

Estimating the Genetic Parameters for Calving Score using a Threshold Model, in Charolais Breed

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Abstract

The aim of this study was to determine the breeding value and heritability for calving score using a threshold model for calves from Charolaise breed. In this study were used records obtained from 2935 calves of Charolais breed from Romanian Breeding Association for Beef cattle. The mean for calving score was 1.35 ± 0.010 . The breeding values for calving score for calves were ranged between -0.2749 and 0.3606. The heritability for calving score was low 0.139. The threshold model was a method of analysis for categorical trait calving score.

Keywords: breeding value, cows, threshold model, calving score

1. Introduction

Calving ease is an important trait in beef cattle breed for health of calf and dam. This trait is correlated with birth weight. Calving difficulty has a great percentage in the first parity of cows. Charolais is a breed from France used for beef production, it had spread in many countries in the world. Charolais breed is characterized by body conformation of the meat type, robust constitution, very precocious, long life and better physiological balance than the other meat breeds, it has abundant muscle mass and less fat (Mirita et al., 1982) [1]. The body development of the Charolais breed is good, it is one of the large meat breeds [1]. Charolais is important for meat production, due the body weight and the good slaughter yield (60%) being suitable for breeding for a large carcass with abundant muscle mass. Due the good biological and production traits, the Charolais breed has spread in our country. In Romania the Breeding Program for Charolais breed had the

main objective the improvement of meat production and the improvement the reproductive and functional traits of the population. In our country for genetic evaluation of beef cattle for calving ease was used the maternal animal model. In Romania Charolais breed was used to crossbred with cows of mixed breeds in order to increase meat production. It is considered very good and can be used for improving the breeds for meat production [1]. Categorical traits can be inherited in a polygenic manner. On the liability scale are one or more threshold points [2]. Threshold models are more adequate for traits with 3 or 4 categories [2]. Threshold models were proposed by Gianola (1982) [3], Gianola and Foulley (1983) [4] and Harville and Mee (1984) [5] as method of analysis for categorical data. The threshold model was used in many studies to estimate the genetic parameters for calving ease (Vostry et al., 2004) [6], Jeyaruban et al. 2016 [7]. Other authors used for genetic evaluation of calving score linear models. The aim of this study was to estimate the breeding values and heritability for calving score in Charolais breed using a threshold model.

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2. Materials and methods

The data from 2935 Charolais calves obtained in the year 2021 were used in this study. The pedigree covered 6022 animals: 2935 calves, 194 bulls and 2893 dams. Calving ease can range from unassisted calving to very difficult calving. In our study we identified and reported three categories of calving: category one is unassisted calving; category two means assistance required; and category three means difficult calving. The model used is the threshold model developed by Grosu et al. [2] and described as follows:

$$\lambda_{ijkl} = f(t)_i + S_j + H_k + a_l + e_{ijkl}$$

where:

λ_{ijkl} = is unknown, underlying liability value for calf l , of sex j , in herd k ,
 $f(t)_i$ = is a function of the thresholds and probabilities of the calving score belonging to category i
 S_j = is a sex of calf effect,
 H_k = is a herd effect,
 a_l = is a calf additive genetic effect,
 e_{ijkl} = is a residual error effect.
 The model can be written in matrix notation as:

$$\lambda = F_t + X_b + Z_u + e$$

where:

λ = is the vector of unobserved liabilities of each animal,
 t = is the vector of $m-1$ thresholds,
 b = is the vector of fixed effects in the model
 u = is the vector of random effects, including random animal additive genetic effects
 e = is the vector of random residuals, assumed to have mean 0 and variance of 1,
 F = is a matrix of probabilities of an animal being in the various categories resulting in a function of the unknown thresholds,
 X, Z = are the usual design matrices of a linear model.

The model included the fixed effect: the sex and the herd. There are two sex categories: female and male. There were 164 farms. The fraction of animals in the first category (unassisted category) is 0.684=(2009/2935). The fraction of animals in the first two categories 0.961=(2821/2935) representing 2009 calves from category one and 812 calves from category two. In category three

(difficult calving) 114 calves were included. From the cows with difficult calving, 29 cows were in the first parity.

From 2935 calves, 1535 calves were females and 1400 were males. Calving score is a trait that it is not distributed normally because the phenotypic expressions have a maximum of 3-4 categories.

The average of birth weight of females calves was 39.82 kg and the average of males calves was 42.53 kg. All calves were born during the year 2021.

3. Results and discussion

The statistical data generated analyzing the calving score are presented in Table 1.

Table 1. The statistics for calving score

Descriptive statistics for calving score	
Mean	1.3543
Standard Error	0.0102
Median	1
Mode	1
Standard Deviation	0.5536
Sample Variance	0.3065
Kurtosis	0.6630
Skewness	1.2803
Range	2
Minimum	1
Maximum	3
Sum	3975
Count	2935
Confidence Level (95.0%)	0.0200

Data displayed in table 1 indicate a calving ease mean of 1.35 and a standard error of 0.01.

The average weight of calves born in the tested period was 41.11±0.110 kg (table 2).

Calving ease could be considered a trait influenced by the weight of the calf being born and is also considered a trait of the cow that is giving birth. The proportions of calves were 68.45% for score 1 (unassisted calving), 27.67% for score 2 (assisted calving) and 3.88% for score 3 (difficult calving). Tomka, 2018 [8] presented the main factors affecting calving difficulty include calf size, pelvic measures of the cow, their compatibility, breed, parity of the calving, sex of

the calf, gestation length and the season of the calving. Heavy birth weight determined problems at calving.

Table 2. The statistics for birth weight

Descriptive statistics for birth weight	
Mean	41.1144
Standard Error	0.1106
Median	40
Mode	40
Standard Deviation	5.9962
Sample Variance	35.9548
Kurtosis	0.5523
Skewness	0.3838
Range	51
Minimum	18
Maximum	69
Sum	120671
Count	2935
Confidence Level (95.0%)	0.2170

The pelvic area is smaller at the first-calf heifers. The abnormal fetal position at birth required the assistance at calving.

Table 3 indicate the breeding value for the best 10 calves for calving score. The calves with low breeding value are the best because the calves had score 1 at calving represented unassisted calving.

Table 3. The breeding value of the 10 best Charolais for calving score

No.	Breeding values for the best calves
1	-0.2749
2	-0.2515
3	-0.2515
4	-0.2440
5	-0.2415
6	-0.2335
7	-0.2335
8	-0.2335
9	-0.2335
10	-0.2335

Table 4 show the heritability for calving score. The heritability in our study is low. The heritability for calving ease is different in beef breeds. The heritability for calving ease from our

study was (0.139), ranged in the values obtained in literature.

Table 4. The heritability of Charolais population for calving score

Trait	h^2
Calving score	0.139

For Charolais breed the direct heritability was 0.13 and maternal heritability was 12 for calving difficulty score (Phocas and Laloë, 2004) [9]. Vostroy et al. (2014) [6] obtained the direct heritability for calving ease in Charolais breed with different models between 0.096 to 0.226 and maternal heritability between 0.060 to 0.104. Vinet et al., 2018, [10] obtained direct heritability for calving ease in Charolais herd was 0.129 lower than in study herein. Berg (1979) [11] showed that age of dam was an important factor in calving difficulty. Most of the problem was associated with 2 and 3 years - old heifers. Hudson et al., 1980, [12] reported that the predictions of the sire of calf effects for ease of calving are useful in assisting herd owners to reduce dystocia incidence.

Mujibi and Crews (2009) [13] reported the direct heritability for percent unassisted calving 0.14 and maternal heritability 0.06 for Charolais cattle. Low direct heritability was reported in Simmental cattle by Jamrozik and Miller, 2014 [14] and Allam et al. 2017 [15] in Holstein cows.

The introduction of gestation length and birth weight data into calving ease evaluation can be a tool for direct and accurate selection for reduced calving difficulty in beef cattle breeds [13]. Dekkers, 1993 [16] compared three breeding strategies for calving ease: separate selection of sire as mates of primiparous and multiparous cows, based on their respective optimal index for direct and maternal calving ease, the selection based on the optimal index for an average mate and selection on direct calving ease. Maximal economic response obtained by strategy two. The incidence of dystocia (mechanical assistance) in Charolais breed was 8% reported by Phocas and Laloë, [17] and 6,6% reported by Eriksson et al. [18]. Kotnik et al. (2009) [19] reported that in Charolais breed difficult calving occurred in 18.7%. Herring 1996 [20] reported that dam's age had an important effect on the incidence of dystocia and that birth weight of the calf was the

trait high correlated with calving difficulty, followed by sex of calf. This author [20] recommended the following practices: mate yearling heifers to low-risk bulls - proven artificial insemination sires whose progeny calve easily, unproven bulls whose own birth weights were low; feed pregnant females adequately, do not underfeed or overfeed, give first-calf 2 year-old heifers extra attention at calving time, known when and how to give assistance and when to consult a veterinarian, for long-term progress in a herd, select artificial insemination sires having above-average breeding values for daughters's first-calf calving ease.

Varona et al. [21] reported that the use of the threshold - linear model for genetic evaluation of calving difficulty seems justified in beef cattle.

Calving ease is a polygenic trait.

Purfield et al., 2020 [22] studied the genes associated with calving performance and this be used in genome mating programs to predict the dystocia event and minimize the risk event.

The reproduction traits are important economic traits in beef production. Calving ease has an important influence on the profitability of the farm. For genetic improvement of the calving ease must take into consideration all the factors affecting this trait. The mating systems are very important for improvement the calving ease trait. In practice it is necessary to identify the sire whose calves will be born without assistance. The improvement of reproduction traits as calving ease determined the increase of the profit of farmers.

Estimating breeding value of cattle for calving ease determine to rank cattle and select them for breeding program.

4. Conclusions

The calving score is an important economic trait in Charolais breed. The heritability of calving score was low in Charolais breed in our study. The threshold model was adequate model for estimation the genetic parameters and breeding value prediction for calving score in Charolais breed.

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