Genetic evaluation of calving ease in Spanish Holstein population.

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Abstract

Calving ease is a trait which has incidence on the profitability of dairy herds. In the Basque country, a region of the north of Spain, calving ease data collection is being done since 1992 and a genetic evaluation of sires appears as a demand of dairy farmers in order to reduce the frequency of calving problems. The establishment of a routine genetic evaluation requires an initial study about which methodology should be chosen. Linear and threshold methodologies with a sire model have been applied to the same data. Estimates of heritability are 0.152, for the threshold model, and 0.028, for the linear model. This last result is lower than those observed by other authors using linear methodology. Pearson correlation (0.87) and Spearman correlation (0.66) between breeding values estimated with both methods are small. Spearman correlation reflects that rankings are quite different. For publication of proofs, estimated breeding values based on threshold sire model are expressed in standard deviation units and a minimum of 50 data per sire are required. Further research will focus on the following issues: improvement of the evaluation model, including in it a maternal genetic effect; implementation of an animal model; study of the influence of calving ease on days open; determination of relationships of calving ease with type traits and analysis of economic impact of calving ease in dairy herds.

1. Introduction.

Calving ease is a trait which has incidence on the reproductive and productive characteristics of the herd (Philipsson *et al*, 1976). Difficult calvings increase direct costs of the herd (veterinary fee, extra farmer labour needs and calf loss) and the indirect ones, related to higher culling rate and to the less animal welfare (Groen *et al*, 1995). Therefore estimation of the breeding values of sires for calving ease is an actual demand of the dairy farmers to artificial insemination centres.

The objective of the genetic evaluation is not, as in productive traits, the selection of genetically superior animals, but to classify the animals to avoid matings which could affect the calf viability and the posterior performance of the cows in the farm.

The present work compares the threshold and linear methodologies to choose one of them in order to establish a routine genetic evaluation of calving ease.

2. Material and methods

2.1. Data used

In the Basque country, a region of the north of Spain, calving ease data collection is being done since 1992. Data are collected at the same time that milk recording. The technician who monthly goes to the farm asks the farmer how the births have occurred since the last visit.

Calving ease is scored in 5 classes: 1= calving without any help; 2= calving with farmer assistance; 3= calving with veterinary assistance; 4= caesarean; 5= bad position of the calf.

Data used in this work were recorded between 1992 and 1995, both included. The total number of records was 61,621. There were removed all data in which there was any error in the information (insemination sire unknown, wrong number of parity, incorrect class of calving ease, improper age of cow, incorrect sex of calf, etc.). Records from multiple parities and data of calvings corresponding to the 5th class of calving ease (bad presentation of calf) were suppressed. All data of sires with less than 10 records were eliminated as well.

The 3rd and 4th classes of calving ease were grouped in one unique class, owing to their low incidence in the population compared to the two other classes and because these classes represent the real problematic calvings that farmers should avoid.

Edits resulted in a final data set of 31,548 records. Distribution of frequencies of each class of calving ease was as follows in Table 1. Pedigree information was composed by 182 sires with data and 186 pedigree sires.

Table 1. Frequency of each class of calving ease.

Class	Frequency (%)	Number of data
1	54.4	17,153
2	43.9	13,847
3+4	1.7	548

2.2. Model used

The model chosen to obtain genetic evaluation and to estimate variance components was a sire model, whose equation is:

$$\mathbf{y} = \mathbf{X}\,\mathbf{b} + \mathbf{Z}\,\mathbf{u} + \mathbf{e}$$

where:
- **y** is the vector of phenotypic values;
- **X** and **Z** are the incidence matrices of fixed effects and additive genetic effects, respectively;
- **b** is the fixed effects vector, which are:
  - herd-year of calving, with 2,849 levels;
  - month of calving, with 12 levels;
  - number of parity, in which there have been considered 2 levels (1st and later calvings);
  - sex of calf, with 2 levels;
- **u** is the additive genetic effect of the sire of calf (Jansen and Serra, 1992; Berger, 1994; McGuirk et al, 1995), whose distribution is a N(0,A σ_s^2), where A is the relationship matrix of the sires and σ_s^2, the sire variance;
- **e** is the residual effect, with a N(0,I σ_e^2) distribution, where I is the identity matrix and σ_e^2 the residual variance.

Environmental effects of significative influence on the determination of calving ease are usually related to the calving-season, the management of the animals, the age of the cow, the sex of the calf (Philipsson et al, 1976). Some authors mention the use of a herd-year-season fixed effect as management effect (Groen et al, 1995; Klassen et al, 1990), while other report the use of fixed herd-year (Averdunk et al, 1995; Berger, 1994; Manfredi et al, 1991b; Pedersen et al, 1995) and in some works this effect is considered as random herd-year-season (Djemali et al, 1987; Weller et al, 1988; Weller and Gianola, 1989). Calving season is reported as an effect which results from the grouping of year months (Berger, 1994; Berglund, 1996; McGuirk et al, 1995; Pedersen et al, 1995) or as month of calving effect (Averdunk et al, 1995; Manfredi et al, 1991b; Weller et al, 1988; Weller and Gianola, 1989). The cow age is included in the evaluation model in some cases (Averdunk et al, 1995; Berglund, 1996; Klassen et al, 1990; Manfredi et al, 1991b; Pedersen et al, 1995; Weller et al, 1988; Weller and Gianola, 1989) and also the parity of dam (Averdunk et al, 1995; Berger, 1994; Djemali et al, 1987; Klassen et al, 1990; Manfredi et al, 1991b; McGuirk et al, 1995). Sex of calf is an effect considered in all works.

Distribution of data by levels of fixed effects, except for the herd-year of calving effect, is shown in Table 2.

Table 2. Distribution of data by each level of fixed effects.

Fixed effect levels	Frequency (%)	Number of data
Month		
January	7.9	2,486
February	7.7	2,416
March	8.4	2,646
April	8.2	2,588
May	8.2	2,600
June	7.9	2,485
July	7.9	2,494
August	8.9	2,813
September	8.8	2,765
October	8.2	2,594
November	9.3	2,936
December	8.6	2,725
Parity		
first	21.6	6,830
later	78.4	24,718
Sex		
male	51.1	16,125
female	48.9	15,423

2.3. Statistical methods used for estimation of variance components and genetic evaluation

Literature generally reflects a better adequation of threshold model to the treatment of discrete and categorical traits (Gianola and Foulley, 1983; Djemali *et al*, 1987; Weller *et al*, 1988; Weller and Gianola, 1989; Manfredi *et al*, 1991a), but many countries use linear methods to work with calving ease trait (Averdunk et al, 1995; Berglund, 1996; Jansen and Serra, 1992; Pedersen *et al*, 1995; Wade, 1991). Present work uses both methodologies and compares them.

The software used in the estimation of variance components was CMMAT (Misztal *et al*, 1987), for the threshold model, and the software of Carabaño (1988), for the linear model. The first estimates variance components through REML methodology, using a Newton-Raphson algorithm, and the second uses a REML EM algorithm.

The genetic evaluation in the threshold model was obtained with CMMAT program as well. In case of the linear model, the genetic evaluation was made by PEST program (Groeneveld *et al*, 1990).

3. Results and discussion.

3.1. Signification of model effects.

All effects were found significative (p=0.0001) in a linear model, in which there were considered these fixed effects and the effect of sire as random effect, without including the pedigree information in the analysis, and R^2 of this model was 0.68 (PROC GLM of SAS, 1988).

3.2. Estimation of variance components.

Estimates of variance components are shown in Table 3.

Table 3. Estimates of variance components.

Model	σ_s^2	σ_e^2	h^2
linear	0.000768	0.108	0.028
threshold	0.0395	1.000	0.152

σ_s^2: genetic variance of sire
σ_e^2: residual variance
h^2: heritability

Heritability obtained with the linear model is lower than that obtained with the threshold model. Sire genetic variance from the linear model is likewise smaller than that from the threshold model, but these values are not comparable as they are based on different scales.

3.3. Correlations between estimated breeding values obtained with both methodologies.

Correlations between estimated breeding values obtained with both methods are shown in Table 4.

Table 4. Correlations between the genetic values obtainedwith threshold and linear model.

Pearson correlation	**Spearman correlation**
0.87	0.66

3.4. Discussion of results.

The higher value of heritability obtained with threshold methodology could be debt to the better adequation of threshold model to the analysis of this kind of traits (Gianola and Foulley, 1983; Weller *et al*, 1988). Other works show the same tendency (Weller *et al*, 1988, Weller and Gianola, 1989, Manfredi *et al*, 1991a). Besides, these heritability values from threshold model were situated among the limits offered by other authors (Berger, 1994; Djemali *et al*, 1987; McGuirk *et al*, 1995; Manfredi *et al*, 1991b). The heritability obtained with the linear model was smaller than those found in most other papers (Averdunk *et al*, 1995; Klassen *et al*, 1990; Pedersen *et al*, 1995; Weller *et al*, 1988).

The inclusion of a maternal genetic effect in the evaluation model would be convenient, in order to avoid a possible overestimation of the additive sire genetic effect (Manfredi *et al*, 1991a).

Another problem that could produce so poor estimates under the linear model is the subjective definition of classes of calving ease, where could exist any kind of confusion between the assignation of scores in some calvings (Manfredi *et al*, 1991a), especially to distinguish between the 1st and 2nd classes. These two first classes have moreover a high frequency in the population and many herd effect levels could have only one of these classes, which could not permit to estimate properly this effect (Djemali *et al*, 1987).

Result of rank correlation means that the ranking of sires will vary substantially depending on the method used for the genetic evaluation. These results of correlations are lower than those obtained by other authors, who find correlations near to one (Weller *et al*, 1988; Manfredi *et al*, 1991a).

3.5. Publication of proofs.

No decision has been made as how the results of the genetic evaluation should be presented. A proposal could be this one:
- A minimum of 50 data per sire should be required for the publication of sire proofs.
- Breeding values could be expressed in standard deviation units, as the results of the evaluation could be interpreted easier by the farmers.
- Sires with smaller values of calving ease could be used without any danger in heifers and sires with higher values should not be used in heifers.

4. Conclusions.

Threshold model appears as better in the analysis of calving ease, due to its higher estimate of heritability. But the low correlations observed between the linear model estimated breeding values and the threshold model ones, indicates that more efforts should be invested in the development of the model. For this reason, further research should be done to improve the model of evaluation, including in it a maternal genetic effect and implementing an animal model. Future works would be also the study of calving ease influence on days open, the determination of relationships with type traits and the estimation of economic impact of calving ease in dairy herds.

Monitoring of data collection is also an important aspect that should be taken into account in order to harmonise criteria of assignation of calving ease scores by farmers and technicians.

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References

Alday, S.; Ugarte E. and Ugarte, C. 1997. Evaluación genética de la facilidad de parto de los sementales de vacuno lechero frisón utilizados en la Comunidad autónoma del País Vasco. *VII Jornadas sobre Producción Animal de la Asociación interprofesional para el desarrollo agrario.* Vol. extra, nº18. Tomo I, pp. 333-335.

Averdunk, G.; Aumann, J.; Thaller, G. and Gierdziewicz, M. 1995. Sire evaluation for fertility and calving ease in Germany. *INTERBULL open meeting, Prague.*

Berger, P.J. 1994. Genetic prediction for calving ease in the United States: Data, models and use by the dairy industry. *J. Dairy Sci.* 77:1146-1153.

Berglund, B. 1996. Ongoing research on the causes of variation in calving performance and stillbirths in Swedish dairy cattle. *Proceedings International Workshop on Genetic Improvement of Functional Traits in Cattle. Gembloux, Belgium.*

Carabaño, M.J. 1988. *PhD. Thesis.* Cornell University N.Y.

Djemali, M.; Berger, P.J. and Freeman, A.E. 1987. Ordered categorical sire evaluation for dystocia in Holsteins. *J. Dairy Sci.* 70:2374-2384.

Gianola, D. and Foulley, J.L. 1983. Sire evaluation for ordered categorical data with a threshold model. *Gen. Sel. Evol.* 15(2), 201-224.

Groen, A.F.; Brandts, A.G.B.M.; Jansen, H.H. and Kenis, E. 1995. Economic value and genetic parameters for calving performance in Dutch dairy cattle breeding. *INTERBULL open meeting, Prague.*

Groeneveld, E.; Kovac, M. and Wang, T. 1990. PEST, a general purpose BLUP package for multivariate prediction and estimation. *Proceedings of 4th world congress on Genetics applied to Livestock Production, Edinburgh.* Vol. XIII, pp.488-491.

Jansen, G. and Serra, M. 1992. Valutazione genetica per la difficoltà al parto. *Bianco Nero* 1/92:20-21.

Klassen, D.J.; Cue, R.I. and Hayes, J.F. 1990. Estimation of repeatability of calving ease in Canadian Holsteins. *J. Dairy Sci.* 73:205-212.

Manfredi, E.; San Cristobal M. and Foulley, J.L. 1991a. Some factors affecting the estimation of genetic parameters for cattle dystocia under a threshold model. *Anim. Prod.* 53:151-156.

Manfredi, E.; Ducrocq V. and Foulley, J.L. 1991b. Genetic analysis of dystocia in dairy cattle. *J. Dairy Sci.* 74:1715-1723.

McGuirk, B.J.; Going, I. and Gilmour, A.R. 1995. The evaluation of Holstein Friesian sires for calving ease in the UK. *INTERBULL open meeting, Prague.*

Misztal, I.; Gianola, D. and Foulley, J.L. 1989. Computing aspects of a non-linear method of sire evaluation for categorical data. *J. Dairy Sci.* 72:1557-1568.

Pedersen, J.; Jensen, J. and Madsen, P. 1995. Evaluation of calving performance of Danish sires. *INTERBULL open meeting, Prague.*

Philipsson, J.; Foulley, J.L.; Lederer, J.; Liboriussen, T. and Osinga, A. 1979. Sire evaluation standards and breeding strategies for limiting dystocia and stillbirth. *Livest. Prod. Sci.* 6:111-127.

SAS. 1988. User’s guide. *Release 6.03 Edition. SAS Institute Inc.*

Wade, K. 1991. The two sides of calving ease. *Holstein Journal.* April, 56-57.

Weller, J.I.; Misztal, I.; Gianola, D. 1988. Genetic analysis of dystocia and calf mortality in Israeli-Holsteins by threshold and linear models. *J. Dairy Sci.* 71:2491-2501.

Weller, J.I. and Gianola, D. 1989. Models for genetic analysis of dystocia and calf mortality. *J. Dairy Sci.* 72:2633-2643.