RESEARCH ARTICLE Asian Journal of Dairy and Food Research, Volume 39 Issue 3: 207-211 (September 2020)

Analysis of Ewe Longevity and Lamb Survival in Teleorman Black Head Sheep

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10.18805/ajdfr.DR-164

ABSTRACT

Background: The aim of this paper was to estimate the genetic parameters for the longevity of ewes and lamb survival at 30 days in a Teleorman Black Head Sheep population.

Methods: Data was analysed with survival model.

Result: Mean length of productive life of ewes was 673.16 days. The heritability for longevity was 0.097 and for lambs' survival at 30 days was 0.098. The breeding value of the best sheep for longevity as productive life ranged from 0.081 months to 0.129 months and for the best lambs for survival at 30 days ranged from 0.041 days to 0.127 days. The results obtained in survival analysis are showing that the improvement of environmental conditions will increase longevity of ewes and survivability of lambs. Daily and careful monitoring of the health of sheep was performed. It was ensured administration of feed and water in a proper state of hygiene, a suckling and milking hygienic and a proper microclimate. Regarding the utility, longevity is a trait that is recommended to be used in local sheep breeding programs in Romania.

Key words: Breeding value, Heritability, Sheep, Survival model.

INTRODUCTION

The inclusion of longevity in selection indices offers the possibility to improve the ewe lifetime performance (Douhart *et al.,* 2016). Longevity is reflected as good health and long time welfare. The farmers select animals to be culled based on their health, productivity and reproductive performance. The average of productive life for a ewe is six years before it is culled. Longevity is a trait affected by genetics and environmental factors as well as by management decisions (Milerski *et al.,* 2018). Longevity is affected by environmental factors such as disease. For a longer production life, the sheep must to have a good health and disease resistance (Milerski *et al.,* 2018). The reasons for culling the ewes are: poor reproduction, low production, diseases susceptibility and physical problems. Improving longevity reduces replacement costs, implicitly production costs.

Teleorman Black Head Sheep breed is a Romanian local sheep breed with high prolificacy. Efficiency of lamb production is affected by ewe productivity, maternal ability of the ewe (milk production and pre-weaning weight gain of lamb), lamb growth after-weaning potential and survival traits (Dickerson, 1970). Improved ewe productivity is a major objective for the sheep industry and can be achieved by increasing the number of lambs successfully reared per ewe (Vatankhah and Talebi, 2009). In our study, the survivability of lambs between birth and 30 days was analysed. Factors such age and body weight of the dam, sex, birth weight of lamb, type of rearing system could affect the lamb mortality (Nash *et al.,* 1996; Vatankhah and Talebi, 2009; Vatankhah, 2013; Bangar *et al.,* 2016). A significant reduction in lamb mortality rate increases the profitability at farm level. Lamb mortality is a complex trait that is influenced by the ewe's maternal ability and the lamb's capability for survival (Vatankhah and Talebi, 2009). Improvement in survivability might be achieved by modifying the condition and suitable preparation for survival. The distinction between models of survival analysis and other models used for conventional evaluation of survival is that the time dependent factors and censored records may be included into the models of survival analysis (Borg, 2007).

The aim of this paper was to estimate the genetic parameters for the longevity of ewes and lamb survival at 30 days in Teleorman Black Head Sheep population.

MATERIALS AND METHODS

The study occurred in the National Research-Development Institute for Animal Biology and Nutrition experimental farm at Balotesti, Romania. The ewes were reared in semi-intensive farming system. The research activities were in

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How to cite this article: Pelmuş, R.Ş., Grosu, H., Rotar, M.C., Gras, M.A., Lazăr, C. and Popa, F. (2020). Analysis of Ewe Longevity and Lamb Survival in Teleorman Black Head Sheep. Asian Journal of Dairy and Food Research. 39(3): 207-211.

Submitted: 25-02-2020 **Accepted:** 10-08-2020 **Published:** 11-09-2020

accordance with Directive 2010/63 of European Union. The pedigree data consisted in 298 animals: 104 ewes, 40 rams and 154 ewes with performances. The ewes were identified in the herd at the start of the production year. Data on the reproductive and productive performances of ewes were recorded. The mean of age at first lambing was 801 days. Twenty ewes from 154 ewes had censored data. Censored data are represented by the absence of age records at the time of the culling and the uncensored data by presence of the records at the time of the culling. Sheep reformation was done because of reproduction, health, productivity and management issues. Data regarding the longevity of ewes were collected between the years 2000-2011. The mean of test-day milk production in productive life of ewes was 0.509 kg. Three levels (high, medium and low) of milk production and two levels of lambing season effect were considered.

The pedigree for study of lamb survival consisted of 205 animals: 107 lambs, 88 ewes and 10 rams. All animals were raised under similar environmental, nutritional and management conditions. Lambs were ear-tagged and weighed at lambing or within 24h of birth. Ewes and their lambs were placed in separate pens and kept for a few days after lambing. The lambs were weighed at birth and age of 30 day. Three levels (high, medium and low) of growth lamb production were considered. Lambs were allowed to suckle dams until weaning. The lambs' data collected in the year 2009 was used in this study. Ninety-four lambs from 107 lambs had censored data. Lamb mortality occurred due to of health and management issues.

Statistical analysis

Ewes and lambs survival data were analyzed with proportional hazard model with R software (done by Horia Grosu, 2013, 2019).

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

Where

The scale and shape parameters calculated (Dorner, 1999) were: λ=0.00167 and ρ=0.74 for ewes' survival analysis and λ=0.00075 and ρ=0.62 for lambs survival analysis.

The hazard function was:

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

The risk factors were modelled as a linear model (Grosu *et al.* 2013),

$$\eta_i = X_i' * b + Z_i' * u$$

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

$h_0(t)$= is the baseline hazard function where ewes (lambs) have no risks, $\eta = 0$

$$\eta_i = X_i' * \widehat{b} + Z_i' * \widehat{u}$$

$$q_i = \exp\rho\ln(t)$$

$$r_{ii} = q_i \exp^{\eta i}$$

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

w_i =1 for the record uncensored and w_i =0 for the record censored.

The mixed model-like equations was:

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

X contains the vector X_i', Z contains the vectors Z_i', R is a diagonal matrix with diagonals equal to r_{ii} and y is a vector of Y_i.

$$\eta i = b_j + h_k + a_i$$

b_j is the fixed level of production effect.

h_k is a random herd-season effect.

a_i is a random ewe additive genetic effect.

RESULTS AND DISCUSSION

Ewes' longevity was influenced by many non-genetic factors and as consequence improved management practice will improve longevity of ewes as productive life.

The fixed effects of survival model were the level production and season of lambing. The level of milk production had very significant effects for longevity of Teleorman Black Head Sheep. Season of lambing are not affecting longevity of Teleorman Black Head Sheep ewes.

Some authors reported the significant effect of different factors of longevity. Annet *et al.* (2011) reported that the factors affecting the chances of survival to the next mating were found to be breed, age at mating, score of body condition at weaning, number of missing teeth and average daily live weight gain per litter. The year of lambing, the parity, the age at first lambing had a significant effect of productive longevity (Getachew *et al.* 2015). Kern *et al.* (2010) studied the influence of different effects of productive life of ewes. The breed, the number of lambing, age at first lambing and farm had a significant effect of the studied trait.

About 12.9% of ewes had censored data. Mean of productive life of ewes with censored data was 247 days and for ewes with uncensored data was 738 days. Mean length of productive life for Teleorman Black Head Sheep ewes was 673.16 days.

Heritability

The heritability for ewe' longevity and lamb' survival at 30 days was estimated (Table 1). The heritability for longevity as productive life of Teleorman Black Head Sheep population was low 0.097 and lower than the values found by different authors. Fuerst–Waltl and Baumung (2009) reported the heritability 0.12 for functional longevity. Milerski *et al.* (2018) reported for Suffolk sheep the high heritability 0.438 for length of production life. Hatcher *et al.* (2009) reported that the heritability of survival in adult of Merino ewes, both within ages and cumulative was 0 at 2 years of age and increased to 0.13 at 5 years. The productive life of a domestic ewe reflects health, reproductive performance and their productivity (Byun *et al.* 2012).

The heritability for lamb survival at 30 days was 0.098 and lower than the heritability found by Barazandeh *et al*. (2012) and Welsh *et al.* (2006). These authors studied the

Table 1: Heritability of Teleorman Black Head Sheep ewes for longevity and lambs'survival at 30 days.

Traits	Heritability	Heritability from literature
Longevity of ewes	0.097	0.12 (Fuerst-Waltl and Baumung, 2009)
		0.438 (Milerski *et al*., 2018)
		0.13 (Hatcher *et al*., 2009)
Lambs' survival at 30 days	0.098	0.02 (Hatcher *et al*., 2010)
		0.23-0.29 (Barazandeh *et al*., 2012)
		0.106 (Welsh *et al*., 2006)
		0.002-0.13 (Getachew *et al.* 2015)

lamb survival across five periods from birth to 7, 14, 56, 70 and 90 day of age. Heritability for lamb survival from birth to 90 days of age in Kermani sheep varied from 0.23 to 0.29 using Weibull function Barazandeh *et al.* (2012). Welsh *et al.* (2006) obtained direct heritability for lamb survival using the threshold model 0.106 for Romney sheep. Direct heritability of lamb survival in different ages ranged from 0.02 to 0.13 in Ethiopian sheep breed Getachew *et al.* (2015), Lori-Bakhtiari breed Vatanhah and Talebi (2009), Australian Merino lambs Hatcher *et al.* (2010) and different breeds in USA Lima *et al*. (2019). The heritability for lambs' survival at 30 days from our study was higher than the heritability found by Hatcher *et al*. (2010) and Shariati *et al.* (2018). Hatcher *et al*. (2010) showed that the lambs survival rate was even lower in lambs of up to 30 (0.02) or 110 (0.027) days of age. Shariati *et al*. (2018) found direct heritability estimates for lamb survival 0.081.

Breeding value

The breeding value of the ewe survivability in the sheep population was estimated using BLUP (Best Linear Unbiased Prediction)-Survival Animal Model. The breeding values of the best 10 Teleorman Black Head Sheep were estimated (Table 2) and ranged from 0.081 month to 0.129 month. Low heritability made this trait difficult to improve, but importance and presence of variability made this trait a viable candidate for a future genomic assisted improvement program. Further studies on extended population are needed for capturing better the variability of the trait.

The breeding value for the lamb survival at 30 days for the best 15 lambs was estimated (Table 3) and ranged from 0.041 days at 0.127 days. Our estimation is more restrained than confidence interval bound of Southey *et al.* (2001) for birth to weaning interval in any scenario (Weibull, Cox and logistic sire models).

In our study the survival rate of lambs from birth to 30 days is 88%. Vatankhah (2013) obtained the survival rate in Lori-Bakhtiari lambs from birth to 1 month 96.34%. Bangar *et al.* (2016) observed that the lamb mortality in Decani breed sheep was 2.21%, 4.70% and 10.10% from birth to 1 month, birth to weaning and birth to 1 year respectively. Survival of female lambs was higher than for male lambs. The higher mortality in male lambs compared to females is in agreement with other studies Nash *et al.* (1996), Mukasa-Mugerva *et al.* (2000), Sawalha *et al*. (2007), Mandal *et al*. (2007). The survival rate of single born lambs was lower than twin born lamb up to 30 days of age. Lima *et al*. (2019) showed that the highest survival rate for Sangsari sheep was from birth to 100 days of age (98%) and that the survival rate of twin born lambs was lower than single born lambs up to 100 days of age. Southey *et al.* (2001) showed that the probability of survival of a lamb until day 10 of its life was 0.9 and to 50 day was 0.85. Kochewad *et al.* (2018) have shown the intensive and semi-intensive system of lambs rearing could be useful for mutton production. Azad *et al.* (2014) and Mohan *et al.* (2018) studied the genetic factors of rams for improving sheep production and fitness traits.

Table 2: Breeding values (months) of the best 10 Teleorman Black Head Sheep ewes for longevity.

No of the best ewes	Estimate breeding values for longevity
1	0.129
2	0.117
3	0.115
4	0.095
5	0.094
6	0.089
7	0.086
8	0.084
9	0.083
10	0.081

Table 3: Breeding values (days) of the best 15 lambs in Teleorman Black Head Sheep breed for survival from birth to 30 days.

No. of the best lambs	Estimate breeding value for lambs survival at 30 days
1	0.127
2	0.115
3	0.113
4	0.112
5	0.111
6	0.110
7	0.108
8	0.098
9	0.089
10	0.084
11	0.067
12	0.045
13	0.043
14	0.041
15	0.041

CONCLUSION

The heritability for longevity of sheep and for survival of lambs at 30 days in Teleorman Black Head Sheep breed were lows which means that this trait falls into the category of the traits difficult to improve. The results obtained in survival analysis are showing that improvement of environmental conditions will increase longevity of ewes and survivability of lambs. Regarding the utility, longevity is a trait that is recommended to be used in local sheep breeding programs in Romania. Low heritability made these traits difficult to improve, but importance and presence of variability made these traits viable candidates for a future genomic assisted improvement program.

ACKNOWLEDGEMENT

This work was supported by funds from the National Research Project ADER 8.1.10 granted by the Romanian Ministry of Agriculture and Rural Development and the National Research Development Project "Projects to finance excellence (PFE)-17/2018-2020" granted by the Romanian Ministry of Research and Innovation.

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