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Estimation of genetic parameters for calving interval in Charolaise and Limousine breeds

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ABSTRACT

The aim of the current study was to estimate the genetic parameters for calving interval in Charolaise and Limousine breeds based on individual animal model. The data were collected from Romanian Beef Cattle Breeders Association. The first calving interval was 383.21±6.34 for Charolaise breed and 372.607±5.31 for Limousine breed, with a total of animals of 237, 100 with records for Charolaise and 264 animals with 112 records for Limousine breed. The heritability for calving interval was 0.222 for Charolaise and 0.231 for Limousine breed, respectively. The breeding values of cattle for first calving interval range between -27.368 and 49.354 for Charolaise breed and between -27.256 and 40.747 for Limousine breed. The reproduction process increases the economic efficiency of Limousine beef production.

Keywords: calving interval, cows, individual animal model, genetic parameters

INTRODUCTION

The reproduction efficiency depends on fertility. The calving interval has important role due to it influence in annually number of calves born. In the national breeding program for Charolaise and Limousine breeds the reproduction traits represent important goals. In the Charolaise breed the average calving interval was 370 days being influenced by breed, individual, and the farm management

The Limousine breed is characterized by highly precocity, resistance, adaptability and a developed maternal instinct (Ciurescu E., 2020) whilethe Charolaise breed has an average precocity, and a good maternal ability. The calving interval depends by the fertility of cows. The fertility has an important role in beef production system, the number of calves born in the population depending on fertility (Jimenez *et al.*, 2023). The fertility has a great importance in herd profitability (Cesarani *et al.*, 2020). The nutrition of cow influenced the fertility. Also, the fertility is influenced by conformation of cattle and farm management. In order to produce healthy offspring, it is necessary to select for reproduction healthy animals to be parents (Rice, 1942). The calving interval can be considered an indicator of cow fertility (Cesarani *et al.*, 2020). To evaluate reproductive performance, age at first calving and calving interval are the traits recorded. The influential factors on calving interval studied in previous research were year of birth, previous calving date and age of dam (McGregor and Casey, 1998). Cesarani *et al.*, (2020) reported that multiple insemination needed for a new pregnancy induce longer calving interval and determinate an increase costs in herd. The calving interval depends by number of services per conception, days to first service- number of days between calving and first insemination date, days open- number of days between calving and conception date. For an optimal calving interval, it is necessary to assure animal health and welfare condition in farm, and a rational management of the breeding. The reproduction potential depends by de management systems implemented in farms (Notter and Johnson, 1988). The most favourable months for cow' fertility were November and December (Keown *et al.,* 1986). The farmers must assure different diets to each cattle category and made severally controls for pregnancy and calving phases. The reproductive performances can be improved by supplementation with Chromium-methionine (Khalili *et al.,* 2012). Fertility can be measured by the gestation rate which is the percentage of cows that remain pregnant in a given period of time. The gestation rate is the result of fecundity rate and conception rate. Increasing fecundity leads to increased earnings from calves, increased herd life, increased farm profits and increase the genetic gain. Currently, there are numerous systems for detecting the heat in cows. The efficiency of beef production system depends by the successful of reproduction (Dickerson, 1970). The individual animal model was performed in order to assess the genetic evaluation of cows' reproduction traits.

The objective of the current study was to estimate the genetic parameters for the first calving interval in Charolaise and Limousine breeds based on the individual animal model.

MATERIALS AND METHODS

The data for calving interval were collected from Romanian Beef Cattle Breeders Association. The pedigree contained 237 cattle: 98 dams, 39 sires and 100 cattle with records from Charolaise breed. In Limousine breed the pedigree contained 264 cattle: 112 dams, 40 sires and 112 cows with records.

The first calving of cows from both breeds was in the year 2020 and the second calving was in 2021. First calving interval was the interval represented by the days between the first and second calving. The fixed effect was represented by season of birth of cows.

The data were processing using individual animal model and R 3.5.1 software (script created by Grosu H., 2005):

The model is:

y=Xb+Za+e (X= the incidence matrices for fixed effects

Z= the incidence matrices for additive genetic effects

y= the vector of performances

b= the fixed effects' vector

a= the vector of the additive genetic effects of cows

e= the vector of error

The mixed model was:

$$\begin{pmatrix} X'X & X'Z \\ Z'Z & Z'Z + A^{-1}K \end{pmatrix} \begin{pmatrix} \tilde{b} \\ \hat{a} \end{pmatrix} = \begin{pmatrix} X'Y \\ Z'Y \end{pmatrix}$$

$$k = \frac{1 - h^2}{h^2}$$

The additive genetic variance and residual variances were estimated:

$$\sigma_e^2 = \frac{P'P - \tilde{b} * X' * P - \hat{a}' * ZP}{n - r(X)}$$

σ^2_e= residual variance

where r(x)= rank of matrix X [1]

$$\sigma_a^2 = \frac{\hat{a}' * A^{-1} * \hat{a} + \sigma_e^2 * tr(A^{-1} * C_{22})}{q}$$

σ^2_a= the additive genetic variance

where C_{22}=the sub-matrix to random effects in the system of equations:

$$C = \begin{bmatrix} X'X & X'Z \\ Z'X & Z'Z + A^{-1} * k \end{bmatrix}^{-1} = \begin{bmatrix} C_{11} & C_{12} \\ C_{21} & C_{22} \end{bmatrix}$$

The heritability' formula was:

$$h^2 = \frac{\sigma_a^2}{\sigma_a^2 + \sigma_e^2}$$

Where σ^2_a= the additive genetic variance

σ^2_e= residual variance

The relative breeding value is:

$$BV\% = 100 + 12 * \left(\frac{BV_{abs} - Average\ BV_{abs}}{\sigma_{BVabs}}\right)$$

BV% = relative breeding value
BV_{abs}= absolute breeding value
σ_{BVabs}= standard deviation of absolute breeding values

RESULTS AND DISCUSSION

Table 1 highlighted the statistics for calving interval in Charolaise breed.

Table 1. The statistics for reproduction traits in Charolaise and Limousine breeds

Trait	Mean±Standard error	The coefficient of variability
The first calving interval in Charolaise breed	383.21±6.341	16.549
The age at first calving in Charolaise breed	793.64±9.967	12.559
The first calving interval in Limousine breed	372.607±5.310	15.082
The age at first calving in Limousine breed	782.544 ±9.19	12.319

In our study the means for calving interval and age at the first calving were lower in Limousine breed than in Charolaise breed. The coefficient of variability was lower for age at the first calving in both breeds and moderate for the first calving interval in Charolaise and Limousine breed. In Charolaise breed the most prevalent calvings were performed in spring (between March and April) as well as in Limousine (April and May) but the calving continuous whole year. The means for calving interval from BLUP solutions, having as fixed effect season of birth in Charolaise breed were: 371. 889 for the cows calves in winter, 393.373 for the cows calves in spring, 369.318 for the cows calves in summer and 384.057 for cows calves in autumn, respectively. For Limousine breed the data analysed based on BLUP solution returns the following outcomes- 371.932 for the cows calves in winter, 377.463 in spring, 362.596 in summer and 374.517 for cows calves in autumn, respectively. Brzakova , (2020) found the average value for first calving interval 392.17 days in Charolaise breed and370.41 days in Aberdeen Angus breed. In the Limousine breed from Hungary the average calving interval was 378.8 days

(Bene, 2022), higher than in our study. Cortes *et al.,* (2015) reported an average of 418.1 days for calving interval in Asturiana de Los Valles beef cattle breed.

In Table 2 the highest breeding values were presented for the first calving interval associated to Charolaise breed. The breeding values for the calving interval recorded negative values because it is important to have a short calving interval in order to obtain a further pregnancy as soon as possible.

Table 2. The highest absolute breeding values for the cows in Charolaise breed

No	The absolute breeding values
1	-27.368
2	-22.670
3	-22.512
4	-22.512
5	-20.768
6	-20.293
7	-20.216
8	-19.613
9	-18.479
10	-18.390

The highest breeding values widely varied between -18.390 and-27.368.

In Table 3 were presented the highest relative breeding values in Charolaise breed.

Table 3. The highest relative breeding values for the cows in Charolaise breed

No	The relative breeding values
1	128.214
2	123.325
3	123.161
4	123.161
5	121.346
6	120.852
7	120.772
8	120144
9	118.964
10	118.872

The highest relative breeding values had values from 118.872 to 128.214 for the cattle in Charolaise breed.

In Table 4 were presented the highest absolute breeding values for the cows from Limousine breed.

Table 4. The highest absolute breeding values for the cattle in Limousine breed

No	The absolute breeding values
1	-27.256
2	-21.564
3	-18.769
4	-17.972
5	-17.472
6	-17.240
7	-17.159
8	-17.139
9	-16.011
10	-15.582

The highest absolute breeding values varied from -15.582 to -27.256 in Limousine breed. Bene *et al.*, (2022) reported the direct breeding values between -8.5 days and +4.7 days in Limousine.

In the Table 5 were presented the highest relative breeding values for the cattle in Limousine breed.

Table 5. The highest relative breeding values for the cattle in Limousine breed

No	The relative breeding values
1	131.617
2	124.898
3	121.599
4	120.658
5	120.068
6	119.794
7	119.698
8	119.674
9	118.343
10	117.837

The highest relative breeding values range between 117.837 and 131.717.

In Table 6 were presented the components of variance for first calving interval in Charolaise and Limousine breed.

Table 6. The components of variance for first calving interval

Trait	Additive variance	Residual variance	Phenotypic variance
The first calving interval in Charolaise breed	364.663	1278.894	1643.558
The first calving interval in Limousine breed	312.517	1038. 286	1350.803

By estimation the components of variance for the first calving trait observed the importance of genetic and environmental components of it. The phenotypic variance was generated by a significant percentage of residual variance 77.8% and 22.2% by additive variance in Charolaise breed and in Limousine breed the additive variance was 23.14% from the phenotypic variance and the residual variance represented 76.86% from the phenotypic variance. The calving interval was highly influenced by the environmental conditions. Brzakova *et al.*, (2020) reported the additive genetic variance in Charolaise breed of 85.909 and residual variance of 1035.6 in Charolaise and Aberdeen Angus breed the additive genetic variance was 93.225 and residual variance 1039.6. Bene *et al.*, (2022) reported the additive direct genetic variance 43.19 and residual variance 1371.93, the phenotypic variance 1419.38. Vesela *et al.*, (2013) found a genetic variance for calving interval of 871.9, the environmental error variance of 1355.8 and phenotypic variance of 2227.7.

Table 7 was highlighted the heritability values for the first calving interval in Charolaise and Limousine breeds.

Table 7. The heritability for first calving interval in Charolaise and Limousine breeds

Trait	The heritability
The first calving interval in Charolaise breed	0.222
The first calving interval in Limousine breed	0.231

The heritability for the first calving interval was higher in Limousine breed compared to Charolaise breed. Cesarani *et al.*, (2020) reported the value for heritability 0.09 in Italian Simmental breed. Bene *et al.*, (2022) evaluated the genetic parameters in Limousine population in Hungary. Gutierrez *et al.*, (2002) reported a 0.13 heritability for calving interval. The direct heritability reported by Bene *et al.*, (2022) for calving interval was low 0.03 and maternal heritability was 0.01 in the Limousine population. The heritability reported by Brzakova *et al.*, (2020) was 0.077 in Charolaise breed and 0.082 in Aberdeen Angus breed. The heritability obtained in our study was lower for Charolaise and higher for Limousine breed than the value obtained by Cortes *et al.*, (2015), 0.227 in Asturiana de Los Valles beef cattle breed. Olori *et al.*, (2002) considered that a combined analysis of calving interval and survival is adequate for evaluation genetic variation of fertility that is possible from calving dates. Gutierrez *et al.*, (2002) reported that age at the first calving is positive genetically correlated with the interval between subsequent calvings, the value of genetic correlation being 0.233.

Conclusion

The values of heritability for first calving interval in Charolaise and Limousine breed were moderate. The improvement the calving interval in Charolaise and Limousine breed by selection determines a high profitability of farms by increased number of calves obtained. By selecting the cows for first calving interval can improve the cows' fertility early.

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