COMPARISON OF DYSTOCIA EVALUATIONS FROM SIRE AND SIRE-MATERNAL GRANDSIRE THRESHOLD MODELS

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INTRODUCTION

Evaluations for calving ease (also known as dystocia) have been calculated in the US since 1977 (Berger, 1994). Initially, evaluations were from a best linear unbiased prediction (BLUP) sire model. In 1988, an ordered categorical analysis using a threshold model was implemented (Berger, 1994). The National Association of Animal Breeders (NAAB) has funded the research, data collection and calculation of calving ease evaluations. In 1999, calculation of the evaluations was moved from Iowa State University to the Animal Improvement Programs Laboratory. The goals of this shift were to integrate the data collection and processing with the national data for yield and pedigree, and to facilitate the development and implementation of a sire-maternal grandsire (MGS) model. Adding a MGS effect to the model is expected to improve accuracy by partially accounting for the genetic merit of the mates of the bull, and differences in the maternal ability of the dams. Ramirez-Valverde *et al.* (2001) found that a sire-MGS model gave similar accuracy to an animal model for sires with > 50 records. The purpose of this study was to determine the feasibility of a sire-MGS model applied to the large US data set and to quantify the differences in sire evaluations between the two models.

MATERIALS AND METHODS

Data. From the national calving ease data used in the August 2001 evaluation there were over 5 million birth score records which had both the sire and MGS identified, dam and sire breed of Holstein or Red and White, single birth, and birth 1980 or later. Frequencies of calving ease scores are in table 1. A total of 45,567 bulls were represented as either sire or MGS; of these, 4273 were only as sire, and 12,997 only as MGS. Data were from 27,524 herds.

Table 1. Frequency of calving ease scores.

Score	Frequency	Percent
1 – No Problem	3,780,000	75.2
2 – Slight Problem	561,546	11.2
3 – Needed Assistance	445,096	8.8
4 – Considerable Force	155,665	3.1
5 – Extreme Difficulty	85,838	1.2

Model. The sire model included herd-year, year-season, sex of calf, parity of dam, birth year group of sire, and sire. MGS and birth year group of MGS were added for the sire-MGS model. A separate category was assigned for each possible score. Herd-year, sire and MGS were random effects. Variance for herd-year was set to 10 percent of residual variance as in Weller *et al.* (1988). A residual variance of 1 was assumed as is customary for threshold models. The sire genetic variance was from a heritability of .16 (Berger, 1994). The maternal variance was assumed to be 40 percent of the direct genetic variance, and the correlation between them was assumed to be -.3 (Varona *et al.*, 1999). Following Bertrand and Benyshek (1987), these parameters were converted to a genetic (co)variance matrix:

$$\mathrm{Var}\begin{bmatrix}\text{sire}\\ \text{MGS}\end{bmatrix}=\begin{bmatrix}.046 & .013\\ .013 & .019\end{bmatrix}$$

For the sire model, the corresponding sire genetic variance was .042. The correlation between the sire and MGS effects is positive even with a negative direct-maternal correlation because of the larger correlation between the direct effects. The 2 seasons started in May and October. Years for herd-year, and year-season were defined as the 12 months starting in May. Berger (1994) had season, not year-season. The year was added to allow seasonal differences to change over time.

Computational method. A general threshold model program, cblup90iod, was used. This program originated from a general mixed-model program blupf90 (Misztal, 1999) with matrices stored in memory. The program, clup90iod, includes a conversion to the threshold model using the formulas of Hoeschele *et al.* (1995) by Benoit Auvray, and conversion to iteration on data by the preconditioned conjugate gradient algorithm (PCG) by Shogo Tsuruta. The PCG solver was easier to implement with iteration on data and faster to converge than Gauss-Seidel at the cost of higher memory requirements (Tsuruta *et al.,* 2000). The program, cblup90iod, supports correlated linear traits and thus could be used for joint analysis with birth weight, days open or other correlated traits. The thresholds: 0, 0.36, 1.0 and 1.51 were estimated in the sire model run and used for the sire-MGS model. Three Newton-Raphson (NR) iterations were completed for the analysis each model. For the sire-MGS model, the number of PCG iterations per NR iteration was limited to 30 in the first iteration. For the last two NR iterations, PCG iteration ended when the convergence criterion value was < $.1\times 10^{-9}$.

RESULTS AND DISCUSSION

Across three NR iterations, for the sire-MGS model, there were 191 PCG iterations that took about 30 hr. The sire model required only 142 PCG iterations. Correlations between the sire effects for groups of sires with different numbers of observations are in table 2.

Table 2. Correlations between sire solutions from sire and sire-MGS models.

Records per bull	Bulls	Correlation
no limit	45,567	.930
<50	34,067	.913
≥50	11,500	.957
≥500	1,319	.984
≥5000	181	.991

The correlations of over .9 show good agreement between the sire and sire-MGS model sire solutions. The correlation increases as the sires have more data. The MGS solutions from the sire-MGS model were somewhat less variable than the sire solutions and had a correlation of .557 with them for all bulls. For the 6,313 bulls with 50 or more records both as a sire and MGS, the correlation was .507. This correlation reflects the positive contribution from the direct genetic effect as a sire and MGS and the negative contribution from the -.3 correlation between direct effect as sire and maternal effect as sire of dam.

Table 3 provides the range in solutions for the effects in the sire-MGS model. The small ranges for sire and MGS birth year groupings show that they had little effect. Males were more difficult births by .19, and first parity more difficult than third or later parity by .38. Second parity births were more difficult than later parities by .014.

Table 3. Range in calving ease score effect solutions from sire-MGS model.

Effect	Levels	Range
Herd-year	136,114	3.26
Sex	2	.19
Parity	3	.38
Sire birth year group	12	.03
MGS birth year group	12	.03
Year-season	44	.23
Sire	45,567	1.36
MGS	45,567	.42

Implementation issues. These evaluations were limited to records with identified MGS. This requirement eliminated nearly half the data. For implementation, all records will be included. The unknown parent grouping that is commonly used in animal models is more complex in sire-MGS models where the MGS may be missing. This is equivalent in an animal model to the animal itself being missing, not its parent. The planned solution is to continue with the year of birth grouping for sire and MGS and use the missing value capability of cblup90iod and different MGS birth year groups when MGS is unknown. Assignment to these groups would be based on dam's birth year. The cblup90iod program allows for differential weighting of records. Those records missing MGS could be given a lower weight to reflect the transfer of MGS variance to residual. Another requirement for implementation is a measure of accuracy. The method currently used (Berger, 1994) will be adapted to work in the new system. Numbers of records and herds will also be reported. In addition to releasing the solutions for sires, the solutions for MGS could be provided for use in estimating total merit of cows. The current practice of reporting evaluations as probabilities of difficult births in first parity will be continued.

CONCLUSIONS

A sire-MGS model is feasible for the USA calving ease data set and provides similar sire evaluations to a sire model. The evaluations of the MGS provide information on the maternal contribution to calving ease and some correction for the merit of the mates of the sire, so should improve accuracy of evaluations. When the MGS is unknown, records can still contribute to solutions for sire, however, those records will not have the benefit of accounting for MGS.

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The general threshold model program, cblup90thr, which is an in-memory version of cblup90iod, is available online from the University of Georgia at:
http://nce.ads.uga.edu/~ignacy/newprograms.html.

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