Genetic Evaluation for Birth Weight and First-Calf Calving Ease for the Angus Breed

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Summary

Expected Progeny Differences (EPDs) for birth weight and first-calf calving ease were estimated in a bivariate analysis. For both traits, a linear model was used where direct and maternal genetic effects were fitted. The data included 2,085,506 birth weight observations and 388,306 first-calf calving ease scores, and the relationship matrix included 2,817,490 animals. Correlations between breeding values for birth weight and first-calf calving ease were moderate to high. First-calf calving ease EPDs can give additional information to identify sires that cause calving difficulties.

Introduction

Although calving ease is scored for Angus cattle, currently no expected progeny differences (EPDs) are calculated. Breeders rely on birth weight EPDs to try to avoid problems with dystocia. As Table 1 shows, the proportion of calving ease scores 2 (some assistance) and 3 (much assistance) has declined steadily in calves from cows of all ages as well as in calves from heifers, particularly since 1990. An analysis in which sires were divided into nine birth weight EPD categories showed that 50% of the progeny of sires in the category with the lowest EPDs were heifer progeny whereas only 2.9% of the progeny of sires with the highest EPDs were heifer progeny. But there may be some interest in calving ease EPDs. Calving ease is considered a trait of the calf and, like weaning weight, can include a direct and a maternal component: First-calf calving ease direct - the ease with which a bull's calves are born to first-calf heifers; first-calf calving ease maternal - the ease with which a sire's daughters calve as first-calf heifers. Whereas traits like birth weight and weaning weight are continuous and are analyzed using a linear model, calving ease is a categorical variable that is scored subjectively on a scale from 1 (no assistance) to 5 (abnormal presentation). Analyzing such a variable with a linear model is considered not optimal. A theoretically better model would be the threshold model concept, especially if the heritability is high and the distribution of the categories is extreme. Simulation studies showed that ranking of sires in the linear model and in the threshold model is very similar and that extremely low calving-ease bulls can be identified in both models, especially if only calving ease scores from heifer progeny are used (BIF Guidelines). For this analysis, it was assumed that accurate breeding values for first-calf calving ease can be estimated in a bivariate linear model with birth weight where birth weight records of all calves and calving ease scores of heifer progeny only are used.

Material and Methods

Data

The data and pedigree files used for this analysis were provided by the American Angus Association (AAA) for the Spring 1998 Angus Sire Evaluation. Records with birth weights less than 40 pounds and more than 150 pounds were deleted. To have a less extreme distribution of calving ease scores, only scores 1, 2, and 3 for calves out of heifers were included. Scores for other calves and scores 4 (caesarian section) or 5 were deleted. Definition of contemporary groups was identical for both traits and included herd, year, season, and sex. Unlike in the routine birth weight evaluation, weaning lot date was not included in order to limit the number of calving ease scores in single-calf contemporary groups. After editing, the data included 2,083,506 animals with birth weight observations of which 376,077 animals also had a calving ease score (1: 87.9%, 2: 9.4%, 3: 2.7%). Sire and dam pedigree information was added from the pedigree file so that animals with a performance record had at least three ancestral generations considered, if available. The total number of animals in the analysis was 2,742,034. This number was slightly higher than the number of animals in the Spring 1998 Angus Sire Evaluation because fewer animals in single-calf contemporary groups had to be deleted.

Models

A computer program developed at Iowa State University, which solves the mixed-model equations by iteration on data and which is used for the routine sire evaluation, was modified so that direct and maternal genetic effects for both birth weight and first-calf calving ease could be estimated. Genetic parameters for the evaluation are shown in Table 2. They are based on estimates of variance components obtained in a series of analyses of smaller data sets. Compared to the model for the routine genetic evaluation, in this bivariate model a higher heritability for birth weight was used (.50 vs. .33), weaning lot date was dropped from the contemporary group definition, and a maternal genetic effect was included.

Results

The program was run on a DEC Alpha station 255/400 with 512 MB RAM and a clock speed of 400 MHz where one round of iteration took about 20 seconds of CPU time. The iteration was stopped when the sum of squared differences between solutions from the actual and the previous rounds divided by the sum of squared solutions from the actual round was considered sufficiently small (10^{-12}). The correlation between breeding values for birth weight from the Fall 1998 Angus Sire Evaluation and for direct birth weight from the bivariate analysis was .964. In preliminary studies with data for the Spring 1998 Angus Sire Evaluation, additional single-trait analyses were carried out with a heritability of .50 and (or) a contemporary group definition as applied in the bivariate analysis. Correlations between breeding values from these analyses (not presented) indicated that increasing the heritability from .30 to .50 most likely was the main reason for differences between breeding values for (direct) birth weight from the Fall 1998 Angus Sire Evaluation and the bivariate analysis.

Statistics for the breeding values for birth weight and first-calf calving ease from the bivariate analysis are shown in Table 3. Breeding values for direct birth weight and direct first-calf calving ease were highly positively correlated (Table 4), indicating that a calf with a large birth weight most likely is being born with some difficulty. The other correlations were moderate, ranging from -.47 to .58. A negative correlation between direct birth weight and maternal birth weight means that daughters of a sire born with a high birth weight likely will give birth to relatively small calves. The negative correlation between direct first-calf calving ease and maternal first-calf calving ease indicated that a sire's daughters born without major problems likely will have a tendency to have problems giving birth.

Based on the results of this evaluation and the development of the calving ease scores, it can be concluded that birth weight EPDs (or EPDs for direct birth weight if maternal genetic effects are fitted in the model) can be used successfully to control calving difficulties. EPDs for direct first-calf calving ease may be used to identify sires that cause calving difficulties although their direct birth weight EPD may be relatively low

Implications

Angus breeders have successfully managed calving ease problems by using low birth weight EPDs on first-calf heifers as evidenced by the trends presented in this report. This is good; however, it does complicate, and in fact biases, genetic evaluations for first-calf calving ease because the difficult-calving bulls just are not being used on heifers. Including all of the birth weight information in a multiple-trait model along with the first-calf calving ease score data helps overcome this bias to some extent, but the help is only as good as the genetic correlation estimates between birth weight (direct and maternal) and first-calf calving ease (direct and maternal). If the Angus Association decides to publish first-calf calving ease EPDs, breeders should be advised to continue to use the birth weight EPDs as the best indicator of calving ease, and secondarily, to use the direct and maternal first-calf calving ease EPDs. Breeders should use caution in using bulls on heifers whose first-calving ease EPDs are extreme outliers, or perhaps of a different sign (+ or -) than what the birth weight EPD would indicate they should be.

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Table 1. Calving ease scores (percentages) for calves from heifers and for calves from cows of all ages.

Birth year	Calving ease score					
	1		2		3	
	Heifers	All Ages	Heifers	All Ages	Heifers	All Ages
1972	90.0	97.9	10.0	2.1	-	0.0
1973	88.0	97.5	12.0	2.5	-	-
1974	86.6	97.1	13.4	2.9	-	0.0
1975	85.2	97.0	14.7	3.0	0.1	0.0
1976	85.9	97.4	14.0	2.6	0.1	0.0
1977	84.0	96.6	16.0	3.4	0.1	0.0
1978	84.5	96.9	15.3	3.1	0.2	0.0
1979	84.5	96.6	13.9	2.9	1.6	0.4
1980	84.3	96.5	12.2	2.7	3.6	0.8
1981	83.2	96.5	12.9	2.8	4.0	0.8
1982	81.3	95.9	13.7	3.1	5.0	1.0
1983	81.8	95.8	13.7	3.2	4.5	1.0
1984	83.2	95.9	12.7	3.1	4.1	1.0
1985	83.9	96.0	12.5	3.1	3.6	0.9
1986	84.0	96.3	12.5	3.0	3.6	0.8
1987	86.1	96.4	10.7	2.8	3.2	0.8
1988	84.7	96.1	11.5	3.0	3.8	1.0
1989	86.0	96.1	10.4	2.9	3.6	1.0
1990	86.6	96.5	10.0	2.7	3.4	0.9
1991	88.2	96.8	8.4	2.4	3.3	0.8
1992	89.7	97.1	7.4	2.1	2.9	0.8
1993	88.8	97.3	8.3	2.3	2.9	0.8
1994	90.1	97.3	7.5	2.1	2.4	0.6
1995	90.8	97.4	6.8	2.0	2.4	0.6
1996	91.3	97.6	6.6	1.9	2.2	0.6
1997	92.2	97.8	5.8	1.7	2.0	0.5

Table 2. Heritabilities (on the diagonal) and genetic correlations (above the diagonal) used for the genetic evaluation of birth weight and first-calf calving ease.

Trait	BW direct	BW maternal	CE direct	CE maternal
Birth weight direct	.50	-.22	.50	-.15
Birth weight maternal		.10	-.10	.20
Calving ease direct			.20	-.30
Calving ease maternal				.10

Table 3. Means, standard deviations, and range of breeding values for birth weight and first-calf calving ease.

Trait	Mean	SD	Low	High
Birth weight direct	5.99	5.65	-21.1	37.9
Birth weight maternal	-.49	1.38	-8.5	10.6
Calving ease direct	.04	.08	-.71	.63
Calving ease maternal	-.06	.04	-.28	.30

Table 4. Correlations between breeding values for birth weight and first-calf calving ease

Trait	BW maternal	CE direct	CE maternal
Birth weight direct	-.41	.88	-.44
Birth weight maternal		-.38	.58
Calving ease direct			-.44