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THE INFLUENCE OF MANAGEMENT PRACTICES ON MILK QUALITY IN A DAIRY CATTLE FARM

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Abstract

In order to provide an up-to-date perspective on farm management techniques, a survey was conducted in a dairy cattle farm to study the relationships between management practices, milk yield and quality. A number of 310 Holstein Friesian cows reared for milk production in a semintensive farming condition were taken into study. Over the course of a year, individual milk analyses were performed on CombiScope FTIR milk analyzer (Delta Instruments, Netherlands). Milk yield per milking session was recorded daily using the AfiMilk system (Kibbutz, Israel). The analysis and interpretation of the results were correlated with the numerous observations made directly on the farm. The average calculated content, per normal lactation, was 8887.79 kg of milk, 369.05 kg fat, and 306.06 kg protein. A strong, positive relationship between milk yield and fat content, which means that an increase or decrease in milk production results in a corresponding change in the amount of fat contained. The yearly average percent of fat was 3.99 %, protein 3.32 %, casein 27.75 %, lactose 4.9 %, SCC 195,900 cells/ml were obtained in the studied farm.

Key words*: dairy cattle, management analysis, milk quality, welfare.*

INTRODUCTION

The global dairy industry is undergoing rapid transformations, which have created substantial commercial opportunities, as well as several sustainability challenges. The most valued agricultural resource in the world in terms of value is milk along with other dairy products (Wilcox et al., 2017; De Vries et al. 2015).

Milk quality in dairy cattle farms is of utmost importance for both the health of consumers and the economic viability of the farm. By implementing best practices in cattle care, milking hygiene, and milk handling, dairy farmers can ensure the production of high-quality milk that meets consumer demands and industry standards (Galanakis, 2018).

Milk production is essential to enriching diets around the world and provides jobs for billions of people (Garcia-Yuste et al., 2020; Ritter et al., 2023).

Management practices play a critical role in influencing the quality of milk produced on dairy cattle farms. A major role in achieving positive results in the dairy farm is played by the farm manager. The manager plans, controls, and coordinates the activity, ensuring that the farm is managed in compliance with the requirements of the legislation, the established objectives, interests and strategies of the farm (Maltz et al., 2020; Scialabba, 2021).

Dairy farms will have to be in harmony with the environment, and with the community, provide appropriate conditions for the maintenance and exploitation of animals, and at the same time be efficient and economically competitive (Webster, 2020; Amaritii & Maciuc, 2023).

Rearing of dairy cows includes all the technical and organizational measures that take place within the farm, such as cattle body hygiene, housing, technological flow, and cow movement (Berckmans, 2022). All of these measures influence both milk production and the productive lifespan of the animals, reproductive capacity, state of health, behavior of cows, the degree of feed usage, but also the economy of the farm (Bilțiu Dăncuș et al., 2022; Nica & Vidu, 2023).

Depending on the rearing conditions ensured, the qualitative and quantitative production of

milk also differs (Goyal, 2023; Rațu et al., 2023). Thus, the farmer must know how the housing conditions can act positively on the production of the cows and use these to his advantage, both for economic purposes and for the dairy cows to express their true genetic potential (Butler et al., 2011; Enea et al., 2023)
The current activity objective is to ensure the stable and sustainable development of the capacity for scientific research, technological development and innovation in the field of rearing and improving dairy cows (Mondal, 2021).

MATERIALS AND METHODS

The research was conducted in the experimental dairy farm of the Research and Development Center for Cattle Breeding Dancu, Iași, on Holstein Friesian dairy cows, primiparous and multiparous.
The experimental dairy farm has as biological material for research a total herd of 791 bovines of the following breeds: 635 Holstein Friesian, of which 315 cows, 72 heifers 248 young cattle, 104 Fleckvieh Simmental of which 47 cows, 8 Heifers, 49 young cattle, and 52 Grey Steppe, 31 cows, 3 heifers, 18 young cattle.
To evaluate associations between management and milk quality with some confidence, we analyzed the technological flow, recorded the individual and total productions, and determined the milk quality during the year 2022.
The individual and total milk production of the Holstein Friesian cows was registered daily in the farm management program Afimilk (Kibbutz, Israel).
The analysis of milk quality was determined on a Combiscope FTIR 600HP milk analyzer, from Delta Instruments (Netherlands), the chemical composition on LactoScope FTIR, and the count of somatic cells on SomaScope LED & flow cytometry. A 50 ml milk sample was heated in a water bath at 37°C and then analyzed for fat, protein, lactose, casein, and SCC count.
The obtained data was analyzed for primary statistical indicators and then proceeded to the statistical significance of the differences, with SPSS and S.A.V.C. programs.

Figure 1. Afimilk Management Software and milk analyzer CombiScope 600HP (original)

RESULTS AND DISCUSSIONS

The activity within the agricultural and livestock farms is under the coordination of the technical director, each farm is conducted by a farm manager, a graduate of higher specialized studies, who is responsible for the achievement of technical and economic indicators.
In the dairy farm, the working schedule is established so that the activities, duration, and sequence are consistent with the biological requirements of the reared cows, thus favoring the maintenance of conditioned reflexes.
Within the livestock farm there are 2 shelters for lactating cows (1,3), between the two shelters is the milking platform (2), shelter for pregnant cows/heifers in advanced stage of pregnancy (4), individual stalls for calves 0-3 months (5), shelter for calves 3-6 months (6), calf shelter 6-12 months (7), heifer shelter (8), area for combined feeds (12), silage cells (11), covered area for straw bales (10), modern manure treatment system (9), summer camp (13), mechanization (14).
To be executed promptly the activities included in the work schedule are carried out on the principle of specialized teams in the intervals 4 – 10 am and 4 – 7 pm (milking, feeding, treatments, artificial insemination, manure removal, cleaning, etc.), reserving the intervals

between 10 am – 4 pm and 7 pm – 4 am for the animals' physiological rest, necessary for rumination, ruminal digestion and milk secretion.
A dairy cattle farm operates on a daily and yearly schedule to ensure the well-being of the cows and the successful production of milk. Compliance with the daily work schedule on the farm results in the creation of conditioned reflexes in the cows, which would otherwise no longer occur. The immediate and long-term effect of not following the program on the farm will be decreased milk production.

Figure 2 The organizational structure of the studied dairy farm (original)

The use of mechanization and automation in the farm means reduced physical effort of the worker and increased labor productivity. Utilizing technological advancements like automated milking systems, data analysis tools, and precision feeding systems can enhance efficiency and improve decision-making (Berckmans, 2022; Wilcox et al., 2017).
The shelters within the farm are closed, equipped with natural and artificial ventilation systems, with automatic brushes for bodily hygiene, and electrically operated. The shelters are provided with a central feeding lane. Access to the feed is achieved through a mechanical grid that individualizes the feed front. During feeding, cows can be restrained using a front feed locking system for administration of hormonal and medicinal treatments, and artificial insemination. A continuous circulation area with a concrete floor is placed between the feeding alley and the rest area. Automatic water bowls are located between the rest areas, on the access aisles, and connected to the public water supply network, with heating to prevent freezing during winter. Providing clean, comfortable, and well-ventilated housing minimizes stress and reduces the risk of disease, impacting milk quality (Maltz et al., 2020).
According to Garcia-Yuste (2020), drinking water on time and in sufficient quantities, at a temperature of 8-12°C, at the smallest possible intervals, ensures 87-88% of the milk content in the water. Efficient water usage for cleaning, irrigation, and animal consumption reduces environmental impact and lowers costs.
Manure evacuation is carried out automatically, with electrically powered scraper plows and sensors for their automatic stop, thus maintaining a high degree of hygiene, reflected in the well-being and health of the animals, but also in the hygienic quality of the milk. The manure ends up in a modern separation system,

which separates the solid part from the liquid part, through decantation and extrusion, thus reducing its volume, and making it easier to store and use in the field. Implementing proper manure storage and handling practices minimizes environmental impact by converting it into fertilizer.

Induction of genetic progress is mainly achieved by using semen from tested Holstein sires, without excluding the other sources of progress - the selection of primiparous cows, respectively the selective reform. Several studies showed that artificial insemination is the most common breeding method on dairy farms and high-quality semen from genetically superior bulls is used to optimize herd performance (Presicce, 2020), also relevant for Romanian dairy farms.

Efficient reproductive management directly impacts the profitability of a dairy cattle farm According to De Vries et al. (2020) reproductive problems are the primary reason for culling cows from the herd. Good reproductive practices help keep culling rates low. Cows that maintain consistent calving intervals contribute to steady milk production levels for the farm. Effective reproduction management allows farmers to selectively breed their best cows, improving the herd's overall genetics over time (Rushen et al., 2017). In the studied dairy farm, the reproduction is organized on the principle of different calving times, which allows for rhythmic milk production throughout the year. Artificial insemination is performed by doctors and veterinary technicians. Correct semen handling and insemination technique by trained personnel are crucial for conception success.

The institution organizes professional qualification courses for employees, both for those with higher and lower education. Educating farm staff on practices like milking hygiene protocols, cow handling, and udder health monitoring ensures consistent implementation and reduces the risk of human error impacting milk quality.

Table 1. Statistics for milk production, by normal lactation, for the Holstein Friesian cattle herd

Parameter	$\overline{X}$	$\pm s_{\bar{x}}$	s	V%	Minimum	Maximum
Milk kg	8887.73	136.734	1304.991	23.684	4263	14527
Fat kg	369.05	5.654	87.041	23.585	175	597
Fat %	4.16	0.01	0.16	3.853	3.52	4.63
Protein kg	306.06	4.7	72.353	23.64	144	477
Protein %	3.44	0.007	0.115	3.344	3.07	3.92

The values of the statistical estimators for milk production calculated for the entire herd are presented in Table 1, where it can be seen that the average production per lactation in the herd is approx. 8888 kg of milk, with 4.16% fat and 3.44% protein, which means very good milk production and quality.

The limits of the variation range are 4263 kg and 14527 kg of milk per normal lactation, with cows that have a percentage of fat in their milk that reaches 4.63%. The amount of fat and protein is dependent on milk production, obtaining an average production of 369 kg of fat and 306 kg of protein. For fat and protein percent, the herd is characterized by low variability, being homogeneous for these characters. (3.85% and 3.34% respectively).

Similar results were obtained by Maciuc (2017), on Holstein Friesian, in analyzing the quality of raw milk for processing.

The analysis of the statistical values calculated monthly for the milk quality indicators in the studied farm indicates that the milk has on average a higher percentage content in the autumn and winter months, the highest average being 4.26% fat in February, this being the highest average value of the year. During the summer months, the fat percentage remains constant, with average values between 3.91% in August and 4.01% in June. The protein percentage is also higher in the winter months, the maximum average value of the protein percentage being that of February of 3.55% and that of casein at 2.85% in November.

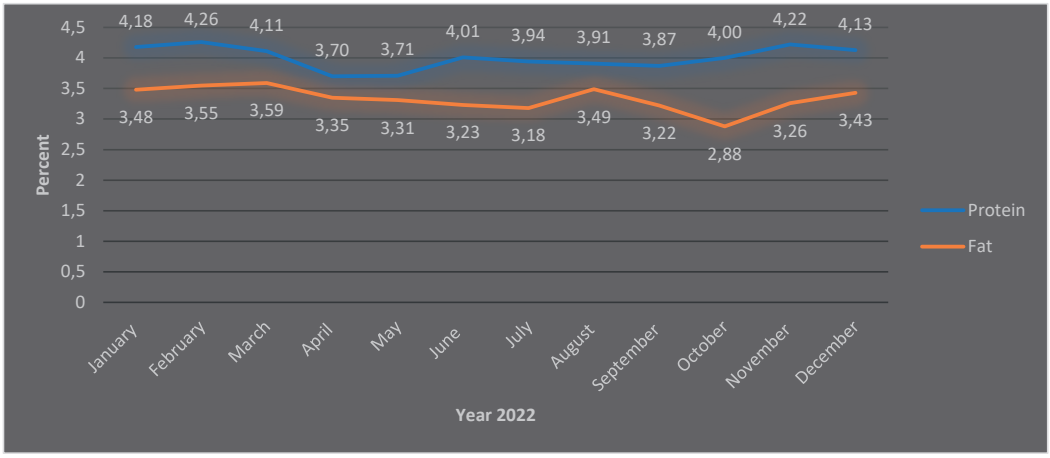

Figure 3. The dynamics of fat and protein average percentage, monthly in year 2022

The herd of dairy cows is characterized by low variability for the characters related to the percentage of fat and protein in milk (values for the coefficient of variation are below 10%), but the same cannot be said when we refer to NCS, in which case the cow population is extremely heterogeneous. The highest SCC averages are recorded during the summer and autumn months, with the maximum average value of 332.000 cells/ml being in August and the lowest in April, its average being 89.670 cells/ml (Figure 4).

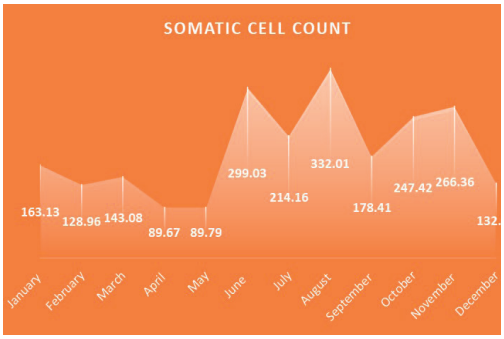

Figure 4. The dynamics of somatic cell count average percentage, monthly in the year 2022

Management practices such as thoroughly cleaning the udder and teats with warm water and a disinfectant before milking reduce bacterial contamination, dipping teats in a disinfectant solution after milking helps prevent the entry of bacteria into the teat canal, and. proper cleaning and maintenance of milking machines and equipment are essential to prevent the spread of bacteria and ensure efficient milking.

Represented in Figure 5 is a Pearson correlation between the amount of fat and milk. The orientation of the regression line and the arrangement of the points on the line denote a positive and strong correlation between milk production and the amount of milk fat, which means that an increase or decrease in milk production results in a change in the same sense of the amount of fat contained.

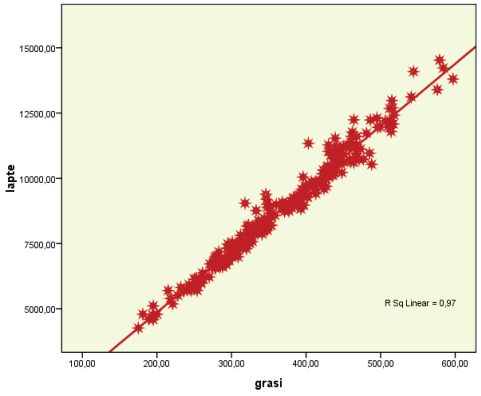

Figure 5. The regression line for the quantity of Milk kg and quantity of Fat kg

In order to statistically characterize the quality indicators of milk for the cattle herd, recorded in 2022, according to the values presented in Figure 6, we can say that milk production in the herd is very qualitative considering the average

values of the fat percentage which is approximately 4%, that of protein which on average is 3.32% and that of casein 27.75%.

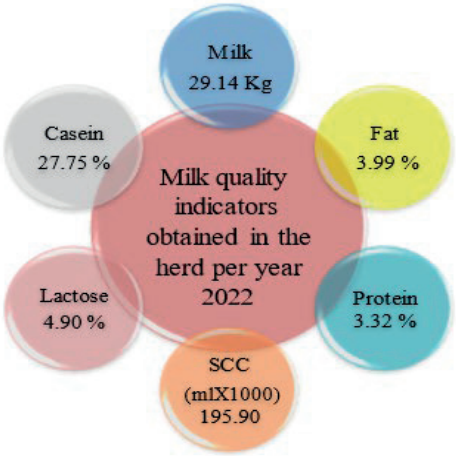

Figure 6. Statistics for the quality indicators of milk, year 2022, in the studied cattle herd

Lactose is 4.9%, a percentage value slightly above the optimal value, and SCC has the average value in the herd of 196.000 cells/ml, below the maximum allowed limit. To characterize the population in terms of the variability of the parameters, we can say that it is homogeneous for % casein, it is medium homogeneous for % fat, % protein, and % lactose being very heterogeneous in for SCC.
Monitoring milk quality parameters and cow health data allows for early detection of potential issues and timely interventions.

CONCLUSIONS

This study investigated the management practices employed at a dairy farm rearing Holstein Friesian cows and analyzed their impact on milk quality. The findings demonstrate that a well-structured management system incorporating best practices contributes significantly to achieving high-quality milk production.
The farm implements a regimented daily schedule for activities such as milking, feeding, and cleaning, ensuring consistency and minimizing stress on the cows. Housing provides a clean, comfortable, and well-ventilated environment with automatic manure removal systems, promoting animal well-being and hygiene. The farm utilizes modern milking equipment and prioritizes staff training on milking hygiene protocols. Effective reproductive management practices, including artificial insemination with high-quality semen, contribute to herd improvement and sustained milk production.
The study revealed an average milk production of 8888 kg per lactation with a fat content of 4.16% and protein content of 3.44%, indicating good overall milk quality.
Milk fat and protein content exhibited low variability, demonstrating herd homogeneity for these traits.
Somatic cell count (SCC) displayed higher values during summer and autumn, suggesting a potential area for improvement in udder health management during these seasons.
This study emphasizes the importance of comprehensive farm management practices for achieving consistent milk quality. By adhering to best practices in areas like cow care, milking hygiene, and data-driven decision-making, dairy farms can ensure the production of high-quality milk that meets consumer demands and industry standards.
Further research could explore targeted strategies for lowering SCC during the summer and autumn seasons to optimize overall milk quality.

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