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Use of residual feed intake as a selection criterion on the performance and relative development costs of replacement beef heifers

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ABSTRACT

Two heifers groups differing in residual feed intake (RFI) were compared with a third control (CON; n = 20) group of randomly selected heifers for performance, reproductive efficiency, and system economics to first calving and repeatability of RFI ranking, with all 3 groups selected from the same cohort. Following weaning, 70 Angus heifers (initial BW = 260 ± 3 kg; 6 mo of age) from a single cohort were fed a forage-based diet (10.0% CP; 65.2% TDN) for 93 d (period 1) where BW, DMI, ADG, G:F, and RFI were evaluated. After period 1 RFI testing, 40 heifers were classified into 2 groups [20 efficient heifers (low RFI; RFI = −1.01 ± 0.10 kg/d) and 20 inefficient heifers (high RFI; RFI = 0.77 ± 0.08 kg/d)] and then selected for a second feeding trial (period 2) and compared with the 20 CON heifers. All 60 heifers in period 2 (BW = 322 ± 2.9 kg; 10 mo of age) were fed for 93 d on a similar forage-based diet (11.0% CP; 66.5% TDN). Low-RFI heifers had the lowest (P = 0.01) RFI value of −0.33 kg/d, followed by CON and high-RFI heifers, −0.09 and 0.42 kg/d, respectively. Control heifers tended (P = 0.08) to have lower ADG (0.83 kg/d) compared with low-RFI (0.92 kg/d) or high-RFI heifers (0.91 kg/d), and low-RFI heifers tended (P = 0.08) to have greater G:F (0.10 ± 0.003) than either CON (0.9 ± 0.003) or high-RFI heifers (0.09 ± 0.003). Spearman rank correlation for RFI between period 1 and 2 was 0.58 ($P < 0.01$); however, 51% of heifers had a different RFI value in period 2 compared with period 1. First-calf pregnancy rates were 80% for low RFI, 93% for CON, and 100% for high RFI (χ^2; P = 0.09). Winter feed costs were ~Can$25 per heifer lower for low-RFI heifers compared with high-RFI animals. Heifers with increased feed efficiency may exhibit reduced reproductive performance, suggesting further research is needed.

Key words: feed efficiency, heifer, reproductive efficiency, residual feed intake

INTRODUCTION

Efficient use of feed and reduced feed costs could improve the economic sustainability of the beef cattle industry. Residual (or net) feed intake (**RFI**) is a measure of feed efficiency and is defined as the difference between actual and expected feed intake to support maintenance and ADG for a group of cattle (Archer et al., 1999). Measurement and prediction of RFI has gained popularity as a selection tool to improve feed efficiency in beef cattle (Blair et al., 2013). It has been reported that cattle with low RFI had similar rates of BW gain to those with high RFI, even though feed intake was lower for the low-RFI cattle (Kelly et al., 2010; Durunna et al., 2012). Thus, selection for RFI may present an opportunity to reduce feed costs along the entire beef supply chain, including the cow-calf sector. Despite potential to improve feed efficiency, adoption of RFI in the cow-calf sector has been constrained, because measuring RFI is technically challenging and costly. Although RFI is a moderately heritable trait (Archer et al., 2002; Blair et al., 2013), substantial reranking of RFI status has been reported for cattle fed the same diet over 2 consecutive periods (Durunna et al., 2012). Moreover, previous research has been conducted with backgrounding or finishing diets that are not representative of the high-forage diets used for developing replacement heifers. In fact, there have been few published studies evaluating RFI with high-forage diets (Kelly et al., 2010; Manafiazar et al., 2015) and with respect to the potential effect on replacement heifer reproductive performance (Kelly et al., 2010; Basarab et al., 2011; Loyd et al., 2011; Black et al., 2013; Hafla et al., 2013; Randel and Welsh, 2013). The objectives of this study were to evaluate performance, reproductive efficiency, and system economics for heifers classified as having either high or low feed efficiency based on RFI values in comparison with heifers randomly selected as replacements.

The authors declare no conflict of interest.

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MATERIALS AND METHODS

Study Site and Management

All experimental procedures were approved by University of Saskatchewan Animal Research Ethics Board (Protocol No. 20090107), and heifers were cared for according to the guidelines of the Canadian Council on Animal Care (2009). The study was conducted at the Western Beef Development Centre's Termuende Research Ranch located near Lanigan (lat. 51°51′N, long. 105°02′W), Saskatchewan, Canada. Daily average temperatures were obtained from Environment Canada (www.climate.weatheroffice.ec.gc.ca) for Watrous, Saskatchewan, approximately 50 km southeast of the study site (51°48′N, 104°51′W).

Animals and Management—Period 1

Spring-born (April to late May) Angus heifers (n = 90), suitable for herd replacements, were sourced from the main Western Beef Development Centre herd, weaned in early October, and allocated to the study. There were 2 consecutive feeding periods during the study, with data collected from November 21, 2012, to May 25, 2013. At weaning, each heifer was identified with a half-duplex radio frequency transponder button (Allflex USA Inc., Dallas/Ft. Worth Airport, TX) in the right ear. All heifers were considered as cohorts for each of the RFI calculations in the 2 periods.

For the study, 3 drylot pens were used, each pen (50 × 120 m) was surrounded by wood slatted fences with 20% porosity and contained an open-faced shed in one end, and water was supplied to each pen in a heated water bowl. In 2 of the pens, feed intake was measured, with 8 GrowSafe Intake (GrowSafe Systems Ltd., Airdrie, Alberta, Canada) feed bunks per pen. The remaining pen had a fence-line bunk (0.5 m of bunk space per animal). Wood chips were used as bedding during inclement weather conditions. Out of the original cohort of 90 heifers, 20 (control; **CON**) were randomly selected before the start of period 1. The CON heifers were group fed; therefore, measurement of individual DMI during period 1 was not possible. However, the amount of feed provided to the CON group, which was fed twice daily ad libitum, was recorded daily to estimate average DMI. The remaining 70 heifers were then randomly allocated to the 2 drylot pens fitted with GrowSafe feed bunks. During period 1 (November 21, 2012, to February 22, 2013; postweaning period), a 21-d adaptation period was followed by a 72-d feeding period, where daily DMI and cumulative BW gain were measured (Archer et al., 1999).

Animals and Management—Period 2

After completing period 1 only 40 heifers [20 most efficient heifers (low RFI) and 20 least efficient heifers (high RFI)] of the 70 animals continued to be evaluated in a second feeding trial (period 2; prebreeding period). The 20 CON heifers were also included in the period-2 trial.

In period 2, the low-RFI, high-RFI, and CON heifers were equally divided into 1 of 2 pens with GrowSafe bunks as described previously. All heifers were provided a 21-d adaptation period to ensure all heifers consumed feed from the GrowSafe bunks. Subsequently, a 72-d feeding period was conducted, just before the start of the breeding season.

In both period 1 and period 2, heifers were fed a similar diet formulated to support growth rates of 0.8 kg/d (NRC, 2000) and reach a prebreeding target BW of 62% (~395 kg) of mature BW (~637 kg). The forage-based diet contained processed bromegrass–alfalfa hay (10.1% CP; 55.0% TDN) and rolled barley (11.0% CP; 75.0% TDN) (DM basis) and was fed ad libitum twice daily (0800 and 1500 h) for the next 185 d (period 1 and period 2; Table 1). However, daily temperatures during the study ranged from −10.0 to −21.3°C (average −15.6°C) and from 5.6 to −6.7°C (average −0.7°C) for period 1 and period 2, respectively. Therefore the hay:barley ratio in diet was adjusted as predicted by CowBytes Beef Ration Balancing Program Version 5.3.1 (AAFRD, 2011; Table 1).

Table 1. Composition of diet fed to heifers during study (DM basis)

Item	Period 1	Period 2
Ingredient composition, %, as-fed basis		
Mixed hay	72.0	70.0
Barley grain	28.0	30.0
Nutrient composition, mean ± SD		
CP, %	10.0 ± 0.3	11.0 ± 0.3
TDN,[1] %	65.2 ± 0.4	66.5 ± 0.6
NE_m, Mcal/kg	1.48 ± 0.01	1.52 ± 0.02
NE_g, Mcal/kg	0.89 ± 0.01	0.93 ± 0.02

[1]Calculated using the Weiss equation (Weiss et al., 1992).

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