

Analysis of Longevity in Romanian Spotted, Simmental Type Cattle Breed

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Abstract

The aim of this study was to estimate the genetic parameters for productive life in Romanian Spotted, Simmental type cattle breed using a survival model. The Weibull proportional hazard model was used in this study. The data of productive life of cattle were obtained from Romanian Breeding Association Romanian Spotted, Simmental type. The data consisted of records of 1064 Romanian Spotted, Simmental cows. The average productive longevity was 1020.9 days for Romanian Spotted, Simmental type cattle breed. The heritability values for productive longevity in this population was 0.097. The breeding values for productive longevity of cattle ranged from -0.827 to 0.478 months. Longevity is an important trait in breeding program.

Keywords: productive longevity, survival model, cattle

1. Introduction

The Romanian Spotted, type Simmental is a breed of cows with dual-purpose, for milk and meat. This breed has a high production of milk and meat. The productive life is the period between the first calving and culling. The longevity shows the genetic potential of the cows to have a long productive life. The factors that influence the productive longevity are: fertility, milk and meat production, the health and age, have shown Janzekovic et al., 2009 [1]. Also, the feeding, the management and the disease resistance influence the functional longevity. The Weibull proportional hazard model has been used to estimate the genetic parameters for longevity by many authors: Morek-Kopec and Zarnecki, 2017 [2], for Polish Simmental cattle, Jovanovac et al., 2013 [3], Raguz et al., 2014 [4] for Simmental populations.

The survival analysis was used in animal science, biology, medicine. The survival analysis was used to genetically evaluate the longevity of cows as well as dairy and beef cows. A long productive herd life determines the low costs of production. Longevity is important economic traits because reduces the cost of replacing cows. Perisic et al. 2009 [5] observed that Simmental breed was the second important breed in Europe after Holstein Friesian cattle. In Romania, the population of Romanian Spotted cows, type Simmental is about 376000 heads. The milk production of Romanian Spotted, Simmental cows ranges from 5000 to 5700 kg of milk. This breed has good qualities for meat production, the interest being to obtain a higher number of calves during the productive life. Many countries have the functional traits such as fertility, health and longevity in the breeding goal. A long productive life indicates a good care of the farmers for the cows. The longevity has a great importance in breeding program for Romanian Spotted, type Simmental, the improvement of this trait increases milk yield. The aim of this study was to estimate the genetic

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parameters for productive life in Romanian Spotted, Simmental type cattle breed using a survival model.

2. Materials and methods

The data of productive life of cattle were obtained from Romanian Breeding Association Romanian Spotted, Simmental type.

The pedigree data for Romanian Spotted, type Simmental population consisted of 1938 animals: 689 cows, 185 bulls and 1064 cows with performances. The data recorded were: date of birth of cows, date of first calving, the second and third calving, the date of milk test-day, the test-day milk yield. From the cows with performances, 686 cows (62% from total cows with performances) had censored data and 396 cows (38%) had uncensored data. Censored data were represented by the absence of age records at the time of culling, while uncensored data were accompanied by the age records at the time of culling. Data were collected between the years 2010-2016. The average of test-day milk yield in productive life of cattle was 18.66 kg. Milk production had 3 levels (high, medium and low) and the season effect comprised 4 levels. The average age at first calving was 29.73 months in Romanian Spotted, type Simmental cattle population. The length of productive life of cows in our study was measured in months.

Statistical analysis. The proportional hazard model was used with R software (done by Grosu, 2013 [6], 2019 [7]):

$$S_t = \exp^{-(\lambda t)^\rho}$$

where “ λ ” is the calculated scale parameter and “ ρ ” is the calculated shape parameter (Dorner 1999 [8]). The survival analysis on Romanian Spotted cattle resulted in $\lambda=0.0279$ and $\rho = 7.68$. The hazard function was expressed as follows:

$$h(t) = \rho\lambda(\lambda\rho)t^{\rho-1}$$

The risk factors were modelled as a linear model (Grosu et al. 2013 [6]):

$$\eta_i = X'_i * b + Z'_i * u$$

where “ b ” are fixed factors, and “ u ” are random factors.

$$S(t, \eta_i) = \exp^{-t^\rho} \exp^{\eta_i}$$

For $\eta = \rho \ln(\lambda)$, and

$$h(t, \eta_i) = \rho t^{\rho-1} \exp^{\eta_i} = h_0(t) \exp^{\eta_i}$$

where “ $h_0(t)$ ” describes the basic hazard function when

$$\eta = 0$$

$$\eta_i = X'_i * \hat{b} + Z'_i * \hat{u}$$

$$q_i = \exp^{\rho \ln(t)}$$

$$r_{ii} = q_i \exp^{\eta_i}$$

$$Y_i = w_i - q_i \exp^{\eta_i} + r_{ii} \eta_i$$

$w_i = 1$ for the uncensored dataset, while $w_i = 0$ for the censored dataset

The mixed model equations were:

$$\begin{pmatrix} X'RX & X'RZ \\ Z'RX & Z'RZ + G^{-1} \end{pmatrix} \begin{pmatrix} \hat{b} \\ \hat{u} \end{pmatrix} = \begin{pmatrix} X'y \\ Z'y \end{pmatrix}$$

where “ X ” includes X'_i , “ Z ” includes Z'_i , “ R ” describes the diagonal matrix, the diagonals are equal to r_{ii} , and y represents a vector of Y_i

$$\eta_i = b_j + h_k + a_i$$

b_j represents the fixed production effect
 h_k represents the random effect of season
 a_i is the genetic effect of cow.

3. Results and discussion

In the survival model in our study, the level of production was considered a fixed effect. The milk production had a significant effect on Romanian Spotted, type Simmental cows' longevity. Jovanovac et al. [3] reported the influence of milk production on longevity in Simmental cattle.

In the Romanian Spotted, Simmental breed population, the age at first calving was 29.73 months, the average daily milk yield in the first lactation was 18.66 kg milk.

The productive longevity in Romanian Spotted, type Simmental cows' population in our study was 1020.9 days. The value obtained in our study was lower than the value 1562.55 days obtained by Petrovic et al. [9] in the Simmental cows from Serbia, and Morek-Kopec and Zarnecki [2] in Polish Simmental breed, 1198 days for cows with

complete survival records and 1093 days for cows with censored data. The values for this trait in Romanian Spotted, Simmental type was higher than 985 days, the length of productive life obtained by Strapakova et al. [10] in Slovak Simmental. The age at first calving in Slovak Simmental was 930 days. The value obtained by us was lower than the value obtained by Raguz et al. [4] for length of productive life for Simmental cow, which was 2.88 years.

Heritability results

The heritability for longevity as productive life of Romanian Spotted cows' population was 0.097. The heritability for functional longevity in our study was within the ranges cited in another studies, which was generally low. Different heritability values for functional longevity have been reported by other authors in different cattle breeds. The heritability from our study was higher than the heritability obtained by Strapakova et al. [10] 0.05 in Slovak Simmental cows. The heritability obtained for Romanian Spotted, type Simmental was similarly with the heritability reported by Morek-Kopec et al. [2] (0.09) in Polish Simmental. Raguz et al. [4] estimated the heritability using linear and survival model. The heritability obtained in our study was higher than the value of heritability reported by Raguz et al. [4] 0.075 when was estimated with survival analysis and the value obtained with linear sire (0.037) and linear animal model (0.056) in Croatian Simmental. The heritability obtained by us was lower than the heritability obtained by Vukasinovic et al. [11] for functional longevity for Simmental from Switzerland 0.198.

Compared to our study, the heritability obtained for productive longevity was lower in other experiments in different breeds. For example, Stanojevic et al. [12] obtained the heritability for length of productive life 0.066 in Black and White cows from Serbia.

Wiebelitz et al. [13] reported lower values for longevity of 0.03-0.05 in German Holstein, Zavadilova and Stipkova [14] obtained 0.03-0.05 in Czech Holstein and Veerkamp et al. [15] obtained the value for heritability for functional longevity of 0.01-0.07 for British Holsteins.

The longevity heritability was different from one breed to another and from one population to another population in the same breed.

Breeding value

The breeding value for longevity in Romanian Spotted, Simmental type populations was estimated using the Best Linear Unbiased Prediction BLUP-Survival Animal Model.

The average breeding value for productive longevity in Romanian Spotted, Simmental type cows from our study was -0.080 months with a standard deviation of 0.228, ranging from a minimum of -0.827 and a maximum of 0.4786 months. The breeding values of the best 10 Romanian Spotted cows are shown in Table 1 and ranged from 0.4669 to 0.4786 months.

The breeding value for the best 10 sire Romanian Spotted, Simmental type ranged between 0.0832 and 0.8021 months, presented in Table 2.

The relative breeding values in Romanian Spotted sire for the best ten sire were presented in Table 3. The relative breeding value of the sire ranged from 24.6 to 156.98. The average relative breeding value of the sire in Romanian Spotted, Simmental type was 101.872.

The relative breeding value for longevity in Croatian Simmental bulls ranged from 67 to 165 and the average reliability of estimated breeding values was 0.49 have shown Jovanovac et al. [3].

Strapakova et al. [16] reported the breeding values for Slovak Simmental bulls ranged from -0.57 to 0.53 days. Relative breeding value of Slovak Simmental bulls ranged from 44.8 to 165.6.

Strapakova et al. [10] have shown that the breeding value of total bulls in Slovak Holstein population ranged from -0.78 to 0.8 days, highlighting the best 10 sires in herd with an average relative breeding value of 100 ± 12 .

Strapak et al. [17] estimated the correlation between longevity and functional longevity in Bavarian Simmental population and obtained a value was 0.69 and the correlation between fertility and functional longevity was 0.20.

Vukasinovic et al. [11] reported that the genetic evaluation of bulls for functional longevity of their daughters has been implemented in the population of Simmental from Switzerland.

Table 1. Longevity breeding values (months) for the best 10 Romanian Spotted, Simmental type

Number of the best cows	The breeding values
1	0.4786
2	0.4783
3	0.4765
4	0.4759
5	0.4758
6	0.4752
7	0.4751
8	0.4731
9	0.4701
10	0.4669

Table 2. Longevity breeding values (months) for the best 10 sire Romanian Spotted, Simmental type

Number of the best sire	The breeding values
1	0.8021
2	0.3570
3	0.3033
4	0.2448
5	0.1869
6	0.1810
7	0.1402
8	0.0985
9	0.0840
10	0.0832

Table 3. Longevity relative breeding values (months) for the best 10 sire Romanian Spotted, Simmental type

Number of the best sire	The relative breeding values
1	156.986
2	127.138
3	123.537
4	119.614
5	115.732
6	115.336
7	112.600
8	109.804
9	108.831
10	108.778

A great importance for milk yield and beef production had age at first calving. Oliveira et al. [18] reported that high proportions (>20%) of censored data had a negative impact on the genetic evaluation of longevity. Longevity influenced the

milk yield and beef production; the increase of longevity determined the increase of the average herd milk production. De Vries and Marcondes [19] reported that the average productive lifespan was 3 to 4 years in countries with high milk yield of dairy cows. The reasons for culling of cows were: problems with conformation, reproduction and health [6]. For increase the longevity was necessary the improvement of the environment, assuring a good housing and feeding. To improve the longevity of the cows the best cows must be inseminate with the best bulls to produce heifers. Al-Samurai et al. [20] have shown that the advantage of survival analysis was a better estimation of heritability value.

Smith and al. [21] have shown that the goals of survival analysis are: compare survival curves, elucidate the factors that influence survival and estimate their effects and estimate the future survival for an individual or for a population.

4. Conclusions

The genetic parameters were more precisely estimated by Weibull proportional hazard model. The heritability for functional longevity was low, this trait was difficult to improve. Longevity is a trait recommended to be included in cattle breeding programs in Romania.

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