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ESTIMATION OF THE HERITABILITY FOR PRODUCTION AND REPRODUCTION TRAITS IN THE PALAS – PROLIFIC LINE SHEP, USING BLUP METHODOLOGY

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Abstract

The purpose of this study is to estimate the heritability in Palas - Prolific Line Sheep, for milk and prolificacy. This objective was undertaken applying the BLUP methodology, to a random regression animal model, for milk yield and, also, to an ordinary animal model for the number of offsprings/ewe/lambing. For milk yield, the data set consisted of 4610 test day records from the first lactation of 485 ewes, with records, sired about 97 rams. Totally, there were 1049 animals, including the ancestors. The fixed effect in the model were fixed lactation curves and flock-test-date. The random effects of animal and permanent environmental effects were modelled using orthogonal polynomials of order three. The curve of daily heritabilities for milk yields were 0.216, 0.133, 0.151, 0.219, 0.280, 0.314, 0.318, 0.292, 0.243, 0.199 and 0.210 for 50, 64, 78, 92, 106, 120, 134, 148, 162, 176, 190 days in milk. For the number of offsprings/ewe/lambing (prolificacy) the heritability was estimated using an animal model. The fixed effect was the year and season of lambing. Random effects was represented by animals. The heritability of prolificacy was 0.177.

***Key words**: animal model, heritability, Palas - Prolific Line Sheep, production and reproduction traits, random regression model.*

INTRODUCTION

The Best Linear Unbiased Prediction (BLUP) and animal model are widely used in the genetic evaluation of milk production traits in sheep. This method uses a statistical model that takes into account the relationships between animals and the genetic and environmental factors that affect milk production (Jurado et al., 2006).

The characteristics of dairy sheep with the greatest economic value are fecundity and milk production (Slavova et al., 2015). Sheep milk is highly nutritious and is an excellent source of protein, calcium, and vitamins. The profitability of the sheep is predicated on the rise in reproduction indices, irrespective of the type of exploitation technique used. The focus of the interest is mostly on fecundity, fertility, and prolificacy indices that are increasing. Because it results in an increase in the number of animals and meat production, intensifying prolificacy is a key goal in the exploitation of all sheep breeds (Bulmaga et al., 2021). Breeders begin by defining the traits they want to enhance in their population, gather data on the animals' performance and genetic relationships, identify the animals with the best genetic potential, determine the ratio of animals to be mated in order to achieve a specific genetic gain in the following generation (Blasco, 2022).

Animal breeding is founded on the idea that a parent's characteristics are more or less reflected in their offspring, which means that a parent's heritable ability to pass on an animal's characteristics to its offspring. In animal breeding, prospective parents are chosen based on specific characteristics, and the best ones are actually employed as parents (Oldenbroek & van der Waaij, 2014). Any breeding program that aims to improve the genetics of livestock must include the estimation of genetic parameters and the breeding value prediction of animals.

The purpose of this paper is to estimate the heritability for milk and prolificacy in Palas - Prolific Line Sheep. The importance of the heritability for any trait is evident in its being an assistant to the breeder in determining both the method of selection and the mating system to be followed, and that determining the expected genetic improvement depends partly on the estimation of the heritability.

MATERIALS AND METHODS

To estimate the heritability of the characters milk quantity and prolificacy, the data from a number of 485 sheep, descendants of a number of 170 fathers and 393 mothers, were used. The average size of the father's family was 2.85 demi-sisters.

For milk production, the phenotypic information was represented by the quantities of milk measured and recorded during the official performance control, in lactating ewes, after the lambs were weaned. In the analysis, only the first lactation, achieved by 485 ewes, in the period 1993-2001, was taken into account. The interval between two controllers was 14 days, and the total number of recorded performances was 4610 checks, with an average of 9.5 controller /sheep.

BLUP methodology was used to estimate heritability, applied to two separate biometric models. Thus, to estimate the heritability of the milk quantity, the test day model with random regressions (random regression test day model) was used, and to estimate the heritability for prolificacy, the individual animal model with repeatability (Repeatability animal Model) was used.

RESULTS AND DISCUSSIONS

Phenotypic structure of the analyzed population. Table 1 shows the average performances of the animals taken in the study, for the two analyzed characters.

Table 1. Average performances for daily milk yield and prolificacy for sample data analysed

Specification	Unit of measurement	n	$\bar{X} \pm s_{\bar{X}}$	Limits (min-max)
Daily Milk Yield	ml.	4610	441.74 ± 3.38	20-2000
Number of lamb/ewe	nr.	485	1.15 ± 0.016	1-2

From the data included in Table 1 it can be observed that the average daily milk production, during lactation after the lambs are weaned, is within normal limits, this being characteristic of a prolific sheep population with a good lactation capacity, Murphy (2016) found that the average daily milk production was within the normal range. This result is consistent with another study (Sutera et al., 2021).

Several studies indicated that there is a common effect of genetic and environmental factors on milk production in sheep, as Capistrak et al. (2002) indicated that environmental factors greatly affect the variation in season length and daily milk quantity, especially among members of the same breed, and this was confirmed by Oravcova et al. (2005), which indicated that 90% of the variation in milk production within a single breed is mainly due to environmental reasons and only 10% is due to genetic reasons, which means the need to involve as many environmental factors as possible or modify them while determining genetic effects, despite genetic control It depends on the factors that contribute directly or indirectly to the production of milk, but these factors are greatly affected by the level of protein in the diet as well as the number of feeding times, which means that there are differences in the amount of milk.

Also, the prolificacy of 115% shows the fact that for every one hundred ewes, a number of 115 lambs are obtained, which places the respective line in the group of populations with good prolificacy. Where the results of the study were observed through a study conducted on Polish sheep, Peter et al. (2017) found that the fertility was approximately 133.86%. Fertility was higher in another study, amounting to 1.52 (Hadeel et al., 2021). The prolificacy rate at birth was 1.15 live births/ewes, which is somewhat low, but the result is similar to what Jawasreh et al. (2010) reached in his study on Awassi sheep, and the rate obtained in the current study is within the range for the breeds of neighbouring regions and countries. The studies unanimously agreed that the reproductive characteristics in sheep (including prolificacy) are complex characteristics and have a low heritability coefficient and are affected by a number of genes. Responsible for the degree of prolificacy changes according to the season, type of nutrition, health status and sex ratio (Jafari et al., 2014).

Genetic structure of the analyzed population. The causal components of the phenotypic, genotypic and environmental variance for each analyzed character are presented in Table 2.

The amount of phenotypic and genetic variation estimated for daily milk production in this study was 2080 and 582, while the remainder that reflects the environmental influences that were not included in the mathematical model amounted to 1498 (Table 2). The high phenotypic variation (sum or sum of genetic and environmental variation) is attributed to the high milk production It is one of the quantitative characteristics of great variation because it is affected by many environmental factors, whether temporary, such as nutrition, temperature, humidity, or fixed factors such as the type of birth, sex of the newborn, season and year of birth, as well as the breed, as well as the number of records or observations that have been approved.

Table 2 shows that the percentage of phenotypic and genetic variation estimated for the prolificacy rate or the number of lambs produced per ewe in this study amounted to 0.119 and 0.021, respectively, which are low estimates (despite its importance) given that this characteristic originally had small rates as well as The low prolificacy rate in this study, which amounted to 1.15 births / ewe, and the estimated variations will reflect or determine the heritability of the trait, as will be shown in the subsequent tables (Tables 3 and 4).

These variance components provide important information on the sources of variation for these traits. The genotypic variance indicates the potential for genetic improvement through selective breeding, while the residual variance can be used to identify areas for improvement in management practices or measurement techniques. Understanding these variance components can help farmers and researchers to develop more effective strategies for improving these performance measures.

Based on the causal components of the variance, the heritabilities of the two analyzed characters were estimated, according to the data in Table 3.

Table 2. Variance causal components for daily milk yield and prolificacy for sample data analised

Specification	Variances		
	Phenotypic (V_P)	Genotypic (V_A)	Residual (V_E)
Daily Milk Yield	2080	582	1498
Number of lamb/ewe	0.119	0.021	0.098

Table 3. The heritability values for daily milk yield and prolificacy

Specification	n	$h^2 \pm s_{h^2}$
Daily Milk Yield	4610	0.280 ± 0.25
Number of lamb/ewe	485	0.177 ± 0.16

It is evident from Table 3 the estimates of the heritability for the two traits studied, and the heritability of daily milk production was 0.28, and this estimate is considered average, but it is considered the upper limit of the majority of previous studies, meaning that there is an important genetic variation in milk production, and therefore it is possible to improve this trait In several ways, if the selection was based on the fact that there is an important genetic variation and that it is one of the traits that are affected by a large number of genes, or by improving the environmental conditions, given that there is a wide variation of up to 0.72, as well as the possibility of improving this trait by cross-crossing with specialized purebreds, This result can be compared with previous studies in the Czech Republic, Bauer et al. (2012)

conducted research on Lacaune and East Friesian ewes using a data collection comparable in size to the Quebec population. They discovered that milk production had a heritability of 0.28. The heritability of daily milk yield was low in a study of Slovakian Lacaune sheep, amounting to 0.15 (Oravcova, 2007). Another study on Awassi had low heritability of daily milk production 0.11 (Al-Dabbagh, 2011).

The estimate of the heritability for the prolificacy in this study was 0.177, and the trait of prolificacy is one of the traits with a very low heritability (0.02-0.05), the result in this study is higher when compared with most studies, Schaeffer & Szkotnicki (2015) noted through their genetic evaluation of sheep in Canada they found that the heritability of prolific is 0.14. This indicates the heritability value is low for prolificacy. The percentage of prolificacy were: 0.30 (Hadeel et al., 2021). The research was carried out on Polish Merino ewes heritability values indicate that the influence of genetic assumptions on ewe fertility is low 0.104 ± 0.024 (Piwczynski and Kowaliskyn, 2013). In a comparative study between the percentage of twins for the ewes of the Iraqi Awassi and the Turkish Awassi under the conditions of the research station, the researchers Ishaq and Ajeel (2013) found that the percentage was 17.42% for the local Awassi and 22.5% for the Turkish Awassi. Therefore, it can be used in genetic improvement programs.

Estimates of the heritability of the same trait differ from one study to another depending on the sample size, the method of estimation, the mathematical model, the place and time of conducting the study, and whether or not to test the matrix of variance components.

Additive genetic and permanent environmental variances, as well as associated heritabilities, for lactation days, 50, 64, 78, 92, 106, 120, 134, 148, 162, 176, 190 days, are presented in Table 4.

Table 4. Additive genetic, permanent environmental variances and associated heritabilities for 50, 64, 78, 92, 106, 120, 134, 148, 162, 176, 190 test days

Variance	Lactation day										
	50	64	78	92	106	120	134	148	162	176	190
V_A	0.074	0.036	0.040	0.062	0.085	0.100	0.100	0.088	0.069	0.056	0.067
V_{per}	0.067	0.037	0.024	0.020	0.019	0.018	0.015	0.013	0.015	0.025	0.053
h^2	0.216	0.133	0.151	0.219	0.280	0.314	0.318	0.292	0.243	0.199	0.210

Table 4 shows the data pertains to the variance in daily milk yield across different days of lactation, as well as estimates of the additive genetic variance (V_A) permanent environmental variance (V_{per}) and heritability (h^2) for each day of lactation. The values (V_A) of and (V_{per}) represent the proportion of variance in milk yield that is due to additive genetic effects and permanent environmental effects, respectively.

The heritability (h^2) is the proportion of the total variance in milk yield that is due to genetic factors and it ranges from 0 to 1.

The values of (V_A) (V_{per}) and h^2 vary across different days of lactation, which suggests that the genetic and environmental factors influencing milk yield may change as lactation progresses. In general, the heritability estimates are moderate to high, with values ranging from 0.133 to 0.318, for lactation days 64 to 134, then it begins to decrease. This indicates that genetic factors play a significant role in determining milk yield in this population. The genetic variances are bigger in the middle of lactation and smaller at the end of the lactation. Other studies confirmed this (Sutera et al., 2021; Popa et al., 2020). Because the genetic variances and the heritabilities associate are high in the middle of the lactation, we can conclude that the number of test days per ewe could be reduced in order to take into account only those that could give high genetic progress.

CONCLUSIONS

Heritability plays a significant role in the milk production and prolific of dairy animals. Milk production has moderate to high heritability, which means that offspring of high-yielding sheep are more likely to produce high amounts of milk.

The heritability is the main genetic parameters used for prediction the breeding values and genetic progress. In the present study, milk yield trait had an intermediate value for heritability, for the whole lactation (0.28), but varied between 0.151 and 0.318, depending the stage of lactation. Because the high values of heritability is in the middle of the lactation, in order to maximize the genetic progress we can reduce the number of test days, only those taken in the middle of lactation.

Fertility have lower heritability, meaning that genetic factors have less influence on these traits than environmental factors.

Dairy farmers can select animals with high milk production and fertility to breed, which can lead to improved genetics in the offspring.

The best model for evaluating the genetics of milk output in sheep is the random regression model, which also allows for selection of lactation curves with high persistency while minimizing costs and improving estimations of breeding value.

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