

age of dam adjustments (add to 210- or 285-day weight)

age of dam	additive adjustment	
	male calves	female calves
2	+60	+54
3	+40	+36
4	+20	+18
5-10	+0	+0
11+	+20	+18

VITA 3

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