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Factors Associated with Feed Intake of Angus Steers

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Summary

Estimates of variance components and heritability of average daily feed intake (AFI) and residual feed intake (RFI) were obtained using an animal model. Data were from 475 Angus steers raised and fed at the Circle A Ranch (Iberia, Mo.). Pedigree files were provided by the American Angus Association. Estimates of heritability after adjustment for average daily gain (ADG) were 0.56 and 0.60 for AFI and RFI. Selection for feed intake (FI) should be effective if FI records are available. Feed intake needs to be adjusted for age and weight on test. Carcass measurements (fat thickness and rib eye muscle area) were significantly associated with AFI and RFI, whether measured by ultrasound at mid-test or by direct measurement at harvest. With carcass measurements held constant, estimates of heritability for AFI were reduced from 0.35 to 0.21 (harvest) and to 0.26 (ultrasound), with the change due to a reduction in the estimate of genetic variance with little change in residual variation. For RFI, the estimate was reduced from 0.60 to 0.37 (harvest) and 0.40 (ultrasound) due to a reduction in estimates of genetic variance and an increase in estimates of residual variation. These results indicate estimated breeding values (EBV) or expected progeny differences (EPD) for fat depth and rib eye area of the carcass, as well for AFI and RFI and other economically important traits, should be weighted by their economic values and included in an economic index for selection.

Introduction

Feed cost for maintenance represents 60 to 65% of the total feed requirements for the cow herd and is the most important determinant of feedlot costs. Variation in feed intake, however, exists among individual animals independent of their body size. The objective of this study was to estimate (co)variance components and heritability of AFI and RFI using data from Angus steers. A second objective was to determine the association of AFI and RFI with carcass traits measured by ultrasound at mid-test or directly at harvest.

Procedure

Data were collected on 4,105 steers raised and fed at the Circle A Ranch (Iberia, Mo.). The pedigree files for sires of these steers were obtained from the American Angus Association (St Joseph, Mo.). Variance components were estimated using the MTDFREML programs (Boldman et al., 1995) from a sample of 475 Angus steers for AFI (lb/day) and RFI (lb/day). Residual feed intake was calculated from AFI for all days on test adjusted to constant ADG and metabolic body weight at mid-test (average of 44 days before end of an average 114-day test period). AFI and RFI were analyzed separately. Covariates in six different models included ADG; age (A, average of 332 days) and weight (W, average of 830 lb) on test; and harvest (S) and ultrasound (U) carcass measures at mid-test (fat thickness, rib eye area, and intra-muscular fat %). All models included contemporary groups (days on feed – pen number – year) and A and W as covariates (usual model) except for the model with no covariates.

Table 1. Estimates of variance components and heritability after adjustment for factors affecting average feed intake (AFI, lb).

Factors		Variation	
Held Constant	Heritability	Genetic	Residual
None	0.31	1.12	2.43
A, W on test[1]	0.35	1.07	2.00
A, W, Carcass (end of test)[2]	0.21	0.54	2.09
A, W, Ultrasound (mid-test)[3]	0.26	0.73	2.09
A, W, ADG	0.56	0.97	0.78
A, W, ADG, Carcass	0.32	0.54	1.12
A, W, ADG, Ultrasound	0.34	0.54	1.07

[1]A = age on test; W = weight on test.
[2]Carcass traits measured at harvest: fat depth, rib eye area, marbling score.
[3]Ultrasound carcass traits measured at mid-test: fat depth, rib eye area, intramuscular fat.

Results

Estimates of heritability and genetic and residual variances for AFI are in Table 1. Adjusting for carcass traits reduced estimates of genetic variation by about one-half with a small increase in estimates of residual variation. The result was smaller estimates of heritability. Correction for more fixed factors usually reduces residual variation and increases heritability. The carcass covariates, however, contain both genetic and residual components. Adjustment for such covariates removes the effects of genes affecting both the carcass traits and feed intake. Only other genes affecting FI but not the carcass traits contribute to genetic variation of FI after adjustment for the carcass traits.

The pattern was the same for carcass traits measured at harvest and by ultrasound at mid-test. These results mean that either traditional measures at harvest or ultrasound measures can be used to adjust AFI, with ultrasound measurements being easier and less expensive to obtain.

Adjusting for ADG reduced estimates of residual variation by about two-thirds with little effect on the estimate of genetic variation, resulting in a larger estimate of heritability. This result implies adjustment was

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mainly for the residual component of ADG and not the genetic component, because for this data set the estimate of heritability for ADG was near zero (usually not so small). Adjusting for ADG and carcass traits reduced estimates of both genetic and residual variation by about 50%. This result combines the effects of adjusting separately for ADG and for carcass traits.

Usually adding more fixed factors, such as age or sex, to a model reduces residual variation, but ADG and the carcass measures all have genetic and residual components. The genetic and residual correlations with AFI and RFI probably explain reductions (or lack of) in estimates of genetic and residual variation for AFI and RFI. That explanation has not been tested. If the necessary records are available, instead of adjusting feed intake to constant ADG, fat depth, rib eye area and marbling, a more satisfactory approach to obtain an economic EBV or EPD would be to use multiple trait analyses (adjusting for contemporary groups and age and weight on test) to obtain EPD for the 5 (or more) traits and weight them by their net economic values.

Estimates of heritability and genetic and residual variances for RFI are in Table 2. All models included effects of pen. Adjusting for either harvest or ultrasound carcass measures reduced estimates of genetic variation by about 40%, and increased estimates of residual variation by about 50%. The result was a much reduced estimate of heritability. With AFI, the genetic variation decreased but the residual variation did not change. The patterns for AFI and RFI may be different because RFI was adjusted for ADG for the test period using a standard adjustment factor. Further adjusting for ADG from the test data had little effect on estimates of variance components and heritability. Adjusting for ADG and carcass measurements resulted in the same estimates as did adjusting for carcass measurements while ignoring ADG. Heritability for RFI is not much different from the estimate of heritability for AFI when

Table 2. Estimates of variance components and heritability after adjustment for factors affecting residual feed intake (RFI, lb).

Factors Held Constant	Heritability	Variation: Genetic	Variation: Residual
None	0.61	1.07	0.67
A, W on test[1]	0.60	1.03	0.69
A, W, Carcass (end of test)[2]	0.37	0.59	1.01
A, W, Ultrasound (mid-test)[3]	0.40	0.64	0.97
A, W, ADG	0.60	1.04	0.68
A, W, ADG, Carcass measures	0.37	0.59	1.01
A, W, ADG, Ultrasound measures	0.40	0.64	0.97

[1]A = age on test; W = weight on test.
[2]Carcass traits measured at harvest: fat depth, rib eye area, marbling score.
[3]Ultrasound carcass traits measured at mid-test: fat depth, rib eye area, intramuscular fat.

Table 3. Regression coefficients* to adjust average feed intake (AFI, lb) to constant age (days) and weight (lb) on test, average daily gain (lb), carcass measurements at slaughter (fat depth, in; rib eye area, in²; and marbling score), and carcass measurements by ultrasound (fat depth, rib eye area, intramuscular fat score) at mid-test.

Model	Age	Weight	ADG	S-fat[a]	S-rea[b]	S-mar[c]	U-fat[d]	U-rea[e]	U-imf[f]
1	-0.015*	0.012*	—	—	—	—	—	—	—
2	-0.018*	0.008*	—	2.162*	0.004*	0.157	—	—	—
3	-0.018*	0.009*	—	—	—	—	3.330*	0.001	0.077
4	-0.004	0.011*	2.272*	—	—	—	—	—	—
5	-0.007	0.010*	2.231*	0.831*	-0.002	0.121	—	—	—
6	-0.009	0.010*	2.230*	—	—	—	1.717*	-0.002*	0.104

[a]S-fat = carcass fat depth.
[b]S-rea = carcass ribeye area.
[c]S-mar = carcass marbling score.
[d]U-fat = fat thickness measured by ultrasound.
[e]U-rea = ribeye area measured by ultrasound.
[f]U-imf = intramuscular fat measured by ultrasound.
*Significant ($P < 0.05$)

Table 4. Regression coefficients* to adjust residual feed intake (RFI, lb) to constant age (days) and weight on test (lb), average daily gain (lb), carcass measurements at slaughter (fat depth, in; rib eye area, in²; and marbling score), and carcass measurements by ultrasound (fat depth, rib eye area, intramuscular fat score) at mid-test.

Model	Age	Weight	ADG	S-fat[a]	S-rea[b]	S-mar[c]	U-fat[d]	U-rea[e]	U-imf[f]
1	-0.004	0.003*	—	—	—	—	—	—	—
2	-0.007	0.002	—	0.699*	-.002*	0.132	—	—	—
3	-0.009	0.002	—	—	—	—	0.132*	-.023*	0.097
4	-0.004	0.003*	-0.038	—	—	—	—	—	—
5	-0.007	0.002	-0.068	0.737*	-0.002	0.132	—	—	—
6	-0.009	0.002	-0.063	—	—	—	0.143*	-.003*	0.097

[a]S-fat = carcass fat depth.
[b]S-rea = carcass ribeye area.
[c]S-mar = carcass marbling score.
[d]U-fat = fat thickness measured by ultrasound.
[e]U-rea = ribeye area measured by ultrasound.
[f]U-imf = intramuscular fat measured by ultrasound.
* Significant ($P < 0.05$)

records are adjusted to a constant ADG. The large estimates of heritability for AFI and RFI while holding ADG constant indicate selection on EPD for AFI or RFI would be effective if FI records were available.

Table 3 contains coefficients for the regression of AFI on covariates such as age on test; for example, a change of one inch in fat depth at harvest is expected to increase AFI by about two pounds. The most important factor associated with AFI was ADG. A one lb increase in ADG is expected to increase AFI by about 2.25 lb. As expected, age and weight on test had significant effects on AFI; younger animals have lower average intakes and heavier animals have greater average intakes. Fat depth had a significant association with feed intake – more fat requires more feed. The expected increase in AFI from a one-inch change in fat depth at harvest (2.16 lb) was less than that expected from a one-inch change in ultrasound fat depth (3.33 lb). The difference may be due to the ultrasound measurements being taken an average of 44 days earlier. Marbling score and intramuscular fat were not significantly associated with AFI, although the regression coefficients suggested that increases in marbling or IMF might be associated with increased AFI.

Table 4 contains coefficients for the regression of RFI on the same covariates used in models for AFI. Fat depth and rib eye area (either at harvest or by ultrasound prior to harvest) were significantly associated with RFI. As with AFI, rather than adjusting RFI to a constant basis for fat depth and rib eye area, EPD (or EBV) for fat depth and rib eye area should be included in an economic EPD along with EPD for RFI and ADG and other economically important traits.

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