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THE SEASONALITY AND ECONOMIC EFFICIENCY OF SHEEP MILK PRODUCTION - A CASE STUDY IN KARAKUL BREED, ROMANIA

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Abstract

The present study aimed to analyze sheep milk production and its economic efficiency in terms of average production, total production, production costs, revenues, and financial outcomes during the 2022-2023 production year. The experiments were conducted on a flock of 35 sheep of the Karakul breed, white variety, raised at the Popauți Research Development and Innovation Station, Botoșani County, Romania. The evaluation of results and calculation of indicators were performed at the University of Agronomic Sciences and Veterinary Medicine Bucharest. These research endeavors are original and pursued two objectives: firstly, the analysis of production performance as aforementioned, and secondly, the improvement of this breed aiming to increase milk production, although the breed is known for its specialization in skin production, the marketing of which has become problematic both in Romania and in traditionally sheep-rearing countries. The method used to determine milk production was the "Bi-monthly coefficient control method, which allows for the determination of milk production both during the suckling period for ewes with lambs and after weaning the lambs". Applying this method to the studied animal population recorded a total production of 1954.12 liters of milk per year, an average monthly milk production of 79.38 liters, an average milk production per sheep of 56.00 liters, and an overall lactation average production of 0.266 liters of milk per sheep per day. Analyzing the productive performances, it can be concluded that this color variety within the Karakul breed can be improved towards increasing milk production without affecting the quality of the skins.

Key words**:** *milk yield, milk production, seasonality, economic efficiency, Karakul breed, Romania*

INTRODUCTION

The Karakul sheep breed, originating from the Bukhara region, Uzbekistan, was introduced to Romania for the improvement of local breeds, with a focus on fur production. Although initially milk production was not a priority, interest in this breed has gradually increased. Improving milk production, especially in ewes whose lambs are sacrificed for fur, has become important for increasing the profitability of farms and diversifying the sheep economy in Romania.

Given the morpho-productive characteristics of the Karakul breed, research conducted by various authors has demonstrated that the body conformation of this breed can easily transition from a breed specialized in fur production to a mixed-purpose breed, suitable for both fur and meat production, as well as fur and milk production [8][9].

In 2023, Ion Buzu highlighted that the Karakul sheep breed, with its morpho-productive traits related to body mass growth, body length, and constitution, can produce lambs with an average body mass ranging between 4.7 and 5.0 kg, sometimes even exceeding 5 kg. He emphasized that lamb body mass correlates phenotypically with various characteristics such as ewe age at lambing, body length, skin thickness, fiber length, skin surface area, and loop size, while constitution is inversely proportional to ewe prolificacy and fur quality [2].

In a study conducted by Frujina C. et al. [5] in 2009, the process of improving the indigenous Turcana breed through crossbreeding with the French Vendeen and White of Central Massif breeds was investigated. The results of the study highlighted significant improvements in growth performance, weight, and average daily gain of young sheep.

During the same period, Raducuta [12] compared milk production in the local (Turcana) breed from north-western Romania, F1 crossbred females in their second lactation, and the milk production of Awassi sheep. The conclusions indicated that F1 females recorded a higher total production than local breeds but lower than those specialized in milk production, such as Awassi.

In 2014, Mihail Groza [6] investigated the influence of color genes in Karakul sheep on milk production and observed that there were no significant differences between color varieties, except for the brown and gray varieties.

In 2006, Malos I.G. [7] presented the idea that improving milk production can be achieved through selection. He highlighted the variability coefficients calculated for average daily and total milk production, as well as for the average lactation period. It was observed that the Karakul breed, especially the black variety, exhibits wide limits in these aspects.

In light of these findings, the main purpose of the study is to demonstrate the economic efficiency of the Karakul breed, white variety, by optimizing its lactogenic potential without compromising the quality of newborn lambs' fur.

MATERIALS AND METHODS

The study was conducted between 2022 and 2023 at the University of Agronomic Sciences and Veterinary Medicine Bucharest, Faculty of Animal Production Engineering and Management, based on data collected from records completed at the S.C.P.C.O.- Popauţi unit, on the Karakul sheep population of Botoșani, white color variety.

The biological material studied consisted of 35 lactating ewes.

Quantitative milk production was determined using the bi-monthly coefficient control method (Nica T., Dermengi B, and Ștefănescu C. in 1965) [10], which allows for the determination of milk production both during the suckling period for ewes with lambs and after weaning the lambs.

The following indicators were determined: total average production per lactation, lactation duration, and average daily production to estimate lactogenic potential and lactation secretion persistence. The structure of the ewe population was then established based on total milk production per lactation and lactation duration to highlight the proportion of superior variants and determine the chances of success in potential milk production-based selection.

Lactation curves were developed using graphical methods.

The economic study consisted of calculating operating expenses, including:

- feed costs;
- costs of electricity and fuel used;
- labor costs.

The results obtained were synthesized in tables and utilized to create graphs for more suggestive interpretation compared to existing bibliographic data.

RESULTS AND DISCUSSIONS

Lactation curve

From the graphical representation of the lactation curve of the sheep nucleus over the months, it can be observed that the highest average production was recorded in March, with 10.95 liters, during the first part of the month, decreasing to 7.30 liters in the second part of the month.

Starting from April, the average production experienced an increase with a peak in May's first half, reaching 8.38 liters, followed by a slight decrease. Subsequently, there was a gradual decline until reaching a threshold of 1.23 liters (Fig. 1).

Milk yield and total production

The dynamics of milk yield and total production are illustrated in Fig. 2, where it is observed that: lactation lasted for an average duration of 7 months, with the average production per lactating sheep being 79.38 liters, the average production per ewe was 56.00 liters, and the average milk yield per ewe over the entire lactation period was 0.266 liters; the lactation curve begins in March, with a production of 18.26 liters/month, followed by a decline and plateau, maintaining around 15.00 liters until June, then gradually decreasing until September, reaching a threshold of 3.30 liters (Fig. 2).

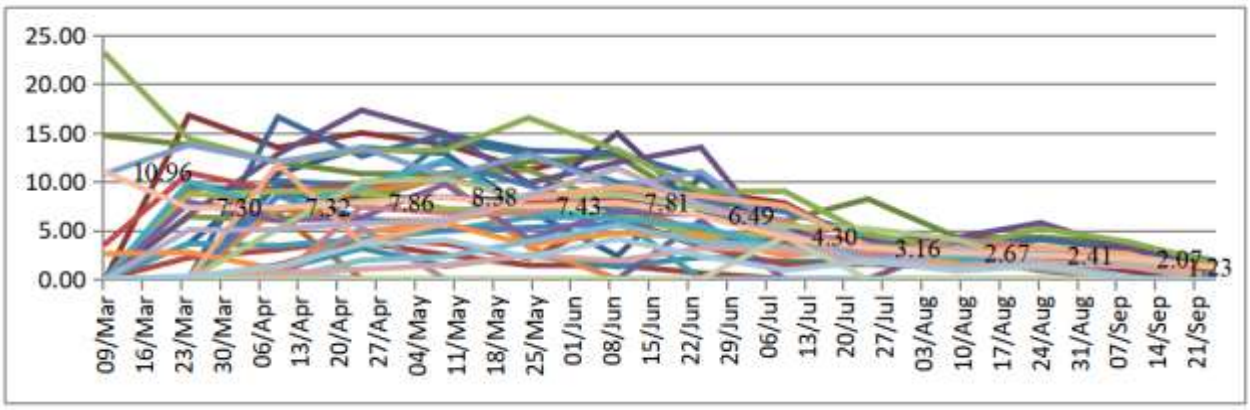

Fig.1. Lactation Curve of the Sheep Nucleus Over Months (liters/sheep)
Source: Own design based on collected farm data.

Total average milk production per month/year (liters)

The average milk production per ewe exhibited considerable variation throughout the year. During the spring and summer months (March-September), production was higher, reaching a peak in May with 15.81 liters, while during the summer months (July-August), production significantly decreased, reaching 3.30 liters in September.

In total, the average milk production per ewe for the entire year was 79.38 liters. It is observed that the highest average productions were recorded in March and April, with 18.26 and 15.18 liters respectively, while the lowest were in September, with 3.30 liters.

Seasonal variability in milk production can be attributed to factors such as the stage of lactation of the ewes, availability of food resources, and environmental conditions. The warmer and drier months of summer can negatively affect milk production, while periods with rich grazing and optimal environmental conditions can stimulate production.

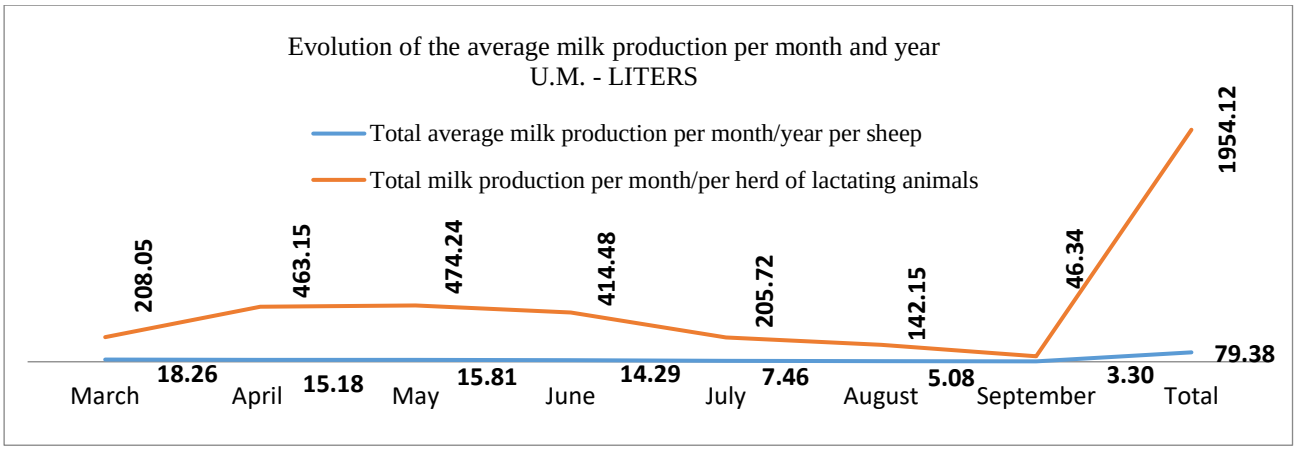

Fig. 2. Dynamics of milk yield and total production by month and lactation year (Liters)
Source: Own design based on the collected data in the farm.

In conclusion, the data indicate significant variation in milk production throughout the year, with clear trends of increase and decrease depending on the season and other environmental and management factors. It is essential for sheep producers to consider these fluctuations in planning and managing nutrition and environmental conditions to optimize sheep production performance.

Total milk production per month/lactation year (liters)

The evolution of milk production showed a significant trend during the monitoring period. Starting from March, milk production recorded an initial value of 208.05 liters, progressively

increasing in the following months. This increase reached a notable peak in May, when production reached 474.24 liters, representing the peak of the lactation period. However, after this peak, milk production experienced a gradual decrease starting from July.

Regarding monthly quantitative variation, the data highlight a significant difference between the maximum and minimum milk production recorded during the study period. In May, production reached its zenith with 474.24 liters, while in September, it recorded the minimum value of 46.34 liters. This variation can be explained by the influence of various physiological and environmental factors that interact during the lactation period.

Regarding influences on milk production, it appears that the presence of the lamb and feeding with green forage played an important role in stimulating milk production, especially in the first 5 months of lactation. This finding emphasizes the importance of adequate nutrition and efficient animal management in optimizing sheep production performance throughout the lactation period.

Table 1. Milk yield by month/year and total production by month/year (Liters)

	March	April	May	June	July	August	September	Total
Total average yield by month/year	18.26	15.18	15.81	14.29	7.46	5.08	3.30	79.38
Total milk production by month/lactation year	208.05	463.15	474.24	414.48	205.72	142.15	46.34	1,954.12

Source: own determination based on the data collected from the registers completed within the S.C.P.C.O.- Popauți unit.

Classification of milk production and milking sheep distribution by class

The milking sheep were classified by production intervals as presented in Table 2.

Table 2. Total Milk Production Classes/Head/Lactation

Nuclee	Classes of total milk production /head/lactation (%)						
	Below 20lt	20.1 – 40lt	40.1 – 60lt	60.1 – 80lt.	80.1 – 100lt.	100.1 – 120 lt	Over 120lt.
White Karakul	22.86	20	11.43	22.86	8.57	8.57	5.71

Source: own determination based on the data collected from the registers completed within the S.C.P.C.O.- Popauți unit.

In terms of the percentage distribution of ewes, based on total production classes per lactation, it was observed that the highest proportion, 28.86%, is held by ewes from production classes below 20 and 60.1 - 80 liters, while the lowest, 5.71%, are those from classes above 120 liters (Table 2, Fig. 3).

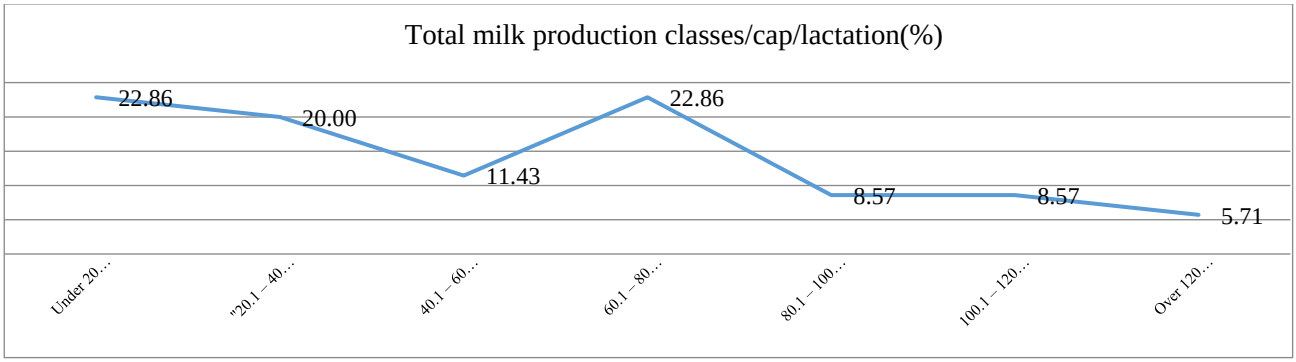

Fig. 3. The distribution of milking sheep by production classes (%)
Source: Own design based on the collected data in the farm.

So, out of the total population of white Karakul sheep, those achieving a production below 20 liters represent 22.86%, while those producing between 20.1 - 40 liters represent 20.00%. Ewes with a production of 60.1 - 80 liters represent 22.86%, those with a production of 80.1 - 100 liters, and those with a production of 100.1 - 120 liters account for 17.14% each, while ewes with a production exceeding 120 liters of milk have a proportion of 5.71%.

Table 3. Lactation Persistence Classes (%)

	Lactation persistence classes (%)								
	Below 60 days	61 – 80 days	81 – 100 days	101 – 120 days	121 – 140 days	141 – 160 days	161 – 180 days	181 – 200 days	Over 200 days
White Karakul	14.28	2.86	5.71	0	2.86	14.28	22.86	25.72	11.43

Source: own determination based on the data collected from the registers completed within the S.C.P.C.O.- Popauţi unit.

Lactation persistence provides us with information regarding total milk production, allowing us to selectively breed only the superior ewes to obtain a flock with high yields. On the other hand, it ensures a substantial income through efficient milk utilization.

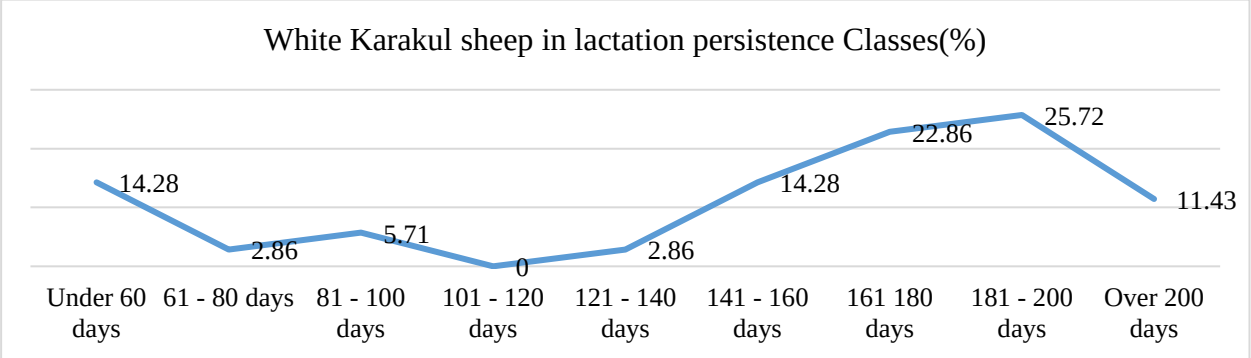

Fig. 4. Distribution of White Karakul Ewes in Lactation Persistence Classes
Source: Own design based on collected farm data.

The distribution of White Karakul ewes in relation to lactation persistence classes highlights that 25.72% of the total population are represented by ewes with a lactation persistence between 181 and 200 days, while only 2.86% fall into lactation persistence classes of 61 – 80 days and 121 – 140 days.

The graph reveals that 77.15% of the total population of White Karakul sheep exhibit a lactation persistence greater than 121 days. In this distribution, the majority of ewes fall into lactation persistence classes between 161 and 200 days, with the highest proportion (25.72%) for 181 – 200 days, followed by 22.86% for 161 – 180 days.

The combined analysis of the percentage distribution of the White Karakul population in production and lactation persistence classes emphasizes the ability to identify and select females with milk yields greater than 60.1 liters within a lactation period of 120-140 days. These findings suggest the possibility of establishing future breeding nuclei based on individuals with superior lactogenic potential.

Figure 5 reveals that the majority of individuals are positioned above average in terms of milk production. This suggests that there is a significant number of animals with yields equal to or greater than the average production, which can be leveraged in their selection for the breeding nucleus.

By identifying and retaining individuals with milk yields above average, it is possible to increase selection efficiency and improve lactation performance. Choosing these specimens for breeding can contribute to enhancing the quality and yield of the livestock intended for milk production.

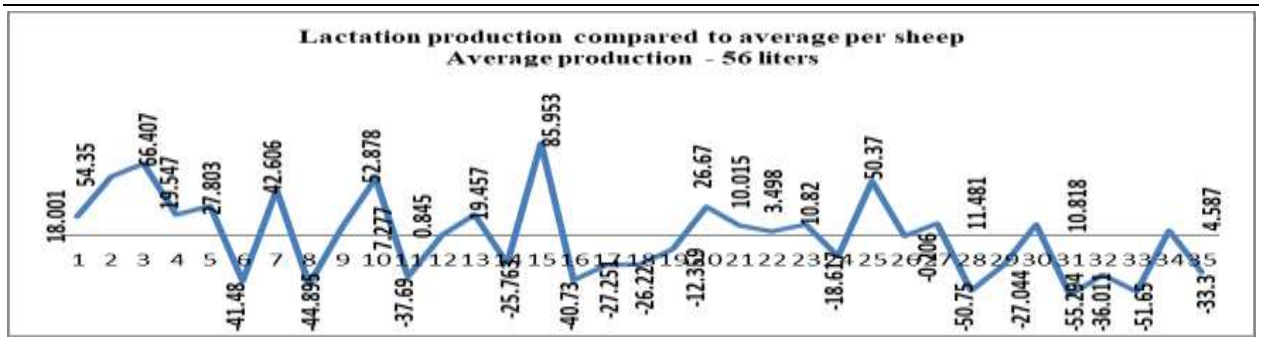

Fig.5. Deviations of Lactation Production from Average/Sheep
Source: Own design based on collected farm data.

In Figure 6, the data highlights that the number of sheep with total productions higher than the average production is significantly larger compared to the number of sheep with productions below average. This suggests that there is a considerable proportion of animals with yields above the average level of the flock.

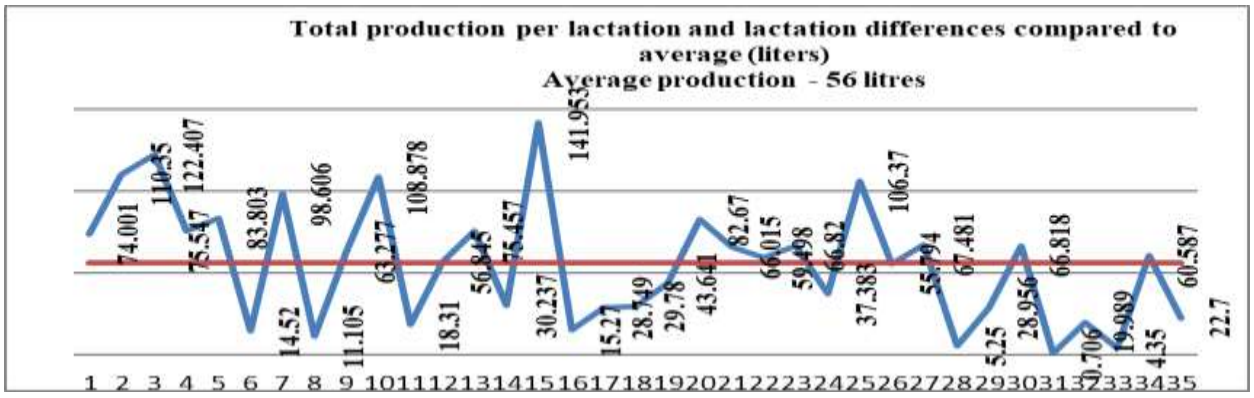

Fig. 6. Evolution of Total Lactation Production and Deviations from Average
Source: Own design based on collected farm data.

The results presented in the graphical representation underline a positive trend regarding the total production of the flock. Identifying these trends and the distribution of total production relative to the mean can guide the selection and management of the sheep flock.

Through the interpretation of graphs and associated data, it is possible to identify and select sheep with total productions higher than the average, thus contributing to improving performance and production efficiency within the farm or livestock unit.

Economic analysis regarding the profitability of production

A. Operating expenses for sheep(a) Expenses for feed are presented in Table 4.

Table 4. Feed Expenses

	Forage	Quantity kg	Price Lei/kg	Cost
1	Alfalafa green mass	17,784.06	0.08	1,422.72
2	Fodder beet - green mass	17,811.25	0.08	1,424.92
3	Cereals	4,680.55	1.0	4,680.55
4	Hay	9,746.45	0.75	7,309.83
5	Suculents–corn silage	1,4854	0.07	1,039.78
6	Straw	5,020.05	0.05	251.00
7	Milk and lamb replacers	624.4	0.5	312.2
	TOTAL			**16,214.8**

Source: "Nutrition and Feeding of Livestock", 2017, accessed on November 10, 2023[11]; Nutrition and Animal Feeding, Practical Workbook, p. 55-56[**4**]; Decision approving the average prices of agricultural products for the year 2022, Accessed on November 10, 2023 [3].

(b) Expenses for electricity and fuels

b1. Energy expenses are presented in Table 5.

Table 5. Energy Consumption and Expenditures

Average livestock			**35 heads**
Exchange rate Lei/Euro			4.97
Indicators	Daily consumption per farm (kw)	Annual consumption per farm (kw)	Tariff Lei/kw
Energy consumption for watering	0.3	109.5	0.45
Total value (Lei/year)		49.28	
Total value (euro)		9.91	
Revine pe animal (Lei)	Per animal (Lei)	1.40	
Revine pe animal (Euro)	Per animal (Euro)	0.28	
Energy consumption for grinding mill	0.5	182.5	0.45
Total value (Lei/year)		82.13	
Total value (Euro)		16.52	
Per animal (Lei)		2.35	
Per animal (Euro)		0.47	
Energy consumption for lighting	0.1	36.5	0.45
Total value (Lei/year)		16.43	
Total value (Euro)		3.3	
Per animal (Lei)		0.47	
Per animal (Euro)		0.1	
Total energy consumption per sheep farm	0.9	328.5	0.45
Total value (Lei/year)		147.83	
Total value (Euro)		29.74	
Per animal (Lei)		4.22	
Per animal (Euro)		0,85	

Source: Own calculation based on technical norms.

B. Income

Assessment of Productions

With a total of 35 sheepskins, valued at 500 lei per animal[1], the total value of the obtained skins is 17,500.00 lei. This aspect indicates the importance of raising and exploiting skins for generating additional income within the unit.

Table 6. Assessment of Gross Product

Specifications	**Indicators**	**Lei/ sheepskin**	**Total**
Sheepskin	35 heads	500	17,500.00
Total milk production	1,954 liters	3 Lei/liter	5,862.00
Subsidies	35 heads	84.49	2, 957.15
			26,319.15

Source: Own design based on the collected data in the farm; data retrieved from publication on January 8, 2019, 15:17, Accessed on December 8, 2023[1].

With a total of 1,954 liters of milk produced, valued at 3 lei per liter, the income generated from milk sales is 5,862.00 lei. This highlights the significant contribution of milk production to the total unit income and emphasizes the importance of optimizing this activity.

For the 35 sheepskins, the obtained subsidies amount to 84.49 lei per animal, generating a total of 2,957.15 lei. These subsidies represent significant financial support for animal raising activities and can contribute to improving the financial performance of the unit.

The total amount of income obtained by the respective unit amounts to 26,319.15 lei, considering the revenues from sheepskin valorization, milk sales, and received subsidies. This sum represents a significant part of the total revenues and demonstrates the diversity of activities and income sources of the unit.

C. The financial result (FR) is calculated according to the formula:

$$FR = I - C,$$

where:

I = income and C = costs

The financial result is presented in Table 7.

Table 7. Financial Result (Lei)

Total income	Total costs	Gross Profit
26,319.15	20,145.59	6,173.56

Source: Own design based on the collected data in the farm.

The financial result (FR) is calculated as the difference between total income and total expenses. From the data presented in Table 7,

it can be observed that the total income amounted to 26,319.15 lei, while the total expenses were 20,145.59 lei. By calculating the difference between income and expenses, we obtain a financial result (FR) of 6,173.56 lei. This positive financial result (FR) indicates that the economic activity or entity has recorded a gross profit, with its value being 6,173.56 lei. The net profit is presented in Table 8. This positive financial result (FR) indicates that the economic activity or entity has recorded a net profit, with its value being 5,185.79 lei.

Table 8. Net Profit (Lei)

Gross profit	Profit tax	Net profit
6,173.56	987.77	5,185.79

Source: Own design based on the collected data in the farm.

CONCLUSIONS

Sheep, through their products: milk and meat, must significantly contribute to meeting the consumption needs, implicitly covering the deficit of animal protein.

This study focused on analyzing milk production in the Karakul breed, specifically the total average production per lactation, lactation duration, and average daily production to estimate lactogenic potential, lactation persistence, and the economic efficiency of raising and exploiting the breed without compromising the quality of the newborn lamb skins.

The study conducted on the sheep flock under investigation highlights a significant variation in the average milk production per ewe throughout the year, with a noticeable increase in spring and summer months, reaching a peak in May at 15.81 liters, and a steep decline in summer months, especially in September, with 3.30 liters. Overall, the annual average production was 79.38 liters. Seasonal variability was influenced by the lactation stage of the ewes and the availability of food resources and environmental conditions. The presence of lambs and feeding with green forage played a significant role in supporting lactogenic production, emphasizing the need for efficient management to optimize the lactogenic performance of the sheep, with the potential to maximize the economic yield of production.

The distribution of Karakul ewes according to production classes and lactation persistence reveals that a significant proportion, 28.86%, of the population presents productions below 20 and between 60.1 - 80 liters, while only 5.71% of total sheep fall into the classes of over 120 liters. This underscores the importance of identifying and selecting specimens with superior lactogenic potential to consolidate the economic performance of the sheep population.

The combined analysis of the percentage distribution of Karakul ewes according to production and lactation persistence highlights the possibility of identifying and selecting females with significant lactate productions, over 60.1 liters, in a period of 120-140 days of lactation. This strategy could contribute to forming future breeding nuclei based on specimens with superior lactogenic potential, thus strengthening the economic efficiency of livestock exploitation.

Most individuals in the sheep population are above average in terms of milk production. This finding indicates the presence of a significant number of animals with productions higher or equal to the average, emphasizing the importance of their utilization in the selection process for the breeding nucleus. Retaining and identifying individuals with above-average lactate productions can lead to more efficient selection and improvement of performances in milk production. Choosing these specimens for reproduction has the potential to improve the quality and yield of the entire herd intended for milk production. The data clearly show that the number of sheep with total productions higher than the average is considerably higher than the number with productions below the average, highlighting the presence of a significant proportion of animals with productions above the average level of the population.

Essentially, increasing the lactogenic potential of Karakul sheep, especially those forming the breeding nucleus at any given time, is important for at least three major reasons:

By slaughtering lambs within the first 24 - 48 hours of birth for obtaining skins, an additional

significant quantity of marketable milk can be obtained by milking during that period.

The existence of superior quantitative and qualitative milk secretion in ewes during the nursing period of lambs is essential (mostly in the first two months of the lambs' life) for their good development, contributing to reducing losses through mortality, increasing organic resistance, and subsequently reaching their productive potential, regardless of the direction of exploitation (skins, wool, milk, meat).

The fact that sheep's milk is in high demand by processors for transformation into various assortments and types of cheeses, highly appreciated by consumers. It should be noted here that the most valuable milk for the processing industry is obtained during the summer-autumn period, which is characterized by a much higher content of dry matter, proteins, and fat.

The economic study clearly indicates that increasing milk production alongside quality skins leads to increased profitability of milk production.

The analysis of expenses in the production unit emphasizes the importance of economic efficiency in managing financial resources. Significant expenses, such as those for fodder and energy, require careful management to optimize costs and maximize the return on investments. Efficient labor management is also essential to ensure a balance between wage costs and operational efficiency. Constant control of these expenses is crucial for the long-term sustainability and competitiveness of the enterprise.

In conclusion, the financial result analysis indicates a positive financial situation, as revenues exceeded expenses, generating a net benefit of 6,173.56 lei. It is important to emphasize that achieving a positive financial result is an indicator of the efficiency and financial sustainability of the economic activity or entity.

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