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CROSSING SYSTEM APPLICATION AND ITS EFFECT ON LAMBS GROWTH TRAITS

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Abstract: Success of crossing depends on the breeds used and the genetic distance among them, as well the combining ability of maternal and individual heterosis to make the proper choice of breeds employed in a crossing system. The aim of this study is to find the effect of genotype and crossing system on early weights and daily gain of lambs. The lambs of purebred Pirot Pramenka (P) got the lowest body weight at birth, at 30 days, at 60 days and 90 days with a value of 3.65 kg, 9.48 kg, 14.99 kg and 21.96 kg while purebred Wurttemberg attained the highest body weight at birth of 4.48 kg. The lambs of three bred crossing (PxWxF) highest on BW30, BW60 and BW90 days. The results showed a highly significant difference on average daily gain (ADG) among genotypes ($P < 0.01$) except on the difference between W – PxW of which belongs to the lower border of significant level ($P < 0.05$). The highest difference on ADG was between P – PxWxF (105.950 g), wherein the lowest difference was between W– PxW (9.290 g). It can close that the attained value between pure bred Wurttemberg (W) and two-bred crossing (PxW) was almost equal. Genotype and crossing system have significant effect on body weight and average daily gain of lambs. Based on the results obtained, it shows an advantage effect of crossing system (PxWxF) when it comes on growth and daily gain of lambs.

Key words: crossing system, body weight, growth traits, daily gain, lamb

Introduction

Crossbreeding to exploit heterosis has been practiced for a long time with livestock *(Rastogi et al., 1982)* while crossbreeding systems utilize breed diversity to increase productivity comparable to purebred flocks *(Petrovic et al., 2011; Fathala et al., 2014).* A great number of different factors influence the growth of lambs while nutrition, health condition and genotype belong to the most important ones (*Kuchtík and Dobeš, 2006).* Crossbreeding is used in order to take advantage

of better combinations of the best characteristics of two or more breeds, i.e. breed complementarities and to utilize hybrid vigor, which are translated to improvement of survival, fertility, growth and disease resistance *(Mahmoud Marai et al., 2009.* An important source for increasing sheep production is crossing different breeds of sheep not only meat breeds but also with meat-fat sheep breeds which have high maturity; high feed efficiency and meat productivity *(Fathala et al., 2014).* Crossbreeding, the mating of two individuals with different breed make-up is widely used in commercial sheep production because of the benefits it has to offer to producers (*Atashi and Izadifar, 2012).*

The success of crossing depends on the breeds used and the genetic distance among them. Likewise, the combining ability, maternal and individual heterosis is needed to make the proper choice of breeds employed in a crossing system. The greatest part of sheep breeding income generation is through production and sale of lambs. The autochthonous or as they are also called local populations, that are most numerous in most countries, including ours, have the genetic potential to meet these challenges *(Skalicki et al., 2003; Petrovic et al., 2013).* The productivity of sheep can be improved with the use of prolific ewes, and the crossbred ewes derived from mating local breed to meat-type rams *(Boujenane and Kansari, 2002).* However, not every crossing is suitable for breeding to obtain the desired objective but also the application of two-breed system and three-breed crossing of selected populations of sheep.

The aim of this study is to determine the influence of genotype and crossing system on early weights and daily gain of lambs.

Material and Methods

Investigations carried out at the Stara Planina- Pirot territory and at the Institute for Animal Husbandry, Belgrade Zemun, in three years period.

The research consists of the following genotypes of sheep

a) pure breed:
   Pirot pramenka (P)
   Wuerttemberg sheep (W)

b) b) Crosses:
   Two breed F1 (Pirot pramenka x Wurttemberg sheep) (PW)
   Three breed F1 (Pirot pramenka x Wurttemberg sheep) x Ile de France (PxWxF)

Lambing of sheep took place during the winter period, after natural mating season from June to September. The animals were on pasture in summer months and at winter period remain in the stable. The lambs have a short suckling twice a

day, supplemented too with alfalfa hay meadow and the concentrate mixture for lambs with 18% protein. Feeding has been ad libitum up to the age of lambs of 90 days. From each tested genotype among the observed has taken for investigation and analysis of 200 lambs (F1 generation) per genotype.

To determine the weight of lambs was performed by portable scale (1-30 days) and scales for flocks' accuracy of 0.10 kg (90 days). In order to determine the neonatal development of all genotypes-pure breeds and crossbreeds, the control measurements included the following growth traits of lambs: The body weights of the lambs at birth (BWB), body weight at 30 days (BW30), body weight at 60 days (BW60) and body weight at 90 days (BW90) were recorded.

For consideration of the dynamics of neonatal development of lambs, were determined the values for the following characteristics:

Average Daily Gain (ADG)

- Daily gain of 1- 30 days
- Daily gain of 31- 60 days
- Daily gain of 61- 90 days
- Average daily gain 1-90 days

The average daily gain (ADG) was calculated by getting the difference between the two successive weight divided by the period days. The statistical analysis was performed by GLM procedure of SPSS software package program version 20, using the next model:

$$Y_{eijk} = \mu + G_i + S_j + e_{ijk},$$

where the symbols have the following meanings:

Y_{eijk}- the value characteristics of the j-th crossing system, the i-th genotype

μ - general population average

G_i-fixed genotype effect

S_j- fixed crossing system effect

e_{ijk}- undetermined effects;

Results and Discussion

The lambs' body weights averages according to genotype and crossing system on different ages are shown in Table 1. It can visualize that the lowest body weight at birth, at 30 days, at 60 days and 90 days was on purebred Pirot Pramenka with a value of 3.65 kg, 9.48 kg, 14.99 kg and 21.96 kg. The highest body weight at birth was 4.48 kg attained by lambs of purebred Wurttemberg (W). The lambs

of three-bred crossing (PxWxF) attained the highest on body weight at 30 days, at 60 days and at 90 days.

Table 1. Body weight averages at birth (BWB), ages 30 days (BW30), 60 days (BW60) and 90 days (BW90) of different genotypes.

Genotype/ crossing system	BWB		BW30		BW60		BW90	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
P	3.65	0.03	9.48	0.11	14.99	0.13	21.96	0.24
W	4.48	0.08	10.83	0.17	19.11	0.27	27.70	0.15
PxW	4.17	0.04	10.98	0.11	18.53	0.21	26.55	0.21
PxWxF	4.35	0.04	12.87	0.10	22.01	0.25	32.19	0.20

Zapasnikiene and Nainiene, (2012), stated that the sheep crossbreds had higher body weight at birth than purebred, was amenable in our result (table 1) with lambs of purebred Pirot Pramenka (P) in comparison with the crosses (PxW; PxWxF) except in the case of purebred Wurttemberg (W) lambs where it showed dominantly on body weight at birth, but interesting that after one month, the lambs of crosses PxW and PxWxF increased on body weight (BW30) higher than purebred W. However only the three-bred crossing (PxWxF)) exceeded purebred W on BW60 and BW90. In the study of *Ružić-Muslić et al., (2005)* that three-bred crossing (PxWxF) realized higher body weight in comparison with two-breed crossing (PxW) affirmed the result obtained in this study. In the study of *Petrović et al., (2011),* that lambs of Pirot Pramenka had the lowest body weight from birth to weaning was consistent with the results we obtained.

Table 2. Lambs average daily gain (ADG) per genotype at first month, second month and third month, (g)

Genotype/ crossing system	First month		Second month		Third month	
	Mean	SE	Mean	SE	Mean	SE
P	194.26	3.93	183.81	3.93	232.33	8.50
W	211.85	6.86	275.77	9.39	286.38	9.83
PxW	227.10	3.86	251.76	7.64	267.25	8.99
PxWxF	284.06	3.59	304.60	8.50	339.60	9.90

The lambs' of three-bred crossing (PxWxF) is dominated on the average daily (ADG) for the three entire months (table 2) with an average value of 284.06 g - first month; 304.60 g –second month; 339. 60 g – third month. The second place was the lambs of two bred crossing (PxW) in first month with an ADG of 227.100

g. In the second and third month, the lambs of purebred Wurttemberg (W) took the second place with an ADG value of 275.77 g and 286.38 g. The lambs of purebred Pirot Pramenka (P) got the least values of ADG for the entire months (first- 194.26 g, second- 183.81 g, third- 232.33 g) of observation.

Fathala et al., (2014), noted that body weight gain was significantly higher in crossbred lambs (Crossbreeding Romanov Ewes with Edilbai Rams) in the first and the second periods of their experiment compared to purebred respectively. At the same time, their results revealed significant advantage of crossbred lambs over purebred lambs in average daily gain on both first and second periods of the experiment. The result we attained in our study (table 2) on the ADG of lambs from two-bred and three-bred crossing showed dominantly over purebred on the first period. However, on the second and third period only the lambs of three-bred crossing (PxWxF) took advantage over purebreds.

The difference in ADG between genotypes is presented in table 3, it can notice that between lambs of purebred (W) and two-bred crossing (PxW) showing the least difference in first month -15.255 g (7.20%) in favor of PxW; 24.010 g (9.54%) second month and in third month 19.135 g (7.16%) in favor of W. It also displayed that the difference between lambs of purebred Pirot Pramenka and three-bred crossing (P – PxWxF) acquired the highest ADG difference in first month- 89.795 g (46.22%); second month- 120.785 g (65.71%); 107.265 g (46.17%) in third month. The difference on gain between lambs W and PxW on the first, second and third month was on the lower level of significant difference ($P < 0.05$) as well on the second month between W – PxWxF, while all others have highly significant difference ($P < 0.01$).

Table 3. Values of daily gain differences (-) between genotypes on first, second and third month, (g)

Genotype pairwise	(-) First month	Level of significant difference	(-) Second month	Level of significant difference	(-) Third month	Level of significant difference
P - W	-17.590	P <0.05	-91.955	P <0.01	-54.050	P <0.01
P - PxW	-32.835	P <0.01	-67.945	P <0.01	-34.915	P <0.01
P - PxWxF	-89.795	P <0.01	-120.785	P <0.01	-107.265	P <0.01
W - PxW	-15.255	P <0.05	24.010	P <0.05	19.135	P <0.05
W - PxWxF	-72.215	P <0.01	-28.830	P <0.05	-53.215	P <0.01
PxW - PxWxF	-56.96	P <0.01	-52.840	P <0.01	-72.350	P <0.01

Regarding the average daily gain (ADG) of lambs for three months period (first to third), it can view in table 4. The highest in ADG obtained in PxWxF with a value of 309.42 g while purebred Pirot Pramenka got the lowest ADG value of which was 203.47 g.

Table 4. Lambs daily gain per genotype from first to third month, (g)

Genotype/ crossing system	Mean daily gain First to third month	
	M	SE
P	203.47	2.67
W	258.00	2.12
PxW	248.71	2.38
PxWxF	309.42	2.20

In table 5, the differences on daily gain among genotypes for three months have demonstrated. It showed a highly significant difference on average daily gain among genotypes ($P < 0.01$) except on the difference between W – PxW of which belongs to the lower border of significant level ($P < 0.05$). As exposed the highest difference was between pairwise P – PxWxF (105.950 g), wherein the lowest difference was between pairwise W– PxW (9.290 g).The differences on daily gain in percentages among genotypes of which showed 26,80% (P – W); 22.23% (P – PxW); 52.07% (P – PxWxF); 3.74% (W – PxW); 19.93% (W – PxWxF); 24.41% (PxW – PxWxF). The differences in daily gain among the genotypes it appeared that between lambs of purebred and two-bred crossing got the minimal percentage of difference.

Table 5. Values of differences on daily gain from first to third month between genotypes, (g)

Genotype/ pairwise	difference (-) first to third month	Level of significant difference
P - W	-54.525	$P < 0.01$
P - PxW	-45.235	$P < 0.01$
P - PxWxF	-105.950	$P < 0.01$
W - PxW	9.290	$P < 0.05$
W - PxWxF	-51.425	$P < 0.01$
PxW - PxWxF	-60.715	$P < 0.01$

The results obtained in our study showed that body weight at birth (BWB), body weight at 30 days (BW30), at 60 days (BW60) and at 90 days (BW90) between purebred Wurttemberg (W) and two-bred crossing (PxW) were nearly equal. According to *Atashi and Izadifar (2012),* they informed that "crossbred lambs generally have no considerable advantage over their purebred contemporaries under same environmental conditions", partially agree with our result but only in the case of lambs of two-bred crossing (PxW) vs. lambs of purebred Wurttemberg (W). *Malik et al. (2000),* stated that the weight of lambs at birth definitely depends on the genotype, concurred with our results. The same authors point out as well that the lambs obtained by crossing have higher daily weight gain and increased body weight in relation to the pure breed. We do agree in those statements because it is true with the result attained specially in the case of lambs; P vs. PxW, P vs. PxWxF and W vs. PxWxF.

In the study of *Kuchtík and Dobeš, (2006*), (the crossing between the Improved Wallachian and East Friesian) they found that genotype have no significant effect on the majority of growth traits was not compatible with the results we acquired.

With regards to the result acquired in this study, it show how the ADG of the local breed increased if crossed with foreign breed and demonstrated the advantage effect of three bred crossing when it comes on growth and daily gain of lambs. Our result supported by *Mahmoud Marai et al., (2009); Petrović et al., (2013),* as they emphasized in their note that "crossing over breed occurs to a greater number of genes combinations and to this extent is more likely to express favorable allele carriers of economically important traits".

Other researchers suggest that crossbreds have higher body weight at birth and higher weight gain than to pure breed *(Doloksaribu et al., 2000; Freking et al., 2000; Snowder and Duckett, 2003; Fogarty, 2006, Cloete et al, 2008). Petrovic et al. (2010*), investigated the preferably crossing combinations of Pramenka breed with foreign population-Wurttemberg and Ile de France sheep whose genetic distance will allow achieving better results. They had come to the conclusion that due to the impact of positive heterosis individuals (100%) and one parent heterosis (100%), lambs realize a high daily gain and high final body weight. This is true with the result we obtained on three-bred crossing (PxWxF). In the same manner as mentioned by *Rastogi et al., (1982)* in which breeds are combined in a three-way cross is important and should be considered in the design of breeding programs.

Conclusion

The results attained on body weights between lambs' pure bred Wurttemberg (W) and two-bred crossing (PxW) has very close values, as well as their average daily gain for three months period, the difference was on the lower

border of significant level with a value of only 9.29 g (3.74%). It can close that the values attained between pure breed Wurttemberg (W) and two-bred crossing (PxW) was almost equal. Genotype and crossing system had significant effect on body weight of lambs and average daily gain. Results of the study has shown the advantage of three-breed crossing when it comes to body weight and daily gains of lambs, which is most importantly from the perspective of production economy. Likewise, the important comparison between the two-breed crossbred (PxW) and purebred Wuerttemberg (W), where the differences are small.

In the application of crossing and crossing system, it is therefore necessary to select the right population to fulfill its goal in sheep breeding.

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Primena sistema ukrštanja i njegov uticaj na osobine porasta jagnjadi

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Rezime

Uspeh ukrštanja zavisi od rasa koje se koriste i genetičke distance između njih. Takođe, efekti majke i individualnog heterozisa u kombinaciji sa izborom rasa odlučujući su faktori ukrštanja. Jagnjad Pirotske pramenke (P) imala su najnižu telesnu masu na rođenju, sa 30, 60 i 90 dana u vrednosti od 3.65 kg, 9.48 kg, 14,99 kg i 21.96 kg, dok rasa Virtemberg ima najveću telesnu masu na rođenju čija vrednost iznosi 4.48 kg. U jagnjadi trorasnog porekla (PxWxF) masa je bila najveća tokom kontrola- BV30, BV60 i BV90 dana. Rezultati su pokazali izuzetno značajnu razliku u prosečnom dnevnom prirastu (ADG) kod ispitivanih genotipova ($P<0,01$) osim razlike između W- PxW koja je na nivou granice značajnosti ($P<0,05$) . Najveća razlika prosečnog dnevnog prirasta ADG bila je između P - PxWxF (105,950 g), dok je najmanja razlika bila između W- PXW (9,290 g). Može se zaključiti da je dostignuta vrednost između jagnjadi Virtemberške rase (-W) i dvorasnih meleza (PxW) skoro jednaka. Genotip i sistem ukrštanja imaju značajan uticaj na telesne mase i prosečnan dnevni prirast jagnjadi. Rezultati ovih

istraživanja pokazali su prednost trorasnog ukrštanja kada su u pitanju masa tela i dnevni prirast jagnjadi, što je i najvažnije iz ugla ekonomike proizvodnje. Takođe je važno poređenje između dvorasnih meleza i čiste virtemberške rase, gde su razlike male.

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