RESEARCH ON THE INFLUENCE OF GENETIC LINEAGE AND ENVIRONMENTAL FACTORS ON PRODUCTIVE AND REPRODUCTIVE PERFORMANCE IN ROMANIAN BLACK SPOTTED CATTLE

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Abstract

This study evaluates the quantitative and qualitative milk production traits, reproductive indices, and the effect of sire lineage in a Romanian Black Spotted cattle herd (Holstein-Friesian strain) managed on a dairy farm in Iasi County. The dataset was compiled from official milk performance recording (COP) records spanning 2024–2025. Data processing included statistical analysis of productive performance across completed lactations (38 cows), reproductive parameters, and seasonal monthly dynamics of milk chemical constituents. The mean recorded yield was 5,803 kg milk, with an average fat content of 4.11% and protein content of 3.69%. Seasonal dynamic analysis highlighted a marked impact of the hot season on milk composition, with milk protein dropping from 4.09% in November to a nadir of 3.15% in July, alongside an altered fat-to-protein ratio (1.27). Reproductive performance was high, exhibiting a 92% conception rate, a service index (services sire per conception) of 1.27, 100% prolificacy, and a calving interval of 372 days. Daughter grouping and ranking revealed superior genetic merit in progeny lines derived from the sires MARMORALL (up to 6,644 kg milk, 4.29% fat, and 3.57% protein in the 7th lactation) and MAIDAL ET (6,427 kg milk, 4.12% fat, and 3.73% protein). The resulting data indicate high genetic potential alongside strong environmental adaptability in the studied nucleus herd, providing reference criteria for targeted breeding selection and nutritional management adjustments during critical periods of heat stress.

Key words: *dairy cows, productive performance, reproductive parameters, sire lineage, milk quality*

INTRODUCTION

The sustainable management of dairy cattle relies on a comprehensive understanding of livestock populations and the genotype-by-environment (G×E) interaction. Within the Romanian Black Spotted (RBS) breed, the infusion of Holstein-Friesian genetics has markedly improved productive performance, securing the breed's role as a major contributor to the domestic dairy market. However, under the production conditions prevalent in Romania, management deficiencies and microclimatic stress frequently prevent cows from expressing their full genetic potential. [1, 5, 12, 19, 27, 34, 38]

Productive performance is governed by an interplay of intrinsic factors (breed, individual variation, lactation stage, age) and extrinsic, management-related variables. Physiologically, milk yield follows an upward trajectory across early parities-typically peaking during the fourth lactation. Nevertheless, lactation persistency and milk composition integrity (fat, protein, and casein) remain heavily contingent upon nutritional management and barn microclimate. Ambient temperatures outside the thermo-neutral

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range of 0.5–21°C disrupt bioenergetic homeostasis, triggering physiological adjustments that impair animal performance. [2, 8, 14, 21, 28, 33, 39]

Another critical operational challenge is maintaining equilibrium between high productivity and reproductive efficiency. Prolonged service periods beyond the 45–90-day benchmark and extended calving intervals exceeding the optimal 365–385-day window inflict major economic losses by decreasing lifetime calf crops and compromising lactation curves. Concurrently, monitoring udder health via somatic cell counts (SCC) serves as a cornerstone for raw milk quality control and mastitis prevention. [3, 9, 15, 22, 26, 31, 36]

Accelerating technological throughput and automating milking and feeding—coupled with the genomic and phenotypic selection of superior progeny for breeding—represent the primary drivers of farm profitability. Within this framework, this study evaluates the applied effects of genetic lineage and environmental variables on milk yield, milk quality, and reproductive indices in a dairy herd managed under commercial conditions in northeastern Romania, with the objective of identifying superior individuals capable of delivering functional longevity and heightened economic returns. [1, 4, 7, 11, 18, 25, 30, 37, 38]

MATERIAL AND METHOD

The research was conducted on a dairy cattle herd belonging to the Romanian Black Spotted breed (Holstein-Friesian strain), managed for milk production on a commercial farm located in Iasi County. The herd is enrolled in the official milk recording scheme (COP) and comprised 52 adult females at the beginning of the monitoring period (2024–2025), of which 38 cows completed their lactations during this interval. The demographic structure of the nucleus herd was characterized by a parity dispersion ranging from the 1st to the 9th lactation, with a replacement rate of 100% and an age distribution dominated by young adult cows (32.7% at 6 years of age and 17.3% under 4 years of age). Birth weight of calves averaged 31 kg. [6, 10, 16, 23, 29, 32,]

The management system applied on the farm is semi-intensive, adapted to the specific pedoclimatic conditions of the Moldavian Plateau. During the cold season and transition periods, the animals are housed indoors in loose housing systems and fed conserved forage with a basal total mixed ration (corn silage, grass, and legume hay/haylage), supplemented with a concentrate mixture to meet nutritional requirements based on production levels. From May to October, the management system includes grazing on natural pastures in the vicinity of the farm, combined with dietary supplementation. Manure removal is carried out mechanically. Milking is performed mechanically twice daily at equal 12-hour intervals using individual milking units, in compliance with pre- and post-milking hygiene standards. [7, 13, 20, 24, 31]

To evaluate genetic determinism, animals were grouped into sire families, identifying the primary artificial insemination sires used (Marmorall, Maidal ET, Ostretin Uganda ET, Gordan ET, Silverio, Leaderwin Mark ET). The ranking of female progeny aimed to assess the transmission of productive potential and its correlation with official selection indices calculated via the animal model: Total Breeding Value Index (IVAT), Milk Index (IVAL), Reproduction Index (IVAR), and Functional Index (IVAF).

For the objective comparison of milk yields obtained at different ages and parities, quantitative and qualitative performance traits were standardized to Mature Equivalent ($ME = P_{real} \times c_a$, P_{real} is the actual production achieved in the standard 305-day lactation, and c_a is the correction factor for age and parity, established according to age at calving and lactation order). Reference values are 1.28 for the 1st lactation, 1.14 for

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the 2nd lactation, 1.05 for the 3rd lactation, 1.00 for the 4th lactation, 1.01 for the 5th lactation, 1.02 for the 6th lactation, 1.04 for the 7th lactation, and 1.05 for the 8th lactation, according to the official mature equivalent scale for Holstein-Friesian populations. [2, 9, 17, 22, 28, 35, 39]

Statistical processing was carried out for the parameters of normal (statistically relevant) lactations: milk production, fat content (F %) and protein content (P %), fat quantity (F kg) and protein quantity (P kg). Primary data were processed using the S.A.V.C. program (System for Analysis of Variance and Covariance) and position and dispersion parameters were calculated: arithmetic mean, standard error of the mean, standard deviation, and coefficient of variation. The statistical significance of differences between means was tested by analysis of variance ANOVA. [3, 8, 15, 21, 27, 33, 37]

RESULTS

Table 1 presents the ranking of daughters according to milk production calculated in ME per standard lactation, and the data analysis highlights a high productive level and remarkable qualitative stability for the studied cattle nucleus. Expressing productions per standard lactation (305 days) allows for an objective comparison of the animals, eliminating distortions caused by animal age and lactation rank. The overall mean of the sample is 5,528.26 ± 358.30 kg milk, with an average content of 4.07 % fat (224.38 kg fat) and 3.64 % protein (201.31 kg protein).

The limits of the variation range are a production minimum of 4,998 kg and a maximum of 6,644 kg. This difference of 1,646 kg indicates the existence of biological variability that constitutes the basis for intra-population selection and mating planning. The productive level increases progressively with advancing age: primiparous cows achieve an average of 5,300 kg milk, while multiparous cows consistently exceed 5,800 kg milk. The performance of primiparous cows represents over 85 % of the average of multiparous lactations, which denotes very good productive precocity of the young females introduced into reproduction.

The fat percentage varied between 3.85 - 4.48 %, and the protein percentage between 3.38 - 4.11 %. The average value of the fat/protein (F/P) ratio stands at 1.12, falling within the physiologically optimal range (1.10–1.50, which attests to normal ruminal balance. Remarkable is the cow RO509005924075, which achieved a production of 5,965 kg milk with 4.48 % fat and 4.11 % protein (268 kg fat and 245 kg protein). [4, 11, 16, 23, 26, 32, 36]

The analyzed herd is structured by paternal lineage resulting from the use of semen from sires of high genetic merit, with the major share belonging to sires Ostretin Uganda ET (15 daughters) and Marmorall (14 daughters).

The progeny of the sire Marmorall comprises 14 evaluated daughters and is distinguished by the largest productive range in the entire herd. Within this family, milk production recorded a minimum of 5,106 kg milk and a maximum of 6,644 kg milk, with fat content (G %) ranging between a minimum of 3.91 % and a maximum of 4.48 %. The milk protein content (P %) fluctuated between 3.46 - 4.11 %. With an average production of 5,572.79 kg milk, this family demonstrates sound hereditary transmission of productive longevity, dominating the upper echelon of the ranking and sustaining high fat and protein percentages in multiparous cows.

The family of the sire Ostretin Uganda ET, consisting of 15 daughters with completed lactations, represents the numerically most extensive genealogical group. The quantitative milk level ranged between a minimum of 4,998 kg and a maximum value of 5,700 kg. Milk qualitative parameters fluctuated between 3.85 - 4.28 % for G %, respectively between

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3.38 - 3.94 % for P %. Although the production average of this progeny is more modest, at 5,348.40 kg milk, the family stands out for its pronounced uniformity and stability across the first three lactations.

The progeny of the sire Maidal ET, although represented by a limited sample of three daughters, recorded the highest average productive potential on the farm, reaching 6,021.67 kg milk. Quantitative production ranged between 5,457 - 6,427 kg. Fat content attained very high values, fluctuating between 4.12 % and 4.30 %, and the protein percentage ranged between 3.47 % and 3.73 %. All daughters of this sire reached advanced parities (lactation ranks VII and VIII), demonstrating that the Maidal ET line transmits exceptional physiological robustness and an outstanding capacity to sustain the lactation curve to its descendants.

Table 1. Ranking of daughters according to milk production expressed in ME, per standard lactation

No.	Animal ID	Sire name	Parity	Milk (kg)	^{1}F (%)	^{2}P (%)	^{1}F (kg)	^{2}P (kg)
1	RO501005939819	Gordan ET	3	5674	4.06	3.80	231	216
2	RO502005941271	Gordan ET	3	5674	3.86	3.68	219	209
3	RO505005933660	Gordan ET	4	5665	4.14	3.57	235	202
4	RO509007343476	Leaderwin Mark ET	4	5981	4.06	3.75	243	225
5	RO509002341714	Maidal ET	7	6427	4.12	3.73	265	240
6	RO502002341713	Maidal ET	8	6181	4.29	3.47	265	215
7	RO508002341711	Maidal ET	7	5457	4.30	3.72	235	203
8	RO502005812229	Marmorall	7	6644	4.29	3.57	286	237
9	RO509005924075	Marmorall	6	5965	4.48	4.11	268	245
10	RO501005924071	Marmorall	6	5845	3.95	3.54	231	207
11	RO503005920301	Marmorall	5	5769	4.01	3.47	232	200
12	RO507005920303	Marmorall	5	5679	3.91	3.46	222	197
13	RO502005812229	Marmorall	6	5613	4.14	3.73	233	209
14	RO500005920302	Marmorall	5	5584	3.94	3.71	220	208
15	RO508005920319	Marmorall	5	5549	4.18	3.67	232	204
16	RO508005933643	Marmorall	4	5343	4.02	3.50	215	187
17	RO502005933658	Marmorall	4	5299	4.08	3.49	216	185
18	RO500005933652	Marmorall	4	5277	4.02	3.56	212	188
19	RO504005933641	Marmorall	4	5213	4.19	3.72	219	194
20	RO506005933647	Marmorall	4	5133	4.20	3.71	216	191
21	RO506005939814	Marmorall	4	5106	4.03	3.77	206	193
22	RO509005941272	Ostretin Uganda ET	4	5700	4.09	3.53	233	202
23	RO506005944355	Ostretin Uganda ET	3	5659	4.18	3.94	237	223
24	RO508005947868	Ostretin Uganda ET	3	5585	4.12	3.50	231	196
25	RO508005946753	Ostretin Uganda ET	3	5537	4.00	3.73	222	207
26	RO503005944356	Ostretin Uganda ET	3	5466	4.28	3.91	234	214
27	RO505005944352	Ostretin Uganda ET	3	5399	4.03	3.75	218	203
28	RO504005947866	Ostretin Uganda ET	3	5345	3.96	3.50	212	187
29	RO504005950400	Ostretin Uganda ET	1	5343	3.95	3.69	212	198
30	RO503005947863	Ostretin Uganda ET	2	5320	3.88	3.63	207	193
31	RO508005949653	Ostretin Uganda ET	2	5297	3.92	3.38	208	180
32	RO501005950401	Ostretin Uganda ET	2	5225	4.08	3.52	213	184
33	RO501005950399	Ostretin Uganda ET	1	5175	3.86	3.56	200	185
34	RO504005944359	Ostretin Uganda ET	3	5138	4.11	3.74	211	193
35	RO502005950392	Ostretin Uganda ET	1	5039	3.85	3.67	194	185
36	RO505005947869	Ostretin Uganda ET	2	4998	4.04	3.52	202	176
37	RO504005950976	Silverio	1	5493	4.05	3.57	223	196
38	RO502005954183	Silverio	1	5450	4.07	3.63	222	198
39	RO505005946770	Silverio	2	5355	4.05	3.60	217	193

Note: ^{1}F – fat; ^{2}P – protein.

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The family of the sire Gordan ET is characterized by production uniformity (averaging 5,671 kg milk), with a variation range between a minimum of 5,665 kg and a maximum of 5,674 kg, and contents of 3.86–4.14 % fat and 3.57–3.80 % protein. The progeny of the sire Silverio confirms the same functional stability (average of 5,432.67 kg milk), fluctuating between 5,355 kg and 5,493 kg, associated with remarkable consistency in fat (4.05–4.07 %) and protein (3.57–3.63 %) percentages.

The evaluation of reproductive efficiency presented in Table 2 reveals an overall very good level of fertility and optimal reproductive management within the dairy cattle herd. The mean calving interval (CI) calculated for the female sample recorded an average value of 387.61 days, ranging from a minimum of 343 days in cow RO501005950401 to a maximum of 451 days recorded in cow RO503005920301. Notably, 25 females, representing nearly 70 % of the herd, achieved an interval below the 400-day threshold, of which 8 individuals fell even below the duration of a calendar year (365 days), ensuring the achievement of one calf per year per cow maintained. The extension of the interval beyond 400 days, observed in a limited number of 11 individuals, is physiologically associated with higher quantitative productions exceeding 5,800 kg milk, in which the high persistency of the lactation curve delayed the onset of a new pregnancy. [5, 10, 14, 18, 25, 29, 34, 39]

The insemination index (Ii) recorded an average of 1.23 services per conception, with a narrow range between 1.00 and 2.00 frozen semen doses. A proportion of 34.2 % of the females conceived at first artificial insemination (AI), and for the majority of the cows the requirement remained below 1.50 doses, confirming a high first-service conception rate, superior quality of the semen used, and high accuracy in estrus detection by farm personnel. Only a single cow in the group reached the level of 2.00 services per conception; however, this was compensated by a production of 6,644 kg milk and an optimal calving interval of 364 days.

Table 2. Ranking of females – reproduction

No	Animal ID	^{1}A	^{2}I$_i$	^{3}CI
1	RO501005950401	U^4	1.00	343
2	RO509005941272	23	1.17	354
3	RO507005920303	30	1.29	356
4	RO501005950399	37	1.00	359
5	RO508005946753	25	1.25	359
6	RO509002341714	35	1.14	364
7	RO503005947863	35	1.25	364
8	RO502005812229	34	2.00	364
9	RO502005941271	24	1.00	368
10	RO500005920302	26	1.71	370
11	RO508005949653	32	1.00	371
12	RO505005933660	24	1.50	373
13	RO501005924071	24	1.29	373
14	RO504005947866	23	1.20	376
15	RO508002341711	U^4	1.17	378
16	RO504005933641	27	1.17	379
17	RO505005947869	32	1.00	381
18	RO502005933658	33	1.17	381
19	RO504005944359	37	1.00	387
20	RO506005939814	26	1.33	388
21	RO505005946770	35	1.50	389
22	RO504005950400	35	1.00	392
23	RO506005944355	32	1.60	394
24	RO508005933643	25	1.17	394
25	RO508005947868	21	1.00	398
26	RO509005924075	36	1.50	404
27	RO503005944356	30	1.60	406
28	RO506005933647	27	1.17	408
29	RO509007343476	35	1.40	409
30	RO500005933652	21	1.33	409
31	RO508005920319	29	1.00	409
32	RO505005944352	32	1.20	410
33	RO502002341713	34	1.29	415
34	RO502005950392	36	1.00	438
35	RO504005950976	28	1.00	440
36	RO503005920301	27	1.33	451
37	RO501005939819	U^4	1.00	U^4
38	RO502005954183	22	1.00	U^4

Note: ^{1}A – age at first calving (months); ^{2}I$_i$ – insemination index (services per conception); ^{3}CI – calving interval (days); U^4 – unidentified.

Age at first calving (VP) presented an overall mean of 29.48 months, with limits ranging between 21 months and a maximum of 37 months. Achieving first calving around the age of 21–25 months in over one-third of the herd confirms adequate physical development of the young females

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during the rearing period and breed-specific precocity, whereas exceeding the 32-month threshold in certain individuals indicates delays at first insemination caused by discrepancies in attaining optimal breeding weight or by calving seasonality. Overall, the recorded indicators demonstrate that the farm maintains well-coordinated reproductive management, curbing losses caused by infertility and strengthening the economic profitability of milk production.

The analysis of the indicators summarized in Table 3 reflects the close interaction between milk production, reproductive physiology, and operational efficiency within the herd. Across the 38 cows that completed a normal lactation during the recording period, total lactation length (DLT) averaged 351 days.

This extension of lactation beyond the technological standard of 305 days represents a common trend in dairy cows upgraded with Holstein-Friesian genetics, driven by both the high persistency of the lactation curve and the delayed onset of a new pregnancy. The mean calving interval (CI) reached 424 days, exceeding the conventionally optimal threshold considered in animal science (365–400 days). However, this herd average includes the lag recorded in high-yielding cows, where sustained daily milk output temporarily suppresses the resumption of normal ovarian cyclicity and prolongs the uterine rest period (SP – service period). Although an extended interval decreases the lifetime calving count of the animal, under the semi-intensive management system of this region, this delay is offset by the milk yields obtained during the extended lactation period.

The dry period (DP) averaged 66 days, closely aligning with the recommended technological optimum for dairy cattle (60 days). Ensuring an adequate dry period demonstrates proper execution of the dry-off protocol, which is essential for mammary tissue regeneration, replenishment of maternal energy and mineral reserves, and the synthesis of high-quality colostrum for the newborn calf.

In the primiparous group, represented by a nucleus of 5 females, age at first calving (VP) was 32 months (967 days). While the recommended optimum for this breed is 24–27 months to curtail heifer rearing costs, the lag up to 32 months reflects delayed entry into reproduction, conditioned by the time required to attain optimal breeding body weight and by the seasonal calving schedule managed on the farm. Overall, these parameters reflect stable functional management of the herd, sustaining high biological potential without premature depletion of the reproductive tract.

Table 3. Herd-level reproduction status

Total cows with completed lactation				of which primiparous cows	
[1]N	[2]DLT	[3]CI	[4]DP	[1]N	[5]VP
38	351	424	66	5	967

Note: [1]N – number of animals; [2]DLT – total lactation length (days); [3]CI – calving interval (days); [4]DP – dry period (days); [5]VP – age at first calving (days).

Figure 1 illustrates Romanian Black Spotted cows included in the study.



Fig. 1 Romanian Black Spotted cattle taken into study (original photo)

The monthly trend of milk quality parameters highlights a close relationship between environmental factors, seasonal feeding regimens, and the synthetic capacity of the mammary gland in Romanian Black Spotted cattle. Over the entire milk recording

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year, the mean was 4.11 % fat and 3.69 % protein, confirming a high biological potential for the studied nucleus. However, the analysis across calendar months shows distinct fluctuations between the cold and summer seasons, driven by the cows' metabolic adaptation to microclimatic conditions and management practices.

The fat percentage recorded a minimum of 3.59 % in October, followed by a marked increase throughout the winter, reaching a peak of 4.35 % in December. During the winter period, fat content remained elevated, ranging between 4.19 % and 4.35 %, supported by a balanced total mixed ration based on stored conserved forages and silages rich in structural fiber, which stimulate the synthesis of ruminal precursors. With the turn-out to pasture and the onset of high ambient temperatures, the fat percentage showed a slight decrease in April (3.91 %) and June–July (3.99 %), followed by a rebound to 4.09 % in August, attributable to the mobilization of body reserves under thermal discomfort.

The protein percentage exhibited a much higher sensitivity to environmental variations than fat. The highest value was reached in November (4.09 %), followed by a stable plateau throughout the winter and early spring months, between 3.55 % and 3.89 %. Beginning in May, amid the dietary transition and rising temperatures, the protein percentage declined steadily, dropping to 3.35 % in May and reaching an annual minimum of 3.15 % in June. This pronounced depression during the hot season (3.15–3.30 % in the June–August interval) is characteristic of heat stress and grazed green fodder consumption, a period during which amino acids are partially diverted from mammary synthesis toward meeting the body's thermoregulatory energy demands. A recovery in protein content was observed only toward late summer, in September (3.45 %), concomitant with the decline in ambient temperatures.

The fat-to-protein ratio fluctuated throughout the year between 0.93 (in November) and 1.27 (in June), maintaining an annual average of 1.12. Subunit values in the first two recording months (0.99 in October and 0.93 in November) reflect a high protein percentage relative to fat level, indicating the absence of a negative energy balance at the start of the production curve. Conversely, during the summer months, driven by the marked drop in protein percentage while fat remained around 4.00 %, the ratio increased to 1.21–1.27. Maintaining the ratio below the critical threshold of 1.35–1.40 even during hot summer months demonstrates sound herd metabolic health, ruling out the incidence of subclinical ketosis or ruminal acidosis and validating the efficacy of the feeding management implemented on the farm.

Table 4. Monthly dynamics of milk quality during the recording year (October 2024 – September 2025)

Recording month (2024-2025)	Fat (%)	Protein (%)	Fat/Protein ratio
October	3.59	3.64	0.99
November	3.79	4.09	0.93
December	4.35	3.89	1.12
January	4.25	3.58	1.19
February	4.22	3.67	1.15
March	4.19	3.55	1.18
April	3.91	3.56	1.10
May	4.08	3.35	1.22
June	3.99	3.15	1.27
July	3.99	3.30	1.21
August	4.09	3.30	1.24
September	3.99	3.45	1.16
Mean	4.11	3.69	1.12

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The analysis of the breeding values summarized in Table 5 provides a clear overview of the genetic structure of the cattle nucleus, highlighting the relationship between selection for milk yield and the preservation of functional and reproductive traits. Since the reference base of the national evaluation system is centered on the conventional value of 100 points, the farm-level averages indicate a balanced population with positive genetic progress for traits of economic interest. The Total Breeding Value Index (IVAT) displays an overall mean of 101.48 points, with a range of variation extending from a minimum of 94.31 points in cow RO508005947868 to a maximum of 112.68 points recorded in cow RO502005812229.

Table 5. Breeding values of the studied herd

No.	Animal ID	[1]IVAT	[2]IVAL	[3]IVAR	[4]IVAF
1	RO502005812229	112.68	114.10	101.59	98.32
2	RO509002341714	109.25	110.20	100.63	100.78
3	RO502002341713	107.87	108.69	98.79	102.19
4	RO500005920302	105.47	106.02	97.57	103.50
5	RO504010135740	104.83	105.55	98.41	98.49
6	RO506005944355	104.77	105.48	99.92	96.91
7	RO505005933660	104.48	104.91	100.48	100.75
8	RO503005920301	104.37	105.01	98.45	98.84
9	RO509005941272	104.33	104.52	103.67	101.76
10	RO500005933652	104.06	104.47	97.11	103.75
11	RO504005950400	103.78	104.13	101.37	99.97
12	RO503005947863	103.41	103.74	100.62	100.43
13	RO507005920303	103.21	103.66	99.14	99.33
14	RO509005924075	103.00	103.33	98.25	101.91
15	RO501005939819	102.83	103.29	97.29	100.21
16	RO509007343476	102.68	103.13	99.03	98.35
17	RO500002341720	102.59	102.96	99.08	99.46
18	RO502005941271	102.11	102.25	101.98	99.78
19	RO508005920319	101.86	101.95	101.95	100.18
20	RO501005924071	101.58	101.87	99.28	98.85
21	RO503005944356	101.39	101.65	98.93	99.18
22	RO508005949653	100.80	100.79	101.69	100.14
23	RO509005955781	100.75	100.84	101.79	98.17
24	RO508002341711	100.37	100.44	100.02	99.48
25	RO502005954183	100.05	99.95	100.37	101.61
26	RO505005946770	99.94	100.10	96.39	100.72
27	RO502005933658	99.77	99.63	102.88	99.34
28	RO508005946753	99.73	99.62	100.42	101.07
29	RO505005947869	99.69	99.72	100.17	98.75
30	RO504005944359	99.55	99.57	98.00	100.87
31	RO504005947866	99.54	99.41	101.30	100.27
32	RO504005933641	99.29	99.12	102.11	99.61
33	RO506005939814	98.64	98.44	99.64	101.26
34	RO501005950401	98.58	98.48	100.51	98.53
35	RO505005944352	98.30	98.12	101.85	98.08
36	RO504005950976	97.98	97.71	99.99	100.97
37	RO502005950392	97.43	97.20	99.40	99.61
38	RO508005933643	97.24	96.80	100.86	101.59
39	RO501005955774	96.98	96.69	100.05	99.23
40	RO501005950399	96.42	95.94	102.47	99.13
41	RO506005933647	96.25	95.83	99.41	100.81
42	RO508005947868	94.31	93.60	103.01	98.42
-	Mean	101.48	101.64	100.13	100.01

Note: [1]IVAT: Total Breeding Value Index; [2]IVAL: Milk Breeding Value Index; [3]IVAR: Reproduction Breeding Value Index; [4]IVAF: Functional Breeding Value Index.

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A proportion of 59.5% of the evaluated herd (25 animals) exceeds the 100-point threshold, reflecting a valuable nucleus of dams capable of passing on these traits to their offspring. An almost perfect convergence is observed between IVAT and the Milk Breeding Value Index (IVAL), which averages 101.64 points, ranging from 93.60 to 114.10 points. This correlation demonstrates that the ranking of cows on the farm is primarily driven by selection pressure exerted on milk volume and dry matter content. Regarding the Reproduction Breeding Value Index (IVAR), the herd average reached 100.13 points, fluctuating within a narrower interval from a minimum of 96.39 points (RO505005946770) to a maximum of 103.67 points (RO509005941272). More than half of the herd (54.8%) achieved an IVAR above 100, indicating sound hereditary fertility. The correlation analysis highlights a slight antagonistic tendency between IVAL and IVAR, a classic physiological phenomenon in milk production for Holstein-Friesian strains, where extreme genetic potential for milk synthesis tends to reduce conception rates. Nevertheless, elite specimens such as RO509005941272 (IVAL = 104.52; IVAR = 103.67) and RO502005812229 (IVAL = 114.10; IVAR = 101.59) manage to combine remarkable yield with above-average reproductive efficiency, representing ideal genotypes for the maternal line of the farm. The Functional Breeding Value Index (IVAF), which measures metabolic resilience, feet and legs soundness, and udder health, averaged 100.01 points, ranging from a minimum of 96.91 points (RO506005944355) to a maximum of 103.75 points (RO500005933652).

Maintaining a balanced average of 100 points demonstrates that production intensification and mechanical milking have not compromised the functional status of the animals. Overall, the distribution of genetic estimators confirms that the cattle nucleus possesses a high biological value, and guiding future corrective matings based on IVAT and IVAL indices, coupled with monitoring IVAR, establishes the prerequisites for increasing milk yield without compromising the herd's productive longevity and reproductive efficiency.

CONCLUSIONS

Based on the processed data and the results obtained and interpreted, the following conclusions can be drawn:

1. The Romanian Black Spotted cattle nucleus confirms a high productive potential of 5,528.26 kg of milk of remarkable quality (4.11% fat and 3.69% protein), maintaining an optimal fat-to-protein ratio (1.12) that demonstrates an excellent metabolic status throughout the year.

2. The half-sib family structure highlights the superior transmission of quantitative performance and productive longevity, with the descendants of the sires Marmorall (peak yield of 6,644 kg of milk) and Maidal ET (average of 6,021.67 kg of milk) standing out, correlated with a high genetic value of the herd (mean IVAT of 101.48 points and IVAL of 101.64 points).

3. The applied technology ensured very good fertility (1.23–1.27 inseminations per pregnancy and a dry period of 66 days), with the extended lactation length (351 days) and calving interval (424 days) being compensated for by the high milk yields achieved.

REFERENCES

1. Afloroaei, AA; Bărbuță, GI; Maciuc, V Research on the management of quantitative and qualitative production performance in two Romanian cattle breeds in the eastern region of Romania. *Scientific Study & Research - Chemistry & Chemical Engineering, Biotechnology, Food Industry,* **2026**, 27 (2), 269–278. doi.org/10.29081/ChIBA.2026.671
2. Amariții (Pădurariu), G; Pânzaru, C; Maciuc, V Milk Quality Dynamics in Romanian Black Spotted and Romanian Spotted Cattle Breeds

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Under Heat Stress. *Agriculture,* **2026**, 16 (2), 274. doi.org/10.3390/agriculture16020274
3. Bărbuță, G; Amariții, G; Maciuc, V Research on the genetic value of a Fleckvieh breed herd and its influence on the productive level. *Scientific Papers. Series D. Animal Science,* **2026**, 69 (1), 45–54.
4. Beliciu, CM; Moraru, CI Effect of solvent and temperature on the size distribution of casein micelles measured by dynamic light scattering. *Journal of Dairy Science,* **2009**, 92 (5), 1829–1839.
5. Besharati, M; Ahmad, S; Jabbar, M; Palangi, V; Esen, S; Esen, VK; Eseceli, H; Mammadov, A; Lackner, M Effects of stress hormones on digestibility and performance in cattle: A review. *Open Agriculture,* **2024**, 9, 20220387.
6. Bewley, JM; Robertson, LM; Eckelkamp, EA A 100-Year Review: Lactating dairy cattle housing management. *Journal of Dairy Science,* **2017**, 100 (12), 10418–10431.
7. Bowen, MK; Chudleigh, F Productivity and profitability of alternative steer growth paths resulting from accessing high-quality forage systems in the subtropics of northern Australia: a modelling approach. *Animal Production Science,* **2019**, 59 (9), 1739–1751.
8. Camara, Y; Sow, F; Govoeyi, B; Moula, N; Sissokho, MM; Antoine-Moussiaux, N Stakeholder involvement in cattle-breeding program in developing countries: A Delphi survey. *Livestock Science,* **2019**, 228, 127–135.
9. Chilimar, S Comparative study of the qualities of cows from Moldovian type of Black spotted and Red of steppe breeds. *Scientific Papers. Series D. Animal Science,* **2013**, 56, 260–267.
10. Ciocan-Alupii, M; Radu-Rusu, RM; Pânzaru, C; Nistor-Anton, M; Bilkevich, V; Maciuc, V Study of productive performance in the Pinzgau breed exploited in the Dornelor basin, Suceava county. *Scientific Papers. Series D. Animal Science,* **2022**, 65 (2), 298–303.
11. Collier, RJ; Renquist, BJ; Xiao, Y A 100-Year Review: Stress physiology including heat stress. *Journal of Dairy Science,* **2017**, 100 (12), 10367–10380.
12. Couvreur, S; Hurtaud, C; Marnet, PG; Faverdin, P; Peyraud, JL Composition of Milk Fat from Cows Selected for Milk Fat Globule Size and Offered Either Fresh Pasture or a Corn Silage-Based Diet. *Journal of Dairy Science,* **2007**, 90 (1), 392–403.
13. Cucu, GI; Maciuc, V; Maciuc, Domnica Scientific research and elements of experimental technique in animal husbandry. *Alfa Publishing House, Iaşi,* **2004**, 242–299.
14. Daley, VL; Armentano, LE; Hanigan, MD Models to predict milk fat concentration and yield of lactating dairy cows: A meta-analysis. *Journal of Dairy Science,* **2022**, 105 (10), 8016–8035.
15. De Moraes, F; Lopes, MA; Carvalho, FM; de Carvalho, PAA; Bruhn, FRP; Lima, ALR; Cardoso, MG Effect of the scale of production on the cost-effectiveness of milk production systems belonging to the "Balde Cheio" program. *Semina: Ciências Agrárias,* **2018**, 39 (3), 1211–1223.
16. Diavão, J; Silva, AS; Sguizzato, A; da Silva, C; Tomich, TR; Pereira, LG How does reproduction account for dairy farm sustainability? *Animal Reproduction*, **2023**, 20 (2), e20230066.
17. Dolle, JB; Delaby, L; Plantureux, S; Moreau, S; Amiaud, B; Charpiot, A; Manneville, V; Chanseaume, A; Chambaut, H; Le Gall, A Environmental impact of french dairy cattle livestock farming systems. *INRA Productions Animales,* **2013**, 26 (2), 207–220.
18. Fadhil, M; Zülkadir, U Association between polymorphisms of Myf5, MSTN and CAST genes and fattening performance in Brown Swiss and Holstein cattle breeds. *Animal Biotechnology*, **2020**, 32 (1), 121–129.
19. Ghirilă, Andreea Bianca; Pece, Aurelia; Mureșan, Gh Study on internal factors influencing milk yield. *Agriculture - Science and Practice,* **2007**, 3-4 (63-64), 135–138.
20. Klein-Jöbstl, D; Arnholdt, T; Sturmlechner, F; Iwersen, M; Drillich, M Results of an online questionnaire to survey calf management practices on dairy cattle breeding farms in Austria and to estimate differences in disease incidences depending on farm structure and management practices. *Acta Veterinaria Scandinavica,* **2015**, 57, 44.
21. Leslie, KE Somatic cell counts: Interpretation for individual cows. *Queen's Printer for Ontario,* **1996**.
22. Maciuc, V Influence of technological factors on the productive level in a Friesian nucleus. *Scientific Papers - Animal Science Series, USAMV Iași,* **2011**, 56, 301–306.
23. Maciuc, V Practical guide to genetic improvement of cattle for milk production. *Alfa Publishing House, Iaşi,* **2003**.

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24. Maciuc, V Research on the incidence of mastitis and its influence on milk production in a herd of cattle. *Scientific Papers. Series D. Animal Science,* **2024**, 67 (2), 346–353.
25. Maciuc, V The management of cattle husbandry. *Alfa Publishing House, Iaşi,* **2006**, 224–277.
26. Maciuc, V; Creangă, Ș; Maciuc, Domnica; Vidu, Livia A New Software Programme for Data Management in Dairy Farms. "ST26733". *Agriculture and Agricultural Science Procedia,* **2015**, 6, 226–231.
27. Maciuc, V; Pădure, R; Afloroaei, AA; Bărbuță, GI; Amariții (Pădurariu), G Research on the influence of farming technology on productive performance and milk quality. *Animal & Food Sciences Journal Iasi,* **2025**, 84 (8), 18–26.
28. Maciuc, V; Pânzaru, Claudia; Ciocan-Alupii, Maria; Rusu-Radu, Gabriela Cristina; Rusu-Radu, RM Comparative Assessment of the Nutritional and Sanogenic Features of Certain Cheese Sorts Originating in Conventional Dairy Farms and in "Mountainous" Quality System Farms. *Agriculture,* **2024**, 14, 172.
29. Maciuc, V; Radu-Rusu, Cristina Gabriela; Popescu, CE; Radu-Rusu, RM Influence of season and cows farming system on milk physical, chemical and hygienic traits. Romanian Biotechnological Letters, **2017**, 22 (6), 13096–13104.
30. Nistor, CM; Băcilă, V; Avram, P; Usturoi, A; Avarvarei, BV Evaluation of raw milk quality gathered from north east area of Romania. *Scientific Papers - Series D - Animal Science,* **2019**, 62 (2), 173–178.
31. Onaciu, G; Jurco, E; Jurco, Simona; Maciuc, V; Ognean, L Influence of varying milk urea nitrogen on chemical, hygienic and physical traits *of cow milk. Romanian* Biotechnological Letters, **2019**, 24 (5), 866–873.
32. Pânzaru, C; Doliș, MG; Radu-Rusu, RM; Pascal, C; Maciuc, V; Davidescu, Mădălina Alexandra Equine Milk and Meat: Nutritious and Sustainable Alternatives for Global Food Security and Environmental Sustainability - A Review. *Agriculture,* **2024**, 14 (12), 2290.
33. Pânzaru, C; Nistor (Anton), M; Davidescu, MA; Doliș, MG; Usturoi, A; Maciuc, V Phenotypic evaluation of milk fat and protein traits in relation to maternal ancestry in two Romanian cattle breeds. *Scientific Study & Research - Chemistry and Chemical Engineering, Biotechnology, Food Industry,* **2025**, 26 (4), 537–544.
34. Pânzaru, C; Radu-Rusu, RM; Doliș, MG; Nistor, M; Maciuc, V; Davidescu, MA Contributions to the study of milk quality from various cattle breeds. *Scientific Study & Research - Chemistry & Chemical Engineering, Biotechnology, Food Industry,* **2024**, 25 (4), 393–401.
35. Roessler, R; Mpouam, SE; Schlecht, E Genetic and nongenetic factors affecting on-farm performance of peri-urban dairy cattle in west Africa. *Journal of Dairy Science,* **2019**, 102 (3), 2353–2364.
36. Schutz, MM Genetic evaluation of somatic cell scores for United States dairy cattle. *Journal of Dairy Science,* **1994**, 77 (7), 2113–2129.
37. Schutz, MM; Maciuc, V; Gay, KD; Nennich, TD Survey of genetic selection on pasture-based dairy farms in the USA and Romania. 63rd Annual Meeting of the European Association for Animal Production, *Bratislava, Slovakia, Book of Abstracts,* **2012**, 18 (43), 315.
38. Terentyev, SE; Lazko, OV; Belokopytov, AV Organizational and economic aspects of the implementation of digital technologies in the innovative development of dairy cattle breeding. Proceedings of the 1st International Scientific Conference Modern Management Trends and the Digital Economy (MTDE 2019), *AEBMR*, **2019**, 81, 46–51.
39. Vidu, Livia; Chelmu, SS; Băcilă, V; Maciuc, V The content of minerals and fatty acids in buffalo milk, depending on the rank of lactation. *Romanian Biotechnological Letters,* **2015**, 20 (1), 10076–10084.

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