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Effect of Heifer Development System on Reproduction and Subsequent Gain as a Pregnant Heifer

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Summary with Implications

Weaned heifers grazed corn residue, upland range, or were fed 1 of 2 drylot diets differing in energy. Heifer development diets did not impact their resulting AI or final pregnancy rates. Cost per pregnant heifer was similar among treatments. A subset of AI-pregnant heifers was placed in a Calan Broadbent individual feeding system during late gestation. As a pregnant heifer, feed efficiency was not impacted by development system. These results indicate producers may utilize their most readily available and/or cost-effective feed resources with no detriment to pregnancy rates or feed efficiency as first-calf heifers.

Introduction

Retaining and developing replacement heifers presents one of the largest expenses to the cow-calf producer. Developing heifers to a lower target BW than previously recommended has been shown to reduce costs, without reducing pregnancy rate. Previous research comparing corn residue and drylot systems has found heifers in the drylot gained more during the development period than heifers grazing corn residue (2013 Nebraska Beef Report, pp. 5–7). However, heifers developed on corn residue experienced increased post-AI ADG while on summer range compared with heifers developed in confinement, possibly due to compensatory gain or retained learned grazing behavior. Greater effort has been made to select heifers with higher feed-efficiency. However, selecting for greater efficiency may decrease DMI in the mature cow. Understanding the long term effects of heifer development on cow efficiency will allow producers to make better management decisions. Whether a difference lies in behavioral effects, or previous diet quality, mature cow intake as a result of development systems, have the potential to impact beef producers' profitability. Therefore, objectives of the current study were to determine if post-weaning heifer development system affected ADG, pregnancy rates, and subsequent feed efficiency as a pregnant heifer.

Procedure

Post-Weaning Development

A 4-yr study conducted at the West Central Research and Extension Center (WCREC), North Platte, NE utilized Angus-based crossbred, spring born heifers. In Yr 1, weaned heifers grazed corn residue (CR, n = 50) or were fed in a drylot (DLHI, n = 50). In Yr 2, 3, and 4, heifers grazed CR (n = 75), upland range (RANGE; n = 75), or were fed 1 of 2 drylot diets (Table 1) differing in energy, high (DLHI, n = 75) or low (DLLO, n = 75). Heifers developed on CR (n = 125) grazed corn residue from mid-November through mid-February and then grazed winter range until estrus synchronization. RANGE heifers (n = 75) grazed winter range from mid-November until estrus synchronization. While grazing corn residue or winter range, heifers received the equivalent of 1 $lb \cdot hd^{-1} \cdot d^{-1}$ of a 29% CP, dried distillers grain-based supplement containing monensin, with hay provided in times of deep snow. All heifers were managed together in a drylot during estrus synchronization and AI.

Prior to estrus synchronization, 2 blood samples were collected 10 d apart to determine plasma progesterone concentration. Heifers with greater than 1 ng/mL at either collection were considered pubertal. Heifers were synchronized using the melengestrol acetate-prostaglandin $F_{2\alpha}$ (MGA-PG) protocol. Heat detection aids (Estrotect, Rockway Inc., Spring Valley, WI) were applied at PG injection (Lutalyse, Zoetis, Florham Park, NJ). Heifers in standing estrus were AI 12 h later. Heifers not expressing estrus received a PG injection 6 d following the first PG injection and placed with bulls. Remaining heifers were combined with the non-AI heifers and bulls 10 d following AI on range at a 1:50 bull to heifer ratio for 60 d. Pregnancy diagnosis was conducted via transrectal ultrasonography (ReproScan, Beaverton, OR) 45 d following AI. Forty-five d after bull removal a second pregnancy diagnosis determined final pregnancy rate.

Pregnant Heifer Feed Efficiency

In mid-October, following final pregnancy diagnosis, a subset of AI-pregnant heifers from each treatment (RANGE, n = 36; CR, n = 46; DLHI, n = 48; DLLO, n = 23) were placed in a Calan Broadbent individual feeding system. Heifers were allowed a 20 d acclimation period before beginning a 90 d trial at approximately gestational d 170. Heifers were offered ad libitum hay (7.9% CP); individual amounts offered were recorded daily and orts collected weekly.

Table 1. Drylot diet composition (DM basis) offered to replacement heifers

Ingredient, %	DLHI[1]	DLLO[2]
Hay	74	83
Wet CGF	21	12
Heifer supplement[3]	5	5

[1] DLHI = heifers in Yr 1, 2, 3, and 4 received a high-energy diet in the drylot for 170 d.
[2] DLLO = heifers in Yr 2, 3, and 4 received a low-energy diet in the drylot for 170 d.
[3] Supplement = dry rolled corn (81.35% of supplement, DM basis), limestone (11.11%), iodized salt (5.55%), trace mix (1.39%), Rumensin-90 (0.37%), and Vitamins A-D-E (0.22%).

Table 2. Effect of development system on heifer gain and reproductive performance

Item	RANGE[1]	CR[2]	DLHI[3]	DLLO[4]	SEM	*P*-value
n	75	125	125	75		
Initial BW, lb	516	520	518	516	11	0.88
Post-development BW[5], lb	664[b]	659[b]	763[a]	708[a,b]	18	< 0.01
Development ADG, lb	0.97[b]	0.86[b]	1.57[a]	1.26[a,b]	0.11	0.01
Pre-breeding BW, lb	714[b]	725[b]	820[a]	765[a,b]	20	0.01
Percent of mature, %	59[b]	60[b]	67[a]	63[a,b]	2	0.01
Pubertal status, %	28	41	86	77	10	0.20
Synchronization ADG, lb	1.57	1.79	1.52	1.72	0.24	0.20
AI pregnancy diagnosis BW, lb	802[b]	818[b]	873[a]	829[a,b]	13	0.02
Final pregnancy diagnosis BW, lb	941	941	985	952	24	0.13
Breeding ADG[6], lb	1.68[a,b]	1.76[a]	1.01[c]	1.26[b,c]	0.22	< 0.01
AI pregnancy, %	67	63	61	49	7	0.39
Final pregnancy, %	84	90	91	91	5	0.59
Calved in first 21 d, %	81[a]	69[ab]	70[ab]	53[b]	12	0.02

[1] RANGE = heifers were offered the equivalent of 0.99 lb · hd^{-1} · d^{-1} while grazing winter range for 170 d before entering the drylot for estrus synchronization and AI.
[2] CR = heifers were offered the equivalent of 0.99 lb · hd^{-1} · d^{-1} while grazing corn residue for 90 d and winter range for 80 d before entering the drylot for estrus synchronization and AI.
[3] DLHI = heifers were developed in the drylot for 170 d and through estrus synchronization and AI on a high-energy diet.
[4] DLLO = in Yr 2, 3, and 4 heifers received a low-energy diet in the drylot for 170 d through estrus synchronization and AI.
[5] BW at the time of blood collection.
[6] ADG in the period between prebreeding and first pregnancy diagnosis.
[a,b,c] Means in a row with different superscripts are different ($P \leq 0.05$).

Table 3. Effects of heifer development system on pregnant heifer feed efficiency

Item	RANGE[1]	CR[2]	DLHI[3]	DLLO[4]	SEM	*P*-value
n	36	46	48	23		
Initial BW, lb	994	1,008	1,041	1,023	22	0.35
Mid BW, lb	1,032	1,052	1,085	1,063	20	0.25
Final BW, lb	1,076	1,096	1,127	1,107	31	0.24
DMI, lb	21.47	21.98	22.44	22.05	1.68	0.27
ADG, lb	0.84	0.99	0.95	0.90	0.37	0.36
RFI[5]	0.094	0.091	-0.056	-0.074	0.160	0.61
F:G	21.4	18.2	21.1	21.3	4.8	0.38

[1] RANGE = heifers were offered the equivalent of 0.99 lb · hd^{-1} · d^{-1} while grazing winter range for 170 d before entering the drylot for estrus synchronization and AI.
[2] CR = heifers were offered the equivalent of 0.99 lb · hd^{-1} · d^{-1} while grazing corn residue for 90 d and winter range for 80 d before entering the drylot for estrus synchronization and AI.
[3] DLHI = heifers were developed in the drylot for 170 d and through estrus synchronization and AI on a high-energy diet.
[4] DLLO = heifers received a low-energy diet in the drylot for 170 d through estrus synchronization and AI.
[5] RFI = Residual Feed Intake

Economic Analysis

Due to price fluctuations during the experiment (2010–2014), an average 5 yr price was used for economic analysis. Heifer value was obtained for the wk heifers were received. Pasture values were calculated as half the cost of a cow-calf pair in the Southwest region of Nebraska and obtained from the Nebraska Farm Real Estate Market Highlights. Wet corn gluten prices were obtained from the USDA-AMS for the third wk in September using Kansas City values. Hay prices were obtained for the third wk of September in the Platte Valley from the Nebraska and Iowa Hay report. Actual supplement costs, both drylot and cube, were used. Other expenses included interest (6.5% of heifer value), vaccine, yardage, trucking for CR heifers, breeding expenses, and other miscellaneous expenses. Cull values of non-pregnant heifers were obtained for the wk of final pregnancy diagnosis. The value of one, non-pregnant heifer was divided by 1 minus pregnancy rate to determine the value of cull heifers per pregnant heifer. This value was subtracted from the total development cost. Finally, the adjusted development cost was divided by pregnancy rate to determine the net cost of one pregnant heifer.

Statistical Analysis

Treatments were the specific heifer development system where CR and DLHI were replicated for 4 yr and RANGE and DLLO were replicated for 3 yr. Treatment group within year was considered the experimental unit, with development treatment fitted as a fixed effect. Data were analyzed using the GLIMMIX procedure of SAS (SAS Inst. Inc., Cary NC). Pregnancy analyses included AI technician as a random effect. Pregnant heifer feed efficiency analyses included pen as a random effect. A P-value ≤ 0.05 was considered significant.

Results

Post Weaning Development Treatment

Heifers had a similar initial BW (P = 0.88, 518 ± 11 lb, Table 2). During development, ADG was greater (P = 0.01) for DLHI heifers (1.57 ± 0.11 lb/d) compared with RANGE and CR (0.97 and 0.86 ± 0.11 lb/d, respectively). Differences in ADG resulted in a similar trend in post-treatment BW; DLHI heifers were heavier than RANGE and CR heifers ($P < 0.01$) but similar to DLLO heifers. At pre-breeding, percent of mature BW was greater ($P = 0.01$) for DLHI heifers compared with RANGE and CR heifers. Many measures were similar among treatments ($P \leq 0.20$), including pubertal status prior to synchronization, ADG from AI to first pregnancy diagnosis, AI pregnancy rate and final pregnancy rate. Body weight at the first pregnancy diagnosis was greatest ($P = 0.02$) for DLHI heifers compared with other treatments. The proportion of heifers that calved within the first 21 d was greater for RANGE heifers compared with DLLO heifers ($P = 0.02$).

Pregnant Heifer Feed Efficiency

In the feed efficiency trial (Table 3), initial and final BW were similar ($P > 0.24$). Both DMI ($P = 0.27$) and residual feed intake (RFI; $P = 0.61$) did not differ between treatments. There was no difference ($P \geq 0.33$) in ADG or F:G. Recent emphasis on genetic selection for feed efficient cattle to optimize feedlot profit has led to the idea of increased feed efficiency in the cow herd. This may cut feed costs, but reproductive performance could be compromised. Some research has found heifers selected for high feed efficiency had lower pregnancy ($P = 0.09$) and calving ($P = 0.05$) rates than low efficiency contemporaries. In the current study, development treatment did not impact feed efficiency as a pregnant first calf heifer. Future studies investigating how heifer development system impacts lifetime feed efficiency are needed.

Economic Analysis

Heifers began development with the same value and receiving diet expense. Diet cost was different ($P < 0.01$) among treatments with the exception of RANGE and CR, which had similar ($P = 0.56$) treatment costs. The most expensive diet, DLHI, and the mean of the 2 least expensive diets, RANGE and CR, indicated a $41 difference. Summer pasture and additional expenses were similar across treatments. Due to numerical differences in pregnancy rates and BW at pregnancy diagnosis, cull heifer value was different ($P < 0.01$) among treatments where RANGE heifers, with the numerically lowest pregnancy rate, had the greatest cull heifer value. These data differ from previous studies that reported similar cull heifer value on intensive and extensive heifer development (2010 Nebraska Beef Report, pp. 8–10). Numerically higher final pregnancy rates resulted in lower cull value for DLHI and DLLO heifers. Net cost per pregnant heifer was similar ($P = 0.99$) among treatments using 5 yr average prices. This contradicts previously reported data suggesting extensive development reduced ($P = 0.01$) cost by $45 per pregnant heifer (2010 Nebraska Beef Report, pp. 8–10). Differences may be due to the extreme price fluctuation in the years this experiment was conducted.

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Table 4. Economic analysis (5 yr avg, 2010 to 2014) of heifer development systems

Item	RANGE[1]	CR[2]	DLHI[3]	DLLO[4]	SEM	*P*-value
Heifer value, $/heifer	876	876	877	877	138	1.00
Feed cost:						
Receiving diet,[5] $/heifer	32	32	32	32	3.43	1.00
Treatment diet, $/heifer	113[a]	109[a]	152[b]	137[c]	4.87	< 0.01
Summer pasture,[6] $/heifer	68	68	68	68	3.69	1.00
Other expenses,[7] $/heifer	311	319	311	311	8.96	0.91
Total development cost	1,401	1,404	1,440	1,425	152	0.99
Less: cull heifer value	228[a]	127[b]	100[b,c]	69[c]	19	< 0.01
Net cost	1,173	1,277	1,340	1,356	137	0.77
Net cost per pregnant heifer, $	1,420	1,413	1,447	1,432	150	1.00

[1] RANGE = heifers were offered the equivalent of 0.99 lb · hd^{-1} · d^{-1} while grazing winter range for 170 d before entering the drylot for estrus synchronization and AI.
[2] CR = heifers were offered the equivalent of 0.99 lb · hd^{-1} · d^{-1} while grazing corn residue for 90 d and winter range for 80 d before entering the drylot for estrus synchronization and AI.
[3] DLHI = heifers were developed in the drylot for 170 d and through estrus synchronization and AI on a high-energy diet.
[4] DLLO = heifers received a low-energy diet in the drylot for 170 d through estrus synchronization and AI.
[5] Heifers received a common receiving diet for 30 d prior to the initiation of the treatments.
[6] Summer pasture was calculated as half the cost of a cow-calf pair.
[7] Other expenses included breeding expense, interest (6.5% of heifer value), yardage, trucking for heifers on CR, vaccinations and other miscellaneous health expenses.
[a,b,c] Means in a row with different superscripts are different ($P \leq 0.05$).