Effect of Beef Heifer Development System on ADG, Reproduction, and Feed Efficiency During First Pregnancy

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Summary

This study evaluated the effect of post-weaning development system on heifer ADG, reproductive performance, and subsequent feed efficiency as a pregnant heifer. Heifers were developed on dormant pasture and grazed corn residue or dormant pasture and placed in a drylot. The following winter, a subset of pregnant heifers were placed in a Calan Broadbent individual feeding system during late gestation. Drylot-developed heifers had greater BW from pre-breeding through pregnancy diagnosis and greater overall ADG during development. However, there was no difference in reproductive performance. Pre-calving BW, ADG, and G:F tended to be greater for drylot heifers. Heifers developed on corn residue had reduced BW through early pregnancy; however, reproductive performance was similar to drylot-developed heifers.

Introduction

Previous literature suggests developing heifers to approximately 65% mature BW to maximize pregnancy rates (*Journal of Animal Science*, 1992, 70:4018-4035). Heifers developed to reduced proportions of mature BW are lighter through pregnancy diagnosis compared to heifers developed to greater proportions of mature BW (*Journal of Animal Science*, 2004, 82:3094-3099; *Journal of Animal Science*, 2008, 86:451-459; *Journal of Animal Science*, 2011, 89:1595-1602) and Roberts et al. (*Proceedings, Western Section American Society Animal Science*, 2009, 60:85-88) reported reduced BW through 5-years of age in heifers restricted feed 140 days post weaning compared to their nonrestricted contemporaries. This reduction in BW suggests reduced maintenance requirements and thus decreased production costs. Furthermore, reduced input production systems report similar reproductive performance when compared to contemporaries fed to a higher plane of nutrition or to a greater proportion of mature BW (*Journal of Animal Science*, 2001, 79:819-826; *Journal of Animal Science*, 2004, 82:3094-3099; *Journal of Animal Science*, 2008, 86:451-459; *Proceedings, Western Section American Society Animal Science*, 2009, 60:85-88; *Journal of Animal Science*, 2011, 89:1595-1602). The objective of this study was to determine the effect of post-weaning development system on heifer ADG, reproductive performance, and subsequent feed efficiency as a pregnant heifer.

Procedure

The University of Nebraska–Lincoln Institutional Animal Care and Use Committee approved the procedures and facilities used in this experiment.

Developing Heifer Management

Weaned crossbred Angus heifers (n= 299) were received at the West Central Research and Extension Center (WCREC), North Platte, Neb. After a 14-day acclimation period, heifers were blocked by BW and randomly assigned to either graze corn residue (CR) or developed in the drylot (DL). Corn-residue heifers grazed dormant pasture 33 days prior to grazing CR 74 days. Subsequently, CR heifers were placed on dormant pastures 66 days prior to being placed in the DL for approximately 40 days for synchronization of estrus and AI. Drylot heifers grazed dormant forage pastures 98 days then were placed in the DL for 112 days. Drylot diet was formulated for heifers to reach 65% mature BW at the beginning of the breeding season. During winter grazing (dormant pasture and corn residue) all heifers were offered 1 lb/day (28% CP) distillers-based supplement. Forty days prior to AI, CR and DL heifers were managed together and fed a common diet. Prior to the breeding season blood samples were collected 10 days apart via coccygeal venipuncture to determine plasma progesterone concentration. Heifers with plasma progesterone concentrations >1.0 ng/mL were considered pubertal.

Estrus was synchronized utilizing the melengestrol acetate-prostaglandin (MGA-PGF) synchronization protocol with heifers fed 0.5 mg/head MGA for 14 days and administered a single injection of PGF 19 days after the end of MGA feeding. Estrus detection was performed for 5 days following PGF administration. Each year heifers were randomly AI to one of four bulls approximately 12 hours after standing estrus. Approximately 10 days following the last day of AI heifers were exposed to bulls (1 bull to 50 heifers) for 60 days. Artificial insemination and overall pregnancy rates were determined 45 days after AI and 45 days after bull removal, respectively, via transrectal ultrasonography.

Primiparous Heifer Management

All heifers remained in a common group through the summer grazing native pasture. After final pregnancy diagnosis, a subset of heifers (year 1 = 38; year 2 = 40; year 3 = 36) confirmed AI pregnant were placed in a Calan Broadbent individual feeding system during late gestation. Heifers were allowed approximately 25 days to adapt to the individual feeding system followed by an 84-day feeding trial. Heifers were offered ad libitum grass hay and either no supplement, 2 lb/

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day distillers-based supplement, or 2 lb/day dried corn gluten-based supplement. Supplements were formulated to be isocaloric and isonitrogenous but differed in rumen undegradable protein. Feed offered was recorded daily and refusals were removed and weighed weekly. Residual feed intake (RFI) was calculated as the actual DMI minus the predicted DMI, with DMI calculated based on NE values of the feed to account for different energy levels of the supplement compared to the control diet.

After calving, heifers remained at WCREC through breeding. Artificial insemination utilized a fixed-timed AI protocol and pairs were transported 27 miles to a commercial ranch in the Nebraska Sandhills for summer grazing. A single bull was placed with heifers approximately 10 days after AI for 60 days. Pairs were returned to WCREC prior to weaning for final pregnancy diagnosis.

Statistical Analysis

Data were analyzed using the MIXED and GLIMMIX procedures of SAS. Year was the experimental unit for heifer development data with development system as the fixed effect. A subset of animals from each development system were placed in 1 of 4 pens where individual feeding occurred. This development by pen classification was included as a random variable and considered the experimental unit for individual feeding data with developmental treatment and barn diet as fixed effects and year considered a random effect. Heifer development × second winter treatment interaction was not significant and was removed from the model. For the individual feeding period, heifer development × barn treatment interaction was not significant, thus all data are presented as the effect of heifer development system. A *P*-value ≤ 0.05 was considered significant.

Table 1. Effect of winter heifer development system on BW, ADG, and reproductive performance.

Item	CR[1]	DL[2]	SEM	*P*-value
n	150	149		
Initial BW, lb	486	485	6	0.93
Prebreeding BW, lb	692	770	19	0.01
AI pregnancy check BW, lb	767	816	25	0.02
Pregnancy check BW, lb	888	931	20	0.05
ADG, lb/day				
Overall[3]	0.94	1.30	0.06	0.01
Dec-Feb[4]	0.10	0.14	0.27	0.64
Feb-April[5]	1.22	2.40	0.17	0.04
April-May[6]	1.78	1.28	0.28	0.25
June-July[7]	1.15	0.86	0.12	0.24
July-Sept[8]	1.70	1.65	0.66	0.61
Cycling[9], %	42	52	15	0.46
AI pregnant, %	69	63	7	0.33
Pregnant, %	93	91	2	0.41
Mature BW, %	57	63	2	0.01

[1]CR = heifers grazed dormant pastures 33 days, corn residue 74 days, and were placed on dormant pastures 66 days prior to entering the drylot 40 days before AI.
[2]DL = heifers grazed dormant pastures 98 days prior to entering the drylot 112 days before AI.
[3]ADG from initiation to prebreeding.
[4]ADG while grazing dormant pasture and corn residue (CR) or dormant pasture (DL).
[5]ADG while grazing dormant pasture (CR) or while in drylot (DL).
[6]ADG while in the drylot.
[7]ADG from the beginning of the breeding season to AI pregnancy detection.
[8]ADG from AI pregnancy to final pregnancy detection.
[9]Considered cycling if blood serum progesterone concentrations were >1 ng/mL.

Results

Heifer Development BW Gain and Reproduction

Data for heifer development BW gain are reported in Table 1. Body weight was similar for CR and DL heifers at the beginning of the experiment. However, prior to breeding, DL heifers were 78 lb (± 19 lb) heavier ($P = 0.01$) than CR-developed heifers. Body weight remained greater for DL heifers at AI pregnancy diagnosis ($P = 0.02$) and final pregnancy diagnosis ($P = 0.05$) compared to CR heifers.

Overall ADG was greater ($P = 0.01$) for DL heifers compared to CR heifers. Drylot-developed heifers also had greater ($P = 0.04$) ADG from February to April compared to CR heifers. This coincides with the time DL heifers were removed from dormant pasture and placed in the DL, and the CR heifers were moved from CR to dormant pasture. However, ADG was similar between CR and DL heifers while both groups were in the DL prior to breeding, and remained similar through AI pregnancy diagnosis.

Although ADG was greater through development for DL compared to CR heifers, there was no difference in the proportion of heifers attaining puberty prior to the breeding season (Table 1). Martin et al., (*Journal of Animal Science*, 2008, 86:451-459) also reported no significant difference in attainment of puberty for heifers fed to 51 vs. 57% mature BW. However, Funston and Larson (*Journal of Animal Science*, 2011, 89:1595-1602) reported decreased puberty in heifers developed on winter range and CR-compared to DL-developed heifers (56 vs. 65% mature BW, respectively). There were no differences in AI pregnancy (69 vs. 63 ± 7%) or final

Table 2. **Effect of winter heifer development system on late gestation ADG, feed efficiency and reproductive performance through the subsequent breeding season.**

Item	CR[1]	DL[2]	SEM	*P*-value
n	58	56		
Initial BW, lb	989	992	19	0.76
Pre-calving BW, lb	1116	1138	20	0.08
DMI, lb/day	22.35	22.36	0.22	0.96
NE DMI, lb/day[3]	11.57	11.59	0.51	0.92
ADG, lb/day	1.54	1.76	0.09	0.09
RFI, NE[4]	0.458	-0.064	0.244	0.33
G:F	0.068	0.078	0.013	0.07
Gestation length, day	276	276	0.66	0.77
Birth date, Julian	60	61	1.42	0.37
Calf birth BW, lb	72	74	1.58	0.39
Calving ease	1.38	1.48	0.11	0.53
Prebreeding BW, lb	972	974	14	0.89
Pregnancy check BW, lb	1063	1046	56	0.64
Pregnant, %	83	81	17	0.83

[1]CR = heifers grazed dormant pastures 33 days, corn residue 74 days, and were placed on dormant pastures 66 days prior to entering the drylot 40 days before AI.
[2]DL = heifers grazed dormant pastures 98 days prior to entering the drylot 112 days before AI.
[3]DMI based on feed net energy values (NRC, 2000).
[4]Residual feed intake (RFI) = actual intake − predicted intake.

pregnancy rates (93 vs. 91 ± 2%; Table 1) for CR and DL, respectively.

Primiparous Heifer Feed Efficiency

Data for primiparous heifers placed in the Calan Broadbent individual feeding system during late gestation are reported in Table 2. Pre-calving BW tended to be greater (*P* = 0.08) for DL compared to CR heifers at the end of the 84 day individual feeding period. There was no difference in DMI or DMI based on feed NE. Average daily gain and G:F tended to be greater (*P* = 0.09; = 0.07, respectively) for DL-compared to CR-developed heifers. Gestation length, calf birth BW, and calving ease did not differ among treatments. Prebreeding BW did not differ between treatments as first-calf heifers and proportion pregnant at weaning was also similar for DL-compared to CR-developed heifers.

Traditional DL development systems would place heifers in DL shortly after weaning. In this experiment, developing heifers on dormant pasture followed by DL increased heifer BW from the end of the development period through pregnancy diagnosis compared to CR-developed heifers. However, reproductive and calving performance was similar between treatments. Reproductive performance was maintained by developing heifers with reduced harvested forage.

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