Optimization of longitudinal lactation length in a Sahiwal herd

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Journal of Livestock Science (ISSN online 2277-6214) 16: 614-621
Received on 14/6/24; Accepted on 16/10/25; Published on 22/10/25
doi. 10.33259/JLivestSci.2025.614-621

Abstract

In modern dairy farming average 305 days lactation considered as standard signifying scientific dairy management practice to keep animal concurrently pregnant and re-initiating annual lactation. Many Sahiwal cows do not reach this standard lactation length (LL)even in organized herd instead dry off early in several occasions. The present study aimed to optimize lactation truncation based on seven-decade data (1955-2024) across parities in Sahiwal herd. Analysis revealed that lactation length in 48% cows were≤ 250 days; in24% between 251 to 305 days, while in 28%≥ 305 days. It was found that sire, periods and seasons of calving had a significant effect on LL. Majority had LL up to 250 days reflecting its biological capability. This may be better proposition that for practical and genetic evaluation purposes 250 days as standard LL for Sahiwal cow and used for comparison among different breeds as a notional standard.

Keywords: Genetic evaluation; Lactation length; Non-genetic factors; Organized herd Sahiwal cow

Introduction

The cow having a high place in the Indian cultures since antiquity, have been an integral part of Indian agriculture and rural livelihoods for centuries, serving as a vital source of milk, meat, draft power, and manure (Venkatasubramanian and Cauvery, 2021).Consequently, India home for a 53 indigenous cattle breeds, giving a high importance for conserving native breeds not only for conserving the genetic diversity but also for sustainable agriculture, since they thrive well under the local tropical conditions unlike the higher-producing exotic breeds (Vyas et al., 2025). Dairy farming is a cornerstone of rural livelihoods in India, providing a steady income source for millions of smallholder families. In India, Livestock contribute 5.50% of total Gross Value Added (GVA) to national GVA and 30.23% to agricultural GVA (Basic Animal Husbandry Statistics, 2024).

Sahiwal is one of the best milch breeds with well-developed udder, having originated in the Indian subcontinent and reared by farmers due to its high adaptability to tropical climates exhibiting high milk yield with remarkable heat tolerance, disease resistance, and its ability to thrive on poor-quality feed and fodder (Ahlawat et al. 2015; Dey, 2017; Pundir 2022, Kumar & Prasad, 2023; Muansangi et al., 2025).The Sahiwal herd of the present study was established in 1955 at ICAR-NDRI, Karnal, India under a Govt initiative, and since then has been maintained under scientific management and breeding for propagation and genetic improvement of the population.

Lactation length, defined as the period from calving to the cessation of milk production, is a critical determinant of dairy productivity. LL had been studied and reported by various workers viz. (248±67) Bajwa et al. (2004), (278) Iltasia et al. (2007), (245±0.5) Rehman and Khan (2011), (215.83±3.08) Narwaria et al. (2015). There is strong correlation between lactation length and with total yield (Narwaria et al., 2015) with substantial genetic variance in it (Worku et al., 2022). Most of times, “short” or “failed” lactations (as ending by ~80-150 days) were reported in tropical cattle and these lactations drastically reduce total milk yield (Bajwa et al., 2004). Premature drying off in 30% of the herd can cut realized production by 60% compared to full lactations (Devi et al., 2023). The truncated milking period of Indian cattle breeds underlies much of their lower average yield, so addressing lactation length is essential for improving per-cow productivity (Sachan et al., 2020). In genetic evaluations and farm planning, yields are typically adjusted to a fixed lactation span (commonly 305 days) so animals can be compared on an equal basis (Cole et al., 2023). The International Committee for Animal Recording explicitly adopts a 305-day lactation standard for dairy genetic evaluations (ICAR, 2021).

Standardizing lactation length in Sahiwal cattle will be crucial for several reasons. Firstly, it will allow for more accurate comparison of milk production across different parities, facilitating better breeding and management practices. Secondly, it will help in identifying different genetic and non-genetic factors that influence lactation length, thereby enabling targeted interventions to enhance productivity (Chitra et al., 2018). Moreover, standardized lactation records are essential for genetic improvement programs, as they provide reliable data for selecting animals with desirable traits in KF cattle (Kumar et al., 2025). In this context, Narwaria et al (2015) studied LL on Sahiwal data (1997-2011) and they revealed that short LL problem was alarming in indigenous cattle and was influenced by various environmental factors and concluded that their findings had to be validated on large-scale data. With this background, the variability in lactation length highlights the need for standardization to optimize milk production and improve the economic viability of dairy farming in Sahiwal cows (Chitra et al., 2016). Under these circumstances, the present study was undertaken with the aims a) to evaluate the lactation length of Sahiwal cattle across different parities over seven decades and to see the effect of various genetic and non-genetic factors that affect the lactation length (LL) b) to find genetic improvement patterns and management strategies for standardizing lactation length in indigenous Sahiwal cattle.

Materials & Methods

Animals

The present study was conducted on Sahiwal cattle herd maintained at ICAR-NDRI, Karnal, located at 29°42’ N latitude and 72°02’ E longitude with a mean sea level of 250 meters. Sahiwal breeding data for the present study were collected (n=1540) from the history-cum-pedigree sheets from 1955-2024 for first lactation length (LL). Ethical approval was not needed for this investigation since it utilized only phenotypic records of cows recorded from the history sheets.

The Sahiwal animals were fed according to the feeding schedule provided by the Animal Nutrition Division, National Dairy Research Institute (NDRI), Karnal.The calves were weaned at birth and fed their dam's colostrum for 4-5 days, followed by whole milk for up to 30 days. Concentrates and green fodder were given to the calves from one month of age and feeding was done according to the nutritional standards. An additional allowance of 1-1.5 kg is given to the pregnant cows after 7 months of pregnancy. Adult heifers and cows were given unlimited green fodder and roughages. All Sahiwal cows were stall-fed in open paddocks at the NDRI farm.

Data standardization and analysis

After the collection of Sahiwal breeding data, a descriptive statistics using SPSS (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp) were run to find out the

distribution patterns of the complete dataset. However, we also wanted to study various genetic and non-genetic factors on the lactation length of Sahiwal cows. For that a data standardization were carried out through removing the inaccurate and incomplete records using the criteria: a) LL <100 days, andb) LL >305 days were removed. In order to account the non-genetic factors, the whole dataset were divided into 13 periods, 4 seasons (Winter: December-March; Summer: April-June; Rainy: July-September; Autumn: October-November) depending on prevalent meteorological factors as recorded in ICAR-CSSRI, Karnal (Singh, 1983) and 10 parties on the basis of available observations. Further, based on type of calving, all the data was classified into two groups namely normal calving and abnormal calving. Abnormal calving included the still birth, dystocia and premature birth.

The following statistical model was used for the least squares analysis of the lactation length to account for the effect of the genetic and non-genetic factors. The models were used with the assumptions that different components being fitted into the model were linear, independent and additive:

$$Y_{ijklmn} = \mu + S_i + P_j + Sn_k + A_l + T_m + e_{ijklmn}$$

where,

Y_{ijklmn} = lactation length of n^{th} cow sired by i^{th} sire calved in j^{th} period of k^{th} season belonging to l^{th} parity with m^{th} type of calving

μ = Overall mean

S_i = Effect of i^{th} sire

P_j= Effect of j^{th} period of caving

Sn_k= Effect of k^{th} season of calving

A_l = Effect of l^{th} parity

T_m = Effect of m^{th} type of calving

e_{ijklmn}= Random error, NID (0, σ_e^2)

The effect of non-genetic factors on LL was estimated using least-squares analysis for non-orthogonal data by General Linear Model of SPSS (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp). The difference of means between subclasses of the seasons, periods, parities and the types of calving were tested for the statistical significance, using Dunkan Multiple Range Test (DMRT) as modified by Kramer (1957).

Results

From Table 1 of descriptive statistics, it was revealed that 66.64% of the Sahiwal cows were having lactation length less than or equal to 250 days (≤ 250 days) and 33.36% of the Sahiwal cows were able to complete the lactation between 251 to 305 days. The occurrence of longer lactations in a many cows attributed to reproductive issues mainly failure to conceive in time and these records were excluded from the present study. The least squares mean (Table 2) of lactation length (LL) in the present investigation was 233.21±3.31 days. The genetic factor considered in the present investigation was the sire effect and it was observed to be significant. The periods of calving and the seasons of calving had a significant effect too, while the parities and the types of calving had no significant effect on LL. There was a steady decline in the LL over time. The highest value for LL was observed during the period 1, while the lowest value was during period 13. This declining trend of LL over a period revealed that change in management and feeding practices had influenced the lactation performance. The highest LL was observed in winter season and lowest in rainy season. The animals which calved in winter season might had benefitted from the comfortable environment and ample feed and fodder availability. In rainy season animals were exposed to various type of diseases and poor-quality forage which leads to early drying off and shorter lactations in animals. Analysis across different parities revealed that the average lactation length ranged from 223.29 to 238.75 days, with no clear trend observed across successive parities. These findings suggest that, under the management and environmental conditions of the present study, the typical lactation length in Sahiwal cows is closer to 250 days, rather than the standard 305-day benchmark traditionally considered.

In the present study both the trait i.e. 305-day lactation milk yield (305dMY) and total milk yield (TMY) were found to be affected by month of conception reflected as the season of calving. That means the cows that calved during the rainy season (July–September) were typically inseminated between October to December months and so on for other seasons as explained in the methodology section.During this period, favourable climatic conditions, better availability of green fodder, and minimal disease outbreaks likely contributed to timely conception. This reproductive efficiency results in optimal calving and subsequent milk production, explaining the higher yields observed in rainy season calvers.The effect of season i.e. month of conception was found to be statistically non-significant on TMY and 305dMY, however both the traits were found to be highest in cows calving during the rainy season and lowest in those calving in the autumn (Table 3). The values of milk yield were not much different among summer and winter seasons

Table 1: Descriptive statistics of LL having class interval of 50 days

Class Range	No of observations	% of animals	Cumulative %
≤50	509	13.31	13.31
51-100	500	13.08	26.39
101-150	439	11.48	37.87
151-200	483	12.63	50.50
201-250	617	16.14	66.64
251-305	1275	33.36	100.00

Table 2: Least squares means ± SE of LL in Sahiwal cattle

Effects	LL (days)	N
Overall mean (μ)	233.21±3.31	2824
Sire	**	
Period of calving	**	
1 (1958-62)	282.57^{c}±15.4	15
2 (1963-67)	246.27^{b}±9.29	44
3 (1968-72)	254.56^{b}±5.39	164
4 (1973-77)	236.54^{b}±5.06	183
5 (1978-82)	237.48^{b}±7.03	80
6 (1983-87)	239.41^{b}±6.07	125
7 (1988-92)	245.69^{b}±5.95	134
8 (1993-97)	237.02^{b}±5.38	169
9 (1998-02)	214.01^{a}±4.54	277
10 (2003-07)	206.44^{a}±4.14	353
11 (2008-12)	218.01^{a}±4.08	417
12 (2013-18)	210.74^{a}±4.12	380
13 (2019-24)	203.00^{a}±3.87	483
Season of calving	**	
1 (Winter)	240.57^{c}±3.52	1196
2 (Summer)	232.96^{b}±3.82	770
3 (Rainy)	224.09^{a}±3.99	549
4 (Autumn)	235.22^{bc}±4.46	309
Parity		
1	227.95±3.61	656
2	233.26±3.59	622
3	232.49±3.85	496
4	238.75±4.16	361
5	237.13±4.6	257
6	236.14±5.38	161
7	235.96±6.19	114
8	233.22±7.2	78
9	233.91±9.79	40
≥10	223.29±9.94	39
Type of calving		
1 (Normal)	237.84±2.28	2686
2 (Abnormal)	228.58±5.48	138
R^2	0.93	
Adjusted R^2	0.085	

** Highly significant (P ≤ 0.01); * Significant (P ≤ 0.05), Means within subclasses with different superscripts differ significantly (P ≤ 0.05) from each other.

Table 3: Effect of season of calving on Total Milk Yield (TMY) and 305-Day Milk Yield (305dMY) in Sahiwal Cows

Season of calving	TMY	305dMY
Population mean	2060.94±55.06	1840.48±40.07
Winter	2071.22±62.54	1876.54±45.55
Summer	2068.06±67.51	1846.85±48.51
Rainy	2136.47±88.35	1915.74±64.39
Autumn	1968.02±126.78	1722.8±88.51

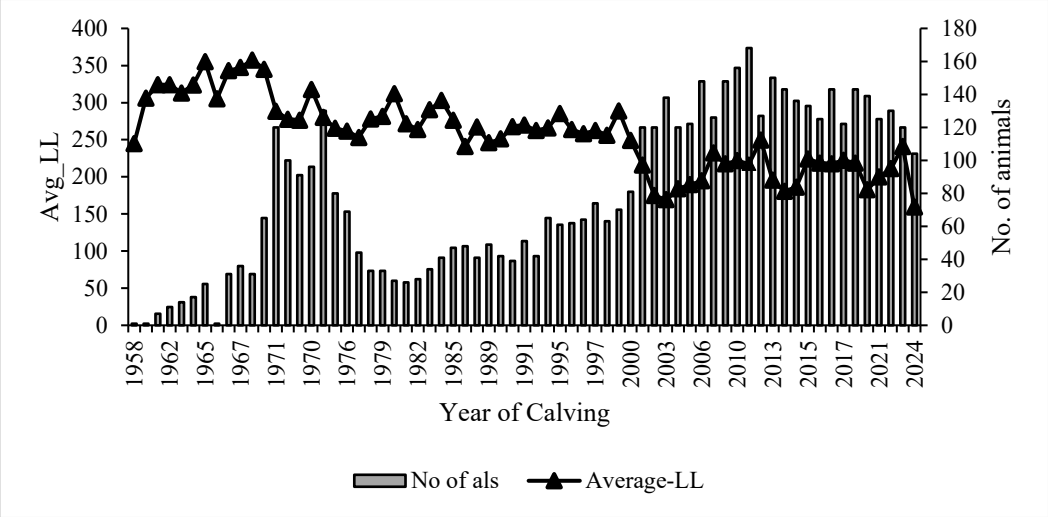

Figure 1. Trends in lactation length (LL) and animal calvings in Sahiwal cattle

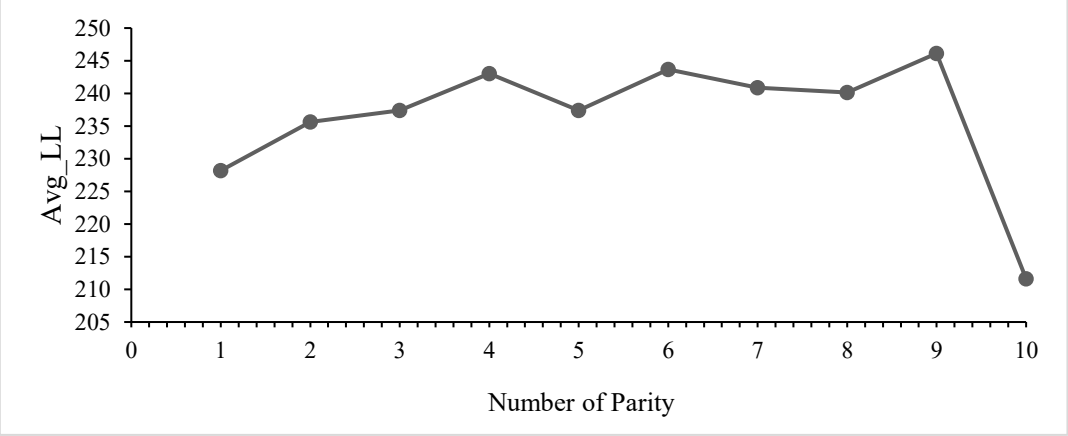

Figure 2. Effect of Parity on Lactation length

Discussion

The lactation length in the Sahiwal cows showed a wide variability with 26.39 % showing lactation length less than 100days and 66.64% had lactation length up to 250days and only 33.36% of the animals had lactation more than 251 days. (Table 1). This might be due to the prolonged lactations resulting from the delayed conception which may be due to poor fertility or missed breeding opportunities and anestrus. These factors extend the interval between calving and the next conception, leading to a longer lactation period and persistent milking. In some cases, this may also be a result of management strategies (like extending the voluntary waiting period) aimed at maximizing milk production, as the animal continues to be milked until it either conceives or is intentionally dried off.(Williams et al., 2021; van Knegsel et al., 2024). It was observed that the early drying off Sahiwal cows had less than 50 days LL (9.58%) indicating low productivity or reproductive issues like post-partum conditions like metritis, mastitis (Gunay and Gunay, 2008; Kumar et al., 2017), poor nutritional status, silent estrus or undetected heat and early culling of animals (Butler, 2000).These findings were important, which will help laid down the importance of enhancing reproductive management and devise suitable culling strategies to improve lactation performance in the Sahiwal herd.

The effect of sire was observed to be significant on LL by a majority of researchers (Choudhary et al., 2019 in Tharparkar cattle; Abbas et al., 2010 in Sahiwal; Kumar et al., 2016 in Ongole), while a non-significant effect of sire was reported by Mire et al. (2009) in the Sahiwal cows.

The effect of period of calving was also observed to be significant by several researchers (Das et al., 2011 in Friesian cross-bred cows; Husain et al., 2015 in Tharparkar cattle; Kumar et al., 2016 in Ongole cattle; Dongre et al., 2017 in Deoni cattle; Beneberu et al., 2020 in Jersey cattle and Chopade et al., 2023 in Frieswal cattle). The lactation length seemed to vary over different periods might be due to the change in management practices applied over the year and the environmental factors like fluctuations in temperature and humidity.

The season of calving was reported to be significant by several workers (Singh et al., 2015 and Choudhary et al., 2019) in Tharparkar cattle, while non-significant effect of season of calving on LL was reported

by Wondifraw et al. (2013) and Narwaria et al. (2015). The differences in lactation length between seasons might be due to variations in production environments and management conditions during these times.

The effect of parity was reported to be significant on LL by various researchers (Alex et al., 2017 in Frieswal cows, Beneberu et al., 2020 in Jersey cattle and Chopade et al., 2023), while the non-significant effect of parity on LL was reported by Dongre et al. (2017). The lower milk yield in early parities is likely due to animals growing and using nutrients for both body growth and milk production (Nyamushamba et al., 2014).

The trends of LL and animal calvings revealed wide variation over the years (Figure 1). Average LL remained above 300 days between 1958-1975 revealing extended lactation under the management conditions prevailing at that time. Also at that time farm was newly established and number of animals were also not very high and less stringent culling or drying-off practices, thus inflating the average LL. From 1970 to mid-1990s declining trend for LL was observed and average LL stabilized around 250-280 days. During this period there was reduction in the number of calvings due to changes in herd size, management strategies and changing reproductive management. From late 1990s onwards there was increase in the number of animals calved and despite this the average LL remains relatively stable (250-270 days). The more uniform management practices and improved record-keeping practices contributed for the stable LL. Although the standard lactation length (LL) was considered as 305 days (ICAR, 2021), findings from the present study indicate that many Sahiwal animals did not achieve this duration. This highlights the need for breed-specific performance benchmarks for other quantitative traits analysis.

The relationship between the parity and lactation length up to 4th parity in Sahiwal cows showed a consistent increase in LL, indicating improved lactation performance and physiological maturity (Figure 2). After the 4th parity, LL remained somewhat stable across the different parities indicating that a pleatue had reached after which there was no further deviation in the LL. The LL in the 10th parity and beyond decreased considerably indicating the effect of higher age, and reproductive stress in animals. These results revealed that LL in Sahiwal cows did not reach up to the 305 days in majority cases, varying between 240-250 days.

Conclusion

The present study revealed a significant influence of period and season of calving on lactation length (LL) in Sahiwal cows, likely due to factors such as nutritional variation, reproductive efficiency, and climatic stress. The significant effect of sire emphasizes the importance of sire selection in improving LL. Most cows lactation lengths around 250 days, suggesting that a 250–305 day range may better reflect the biological and management realities of Sahiwal cattle. However, the 305-day standard remains useful for inter-breed comparisons.

Acknowledgements

Authors duly thankful to Director, ICAR-NDRI, Karnal and the Faculty of Animal Genetics and Breeding Division for providing facilities for carrying out the research work.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Ethical statement

Ethical approval was not needed for this investigation since it utilized only phenotypic records from history sheets.

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