



FEED EFFICIENCY IN GROWING STEERS: RELATIONSHIPS BETWEEN EFFICIENCY AND CARCASS ULTRASOUND TRAITS

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Abstract

Phenotypic correlations between feed efficiency and carcass traits were examined in growing steers. Two feed efficiency trials were conducted using 233 Santa Gertrudis steers. Steers were individually fed a roughage-based diet for 77 days. Individual feed intake was recorded weekly and body weight was measured bi-weekly. Ultrasound measurements of the 12th rib fat thickness (back fat), longissimus muscle area (REA) and percentage intramuscular fat were obtained on day 0 and 77. Residual feed intake (RFI_p) is a measure of feed efficiency that attempts to measure variation in feed intake beyond that needed for growth and maintenance. Residual feed intake was calculated as the difference between actual feed intake and expected feed intake predicted by a linear regression model of dry matter intake (DMI) on mid-test BW^{0.75} (MBW) and average daily gain (ADG) with trial, trial × MBW, and trial × ADG as random effects. Steers were ranked by RFI into low, medium, and high RFI groups <0.5 SD, ± 0.5 SD, > 0.5 SD, respectively, from the mean RFI_p of 0.0 ± 1.01 kg/d. Overall means for ADG and DMI were 0.38 kg/d (SD = 0.57) and 9.79 kg/d (SD = 1.03), respectively. Stepwise regression indicated that inclusion of gain in back fat (GBF) into the base model increased the r² (0.43 vs. 0.46). RFI_p was positively correlated (*P* < 0.05) with DMI (*r* = 0.76), and FCR (*r* = 0.49), but not with MBW or ADG. Feed to gain ratio (FCR) was negatively correlated (*P* < 0.05) with ADG (*r* = -0.70). Carcass adjusted for RFI (RFI_c) was positively correlated (*P* < 0.05) with DMI (*r* = 0.75) and FCR (*r* = 0.49), but not with MBW or ADG. Gain in back fat was positively correlated (*P* < 0.05) with RFI_p (*r* = 0.14), but not correlated (*P* > 0.05) with FCR or RFI_c. Gain in REA was not correlated (*P* > 0.05) with FCR, RFI_c, or RFI_p. The Spearman rank correlation between RFI_p and RFI_c was high (*r* = 0.91). Results suggest that RFI is independent of growth rate and mature size, but related to DMI. Selecting for favorable RFI_p phenotypes can potentially improve feed efficiency in cattle. Adjusting RFI for ultrasound carcass traits could also improve feed efficiency independent of growth, body size, and carcass composition.

Introduction

Past attempts to quantify feed efficiency in beef cattle has been accomplished through feed conversion ratio (FCR), a gross measure of feed efficiency not accounting for feed needed for maintenance and growth. An alternative measure of feed efficiency is residual feed intake (RFI), which attempts to measure variation in feed intake beyond that needed for growth and maintenance. Residual feed intake (RFI) has been shown to be moderately heritable (Herd et al., 2003) and genetically independent of BW and ADG (Arthur et al., 2001). It has been observed that more feed efficient animals have reduced daily feed activity as compared to less efficient animals (Golden et al., 2008). Selecting for RFI will improve feed efficiency without increasing growth rate and mature size of the animal (Baker et al., 2006; Johnson et al., 2002). Phenotypic correlations show that RFI has little to no influence on growth or longissimus muscle area, and only displays a slight decrease in subcutaneous fat depth. Thus, selecting animals based on RFI is unlikely to exhibit undesirable responses in performance traits of growing animals (Arthur et al., 1997).

Objectives

- To characterize feed efficiency traits in growing steers.
- To examine phenotypic correlations between feed efficiency and carcass ultrasound traits in growing steers.

Materials and Methods

- Two trials were conducted with Santa Gertrudis steers (n = 233) during which steers were fed a roughage-based diet (2.1 Mcal ME/kg DM) during the growing phase.
- Steers were weighed at 14-d intervals and DMI measured (Calan gate or GrowSafe) for 70 d during both the growing.
- Ultrasound measurements of the 12th rib fat thickness (BF), longissimus muscle area (REA), and percentage intramuscular fat (IMF) were taken on day 70.

Calculations and Statistical Analysis:

- Partial correlation and least squares means were determined using PROC CORR and GLM functions of SAS.
- Steers were ranked by RFI, separated into low, medium, and high efficiency groups that were < 0.5 SD, ± 0.5 SD and > 0.5 SD, respectively, from the mean RFI and data analyzed with a model that included RFI group as the main effect.
- Residual feed intake was defined in two ways for analysis. Base RFI (RFI_p) was the residual term from the phenotypic linear regression of DMI on ADG and MBW, and RFI_c was the residual term from the phenotypic linear regression of DMI on ADG, MBW and gain in back fat.
- Partial correlation coefficients between RFI_p and RFI_c was determined using PROC CORR SPEARMANN of SAS.

Results

- FCR was negatively correlated (*P* < 0.05) with ADG (*r* = -0.70).
- RFI_p was positively correlated (*P* < 0.05) with DMI (*r* = 0.76) and FCR (*r* = 0.49).
- RFI_c was positively correlated (*P* < 0.05) with DMI (*r* = 0.75) and FCR (*r* = 0.49).
- Gain in BF was positively correlated (*P* < 0.05) with RFI_p (*r* = 0.14).
- Gain in REA was not correlated (*P* > 0.05) with FCR, RFI_p, or RFI_c.
- Spearman rank correlation between RFI_p and RFI_c was high (*r* = 0.91).

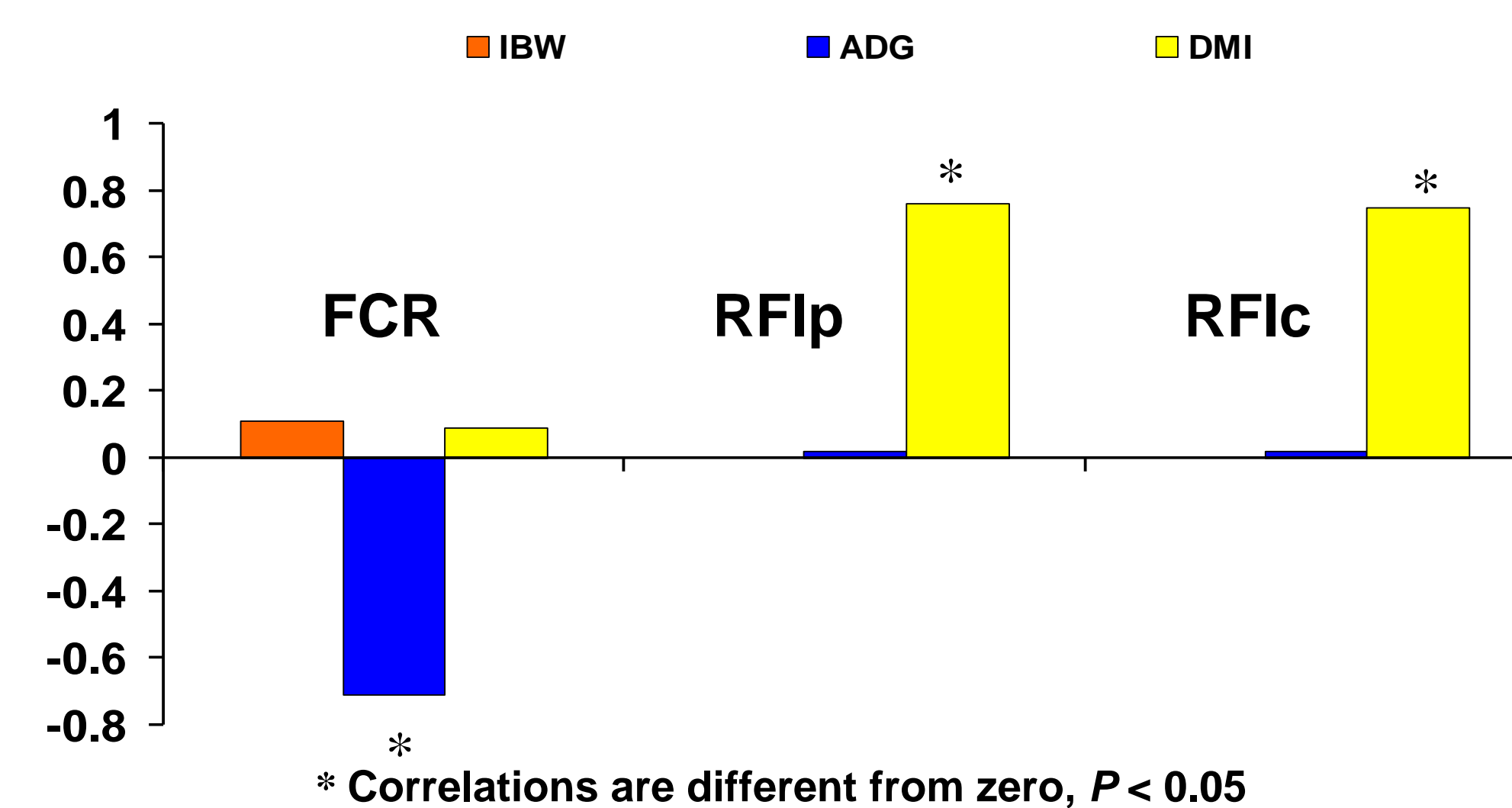


Figure 1. Phenotypic Correlations between Feed Efficiency and Performance Traits in Growing Steers

Results

Trait	Low	Medium	High	SE	<i>P</i> -value
Number of steers	67	97	69		
RFI, kg/d	-0.97 ^a	-0.06 ^b	1.05 ^c	0.05	<0.001
Initial BW, kg	302.38	306.16	302.65	3.82	0.69
ADG, kg/d	1.04	1.03	1.06	0.02	0.79
DMI, kg/d	8.79 ^a	9.72 ^b	10.85 ^c	0.10	<0.001
FCR, DMI/ADG	9.05 ^a	9.89 ^b	10.91 ^c	0.19	<0.001

^aLow, medium, and high RFI steers were < 0.5 SD, ± 0.5 SD, and > 0.5 SD from the mean RFI of 0.00 ± 0.88. ^{abc}Means with different superscripts in the same row differ, *P* < 0.05.

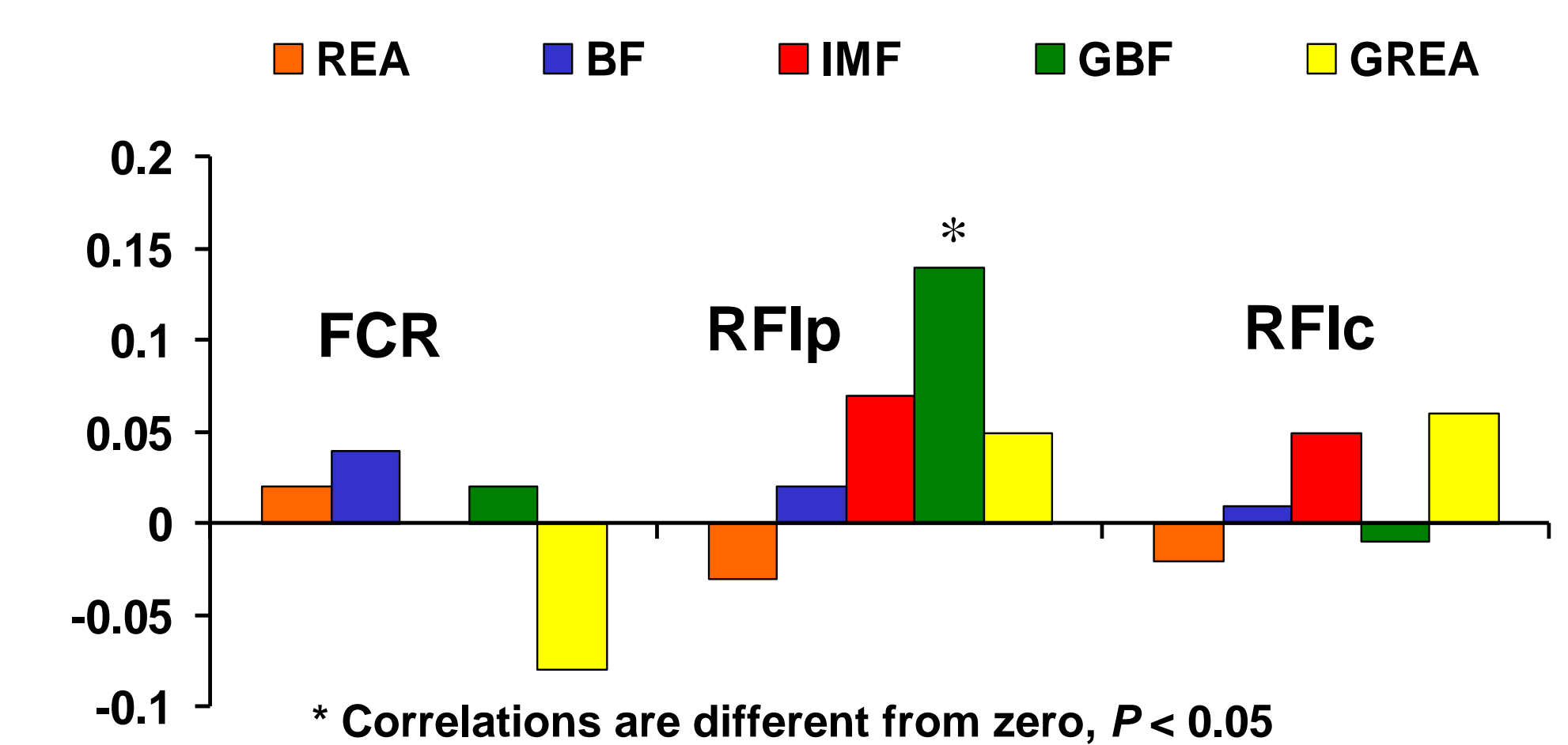


Figure 2. Phenotypic Correlations between Feed Efficiency and Carcass Ultrasound Traits in Growing Steers

Trait	Feed Efficiency Trait		
	FCR	RFI _p	RFI _c
IBW	no	no	no
ADG	---	no	no
DMI	no	+++	+++
REA	no	no	no
BF	no	no	no
IMF	no	no	no
GBF	no	+	no
GREA	no	no	no

+++ *r* > 0.50 --- *r* > -0.50

Conclusion

Results in this study indicate that RFI_p is independent of growth rate and mature size, but highly correlated with DMI. Selecting for favorable RFI_p phenotypes has the potential to improve feed efficiency in cattle. Adjusting RFI for ultrasound carcass traits could also improve feed efficiency independent of growth, body size, and carcass composition.