Implementation of National Cattle Evaluation Programs for Growth and Maternal Traits

A.S. Leaflet R1534

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Summary

Beginning with the fall 1997 sire evaluation, Iowa State University will be responsible for the genetic evaluation not only of carcass traits but also of growth and maternal traits for the American Angus Association. National Cattle Evaluation Programs were implemented according to the guidelines of the Beef Improvement Federation. Expected Progeny Differences (EPDs) for birth weight, weaning weight, postweaning gain, and yearling height were estimated from several single-trait and multiple-trait animal models using computer programs developed at ISU. A test run was conducted using the data for the spring 1997 sire evaluation, and EPDs were compared to those estimated at the University of Georgia from the same data base.

Introduction

Although the genetic evaluation of carcass traits for the American Angus Association (AAA) has been conducted at Iowa State University (ISU) for several years, until recently the University of Georgia (UGA) was responsible for the genetic evaluation of growth and maternal traits. In 1996, the American Angus Association decided to move that part of its sire evaluation back to Iowa State University where it had been until the mid-eighties. The fall 1997 sire evaluation was scheduled to be the first one done at ISU.

Implementation

Implementation of the programs started in January 1997. To test the programs, AAA provided the raw data and the pedigree file used by UGA for the spring 1997 evaluation as well as the results from this evaluation. UGA provided information about the genetic models and parameters as well as the numbers of records going into the evaluation. Data were edited and Expected Progeny Differences (EPDs) were obtained according to the guidelines for National Cattle Evaluation Programs (Beef Improvement Federation, 1996).

Data Preparation and Editing

The data included records for birth weight, weaning weight, postweaning gain, and yearling height for calves born from 1972 to 1996. Weaning weight records had been adjusted to 205 d by the AAA. Observations for all traits were adjusted for sex, age of dam, and genetic group of the dam.

Contemporary groups were defined for each trait to group animals performing under similar conditions. For example, contemporary groups for weaning weight were determined by herd, year, sex, and weaning lot. To be useful in genetic evaluation, contemporary groups should have at least two animals. Therefore, records of animals in single-calf contemporary groups were deleted. Records were also deleted if they exceeded certain ranges.

The next step was to add sire and dam pedigree information from the AAA pedigree file to improve prediction accuracy. This pedigree file basically includes all Angus sires and dams that have ever been registered. Animals with a performance record had at least three ancestral generations considered, if available.

Although the same data were used, the numbers of observations that passed the edits were slightly different from the numbers provided by UGA. The reason was unknown because information about the edits applied at UGA was not available.

Models and Parameters

Three animal models were used for the evaluation. As was done at UGA, birth weight was analyzed with a single-trait model fitting contemporary group as fixed effect. A heritability of .33 was assumed. Whereas UGA analyzed weaning weight and postweaning gain separately with single-trait models, here they were analyzed together in a multiple-trait model. For both traits, contemporary group was included as a fixed effect. A simple animal model such as for birth weight was used for postweaning gain. The model for weaning weight additionally included maternal genetic effects and permanent environmental effects of the dam so that breeding values for direct and maternal weaning weight were estimated. For postweaning gain a heritability of .17 was assumed. The values used for weaning weight were .18 for the direct heritability, .14 for the maternal heritability, and .14 for the fraction of variance due to permanent maternal environmental effects. The correlation between direct and maternal effects was assumed to be zero as were all correlations between weaning weight and gain.

For yearling height a single-trait simple animal model was used including contemporary group as fixed effect and assuming a heritability of .50. UGA analyzed yearling height in a multiple-trait model with weaning weight and fitted direct and maternal genetic effects for both traits.

Computer Programs

Breeding values were estimated using either a single-trait or a multiple-trait version of a program by Northcutt et al. (1994). The program solves the mixed model equations by iteration on data (Schaeffer and Kennedy, 1985) and uses Gauss-Seidel for the fixed and the permanent environmental effects and second-order Jacobi for the genetic effects. Convergence criterion was the sum of the squared differences between solutions from the actual and the previous rounds divided by the sum of the squared solutions from the actual round. Programs were stopped if the convergence criterion was considered to be sufficiently small, i.e., less than 10^{-8}. Programs were run on a DEC Alpha station 255/300 with 512 MB RAM and a clock speed of 300 MHz. For example, one round of iteration in the two-trait analysis of weaning weight and postweaning gain with approximately 10,500,000 levels of fixed and random effects took about 55 seconds of CPU time.

Results

Because the genetic predictions of breeding values of animals are generally published as EPDs the breeding values obtained from the genetic evaluation were divided by 2. For all traits, EPDs agreed well with the EPDs estimated at UGA. Rank correlations were very high. As expected, they were greater for birth weight and direct and maternal weaning weight than for postweaning gain and yearling height. In general, EPDs had higher mean values and standard deviations than the EPDs estimated at UGA. The reason for this might be that in these analyses more iterations were carried out than in a routine evaluation. Monitoring mean values and standard deviations during the iteration process showed both quantities to increase for a relatively large number of iterations. However, after a certain number of iterations the ranking of animals is not expected to be affected considerably.

Fall 1997 Evaluation

Data

Data and pedigree files for the fall 1997 evaluation were provided by AAA in June 1997. The data file included 2,589,007 performance records of calves born from 1972 to 1996. Numbers of observations for birth weight and weaning weight, postweaning gain, and yearling height were 1,989440, 2,589,007, 1,260,765, and 180941, respectively. The pedigree file included 11,711,514 animals. Data were edited and prepared for the genetic evaluation as described above. Numbers of records that passed the edits and numbers of animals after adding pedigree information are in Table 1. Pedigree information for postweaning gain was not explicitly added because it was supposed to be analyzed in a multiple-trait model with weaning weight.

Genetic Evaluation

The same models and genetic parameters were used as for the test run described above. Computer programs were modified so that breeding values estimated in the test run could be used as starting values if available, thus considerably reducing the number of iterations necessary to reach a sufficient convergence level. Accuracies of breeding values were estimated based on an approach by Meyer (1989). Some modifications were made to make the approach more suitable for beef cattle where, due to limited use of artificial insemination, progeny of sires very are not distributed equally across herds.

Results

Means and standard deviations of EPDs adjusted to base year 1979 are given in Table 2. EPDs for yearling weight were calculated as EPD for direct weaning weight plus EPD for postweaning gain; EPDs for combined maternal value were calculated as one-half direct weaning weight plus maternal weaning weight. EPDs from the spring 1997 evaluation had been adjusted to base year 1977. Mean EPDs from the fall 1997 evaluation were greater than those from the spring 1997 evaluation. Therefore, EPDs were adjusted so that the average EPDs of animals born in 1979 were zero in order to make the transition of genetic evaluation from UGA to ISU as smooth as possible for the producers. Rank correlations between EPDs from the test run and the fall 1997 evaluation were very high for all traits. Some changes in EPDs were expected because more information was available due to the addition of data. However, changes were within the expected range.

Conclusions

National Cattle Evaluation Programs for genetic evaluation of growth and maternal traits for the American Angus Association were successfully implemented at Iowa State University. Ongoing research activities are directed towards upgrading the programs. These activities include variance component estimation for all traits currently being evaluated. Models for the genetic evaluation of calving ease are developed. Fixed effects adjustment factors are being researched as a part of the upgrading process.

References

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Table 1. National Cattle Evaluation for American Angus Association - Fall 1997.

Trait	No. of Records	No. of Animals
Birth weight	1,914,713	2,558,315
Weaning weight	2,530,585	3,251,214
Postweaning gain	1,236,474	-
Yearling height	171,662	349,422

Table 2. Expected progeny difference means, standard deviations, and range.

Trait	Mean	SD	Low	High
Birth wt, lb.	1.51	2.36	-9.9	14.1
Weaning direct, lb.	9.48	14.78	-55	71
Weaning (milk), lb.	3.84	6.76	-38	38
Combined maternal, lb.	8.58	12.70	-41	61
Yearling wt, lb.	16.34	25.66	-71	114
Yearling ht, in.	.34	.45	-3	3.1