University of Nebraska - Lincoln
DigitalCommons@University of Nebraska - Lincoln

Nebraska Beef Cattle Reports | Animal Science Department

2010

Genetic and Phenotypic Parameter Estimates for Feed Intake and Other Traits in Growing Beef Cattle

Kelsey Rolfe
University of Nebraska-Lincoln, krolfe2@unl.edu

Merlyn K. Nielsen
University of Nebraska-Lincoln, mnielsen1@unl.edu

Calvin L. Ferrell
University of Nebraska-Lincoln

Thomas G. Jenkins
University of Nebraska-Lincoln

Follow this and additional works at: https://digitalcommons.unl.edu/animalscinbcr

Part of the Animal Sciences Commons

Rolfe, Kelsey; Nielsen, Merlyn K.; Ferrell, Calvin L.; and Jenkins, Thomas G., "Genetic and Phenotypic Parameter Estimates for Feed Intake and Other Traits in Growing Beef Cattle" (2010). *Nebraska Beef Cattle Reports*. 583.
https://digitalcommons.unl.edu/animalscinbcr/583

This Article is brought to you for free and open access by the Animal Science Department at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Nebraska Beef Cattle Reports by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

Genetic and Phenotypic Parameter Estimates for Feed Intake and Other Traits in Growing Beef Cattle

Kelsey M. Rolfe
Merlyn K. Nielsen
Calvin L. Ferrell
Thomas G. Jenkins

Summary

The goal of this study was to estimate genetic and phenotypic parameters for growth, feed intake, feed efficiency, and temperament traits in a mixed-breed composite population of growing beef cattle. Intake and gain:feed (G:F) were moderately heritable; however, residual feed intake (RFI) was more heritable than other measures of feed efficiency. Adjusting RFI and G:F for carcass fatness had little effect on heritability and correlations with remaining traits. Flight speed was moderately heritable and highly repeatable. Flight speed was not highly correlated with measures of intake or feed efficiency. Some small breed effects were observed. High heritability estimates indicate that selection for or against specific intake and feed efficiency traits may be successful. Flight speed may be useful in selection as an indicator of temperament, but does not appear to be a useful indicator of feed efficiency.

Introduction

Approximately two-thirds of the cost of beef cattle production is attributed to the cost of feed; however, less than 20 percent of nutrients consumed are converted into usable product. Thus, the genetic component of feed utilization in beef cattle has been an area of interest.

Traits that support efficient use of grazed forages may be biologically different from those that support efficient use of harvested feeds. Therefore, biological efficiency of beef production is separated into two very distinct systems: a cow-calf system and post-weaning calf growth system. Better understanding of the genetic variation of feed requirements may enable selection of more efficient animals.

In conjunction with studying feed intake and efficiency of feed utilization, emphasis also has been placed on the study of cattle temperament. Research indicates temperament may be useful in genetic evaluations as an indicator trait for economically relevant traits, such as feed efficiency, or it may have direct economic value. The objectives of this research were to estimate genetic and phenotypic parameters for growth, feed intake, feed efficiency, and temperament traits in a mixed-breed composite population of growing beef cattle.

Procedure

Steers (n = 998) were born from 2003 to 2006 at the U.S. Meat Animal Research Center, Clay Center, Neb., and were produced by randomly mating F1-cross sires to straight-bred and F1 females. Seven breeds were represented in various percentages, and these breed percentages varied across animals. Breeds represented were: Hereford, Angus, Simmental, Charolais, Limousin, Gelbvieh, Red Angus, and MARC III (¼ Hereford, ¼ Angus, ¼ Pinzgauer, ¼ Red Poll). Either Hereford or Angus or both were a fraction of each steer. Spring-born steers were weaned at an average age of 165 days, received a series of lower energy diets through the fall, were assigned randomly to pen in December of each year, and then relocated to the feeding facility where individual feed intake measurements of calves in a pen environment were taken using the Calan Broadbent Feeding System. Daily feed provided to each animal was recorded. Feed was delivered to the steers each morning at 0800 hr and feed refusals were collected once per week.

Table 1. Composition of finishing diet.

Ingredient	% Diet (DM)
DRC	82.668
Alfalfa	10.602
SBM	5.663
Limestone	0.574
Urea	0.401
Salt	0.062
Rumensin	0.015
Vitamin A, D, E supp	0.008
Trace mineral supp	0.007

Steers were on feed for an average of 140 days. Weights were collected two consecutive days at the beginning and end of the experiment each year, with interim weights taken every four weeks. Each year steers were serially slaughtered in four groups. Because steers varied in time on feed and data collection, final body weight, cumulative feed intake, backfat, and marbling were adjusted to the average time on feed. The composition of the finishing diet is given in Table 1.

Performance traits analyzed were ADG, DMI, mid-period body weight (MBW), residual feed intake (RFI, determined from DMI adjusted for MBW and ADG), adjusted residual feed intake (RFI_{adj}, adjusted for carcass fatness), gain:feed (G:F), and adjusted gain:feed ($G:F_{adj}$, adjusted for carcass fatness; G:F is a common measure of feed efficiency [output/input]). Flight speed (FS) data were collected at least twice (separated by ~60 days) as an indicator trait for temperament. Each steer was released from a scale and traveled around a working chute before crossing the first set of electric eyes. The second set of electric eyes was placed 14.2 feet from the first set of electric eyes. Breaking the light beam at each set of electric eyes initiated the start and then the end of the time measurement, and 14.2 feet divided by time provided flight speed in ft/sec. Table 2 provides descriptive statistics for traits measured.

Restricted Maximum Likelihood

© The Board of Regents of the University of Nebraska. All rights reserved.

Table 2. Descriptive statistics for traits[1].

Variable	Mean	SD	CV
ADG, lb	3.48	0.51	15
MBW, lb	1,036	109	11
DMI, total lb	2,781	353	13
RFI, lb	0.48	206	7[2]
G:F	0.18	0.05	12
FS, ft/s	8.63	3.12	36

[1]MBW = mid-period body weight; RFI = residual feed intake; G:F = gain:feed; FS = flight speed.
[2]Relative to the mean for DMI.

Table 3. Estimates of heritabilities[1] and genetic[2] and phenotypic[3] correlations for traits[4].

	ADG	MBW	DMI	RFI	GF	FS
ADG	0.22	0.50	0.51	-0.16	0.48	0.09
	(0.08)	(0.17)	(0.16)	(0.20)	(0.18)	(0.09)
MBW	0.45	0.48	0.69	-0.18	-0.33	-0.33
	(0.03)	(0.10)	(0.10)	(0.17)	(0.18)	(0.16)
DMI	0.66	0.74	0.32	0.52	-0.53	-0.22
	(0.02)	(0.02)	(0.09)	(0.13)	(0.18)	(0.18)
RFI	0.00	0.04	0.59	0.46	-0.70	-0.13
	(0.04)	(0.04)	(0.02)	(0.10)	(0.11)	(0.17)
G:F	0.55	-0.22	-0.25	-0.63	0.36	0.3
	(0.02)	(0.04)	(0.03)	(0.02)	(0.10)	(0.18)
FS	-0.06	-0.35	-0.05	-0.00	0.00	0.30
	(0.03)	(0.03)	(0.01)	(0.00)	(0.00)	(0.07)

[1]Heritability estimates are on the diagonal (± standard error, below).
[2]Genetic correlation coefficients are above the diagonal (± standard error, below).
[3]Phenotypic correlation coefficients are below the diagonal (± standard error, below).
[4]See Table 2 for trait definitions.

methods were used in univariate and bivariate models that accounted for the fixed effects of year, season (FS only), pen size (some pens held 4 steers and others held 8), age at weaning, breed heterozygosity (expected to be proportional to expressed heterosis), and fraction of each breed; random effects were animal genetic, pen nested within pen size, permanent environmental (FS only), and residual.

Results

Adjusting for carcass fatness had little effect on the heritability estimates of RFI and G:F, as well as phenotypic and genotypic correlations with remaining traits; therefore, only the non-adjusted trait is presented and discussed. Table 3 provides heritability and correlation estimates for all traits. Average daily gain was lowly heritable (0.22); whereas MBW was more highly heritable (0.48), with DMI being intermediate (0.32). As expected, strong positive genetic (r_g) and phenotypic (r_p) correlations between ADG and MBW were found (r_g = 0.50 and r_p = 0.45). Furthermore, strong positive correlations were found between ADG and DMI (r_g = 0.51 and r_p = 0.66). Mid-period body weight also was highly correlated with DMI (r_g = 0.69 and r_p = 0.74).

As expected, no phenotypic correlation between RFI and ADG was found (r_p = 0.0). Likewise, RFI was phenotypically independent of MBW (r_p = 0.04). Feed intake was highly correlated with RFI (r_g = 0.52 and r_p = 0.59), also as expected. Conversely, G:F was highly correlated with component trait ADG (r_g = 0.48 and r_p = 0.55). Low to moderate negative correlations between G:F and MBW, as well as G:F and DMI, were found (r_g = -0.33 and r_p = -0.22; r_g = -0.53 and r_p = -0.25, respectively). Flight speed was moderately heritable (0.30) and highly repeatable (0.63), which indicates that taking multiple measurements may not be necessary, and one measurement midtest may be adequate. Despite this, FS was not highly correlated with measures of feed intake and efficiency.

In general, breed differences were small; still, some breed effects were observed. A steer with a greater fraction of a specific breed will exhibit a greater "breed effect" for that specified breed. The Limousin breed effect was greater than average for ADG ($P < 0.05$), and also gave higher G:F ($P < 0.01$), indicating this breed was more efficient than others included in the evaluation. The Simmental breed effect produced steers that were heavier ($P < 0.05$) at mid-test and had a lower G:F ($P < 0.01$). The Angus breed effect influenced steers to consume more ($P < 0.1$) throughout the trial, and Angus had higher RFI ($P < 0.1$). This suggests that the Angus breed effect contributes to less efficient feed utilization than other breeds evaluated. Finally, the Hereford effect on steers was to produce slower FS ($P < 0.01$), suggesting a docile temperament. Breed heterozygosity, and thus heterosis, was not an important source of variation for any of the body weight and gain measures or any of the feed intake and efficiency measures, as expected due to the moderate heritability estimates for these traits.

Heritability estimates obtained from these data are greater than some found in previous literature, likely due in part to the larger range of genetic variation of the breeds included in this population of cattle and the many breed combinations. Higher heritability estimates indicate that selection for or against specific intake and feed efficiency traits would be successful in production of more efficient animals. Flight speed is not recommended as a selection tool for intake or feed efficiency traits, but it may be a useful indicator of temperament.

[1]Kelsey M. Rolfe, research technician, Merlyn K. Nielsen, professor, Animal Science, University of Nebraska, Lincoln, Neb.; Calvin L. Ferrell and Thomas G. Jenkins, research scientists, U.S. Meat Animal Research Center, Clay Center, Neb.

© The Board of Regents of the University of Nebraska. All rights reserved.