Analysis of the Correlation between Feed Quality and Dairy Cow Productivity on Farms in Călărași

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Abstract

Milk is essential in human nutrition, primarily due to its rich nutritional profile and benefits. The composition and quality of milk can vary significantly depending on several factors such as: breed, lactation, nutrition, animal husbandry system, feeding system, milking system, and environmental conditions. This study investigates the correlation between feed quality and dairy cow productivity in a Holstein dairy farm located in Călărași County, Romania. Holstein cows in Romania are widely raised due to their adaptation to diverse environmental conditions and their ability to produce large quantities of milk. By monitoring the types of cows and their feed nutritional profiles, the research aims to understand how different feeding strategies influence milk production. The study incorporates data collected from 356 cows in January to 424 cows in December. The results indicate a significant relationship between high-quality forage, ration, and improved milk production, demonstrating that improved forage quality leads to higher yields in terms of total milk production.

Keywords: cow farm, Holstein breed, milk production, milk quality, rearing systems.

1. Introduction

Cow's milk provides multiple nutritional advantages, being particularly abundant in vital nutrients including calcium, vitamin D, and high-quality proteins [1]. Its consistent intake enhances skeletal integrity, promotes muscle functionality, and can potentially lower the incidence of chronic illnesses [2,3].

An in-depth analysis of the relationship between feed quality and dairy cow productivity is crucial to improving farm performance and effectively addressing the population's nutritional demands [4,5].

The dairy sector in Romania is distinguished by a significant cattle population, estimated at 1.6 million dairy cows, which collectively yield roughly 4.7 million tonnes of milk annually. Despite this considerable production capacity, the industry has encountered substantial difficulties, notably reflected in the reduction of dairy cow populations by approximately 3.3% and a sharp decline in raw milk output by 18.4% from 2010 to 2020. Addressing these issues through targeted strategic measures is essential for boosting productivity and ensuring the sector's long-term sustainability [6].

Feed quality represents a crucial determinant of dairy cow productivity. Nutritionally balanced and high-quality feed significantly improves milk production and enhances overall animal health. On the other hand, inferior feed quality may contribute to health problems, including mastitis, decreased milk yields, and impaired welfare conditions for cows [7,8].

The Holstein Friesian breed is recognized globally for its outstanding milk production capacity, being predominant in the dairy industry in over 160 countries. According to a study conducted in

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Australia, this breed is distinguished by its average annual production of approximately 10,000 liters of milk per cow, with a fat content of 3.82% and protein of 3.21%. In addition, research indicates that Holstein Friesian cows have an average daily milk production of 23.2 kg, highlighting their efficiency in intensive farming conditions [9,10]. These characteristics make the Holstein Friesian a preferred choice for commercial farms aiming to maximize milk yield. The milk produced by Holstein Friesian cows is valued not only for its high volume but also for its nutritional quality, especially its lactose content. Studies indicate that the average lactose concentration in the milk of these cows varies between 4.10% and 4.48%, with values being influenced by factors such as the timing of milking and the stage of lactation [10,11]. In Romania, the Holstein Friesian breed has been widely adopted due to its adaptability to local conditions and its production potential. A comparative study conducted on 59 Romanian farms, analyzing over 34,000 full lactations between 2012 and 2017, highlighted the superior performance of this breed in the national context [12]. The adoption of this breed significantly contributes to improving milk production in Romania, providing economic and nutritional benefits.

The present research targets a dairy farm in Călărași, an agriculturally important region in Romania. Through examining the relationship between feed quality and the productivity of dairy cattle, this study seeks to uncover critical factors that could guide best practices and policymaking. A clear comprehension of these interactions is crucial for optimizing farm efficiency, safeguarding animal welfare, and fulfilling the nutritional requirements of the population.

2. Materials and methods

This study was conducted over a 12-month period, from January to December 2024, at an intensive dairy cow farm located in Călărași County, in southeastern Romania. The research aimed to monitor and evaluate the correlation between feed quality and milk productivity in Holstein Friesian dairy cows raised under controlled and intensive management systems.

Study Area Description

Călărași County is situated in the southeastern region of Romania and is characterized by predominantly flat plains and floodplains, with an average altitude of 46 meters above sea level, ranging from a minimum of 8 meters to a maximum of 83 meters. The region belongs to the Romanian Plain, specifically the Muntenia Plain, and is traversed by the Danube River and the Borcea branch. The local climate is temperate-continental, strongly influenced by the flat relief, resulting in hot, dry summers and cold winters. These climatic conditions directly impact forage production, feed preservation, and animal welfare, thus indirectly influencing milk yield and quality.

Farm presentation

The dairy farm is located in Călărași County, operates as a modern zootechnical center, specialized in the breeding and exploitation of dairy cattle. The unit has a maximum capacity of approximately 440 lactating cows and 550 cattle in total, operating in an intensive and closed system. The farm's activity is structured in two large shelter complexes: one for lactating cows and the other for young cattle and cows in the dry period.

The shelters are equipped with modern infrastructure: feeding areas with self-catching fences, cubicles with chopped straw, concrete circulation alleys, and stainless steel tilting drinkers. The farm is equipped with a GEA Magnum rotary milking parlor with 32 stations, which allows simultaneous milking of cows in a continuous flow, streamlining daily operations. The milk is transported through stainless steel pipes to a cooling tank with a capacity of 16,000 liters, being kept at optimal temperatures until delivery to processors.

The farm has sanitary, electrical installations, and technologies for manure management (concrete platforms, gutters, a collection basin with waterproofing, and a pumping system), respecting environmental and animal welfare requirements. In addition to animal shelters, the unit includes feed spaces, calving areas, individual stalls for newborn calves (24 heads/cycle), and collective stalls (180 heads/series).

Animal Selection and Farm Conditions

The study population consisted of Holstein Friesian dairy cows raised on a single intensive farm operating under commercial standards of animal welfare, nutrition, and hygiene. The herd

size varied slightly from month to month, starting with 356 lactating cows in January and increasing to 424 by December. The monthly cow counts were as follows: 356 (January), 367 (February), 366 (March), 377 (April), 383 (May), 385 (June), 397 (July), 401 (August), 411 (September), 409 (October), 415 (November), and 424 (December).

All animals included in the study were carefully selected based on uniformity in age body weight (average 600–650 kg), lactation stage (between day 60 and 180), and clinical health status. Only cows with a history of consistent lactation performance and no prior incidences of mastitis or metabolic disorders were included. The farm adhered to European Union standards of animal husbandry, including free-stall housing, scheduled milking (twice daily), and veterinary supervision.

Feeding System

The cows were fed a ration that did not change throughout the 12 months, a stock ration. The basic ration consisted of corn silage, alfalfa hay to which was added a farm mix consisting of corn grain, barley, sunflower meal, wheat bran, monocalcium phosphate and NaCl. Although the total mixed ration (TMR) provided to lactating cows remained unchanged in terms of formulation, the nutritional value of the feed components may vary due to differences in feed quality from different storage lots. This highlights the importance of continuous monitoring of the chemical composition of feeds, as fluctuations in parameters such as dry matter, crude protein, and fiber content can significantly affect production and composition.

Holstein Friesian cow diet

To support optimal milk production in Holstein Friesian cows, with an average weight of 600–650 kg and in an intensive farming system, it is essential to formulate balanced energy and protein rations, which also ensure the adequate intake of macro- and microelements. Table 1 presents the daily ration per cow, composed of fibrous and bulky basic feeds (alfalfa hay and corn silage), supplemented with a farm-specific concentrated mixture (Table 2), formulated to provide increased nutrient density and mineral balance.

The ratio of physically efficient fiber (alfalfa) to readily available energy (starch from silage) is essential for maintaining stable rumen fermentation and preventing subclinical acidosis. Corn silage contributes significantly to the intake of net lactation units (NLU), while alfalfa hay provides a consistent intake of rumen degradable protein (RDP) and calcium, important in preventing postpartum hypocalcemia.

Table 1. Basic ration for Holstein cows 600 kg, daily production 25 kg milk/cow

Feed	*Quantity kg/cow*
Alfalfa hay	9
Corn silage	25
Farm mix	10

Table 2. Farm mix recipe for 10 kg/cow

Farm mix	*Quantity kg/cow*
Corn kernels	5,25
Barley	3
Sunflower meal	0,8
Wheat bran	0,7
Monocalcium phosphate	0,15
NaCl	0,1

This blend is a customized concentrate to ensure a balance between non-protein energy and metabolic protein, as well as to supplement the need for essential microelements. The presence of monocalcium phosphate and salt contributes to balancing the Ca:P ratio (ideally around 2:1), essential for the prevention of metabolic disorders (e.g. hypophosphatemia). The presented ration is well balanced and suitable for Holstein cows in medium to high lactation (20–25 liters/day), with an optimal ratio between bulky and concentrated. This structure allows easy adaptation to production needs and maintains the metabolic and reproductive health of the animals. Between October and February, carrots were also integrated (approximately 2-3kg/cow), which brought an extra dose of beta-carotene, with positive effects

Milk Production Monitoring

Milk production was recorded daily for each lactating cow using electronic milking meters installed on all milking units. Data collection was automated and centralized using a dairy herd management software system. Daily production data were stored and verified for consistency, with extreme outliers flagged and excluded following validation protocols. Key parameters recorded included: daily milk yield per cow (kg/day); monthly total milk yield (kg/month); Monthly average milk yield per cow; daily milk yield variability across cows. Monthly aggregation of data allowed for inter-month comparisons and seasonal trend analysis.

Statistical Analysis

Descriptive statistics were used to characterize daily and monthly milk production. One-way ANOVA was applied to determine whether significant differences existed between months regarding average milk yield per cow.

3. Results and discussion

The descriptive parameters of daily milk production (kg/day) during January–December 2024 are presented in Table 3, the parameters calculated based on daily records of an intensively farmed Holstein Friesian cow. 365 valid observations, distributed over the months of the year, were analyzed to highlight seasonal variations and production trends. The average value of daily milk production ranged between 7,213 kg in January and a maximum of 10,558 kg in December, reflecting a significant seasonal increase. In the first months of the year (January–March), a gradual increase in production was observed. The peak of productivity is reached in December (10,558 kg) and August (10,460 kg), suggesting an optimal response to adapted nutrition and maintenance conditions. The median values are close to the averages in all months, indicating a relatively symmetrical distribution of the data, without the presence of extreme values that would significantly distort the average. The total monthly production follows the same pattern as the average, reaching maximum values in months with 31 days (e.g., December: 327,325 kg) and minimums in February (243,765 kg, 29 days in 2024). The standard deviation values vary between 191.73 kg (January) and 345.53 kg (April), indicating a moderate to high variability of daily production in certain periods. The largest fluctuations are recorded in the months of April, August, and December – months with climatic transitions, which may reflect differentiated responses between individuals. The difference between the minimum and maximum values varies between ~500 kg and ~1100 kg daily, depending on the month. The highest maximum was recorded in December (11,058 kg/day) and the lowest minimum in June (9,215 kg/day), highlighting the impact of management factors such as silage quality, high summer temperatures, etc. The mean ± standard deviation interval provides an estimate of the daily dispersion of production. For example, in March (9747.81 ± 240.69 kg), 68% of the daily values were between 9507 and 9988 kg, which demonstrates a productive stability in the spring months.

Table 3. The descriptive parameters of daily milk production (kg/day) during January–December 2024

	January	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*
Mean	7213,16	8405,69	9747,81	10193,17	10159,13	9651,73	9906,71	10460,32	9921	9872,48	10074,23	10558,87
Median	7274	8432	9752	10187	10121	9696,5	9891	10464	9890,5	9866	10113,5	10516
Sum	223608	243765	302182	305795	314933	289552	307108	324270	297630	306047	302227	327325
Std. Deviation	191,73	240,94	240,69	345,53	266,7	253,61	245,41	311,48	290,81	290,3	233	302,48
Minimum	6870	8031	9262	9685	9654	9215	9493	10004	9447	9382	9606	10124
Maximum	7494	8818	10083	10691	10625	10046	10357	10944	10370	10338	10486	11058
Number of valid values	31	29	31	30	31	30	31	31	30	31	30	31
Mean ± SEM.	7213,16 ± 33.43	8405,69 ± 44.72	9747,81 ± 43.22	10193,17 ± 63.07	10159,13 ± 47.89	9651,73 ± 46.29	9906,71 ± 44.07	10460,32 ± 55.94	9921 ± 53.09	9872,48 ± 52.13	10074,23 ± 42.54	10558,87 ± 54.33

Figure 1 illustrates the monthly relationship between the total quantity of milk produced (blue bars) and the number of milking cows (green line). A progressive increase in both milk production and the number of milking cows can be observed throughout the year 2024, reflecting intensive herd management and sustained productive efficiency. During the months of January to March, milk production steadily increases, even though the number of cows remains relatively stable (356–366 heads). From July to December, the number of cows in

lactation continuously increases (up to 424 in December), corresponding with the peak of total milk production, recorded in December (327,325 kg). This trend supports the idea that the dynamics of the lactating herd have a direct impact on the total milk output per month, influenced by internal factors such as nutrition, health status, and animal welfare regulation of lactation.

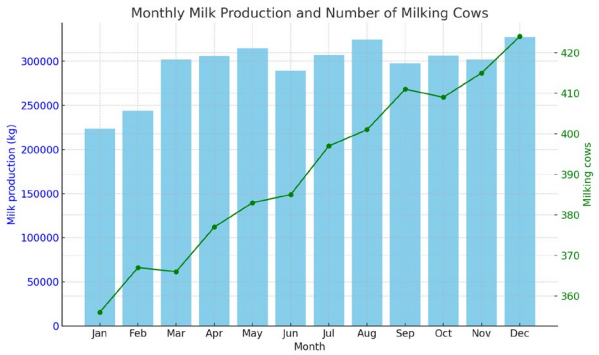

Figure 1. Variation in milk production depending on the number of cows milked

A clear upward trend is visible from January to December, culminating in the highest recorded production of 327,325 kg in December. This increase mirrors the gradual growth in herd size, which rises from 356 cows in January to 424 cows in December. Statistically, this trend implies a direct positive correlation between the number of lactating cows and total monthly output. While this is expected, it is important to consider that herd size alone does not explain all variations. For example, April and May, with 377 and 383 cows respectively, yield higher production than June, which had 385 cows, suggesting other influencing factors like feed quality, cow comfort, more precisely high temperature, or health status. The lowest production (223,607 kg) was observed in January, due to colder environmental temperatures, which are known to reduce feed intake and increase energy expenditure on thermoregulation. Analyzing seasonal influence, milk production shows a notable peak during the summer and early autumn months (August to October), with monthly outputs exceeding 300,000 kg. This aligns with optimal forage availability and longer daylight duration, which positively influence both appetite and hormonal regulation of lactation.

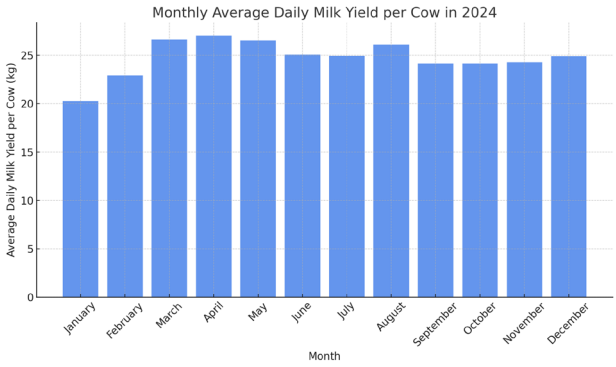

Figure 2. Monthly Average Daily Milk Yield per Cow in 2024

In Figure 2 reflects the monthly average milk yield per cow, offering a more refined view of individual productivity across the year. The highest average yield per cow was recorded in April (27.04 kg/day) and May (26.53 kg/day), coinciding with favorable spring conditions and peak lactation periods for most cows. In contrast, the lowest average was in January (20.26 kg/day), which aligns with both lower temperatures and early-lactation recovery.

Scientifically, the differences observed are likely multifactorial. Besides environmental factors, lactation stage, cow genetics, health, and housing comfort, all play critical roles. The data reveal that productivity tends to stabilize in mid-year (June–September) around 24–26 kg/day, reflecting a balance between climatic stress and nutritional adequacy.

4. Conclusions

The ration for Holstein Friesian cows (600–650 kg) composed of alfalfa hay, corn silage and a custom farm mix enriched with calcium, phosphorus and salt successfully supports daily productions between 20-27 liters of holiday milk, while maintaining animal health and productivity.

The highest individual productivity occurs in spring (April-May), and the maximum total monthly production is recorded in December (327,325 kg), coinciding with the highest number of lactating cows (n = 424).

Data analysis revealed moderate variability in daily production (standard deviation ranging from 191.73 to 345.53 kg/day), with symmetrical distributions and the absence of extreme outliers, confirming the consistency of production throughout the year.

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