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Assessing Somatic Cell Count Criteria for Enhanced Cow Care: Implications for Udder Health after Calving

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Abstract

The condition of the udder is crucial for the performance of milk farming and the time after calving presents higher chances of developing intramammary diseases. It is essential to maintain the somatic cell count, which reflects the immunological responses in breast cells, to identify udder condition difficulties earlier. Recognizing potential constraints is crucial, encompassing changes in administration approaches, ecological conditions and specific cattle behaviors. The data included a range of management approaches and climatic variables, which helped to develop the information on the characteristics of Somatic cell count (SCC) through this crucial period. The cattle's dairy collections were classified by their constructed somatic cell count (CSCC) during the initial two milk evaluations after lactation. Particular standards were used to establish the presence of intramammary diseases. The intention of this investigation was to examine the frequency of intramammary diseases in newly lactating first-time dairy cattle in India. The results emphasize the significance of integrating SCC standards into regular measurement techniques to enhance the overall maintenance of udder condition in dairy cows. The implementation of improved SCC requirements has the possibility of making a substantial impact on preventive udder condition administration, ultimately enhancing both cow welfare and the efficiency of milk manufacturing.

Keywords: Somatic Cell Count, Udder Health, Calving, Primiparous Cows

INTRODUCTION

The condition of the udder is a crucial element of milk production and its importance becomes even more evident after delivering a calf. The transformation from delayed pregnancies to initial feeding is a critical moment for dairy cattle, characterized by significant physiological transformations and heightened dependability to numerous health conditions (1). It is of essential importance to consider the consequences for udder conditions during this critical period to guarantee the welfare of the dairy cows and the overall efficiency of the herds. Following the birth of a calf, the udder experiences a swift and significant change to fulfill the requirements of producing milk. The initiation of lactation stimulates enhanced blood circulation to the udder, characterized by a sudden rise in hormonal function. Although this physiological change is necessary for the production of milk, it makes the udder more susceptible to harm (2). It is crucial to maintain excellent udder health after calving to protect and handle possible issues that can negatively impact milk supply and the general well-being of dairy cattle.

After calving, one of the main consequences for udder hygiene is the enhanced susceptibility to mastitis, which is an inflammation ailment affecting the breast glands. Mastitis not only has adverse effects on the production and amount of milk, but it also imposes a significant financial strain on dairy farms due to the expenses of treatment and the probable periods of milk storage (3). Immediate recognition of mastitis indications, combined with suitable care techniques, is vital in minimizing its effect on udder condition.

Evaluating the SCC criterion is a significant element in the management and improvement of dairy cow condition (4). Somatic cells, specifically leukocytes or white blood cells, are essential constituents of milk and

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have a vital function in defending the udder's immunity system. Nevertheless, an increased SCC in milk suggests the presence of underlying udder health problems, which can have consequences for both the cow's welfare and the quantity of the milk. Monitoring SCC is an essential diagnostic method for assessing the health of the udder (5). The assessment entails quantifying the number of somatic cells present in each milliliter of milk, where elevated measurements indicate the presence of irritation or infections in the breast glands. Gaining a more extensive comprehension of the SCC criterion empowers dairy producers to employ focused management tactics to preserve and enhance the well-being of their cattle.

Optimal SCC levels are crucial for guaranteeing the quality of milk. An increased SCC can lead to a reduction in milk production, changes in milk substance and a decline in the quality of dairy products. Moreover, milk with elevated SCC is more susceptible to deterioration, which impacts its duration of storage and market value (6). Hence, it is crucial to define and assess SCC criteria to maintain a lucrative and recognized dairy enterprise. Identifying thresholds that indicate subclinical and clinical mastitis is a crucial part of evaluating the SCC criterion. Subclinical mastitis, which is defined by increased SCC without observable indications of irritation, is disregarded and can have a substantial impact on milk quantity and purity. Monitoring SCC levels enables timely identification and assistance, thereby halting the advancement of subclinical mastitis to the diagnostic phase, characterized by observable evidence, including udder enlargement and temperature (7, 8).

Study (9) developed "somatic cell count (SCC)." Subsequent calving was more common in mature cattle, that had an averaged significant SCC during the prior breastfeeding and that produced a lot of milk shortly to dry-off. The results showed that "dry cow therapy (DCT)" was remaining a reliable technique to maintain mastitis at home. It was important to pay attention to the udder health of cows that have a high milk production.

Research (10) presented a standard administration technique in cattle herds, milking stopped when lactation finished. The dry phase was crucial for milk productivity and udder wellness. Results of the investigation suggested that to maximize cow satisfaction and welfare, it was better to stop milking a few days before the last milking to lower milk production at dry-off and speed up breast gland development.

Paper (11) examined the correlations between "Udder edema (UE)" and the occurrence of health issues, as well as milk productivity and reproduction in dairy cattle during the initial lactation period. The connection between UE wellness along with production was unresolved as well as more exploration was needed to understand the processes and impacts of UE.

Article (12) investigated that the culling was a crucial method of managing cattle herds, considering it had a significant impact on the economic aspects of the herd and the well-being of the cows. The obtained coefficients were processed for primary components evaluation and clustering to investigate differences in culling hazard indicators across different cows.

Study (13) evaluated the impact of implementing administration methods in milking operations on reducing SCC amounts and enhancing milk production. Consequently, the widespread distribution of understanding, provision of technical support and availability of innovative technologies were crucial for enhancing management methodologies and milk production.

Research (14) developed an innovative technique employing flow cytometry to efficiently and accurately measure the SCC and a quantitative variable called “differential somatic cell count (DSCC)” in specific cow dairy collections. The newly developed DSCC parameter quantified the proportion of “polymorphonuclear leukocytes (PMN)” and lymphocytes in milk, making it a valuable addition to the generally recognized SCC.

Paper (15) evaluated the innovative DSCC in relation to SCC as an additional signal for the detection of "intra-mammary infection (IMI)" in lactating dairy cattle. The investigation was essential to enhance the operational employ of the combination of DSCC and SCC for the recognition of IMI at the completion of breastfeeding time.

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Article (16) investigated the identification of subclinical mastitis incidents and new occurrences of clinical mastitis employing "online cell counts (OCC)" obtained during each milking session. The technologies could be customized to satisfy the specific requirements of specific producers in managing udder conditions in their cows by integrating various warnings.

Study (17) investigated the correlation between systemic characteristics and SCC in milk cattle. The investigation determined that the “malondialdehyde (MDA)” and “White Blood Cells (WBC)” indicators could be used to evaluate the systemic destruction caused by subclinical mastitis in dairy cattle' mammary glands.

Research (18) evaluated the potential milk earnings that could be obtained per cattle for herds transitioning from one average SCC to an innovative reduced one. The findings demonstrated that the estimation of overall milk production losses in a herd was influenced by the distribution of individual SCC and the number of lactations in the herd.

Article (19) presented excessive somatic cell counts in milk produced, decreased the durability of watery milk and reduced productivity in dairy items during manufacturing. Consequently, farmers face restrictions for having a significant substantial reservoir somatic cell count or receive more payment for having a minimal quantity reservoir somatic cell count.

Paper (20) investigated the correlations between locomotors evaluation, cleanliness, body condition score (BCS), laying behavior, milk manufacturing and the SCC of dairy cattle, categorized as either low or high. These findings indicated that low BCS might operate as a mediator between lying behavior, cleanliness and production efficiency in relation to high SCC.

The intention was to examine the frequency of intra-mammary disease in lactating primiparous dairy cattle by utilizing milk-preserving calf-constructed somatic cell count.

MATERIALS AND METHODS

Breeding Decisions

At the stage of individual cattle, the species and the father had an essential association with CSCC classifications. For instance, a greater proportion of Jersey PC cattle were classified as H-H compared to Swedish Holstein (WO) and Swedish Red (WE) PC cattle. Additionally, PC cattle from certain WO and WE parents were classified as L-L or H-H equated to PC cattle from other parents in every species.

The investigation included cows that were part of the Swedish official milk recording scheme (SOMRS) for the years 2020-2022. The number of cows included in the investigation was 3,100, 2,900 and 2,700 for the years 2020, 2021 and 2022, accordingly. Out of all the cattle, only that had manufacture evidence for all four years and had at minimum 15 primiparous cows every year, with their initial milk preserving between 6 and 45 days after calving and their secondary milk preserving between 30 and 50 days after the first milk preserving, were determined. This resulted in an overall of 1,600 cattle.

Information Gathering and modifying

Data regarding the species of cattle, lactation quantity, calving times and milk collection information on CSCC and milk productivity were gathered from the SOMRS for specific herds. Data regarding the yearly number of animals in a herd, the SCC of milk and milk manufacturing, along with details about the technologies used for generation and milking, were obtained from identical providers.

The CSCC information was collected for primiparous cows during their first milk preservation, which occurred between 6 and 45 days after calving. Additionally, their secondary milk preservation took place between 30 and 50 days after the first milk preservation. The CSCC from the two milk collections was used to allocate each

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primiparous calf a CSCC classification (low-low (L-L), low-high (L-H), high-high (H-H), high-low (H-L), or inconclusive) based on certain cutoff values.

During milk preservation, an SCC of 80,000 cells/mL or less was classified as low while an SCC of more than 100,100 cells/mL was classified as high. If the somatic cell SCC was within the specified range during one or both milk records, the cow was categorized as inconclusive. The CSCC cutoffs were determined based on the CSCC values from the initial and secondary milk preservation after calving for non-infected and infected cattle.

ANALYTICAL MEASUREMENTS

Cattle grade

Analytic characteristics were computed for the first and secondary milk preserving of CSCC, as well as the percentage of primiparous calves in each of the 6 CSCC classifications. These calculations were performed for the years 2020, 2021 and 2022. The combined t-test was employed to examine if there were substantial disparities in CSCC (somatic cell count) between the initial and subsequent milk observations in a given year, as well as among generations (2020, 2021 and 2022) for initial and subsequent milk observations.

The investigation examined the relationship between different breeds (Swedish Red, Swedish Holstein, Jersey, crossbreeds and other breeds) and classifications of chronic subclinical mastitis (CSCC). This was done employing a statistical model called multinomial logistics classifier, implemented with the "mlogit" command in Statistics. The CSCC classifications (LL, L-H, H-H, H-L, or inconclusive) were the dependent component, while species, ages at calving, days in milk at initial milk preserving along with the year and month of initial milk preserving were the informative conditions. The analysis accounted for the clustering of data in herds, using the "cluster" selection in statistics to calculate standard errors that consider the connection in each group. The models were constructed using a manual stepwise, backward component evaluation process, in which the starting model had all independent components as main effects. The models included variables that had a strong correlation ($P < 0.05$) with the dependent variable. Furthermore, the presence of convergence among variables was assessed in multivariable algorithms using Spearman rank coefficients. We conducted a systematic analysis of the potential two-way correlations among the significant core elements in the methodology.

To determine if the selection of a reproduction father for initial-time calving cows was connected to specific classifications of chronic subclinical mastitis CSCC, two distinct multinomial logistics classifier algorithms were employed. These models were adjusted for clustering in herds and they were applied separately to initial-time calving cows of WE or WO breeds. Only sires that had generated at least 1,100 initial-time calving cattle in the available information were included in the evaluation. The data collection had a total of 3,900 sires. However, only 16 of them (8 WO, 7 WE and 1 Danish Red) had created at least 1,100 primiparous cattle.

RESULTS

Cattle Statistics

The investigation encompassed a total of 1,600 cattle. Based on data obtained from the dairy and medical monitoring schemes, it was found that 65% of the cattle involved in the investigation utilized loose breeding arrangements, primarily free stalls, while 38% employed tie stalls. Additionally, 34% of the participants employed Automated Milking Systems (AMS) for milking their cows, while another 34% used tie stall dairy. The other cattle utilized either a milking facility or a rotational system. Organic farming was found on 15% of the farms, whereas standard manufacturing was found on 86% of the farmers.

The collection included 51,850, 52,100 and 51,350 primiparous cattle for the years 2020, 2021 and 2022 accordingly. The average amount of initial-time mother cattle with evidence from the initial two milk observations after giving birth to each cattle was 33 (with a median of 26 and an interquartile variation of 18-39), 34 (with a median of 25 and an interquartile variation of 19-37) and 31 (with a median of 23 and an

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interquartile variation of 17-36) for the years 2020, 2021 and 2022, correspondingly. The average representation of these cattle, measured by median and inter-quartile variation (IQR), was 81% (with a median of 84% and an IQR of 73-92), 82% (with a median of 85% and an IQR of 73-92) and 79% (with a median of 83% and an IQR of 70-91) of all primiparous cattle each herd in the years 2020, 2021 and 2022, correspondingly. The average (middle value; range between the 25th and 75th percentiles) days in milk at the initial and secondary milk observations for every year were 20 (with a middle value of 20 and a range of 13 to 27) and 50 (with a middle value of 50 and a range of 43 to 58), respectively. The average (middle value; range between the 25th and 75th percentiles) CSCC at the initial and subsequent milk observations for every year were 205,100 (with a middle value of 58,100 and a range of 32,100 to 135,100) and 130,100 (with a middle value of 37,100 and a range of 21,100 to 84,100) cells per milliliter, correspondingly.

Classification of Primiparous Cows and Other CSCC Levels

Table (1) provides the descriptive characteristics of the CSCC for the initial-time mothers' cattle involved in the investigation. The average CSCC was greater during the initial milk observation compared to the subsequent milk preserving and the pattern was observed across all years ($P < 0.0001$). The average CSCC during the initial and secondary milk preserving was greater in the year 2020 compared to the initial and secondary milk preserving in 2021 and 2022 ($P < 0.0001$). Additionally, the CSCC in 2021 was greater than in 2022 ($P < 0.0001$).

Table (1). Cattle constructed dairy SCC qualitative information

(Source: author)

Year	Sample Size (n)	Metric	initial	Secondary
2020	51,850	Mean (A)	225	143
		(SD)	657	445
		Mean (G)	85	51
		(95% CI)	76-79	59-60
		Median	70	40
		(50% IQR)	43-150	24-90
2021	52,100	Mean (A)	200	138
		(SD)	590	448
		Mean (G)	75	50
		(95% CI)	74-75	49-58
		Median	60	39
		(50% IQR)	34-145	22-88
2022	51,350	Mean (A)	200	128
		(SD)	641	448
		Mean (G)	70	49
		(95% CI)	70-71	46-47
		Median	58	38
		(50% IQR)	40-137	25-84

The yearly percentage of first-time mother cattle in the six classifications of the CSCC is provided in Figure (1). Each year, over 86% of the cattle were assigned to a CSCC classification. Around 51 to 54% of the cattle were classified into the (L-L) group, while 14 to 15% were classified as (H-H), indicating favorable and unfavorable udder health conditions, accordingly. By comparison, the percentages for the L-H, H-L and uncertain categories were 5.6%, 15.7% and 14.5%, respectively.

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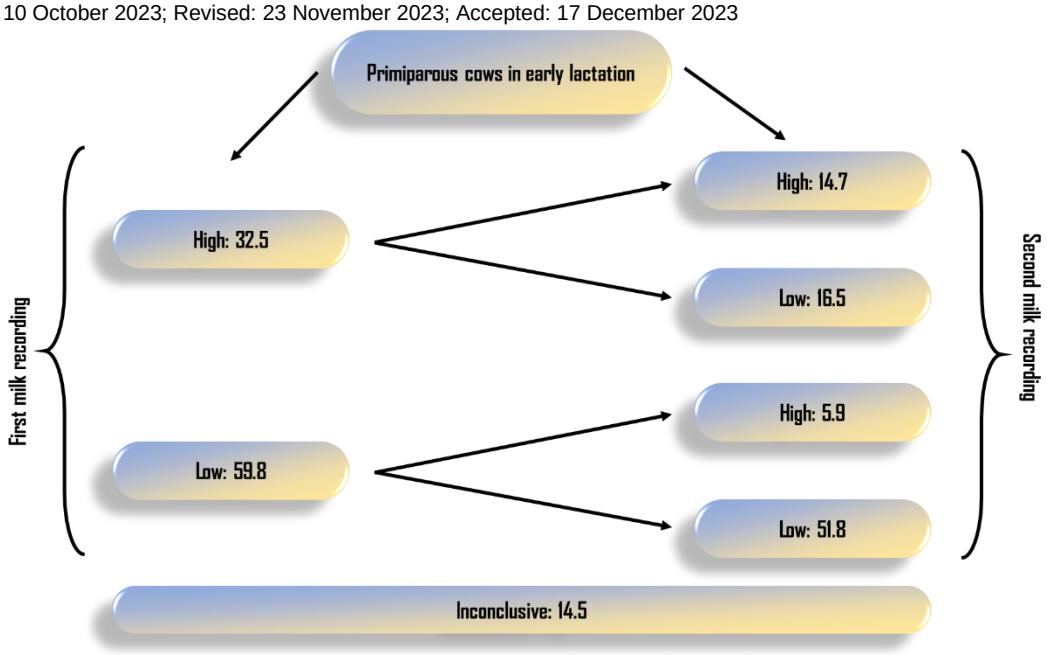

Figure (1). Predicated On Cattle Constructed SCC At The Initial And Secondary Month Dairy Preserving After Lactation In Primiparous Cattle
(Source: author)

Interactions between CSCC Classifications and Breeds at the Cattle Grade

The allocation of first-time mother cattle in every CSCC classification exhibited variation across different species (Table (2)). The WO breeds had the largest percentage of primiparous cattle in the (L-L) group (62.5%), while Jersey cattle had the lowest percentage (48.7%). The percentage of cows falling into the (L-H) (6.4–7.3%), (H-L) (15.5–17.5%) and inconclusive (14.0–18.8%) classifications showed less variation among different species. The Jersey species had the largest percentage of primiparous cattle in the H-H group (21.9%), while cattle of the WO species had the lowest percentage (12.8%).

Table (2). The population of primiparous cattle is classified based on their cattle CSCC
(Source: author)

Breed		CSCC Classification					
		L-L	L-H	H-L	H-H	Insufficient	Overall
WE	n	3,050	3,500	7,450	7,799	7,572	29,371
	%	51.4	6.4	15.2	16.4	10.6	100.0
WO	n	51,650	4,322	12,960	8,999	12,060	89,991
	%	55.8	3.4	15.4	13.5	12.5	100.0
Jer	n	415	66	175	225	180	1,061
	%	39.7	6.9	16.8	21.5	15.8	100.0
WE × WO	n	2,888	327	888	807	800	5,710
	%	50.7	5.8	15.7	14.7	13.1	100.0
WE cross	n	3,720	379	1,044	1,055	1,015	7,213
	%	51.9	5.7	14.8	14.5	13.6	100.0
WO cross	n	235	30	79	77	66	487
	%	48.9	6.6	16.9	15.9	12.8	100.0
Other	n	5,821	735	2,025	1,988	1,797	12,366

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	%	47.4	6.9	16.8	16.7	12.2	100.0
Total	n	67,779	15,980	24,621	20,950	23,490	152,820
	%	51.6	5.7	15.9	13.8	13	100.0

The possibilities highlight the lesser potential of cattle belonging to the L-L classification and the higher potential of being in the H-H or indeterminate classification, specifically for cows of the Jersey breeding.
The majority of the quantitative disparities in the proportions of cattle belonging to various breeds in the CSCC classifications were found to be substantial in the multivariable multinomial logistics classifier assessment. Comprehensive findings can be found in Supplementary Statistics S2 and Table S2. For instance, the relative risk ratio that is a first-time mother cattle in the H-H classification, compared to a first-time mother cattle in the L-L classification, showed an essential increase if the cow belonged to the WE, Jersey, WE × WO, WE crossbreed, or other species, as opposed to WO. Furthermore, the relative risk ratio of being a first-time mother cattle in the H-H classification, compared to a first-time mother cattle in the L-L classification, showed an essential increase if the cattle belonged to the Jersey species or other species, compared to the WE species, other breeds evaluated to WE × WO, or other breeds compared to WE crossbreeding**.**

Primiparous Cattle of the WE Breeding: Relationships among CSCC Classifications and Sire at the Calf Stage

The examination of the connection between sire and CSCC classification of primiparous calves included 7 WE breeds (WE_1 to WE_7) that had each produced at least 1,100 cows. Table (3) displays the proportion of first-time mother cattle categorized by their CSCC in each breed. Sire WE_3 had the greatest percentage of first-time mothers among cattle in the L-L CSCC classification (62.5%), whereas sire WE_1 had the maximum percentage of first-time mothers among cattle in the H-H CSCC classification (16.9%).

Table (3). The proportion of primiparous cattle
(Source: author)

SIRE		CSCC classification					
		L-L	L-H	H-L	H-H	Insufficient	Overall
WE_1	n	1,295	129	418	447	379	2,668
	%	49.9	4.8	15.5	16.8	13	100.0
WE_2	n	575	68	196	181	232	1,252
	%	46.6	5.5	15.8	14.6	17.5	100.0
WE_3	n	618	55	137	93	117	1,020
	%	61.9	5.8	13.6	8.2	10.5	100.0
WE_4	n	1,082	97	287	244	338	2,048
	%	53.9	4.9	14.1	11.9	15.2	100.0
WE_5	n	755	89	225	249	236	1,554
	%	49.8	5.5	14.7	14.5	15.5	100.0
WE_6	n	1,026	119	276	274	268	1,963
	%	52.8	5.7	14.5	14.1	12.9	100.0
WE_7	n	911	121	289	305	313	1,939
	%	47.6	5.9	15.6	15.9	15	100.0
Total	n	6,262	678	1,828	1,793	1,883	12,44
	%	50.9	5.3	14.8	14.6	14.4	100.0

The possibilities highlight, for instance, the elevated possibility of a cattle that are primiparous in the L-L group, as well as the reduced possibility of being in the H-H or indeterminate classification when the father is WE_3.

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The multivariable multinomial logistics classifier assessment revealed substantial variations in the proportion of primiparous cattle among the different classifications of sire conception rate (CSCR) among WE sires. Comprehensive findings can be seen in Supplementary Statistics S3 and Table S3. For instance, the comparative risk ratio of being first-time mother cattle in the H-H group, compared to initial-time mother cattle in the L-L classification, lowered if the sire was WE_3, as opposed to the other breeds or if the sire was WE_4, as opposed to WE_1, WE_2, WE_5, or WE_7. Furthermore, the risk ratio showed a decrease when the sire was WE_6 as opposed to WE_1, WE_5, or WE_7.

Primiparous Cattle of the WO Breeding: Relationships regarding CSCC Classifications and Sire at the Calf Phase

The examination of the relationship between father and CSCC classification of primiparous cattle included the 8 WO fathers (WO_1 to WO_8) that had each produced at least 1,100 primiparous cattle. Table (4) shows the proportion of primiparous cattle categorized by different CSCC groups in the father. Father WO_8 exhibited the greatest percentage of primiparous cattle in the L-L CSCC classification (72.8%), whereas father WO_1 had the highest percentage of primiparous cattle in the H-H CSCC classification (30.5%).

Table (4). Primiparous cattle distributed insufficient based on CSCC.
(Source: author)

Sire	CSCC classification	L-L	L-H	H-L	H-H	Insufficient	Overall
WO_1	n	850	109	358	405	280	2,002
	%	42.6	5.5	17.9	20	14	100.0
WO_2	n	690	64	234	148	157	1,229
	%	53.8	4.7	18.4	11.6	11.5	100.0
WO_3	n	588	76	172	192	185	1,213
	%	48.4	6.5	14.4	16.7	14	100.0
WO_4	n	685	59	190	111	157	1,202
	%	58.1	4.5	16.5	8.8	12.1	100.0
WO_5	n	944	106	226	143	217	1,636
	%	58.5	6.6	14.5	8.4	12	100.0
WO_6	n	1,297	198	510	608	479	3,092
	%	42.5	6.6	16.3	19.9	14.7	100.0
WO_7	n	1,074	110	296	159	234	1,873
	%	57.9	6.9	13.9	8.6	12.7	100.0
WO_8	n	1,431	128	325	188	248	2,323
	%	62.4	5.4	12.8	8.5	10.9	100.0
Total	n	7,559	850	2,311	1,954	1,957	13,781
	%	52.4	5.9	15.9	13.8	12	100.0

Notably, if the father was WO_8, the possibility of a cattle staying primiparous is better in the L-L group. Conversely, if the father was WO_1 or WO_6, the possibility of cattle remaining in the H-H classification is greater.

The multivariable multinomial logistics classifier investigation revealed substantial variations in the frequency of primiparous cattle among different classifications of sire's CSCC. Comprehensive outcomes can be seen in Supplementary Information S4 and Table S4. For instance, the relative risk ratio of first-time mother cattle in the H-H classification, as opposed to initial-time mother cattle in the L-L classification, increased when the sire

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was WO_1, WO_2, WO_3, or WO_6, compared to when the sire was WO_8. Similarly, the risk ratio was higher when the sire was classified as WO_1 or WO_6, as opposed to WO_2, WO_3, WO_4, WO_5, or WO_7.

CONCLUSION

The importance of maintaining healthy udders in dairy production, after calving, can be emphasized properly. The increased possibility of diseases in the mammary glands indicates the importance of closely evaluating the situation. The somatic cell count is a vital measure of the immune responses in the mammary tissues. It is essential to recognize potential limitations stemming from variations in management practices, environmental factors and individual cow characteristics. The extensive data covering various administration approaches and ecological variables in newly lactating first-time dairy cattle in India helps to provide a detailed recognition of somatic cell count changes throughout this crucial phase. The investigation emphasizes the significance of including somatic cell count restrictions in regular observing protocols by examining the categorization of cattle-constructed somatic cell count quantities and distinguishing between low and high levels in the initial two milk observations after calving based on cutoffs that indicate intra-mammary disease. This investigation demonstrates the requirement of improving the criterion for somatic cell count. It demonstrates that performing so can assist in the proactive regulation of udder wellness, improving both cow wellness and the long-term efficiency of milk productivity. The generalization of the somatic cell count criterion can be affected by these elements, which means that attention should be applied when transferring the observations to different milk farming environments. Further investigation may focus on enhancing the criterion for somatic cell count by considering distinct regional and cow features, hence improving reliability in the maintenance of udder condition.

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