RESEARCH ON THE INFLUENCE OF FARMING TECHNOLOGY ON PRODUCTIVE PERFORMANCE AND MILK QUALITY

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Abstract

The study was conducted to highlight the influence of technology applied on the farm on productive performance. The biological material consists of a herd of 263 cows belonging to the Holstein-Friesian breed, exploited in the conditions of a farm from Bistrița Năsăud county, the NW area of Romania. For the statistical processing of primary data, it was used the S.A.V.C. computer program. The use of robots in the application of exploitation technology favors the achievement of very high performances. The average production in the first lactation was 8197 kg of milk, the highest productive average being 10978 kg of milk in the 7th lactation. The somatic cell count (SCC) in milk had an average value of 206.23 thousand /ml. Calving interval (CI) has an average value of 381.54 days. To obtain a gestation, were used for a female an average of 1.85 straws. Increasing the genetic potential and productivity of cattle populations, along with optimizing exploitation technologies on cattle farms, management and correct economic management, are important ways to increase quantitative and qualitative milk production.

Key words: *Holstein, robots, milk, performance, quality*

INTRODUCTION

Milk is a food that, through its rich chemical composition and high nutritional value, covers to the greatest extent the human need for food of animal origin, being indispensable in the nutrition of children, the sick persons or those who work in toxic environments. At the same time, milk is also the raw material from which numerous dairy products are prepared (butter, cream, dietetic products, cheeses, sour dairy products), with a large quantitative and qualitative weight in human nutrition. [8, 10, 11, 13, 16, 18].

Cattle husbandry represents the complex of technical, technological, economic and sanitary-veterinary measures, applied in flow to maximize and streamline production while maintaining the normal health of the animals. [1, 2, 3, 5, 6].

Production integration consists of achieving a rational flow of all production, processing and valorization factors (land, barns, animals, production facilities and equipment, milk production, primary treatment, storage and marketing of milk products). [7, 9, 17].

In our country, the technology for exploiting dairy cows is deficient, which means that dairy cows only achieve 2/3 of their genetic potential. [9, 12, 14, 15].

In developed countries, dairy cow exploitation is carried out rationally, which makes the level of milk production reflect the genetic potential of the animals. The intensification of dairy cow exploitation is a permanent concern of farmers in Western countries and is reflected in the significant increase in production per head of animal and per unit of built-up area, per unit of

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agricultural area or per unit of time. [2, 7, 9, 19].

Carrying out milk production in specialized farms maximizes and streamlines milk production, simplifies and rationalizes technological processes.

Considering the above, we set out to conduct research in which we pursued the opportunity of exploiting dairy cows, following a complex and creative analysis of all the factors and links that make up the exploitation technology, in a closed-circuit farm in Bistrița Năsăud County, the NW area of the country.

MATERIAL AND METHOD

The research was conducted on a herd of 263 dairy cows of the Holstein-Friesian breed. The total herd on the farm was 458 cattle, of which 263 heads were lactating cows, 80 heifers and 115 calves of different age categories. It is known that both internal factors, as well as operational and environmental factors, influence the quantitative and qualitative performances of cattle. [6, 9].

The aim of the work was to follow the influence of exploitation technology on productive performance and milk quality. In order to achieve the objectives proposed in the research, we studied exploitation technology and technological flow, the origin of the animals, productive performance of the offspring in exploitation, the body development of the animals, the main reproductive indices and milk quality indicators.

Animal livelihood constitutes the totality of measures regarding housing, body hygiene, movement of dairy cows and daily technological flow, on the farm, in order to ensure the reflection of the productive potential and the normal maintenance of animal health.

The cows are kept free in a closed, modern, hall-type barn with three technological areas of rest, movement and feeding. Ventilation, reproduction activity, milking of the cows, the health of the animals are automated with high-performance software that allows the farmer to monitor the technological flow. The barn is equipped with four robots: a milking robot (Lely Astronaut), one for preparing the feed mixture and distributing the feed (Vector), two for cleaning the floor of the stall (Discovery) and one that brings the food closer to the feeding front (Juno).

In 2015, the farm entered a modernization process through its own funds, including EU funds obtained under measure 1.4.1 of 700,000 thousand Euros, and the co-financing from the farmer was 30%, which allowed the purchase of equipment and the entire range of farm robots (Lely).

Also under measure 1.4.1, in 2018, the farmer accessed a project worth 1,000,000 Euros, money used to build a new shelter equipped with robots, bunks and all the technology necessary to intensify the technological flow. The herd also increased to 300 dairy cows.

The primary data used in the research came from direct observations and determinations on the farm as well as from the primary database of the farm, but also from the records of the Official Production Control (OPC) carried out by the Association of Cattle Breeders. All data were statistically processed $\bar{x}$, $\pm s_{\bar{x}}$, s, V% and summarized in next tables and figures. [4, 10, 18]

Increasing the genetic potential and productivity of cattle populations, along with optimizing exploitation technologies in small and medium-sized family farms, and correct economic management and administration, are important ways to increase profitable milk and meat production.

RESULTS

Dairy cows are husbandry and exploited in free range, in a modern and closed barn-type (figure 1) with three technological areas for rest, movement and feeding. Ventilation, breeding activity, milking of

cows, and animal health are automated with high-performance software that allows the farmer to monitor the technological flow.

Fig. 1 Dairy cow shed (original photo)

The barn is equipped with four robots, namely: a milking robot (Lely Astronaut – fig. 2), one for preparing the feed mixture and distributing the feed (Vector), two for cleaning the floor of the stall (Discovery) and one that brings the food closer to the feeding front (Juno). Through ventilation, the temperature in the barn ensures the thermal comfort of the animals, and the load of pollutants containing carbon dioxide and monoxide is permanently eliminated, the air in the stall being within the optimal permitted limits.

Fig. 2 Lely Astronaut milking robot (original photo)

The farm is strategically located near a river and is advantageous in terms of the hydrographic network.

The results obtained from the comparative analysis of the productive level of mother cows and descendants are presented in table 1. In ascendance cows had an average milk production of 9409.3 kg, and daughter cows achieved an average production of 8861.62 kg of milk.

Table 1 Comparative analysis of milk production in mothers and daughters

Specification	Traits	N	$\overline{X}$	$\pm s_{\bar{x}}$	S	V%	Min.	Max.
Daughters	Milk Kg	263	8861.62	218.64	1943.313	21.93	3477	14057
	Fat Kg	263	335.97	8.081	71.825	21.378	140	537
	Fat %	263	3.82	0.048	0.425	11.129	2.6	5.08
	Protein Kg	263	299.66	7.206	64.051	21.375	121	459
	Protein %	263	3.39	0.03	0.263	7.741	2.62	4.18
Mothers (M)	Milk Kg	79	9409.3	236.361	2100.823	22.327	4859	15130
	Fat Kg	79	367.71	9.157	81.385	22.133	181	533
	Fat %	79	3.92	0.042	0.375	9.557	3.21	5.11
	Protein Kg	79	319.16	7.947	70.637	22.132	165	482
	Protein %	79	3.4	0.027	0.238	7.002	2.75	4.12

Table 2 presents the results obtained from the analysis of the productive performances achieved by the offspring which are exploited on the farm under study. An upward evolution of milk production was observed starting with the

1st lactation and up to the 5th lactation, when the daughter cows reach the maximum production of 10845.93 kg of milk.

Table 2 Statistics for milk production in the studied herd

Lactation	Traits	n	$\overline{X}$	$\pm s_{\bar{x}}$	s	V%	Min.	Max.
1st	Milk Kg	263	8197.16	124.547	2019.81	24.640	2541.00	15711.00
	Fat Kg	263	314.22	4.167	67.581	21.508	107.00	485.00
	Fat %	263	3.88	0.026	0.429	11.050	2.47	5.66
	Protein Kg	263	275.13	3.878	62.893	22.859	81.00	442.00
	Protein %	263	3.38	0.015	0.245	7.250	2.81	5.27
2nd	Milk Kg	186	9653.15	144.371	1968.96	20.397	3997.00	15940.00
	Fat Kg	186	369.13	5.082	69.312	18.777	173.00	556.00
	Fat %	186	3.86	0.033	0.444	11.498	2.60	5.82
	Protein Kg	186	328.00	4.573	62.371	19.015	141.00	515.00
	Protein %	186	3.41	0.017	0.234	6.864	2.62	4.18
3rd	Milk Kg	111	9916.40	179.99	1896.29	19.123	3093.00	15838.00
	Fat Kg	111	392.41	7.798	82.157	20.937	132.00	623.00
	Fat %	111	3.97	0.045	0.471	11.875	3.19	6.04
	Protein Kg	111	335.23	5.873	61.871	18.456	113.00	459.00
	Protein %	111	3.39	0.023	0.243	7.173	2.75	4.08
4th	Milk Kg	59	10031.39	255.548	1962.901	19.568	5051.00	13401.00
	Fat Kg	59	400.51	10.441	80.202	20.025	203.00	597.00
	Fat %	59	4.02	0.061	0.472	11.748	2.98	5.65
	Protein Kg	59	340.93	8.599	66.049	19.373	175.00	449.00
	Protein %	59	3.41	0.032	0.247	7.257	2.98	4.19
5th	Milk Kg	27	10845.93	425.828	2212.666	20.401	6217.00	15130.00
	Fat Kg	27	425.59	14.832	77.069	18.109	260.00	549.00
	Fat %	27	3.96	0.086	0.444	11.222	3.39	5.21
	Protein Kg	27	362.48	14.437	75.017	20.695	223.00	537.00
	Protein %	27	3.35	0.041	0.211	6.306	2.96	3.75
6th	Milk Kg	17	10754.71	440.814	1817.522	16.900	8206.00	13576.00
	Fat Kg	17	413.94	20.159	83.118	20.080	308.00	576.00
	Fat %	17	3.85	0.111	0.460	11.922	3.00	5.07
	Protein Kg	17	354.88	16.874	69.572	19.604	233.00	462.00
	Protein %	17	3.30	0.087	0.357	10.823	2.66	3.82

Regarding the body development of the animals from studied herd, the results obtained are presented in table 3. We find a body development that falls within the optimal limits for the Holstein-Friesian cattle breed.

Table 3 Statistics for body development in the studied herd

Traits	n	$\overline{X}$	$\pm s_{\bar{x}}$	s	V%	Min.	Max.
Height (cm)	200	165.8	1.132	5.061	3.053	153	171.5
Chest circumference (cm)	200	207.83	1.526	6.823	3.315	185	215
Height at the rump (cm)	200	164	1.364	6.102	3.59	145	173
Body weight (Kg)	200	650.5	7.956	35.582	5.725	550	710
Oblique trunk length (cm)	200	159.88	1.019	4.559	2.852	148	169
Shin-bone perimeter (cm)	000	18.39	0.154	0.654	3.558	17.5	20

Based on the individual recorded values, statistical estimators were calculated for the age of the females at first calving (AFC), the number of inseminations performed to obtain pregnancy and the interval between calvings (CI.). Table 4 presents the results obtained through statistical processing.

Table 4 Statistics of the main reproductive indices in the studied herd

Caractere	n	$\overline{X}$	$\pm s_{\bar{x}}$	s	V%	Min.	Max.
Age of first calving. (months)	125	26.41	0.261	2.826	11.576	21	30
Number of AI per gestation	125	1.85	0.105	0.776	19.243	1	3
Calving Interval (days)	125	373.54	4.032	39.304	10.221	325	409

The qualitative analysis of milk aimed to determine the quality indices for each animal taken into the study, and the results obtained are presented in table 5. We find that the milk obtained in the studied farm is of good quality.

Table 5 Statistics for quality indices of milk production in studied herd

Traits	n	$\overline{X}$	$\pm s_{\bar{x}}$	s	V%	Min.	Max.
Milk Kg	263	9633.17	83.656	2162.157	23.402	3541	15940
Fat kg	263	377.58	3.152	81.457	22.78	107	623
Fat %	263	3.95	0.017	0.447	11.45	2.47	6.04
Protein Kg	263	311.68	2.717	70.22	22.529	81	537
Protein %	263	3.39	0.009	0.244	7.197	2.62	5.27
NSC thousand/ml	263	157.74	16.925	116.031	70.606	27.00	405.00

DISCUSSIONS

In the studied farm, cattle are kept in closed barns, free-range housing with a compartmentalized resting area (fig. 3), a movement area and an individualized feeding area. In the barn, the microclimate is well optimized to positively influence milk production and air exchange is achieved with the help of fans, and the humidity level is within the limits of 65-70%, so that the animals can express their genetic potential.

In correlation with the predominantly mountainous relief type, the precipitation level shows minimum values of 500 mm reaching up to 1500 mm. Air currents show an average of 3.5 m/s, being days when the wind shows intensification. The weather is one of the factors influencing milk production.

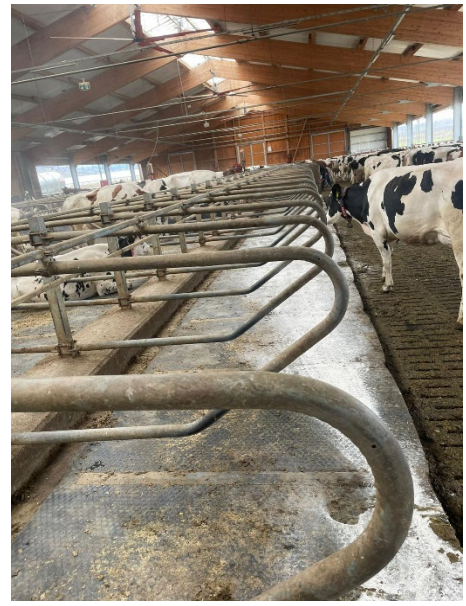

Fig. 3 Interior view of the barn (original photo)

Cows are fed from stock, with the technological trailer and by means of the robots provided. Feeding "from stock" of dairy cows consists of feeding them throughout the year with the same types of feed, that is, from those that can be consumed and stored, namely: hay, semi-hay, silage, coarse and cultivated or industrial concentrates. The basis of the dairy cow diet is formed by voluminous and succulent feed that can satisfy 60-100% of the required values, to which concentrates are added, depending on milk production.

Lely Astronaut type robots ensure milking of a herd of 260 cows that can be milked several times in 24 hours, as concentrate supplements are administered during milking. Cows are milked on average 5 times a day. Milking robots ensure good udder hygiene, quality milking, fast and as complete as possible. The evacuation of manure from the barn is done with the help of Lely Discovery robots (fig. 4). The mobile device for cleaning the barns is equipped with robotic technology. Its flexibility and precision ensure that the movement area in the cow barn is kept as clean as possible. It is a battery-operated vehicle and upon installation, the route that Discovery will have to follow is programmed using the E-LINK remote control. After finishing cleaning in the stables, Discovery returns to the charging station.

Fig. 4 Manure evacuation with the Lely Discovery robot (original photo)

The farmer wants to open a dairy factory that can process a much larger production of milk. The small dairy processing station on the farm covers only a quarter of the total milk production obtained daily.

The productive level in the case of ascendance was analyzed (tab.1) to highlight the evolution of productive performances from one generation to another. The average value of 8861.62 kg of milk of the daughters and the maximum productive value of 14057 kg recorded in them are lower values than the average of 9409.3 kg of milk and the maximum of 15130 kg of milk in the case of mother cows. The studied character presents heterogeneity in both mother cows and daughters, the coefficient of variability having values of 22.32% respectively 21.93%. Accordingly, the amount of fat and the amount of protein are higher in ascendance compared to daughter cows. The explanation is that the climatic fluctuations in the area where the farm is located are very high, which ultimately determines the quality of the feed and, last but not least, the productive level, quantitative and qualitative.

The analysis of milk production in the descendance (tab. 2) highlights an upward evolution starting with the 1st lactation when we record an average value of 8861.62 kg of milk with limits between 2541 and 15711 kg of milk and the 5th lactation when it reaches a maximum average value of 10845.93 kg of milk with limits between 6217 and 15130 kg of milk. After the fifth lactation, milk production begins to decrease insignificantly. The studied character has a coefficient of variability with a value greater than 20%, which highlights a heterogeneous population with wide possibilities for selection and genetic improvement of the herd. Milk production being strongly and positively correlated (98.00%) with the amount of fat and the amount of protein, we find that the evolution of the two mentioned

characters is similar to that of milk production. Therefore, the amount of fat and the amount of protein increase with the succession of lactations, reaching maximum values of 425.29 kg of fat and 362.48 kg of protein in the 5th lactation, after which they begin to decrease insignificantly in the following lactations.

This evolution of the productive level is normal and desirable, since the productive level increases with age and after reaching a maximum level and an advanced age, it begins to decrease. Of course, environmental, technological and climatic factors significantly influence the quantitative and qualitative milk production.

The body development of the studied herd (tab. 3) falls within the optimal limits for the Holstein-Friesian cattle breed. The analyzed herd has an average height value of 165.8 cm, a chest circumference of 207.83 cm, an average body weight of 650.5 kg and an oblique trunk length with an average value of 159.88 cm. This characters highlight the body development and have a low coefficient of variability with values between 2.8 and 3.5%. Therefore, the possibilities of genetic improvement of the studied cattle herd through selection are reduced.

The study of reproductive indices (tab.4) revealed that the age of first calving in cows from the analyzed herd has an average value of 26.41 months, a value as good as possible for the mountainous area where the farm is located.

The calving interval (C.I.) has an average value of 373.54 days and falls within the optimal limits recommended by the specialized literature. Also, the number of I.A. to obtain a pregnancy has an average value of 1.85 sequins, with limits between 1 and 3 sequins. The studied herd has an average coefficient of variability for the studied reproductive indices [9, 17].

The results obtained for milk quality indicators are presented in table 5. Cow's milk is essential for a healthy body, and this has been proven continuously since the beginning of time. But for milk to fulfill its important role, it must meet the optimal quality limits imposed by the E.U.

Practically, once milked, milk can have different qualities; as a rule, the quality of milk is determined according to its content in its components (proteins, fats, water, etc.), cells from the cow's udder or microbes from the shelter or udder.

Analyzing the information in table 5, we find that an average production of 9239 kg of milk was achieved with a content of 3.95% fat and 3.39% protein, which means that the production achieved is good, both quantitatively and qualitatively.

The amount of fat in milk had an average value of 377.58 kg and that of protein of 311.68 kg, the herd being heterogeneous for these characters but also for the quantitative production of milk. The percentage of fat and protein have a low to medium coefficient of variability with values between 7.19 and 11.45 % [11, 18].

Number of Somatic Cells (NSC) represents the number of cells present in one milliliter of milk, mainly epithelial cells and leukocytes (white). NSC is the main indicator for udder health and implicitly for milk quality. An increase in NSC is a clear sign of inflammation or infection in the udder (mastitis), as the body releases more immune cells to fight the infection.

In the studied population, the average value recorded for NSC was 157.74 thousand/ml with limits between 27.00 and 405.00 thousand/ml. Therefore, the milk obtained in the studied farm is of good quality and is suitable for consumption and processing. In conclusion, maximum efficiency and the reality of quality production cannot be achieved without providing modern equipment, installations, machines and technology on farms. Ensuring the health of animals and the health of products must be important concerns of the farmer. For this, the farmer

must have solid professional knowledge and access to information without which he cannot achieve efficient exploitation of dairy cows.

CONCLUSIONS

1. In the farm under study, the exploitation technology influences the quantitative and qualitative milk production. Large investments were made and the technological flow was intensified so that an average production of 9633 kg of milk and an average value for NSC of 157.74 thousand/ml was obtained.

2. The body development of the studied herd falls within the optimal limits for the Holstein-Friesian cattle strain. The analyzed herd has an average height value of 165.8 cm, a chest circumference of 207.83 cm, an average body weight of 650.5 kg and an oblique trunk length with an average value of 159.88 cm.

3. Ensuring the health of animals and the safety of products must be an important concerns for the farmer. For this, the farmer must have solid professional knowledge and access to information without which he cannot achieve efficient exploitation of dairy cows.

REFERENCES

1. Bewley, JM; Robertson, LM; Echelkamp, EA A 100-Year Review: Lactating dairy cattle housing management. *Journal of Dairy Science*, **2017**, *100* (12), 10418-10431.
2. 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.
3. 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.
4. Cucu, GI; Maciuc V; Maciuc Domnica Scientific research and elements of experimental technique in animal husbandry. *Alfa Publishing House*, Iaşi**, 2004**, 242-299.
5. 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-Ciencias Agrarias*, **2018**, *39*(3), 1211-1223.
6. 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.
7. Klein-Jobstl, 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*, *57*, Article Number: 44.
8. Leslie, KE Somatic cell counts: Interpretation for individual cows. *Queen's Printer for Ontario*, **1996**
9. Maciuc, V The management of cattle husbandry. *Alfa Publishing House, Iaşi*, **2006**, 224-277
10. Maciuc, V; Creangă, S; Maciuc Domnica; Vidu Livia A New Software Programme for Data Management in Dairy Farms. "ST26733". *International Conference "Agriculture for Life, Life for Agriculture". Agriculture and Agricultural Science,* **2015**,*6*, 226 – 231
11. 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 Letter*, **2017**, *22* (6), 13096.
12. 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
13. 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. ISSN 2285-5750, Bucharest
14. 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 Letter*, **2019**, *24* (5), 866-873,

15. Panzaru, C; Dolis, M; Radu-Rusu, RM; Pascal, C; Maciuc, V; Davidescu, Madalina Equine Milk and Meat: Nutritious and Sustainable Alternatives for Global Food Security and Environmental Sustainability-A Review. *Agriculture*, **2024,** *14* (2). DOI 10.3390/agriculture14122290
16. Schutz, MM Genetic evaluation of somatic cell scores for United States dairy cattle. *Journal of Dairy Science*, **1994**, *77* (7), 2113-2129.
17. 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.
18. Vidu Livia; Chelmu, SS; Băcilă, V; Maciuc, V The content of minerals and fatty acids in buffalo milk, depending on the reank of lactation. *Romanian Biotechnological Letter*, **2015**, *20* (1), 10076-10084.

West, JW Effects of Heat-Stress on Production in Dairy Cattle. *J. Dairy Sci*, **2003**, *86*, 2131-21441.