MULTIVARIATE ANIMAL MODEL USED TO ESTIMATE THE BREEDING VALUES FOR WEIGHT GAINS TRAITS IN SHEEP

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Abstract

The aim of the present study was to estimate the genetic and phenotypic parameters for growth gains traits and the breeding values of Teleorman Black Head lambs. The biological material consisted of 162 lambs with performances. The traits of interest were the weight gain from birth to 30 days and the weight gain from birth to 60 days. The variance components were estimated using the multivariate animal model by Restricted Maximum Likelihood method. The heritability estimates for the weight gain from birth to 30 days and weight gain from birth to 60 days were 0.60 and 0.83 respectively. The correlations between traits were positive and medium. The greater heritability of the traits studied in the present paper and the medium correlation between traits suggested that animals may be selected at an early age. The estimated breeding value predicts the breeding potential of the recorded animals.

Key words: sheep, genetic parameters, multivariate animal model

INTRODUCTION

Meat production in sheep depends on ewe reproduction performance, lamb survival and growth traits. In order to increase the meat production in sheep must improve the growth potential of the lambs.

Selection of sheep is based on a combination of several traits of economic importance that may be phenotypically and genetically related. The main advantages of multivariate Best Linear Unbiased Prediction (MBLUP) is that it increases the accuracy of evaluations. The gain in accuracy is dependent on the absolute difference between the genetic and residual correlations between the traits. Traits with lower heritability benefit more when analysed with traits with higher heritability in a multivariate analysis. A multi-trait analysis on weaning and yearling weight can eliminate this selection bias due to culling. Many authors used a multivariate animal model to determine the genetic parameters in sheep [1], [2], [3], [4].

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MATERIAL AND METHOD

The 162 records for the gain weight from birth to 30 days and 162 records for the gain weight from birth to 60 days for Teleorman Black Head lambs from National Research-Development Institute for Animal Biology and Nutrition, Balotești were used in this study. The suckling period lasted 60 days.

The model for a multivariate analysis resembles a stack of the univariate models for each of the traits. Consider a multivariate analysis for two traits, with the model for each trait of the form given [5]. In this study the fixed part of the model includes the sex effects levels of lambs:

$$y_1=X_1b_1+Z_1a_1+e_1$$

for trait 1 and for trait 2,

$$y_2=X_2b_2+Z_2a_2+e_2$$

If animals are ordered within traits, the model for the multivariate analysis could be written as:

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} X_1 & 0 \\ 0 & X_2 \end{bmatrix} \begin{bmatrix} b_1 \\ b_2 \end{bmatrix} + \begin{bmatrix} Z_1 & 0 \\ 0 & Z_2 \end{bmatrix} \begin{bmatrix} a_1 \\ a_2 \end{bmatrix} + \begin{bmatrix} e_1 \\ e_2 \end{bmatrix}$$

Where
y_i=vector of observations for the i^{th} trait
b_i=vector of fixed effects for the i^{th} trait
a_i=vector of random animal effects for the i^{th} trait
X_i and Z_i are incidence matrices relating records of the i^{th} trait to fixed and random animal effects respectively

It is assumed that:

$$var\begin{bmatrix}a_1\\a_2\\e_1\\e_2\end{bmatrix}=\begin{bmatrix}g_{11}A & g_{12}A & 0 & 0\\g_{21}A & g_{22}\,A & 0 & 0\\0 & 0 & r_{11} & r_{12}\\0 & 0 & r_{21} & r_{22}\end{bmatrix}$$

where:
G = additive genetic variance and covariance matrix for animal effect with each element defined as below
g_{11}= additive genetic variance for direct effects for trait 1
g_{12} = g_{21}=additive genetic covariance between both traits
g_{22} = additive genetic variance for direct effects for trait 2
R = variance and covariance matrix for residual effects

The mixed model equations are:

$$\begin{bmatrix}X'R^{-1}X & X'R^{-1}Z'\\Z'R^{-1}X & Z'R^{-1}Z+A^{-1}G^{-1}\end{bmatrix}\begin{bmatrix}\hat{b}\\\hat{a}\end{bmatrix}=\begin{bmatrix}X'R'y\\Z'R^{-1}y\end{bmatrix}$$

where:

$$X=\begin{bmatrix}X_1 & 0\\0 & X_2\end{bmatrix}, Z=\begin{bmatrix}Z_1 & 0\\0 & Z_2\end{bmatrix}, \hat{b}=\begin{bmatrix}\hat{b}_1\\\hat{b}_2\end{bmatrix},$$

$$\hat{a}=\begin{bmatrix}\hat{a}_1\\\hat{a}_2\end{bmatrix}, \text{and } y=\begin{bmatrix}y1\\y2\end{bmatrix}$$

RESULTS AND DISCUSSION

Table 1 shows the mean of the weight gain from birth to 30 days and the weight gain from birth to 60 days. The mean for the weight gain from birth to 30 days for males was higher than in females but the weight gain from birth to 60 days was lower than in females. The results indicate that growth traits are influenced by environmental factors. Table 2 gives the breeding values from the best 15 animals for weight gain from birth to 30 days and the breeding values for the weight gain from birth to 60 days. The animals with a higher breeding value for the weight gain will produce lambs which will be heavier. The variance components and heritability for the studied traits are given in table 3. The heritability for the weight gain from birth to 30 days and for the weight gain from birth to 60 days (weaning) were higher, of 0.60 and 0.80 respectively, than the heritability obtained by [6] for weight gain from birth to weaning, which was 0.36. The heritability estimated for pre-weaning average daily gain and post weaning average daily gain by [7] was 0.08 and 0.1. [8] reported that the direct heritability of pre-weaning gain and post – weaning gain varied between 0.12 and 0.19.

The genetic, environmental and phenotypic correlations between traits are presented in Table 4. All correlations between the weight gain from birth to 30 days and the weight gain from birth to 60 days were positive and medium.

The estimates of direct genetic correlation between pre-weaning gain and post– weaning gain obtained by [8] were positive and varied between 0.54 and 0.74.

Multi-trait estimates are supposed to be more efficient as they take into account correlations between traits.

The greater heritability of the traits studied in the present study and the medium correlation between traits suggested that animals may be selected at an early age.

Table 1 Mean and standard error mean for the weight gain from birth to 30 days and the weight gain from birth to 60 days

Sex	Mean for the weight gain from birth to 30 days	Mean for the weight gain from birth to 60 days
Male (n=90)	7.79±0.29	12.62±0.43
Female (n=72)	6.86±0.29	14.02±0.14

Table 2 The breeding value for the weight gain of the best Teleorman Black Head lambs from our study

No.	Breeding value for the weight gain from birth to 30 days	Breeding value for the weight gain from birth to 60 days
1	3.60	10.32
2	3.17	9.14
3	2.95	9.09
4	2.94	8.84
5	2.88	8.33
6	2.36	8.20
7	2.35	7.22
8	2.34	6.58
9	2.30	6.21
10	2.30	5.37
11	2.29	4.78
12	2.17	4.31
13	2.10	4.20
14	1.99	4.16
15	1.96	3.74

Table 3 Estimates of variance components and heritability for studied traits

Traits	σ^2_a	σ^2_e	σ^2_p	h^2
Weight gain from birth to 30 days	5.42	3.56	8.98	0.60
Weight gain from birth to 60 days	15.25	2.99	18.24	0.83

Table 4 Estimate of genetic, environmental and phenotypic correlations between studied traits

Traits	r_g	r_e	r_p
Weight gain from birth to 30 days and weight gain from birth to 60 days	0.65	0.52	0.59

CONCLUSIONS

The estimates of heritability for the studied traits were high and increased with lamb's age. The genetic correlation between the studied traits was positive and moderate. The application of genetic selection programs based on estimated breeding value can improve the growth traits of the lambs.

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