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REPRODUCTION AND FEED EFFICIENCY IN BEEF HEIFERS

By: Dr. Daalkhaijav Damiran, Dr. Gregory Penner, Kathy Larson MSc, and Dr. Bart Lardner

Introduction

Heifers need to be fed appropriately, utilize feed efficiently, and be reproductively sound for cow-calf producers to optimize productivity and profitability. Because feed costs represent up to 70% of the production costs in a beef operation, improving feed efficiency is important. Residual feed intake (**RFI**), which is the difference between an animal's actual intake and its predicted intake for a known level of performance and body weight, has been used as an indicator of feed efficiency, and is calculated by subtracting an animal's expected feed intake from its feed actual intake (Arthur et al., 2001). Therefore, a most efficient RFI heifer (**ME**) will eat less than the herd average, but gain the same, resulting in a negative RFI number. The calculated RFI number for a least efficient heifer (**LE**) will be positive, because the heifer consumes more than her counterparts for the same level of performance. RFI is considered to be a moderately heritable trait (Herd et al., 2000) suggesting that there may be a potential to improve the feed efficiency of cow-calf herds on a long-term basis by selecting females for both feed efficiency and reproductive traits at an early age. However, there has been limited research conducted relating feed efficiency and reproductive performance on forage based diets.

The objective of this study was to compare most efficient and least efficient heifers with a randomly selected (**CON**) group of heifers for performance and reproductive efficiency measurements at first calving.

Trial Management and Measurement

The study was conducted at the Western Beef Development Centre (**WBDC**) located at Lanigan, Saskatchewan. A total of 90 spring born Angus replacement heifers weighing an average 575 lb and weaned in October, were sourced from the main WBDC herd. Prior to evaluating RFI, 20 heifers were randomly selected from the group as replacement heifers (control group, **CON**), based on phenotype. In Phase 1, the remaining 70 heifers were evaluated for RFI (21-d acclimation period preceding a 70-d forage-based feeding trial using GrowSafe system; Archer et al., 1997), and from these 70 animals, the 20 most efficient (**ME**; RFI = -2.2 lb/d) and 20 least efficient heifers (**LE**; RFI = 1.7 lb/d) were selected (Damiran et al., 2014). Then in Phase 2, the 20 CON, 20 ME and 20 LE heifers were housed in 1 of 2 drylot pens (50 m × 120 m) (30 heifers/pen) surrounded by wooden slatted fences. Heifers were then fed a forage-based diet (similar to Phase 1) (72% coarsely chopped grass-legume hay and 28% rolled barley grain) containing 10.1% CP and 65.3% TDN for a 185-d (Phase

1, November 2012 to February 2013; Phase 2, March 2013 to May 2013) post-wean development period. Heifers were fed using the GrowSafe system (GrowSafe Systems Ltd., Airdrie, Alberta), and individual feed intake was recorded as described by Durunna et al. (2011). Each pen had access to well water through heated water bowls. Heifer BW and body condition were monitored during the study. Average daily gain (**ADG**) was also calculated and diet amounts offered to the heifers were adjusted to obtain desired gains. Heifers were supplied with free choice loose mineral.

Following winter development (2 June, 2013), heifers were exposed to Angus bulls at a heifer:bull ratio of 20:1 for a 63-d breeding season. Estrus was synchronized with a single injection of estroPLAN (Parnell Technologies Pty Ltd, Alexandria, Australia) administered 5 d after bulls were placed with heifers. Heifers were managed as a single group on tame grass pasture during the breeding season and until pregnancy diagnosis (mid-October). Pregnant heifers grazed swathed barley (10.8% CP, 69.3% TDN) in early stage of gestation (mid-November to end of January; 23-34 wk of gestation); followed by drylot feeding free choice grass-legume hay (9.7% CP, 58.5% TDN) with range-pellet supplementation (6 lb/per animal day; 13.6% CP, 79.5% TDN; 0.6% of BW) during the pre- and post-calving stages (mid-February to end of May 2014).

Reproductive data collected included pregnancy rate, calf birth weight, and calving date. Calving difficulty was evaluated on a 1 to 5 score; where 1 = no assistance, 2 = easy pull, 3 = mechanical pull, 4 = hard mechanical pull, and 5 = caesarean section. Calves were weaned on 29 September, 2014 and 205-d adjusted weaning weights were recorded.

Winter development costs were calculated using a similar procedure as described by Lardner et al. (2014). Using individual feed intake data and feed costs, daily feed costs were calculated for each animal, followed by feed cost for the entire heifer development period. The price of hay and rolled barley grain was $94/tonne and $259/tonne, respectively. Costs associated bedding, yardage, labor, equipment use, infrastructure (fence, water bowl, feed trough), and manure removal were adapted from previous studies (Lardner et al., 2014) conducted at the WBDC.

Results and Discussion

Feed Intake and Heifer Performance

Table 1 presents the hay and supplement (rolled barley) intake for each group of heifers to obtain desired gains. Barley grain was allocated at 0.75% BW. As Herd et al. (2000) pointed out a 5-percent improvement in feed efficiency could have an economic effect of four times greater than a 5-percent improvement in average daily gain. The ME heifers consumed 3 and 10% less feed than CON and LE heifers, respectively. This suggested that selecting feed efficient animals will have a great effect on the unit cost of

Table 1. Forage and barley grain intake (lb/day, DM basis) of heifer during winter development period

	Heifer group[1]		
Item	**CON**	**ME**	**LE**
Total DMI	19.2	18.6	20.5
Hay	13.9	13.4	14.7
Barley	5.4	5.2	5.7

[1]CON = control (randomly selected) heifer; ME = most efficient; LE = least efficient (n = 20).

production and the value of the breeding stock.

Heifer performance data are presented in **Table 2**. The long-standing rule of thumb is that heifers need to be developed to reach 60 to 65% of mature BW by the onset of their first breeding season (Lardner et al., 2014). Average fall mature cow BW at WBDC was 1405 lb. Therefore, heifers in all groups achieved the targeted pre-breeding BW (avg. 61.4% of mature BW). Most efficient heifers had similar rates of gain to LE heifers. However, selection for ME heifers (0.12) improved gain to feed ratio by 5 and 11%, than that of CON (0.13) and LE (0.14) heifers, respectively. Heifers were not much different in age (avg. 14.3 mo) at breeding. Based on first-calf pregnancy rate, the heifer groups can be ranked as follows: ME (80%) < CON (93%) < LE heifers (100%). The pregnancy results of current study suggests reduced reproductive performance, which warrants further studies involving larger sample sets.

Table 2. Growth performance of beef heifers from start of development period to first pregnancy diagnosis

	Heifer group[1]		
Item	**CON[1]**	**ME**	**LE**
Initial BW, lb	576	588	562
Final BW, lb	860	876	850
BW, % mature BW[2]	61.2	62.4	60.5
ADG[2], lb	1.5	1.6	1.6
G:F[3]	0.13	0.12	0.14
Final BCS	2.7	2.6	2.6
Age at breeding, mo	14.1	14.5	14.3
Pregnancy diagnosis BW, lb	1045	1047	1014
Pregnancy diagnosis BCS, lb	2.8	2.8	2.7
ADG[4]	1.2	1.1	1.0
Pregnancy rate, %	92.9	79.5	100.0

[1]CON = control (randomly selected) heifer; ME = most efficient; LE = least efficient (n = 20).
[2]ADG during November to June (185 d) winter development period.
[3]G:F; Gain to Feed ratio, lb of BW gain/ lb of feed
[4]ADG during June to October (142 d) summer grazing to pregnancy diagnosis.

Calf Performance

First calf performance data are presented in **Table 3**. The ME heifers had slightly lighter calves (71 lb. vs. 77 lb.) and a lower portion of the ME heifers calved in the first 21 days (49% vs. 72%). Likewise, the 205-d adjusted weaning weight (531 lb. vs. 567 lb.) was lower for the ME group than in LE group. A study by Randel and Welsh (2013) suggests that feed efficient heifers appear to reach puberty later and get pregnant later in the breeding season compared to inefficient heifers. Being older at puberty and having calves later in the calving season probably explains why they were bred and calved somewhat later in current study.

Table 3. First calf performance of beef heifers

	Heifer group[1]		
Item	**CON**	**ME**	**LE**
Calf birth date, Julian date	97	99	98
Calf birth BW, lb	75	71	77
Calving difficulty score[2]	1.0	1.0	1.4
Calving distribution, % of total			
1 to 21 d	90	49	72
22 to 42 d	10	44	28
43 to 63 d	-	7	-
Calf 205-d adjusted weaning BW, lb	565	531	567

[1]CON = control (randomly selected) heifer; ME = most efficient; LE = least efficient (n = 20).
[2]Scoring system 1 to 5: 1 = no assistance; 2 = easy pull; 3 = mechanical pull; 4 = hard mechanical pull; and 5 = caesarean section.

Heifer Development Cost

The economic analyses of winter development from weaning to breeding are summarized in **Table 4**. As expected, the ME heifers had lower total feed cost than their LE counterparts (1.38 vs. 1.52 $/d), total daily cost ($1.61 vs. $1.75 $/d), and subsequently total development cost ($299 vs. $323/185 d). The cost of randomly selected heifers were intermediate ($307/185 d) between ME and LE groups. Thus during the winter development period, the savings in the feed cost would amount to ~$25/heifer when ME heifers were selected rather than LE animals.

Table 4. Economic analysis of heifer development from weaning to breeding ($/heifer/d)

	Heifer group[1]		
Item	**CON**	**ME**	**LE**
Total feed cost[2]	1.43	1.38	1.52
Labor[3]	0.07	0.07	0.07
Other[3,4]	0.16	0.16	0.16
Manure cleaning[3]	0.03	0.03	0.03
Total cost, d	1.66	1.61	1.75
Total developing cost, $/185 d	307	299	323

[1]CON = control (randomly selected) heifer; ME = most efficient; LE = least efficient (n = 20).
[2]Cost of forage + barley + minerals.
[3]Adapted from Lardner et al. (2014).
[4]Other = bedding, equipment, repairs and depreciation.

Conclusions and Implications

Selecting feed efficient heifers may reduce feed cost by $0.05 to 0.14 hd/day during the winter development period. However, with the selection for feed efficient animals, there may be a risk for reduced reproductive efficiency. These disadvantages should be subtracted from the advantages to give the net position on the management practice being considered. Also cost will be affected by the population number of selection. In general, someone has the potential to have a better cost benefit if selected a few heifers from a large population.

Further research with a larger number of heifers is warranted to determine the relationship between feed efficiency and reproduction. Determining individual feed efficiency based on feed intake and gain is very time-consuming, labor intensive and costly, therefore finding a more easily measured predictor of RFI in the future may be necessary. Recent advances in sequencing the cattle genome and genomic testing technology have the potential to select replacement heifers for accurately. As genomic testing technology improves the applicability and accuracy of techniques such as DNA genotyping, the selection of replacement heifers and development costs will also improve.

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