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DEVELOPING REPLACEMENT HEIFERS: RECENT RESEARCH FINDINGS ON TARGET WEIGHTS AND FAT SUPPLEMENTATION

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TARGET WEIGHT AND TIME OF BREEDING REPLACEMENT HEIFERS

Proper development of replacement heifers is critical. Heifers should be managed to reach puberty early, conceive early in the first breeding season, calve unassisted, and breed back early for their second calf. This development needs to be accomplished at low costs without sacrificing performance. Previous studies (Patterson et al., 1992) indicate puberty can be expected to occur at a genetically predetermined size among individual animals; and only when heifers reach predetermined target weights can high pregnancy rates be obtained. Recommended guidelines generally have been 60 to 66% of mature weight in beef heifers, depending on frame size (Patterson et al., 1992). Some studies do not support a critical body weight or composition hypothesis in heifer development (Brooks et al., 1985).

Inconclusive results not only exist regarding the appropriate target weight, but also the appropriate time heifers should be placed with bulls in relation to the mature cowherd. Common practice is to breed heifers before the cowherd so they have a longer rebreeding period. This development program requires additional resources if heifers are developed to the same target weight, because an accelerated rate of gain is needed to reach the target weight earlier. As summer calving has gained interest in Nebraska, heifer development programs that allow heifers to conceive early as yearlings and rebreed for a second calf at the lowest cost possible are needed.

The objectives of this study were: 1) to compare development of spring-born heifers at two prebreeding target weights (55% or 60% of mature weight) and determine effects on reproduction and cow and calf productivity, and 2) to develop summer-born heifers to similar target weights, but different breeding dates (30 days before or same date as mature cowherd) and determine effects on reproduction and subsequent cow and calf productivity.

METHODS

A three-year study was initiated using heifer calves selected from the MARC II (1/4 Gelbvieh, _ Simmental, _ Angus, _ Hereford) cowherds at the Gudmundsen Sandhills Laboratory near Whitman, Neb. In 1998, 1999 and 2000, approximately 80 spring-born heifers and 50 summer-born heifers were selected each year as replacements for the spring (calve in March and April) and summer (calve in June and July) cowherds. The genetic composition was similar in each herd and the same bulls were used in both herds each year.

Each year, weaned heifers were placed in drylot pens by treatment groups for the winter feeding phase. They were fed meadow hay, wheat middlings and soybean hull based pellets, and cracked corn in balanced diets to achieve the desired gains and target weights. Hay (9 to10% CP) was fed ad libitum in bale feeders. Pellets (20% CP) with Rumensin (80g/ton) and a vitamin-mineral mix were fed in bunks with cracked corn as needed. Heifers were weighed monthly and diets adjusted to obtain desired gains.

After the winter-feeding phase, heifers were weighed, body condition scored on May 15, and moved to native range for summer grazing. Before the breeding season, heifers were pelvic measured and blood samples were taken 10 days apart to determine cycling status.

The bred heifers grazed subirrigated meadow re-growth during the fall, and fed meadow hay and supplement (1.5 lb/day, 40% CP) during the winter. All pregnant 3-year-old cows were placed with the mature cowherds and fed and managed with them thereafter.

Spring Heifers

Weaned spring heifers were allotted to treatment by age and weight in mid-December. They were assigned to either a low or high-gain treatment. The low-gain treatment was fed to reach a prebreeding target weight of 660 lb (55% of mature weight) by May 15. The high-gain treatment was fed to reach a prebreeding target weight of 720 lb (60% of mature wt) by May 15.

Four Angus bulls were placed with the spring heifers on May 20 for a 45-day breeding season. Approximately 60 days after the end of the breeding season, heifers were palpated for pregnancy, weighed, and condition scored.

Calving began approximately March 1 for the spring heifers. Calving difficulty and calf birth weight were recorded and calving assistance provided as needed. After calving, spring heifers were fed meadow hay plus supplement (1.5 lb, 40% CP).

The spring 2-year-old cows were exposed to MARC II bulls on June 5 each year for rebreeding. Calves from spring 2-year-old cows were weaned in early September.

Summer Heifers

Weaned summer heifers were allotted to treatment by age and weight in mid-January. They were assigned to either an August or September breeding group. These heifers were developed to reach target weights of approximately 720 lb or 60% of mature weight by the beginning of breeding season. Summer heifers were exposed to bulls beginning either August 5 (30 days before the mature cowherd) or September 5 (same date as the mature cowherd). Four Angus bulls (the same bulls used with the spring heifers) were used on the summer heifers for 45 days. Approximately 60 days after the end of each breeding season, heifers were palpated for pregnancy, weighed, and condition scored.

Summer heifers were fed meadow hay plus supplement (1.5 lb, 40% CP) until May 15, and then moved to summer range where they calved. Calving began approximately May 15 for the August-bred heifers, and June 15 for the September-bred heifers. Calving difficulty and calf birth weight were recorded on all heifers and calving assistance provided as needed.

The summer 2-year-old cows were placed with MARC II bulls on September 5. The summer 2-year-old cows were fed 1 lb/day of 48% CP cubes during the breeding season in 1999, and in 2000 and 2001 the 2-year-old cows were fed cubes (1 lb/day; 48% CP) 45 days before and during the breeding season. Calves from summer cows were weaned in late November.

RESULTS

Spring Heifers

Heifers on the high-gain diet gained 0.3 lb/day more than on the low-gain diet (1.4 vs 1.1 lb/day; Table 1) and cost $22/head more during the 155-day wintering period. At prebreeding the high-gain heifers weighed 51 lb more than the low-gain group and had 0.4 unit higher condition score (6.0 vs 5.6 BCS, Table 1). The high-gain heifers were 57% of mature weight and the low-gain heifers were 53% of mature weight at prebreeding. The percentage of heifers cycling before breeding was 11% higher for the high-gain heifers (85 vs 74%). The 45-day pregnancy rate was not statistically different between groups (92 vs 88% for low and high gain, respectively).

Data for calving and weaning of the first calf, and reproduction (through fourth pregnancy) of the spring cows are presented in Table 2. The high gain cows were heavier at calving and weaning. These differences in heifer development weights carried over through the fourth pregnancy diagnosis. Average calf birth date, calf birth weight, calving difficulty, and calf losses were similar for both groups through three calf crops. Calf gain and adjusted 205-day weights were also similar for both groups of cows indicating milk production was probably similar. Percentage of cows rebreeding for their second, third, and fourth calves were similar for both groups (Table 2). There were no differences in pregnancy or calf production data when heifers were developed at either 53 or 57 % of mature weight. However, costs were increased for the high-gain group.

Summer Heifers

Heifers averaged 403 lb at the beginning of the experimental feeding period (mid-January, Table 1). August heifers gained 0.3 lb/day faster than the September heifers; feed cost was $11/head higher for the August group than the September group ($66 vs $55). The August heifers (580 lb) were heavier by mid-May than the September heifers (549 lb). However, the September heifers were heavier at breeding (703 and 727 lb for August and September, respectively). These weights were approximately 60% of mature weight. The percentage of heifers cycling before breeding was similar for both groups.

The 45-day yearling pregnancy rate was not statistically different for September (93%) and August heifers (88%). Calf birth weights were similar for the 2-year-old cows (Table 2). However, calving difficulty percentage was higher for the cows calving in May (13%) than those calving in June (0%). The prebreeding pelvic area (Table 1) was slightly larger (6 cm^2) for the June calving cows, which may have had some influence on calving difficulty. When comparing calving difficulty between the various groups (March vs May vs June calving), cows calving in May or June appear to have less calving difficulty than those calving in March. This difference was not due to smaller calf birth weights. The factors influencing calving difficulty may have included warmer temperatures, less heifer stress, more pelvic relaxation, better nutrition on green grass and more heifer exercise.

Calf gain to weaning was greater for the calves of the 2-year-old May calving cows. Actual calf weaning weights were 69 lb heavier and adjusted 205-day weights were 24 lb heavier for the May calving cows (Table 2).

Cow pregnancy rates for the second calf were low for both groups (78 and 82%, for May and June calving, respectively). This was probably due to the low nutritional value of mature grass during the September and October breeding. However, 2-year-old cows were supplemented (1 lb/day; 48% CP) during the breeding season the first year and an additional 45 days before breeding the next two years.

Subsequent calf performance and pregnancy rates did not differ through the next two calf crops. However, cow weight (second and third calf weaning) tended to be heavier for heifers developed to breed and calve earlier (May vs June). This is similar to the spring heifer development study in which heifers developed on an accelerated rate of gain had heavier mature weights. There may be an opportunity to manipulate mature weight and nutrient requirements by heifer development regimen.

May calving 2-year-old heifers had heavier actual and adjusted 205-day calf weaning weights compared to June calving heifers. June-born calves had similar birth weights to May-born calves, but less calving difficulty was experienced with June calving.

Pregnancy rates of summer heifers were satisfactory at yearling breeding, but unsatisfactory at rebreeding. Additional supplementation is required to improve rebreeding rates in summer calving cows probably due to diminishing nutrient values in native forages during the breeding season.

Table 1. Heifer development and breeding results for spring and summer heifers (1998-2000)

	Spring		Summer	
Trait	Low-gain	High-gain	August breeding	September breeding
No. of heifers	120	120	73	73
Beginning wt[a], lb	469	469	402	403

Winter ADG, lb/day	1.1[b]	1.4[c]	1.5[b]	1.2[c]
Prebreeding wt, lb	638[b]	689[c]	703[b]	727[c]
Prebreeding body condition	5.6[b]	6.0[c]	5.5	5.4
Pelvic Area, cm^2	174	171	175[b]	181[c]
Cycling before breeding, %	74[b]	85[c]	89	92
Start of breeding season	May 20	May 20	Aug 5	Sept 5
Pregnant in 45 days, %	92	88	88	93

[a] Heifer development began in mid-December for spring and mid-January for summer heifers.
[bc] Treatment means in row within season differ ($P<0.05$).

Table 2. First year calf production, and rebreeding of 2-yr-old cows over 3 years

	Spring		Summer	
Trait	Low-gain	High-gain	August breeding	Sept. breeding
Calving season began	Mar. 1	Mar. 1	May 15	June 15
Precalving wt, lb	915[b]	940[c]	895	908
Precalving body condition	5.2	5.3	5.3	5.2
Calf birth date	Mar. 13	Mar. 12	May 24[b]	June 23[c]
Calf birth wt,[a] lb	73	73	73	74
Calving difficulty, %	21	19	13[b]	0[c]
Weaning date	-----Sept. 6-----		-----Nov. 27-----	
Actual calf weaning wt[a], lb	405	411	396[b]	327[c]
Calf ADG[a], lb/day	1.87	1.89	1.75[b]	1.63[c]
205d adjusted calf weaning wt[a], lb	456	460	433[b]	409[c]
Cow weight at weaning, lb	914	929	910	910
Cow body condition	5.1[b]	5.3[c]	5.0	5.0
Cows pregnant with 2[nd] calf, %	91	91	78	82

Cows pregnant with 3rd calf, %	94	92	95	87
Cows pregnant with 4th calf, %	96	96	97	95

[a] Calf weights adjusted for sex.
[bc] Treatment means in row within season differ (P<0.05).

FAT SUPPLEMENTATION AND HEIFER DEVELOPMENT

Adequate nutrition is critical for successful reproductive function. Inadequate dietary energy intake and poor body condition can negatively affect reproductive function. Supplemental lipids have been used to increase the energy density of the diet and avoid negative associative effects sometimes experienced with cereal grains in high roughage diets. Supplemental lipids may also have direct positive effects on reproduction in beef cattle independent of the energy contribution. Lipid supplementation has been shown to positively affect reproductive function in several important tissues including: the hypothalamus, anterior pituitary, ovaries, and uterus. The target tissue and reproductive response appears to be dependent upon the types of fatty acids contained in the fat source.

Garcia et al. (2003) hypothesized diets high in linoleic acid would increase conjugated linoleic acid (CLA) tissue content, reduce adiposity and leptin production, and result in an increase in the age at puberty in heifers. Heifers were fed whole sunflower seeds (5% added fat; 70% linoleic acid) from 4 months of age until post-pubertal slaughter. It was concluded diets high in linoleic acid fed to growing heifers beginning early in life have little or no effect on total carcass fat, circulating leptin, or age at puberty despite measurable increases in CLA accumulation.

Feeding 2 lb (6 to 7% total dietary fat; Funston et al., 2002) of whole sunflower seeds for either 30 or 60 days before AI did not improve estrous response, conception, or pregnancy rate in beef heifers. In this study, heifers fed sunflower seeds for 60 days had lower gain than heifers fed a control diet without added fat. It is possible this level of added fat inhibited fiber digestion.

Howlett et al. (2003) fed whole soybeans, whole cottonseed, or pelleted soybean hulls for 112 days in a total mixed diet to replacement heifers. Soybeans and cottonseeds contributed approximately 2% added fat to the diet. Heifers were synchronized with melengestrol acetate (MGA)/$PGF_{2\alpha}$ and experimental diets were discontinued approximately one week before the first MGA feeding. Treatment did not affect the proportion of heifers pubertal before beginning MGA feeding. First service conception rates were also not affected by treatment. However, there was a 20% increase ($P = 0.27$) in first service conception rates in the soybean fed group (57%) compared to controls (37%). In this study 96 heifers were split into three treatments and a control group, which may have led to the inability to detect statistical differences among treatments. Neither estrous response nor time of estrus was reported.

Research is currently being conducted to determine the effects of the inclusion of soybeans in heifer development diets on synchronization, conception, and pregnancy rates of replacement beef heifers. April-born crossbred females (n=104) weighing 660 lb at 10 months of age were randomly assigned to one of two diets formulated to be isocaloric and isonitrogenous. Heifers received either a control diet containing corn silage, wheat straw, wet corn gluten feed, and brome hay or a diet containing corn silage, wheat straw, and 3 lb whole soybeans (4% added fat) for 110 days. A mineral and vitamin supplement with Bovatec was also added to each diet. Diets were formulated to achieve approximately 65% of mature weight at breeding.

All heifers were fed MGA (0.5 mg/day) for 14 days prior to a PGF_2_ injection (25 mg) on day 110 to synchronize estrus. Heifers were artificially inseminated 12 hours after visual detection of estrus. Bulls were placed with heifers 10 days after the last AI for a 60-day breeding period. Pregnancy to AI was determined by ultrasonography 45 days after the last AI. Blood samples were collected prior to, during, and at the end of the feeding period (at the time of PGF_2_ injection). Progesterone was assayed in serum samples to determine estrous activity.

There were no differences in estrous activity before experimental diets were fed (81%), during (93%), or at the time of PGF_2_ injection (91%). Soybean-fed heifers had a lower synchronization rate (96 vs 81% for control and soybean-fed heifers, respectively) and a delayed estrous response to synchronization (2.9 vs 3.2 days after PGF_2_ for control and soybean-fed heifers, respectively). There were no statistical differences in AI conception (72 vs 81% for control and soybean-fed heifers, respectively), AI pregnancy (69 vs 65% for control and soybean-fed heifers, respectively), or final pregnancy rates (94 vs 90% for control and soybean-fed heifers, respectively). The reason for the lower synchronization rate and delayed time of estrus is unknown. However, analysis of the extracted soybeans indicated the presence of three phytoestrogens: genistein, daidzein, and glycitein. The combination of these phytoestrogens may have induced the altered reproductive response in soybean-fed heifers.

Studies are limited on the use of fat supplements in replacement heifer diets. In most studies, heifers have been on a positive plane of nutrition and developed to optimum weight and age at breeding. It appears there is limited benefit of fat supplementation in well-developed replacement females and is probably only warranted when supplements are priced comparable to other protein and energy sources. There may have been a positive response to fat supplementation had heifers been nutritionally challenged. The possibility also exists for negative effects due to decreasing adiposity and the presence of other compounds (ie. phytoestrogens) found in some fat sources. More research is needed to elucidate possible mechanisms by which fat supplementation may impact (positive or negative) reproduction in developing heifers.

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