2010

Genetic Analysis of Mature Size in American Angus Cattle

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Summary

Genetic parameters for weights and heights of mature cows were estimated using a repeatability model from field data provided by the American Angus Association. The results showed that the heritabilities of both traits were large, and correlations between them were positive and strong. Selection on either trait should easily produce a response, and changing one should lead to a correlated response in the other. Genetic trend was generally for increasing cow weight over the last 25 years.

Introduction

Cow weights and heights affect efficiency, maintenance requirements, cow-calf profitability, reproduction, and cull cow value. Mature size impacts the profitability of beef enterprises and thus should be considered in selection programs. Previous estimates of direct heritability have been generally moderate to high.

The objective of this study was to estimate genetic parameters and (co) variance components for mature weight and mature height of Angus cows using a repeatability model and to estimate genetic trends for both traits.

Procedure

The data and pedigree files used for the analysis were supplied by the American Angus Association (AAA). Two samples were obtained from the complete data file based on the last digit of the herd code. The first sample contained 23,658 mature weight (MWT) and 13,012 mature height (MHT) records (Table 1). The second sample contained 23,698 MWT and 13,310 MHT records. All weights were corrected for body condition score.

Table 1. Summary of data for analyses of mature cow weight (MWT, lb) and mature cow height (MHT, in) for two samples of Angus cows.

	Sample 1		Sample 2	
	MWT1	MHT1	MWT2	MHT2
No. records	23,658	13,012	23,698	13,310
No. cows	14,056	8,131	15,038	8,439
No. cont. groups	1,180	581	1,227	692
No. pedigree	43,105	43,105	44,141	44,141
Means	1315.3	53.4	1296.9	52.8

Table 2. Estimates of genetic parameters (SE) for mature cow weight (MWT, lb) and mature cow height (MHT, in) for two samples of Angus cows (single trait analyses).

	Sample 1		Sample 2	
Estimates	MWT1	MHT1	MWT2	MHT2
Heritability[a]	0.45 (0.012)	0.64 (0.018)	0.48 (0.011)	0.62 (0.018)
Repeatability[a]	0.64	0.77	0.66	0.70
Cont. group[b]	0.50	0.52	0.52	0.46
Phenotypic variance	24363	5.62	25929	5.12

[a]Fraction of phenotypic variance not including contemporary group variance.
[b]Fraction of phenotypic variance including contemporary group variance.

Table 3. Estimates of genetic parameters for mature cow weight (MWT, lb) and mature cow height (MHT, in) for two samples of Angus cows (two trait analyses).

	Sample 1		Sample 2	
Estimates	MWT1	MHT1	MWT2	MHT2
Heritability[a]	0.44	0.62	0.47	0.62
Repeatability[a]	0.64	0.76	0.66	0.70
Cont. group[b]	0.50	0.53	0.52	0.46
Phenotypic variance	24346	5.59	25689	5.06

[a]Fraction of phenotypic variance not including contemporary group variance.
[b]Fraction of phenotypic variance including contemporary group variance.

The four-generation pedigree files included 43,105 and 44,141 animals for samples 1 and 2, respectively (Table 1). The records were from cows born between 1983 and 2006. The range in ages when cows were weighed was 2 to 11 years, with the majority (80%) of records for cows between 2 and 6 years of age. Cows on average had 1.7 records for MWT. Univariate and bivariate analyses were used to estimate genetic parameters for MWT and MHT. Estimates were obtained using the MTDFREML programs. The animal model included age as fixed factor; random factors were contemporary group, permanent environmental effect of the cow, additive genetic value of the cow, and residual. Contemporary group was formed by herd and year of measurement.

Results

Estimates of variance and covariance components, heritability and repeatability for samples 1 and 2 are reported in Tables 2 and 3. Estimates of heritability for MWT were similar to those from previous studies. Previous estimates of heritability for mature weight and height have ranged from moderately to highly heritable. The results for MWT from the current study agree with previous work using data from the AAA. The estimates obtained from the current study have smaller standard errors. For MHT, estimates from the current study are less than estimates previously reported from AAA field data. Estimates of repeatability for samples 1 and 2 were

(Continued on next page)

Table 4. Estimates of correlations between mature cow weight (MWT) and mature cow height (MHT).

	Sample 1			Sample 2		
	Genetic	PE	Residual	Genetic	PE	Residual
Correlations	0.80	0.75	0.15	0.83	0.69	0.18

PE: Permanent environmental effect.

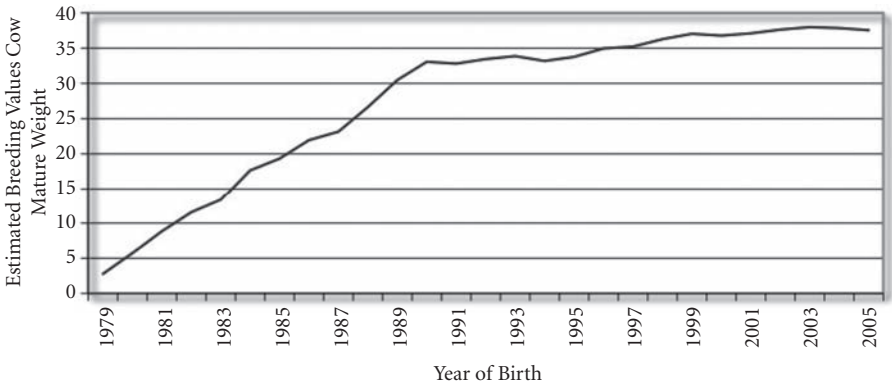

Figure 1. Genetic trend for cow weight (MWT).

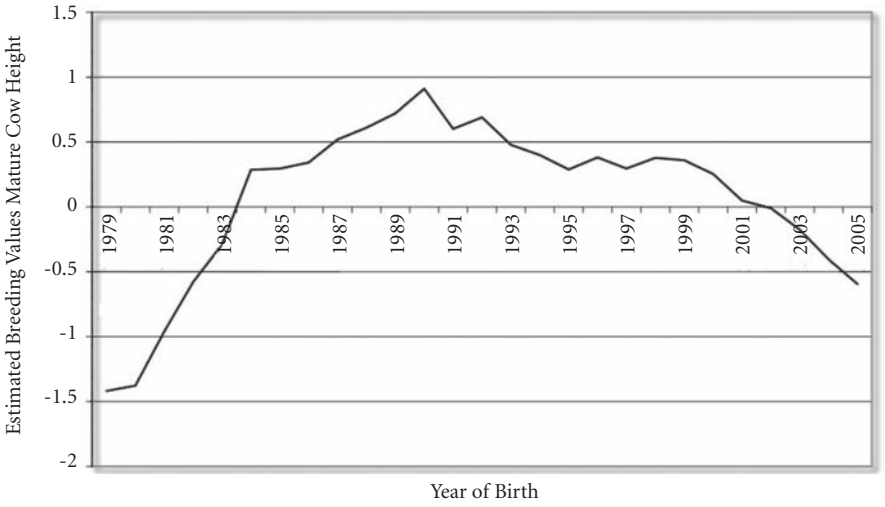

Figure 2. Genetic trend for cow height (MHT).

0.64 and 0.65 for MWT and 0.77 and 0.70 for MHT. Contemporary groups accounted for approximately 50% of phenotypic variance for both MWT and MHT.

Estimates of the genetic correlation between weight and height were strong and positive, ranging from 0.80 to 0.83. The permanent environmental correlations also were high, ranging from 0.69 to 0.75 (Table 4).

Changes in estimated breeding values (EBVs) by year of birth from the whole data file (about 238,000 records of 138,000 cows with a pedigree file of 308,000 animals) for mature weight and mature height are represented graphically in Figures 1 and 2. An EBV is equal to twice the animal's expected progeny difference (EPD). Birth years of cows with EBVs for MWT and MHT ranged from 1979 to 2006. Cows born prior to 1983 did not have a record themselves, but genetic merit was estimated using pedigree relationships and the performance of progeny. The MWT trend suggests that MWT has been increasing and recently has begun to plateau. During the ascending time (first 11 years), the regression coefficient for EBV/year was 5.54 lb/year, and after the apparent plateau, was 0.64 lb/year. For MHT, there was a positive trend throughout the first 13 years of the data and then a decline for the rest of the years represented in the analysis. The regression coefficient for the positive trend during the first 13 years was 0.082 in/year, and during the decline was -0.035 in/year.

Implications

Results from the current study, as expected, show that both MWT and MHT would respond favorably to selection and that changing one would lead to correlated response in the other. Selection would be more accurate for MHT than for MWT because heritability is greater and less variation is due to permanent environmental effects. The repeatability model used gave us more accurate results because permanent environmental effects were considered in the model. Ignoring permanent environmental effects in the case of repeated records can lead to overestimates of genetic parameters.

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