ENVIRONMENTAL FACTORS AFFECTING PERFORMANCE TRAITS IN LATVIAN SHEEP POPULATION

Anita Puste[1], Daina Kairiša[1], Rita Sarma[2]
[1]Latvia University of Agriculture
[2]State agency 'Agricultural Data Centre'
Anita.Puste@ldc.gov.lv

Abstract

This study investigates different environmental effects on birth weight, weaning weight, and pre-weaning daily gain using different statistical models in the Latvian sheep population. The coefficients of determination (R^2) were used to estimate the extent of different non-genetic factors influencing birth weight, weaning weight, and pre-weaning daily gain. Data were collected of 4460 lambs born in 36 herds during 2008 to 2010. The birth weight (on average 4.1 ± 0.01 kg), weaning weight (on average 21.0 ± 0.07 kg) and pre-weaning daily gain (on average 242.1 ± 0.93 g) was significantly affected by type of birth and sex, lambing age of dam (covariate) and herd, year, season of birth ($p<0.01$). Coefficients of determination were estimated from 0.14 to 0.42 for birth weight, from 0.13 to 0.49 for weaning weight, and from 0.10 to 0.46 for pre-weaning daily gain. The results show that when the fixed effects of HYS (interaction between the herd, year, and season of birth) were included it improved the quality of the statistical model most of all, because higher determination coefficients were obtained for all traits: 0.42 for birth weight, 0.49 for weaning weight, and 0.46 for pre-weaning daily gain.

Key words: weight, daily gain, performance traits, environmental factors.

Introduction

Sheep farming is one of the oldest agricultural branches in Latvia. Historically, the main goal was to provide country with a good quality of sheep (particularly lamb) meat, also to produce wool and fur. Today, the sheep breeding becomes more and more popular, because it is a complementary component of a mixed farming system. The high fertility and short generation intervals make it popular among breeders.

Economically important traits in the sheep industry are birth weight, weaning weight, and pre-weaning daily gain. These traits are influenced by several genetic and environmental factors (sex of lamb, type of birth, seasonal variation during different years). Environmental factors influence the estimation of breeding value. Investigation and determination of environmental factors that have effect on traits and correction of records for these factors cause estimated genetic parameters and breeding value to show animal's genetic potential (Rashidi et al., 2008). The significant influences of environmental factors on body weight at the various ages can be explained in part by differences in year, male and female endocrine system, limited uterine space and inadequate availability of nutrients during pregnancy, competition of milk between twins, maternal effects and maternal ability of dam in different ages (Mohammadi et al., 2010).

A. Hussain (2006) found that the influence of year of birth, sex, and type of birth on birth weight was significant. The age of dam (covariate) affected birth weight of lambs and was significant ($p<0.01$) too. Also S.Alipour and M.A.Edriss (1997) reported that there were highly significant year and sex effects on body lamb weight at birth.

S.Alipour and M.A.Edriss (1997) reported that year of birth, sex, age of dam, and type of birth significantly affected weaning weight. P.Akhtar et al. (2001) reported that the effect of type of birth of lamb and age of the dam on weaning weight was not significant.

According to P.Akhtar et al. (2001) and A.Hussain (2006), pre-weaning daily gain was affected significantly by year and season of birth, and sex of lamb ($p<0.01$). However, G.D.Snowder and L.D.Van Vleck (2003) reported that type of birth, sex of lamb, and age of dam had no significant effect on pre-weaning daily gain.

The influence of environmental factors on the productivity of sheep has not been widely studied in Latvia, therefore included it in our study.

The aim of the study was to determine the influence of environmental factors on three performance traits using different statistical models in the Latvian sheep population.

Material and Methods

The data for this study were collected from the Latvian State agency 'Agricultural Data Centre' which is responsible for the data processing of the sheep recording results. Performance traits examined in the present study were birth weight, weaning weight (weight at 70 days of age), and pre-weaning daily gain (the average daily gain from birth to weaning). Recording data collected from 4460 lambs located in 36 herds (on average 6 to 582 lambs in one herd). Animals were born in the period from 2008 to 2010 (79% of lambs born in 2010, of witch 86% of lambs were born in first four months of the year). The twinning rate in this data set was 70%, but 20% of all lambs born as singles. The sex ratio males and females was 49.6:50.4, respectively. Latvian dark-head sheep breed is the main sheep breed in Latvia, and 94% of all lambs of this study

belong to this breed. Other breeds of the present study are Oxforddown, Suffolk, and German Merino Local, since these breeds have been more recently used like sire breeds to improve quality of lamb in Latvia.

Each observed value of the trait was assumed to the different statistical model. As shown in Table 1, interaction between the birth type of lamb and sex as the fixed effect and lambing age of dam as covariate is included in all statistical models: the fixed herd of birth effect in the 1st model, the fixed herd×year (interaction between the herd and the year of birth) effect in the 2nd model, the fixed HYS (interaction between the herd, the year and the season of birth) effect in the 3rd model, and the fixed TOB (birth type of lamb)×sex effect in the 4th model.

Table 1

Gradation classes of fixed factors and covariates

Symbol	Factors (fixed or covariates) included in the models	Number of gradation classes
(Herd)	the herd of birth (fixed)	36 (2nd model)
(Herd×Year)	interaction between the herd and year of birth (fixed)	59 (3rd model)
(HYS)	interaction between the herd, year and season of birth (fixed)	92 (4th model)
(TOB×Sex)	interaction between the birth type of lamb and sex (fixed)	6 (all models)
(Age)	calving age of dam (covariate)	4 (all models)

The year of birth was divided into 2 classes (year1st 2008/2009 birth; 2nd birth year 2010). The birth year was divided into 2 seasons (1st season from October to March, 2nd season from April to September). The age of dam (13 – 123 months) was divided into 4 classes.

The quality of the model was determined by calculating the determination coefficient (CD), using the GLM procedure of SAS statistical package (SAS, 1998).

Results and Discussion

The results of this study showed that economically important traits in sheep breeding are birth weight, weaning weight, and pre-weaning daily gain. These traits are affected not only by genetic factors but also by environmental factors as herd, sex, age, season, age of dam, type of birth, etc**.** Therefore, it is essential to estimate the extent of all such factors so that the genetic variation among animals can be used to design breeding plans for the improvement.

Mean performance values for three traits are summarized in Table 2. The results showed that the average birth weight was 4.1 ± 0.01 kg, the weaning weight was 21.0 ± 0.07 kg, and the pre-weaning daily gain was 242.1 ± 0.93 g.

The lambs born in 2010 were slightly heavier (4.1 ± 0.01 kg) than the lambs born in years 2008 and 2009 (4.10 ± 0.013 kg) ($p<0.01$). The lambs born during autumn season were heavier (4.2 ± 0.03 kg) than the lambs born during the spring season (4.1 ± 0.01 kg) ($p<0.01$). Lambs born as single were heavier (4.6 ± 0.03 kg) than twins (4.0 ± 0.01 kg) and triplets (3.7 ± 0.03 kg) ($p<0.01$). The male lambs were also heavier than females. The average birth weight for male lambs was 4.2 ± 0.02 kg, and for females – 4.0 ± 0.02 kg ($p<0.01$).

The birth weight of lambs varied significantly depending on the type of birth, and the sex of the lamb born. This is due to the reason that lambs born as single have to better opportunities in the dam's uterus than the multiple births. Male lambs are heavier than female lambs, witch is due to the reason that the gestation period for male lambs is slightly longer (1-2 days) as compared to female lambs (Hussain, 2006).

Weaning weight of the lamb indicates the mothering ability of dam as well the growth potential inherited by the lamb. The highest value for weaning weight (21.8 ± 0.17 kg) was in 2008/2009, while lower (20.8 ± 0.08 kg) was in 2010. The data revealed that the autumn-born lambs weighed heavier (23.2 ± 0.18 kg) than spring born lambs (20.6 ± 0.07 kg) ($p<0.01$). Weaning single-born lambs were heavier at (24.0 ± 0.17 kg) than twins (20.4 ± 0.08 kg) and triplets (19.5 ± 0.19) ($p<0.01$). Similarly, the male lambs were also heavier than the females (21.6 ± 0.10 vs. 20.5 ± 0.09 kg) ($p<0.01$).

The finding of L.Carrillo and J.U.Segura (1993) also reported that the male lambs weighed more than female lambs at weaning, but single-born lambs were heavier than twins and triplets. A.Hussain (2006) analyzed variation of weaning weight in different studies and reported that wide variation observed in the weaning weight of sheep suggested that there is a scope for improvement in this trait by adopting different breeding methods.

The pre-weaning daily gain ranged from 239.1 ± 1.00 g (in 2010) to 253.2 ± 2.23 g (in 2008/2009). Autumn-born lambs have a higher (271.3 ± 2.44 g) pre-weaning daily gain than spring-born lambs (236.4 ± 0.97 g) ($p<0.01$). Single-born lambs also have a higher pre-weaning daily gain (277.9 ± 2.16 g) than twins (234.5 ± 1.05 g) and triplets (226.5 ± 2.60 g). Male lambs have a higher pre-weaning daily gain (248.8 ± 1.40 g) than female lambs (235.5 ± 1.21 g) ($p<0.01$).

M.Nawaz and M.K.Ahmad (1998) reported that single lambs grew 23% faster than twins, and twin lambs grew 11% faster than triplets. The superiority of singles over triplets was 37% in the pre-weaning daily weight gain. Spring-born lambs grew 33% faster ($p<0.01$) than autumn-born lambs, but males grew 14% faster than females ($p<0.01$). A.Hussain (2006) pointed out that the contradictions in different studies may be due to different breeds of sheep, as well as, climatically and ecological differences where sheep farming had been practiced.

Table 2

Mean performance values for three traits

Factors	Gradation classes	n	Performance traits ($\bar{x} \pm s_{\bar{x}}$)		
			birth weight (kg)	weaning weight (kg)	pre-weaning daily gain (g)
Year of birth	2008/2009	936	4.0 ± 0.03^{a}	21.8 ± 0.17	253.2 ± 2.23
	2010	3524	4.1 ± 0.01^{a}	20.8 ± 0.08	239.1 ± 1.01
Season of birth	1: spring	3727	4.1 ± 0.01^{b}	20.6 ± 0.07^{b}	236.4 ± 0.97^{b}
	2: autumn	733	4.2 ± 0.03^{b}	23.2 ± 0.18^{b}	271.3 ± 2.44^{b}
Birth type	Singe	870	4.6 ± 0.03^{c}	24.0 ± 0.16^{c}	277.9 ± 2.16
	Twin	3122	4.0 ± 0.01^{c}	20.4 ± 0.08^{c}	234.5 ± 1.05
	Triplet	468	3.7 ± 0.03^{c}	19.5 ± 0.19^{c}	226.5 ± 2.60
Sex	Male	2212	4.2 ± 0.02^{d}	21.6 ± 0.10^{d}	248.8 ± 1.40^{d}
	Female	2248	4.0 ± 0.02^{d}	20.5 ± 0.09^{d}	235.5 ± 1.21^{d}
On average:		4460	4.1 ± 0.01	21.0 ± 0.07	242.1 ± 0.93

[a, b, c, d,] – Performance traits marked with identical letter differ significantly ($p<0.01$) between the birth years ([a]), birth season ([b]), birth type ([c]), or sex ([d])

The interaction effect between the birth type of lamb and sex, the effect of lambing age of dam and the effect of the herd of birth or the interaction effect between the herd and year of birth or the interaction effect between the herd, year and season of birth on birth weight, weaning weight and pre-weaning daily gain were significant in all cases ($p<0.01$).

The significant effect of year, sex, birth type and age of dam on the birth weight of lambs as obtained in the present study agrees with the findings of other researchers (Hussain, 2006; Babar et al., 2004; Alipour and Edriss, 1997).

The present study only partially confirmed investigations of S.Alipour and M.A.Edriss (1997) that year of birth, sex, age of dam and type of birth significantly affected the weaning weight, and research of P.Akhtar et al. (2001) that the effect of type of birth of the lamb and age of the dam on the weaning weight was not significant.

The greatest effect on the pre-weaning daily gain was significantly observed by year and season of birth and sex of lamb ($p<0.01$) thus confirming findings of P.Akhtar et al. (2001) and A.Hussain (2006).

Coefficients of determination were estimated from 0.14 to 0.42 for birth weight, from 0.13 to 0.49 for weaning weight, and from 0.10 to 0.46 for pre-weaning daily gain using different statistical models (Table 3).

Table 3

Coefficient of determination (R^2) for performance traits

Information about different models	R^2		
fixed effects and covariates	birth weight	weaning weight	pre-weaning daily gain
(TOB×Sex) + (Age)	0.14	0.13	0.10
(TOB×Sex) + (Age) + (Herd)	0.38	0.44	0.40
(TOB×Sex) + (Age) + (Herd*Year)	0.41	0.46	0.43
(TOB×Sex) + (Age) + (HYS)	0.42	0.49	0.46

The higher determination coefficients for all performance traits were obtained when the interaction effect between the herd, year and season of birth was included in the statistical model. Although the largest part of the lambs were born during spring the season, it is possible to improve the quality of the statistical model.

The results of this study confirmed that environmental factors are significant sources of variation for different performance traits and therefore play an important role in expression of genetic potential. Therefore, effects of environmental factors need to be considered for estimation of the breeding value.

Conclusions

1. The data revealed that the male lambs weighed more than female lambs at birth (4.2 ± 0.02 kg) and weaning (21.6 ± 0.10 kg), and they had a higher pre-weaning daily gain (248.8 ± 1.40 g) ($p<0.01$). Single-born lambs also were heavier than twins and triplets and had a higher pre-weaning daily gain: the average birth weight was 4.6 ± 0.03 kg ($p<0.01$), weaning weight – 24.0 ± 0.16 kg ($p<0.01$), and pre-weaning daily gain – 277.9 ± 2.16 g.
2. The results showed that the birth weight, weaning weight, and pre-weaning daily gain was significantly influenced by various environmental factors: type of

birth and sex, lambing age of dam and herd, season of birth ($p<0.01$).

3. The highest determination coefficients were obtained using the statistical model with fixed HYS (interaction between the herd, the year, and the season of birth) effect (0.42, 0.49, and 0.46, respectively for birth weight, weaning weight, and pre-weaning daily gain).

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