# Relationships between beef heifer feed efficiency traits and Igenity panel scores in western Canada[1]

**Daalkhaijav Damiran,[*,†] Gregory B. Penner,[*] Kathy A. Larson,[†] Federico Añez-Osuna,[*] and H. A. (Bart) Lardner[*,†,2]**

[*]Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK S7N 5A8, Canada; [†]Western Beef Development Centre, Humboldt, SK, S0K 2A0, Canada



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## INTRODUCTION

Feed costs comprise a significant portion of overall costs in beef production. Improved feed utilization and thus, reduced feed costs would improve the economic and environmental sustainability of the beef cattle industry. Therefore, the knowledge about selection decisions regarding which heifers to use as replacements within the cow–calf herd is important. Recent advances in genomic testing technology have the potential to revolutionize beef cattle breeding and marketing. The Merial Ltd. (Duluth, GA) Igenity profile generates genotypic information that may be used to predict beef cattle performance traits such as feed efficiency, ADG, calving ease, stayability, docility, and several slaughter traits such as yield grade, rib-eye area, and fat thickness (Van Eenennaam, 2007). Cow–calf producers are interested in using DNA tests as a selection technique to improve fertility and longevity in their herds, to differentiate calves for marketing or for retained ownership, to select replacement heifers with greater potential for breeding success, and to validate their sire selections and management practices. One previous study (Upton, 2001) found that the Igenity feed efficiency molecular breeding values were significantly and positively associated with residual feed intake (**RFI**) for Brahman (*Bos indicus*) cattle. However, the utility of the Igenity profile (i.e., efficient vs. inefficient beef cattle) to identify efficient or inefficient cattle under western Canadian environmental conditions with forage-based diets is unknown. Furthermore, beef heifers and cows are commonly fed low-quality forages differing from most RFI testing strategies, thereby leaving a question for whether application of RFI for use in cow–calf herds is relevant. As such, the validation of RFI and gain under different environmental and dietary conditions (i.e., energy density) requires further exploration, particularly when cattle are fed forage-based diets and exposed to extreme conditions during both the summer and winter grazing periods. Therefore, the objectives of this study were: 1) to determine whether Igenity profile marker scores (genotypic data) for feed efficiency are correlated with measured feed efficiency, individual DMI and gain data (phenotypic data), 2) to determine if DNA genotype (marker score) information can be used to identify more or less efficient beef animals fed forage-based diets.

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[2]Corresponding author: bart.lardner@usask.ca

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## MATERIALS AND METHODS

All animals used in the study were cared for in accordance with the Canadian Council of Animal Care (2009) guidelines.

### *The Study Site and Animal Management*

The study was conducted at Western Beef Development Centre's, Termuende Research Ranch near Lanigan, Saskatchewan, Canada (51°51′N, 105°02′W) over 3 consecutive years (2012–2013; 2013–2014; and 2014–2015). In each year, heifers were weaned in October and selected as replacements to reach a similar target-weight and BCS at first breeding. In yr 1, the test ran from December 10, 2012, to February 20, 2013 (71 d). In yr 2, the test ran from October 31, 2013, to February 11, 2014 (103 d). In yr 3, the test ran from October 30, 2014, to January 30, 2015 (92 d). There were 206 spring-born black Angus, nulliparous heifers (69, 69, and 68 heifers for yr 1, 2, and 3, respectively). For this study, two drylot pens were used, each pen (50 × 120 m) was surrounded by wooden slatted fences, containing an open-faced shed in one end, and water was supplied to each pen in a heated water bowl. In each of two pens, eight GrowSafe Intake (GrowSafe Systems Ltd., Airdrie, AB, Canada) feeding troughs were installed. Heifers were assigned randomly to one of two pens (35 or 34 heifers/pen). Each heifer was identified with a radio frequency transponder button (half duplex RFID, Allflex USA Inc., Dallas/Ft. Worth Airport, TX) in their ears. The transponder button was located 5 to 6 cm from the base of the ear, in the middle, with the transponder button on the inside part of the ear.

### *Feeding Management*

A forage-based diet was designed to meet nutrient requirements in accordance with the NRC (2000) beef model for replacement heifers. Heifers were fed to achieve a moderate rate of gain (0.64 kg/d). The diet (10.7% CP; 65.6% TDN) consisted of 72% brome grass/alfalfa hay and 28% rolled barley (DM basis). The heifers were adjusted to their trial rations and to the GrowSafe System feeding units during a pretest adjustment period of at least 21 d. Feed was delivered ad libitum, once daily at 0800 h using a Farm Aid Mixer Wagon equipped with a digital scale (model 430, Corsica, SD). The barley grain was dry rolled (Ross Kamp Champion, Waterloo, IA) to a processing index of 76% and brome grass/alfalfa hay was ground through a 9.5-cm screen. Heifers also had ad libitum access to a commercial 2 : 1 mineral supplement over the course of the trial.

### *Animal and Feed Intake Measurements*

All heifers were weighed on 2 consecutive days at the start and end of the trial and every 2 wk throughout the trial. Ultrasound measurements of subcutaneous body fat were (**RIB**: rib fat; mm) determined at the start end of the trial period using an Aloka 500V real-time ultrasound machine (3.5 MHz; Aloka Inc., Wallingford, CT) equipped with a 17-cm linear array transducer. Feed intake was measured with the GrowSafe (GrowSafe Systems Ltd., Airdrie, Alberta, Canada) automatic feeding system as described by Durunna et al. (2012). Feed conversion ratio for each animal was calculated as the ratio of ADG to DMI (**G : F**).

### *Igenity Scores*

From each heifer, tail hair with the follicle attached were collected and sent to GenServe Laboratories (Saskatchewan Research Council, Saskatoon, SK, Canada) for Merial IGENITY scoring. Scores were available for RFI, ADG, tenderness, marbling, percentage of Choice, 12th-rib fat thickness, yield grade (**YG**), rib-eye area, pregnancy rate, stayability, maternal calving ease, and docility and were reported on a scale of 1 to 10. Simultaneously, Igenity production index (**IPI**) was calculated based on the following traits and their weightings: RFI 15%, ADG 15%, tenderness 10%, percent of Choice 20%, stayability 30%, and maternal calving ease 10%. Except for 12th-rib fat thickness and YG, a greater score indicates a more desirable phenotype.

### *RFI Calculations*

RFI was calculated by the method of Arthur et al. (2001) within each study year. Actual DMI was regressed on mid-test metabolic BW and ADG to calculate an expected DMI for each heifer using the PROC REG procedure (SAS Inst. Inc., Cary, NC).

The model for expected feed intake was:

$$y_i = b_0 + b_1 \mathrm{ADG}_i + b_2 WT_i + e_i,$$

where $\mathrm{ADG}_i$ was the ADG of animal $_i$, $WT_i$ was the midtest metabolic ($\mathrm{BW}^{0.75}$) BW of animal $_i$, and $e_i$ was the error. Expected DMI was calculated within each contemporary test year. The RFI was calculated by subtracting the expected intake from the actual intake for each animal. Based on these calculations, the heifers were classified into low (<0.5 SD; low-RFI), medium (±0.5 SD; medium-RFI), or high (>0.5 SD; high-RFI) RFI classes. For data analysis purpose, each class of heifers further separated into subgroups (experimental unit) based on whereabouts (either of two pens).

### *Statistical Analysis*

Animal performance data (BW, BW change, rib fat, rib fat change, DMI, RFI, and G : F), and Igenity panel scores (for RFI, ADG, tenderness, marbling, percentage of Choice, 12th-rib fat thickness, yield grade, and rib-eye area, pregnancy rate, stayability, maternal calving ease, docility, and IPI) were analyzed using the MIXED procedure of SAS 9.2 (SAS, 2003). The model used for the analysis was: $Y_{ij} = \mu + T_i + e_{ij}$; where $Y_{ij}$ was an observation of the dependent variable *ij*; $\mu$ was the population mean for the variable; $T_i$ was the fixed effect of the animal RFI class (low-RFI, medium-RFI, and high-RFI class; and $e_{ij}$ was the random error associated with the observation *ij*. When a significant difference ($P < 0.05$) was detected, means were separated using the Tukey–Kramer posttest. Each replicate class in each heifer class in each pen was considered an experimental unit making for a total of 18 experimental units over the 3-yr study. Year was included as a random (block) variable in all analyses. Pearson correlation statistic was used to determine the relationship among genotypic (Igenity panel score) and phenotypic traits (measured traits) of animals. In addition, Spearman rank correlation was also used to determine if the phenotypic and genotypic measurements of RFI ranked the animals in a similar order.

## RESULTS AND DISCUSSION

### *Heifer Performance (Phenotypic Data)*

Heifer classes differing in measured RFI did not differ ($P > 0.05$; Table 1) in final BW (317.6 ± 2.0 kg), ADG (0.67 ± 0.01 kg/d), or final rib fat (3.1 ± 0.06 mm). However, the greatest ($P < 0.05$) DMI was observed in high-RFI (8.7 ± 0.57 kg/d), the lowest ($P < 0.05$) was observed in low-RFI (7.27 ± 0.80 kg/d), and intermediate was observed in medium-RFI classes (8.15 ± 0.70 kg/d). The RFI was different ($P < 0.05$) among classes; it was −0.73 ± 0.41, −0.02 ± 0.17, and 0.73 ± 0.36 kg/d for low-RFI, medium-RFI, and high-RFI classes, respectively. High-RFI heifers (0.07 ± 0.001) had lower ($P < 0.05$) G : F than either low-RFI (0.09 ± 0.002) or medium-RFI classes (0.08 ± 0.001) G : F. Medium-RFI heifers had similar ($P > 0.05$) with either low-RFI or high-RFI class in G : F. The results of this study agree with other published results (Durunna et al., 2012) that suggested low RFI heifers had similar rates of gain to high RFI heifers, even though feed intake for low-RFI heifers was less.

### *Igenity Panel Scores*

Heifer Igenity panel scores are presented in Table 2. Heifer classes did not differ in Igenity panel scores for ($P > 0.05$) IPI (6.2 ± 0.1), ADG

**Table 1.** Performance and DMI of beef heifers with different RFI during pre-breeding feeding period over 3 yr[1]

| Item | Low-RFI | Medium-RFI | High-RFI | SEM | *P*-value |
|---|---|---|---|---|---|
| No. heifer | 61 | 84 | 60 | | |
| Body weight (BW), kg | | | | | |
| Initial BW | 257.0 | 259.1 | 256.8 | 2.60 | 0.79 |
| Final BW | 316.2 | 319.1 | 316.8 | 5.44 | 0.93 |
| Change | 59.2 | 60.0 | 60.0 | 4.94 | 0.99 |
| Metabolic BW, kg of $BW^{0.75}$ | 69.6 | 70.1 | 69.6 | 0.63 | 0.86 |
| ADG, kg/d | 0.66 | 0.68 | 0.67 | 0.02 | 0.93 |
| Rib fat[2], mm | | | | | |
| Initial rib fat | 2.5 | 2.5 | 2.4 | 0.26 | 0.98 |
| Final rib fat | 2.9 | 3.1 | 3.0 | 0.23 | 0.91 |
| Change | 0.5 | 0.6 | 0.6 | 0.11 | 0.69 |
| DMI | 7.2[c] | 8.2[b] | 8.8[a] | 0.13 | <0.01 |
| DMI, % BW | 2.5[c] | 2.8[b] | 3.1[a] | 0.03 | <0.01 |
| RFI[3], kg/d | −0.8[c] | 0.0[b] | 0.7[a] | 0.09 | <0.01 |
| G : F | 0.09[a] | 0.08[ab] | 0.07[b] | 0.010 | 0.02 |

[a–c]Within a row, means with different superscripts differ by the Tukey's test ($P < 0.05$). Pen was considered experimental unit. Heifers were allocated randomly one of two pens (50 × 120 m) each with eight GrowSafe bunks (model 4000E, GrowSafe Systems Ltd., Airdrie, AB, Canada).

[1]The classes were assigned as low-RFI (efficient) = RFI < −0.5 SD less than the mean, medium-RFI = RFI ± 0.5 SD greater than and less than the mean, and high-RFI (inefficient) = RFI > 0.5 SD greater than the mean.

[2]Rib fat thickness of the live animal was measured with ultrasound.

[3]RFI was calculated from MWT, ADG, and DMI following Arthur et al. (2001).

**Table 2.** Igenity panel scores of beef heifers with different RFI during pre-breeding feeding period over 3 yr[1,2]

| Item | Low-RFI | Medium-RFI | High-RFI | SEM | *P*-value |
|---|---|---|---|---|---|
| No. heifer | 61 | 84 | 60 | | |
| Igenity production index[3] | 6.2 | 6.0 | 6.1 | 0.07 | 0.13 |
| RFI | 6.8[ab] | 7.2[a] | 6.6[b] | 0.14 | 0.03 |
| ADG | 6.3 | 6.4 | 6.2 | 0.10 | 0.62 |
| Tenderness | 6.2 | 6.0 | 6.1 | 0.32 | 0.88 |
| Marbling score | 6.9 | 6.9 | 7.0 | 0.13 | 0.65 |
| Percent of Choice | 6.9 | 6.9 | 7.0 | 0.13 | 0.65 |
| Yield grade | 6.5 | 6.5 | 6.6 | 0.12 | 0.86 |
| Twelfth-rib fat thickness | 5.9 | 5.9 | 5.9 | 0.12 | 0.96 |
| Rib-eye area | 4.4 | 4.4 | 4.3 | 0.15 | 0.81 |
| Pregnancy rate | 5.5 | 5.2 | 5.3 | 0.14 | 0.35 |
| Stayability | 6.5 | 6.6 | 6.6 | 0.19 | 0.85 |
| Calving ease | 5.2 | 5.0 | 5.1 | 0.14 | 0.75 |
| Docility | 6.1 | 6.0 | 6.0 | 0.13 | 0.72 |

[ab]Within a row, means with different superscripts differ by the Tukey's test ($P < 0.05$). Pen was considered experimental unit.

[1]Analysis was conducted by GenServe Laboratories, Saskatchewan Research Council for Merial IGENITY scoring. Panel scores range from 1 to 10. For most panels, 10 is preferred. However, 1 is preferred for yield grade and 12th-rib fat thickness panels.

[2]The classes were assigned as low-RFI (efficient) = RFI < −0.5 SD less than the mean, medium-RFI = RFI ± 0.5 SD greater than and less than the mean, and high-RFI (inefficient) = RFI > 0.5 SD greater than the mean. RFI was calculated from MWT, ADG, and DMI following Arthur et al. (2001).

[3]Igenity production index was calculated based on following traits and their weightings: RFI 15%, ADG 15%, tenderness 10%, Choice 20%, stayability 30%, and maternal calving ease 10%.

(6.3 ± 0.1), tenderness (6.2 ± 0.32), marbling (6.9 ± 0.13), percent of Choice (6.9 ± 0.13), YG (6.5 ± 0.12), rib fat thickness (5.9 ± 0.12), rib-eye area (4.4 ± 0.15), pregnancy rate (6.5 ± 0.12), stayability (6.5 ± 0.19), calving ease (5.2 ± 0.14), as well as docility (6.1 ± 0.13). Although, high-RFI heifers (6.6 ± 1.1) did not differ ($P > 0.05$) from low-RFI (6.8 ± 3.1) in Igenity panel scores, they were lower ($P < 0.05$) than medium-RFI heifers (7.2 ± 0.1), which indicated that Igenity panel scoring technique may have some problem in RFI prediction.

### *Relationship between Beef Heifer Phenotypic Traits and Corresponding Igenity Panel Scores*

The correlation coefficients among beef heifer phenotypic traits and their Igenity panel scores were (data not shown) analyzed. The tenderness score was weak ($r = 0.18$) but significantly affected ($r = 0.18$; $P < 0.05$) with measured G : F. Likewise, DMI was also very weak but positively correlated ($r = 0.15$; $P < 0.05$) with Igenity scores for either marbling or percent of Choice. In general, the Igenity panel scores showed low correlations ($-0.4 > r < 0.4$) with their corresponding phenotypic traits. Even very weak but a negative correlation ($r = -0.15$; $P < 0.05$) was detected between phenotypic (measured) ADG and ADG Igenity panel score. Spearman rank correlation coefficients ($r$) for the pooled data set (pooled across all heifers) were 0.24 ($P < 0.01$; data not shown) for phenotypic RFI vs. RFI Igenity score "paired" estimates, which indicated that only ~6% of animals were ranked similar order by phenotypic and Igenity panel scores. However, Van Eenennaam et al. (2007) found mixed results when evaluating SNP-panels for beef cattle.

Overall, as this study revealed, there appears to be very little or no evidence of relationships between replacement heifer actual performance and corresponding Igenity panel scores. Accuracies of Igenity panel scoring technique generally decreased with an increasing genetic distance between the training and the validation population (Boerner et al., 2015). On the other hand, animal feed efficiency phenotypic parameters are not consistent overtime; the switch from one RFI classification to another exists in heifers (Durunna et al., 2012, Damiran et al., 2018) due to different diet or a different maturity stage or environment. Therefore, this technique needs to be validated using local population before using it in beef industry for selection decision in western Canada.

## IMPLICATIONS

The results of this study suggest that SNP in the panels are less associated with pheotypic feed efficiency traits for beef cattle under western Canadian environmental conditions with forage-based diets,

which emphasizes the need for continual validation of commercially available marker panels using local herd population.

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