Effects of Postpartum Nutrition and Once-Daily Suckling on Reproductive Efficiency and Preweaning Calf Performance in Fall-Calving Brahman (*Bos indicus*) Cows[1,2]

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ABSTRACT: Brahman cows were used to evaluate the effects of postpartum nutrition and suckling on reproductive and calf performance. Cows received high or low TDN and once-daily or unrestricted suckling. High TDN (H; 111% of NRC recommendation) cows received a 75% corn:25% soybean meal diet. Low TDN (L; 93% of NRC recommendation) cows received no concentrates. Once-daily suckled (restricted, R) cows nursed calves for 30 min/d starting at d 21 after calving. In the unrestricted (U) suckling groups, calves had continuous access to cows. By 2 wk of suckling restriction, more ($P < .01$) R than U cows had progesterone concentrations of ≥ .7 ng/mL (55 vs 0%) and more ($P < .05$) HR than LR cows had progesterone concentrations ≥ .7 ng/mL (70 vs 40%). All groups had increases in progesterone and 13,14-dihydro-15-keto-prostaglandin $F_{2\alpha}$ before estrus. The interval to first estrus was shorter ($P < .01$) for R than for U cows (42 vs 65 d). By d 42 postpartum, more ($P < .01$) R than U cows exhibited estrus (67 vs 0%), and more ($P < .05$) HR than LR cows exhibited estrus (89 vs 44%). Calving interval was shorter ($P <$ .01) for R than for U cows (361 vs 395 d). Initial ADG were lower ($P < .01$) for R than for U calves (.02 vs .69 kg), but weaning weights were similar. Once-daily suckling permitted ovarian activity, hastened return to estrus, and reduced calving interval without reducing weaning weights. Increased postpartum energy intake enhanced the response to restricted suckling.

Key Words: Brahman, Suckling, Energy Intake, Hormones, Postpartum Interval

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Introduction

Averaging a 12-mo calving interval can be difficult for beef producers, especially those using Brahman cows. A major impediment to achieving yearly calving intervals are long anestrous periods after parturition. To overcome postpartum acyclicity, cows must recover from the suppressive effects of pregnancy and parturition on the pituitary-ovarian-endocrine axis (Malven, 1984; Nett, 1987). Pituitary and ovarian function in suckled beef cows may return within 4 to 5 wk after calving (McNatty, 1988; Wright et al., 1990). Nutrition and suckling are two major factors controlling the length of the postpartum anestrous period (Randel, 1990; Short et al., 1990; Williams, 1990). Strategic management of nutrition and suckling should improve reproductive performance of cows without decreasing the growth performance of calves. The objectives of this experiment were to evaluate the effects of restricted suckling and postpartum nutrition on postpartum reproductive performance in Brahman cows, progesterone, and 13,14-dihydro-15-keto-prostaglandin $F_{2\alpha}$ (**PGFM**) concentrations relative to corpus luteum activity, first postpartum estrus, and preweaning growth of suckling calves.

Materials and Methods

Cattle. At parturition, 12 primiparous and 27 multiparous Brahman (*Bos indicus*) cows were classified by parity and sex of calf and assigned randomly to a 2 × 2 factorial arrangement of treatments. The cows were fed either a high or low TDN diet, and suckling was either restricted or unrestricted. The calving period was from August 22 to October 31.

The cows remained on the study from calving until their second estrus or until d 90 after calving, if estrus was not detected. From parturition to 3 d after the first detected estrus, cows were maintained on drylots; thereafter, they were maintained on ryegrass pasture. Cows not detected in estrus remained on drylot for 90 d before going to pasture.

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Nutrition. Nutritional treatments began at calving and ended at either first estrus or on d 90 in anestrous cows. Cows fed high (**H**) TDN received a diet that included coastal bermudagrass hay available to appetite and 3.6 $kg{\cdot}cow^{-1}{\cdot}d^{-1}$ of concentrate (75% corn and 25% solvent-extracted soybean meal). Low (**L**) TDN cows received coastal bermudagrass hay to appetite. All cows had ad libitum access to water and mineral supplements.

The concentrate diet contained 3.4% ether extract, 17.5% CP, and 79% TDN. The coastal bermudagrass hay contained 2% ether extract, 12.4% CP, and 49% TDN. All cows received dietary protein that met or exceeded their daily requirement. High TDN cows were fed 111% of their daily requirement and low TDN cows were fed 93% of their daily requirement (NRC, 1984). When moved to pasture, cows grazed ryegrass and received .9 $kg{\cdot}cow^{-1}{\cdot}d^{-1}$ of the concentrate diet described previously.

Suckling. Suckling treatments were initiated on d 21 after calving and ended at first postpartum estrus or d 90 after calving in anestrous cows. Cows in the unrestricted (**U**) suckling groups remained with their calves throughout the study period. Once-daily (restricted, **R**) suckled cows were maintained with their calves from birth until d 21 after calving. From d 21 until first estrus, restricted cows were kept separated from their calves except for a 30-min period every morning when their calves were allowed to nurse. After first estrus, suckling restriction was terminated, and the eligible pairs were maintained together for the remainder of the study.

Separated calves were kept in a sheltered pen. Concentrates, coastal bermudagrass hay, and water were available for ad libitum intake. The concentrate diet was the same as that received by the cows.

Body Weights, Estrus Detection, and Breeding. Cows calved in at least moderate body condition (body condition score ≥ 5 on a 9-point system). Cow and calf weights were recorded weekly from calving. Weaning weights were recorded on April 3, standardized to 205 d of age, and adjusted for age of cow (BIF, 1990). Estrus was detected by visual observation and with the aid of epididymectomized bulls equipped with chin-ball markers. Estrus dates were confirmed with plasma progesterone concentrations. Progesterone concentrations ≥ .7 ng/mL were considered to indicate luteal activity. In the ryegrass pasture, there was one fertile bull equipped with a chin-ball marker. Cows were eligible to become pregnant at their second postpartum estrus. The breeding period ended on February 1. Pregnancy was determined by palpation per rectum on March 15.

Blood Sampling. Blood samples were collected by tail vessel puncture, using heparinized vacuum tubes, to determine plasma concentrations of PGFM and progesterone. From calving to d 18 after calving, samples were collected every 3rd morning. From d 19 to 36 after calving or to first estrus, samples were collected every 12 h for PGFM analysis and every 72 h for progesterone analysis. From d 37 to 90 after calving or to first estrus, blood samples were collected every morning for progesterone and PGFM analysis. After first estrus, samples were collected every 72 h for 3 to 4 wk to determine progesterone concentrations. Samples were obtained before the morning suckling session in the R suckling groups. All samples were processed immediately to yield plasma. Plasma was stored at −20°C until analyses.

Blood Constituents. Plasma concentrations of progesterone and PGFM were determined with a direct RIA (Williams, 1989; Velez et al., 1991). For the progesterone RIA, GDN #337 antibody (G. D. Niswender, Colorado State University, Ft. Collins) was used, with an interassay CV of 13.8% and an intraassay CV of 8.7%. For the PGFM RIA, PGFM #133 antibody (R. V. Haning, Jr., Women & Infants Hospital of Rhode Island, Providence) was used, with an interassay CV of 13.7% and an intraassay CV of 9.6%.

Statistical Analysis. The experiment was a randomized complete block design. Parity and sex of calf were considered blocks. The effects of treatments and interactions on non-repeated measures, such as postpartum interval and ADG, were tested with analyses of variance (Ott, 1988) with least squares means generated using SAS GLM procedures (SAS, 1988). Cow and calf ADG were compared from calving to d 21 after calving, d 21 to 28 after calving, and d 28 to 35 after calving. Frequency data were compared using analysis of variance procedures for categorical data (Rutledge and Gunsett, 1982) with data coded as 0 ("no" response) or 1 ("yes" response). Least squares means for progesterone and PGFM concentrations were derived from split-plot analyses of variance models for repeated measures over time (Wilcox et al., 1990) using SAS GLM procedures (SAS, 1988). Progesterone and PGFM concentrations were determined during intervals from calving to d 18 after calving, d 21 to 36 after calving or to first estrus, and d 10 before estrus to first estrus. Group means (HR vs LR) were compared if at least moderate ($P < .15$) nutrition × suckling interactions occurred (Lowry, 1992). Means were compared with pairwise *t*-tests (Ott, 1988).

Results

Endocrine Profiles. Mean progesterone concentrations were similar between multiparous and primiparous cows in all time periods evaluated. Average PGFM concentrations were greater ($P < .05$) in multiparous cows than in primiparous cows from d 21 to 36 after calving (23.2 ± 2 vs 9.3 ± 1.5 pg/mL) and during the 10-d period before first estrus (21 ± 2.7 vs 7.1 ± 3.7 pg/mL).

Progesterone and PGFM concentrations decreased to baseline during the first 18 d after calving and were not influenced by diet. Interacting with day after calving, restricted suckling resulted in increased ($P < .001$) progesterone concentrations within the 1st wk of suckling restriction and a PGFM increase ($P < .005$) during the 2nd wk of restricted suckling (Figure 1). During the 16 d after the start of suckling restriction, a greater ($P < .001$) proportion of R than of U cows had peak progesterone concentrations ≥ .7 ng/mL (55 vs 0%). By d 37 after calving, nearly one-half of the R cows exhibited first estrus, whereas all the U cows remained anestrous (45 vs 0%; $P < .005$).

A trend was seen in which nutrition consistently interacted ($P < .15$) with suckling to alter endocrine patterns during the 2 wk following the start of restricted suckling. The HR group showed a consistent progesterone increase and subsequent increase of PGFM (Figure 2). The LR group showed an inconsistent increase of progesterone with an increase in PGFM not evident until d 36 after calving (Figure 2). During the 2 wk of suckling restriction, a greater ($P < .05$) percentage of HR than of LR cows had peak progesterone concentrations ≥ .7 ng/mL (80 vs 50%) and exhibited first estrus by d 37 after calving (60 vs 30%). All groups showed increased progesterone and PGFM concentrations during the 10 d before first estrus (Figure 3).

Cow Performance. During the first 5 wk after calving, cows maintained good body condition. Due to increased TDN intake, H cows gained BW, whereas L cows lost weight during the first 3 wk after calving (.45 vs −.39 ± .19 kg·cow^{-1}·d^{-1}; $P < .005$). Initiation of restricted suckling resulted in an average BW change

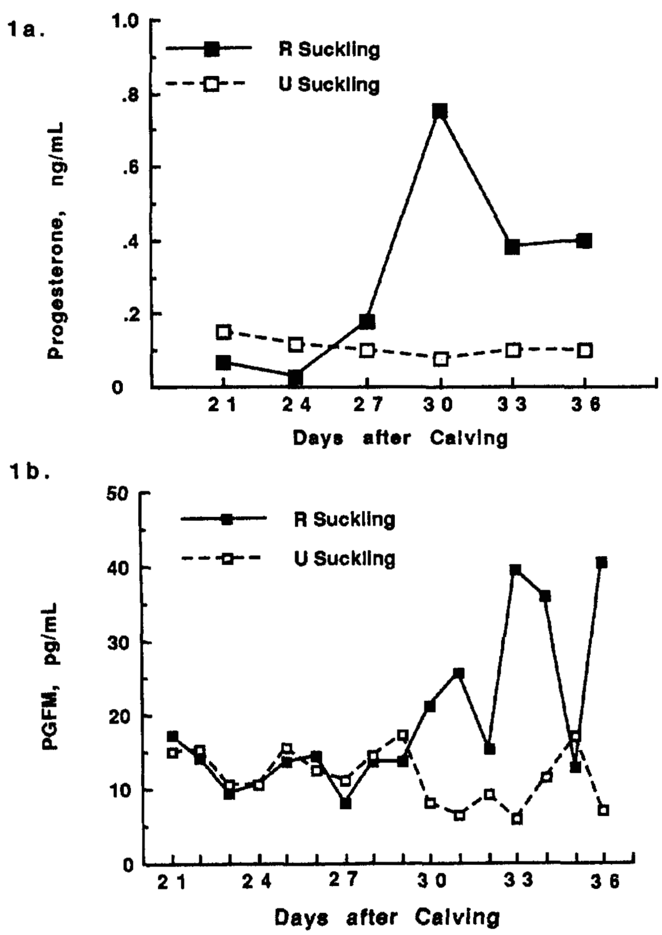

Figure 1. Effect of suckling × day after calving on mean concentrations of (a) progesterone and (b) 13,14-dihydro-15-keto-prostaglandin $F_{2\alpha}$ (PGFM) from d 21 to 36 after calving ($P < .01$ for suckling × day interaction). For progesterone SEM, restricted (R) = .09; unrestricted (U) = .08. For PGFM SEM, R = 7.1; U = 6.26.

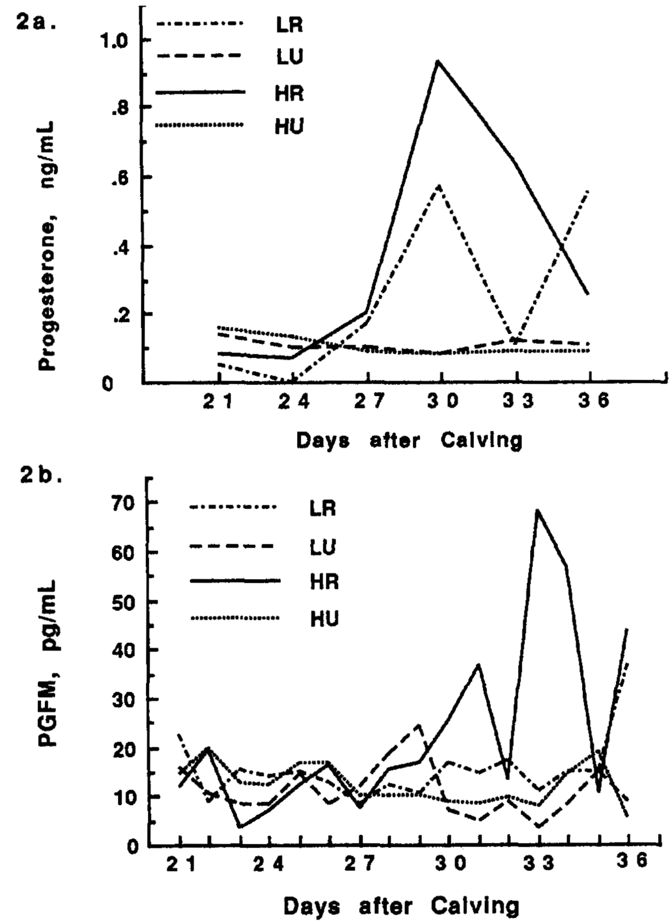

Figure 2. Effect of nutrition × suckling × day postpartum on mean concentrations of (a) progesterone and (b) 13,14-dihydro-15-keto-prostaglandin $F_{2\alpha}$ (PGFM) from d 21 to 36 after calving ($P < .1$ for nutrition × suckling × day interaction). For progesterone SEM, LR = .12; LU = .12; HR = .13; HU = .11. For PGFM SEM, LR = 9.39; LU = 9.04; HR = 12.4; HU = 8.66. L = low TDN; H = high TDN; R = restricted suckling; U = unrestricted suckling.

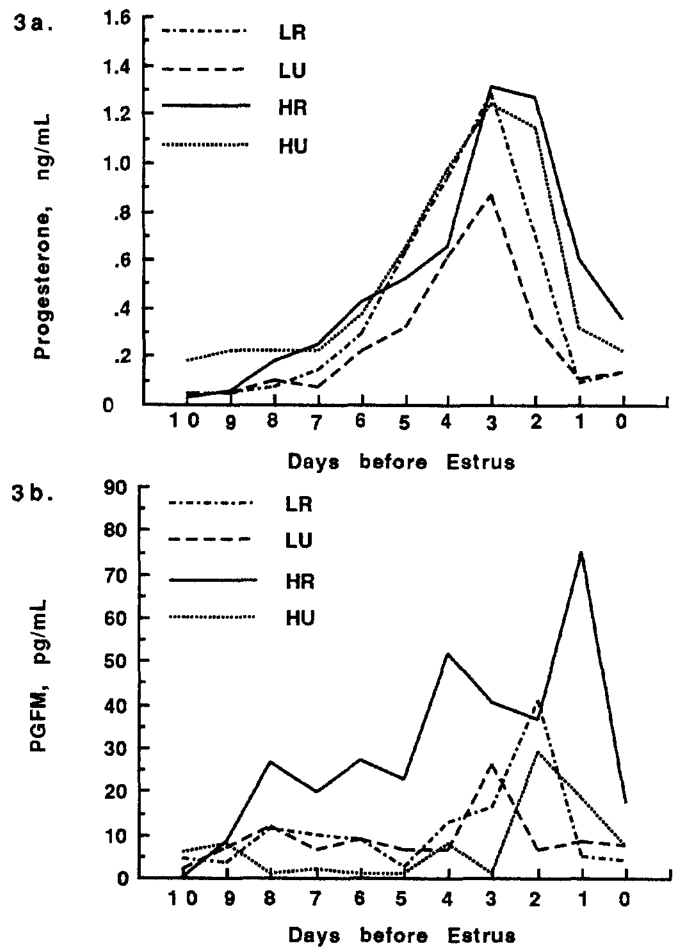

Figure 3. Mean plasma concentrations of (a) progesterone and (b) 13,14-dihydro-15-keto-prostaglandin $F_{2\alpha}$ (PGFM) in cows during the 10 d before the first postpartum estrus. For progesterone SEM, LR = .18; LU = .25; HR = .18; HU = .24. For PGFM SEM, LR = 11.25; LU = 16.13; HR = 11.71; HU = 15.07. L = low TDN; H = high TDN; R = restricted suckling; U = unrestricted suckling.

of −2.3 ± .4 kg·cow^{-1}·d^{-1} in R cows during the 1st wk of calf separation, whereas U cows were able to maintain BW during the same period (.29 ± .38 kg·cow^{-1}·d^{-1}; P < .001). Weight change for the R cows became positive (.72 ± .34 kg·cow^{-1}·d^{-1}) during the 2nd wk of calf separation.

Multiparous cows tended (P < .1) to have decreased postpartum intervals compared to primiparous cows (48.9 ± 2.8 vs 57.6 ± 4.2 d) and a higher rate of return to estrus by d 42 after calving (45 vs 17%). More (P < .05) multiparous than primiparous cows were detected in second estrus by 73 d after calving (56 vs 17%).

The interval to first estrus was 3 wk shorter (P < .001) for R cows than for U cows (Table 1). By d 42 after calving, a majority of the R cows returned to estrus, but none of the U cows did (Table 1). Nutrition tended to influence the response to restricted suckling. With evidence of a moderate (P < .15) interaction between suckling and nutrition, postpartum interval was shorter for HR than for LR cows (37 vs 46.9 ± 4.2 d). In addition, nutrition interacted (P < .05) with suckling by permitting more (P < .005) HR than LR cows to exhibit estrus by d 42 after calving (89 vs 44%). By d 73 after calving, all R cows had exhibited first estrus, and 54% more (P < .005) R than U cows exhibited second estrus (Table 1).

Cumulative pregnancy rates were greater for multiparous cows than for first-calf cows (81 vs 25%; P < .005). A greater proportion of multiparous than of primiparous cows had calving intervals of 365 d or less (44 vs 8%; P < .05). Overall pregnancy rates were similar for the various treatment groups. Restricted suckling shortened (P < .001) calving intervals by 34 d and increased (P < .001) the proportion of calving intervals of ≤ 365 d (Table 1).

Calf Performance. Calves of multiparous cows had greater (P < .05) rates of gain than calves of primiparous cows from 21 to 28 d of age (.23 ± .1 vs .48 ± .07 kg·calf^{-1}·d^{-1}). During the 1st wk of restricted suckling, daily weight change in R calves was reduced (P < .001) compared with that in U calves (.02 vs .69 ± .08 kg·calf^{-1}·d^{-1}). During the 2nd wk of calf removal, R calves gained body weight at a rate similar (P = .6) to that of U calves (.7 vs .63 ± .1 kg·calf^{-1}·d^{-1}). Adjusted weaning weights were not significantly altered by experimental treatments.

Discussion

Restricted suckling caused an increase of progesterone from basal concentrations in R cows and increased the occurrence of first estrus by d 37 after calving. Initial increases in progesterone were occurring before estrus. Previous reports have shown increased progesterone concentrations before first estrus in postpartum beef cows (Humphrey et al., 1983; Dawuda et al., 1988). By d 37 after calving, pre-estrual peaks in progesterone concentrations were ≥ .72 ng/mL and were considered to indicate luteal activity. Perry et al. (1991) reported an average peak progesterone concentration of .7 ng/mL during the first postpartum luteal phase in suckled *Bos taurus* beef cows. Increased progesterone concentrations within 1 wk after calf removal indicate that restricted suckling permitted the initiation of ovarian activity within 1 wk after calf separation and that estrus occurred soon after.

Restricted suckling shortened the postpartum interval to first estrus and reduced calving interval by 1 mo, to just under 365 d. In addition, restricted suckling increased the proportion of cows detected in first estrus by d 42 and 73 after calving and increased

Table 1. Effect of suckling management on return to first estrus after parturition and calving interval

Trait	Restricted	Unrestricted	*P*-value
Postpartum interval to first estrus, d[a]	41.9 ± 3	64.6 ± 3.9	.001
First estrus by d 42 after calving, %	67	0	.001
First estrus by d 73 after calving, %	100	56	.005
Second estrus by d 73 after calving, %[b]	70	16	.005
Calving interval of 365 d or less, %	60	5	.001
Calving interval, d[a]	361.3 ± 7.7	395.4 ± 8.4	.001

[a]Least squares means ± SE.
[b]First chance to be bred if postpartum interval to first estrus was ≤ 90 d.

the proportion of cows with calving intervals of 365 d or less. Proportional return to estrus was compared at d 42 and 73 after calving because they are pivotal days in maintaining 365-d calving intervals in Brahman cows with respect to their average length of gestation. Plasse et al. (1968) found the average gestation length of Brahman cows to be 292 d. Average gestation length in this study was 291.9 d, with a range of 283 to 299 d.

Previous reports have also shown restricted suckling of *Bos indicus* cows to reduce postpartum interval (Del Vecchio et al., 1988; Ruas et al., 1991) and calving interval (Moore and Campos da Rocha, 1983; Escobar et al., 1984; Guimaraes Filho, 1985). This study further supports the suggestion that restricted suckling can be beneficial in the management of *Bos indicus* cows. Restricted suckling allowed for 365-d calving intervals despite the fact that cows were not serviced until second estrus. Fertility of the estrus induced by restricted suckling was not determined; however, average estrous cycle length after first estrus was normal for all groups.

Restricted suckling hastened the return to estrus despite the loss of BW during the 1st wk of restricted suckling. The weight loss of the cows was probably due to the stress of having their calves removed, reduced feed consumption, and increased activity in searching for "lost" calves (Symington and Hale, 1967). The stressed condition was temporary; R cows had positive ADG during the 2nd wk of suckling restriction. Hill and Godke (1987) reported that restricted suckling reduced postpartum interval and increased the frequency of return to first estrus in cows despite an increased amount of weight loss.

Increased TDN consumption enhanced the ovarian response to restricted suckling. Ovarian response in the HR cows was synchronous; 70% of the group exhibited an initial progesterone increase during the 2-wk period after restricted suckling began. Ovarian response in the LR cows was variable; 40% of the group experienced increased progesterone concentrations during the 2-wk period following the start of restricted suckling. The moderate adjustment in TDN consumption did not influence return to estrus in U cows but did shorten the postpartum interval and increase the frequency of return to estrus in response to restricted suckling. The effects of dietary energy on reproduction depend on the degree of restriction, body condition, and the stability or change of body weight (Short and Adams, 1988). The influence of diet in the R cows was apparent despite the facts that the two diets did not differ greatly from NRC maintenance requirements, cows calved in good body condition, and R cows initially lost weight. It apparently does not take a large difference in energy intake to affect cows coming out of postpartum anestrus as a result of suckling manipulation. In a related study involving primiparous beef cows, Whisnant et al. (1985) reported that LH release in response to calf removal was decreased when energy intake was below maintenance requirements. Increased energy intake was also shown to shorten postpartum interval and increase the frequency of return to estrus in once-daily suckled primiparous cows (Randel and Welker, 1977).

During the initial 2 wk of suckling restriction, a persistent increase in PGFM followed the onset of ovarian activity in U cows. Differences in the PGFM profiles between U and R treatments and between HR and LR groups seemed to be associated with differences in their progesterone profiles in response to restricted suckling. Before first estrus, all groups exhibited increased progesterone concentrations. In addition, all groups experienced increased concentrations of PGFM 1 to 3 d before first estrus. These findings indicate that prostaglandin $F_{2\alpha}$ may be associated with ending the period of increased progesterone concentrations experienced before first estrus in postpartum beef cows. Indeed, PGFM concentrations were shown to increase during luteolysis, terminating the first luteal experience in postpartum dairy cows (Peter et al., 1989).

Weaning weights were not affected by restricted suckling. The lack of weight gain experienced by R calves during treatment was temporary, lasting only through the 1st wk of restricted suckling. The restricted suckling period was brief, 2 to 4 wk, relative to the 6- to 7-mo preweaning growth period of the calves. In agreement with the present findings, Randel and Welker (1976) and Odde et al. (1986) reported that restricted suckling lowered calf ADG but ultimately had no effect on weaning weight.

Implications

In Brahman cows calving in moderate body condition, restricted suckling hastened the return of cyclic ovarian activity, subsequently reducing postpartum intervals to estrus and calving intervals. Endocrine and performance responses to restricted suckling were altered by moderate changes in postpartum energy intake. Restricted suckling caused temporary reductions in daily weight gain of calves but did not reduce weaning weights. For beef producers using Brahman and other *Bos indicus* cows, restricted suckling may be a useful management practice, in conjunction with adequate nutrition, to improve postpartum reproductive performance and shorten calving intervals.

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