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SHORT AND LONG-TERM REPRODUCTIVE RESPONSES OF HEIFERS FED DIFFERENT NUTRITIONAL REGIMES PRE- AND POST-BREEDING[1]

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ABSTRACT: The effects of nutrition level in the prepubertal period (PRE) and post-breeding through gestation and early lactation period (POST) on subsequent heifer reproductive performances were evaluated. Over a three year period, 250 Angus x Hereford heifers were stratified by age and weight with groups randomly assigned in a 2 x 2 factorial arrangement of treatments with high (H) and low (L) levels of supplementation (barley and biuret) in PRE and POST (H-H, H-L, L-H and L-L). In PRE, basal diets were native flood meadow hay *ad lib.* For basal diets in POST, all heifers initially grazed high desert rangeland pastures and then switched to hay as above for winter. At breeding, heifers fed H in PRE had increased ($P < .0001$) weight gains (124 vs 97 kg), condition scores (5.8 vs 5.3), and total pelvic size (171 vs 160 cm^2) when compared to heifers fed L. After breeding, weight gains were greater ($P < .0001$) for H-H and L-H (36 and 41 k) than for H-L and L-L (24 and 26 kg). Additionally, condition scores were lower in L-L (5.6; $P < .01$) than in the other treatment groups (H-H, 6.0; H-L, 5.9; L-H, 5.9). Conception rates and calving dates for the first pregnancy were not different ($P > .05$) between groups. Calf birth weights were greater ($P < .05$) in H-H and L-H (32 and 33 kg) than in L-L (31 kg) but not different from H-L (32 kg). Sex adjusted weaning weights were lower ($P < .01$) in L-L than in L-H (141 vs 150 kg), but not different from H-H or H-L (148 and 146 kg). For the second pregnancy, conception rates were increased ($P < .05$) from 87 to 95% (pooled SE, 2.8) with H as compared to L in the POST of the first year. Improving nutrition for primiparous beef heifers during their first gestation and early lactation improved calf production and increased conception rate in the subsequent breeding season. Higher nutrient content level in the prepubertal period did not improve overall performance.

Key Words: Beef Heifers, Nutrition, Reproduction.

Introduction

Profits in the beef cattle industry are affected by the ability to produce a live calf crop. Failure of cows to become pregnant ranks first and perinatal calf losses rank second in affecting calf crop (Deziuk and Bellows, 1983). In most production systems, cows must conceive early in a well-defined breeding season in order to produce one calf per cow per year.

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Cow weight and body condition at many stages including puberty, breeding, parturition, lactation and re-breeding greatly impact reproductive efficiency and are influenced by nutrition level. Numerous researchers have investigated the effects of dietary energy, protein and lipid on reproduction (Dunn, et al., 1969; Marston, et al., 1995; Williams, 1989). The objectives of this study were to assess the reproductive responses of three heifer groups over three years (puberty through third conception) exposed to an integrated nutrition and breeding program. The results pertaining to nutrition are covered here, and those for breeding to reduce dystocia and 48 h calf removal prior to breeding are contained in a companion paper (Bailey et al., 1996) in these proceedings.

Materials and Methods

Over a three year period, 250 weaned Angus x Hereford heifers were stratified by age and weight, and within stratum randomly assigned to treatments. Treatments were arranged in a 2 x 2 factorial experiment with high (H) and low (L) levels of supplementation fed in the prepubertal period (PRE) and post-breeding through gestation and early lactation period (POST) (H-H, H-L, L-H and L-L). For the PRE treatment, all heifers were wintered on a basal diet of native flood meadow hay *ad lib.* until breeding, with half receiving supplements of 1.35 kg barley and .05 kg biuret (1.4 kg total) (L) and half receiving 2.25 kg total supplements (H) in order to achieve BW 60 and 65% of mature weight at breeding. Supplements were adjusted as needed so that weight goals could be reached. One month prior to and during the breeding season all heifers grazed meadow hay aftermath and were fed rake bunched flood meadow hay with no supplements. After breeding, all animals were pastured on high desert rangeland where they were divided into the POST treatment groups of L (no supplementation) and H (0.9 kg barley and .04 kg biuret daily). These treatments were designed to provide a range of 75 to 90% of mature weight at calving. In the subsequent winter, all animals were again fed a basal diet of meadow hay as above but continued POST treatment levels of L and H.

Prior to first breeding, heifers were weighed, condition scored (CS) (1 to 9 scale; 1 = emaciated, 9 = obese), and total pelvic size measured with a Rice Pelvimeter. As reported in the companion paper (Bailey et al., 1996), heifers were bred via natural service to either Angus x Hereford bulls or to Longhorn bulls. Heifer weight and CS were recorded after the breeding season ended (mid-summer), at pregnancy testing (mid-fall), and in mid-winter). Conception rate was calculated as total number of heifers pregnant at 90 d post-breeding per number of heifers exposed to bulls during the 45 day breeding season (i.e., cumulative pregnancy rate). At calving, heifer body weight, calf weight, dystocia score, and calving date were recorded. Heifer and calf weights and percent calf crop at weaning were also recorded. Prior to the second breeding season heifers were weighed and CS. Immediately before breeding to Angus x Hereford bulls, heifers were divided into two groups for 48 h calf removal (**CR**) or no calf removal (**NCR**), again as part of the companion study (Bailey et al., 1996). Results relating to the breeding schemes will only be referred to in this paper where significant interactions with PRE or POST nutrition treatments are present. Cumulative pregnancy rate and CS were also recorded at 90 d after the second breeding season. Calving interval, dystocia score, calf birth weight, and percent live calves were recorded at second calving also. Conception rate was also calculated for the third breeding season.

Data were analyzed by general linear models procedure of SAS (1988) as a 2 x 2 factorial design evaluated using pre-planned contrasts. Means were separated by least significant difference procedure protected by a prior F-test P < .05 (Steel and Torrie, 1980).

Results and Discussion

Reproductive performance of heifers by treatment is presented in Table 1. Heifers fed H in the PRE had increased (P < .0001) weight gains (125 vs 96 kg), CS (5.8 vs 5.3) and total pelvic size (171 vs 160 cm^2) prior to breeding as compared to those receiving L. This satisfied the goal of a breeding weight of 65% and 60% of mature weight for H and L groups, respectively. In a compensatory growth manner, heifers that were in the L group gained more (P < .0001) weight than the H group durin the following 60 day unsupplemented period, i.e., into the breeding season (50 vs 43 kg).

At pregnancy testing two months into POST, weight gains were greater (P < .0001) for H-H and L-H heifers (36 and 40 kg) than for H-L and L-L groups (24 and 26 kg) and CS was lowest (P<.01) for the L-L group. Conception rates, however, were not different between groups. Mid-winter heifer weight gains were higher (P < .0001) for H-H and L-H (44 and 49 kg) than for H-L and L-L (29 and 29 kg), with L-H greater (P < .05) than H-H. Weight gains 2 months prior to calving were not different (P = .13). Heifer weights at calving were highest in H-H (386 kg) and lowest in L-L (343 kg) groups (P < .0001), or approximately 85 and 75% of mature BW. Calf birth weights were higher (P < .02) for H-H and L-H (32 and 33 kg) when compared to L-L (31 kg), but not different (P = .22) from H-L (32 kg). First year calving dates and dystocia scores were not different between groups (data not shown). Sex adjusted weaning weights (**SAWW**) of first calves from the L-H group (150 kg) were higher (P < .01) than those from L-L (141 kg), but not different from H-H and H-L (148 and 146 kg). For SAWW, L-L tended (P = .06) to be lower than H-H but not different from H-L.

Prior to the second breeding season, CS for H-H and L-H (5.2) were higher (P < .0001) than those for H-L and L-L (4.6 and 4.4). Heifers lost less (P < .01) weight when fed L-H than when fed H-L (30 vs 40 kg), but loss was not difference from H-H and L-L (34 and 36 kg) fed heifers. Second year conception rates were increased (P = .03) from 86 to 95% (pooled SE, 2.8) by effects of H compared to L in the POST of the first year, i.e., immediately prior to the second breeding season. This significance level is seen when heifer data from each group (n = 125) in POST are combined, but not seen if also separated according to previous nutritional regime, i.e., H-H, H-L, L-H and L-L (Table 1). Failure to detect significance in the later may be an effect of reduced numbers per treatment for obtaining these means. A significant (P < .05) POST by CR interaction was present for second year's conception rates. Although no difference in conception rate due to CR or NCR was found when heifers were fed H in POST of the first year, with NCR conception rates for L were lower (P < .005) than for H (81 vs 97%; Bailey et. al., 1996). For second year calving dates, heifers in the L-H group calved ealier (P = .03) than those in L-L (84 vs 90 d, Julian date). Apparently, they conceived ealier, possibly due to a shorter post-partum anestrous period or increased fertility. Heifer weight gain between the first and second calvings was not different between H and L groups. However, there was a significant interaction between POST and CR for that gain. Heifers in POST H with CR gained less (P = .01) than heifers in L with NCR (23 vs 36 kg). Second calf birth weights (**CBW2**) were lower (P < .04) for L-L (34 kg) as compared to weights for H-H, H-L, and L-H (36, 35, and 35 kg, respectively). A calf sire type (Angus x Hereford or Longhorn) by POST interaction was present for CBW2 (data not shown). For the second calf, SAWW was not different (P = .8) between H and L groups alone, however, a significant (P < .05) interaction between PRE and CR was present. Low PRE with CR had lower (P < .05) SAWW than H or L PRE with NCR and H POST with CR (145, 150, and 145 kg, respectively). Third year conception rate was lower (P = .04) for L-L (66%) than for H-L (86%) and tended (P = .06) to be lower that H-H (83%), but was not different from L-H (80%). The low rate with L-L may have possibly been due to those heifers on L-L having extended calving dates the previous year and therefore not returning to a fertile state during the defined breeding season.

Implications

Improving nutrition for primiparous beef heifers during their first gestation and early lactation improved conception rates in their second breeding season. Higher nutrient content level in the prepubertal period did not improve overall performance. Interactions between nutrition level and breeding schemes existed, therefore, individual assessment of conditions of heifers and of available feed resources are important in predicting outcome with respect to profitable management. As an example, calf removal prior to breeding was beneficial if heifers had been fed a low nutrition level in the post-breeding period.

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Table 1. Heifer reproductive performance by treatment[a]

Item	Nutrition level in PRE[b]		
	High	Low	SE[c]
Initial BW (kg)	177	176	1.6
BW after PRE (kg)	301[k]	274	2.4
CS after PRE[g]	5.8[k]	5.3	.05
Total pelvic are (cm²)	171[k]	160	1.8
BW after breeding (kg)	345[k]	324	2.5

Item	Nutrition level in POST[b]				
	High[d]	Low[d]	High[e]	Low[e]	SE[c]
BW in mid-fall (kg)[f]	377[k]	372[kl]	364[l]	350	3.6
CS at pregnancy test[g]	6.0	5.9	5.9	5.6[k]	0.7
Conception rate 1(%)	97	95	99	94	3.0
BW in mid-winter (kg)[h]	422[k]	400	413[k]	381[l]	4.3
Calving date 1 (Julian)	72	71	70	74	1.9
BW at calving (kg)	386[k]	360[l]	372[l]	343	4.6
Calf birth wt 1 (kg)	32[k]	32[kl]	33[k]	31[l]	.49
Weaning wt 1,(kg)[i]	148[kl]	146[kl]	150[l]	141[k]	2.5
Calves weaned (%)	100	98	100	100	1.0
BW after POST (kg)	354[k]	321[l]	342[k]	304	4.6
CS after POST[g]	5.2[k]	4.6	5.2[k]	4.4	.11
Conception rate 2 (%)	96	87	94	87	4.0
Calving date 2 (Julian)	89[kl]	85[kl]	84[k]	90[l]	2.1
Calf birth wt 2 (kg)	36	35	35	34[k]	.35
Live calves (%)	98	94	96	100	2.4
Weaning wt 2 (kg)[i]	143	146	144	141	3.2
Final wt gain (kg)[j]	25	33	26	33	3.3
Conception rate 3 (%)	83[kl]	86[k]	80[kl]	66[l]	7.0

[a]Least squares means.
[b]Prepubertal period (PRE) and post-breeding through early lactation period (POST).
[c]Pooled SE of least squares means.
[d]Previously in high nutrition level during PRE.
[e]Previously in low nutrition level during PRE.
[f]After 60 d of POST.
[g]Condition score (CS); scale 1-9.
[h]After 150 d of POST.
[i]Sex adjusted.
[j]Wt gain between weaning calf 1 and 2.
[k,l]row means without a common superscript differ, $P < .05$.