



75th EAAP Annual Meeting, Florence – Italy, 1-5 September 2024

PHENOTYPIC AND GENETIC PARAMETERS OF LACTATION PERSISTENCY AND MILK YIELD OF PATCH-FACED MARITZA SHEEP BREED



Petya ZHELYAZKOVA

*Breeding Association of Maritza Sheep Breeds,
Plovdiv, BULGARIA*

Doytcho DIMOV

*Department of Animal Sciences, Agricultural University,
Plovdiv, BULGARIA*

Horia GROSU

*Animal Science Faculty, University of Agricultural Sciences and Veterinary Medicine,
Bucharest, Romania*



Patch-faced Maritza sheep breed – *short information*

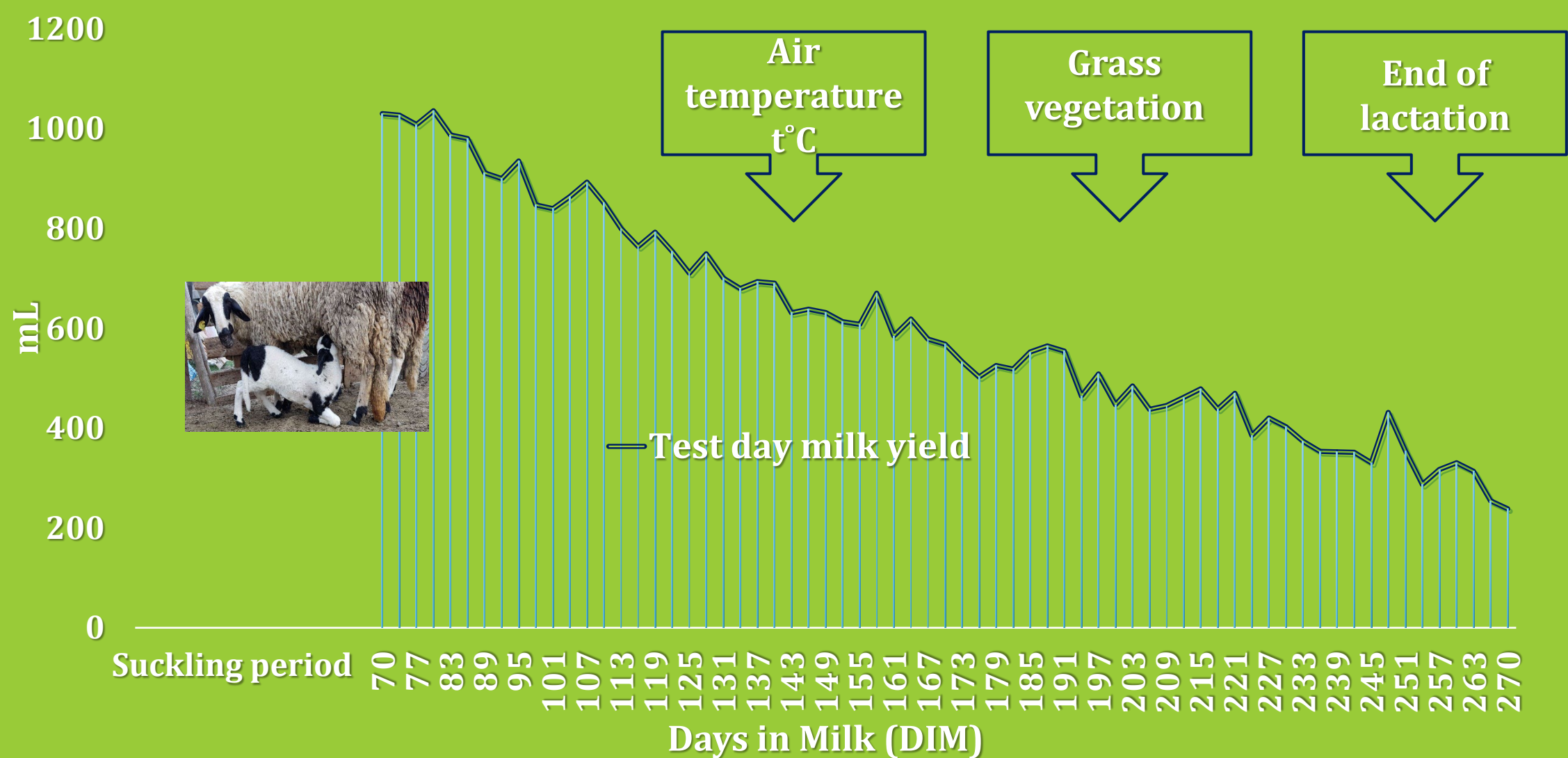
- ✓ Bulgarian native sheep breed
- ✓ Dual purpose – meat and milk



- Recognized breeding association;
- Approved breeding program;
- Population size – 9 191;
- 83 flocks;
- Main traits for selection & Prolificacy, Litter weight at weaning and Milk yield.



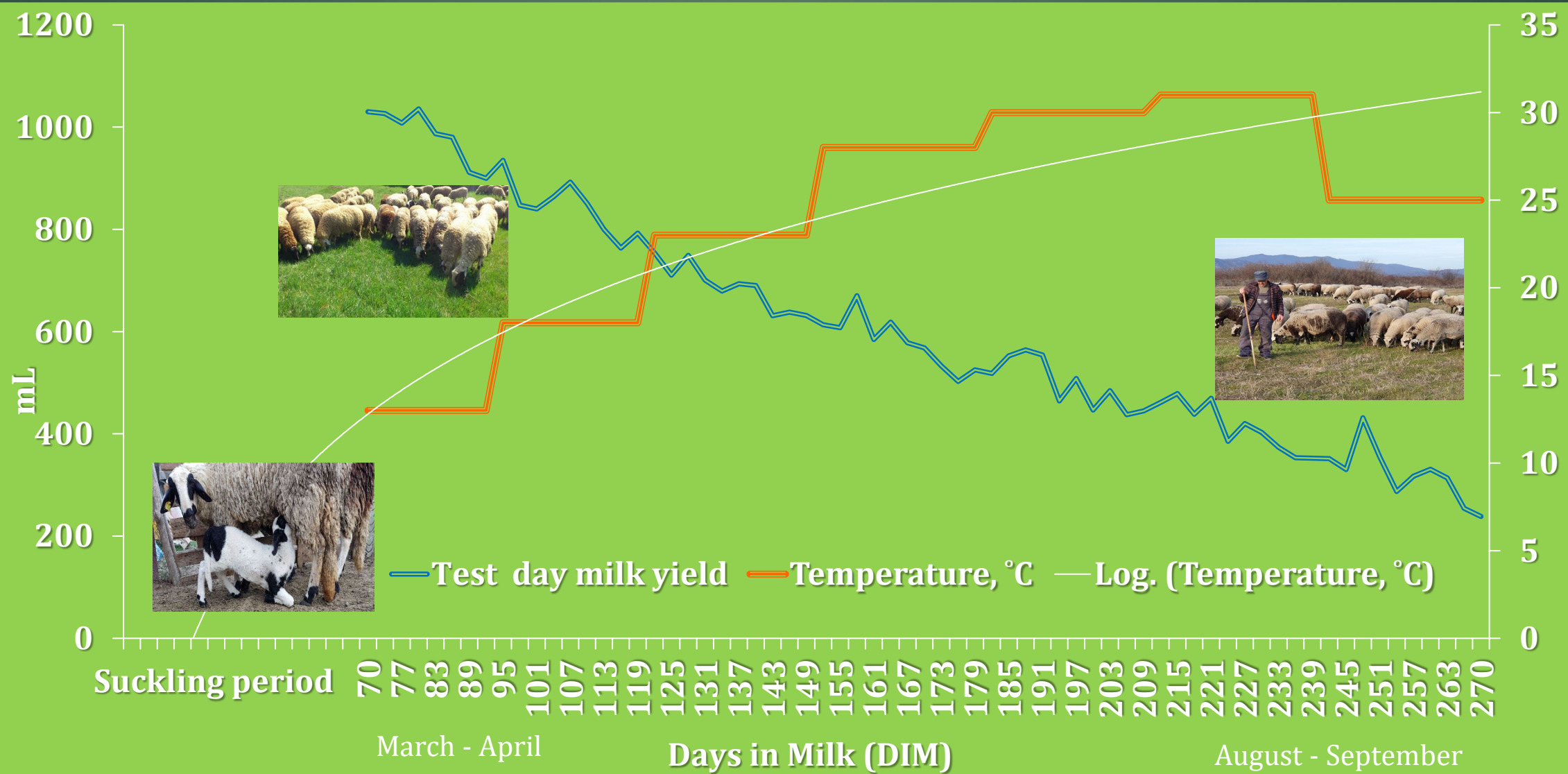
Lactation curve in sheep in traditional production systems?



The milk yield potential of Patch-faced Maritza sheep is realized under the strong influence of environmental factors



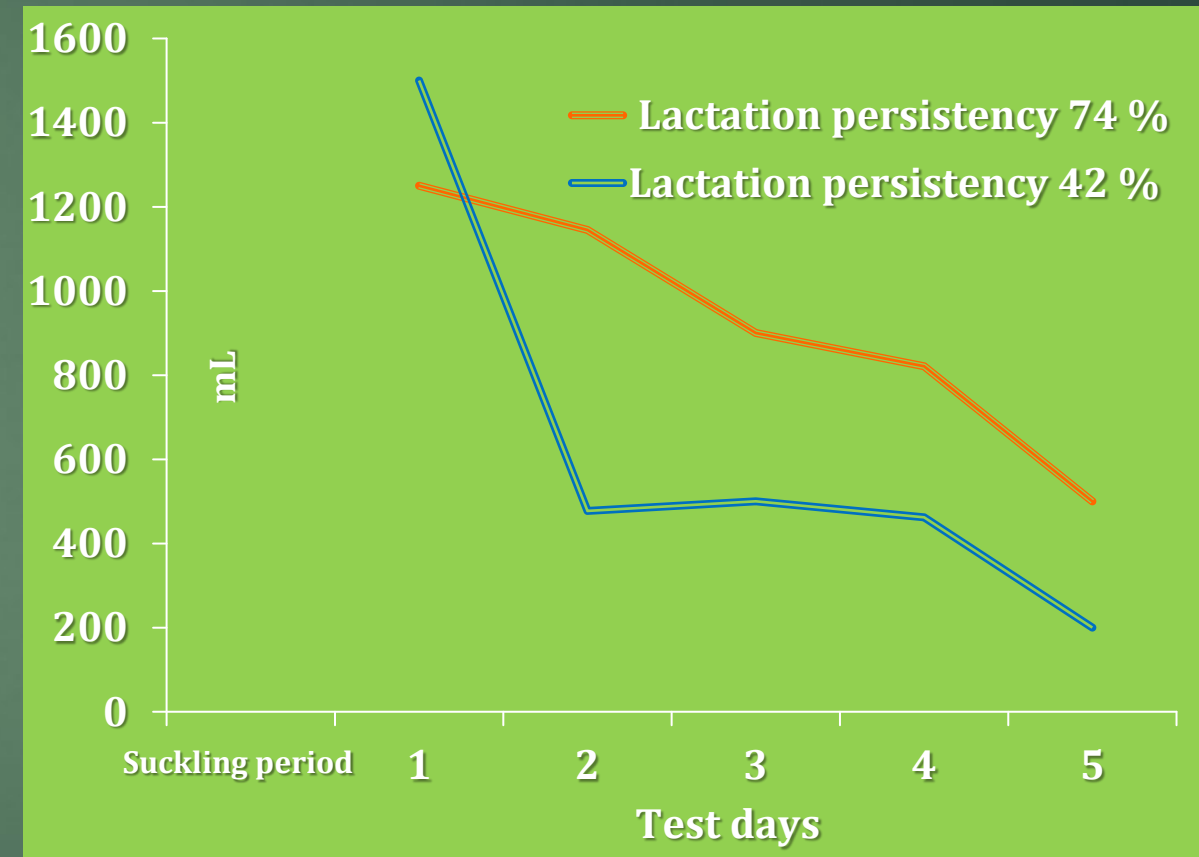
Effect of air temperature on lactation curve in sheep in traditional production systems? Change of pasture grass!!





The aims of this research:

- Adopting the new breeding scheme for endangered native breed:
- - **Optimal Contribution of Selection;**
- We undertook this research with the aim to:
- Estimate the **phenotypic parameters** ($\bar{x}$, $\pm$ SD, CV %, min and max values) of milk yield and lactation persistency in Patch-faced Maritza sheep breed;
- Estimate the **genetic parameters** (h^2 and r_w) of lactation persistency and milk yield in in this native sheep breed.



In search of new traits for resilience in sheep breeding we tried to analyse the accumulated database on the milk yield of native Bulgarian sheep breed Patch-faced Maritza sheep breed.



Material and methods

- The data used for this analysis were provided by the Breeding association of native Maritza sheep breeds;
- Database of **643 lactation records for 351 ewes** of the Patch-faced Maritza sheep breed were used;
- The analyses includes data for the period 2018 – 2023 (**6 years**);
- The **pedgree data** includes **586** animals, which 351 ewes had records, as **daughters of 35 rams**;
- Each lactation record per ewe included **5 test day milk yield records** during the milking period;
- Lactation persistency was calculated as the **ratio of average test day milk yield to maximum TDMY over the course of milking period for each ewe, expressed as %**;
- Variance components of lactation persistency and milk yield were estimated by using **two types of animal models**: A single trait repeatability animal model (AM) for each trait and a simultaneous two trait repeatability AM;
- **The suckling period** (SP) was included as a regression and the age of the ewe was included as a fixed effect;
- **Flock and farming year** were concatenated as common fixed effect in the models.



Material and methods

**All calculations of phenotype parameters
were performed in IBM SPSS software**

X – mean;

S.D. – standard deviation;

MIN - minimum value;

MAX - maximum value;

CV - coefficient of variation.





Material and methods

Single Trait Repeatability Animal Model

$$y_{ijklm} = FY_i + Age_j + SP_k + a_l + p_l + e_{ijklm}$$

where:

FY_i = The fixed effect of the Flock_Year (18 levels),

Age_j = The fixed effect of the Age (9 levels),

SP_k = Suckling Period (covariate) ,

a_l = Random Breeding value (586 levels),

p_l = Random permanent environmental effect (351 levels),

e_{ijklm} = random error,

$$y = X_1b_1 + X_2b_2 + b_3X_3 + Z_1a + Z_2p + e$$

$$\begin{bmatrix} X^T \cdot X & X^T \cdot Z_a & X^T \cdot Z_p \\ Z_a^T \cdot X & Z_a^T \cdot Z_a + A^{-1} \cdot k_a & Z_a^T \cdot Z_p \\ Z_p^T \cdot X & Z_p^T \cdot Z_a & Z_p^T \cdot Z_p + I_p \cdot k_p \end{bmatrix} \cdot \begin{bmatrix} \tilde{b} \\ \hat{a} \\ \hat{p} \end{bmatrix} = \begin{bmatrix} X^T \cdot y \\ Z_a^T \cdot y \\ Z_p^T \cdot y \end{bmatrix}$$

The heritability of the traits was estimated as follows:

$$h^2 = \frac{\sigma_a^2}{\sigma_a^2 + \sigma_p^2 + \sigma_e^2}$$

The repeatability of the traits was estimated as follows:

$$rw = \frac{\sigma_a^2 + \sigma_p^2}{\sigma_a^2 + \sigma_p^2 + \sigma_e^2}$$



Material and methods

Two Traits Repeatability Animal Model

MME

$$\begin{bmatrix} X_t^T \cdot R^{-1} \cdot X_t & X_t^T \cdot R^{-1} \cdot Z_{ta} & X_t^T \cdot R^{-1} \cdot Z_{tp} \\ Z_{ta}^T \cdot R^{-1} \cdot X_t & Z_{ta}^T \cdot R^{-1} \cdot Z_{ta} + (G^{-1} \otimes A^{-1}) & Z_{ta}^T \cdot R^{-1} \cdot Z_{tp} \\ Z_{tp}^T \cdot R^{-1} \cdot X_t & Z_{tp}^T \cdot R^{-1} \cdot Z_{ta} & Z_{tp}^T \cdot R^{-1} \cdot Z_{tp} + (P^{-1} \otimes I_p) \end{bmatrix} \cdot \begin{bmatrix} \tilde{b} \\ \hat{a} \\ \hat{p} \end{bmatrix} = \begin{bmatrix} X_t^T \cdot R^{-1} \cdot y \\ Z_{ta}^T \cdot R^{-1} \cdot y \\ Z_{tp}^T \cdot R^{-1} \cdot y \end{bmatrix}$$

Material and methods

Two Traits Repeatability Animal Model

$$R = R_0 \otimes I_N \quad ; \quad R_0 = \begin{bmatrix} \sigma_{e1}^2 & \sigma_{e1e2} \\ \sigma_{e1e2} & \sigma_{e2}^2 \end{bmatrix}$$

σ_{e1}^2 = Error variance for Milk Yield,

σ_{e2}^2 = Error variance for Lactation Persistency,

σ_{e1e2} = Error covariance between Milk Yield and Lactation Persistency,

I_N = Identity matrix with the length of records,

G = Genetic covariances between the two traits:

$$G = \begin{bmatrix} \sigma_{a1}^2 & \sigma_{a1a2} \\ \sigma_{a1a2} & \sigma_{a2}^2 \end{bmatrix}$$

σ_{a1}^2 = Genetic additive variance for Milk Yield,

σ_{a2}^2 = Genetic additive variance for Lactation Persistency,

σ_{a1a2} = Genetic (co)variance between Milk Yield and Lactation Persistency,



Material and methods

Two Traits Repeatability Animal Model

Genetic, permanent environmental, error and phenotypic correlations:

1) Generic correlation:
$$r_g = \frac{\sigma_{a_i a_j}}{\sqrt{\sigma_{a_i}^2 \cdot \sigma_{a_j}^2}}$$

2) Permanent environmental correlation:
$$r_p = \frac{\sigma_{p_i p_j}}{\sqrt{\sigma_{p_i}^2 \cdot \sigma_{p_j}^2}}$$

3) Error correlation:
$$r_e = \frac{\sigma_{e_i e_j}}{\sqrt{\sigma_{e_i}^2 \cdot \sigma_{e_j}^2}}$$

4) Phenotypic correlation:
$$r_f = \frac{\sigma_{f_i f_j}}{\sqrt{\sigma_{f_i}^2 \cdot \sigma_{f_j}^2}}$$

Where:
$$F = G + P + R = \begin{bmatrix} \sigma_{f_i}^2 & \sigma_{f_i f_j} \\ \sigma_{f_i f_j} & \sigma_{f_j}^2 \end{bmatrix}$$



Material and methods

All analyses for calculation of genetic parameters for two traits were performed in R software environment

σ_a^2 - additive variance

σ_p^2 - per.envir. variance

σ_e^2 - variance error

G = Genetic covariances



h^2 - heritability

r_w - repeatability

r_g - genetic correlation

r_p - perm. environ. correll.

r_e - error correlation

r_f - phenotypic correllation



Results and Discussions

Phenotypic parameters of milk yield and lactation persistency

Table 1. Descriptive statistics of traits for Patch-faced Maritza sheep breed(n=643).

Traits	$\bar{x} \pm SD$	Min	Max	CV, %
Suckling period, <i>days</i>	70.79±16.61	30.00	125.00	23.46
Milk yield for milking period, <i>L</i>	115.57±34.43	51.02	293.34	29.79
Average TD milk yield, <i>mL</i>	770.49±229.55	340.00	1956.00	29.79
Max TD milk yield, <i>mL</i>	1271.10±44763	418.00	3550.00	35.22
Lactation period, <i>days</i>	222.92±16.34	179.00	276.00	7.33
Age, <i>years</i>	3.68±1.60	1.00	9.00	43.49
Lactation persistency, %	62.43±9.70	35.43	88.03	15.54



Results and Discussions



Heritability (h^2) and repeatability (r_w) of milk yield and lactation persistency using simple repeatability animal model

Table 2. Heritability (h^2) and repeatability (r) of milk yield and lactation persistency of Patch-faced Maritza sheep using simple repeatability animal model.

Traits	$h^2 \pm SE$	$r_w \pm SE$
Milk yield, <i>L</i>	0.220±0.025	0.315±0.060
Lactation persistency, %	0.112±0.020	0.141±0.040

- Regression of suckling period on milk yield was -0.360;
- Regression of suckling period on Lactation persistency was 0.0022.



Results and Discussions

Heritability (h^2) and repeatability (r_w) of milk yield and lactation persistency

Table 3. Heritability (h^2) and repeatability (r) of milk yield and lactation persistency of Patch-faced Maritza sheep using two-traits repeatability animal model.

Traits	$h^2 \pm SE$	$r_w \pm SE$
Milk yield, <i>L</i>	0.208±0.024	0.276±0.057
Lactation persistency, %	0.092±0.018	0.132±0.038

- Regression of suckling period on milk yield was -0.357;
- Regression of suckling period on Lactation persistency was 0.0022.



Results and Discussions

Phenotypic, genetic, permanent environmental and error correlations

Table 4. Phenotypic, genetic, permanent environmental and error correlations between milk yield and lactation persistency for Patch-faced Maritza sheep breed.

Correlating traits	Phenotypic correlation	Genetic correlation	Permanent Environmental correlation	Error correlation
Milk yield – Lactation persistency	-0.047 ± 0.174	0.038 ± 0.107	0.028	-0.068

- Our research show that between milk yield and lactation persistence in this native sheep breed, weak phenotypic correlation with a negative sign. Genetic correlation is also weak but with a positive sign. The same is true for the permanent mean correlation and error correlation.



Conclusions

- Principally, conservation by sustainable utilization for meat and milk production is the main breeding strategy for Patch-faced Maritza sheep breed.
- Regular and long-term implementation of milk recording will give the chance to be accumulated bigger milk yield database and use data for genetic improvement for good milk yield with higher persistency of lactation.
- Heritability and repeatability are intermediate for milk yield but low for the persistence of lactation.
- There is positive but low genetic correlation between lactation persistency and milk yield which indicates that selection for high milk yield will not necessarily lead to higher lactation persistency.



Thank you for your attention!



Patch-faced Maritza sheep breed