



Maternal breed effects on growth performance and feed conversion efficiency of Norwegian blackface-sired lambs under intensive fattening conditions

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Abstract. This study evaluated the effects of maternal breed background on growth performance and feed conversion in lambs sired by Norwegian Blackface rams under intensive fattening conditions. A total of 150 lambs were assigned to three groups according to maternal breed (Țurcană, Țigaie, and Stogoșă; $n = 50$ per group). The 105-day trial comprised a 15-day growth phase, a 60-day fattening phase, and a 30-day finishing phase. Lambs were fed complete mixed rations ad libitum, and body weight was recorded at the end of each phase. Average daily gain did not differ during growth ($P = 0.427$), but significant group effects were observed during fattening ($P = 0.014$), finishing ($P = 0.003$), and across the entire trial ($P < 0.001$). Overall average daily gain was highest in Țigaie-derived lambs (181.39 ± 1.06 g day⁻¹), intermediate in Stogoșă-derived lambs (172.99 ± 1.11 g day⁻¹), and lowest in Țurcană-derived lambs (163.59 ± 1.21 g day⁻¹). During finishing, Țigaie-derived lambs maintained the highest gain (174.99 ± 9.18 g day⁻¹), exceeding both Stogoșă- and Țurcană-derived lambs. Descriptive feed-conversion values followed the same ranking: Țigaie-derived lambs required 6.1 feed units and 671 g digestible crude protein per kilogram of gain, compared with 6.3 and 693 g in Stogoșă-derived lambs and 6.6 and 705 g in Țurcană-derived lambs. These findings indicate that Țigaie maternal background was associated with the most favorable overall growth and feed-use profile, although feed-conversion differences require confirmation using replicated intake measurements.

Keywords: maternal breed, lamb growth, feed conversion, crossbreeding.

Introduction. Improving growth performance and feed-use efficiency is a major objective in commercial lamb production. The economic sustainability of intensive fattening systems depends largely on the ability of animals to convert dietary nutrients into body weight gain within a relatively short production period. Lambs with higher average daily gain generally reach the target slaughter weight earlier, thereby reducing the duration of fattening and the amount of feed required for maintenance (Ghița et al., 2010; Popa et al., 2011; Zaharia et al., 2012). However, rapid growth does not necessarily imply efficient nutrient utilization, and the simultaneous evaluation of growth rate and feed conversion is therefore essential when assessing the productive potential of different genetic groups (Ghița et al., 2010; Zaharia et al., 2012).

Growth performance in lambs is influenced by a complex interaction between genetic and environmental factors. Breed, parental genotype, sex, birth type, age, initial body weight, health status, diet composition and management conditions can all affect the rate and efficiency of post-weaning growth (Cîmpean et al., 2025b; Ghița et al., 2010; Popa et al., 2011; Zaharia et al., 2012). Oxidative stress has also been associated with impaired growth performance and metabolic health in intensively reared animals, although this relationship has been investigated more extensively in poultry than in sheep (Cîmpean et al., 2025a). Among the factors affecting lamb development, genetic background is particularly important because breeds differ in mature body size, growth potential, nutrient partitioning, body composition and adaptability to intensive production systems (Ghița et al., 2010; Ilișiu et al., 2010; Popa et al., 2011). These differences may

become more pronounced as lambs advance through successive growth, fattening and finishing stages.

Crossbreeding represents an important strategy for combining the adaptive characteristics of local sheep populations with the superior growth and carcass traits of specialized meat breeds (Ilişiu et al., 2010; Lipecka et al., 2001; Popa et al., 2011; Vicovan et al., 2017; Zamfir et al., 2017). Maternal breeds contribute not only half of the lamb's genetic background but also important prenatal and early postnatal influences. Maternal effects may be associated with the uterine environment, milk production, mothering ability, disease resistance, neonatal vitality and adaptation to local climatic and feeding conditions (Cîmpean et al., 2025b). The paternal breed, particularly when used as a terminal sire, may contribute traits related to growth intensity, muscular development, feed efficiency and carcass value (Ilişiu et al., 2010; Lipecka et al., 2001; Popa et al., 2011; Vicovan et al., 2017; Zamfir et al., 2017). Consequently, the productive performance of crossbred lambs depends on both parental components and on their interaction under specific management conditions.

Romania has a diverse sheep population that includes several locally important breeds with distinct productive and adaptive characteristics (Bogdan et al., 2006; Cighi, 2016; Coroian et al., 2009; Rakossy et al., 2019ab). The Țurcană breed is widely distributed and valued for its resistance, mobility and ability to use extensive grazing resources, while its performance under fattening conditions has been examined in both purebred and crossbred lambs (Popa et al., 2011; Zaharia et al., 2012; Zamfir et al., 2017). The Țigaie breed is a dual-purpose population with potential for milk, meat and wool production, and previous research has evaluated the improvement of its lamb-production characteristics through crossbreeding with high-performance breeds (Ghița et al., 2010; Ilişiu et al., 2010). Stogoșă sheep represent a locally adapted genetic group with characteristics intermediate between major Romanian sheep populations. Although these breeds are adapted to regional production conditions, their growth performance under intensive fattening may differ, particularly when they are used as maternal populations in crossing systems with specialized meat sires (Ghița et al., 2010; Ilişiu et al., 2010; Popa et al., 2011; Zaharia et al., 2012; Zamfir et al., 2017).

In the present study, the Norwegian Blackface breed was used as a common paternal genotype to evaluate whether differences in maternal breed background were associated with variation in the growth trajectory and nutrient requirements of the crossbred offspring. The use of a common sire breed reduced paternal genetic variation among the experimental groups and allowed the comparison to focus primarily on maternal breed background. Under standardized feeding and housing conditions, comparisons among maternal breed groups may provide useful information for selecting suitable ewe populations for intensive lamb production.

Growth performance should be evaluated throughout the entire production cycle rather than at a single time point. Average daily gain may change substantially as lambs increase in age and body weight. During the early stages of growth, a high proportion of retained nutrients is directed toward lean tissue development. As animals approach physiological maturity, maintenance requirements increase and a greater proportion of weight gain may consist of adipose tissue. Because fat deposition requires more energy than lean tissue deposition, feed conversion generally becomes less favorable during the later stages of production. Breed-related differences may therefore be limited during early growth but become more evident during fattening or finishing, as suggested by comparative studies of Romanian local breeds and their crossbred offspring (Ghița et al., 2010; Popa et al., 2011; Zaharia et al., 2012).

The evaluation of feed conversion is especially relevant because feed represents one of the largest variable costs in intensive sheep production. Animals that require fewer feed units or less digestible protein to produce one kilogram of body weight gain may offer both economic and environmental advantages. Improved feed efficiency can reduce feeding costs, nutrient losses and the quantity of resources required to produce a given amount of animal product. Nevertheless, feed-conversion values must be interpreted together with growth rate because a low feed requirement per kilogram of

gain is most valuable when accompanied by adequate productive performance (Ghița et al., 2010; Popa et al., 2011; Zaharia et al., 2012).

Previous studies have examined the fattening aptitude of Romanian local breeds, the growth of Țurcană and Suffolk × Țurcană lambs, the performance of hybrid ram lambs and the carcass characteristics of crosses involving local and specialized breeds (Ghița et al., 2010; Ilișiu et al., 2010; Lipecka et al., 2001; Popa et al., 2011; Vicovan et al., 2017; Zaharia et al., 2012; Zamfir et al., 2017). However, comparative information on the post-weaning performance of crossbred offspring derived from several Romanian maternal breeds and reared under identical intensive feeding conditions remains limited. In particular, insufficient information is available regarding the response of lambs produced from Țurcană, Țigaie and Stogoșă ewes mated with a common specialized meat sire. Evaluating these maternal breed groups under the same feeding, housing and health-management conditions can help identify differences in growth potential while reducing the influence of major environmental sources of variation.

The objective of the present study was therefore to evaluate the effects of maternal breed background on growth performance and feed-conversion efficiency in Norwegian Blackface-sired lambs derived from Țurcană, Țigaie and Stogoșă ewes during an intensive 105-day production cycle. Average daily gain was assessed during the growth, fattening and finishing stages and across the entire experimental period, while feed-unit and digestible crude protein requirements per kilogram of body weight gain were used to describe feed conversion. It was hypothesized that maternal breed background would influence both the magnitude and the stage-related pattern of growth and feed utilization, resulting in differences in overall productive efficiency among the three crossbred groups.

Material and Method. The biological material consisted of 150 lambs divided into three experimental groups of 50 animals each, comprising Țurcană, Țigaie, and Stogoșă sheep crossed with Norwegian Blackface rams (Åby et al., 2024). The lambs originated from state farms and private holdings in Sălaj County. At group formation, the animals were 2.0–2.5 months old, with mean body weights of 14.85 ± 0.11 kg in the Țurcană group, 15.18 ± 0.10 kg in the Țigaie group, and 14.95 ± 0.10 kg in the Stogoșă group. All animals underwent veterinary examination and received prophylactic and antiparasitic treatments. Experimental groups were formed according to age and body weight to ensure adequate homogeneity.

The lambs were housed throughout the experiment in sectional pens with metal-slatted floors inclined by 2.0–2.5 cm. Each pen had an area of 24 m², measuring 6 × 4 m, with the 6 m side serving as the feeding frontage. The fattening trial lasted 105 days and included three consecutive phases: a 15-day growth phase, a 60-day fattening phase, and a 30-day finishing phase.

The animals were fed *ad libitum* with a complete mixed ration. During the growth phase, the diet contained 10% natural hay, 20% alfalfa hay, 10% maize cobs, 20% maize, 8% barley, 30% peas, 1% calcium, and 1% salt, providing 0.82 feed units · kg⁻¹, 98 g digestible crude protein · kg⁻¹, and 120 g digestible crude protein · feed unit⁻¹. During the fattening phase, the ration contained 15% natural hay, 20% alfalfa hay, 10% maize cobs, 20% maize, 13% barley, 20% peas, 1% calcium, and 1% salt, providing 0.80 feed units · kg⁻¹, 88 g digestible crude protein · kg⁻¹, and 110 g digestible crude protein · feed unit⁻¹. During the finishing phase, the diet contained 5% natural hay, 20% alfalfa hay, 5% maize cobs, 35% maize, 12% barley, 20% peas, 1% calcium, and 1% salt, providing 0.90 feed units · kg⁻¹, 90 g digestible crude protein · kg⁻¹, and 100 g digestible crude protein · feed unit⁻¹. Roughages represented 40% of the ration during the growth phase, 45% during the fattening phase, and 30% during the finishing phase, whereas concentrates and mineral supplements accounted for 70% of the finishing diet. Water was supplied *ad libitum* through automatic float-operated drinkers located opposite the feeding troughs.

Each lamb was weighed individually at the beginning of the adaptation period and at the end of each experimental phase. Average daily gain was calculated for each phase and for the entire 105-day fattening period. At the beginning of August, partial shearing

was performed, and the quantity of wool obtained from each animal was individually recorded. At the end of the experiment, five lambs from each group were slaughtered, and dressing percentage, leg weight, and the tissue composition of the leg were determined. The data were statistically processed by calculating mean values, the main estimates of variability, and the significance of differences among the three experimental groups.

Results and Discussion

Average Daily Gain. Average daily gain during the growth period did not differ significantly among breeds ($F(2, 97.87) = 0.86$, $P = 0.427$). Stogoșă lambs recorded the highest numerical value, at $224.59 \pm 7.35 \text{ g} \cdot \text{day}^{-1}$, followed by Jigaie lambs at $220.00 \pm 6.84 \text{ g} \cdot \text{day}^{-1}$ and Țurcană lambs at $211.10 \pm 7.41 \text{ g} \cdot \text{day}^{-1}$. However, none of the pairwise differences were statistically significant (Table 1).

During the fattening period, average daily gain differed significantly among breeds ($F(2, 91.89) = 4.45$, $P = 0.014$). Stogoșă lambs showed the highest average daily gain, at $180.28 \pm 2.18 \text{ g} \cdot \text{day}^{-1}$, followed by Jigaie lambs at $178.59 \pm 1.84 \text{ g} \cdot \text{day}^{-1}$ and Țurcană lambs at $166.59 \pm 4.09 \text{ g} \cdot \text{day}^{-1}$. Compared with Țurcană lambs, average daily gain was higher by $12.00 \text{ g} \cdot \text{day}^{-1}$ in Jigaie lambs ($P = 0.025$; 95% CI: 1.24–22.76) and by $13.69 \text{ g} \cdot \text{day}^{-1}$ in Stogoșă lambs ($P = 0.012$; 95% CI: 2.60–24.78). No significant difference was observed between Jigaie and Stogoșă lambs ($P = 0.824$).

A significant breed effect was also observed during the finishing period ($F(2, 97.62) = 6.08$, $P = 0.003$). Jigaie lambs recorded the highest average daily gain, at $174.99 \pm 9.18 \text{ g} \cdot \text{day}^{-1}$, compared with $141.00 \pm 7.86 \text{ g} \cdot \text{day}^{-1}$ in Stogoșă lambs and $134.00 \pm 8.37 \text{ g} \cdot \text{day}^{-1}$ in Țurcană lambs. The average daily gain of Jigaie lambs exceeded that of Țurcană lambs by $40.99 \text{ g} \cdot \text{day}^{-1}$ ($P = 0.004$; 95% CI: 11.43–70.55) and that of Stogoșă lambs by $33.99 \text{ g} \cdot \text{day}^{-1}$ ($P = 0.016$; 95% CI: 5.23–62.75). The difference between Țurcană and Stogoșă lambs was not significant ($P = 0.815$).

Across the entire experimental period, average daily gain differed significantly among all three breeds ($F(2, 97.71) = 60.86$, $P < 0.001$). Jigaie lambs achieved the highest overall average daily gain, at $181.39 \pm 1.06 \text{ g} \cdot \text{day}^{-1}$, followed by Stogoșă lambs at $172.99 \pm 1.11 \text{ g} \cdot \text{day}^{-1}$ and Țurcană lambs at $163.59 \pm 1.21 \text{ g} \cdot \text{day}^{-1}$. Jigaie lambs exceeded Țurcană lambs by $17.80 \text{ g} \cdot \text{day}^{-1}$ ($P < 0.001$; 95% CI: 13.97–21.63) and Stogoșă lambs by $8.40 \text{ g} \cdot \text{day}^{-1}$ ($P < 0.001$; 95% CI: 4.76–12.04). Stogoșă lambs also recorded a significantly higher average daily gain than Țurcană lambs, with a mean difference of $9.40 \text{ g} \cdot \text{day}^{-1}$ ($P < 0.001$; 95% CI: 5.49–13.31).

Table 1
Average daily gain of lambs according to breed and experimental period

Experimental period	Breed	n	Mean $\pm$ SE, $\text{g} \cdot \text{day}^{-1}$	SD	Significance group
Growth period	Țurcană	50	211.10 ± 7.41	52.42	a
	Jigaie	50	220.00 ± 6.84	48.41	a
	Stogoșă	50	224.59 ± 7.35	51.97	a
Fattening period	Țurcană	50	166.59 ± 4.09^1	28.95	b
	Jigaie	50	178.59 ± 1.84	13.03	a
	Stogoșă	50	180.28 ± 2.18^2	15.39	a
Finishing period	Țurcană	50	134.00 ± 8.37^2	59.16	b
	Jigaie	50	174.99 ± 9.18^2	64.90	a
	Stogoșă	50	141.00 ± 7.86^2	55.56	b
Entire experimental period	Țurcană	50	163.59 ± 1.21	8.57	c
	Jigaie	50	181.39 ± 1.06^2	7.49	a
	Stogoșă	50	172.99 ± 1.11^2	7.82	b

Within each experimental period, means assigned different lowercase letters differed significantly according to the Games–Howell test ($P < 0.05$).

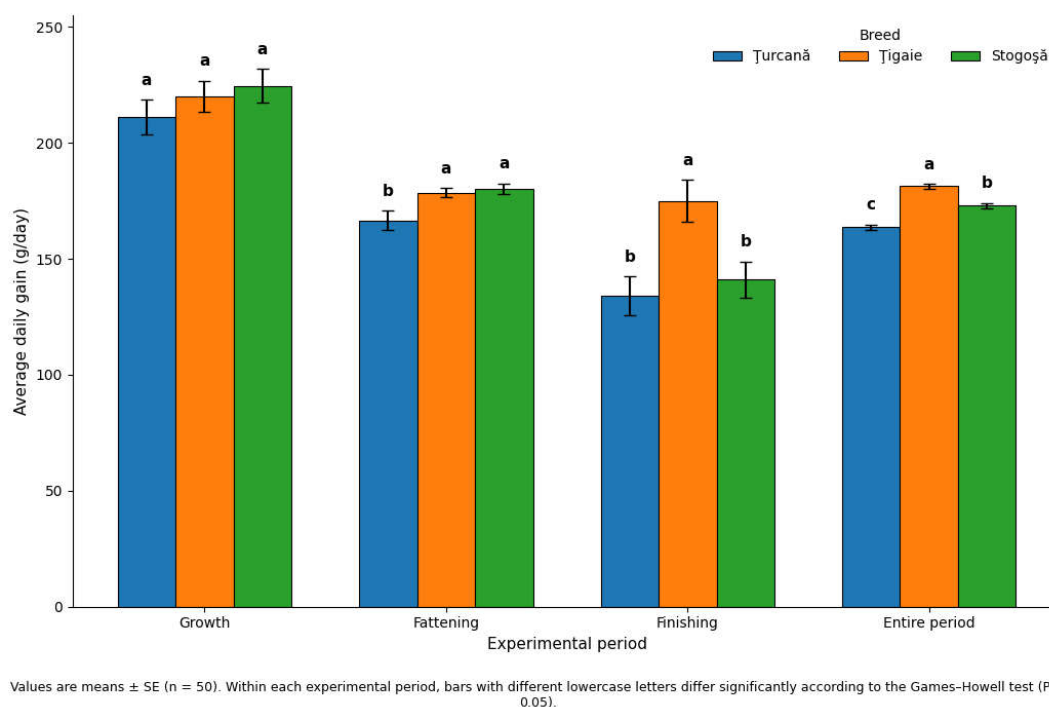


Figure 1. Breed-related variation in average daily gain across the experimental periods.

Figure 1 illustrates the variation in average daily gain among Turcană, Jigaie, and Stogoșă lambs across the growth, fattening, and finishing periods, as well as over the entire experimental period. Error bars represent the standard error of the mean, while different lowercase letters indicate statistically significant differences among breeds within the same experimental period according to the Games–Howell test ($P < 0.05$).

During the growth period, average daily gain was similar among the three breeds. Stogoșă lambs showed the highest numerical value, at $224.59 \pm 7.35 \text{ g} \cdot \text{day}^{-1}$, followed by Jigaie lambs at $220.00 \pm 6.84 \text{ g} \cdot \text{day}^{-1}$ and Turcană lambs at $211.10 \pm 7.41 \text{ g} \cdot \text{day}^{-1}$. However, all three means were assigned the same significance letter, confirming the absence of statistically significant differences among breeds ($P = 0.427$). The overlapping error bars further support the similarity in early growth performance under the applied feeding and management conditions.

During the fattening period, average daily gain decreased in all three groups compared with the initial growth stage. Stogoșă lambs maintained the highest mean gain, at $180.28 \pm 2.18 \text{ g} \cdot \text{day}^{-1}$, closely followed by Jigaie lambs at $178.59 \pm 1.84 \text{ g} \cdot \text{day}^{-1}$. Both groups significantly outperformed Turcană lambs, which recorded $166.59 \pm 4.09 \text{ g} \cdot \text{day}^{-1}$. The differences between Jigaie and Stogoșă lambs were not statistically significant, as indicated by the common letter “a”, whereas Turcană lambs were assigned the letter “b”. This pattern indicates that the growth response of Jigaie and Stogoșă lambs was comparable during the main fattening phase and superior to that of Turcană lambs.

The clearest breed-related divergence was observed during the finishing period. Jigaie lambs maintained a relatively high average daily gain of $174.99 \pm 9.18 \text{ g} \cdot \text{day}^{-1}$, whereas the corresponding values decreased to $141.00 \pm 7.86 \text{ g} \cdot \text{day}^{-1}$ in Stogoșă lambs and $134.00 \pm 8.37 \text{ g} \cdot \text{day}^{-1}$ in Turcană lambs. Jigaie lambs therefore achieved a 30.6% higher daily gain than Turcană lambs and a 24.1% higher gain than Stogoșă lambs. The significance grouping confirms that Jigaie lambs differed from both other breeds, while the difference between Turcană and Stogoșă lambs was not significant. The larger error bars recorded during finishing indicate greater individual variability in growth response during this stage than during the fattening period.

When the entire experimental period was considered, all three breeds differed significantly from one another. Jigaie lambs recorded the highest overall average daily gain, at $181.39 \pm 1.06 \text{ g} \cdot \text{day}^{-1}$, followed by Stogoșă lambs at $172.99 \pm 1.11 \text{ g} \cdot \text{day}^{-1}$

and Țurcană lambs at $163.59 \pm 1.21 \text{ g} \cdot \text{day}^{-1}$. Relative to Țurcană lambs, overall gain was 10.9% higher in Țigaie lambs and 5.7% higher in Stogoșă lambs. Țigaie lambs also exceeded Stogoșă lambs by approximately 4.9%. The distinct significance letters assigned to the three means indicate a clear ranking of overall growth performance: Țigaie (>) Stogoșă (>) Țurcană.

The graphical pattern also shows that average daily gain declined progressively from the growth to the finishing stage in Țurcană and Stogoșă lambs. In contrast, Țigaie lambs exhibited only a moderate reduction between the fattening and finishing periods, suggesting a more sustained growth response during the later stage of the production cycle. This sustained finishing performance largely explains the superior overall average daily gain recorded in the Țigaie group.

From a biological perspective, the decline in average daily gain across successive stages is consistent with the general reduction in relative growth rate as animals increase in age and body weight. However, the more pronounced decrease observed in Țurcană and Stogoșă lambs indicates that the magnitude of this age-related reduction differed among the studied groups. Under the feeding and management conditions of the present experiment, Țigaie lambs displayed the most stable growth trajectory and the highest cumulative performance.

The results demonstrate clear differences in productive response among the three breeds, particularly during fattening and finishing. Nevertheless, these differences should not be interpreted as being exclusively genetic. Average daily gain may also be influenced by sex, initial body weight, previous nutritional management, feed intake, health status, maternal effects, and the degree of genetic uniformity within each group. Therefore, the findings support a breed-associated difference in growth performance under the specific conditions of this experiment, but they do not establish a purely causal genetic effect.

It should also be noted that the value for the entire experimental period represents an overall summary and not an additional chronological production stage. Consequently, this category should be interpreted separately from the three successive experimental periods. Overall, the figure indicates that early growth performance was comparable among breeds, whereas significant differences emerged during fattening and became most pronounced during finishing. Țigaie lambs showed the most favourable overall growth performance, Stogoșă lambs ranked second, and Țurcană lambs recorded the lowest cumulative average daily gain.

Table 2

Feed conversion according to breed and production stage

<i>Breed</i>	<i>Nutritional parameter</i>	<i>Growth stage</i>	<i>Fattening stage</i>	<i>Finishing stage</i>	<i>Overall mean</i>
Țurcană	Feed units $\cdot \text{kg}^{-1}$ weight gain	4.8	6.6	8.1	6.6
	Digestible crude protein, $\text{g} \cdot \text{kg}^{-1}$ weight gain	576	726	810	705
Țigaie	Feed units $\cdot \text{kg}^{-1}$ weight gain	4.6	6.2	7.2	6.1
	Digestible crude protein, $\text{g} \cdot \text{kg}^{-1}$ weight gain	552	682	720	671
Stogoșă	Feed units $\cdot \text{kg}^{-1}$ weight gain	4.5	6.3	7.8	6.3
	Digestible crude protein, $\text{g} \cdot \text{kg}^{-1}$ weight gain	540	693	780	693

Feed conversion was expressed as the number of feed units and the amount of digestible crude protein required per kilogram of body weight gain.

Feed Conversion. Feed conversion varied across breeds and production stages (Table 2). Because lower values indicate a smaller amount of feed required per kilogram of body weight gain, reduced feed-unit and digestible crude protein requirements reflect better feed efficiency.

During the growth stage, Stogoșă lambs showed the most favourable feed conversion, requiring 4.5 feed units and 540 g of digestible crude protein per kilogram of weight gain. The corresponding values were 4.6 feed units and $552 \text{ g} \cdot \text{kg}^{-1}$ in Țigaie

lambs and 4.8 feed units and 576 g · kg⁻¹ in Țurcană lambs. Relative to Stogoșă lambs, feed-unit requirements were 2.2% higher in Țigaie lambs and 6.7% higher in Țurcană lambs.

During the fattening stage, Țigaie lambs showed the lowest feed requirements, at 6.2 feed units and 682 g of digestible crude protein per kilogram of gain. Stogoșă lambs required 6.3 feed units and 693 g · kg⁻¹, whereas Țurcană lambs required 6.6 feed units and 726 g · kg⁻¹. Compared with Țigaie lambs, feed-unit consumption was 1.6% higher in Stogoșă lambs and 6.5% higher in Țurcană lambs.

The greatest differences among breeds were observed during the finishing stage. Țigaie lambs maintained the most favourable feed conversion, requiring 7.2 feed units and 720 g of digestible crude protein per kilogram of gain. Stogoșă lambs required 7.8 feed units and 780 g · kg⁻¹, while Țurcană lambs showed the highest requirements, at 8.1 feed units and 810 g · kg⁻¹. Thus, feed-unit consumption was 8.3% higher in Stogoșă lambs and 12.5% higher in Țurcană lambs than in Țigaie lambs.

Feed requirements increased progressively from growth to finishing in all three breeds. Between the growth and finishing stages, feed-unit consumption increased by 68.8% in Țurcană lambs, 56.5% in Țigaie lambs, and 73.3% in Stogoșă lambs. This stage-related increase indicates a progressive decline in feed conversion efficiency as the lambs approached the end of the production cycle.

Based on the reported overall values, Țigaie lambs showed the most favourable feed conversion across the entire experimental period, requiring 6.1 feed units and 671 g of digestible crude protein per kilogram of weight gain. Stogoșă lambs ranked second, with requirements of 6.3 feed units and 693 g · kg⁻¹, whereas Țurcană lambs showed the least favourable overall conversion, requiring 6.6 feed units and 705 g · kg⁻¹. Compared with Țigaie lambs, overall feed-unit consumption was 3.3% higher in Stogoșă lambs and 8.2% higher in Țurcană lambs. Overall digestible crude protein consumption was 3.3% higher in Stogoșă lambs and 5.1% higher in Țurcană lambs.

The ranking observed for overall feed conversion was consistent with the average daily gain results, as Țigaie lambs combined the highest overall growth rate with the lowest feed requirement per kilogram of gain. Stogoșă lambs showed intermediate efficiency, whereas Țurcană lambs required the greatest amount of feed per unit of body weight gain. Nevertheless, these differences should be interpreted descriptively and should not be described as statistically significant because measures of variability and independent experimental replicates were not available.

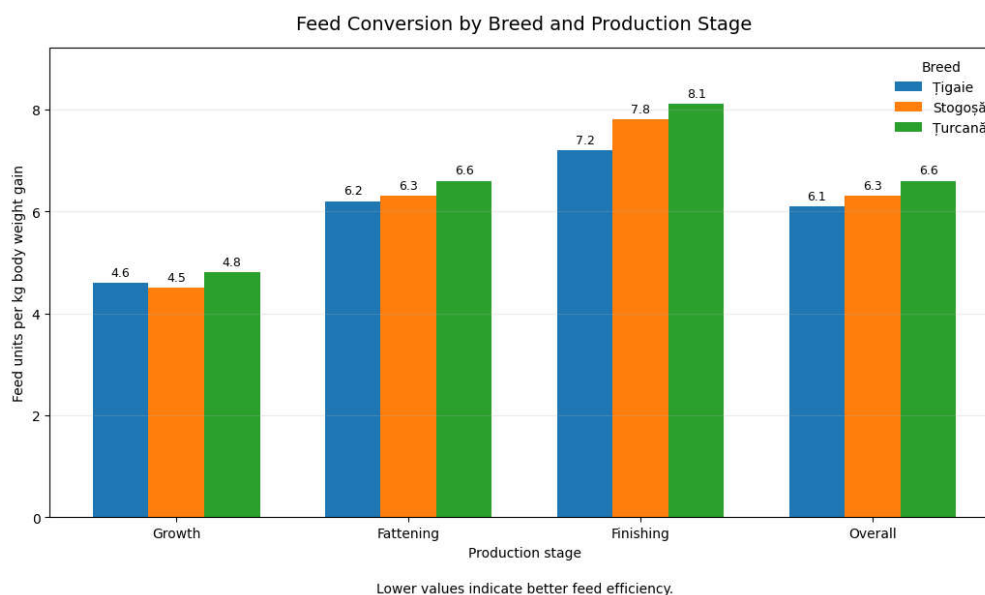


Figure 2. Feed-unit requirements per kilogram of body weight gain in Țigaie, Stogoșă, and Țurcană lambs across production stages.

Figure 2 illustrates the feed-unit requirements per kilogram of body weight gain in Țigaie, Stogoșă, and Țurcană lambs during the growth, fattening, and finishing stages, as well as across the overall experimental period. Because lower values indicate that less feed was required to achieve one kilogram of live-weight gain, reduced feed-unit requirements reflect greater feed conversion efficiency.

During the growth stage, Stogoșă lambs showed the most favorable feed conversion, requiring 4.5 feed units per kilogram of body weight gain. The corresponding value for Țigaie lambs was 4.6 feed units $\cdot$ kg⁻¹ gain, representing an increase of 2.2% relative to Stogoșă lambs. Țurcană lambs had the highest feed requirement at this stage, with 4.8 feed units $\cdot$ kg⁻¹ gain, which was 6.7% higher than that recorded for Stogoșă lambs. Overall, breed-related differences were relatively small during the growth stage, with values ranging from 4.5 to 4.8 feed units $\cdot$ kg⁻¹ gain.

During the fattening stage, Țigaie lambs exhibited the lowest feed requirement, at 6.2 feed units $\cdot$ kg⁻¹ gain. Stogoșă lambs required 6.3 feed units $\cdot$ kg⁻¹ gain, corresponding to a 1.6% increase compared with Țigaie lambs. The highest value was again observed in Țurcană lambs, which required 6.6 feed units $\cdot$ kg⁻¹ gain, or 6.5% more than Țigaie lambs. These results indicate that Țigaie lambs used feed most efficiently during the fattening stage, whereas Țurcană lambs showed the least favorable conversion.

The greatest between-breed differences were observed during the finishing stage. Țigaie lambs maintained the most favorable feed conversion, requiring 7.2 feed units $\cdot$ kg⁻¹ gain. Stogoșă lambs required 7.8 feed units $\cdot$ kg⁻¹ gain, which was 8.3% higher than the value recorded for Țigaie lambs. The highest requirement was observed in Țurcană lambs, at 8.1 feed units $\cdot$ kg⁻¹ gain, representing a 12.5% increase relative to Țigaie lambs. The wider range of values recorded during finishing suggests that breed-related differences in feed efficiency became more pronounced toward the end of the production cycle.

Feed-unit requirements increased progressively from the growth to the finishing stage in all three breeds. In Țigaie lambs, the requirement increased from 4.6 to 7.2 feed units $\cdot$ kg⁻¹ gain, corresponding to a 56.5% increase. In Stogoșă lambs, the increase was from 4.5 to 7.8 feed units $\cdot$ kg⁻¹ gain, equivalent to 73.3%, which was the largest relative increase among the three breeds. In Țurcană lambs, feed-unit requirements increased from 4.8 to 8.1 feed units $\cdot$ kg⁻¹ gain, representing an increase of 68.8%. This consistent stage-related pattern indicates a progressive decline in feed conversion efficiency as the lambs approached the end of the production period.

The increase in feed requirements during the later production stages may reflect age-related changes in growth dynamics and body composition. As animals approach physiological maturity, the relative rate of lean tissue deposition generally declines, whereas a greater proportion of body weight gain may be associated with fat deposition. Because fat accretion has a higher energy cost than lean tissue growth, a greater amount of feed may be required to achieve the same unit of live-weight gain. However, this interpretation should be regarded as a biologically plausible explanation rather than a directly tested mechanism in the present study.

The overall values further support the superior feed efficiency of Țigaie lambs across the experimental period. On average, Țigaie lambs required 6.1 feed units $\cdot$ kg⁻¹ gain, the lowest value among the three breeds. Stogoșă lambs ranked second, with 6.3 feed units $\cdot$ kg⁻¹ gain, corresponding to a 3.3% increase relative to Țigaie lambs. Țurcană lambs showed the highest overall requirement, at 6.6 feed units $\cdot$ kg⁻¹ gain, which was 8.2% higher than that of Țigaie lambs.

Accordingly, the overall ranking for feed conversion efficiency was Țigaie, followed by Stogoșă and Țurcană. Țigaie lambs combined the lowest average feed requirement with consistently favorable conversion during the fattening and finishing stages. Stogoșă lambs performed particularly well during the growth stage but showed a more pronounced increase in feed requirements during the subsequent stages. By contrast, Țurcană lambs generally required more feed per kilogram of body weight gain, particularly during the finishing stage.

Overall, the data shown in Figure 2 indicate that both breed and production stage were associated with variation in feed conversion. Feed efficiency declined progressively as the production cycle advanced, and descriptive differences among breeds were most apparent during the finishing stage. Nevertheless, these results should be interpreted cautiously. Because measures of variability, independent experimental replication, and inferential statistical analyses were not available, the observed differences cannot be considered statistically significant and should be reported only as descriptive trends.

Discussion. The present study demonstrates that maternal breed background was associated with the post-weaning growth performance of lambs obtained by crossing Țurcană, Țigaie, and Stogoșă ewes with Norwegian Blackface rams. The three experimental groups were comparable at the beginning of the trial, with mean body weights of 14.85 ± 0.11 kg in the Țurcană group, 15.18 ± 0.10 kg in the Țigaie group, and 14.95 ± 0.10 kg in the Stogoșă group. Consequently, the differences recorded during the 105-day experimental period were unlikely to have resulted from a substantial initial body weight advantage. Instead, they reflected differences in the growth trajectories of the three crossbred groups under the same general feeding and management conditions. During the initial 15-day growth stage, average daily gain was relatively similar among groups. Stogoșă-derived lambs recorded the highest numerical gain, at 224.59 ± 7.35 g · day⁻¹, followed by Țigaie-derived lambs at 220.00 ± 6.84 g · day⁻¹ and Țurcană-derived lambs at 211.10 ± 7.41 g · day⁻¹. However, the overall group effect was not significant ($F(2, 97.87) = 0.86$, $P = 0.427$), and none of the pairwise comparisons differed significantly. These findings suggest that the three groups had a comparable capacity for early post-weaning growth during the first stage of the experiment.

The relatively high variability observed during the growth stage may have contributed to the absence of statistically significant differences. Standard deviations ranged from 48.41 to 52.42 g · day⁻¹, indicating substantial individual variation within each group. Such variation may reflect differences in adaptation to the experimental diet, previous feeding conditions, health status, maternal environment, or individual growth potential. Therefore, the small numerical advantage observed in the Stogoșă group during this stage should not be interpreted as evidence of superior early growth performance.

Differences among groups became more apparent during the 60-day fattening stage. Average daily gain differed significantly among groups ($F(2, 91.89) = 4.45$, $P = 0.014$). Stogoșă-derived lambs achieved 180.28 ± 2.18 g · day⁻¹, closely followed by Țigaie-derived lambs at 178.59 ± 1.84 g · day⁻¹, whereas Țurcană-derived lambs recorded 166.59 ± 4.09 g · day⁻¹. Compared with the Țurcană group, daily gain was 12.00 g higher in the Țigaie group ($P = 0.025$) and 13.69 g higher in the Stogoșă group ($P = 0.012$). In contrast, the difference of 1.69 g · day⁻¹ between the Țigaie and Stogoșă groups was not significant ($P = 0.824$).

The fattening-stage results indicate that lambs derived from Țigaie and Stogoșă ewes responded similarly during the principal growth period and both outperformed those derived from Țurcană ewes. The relatively low standard deviations recorded in the Țigaie and Stogoșă groups, at 13.03 and 15.39 g · day⁻¹, respectively, also indicate a more uniform growth response than in the Țurcană group, which had a standard deviation of 28.95 g · day⁻¹. This greater uniformity may be relevant in intensive production systems, where consistent growth facilitates feeding management and the achievement of a uniform slaughter weight.

The clearest differentiation among groups occurred during the 30-day finishing stage. The group effect remained significant ($F(2, 97.62) = 6.08$, $P = 0.003$), with Țigaie-derived lambs maintaining an average daily gain of 174.99 ± 9.18 g · day⁻¹. By comparison, average daily gain declined to 141.00 ± 7.86 g · day⁻¹ in Stogoșă-derived lambs and to 134.00 ± 8.37 g · day⁻¹ in Țurcană-derived lambs. The Țigaie group exceeded the Țurcană group by 40.99 g · day⁻¹ ($P = 0.004$) and the Stogoșă group by 33.99 g · day⁻¹ ($P = 0.016$). No significant difference was detected between the Stogoșă and Țurcană groups ($P = 0.815$).

Expressed in relative terms, finishing-stage daily gain was approximately 30.6% higher in the Țigaie group than in the Țurcană group and 24.1% higher than in the Stogoșă group. This marked advantage indicates that the superior overall performance of Țigaie-derived lambs was largely determined by their ability to sustain growth during the final stage of the production cycle. In contrast, Stogoșă-derived lambs performed well during growth and fattening but showed a pronounced reduction in daily gain during finishing.

The stage-related evolution of average daily gain differed substantially among groups. In Țurcană-derived lambs, daily gain decreased from $211.10 \text{ g} \cdot \text{day}^{-1}$ during growth to $166.59 \text{ g} \cdot \text{day}^{-1}$ during fattening and $134.00 \text{ g} \cdot \text{day}^{-1}$ during finishing. This corresponds to an overall reduction of approximately 36.5% between the growth and finishing stages. Stogoșă-derived lambs showed an even more pronounced decline, from 224.59 to $141.00 \text{ g} \cdot \text{day}^{-1}$, representing a reduction of approximately 37.2%. By contrast, Țigaie-derived lambs decreased from 220.00 to $174.99 \text{ g} \cdot \text{day}^{-1}$, corresponding to a smaller reduction of approximately 20.5%.

The progressive decline in growth rate observed particularly in the Țurcană and Stogoșă groups is biologically consistent with the reduction in relative growth intensity that occurs as animals increase in age and body weight. As lambs approach a more advanced stage of physiological maturity, maintenance requirements represent a greater proportion of total nutrient requirements, and a larger proportion of body weight gain may consist of adipose tissue rather than lean tissue. Because fat deposition requires more energy than lean tissue deposition, growth generally becomes less efficient during the later stages of production. Nevertheless, body composition was not measured repeatedly during the experiment, and this explanation should therefore be considered biologically plausible rather than directly demonstrated.

Across the entire 105-day experimental period, statistically significant differences were detected among all three groups ($F(2, 97.71) = 60.86, P < 0.001$). The Țigaie group achieved the highest overall average daily gain, at $181.39 \pm 1.06 \text{ g} \cdot \text{day}^{-1}$, followed by the Stogoșă group at $172.99 \pm 1.11 \text{ g} \cdot \text{day}^{-1}$ and the Țurcană group at $163.59 \pm 1.21 \text{ g} \cdot \text{day}^{-1}$. The Țigaie group exceeded the Țurcană group by $17.80 \text{ g} \cdot \text{day}^{-1}$ and the Stogoșă group by $8.40 \text{ g} \cdot \text{day}^{-1}$, while the Stogoșă group exceeded the Țurcană group by $9.40 \text{ g} \cdot \text{day}^{-1}$. All three pairwise differences were significant at $P < 0.001$.

Relative to the Țurcană group, overall average daily gain was approximately 10.9% higher in Țigaie-derived lambs and 5.7% higher in Stogoșă-derived lambs. The overall gain of the Țigaie group was also approximately 4.9% higher than that of the Stogoșă group. The low standard errors and standard deviations recorded for the overall period indicate that the cumulative differences were consistent within groups. Therefore, the overall ranking of growth performance was clearly Țigaie, followed by Stogoșă and Țurcană.

The feed-conversion results supported the pattern observed for average daily gain. During the growth stage, Stogoșă-derived lambs showed the lowest nutritional requirements, at 4.5 feed units and 540 g of digestible crude protein per kilogram of body weight gain. The corresponding values were 4.6 feed units and $552 \text{ g} \cdot \text{kg}^{-1}$ in the Țigaie group and 4.8 feed units and $576 \text{ g} \cdot \text{kg}^{-1}$ in the Țurcană group. The differences were relatively small during this early stage, which was consistent with the absence of significant differences in average daily gain.

During the fattening stage, Țigaie-derived lambs showed the most favorable conversion, requiring 6.2 feed units and 682 g of digestible crude protein per kilogram of gain. Stogoșă-derived lambs required 6.3 feed units and $693 \text{ g} \cdot \text{kg}^{-1}$, whereas Țurcană-derived lambs required 6.6 feed units and $726 \text{ g} \cdot \text{kg}^{-1}$. Compared with the Țigaie group, feed-unit requirements were 1.6% higher in the Stogoșă group and 6.5% higher in the Țurcană group. Thus, although average daily gain was similar in the Țigaie and Stogoșă groups during fattening, the Țigaie group achieved this performance with a slightly lower nutritional requirement per kilogram of gain.

The largest differences in feed conversion were observed during finishing. The Țigaie group required 7.2 feed units and 720 g of digestible crude protein per kilogram of gain, compared with 7.8 feed units and $780 \text{ g} \cdot \text{kg}^{-1}$ in the Stogoșă group and 8.1 feed

units and $810 \text{ g} \cdot \text{kg}^{-1}$ in the Țurcană group. Feed-unit requirements were therefore 8.3% higher in Stogoșă-derived lambs and 12.5% higher in Țurcană-derived lambs than in Țigaie-derived lambs. This pattern was consistent with the markedly higher finishing-stage average daily gain recorded in the Țigaie group.

Feed conversion deteriorated progressively from growth to finishing in all three groups. Feed-unit requirements increased from 4.6 to 7.2 units $\cdot \text{kg}^{-1}$ gain in the Țigaie group, representing an increase of 56.5%. In the Stogoșă group, requirements increased from 4.5 to 7.8 units $\cdot \text{kg}^{-1}$ gain, corresponding to an increase of 73.3%. In the Țurcană group, the increase was from 4.8 to 8.1 units $\cdot \text{kg}^{-1}$ gain, or 68.8%. Therefore, although efficiency declined in all groups, the magnitude of the decline was lowest in Țigaie-derived lambs.

The overall feed-conversion values further confirmed the advantage of the Țigaie group. Across the experimental period, Țigaie-derived lambs required 6.1 feed units and 671 g of digestible crude protein per kilogram of body weight gain. Stogoșă-derived lambs required 6.3 feed units and 693 g $\cdot \text{kg}^{-1}$, whereas Țurcană-derived lambs required 6.6 feed units and 705 g $\cdot \text{kg}^{-1}$. Relative to the Țigaie group, overall feed-unit requirements were 3.3% higher in the Stogoșă group and 8.2% higher in the Țurcană group. Digestible crude protein requirements were 3.3% and 5.1% higher, respectively.

The agreement between growth performance and feed conversion strengthens the interpretation of the findings. The Țigaie group combined the highest overall average daily gain of $181.39 \text{ g} \cdot \text{day}^{-1}$ with the lowest overall feed requirement of 6.1 feed units $\cdot \text{kg}^{-1}$ gain. The Stogoșă group showed intermediate overall performance, with $172.99 \text{ g} \cdot \text{day}^{-1}$ and 6.3 feed units $\cdot \text{kg}^{-1}$ gain. The Țurcană group recorded both the lowest overall daily gain, at $163.59 \text{ g} \cdot \text{day}^{-1}$, and the highest feed requirement, at 6.6 feed units $\cdot \text{kg}^{-1}$ gain. This consistency suggests that the higher growth of Țigaie-derived lambs was accompanied by a more favorable use of the supplied nutrients.

However, the feed-conversion data should be interpreted more cautiously than the average daily gain results. The reported feed-conversion values were calculated at group level, and measures of variability and independent pen-level replication were not available. Consequently, statistical significance cannot be established for differences in feed-unit or digestible crude protein requirements. These values should therefore be described as numerical or descriptive differences rather than statistically confirmed effects.

An additional consideration is that diet composition changed among the three production stages. The diets provided 0.82 feed units and 98 g of digestible crude protein per kilogram during growth, 0.80 feed units and 88 g $\cdot \text{kg}^{-1}$ during fattening, and 0.90 feed units and 90 g $\cdot \text{kg}^{-1}$ during finishing. The roughage proportion also changed from 40% during growth to 45% during fattening and 30% during finishing. Therefore, the stage-related changes in growth and feed conversion cannot be attributed exclusively to increasing age or body weight, because physiological stage and diet composition changed simultaneously.

The findings should also be interpreted in relation to the crossbred structure of the experimental groups. All lambs were sired by Norwegian Blackface rams, while the maternal breeds were Țurcană, Țigaie, and Stogoșă. Accordingly, the results represent differences among maternal breed groups within a common paternal background and should not be presented as direct comparisons among purebred lambs. The observed performance may reflect maternal breed effects, interactions with the Norwegian Blackface paternal genotype, heterosis, or a combination of these factors.

Other potential sources of variation include sex, litter size, dam age, maternal nutrition, previous farm management, health status, and farm of origin. Because the lambs originated from both state farms and private holdings, environmental conditions before the experiment may not have been identical. Although the groups were formed according to age and body weight, the absence of detailed adjustment for these additional factors limits the extent to which the observed differences can be attributed exclusively to maternal breed background.

Overall, the results indicate that Țigaie-derived lambs exhibited the most favorable productive profile under the conditions of the present experiment. Their principal

advantage was the ability to maintain a relatively high daily gain during finishing, resulting in the highest overall growth rate and the lowest descriptive feed requirement per kilogram of gain. Stogoșă-derived lambs showed favorable growth during the initial and fattening stages but experienced a pronounced decline during finishing. Țurcană-derived lambs recorded the lowest cumulative growth and the highest overall nutritional requirement.

These findings suggest that Țigaie ewes may represent a favorable maternal component in terminal crossing systems involving Norwegian Blackface rams and intensive lamb production. Nevertheless, this conclusion should be confirmed through experiments incorporating replicated pens, individual feed-intake measurements, balanced distributions of sex and birth type, documented pedigrees, and statistical models accounting for farm of origin and repeated measurements. Such an approach would allow growth performance, feed efficiency, maternal effects, and crossbreeding effects to be evaluated more precisely.

Conclusions. Maternal breed background influenced the productive performance of Norwegian Blackface-sired lambs under intensive feeding conditions. Țigaie-derived lambs showed the highest overall average daily gain and the most favorable descriptive feed conversion, particularly during the finishing stage. Stogoșă-derived lambs had intermediate performance, while Țurcană-derived lambs recorded the lowest overall growth rate and the highest feed requirement per kilogram of gain.

These results suggest that Țigaie ewes may represent the most suitable maternal component for terminal crossing with Norwegian Blackface rams in intensive lamb production systems. However, the feed-conversion differences should be interpreted descriptively and confirmed in future studies using individual intake measurements and replicated experimental units.

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References

- Åby, B. A., Bhatti, M. A., & Steinheim, G. (2024). Rumen size of sheep: difference between a modern and a native Norwegian sheep breed. *Acta Agriculturae Scandinavica, Section A—Animal Science*, 73(3-4), 79-85.
- Bogdan, L., Groza, I., Simona, C., Pall, E., & Simonca, S. (2006). Reserches regarding extraseason estrus inducing and siconisation in sheep. *Buletin USAMV-CN*, 63, 195–200.
- Cighi, V. (2016). Morpho-productive characterization of a Tsigai breed sheep stock. *ABAH Bioflux*, 8(1), 15-20.
- Cîmpean, A., Brozan, M. M., & Pojar, T. N. (2025a). The impact of oxidative stress on growth performance and metabolic health in broiler chickens. *Cluj Veterinary Journal*, 30(1), 19–31.
- Cîmpean, A., Pojar, T. N., & Borzan, M. M. (2025b). Evaluating the Apgar Index in newborn lambs: A comparative study across first, second, and third lambings in Merino Breed Type M. *Revista Română de Medicină Veterinară*, 35(2), 101–106.

- Coroian, C., Dărăban, S., Pop, A., Cătoi, C., Odagiu, A., Pece, A. (2009). The study of intensive fattening of youth sheep from different breeds in Romania. *ABAH Bioflux*, 1(1), 49-56.
- Ghița, E., Lazăr, C., Pelmuș, R., & Voicu, I. (2010). Comparative research on the fattening aptitudes of the growing lambs of local Romanian breeds. *Biotechnology in Animal Husbandry*, 26(1-2), 13-20.
- Ilișiu, E., Dărăban, S., Gabi-Neacșu, M., Ilișiu, V.-C., & Rahmann, G. (2010). Improvement of lamb production in Romania by crossbreeding of local Tsigai breed with high performance breeds. *Landbauforschung – Applied Agricultural and Forestry Research*, 60(4), 259-266.
- Lipecka, C., Gruszecki, T., Pięta, M., Szymanowska, A., Patkowski, K., Szymanowski, M., & Junkuszew, A. (2001). Meat performance of hybrid ram lambs with different shares of a prolific breed. *Archiv für Tierzucht*, 44(Special Issue), 370-376.
- Popa, D., Rusu, M., Padeanu, I., Cotirlea, D., Voia, S., Sprinjean, D., & Bozdog, C. (2011). Results regarding body weight and average daily gain in Turcana and crossbred Suffolk × Turcana lambs. *Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Veterinary Medicine*, 68(1), 291-294.
- Rakossy, Z., Petrescu-Mag, I. V., Kovacs, E., Gavriloaie, C., Corioan, C. O., Păpuc, T., Ungureanu, T., Botha, M. (2019a). Saving the black variety of the Red face Tsigai - documenting efforts to rescue an endangered breed. *ABAH Bioflux*, 11(2), 54-61.
- Rakossy, Z., Petrescu-Mag, I. V., Kovacs, E., Gavriloaie, C., Corioan, C. O., Păpuc, T., Ungureanu, T., Botha, M. (2019b). Why should be rescued the black variety of the Red face Tsigai? *ABAH Bioflux*, 11(2), 62-68.
- Vicovan, G. P., Enciu, A., Neacșu, C., Vicovan, A., & Radu, R. (2017). Researches regarding slaughtering output and carcass characteristics at crossbreeds F1 Romanov × Palas Merino and F1 Prolific Breed-Palas × Palas Merino. *International Journal of Science and Research*, 6(1), 1498-1502.
- Zaharia, R., Pascal, C., Zaharia, N., Lazăr, R., & Salamon, S. (2012). The influence of the fattening system on growth rate and dressing percentage of the Țurcană lambs bred in mountain areas in the north-east of Romania. *Scientific Papers-Animal Science Series: Lucrări Științifice, Seria Zootehnie*, 57, 190-195.
- Zamfir, C. Z., Vicovan, G. P., Răducu, R., Enciu, A., Nicolescu, A., Stanciu, M., & Pivodă, C. A. (2017). Researches regarding the improvement of the meat production at the local sheep breeds from Romania through crossbreeding with specialized breeds, Palas Meat Breed, Suffolk, Charollais. *Scientific Papers-Animal Science Series: Lucrări Științifice – Seria Zootehnie*, 68, 53-58.

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