Kansas Agricultural Experiment Station Research Reports

Volume 1
Issue 1 *Cattlemen's Day*

Article 9

January 2015

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Recommended Citation

Retallick, K. J.; Bormann, J. M.; Weaber, R. L.; MacNeil, M. D.; Bradford, H. L.; Freetly, Harvey C.; Snelling, W. M.; Thallman, Mark; Moser, D.; and Kuehn, Larry (2015) "Genetic Variance and Covariance Components for Feed Intake, Average Daily Gain, and Postweaning Gain in Growing Beef Cattle," *Kansas Agricultural Experiment Station Research Reports*: Vol. 1: Iss. 1. https://doi.org/10.4148/2378-5977.1023

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This beef cattle management is available in Kansas Agricultural Experiment Station Research Reports: https://newprairiepress.org/kaesrr/vol1/iss1/9

Genetic Variance and Covariance Components for Feed Intake, Average Daily Gain, and Postweaning Gain in Growing Beef Cattle

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Introduction

Feed is the greatest cost for a beef cattle production enterprise. Data collection to determine feed efficiency of animals is also costly, because both gain and intake records are needed to calculate feed efficiency. Electronic intake monitoring systems such as GrowSafe or Insentec to collect feed intake data are expensive and thus limit the number of animals that can be tested. Scientists have worked to pinpoint optimal test durations for collecting both weight gain and feed intake records to lessen costs.

A 70-day performance test is currently recommended for accurate calculation of efficiency, with growth data as the limiting factor. Research has suggested that a 35-day test is adequate to measure feed intake, but a test period of at least 70 days is suggested to measure gain with sufficient accuracy. The objective of this study was to estimate genetic parameters for growth and intake traits with particular attention to the relationship between on-test average daily gain (ADG) and national cattle evaluation postweaning gain (PWG). If the correlation between these two traits is strong, it could allow for the use of PWG as a proxy for ADG in the genetic evaluation of feed efficiency. This substitution would allow producers to reduce the length of the test required to measure feed intake accurately.

Experimental Procedures

On-test average daily feed intake (ADFI), ADG, and PWG calculated from weaning weights and yearling weights were recorded for 5,606 growing steers and heifers born from 2003 through 2012 at the U.S. Meat Animal Research Center in Clay Center, NE. Data from 2003 through 2004 were from spring-born steers, whereas data from subsequent years included both steers and heifers. Beginning in 2007, data were collected from both spring- and fall-born calves. Contemporary groups for ADFI and ADG were defined as birth location, season, on-test date, and feeding management code.

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The PWG contemporary groups were defined as birth location, season, weaning date, and yearling weigh date. A three-generation pedigree containing 9,211 animals from 27 different breed groups was used in the analysis. On-test ADFI and ADG data test periods ranged from 62 to 148 days. Individual feed intake records were acquired using the Calan Broadbent Feeding Systems (American-Calan-Broadbent; Northwood, NH) or Insentec Systems (Marknesse, The Netherlands). Independent quadratic regressions were fitted for body weight on time, and on-test ADG was predicted from the resulting equations. PWG was calculated by subtracting 205-day age-adjusted weights from 365-day age-adjusted weights and dividing by 160 days. Genetic and residual components of variance and covariance were estimated using multiple-trait animal mixed models with ADG, ADFI, and PWG for both sexes as dependent variables using ASREML 3.0. Contemporary groups were fitted as fixed effects. Covariates included age on test, age of dam, direct and maternal heterosis, and breed origin.

Results and Discussion

Descriptive statistics are provided in Table 1. More records were available from steers than from heifers. All individuals have recorded measures for on-test ADFI and ADG, but PWG observations for four individuals were missing. Both individual direct and maternal heterosis had significant effects on growth and feed intake. Heterosis effects resulted in increased ADFI, ADG, and PWG. Genetic parameter estimates are given in Table 2. These estimates confirm that the genetic antagonism between growth and feed intake can be broken, and genetic improvement of feed efficiency is feasible. Estimates for on-test ADG for both sexes were lowly heritable in these data, which is dissimilar to estimates reported in previous literature. Nkrumah et al. (2007) reported ADG heritability estimates in a population of young Charolais bulls on an 84-day performance test of 0.34, whereas Arthur et al. (2001) reported heritability estimates of 0.28 for ADG in a population of Angus bulls and heifers on a 70-day test. In a mixed population of Angus, Hereford, and Shorthorn cattle, heritability estimates were maximized with a 70-day test ($h^2 = 0.35$) and decreased as subsequent test days were added until day 119 ($h^2 = 0.28$; Archer et al., 1997). The lower heritability estimates experienced in the current analysis could be owing to increased variation among breeds in the population.

Genetic correlations among traits within sexes had strong positive relationships, meaning that on average as one trait increased, the other did as well. Correlations among traits between steers and heifers could be estimated through ancestral relationships. The strong correlations between on-test ADG and PWG in both steers and heifers suggests that PWG is a viable substitute for on-test ADG when evaluating feed efficiency.

Implications

If PWG was used as an alternative measure for on-test ADG to predict feed efficiency, it could allow for a shorter 35-day intake test as supported by previous studies. A shorter test would allow more animals to be tested annually through a given set of facilities at a lower cost per animal. Testing a greater number of animals facilitates increasing selection intensity with a resultant increase in the overall rate of genetic change of feed efficiency.

Acknowledgements

We thank the U.S. Meat Animal Research Center for providing data and the American Simmental Association for financial support of this project.

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Table 1. Descriptive statistics for steer and heifer average daily feed intake (ADFI), average daily gain (ADG), and postweaning gain (PWG)

Trait	Number	Mean	Standard deviation
Steer ADFI	3,212	9.45	1.48
Steer ADG	3,212	1.99	0.57
Steer PWG	3,211	3.06	0.42
Heifer ADFI	2,394	7.75	1.28
Heifer ADG	2,394	1.02	0.49
Heifer PWG	2,392	1.93	0.46

Table 2. Heritability estimates (on diagonal SE below) and genetic correlations (diagonal SE below) for steer and heifer average daily feed intake (ADFI), average daily gain (ADG), and postweaning gain (PWG)

Trait	SADFI	SADG	SPWG	HADFI	HADG	HPWG
Steer ADFI	**0.43** (0.05)					
Steer ADG	0.73 (0.12)	**0.09** (0.03)				
Steer PWG	0.58 (0.06)	0.81 (0.14)	**0.36** (0.05)			
Heifer ADFI	0.71 (0.09)	0.66 (0.20)	0.65 (0.09)	**0.39** (0.05)		
Heifer ADG	0.51 (0.15)	0.39 (0.27)	0.71 (0.15)	0.64 (0.12)	**0.14** (0.04)	
Heifer PWG	0.47 (0.09)	0.67 (0.20)	0.91 (0.08)	0.77 (0.05)	0.65 (0.12)	**0.42** (0.05)