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Milk yield variation in first three lactations and factors affecting milk yield in Sahiwal cattle

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The genetic evaluation based on life time production is gaining importance. Longer productive life not only reduces rearing costs per year of productive life but also allows exploitation of maximum genetic potential of the cow (Kathiravan *et al.* 2010). Test-day models have recently gained considerable interest. Sire evaluation using a test day model has higher accuracy due to larger number of measurements per daughter than one lactation record in 305-day milk yield model (Gupta 2013) and also accounts for short-term environmental factors specific to individual yields. In the current scenario there is need to study the milk yield of different lactation for determining lifetime performance and also to shift from 305-day milk yield models to test day milk yield models for early and accurate genetic evaluation. Hence, present study was done to evaluate the milk yield of Sahiwal cattle in different lactations and factors affecting 305-day milk yield and test day milk yields.

The data of first to third lactation 305-day milk yield (305-DMY) and monthly test day milk yields of Sahiwal cattle spread over a period of 52 years (1961–2012) maintained at ICAR-National Dairy Research Institute (NDRI) were used for the present study. The monthly test day records were taken on 6th (TD1), 36th (TD2), 66th (TD3), 96th (TD4), 126th (TD5), 156th (TD6) 186th (TD7), 216th (TD8), 246th (TD9) and 276th day of lactation (TD10). The data were classified according to the season, year of calving, age groups and service period. Seasons namely, winter (December-March), summer (April -June), rainy (July - September) and autumn (October-November) were grouped. The year of calving effect was considered and year with no observation and less than 3 records were excluded from present study. Age at calving was grouped into 11 classes (≤ 900 days as first and ≥ 1441 days as last class) for first lactation while age at second and third calving was grouped into 12 classes of 60 days interval. For second lactation age group classes considered were ≤1,300 days as first class and ≥ 1,900 days as last class. For third lactation age group classes considered were ≤ 1700 days as first class and ≥ 2,301days as last class. The service period was divided into different classes of 30 days interval. For first lactation 13 service period classes with ≤ 60 days as first and > 390 days as last class and for second and third lactation 9 classes with ≤ 60 days as first and > 270 days as last class were considered. The influence of various nongenetic factors was studied by least squares analysis of variance for unequal non-orthogonal data (Harvey 1990). The following linear fix effect model was considered.

$$Y_{ijklm} = \mu + S_i + P_j + A_k + D_l + e_{ijklm}$$

where, Y_{ijklm}, 305-day milk yield/test day milk yield of the mth individual in ith season, jthyear, kth age group class and lth service period class; μ , overall population mean; S_i, fixed effect of ithseason of calving/season of test day recording month; P_j, Fixed effect of jthyear of calving ; A_k, fixed effect of kth age at calving class; D_l, fixed effect of lth service period class; and e_{ijklm} , random error, NID (0, σ^2_e).

Lactation 305-day or less milk yield: The least squares mean of first lactation 305-day milk yield (FL305DMY) was similar to milk yield reported by Singh *et al.* (2005) but higher than the values reported by Debbarma *et al.* (2010), Dongre (2012) and Gupta (2013) in Sahiwal cattle. The second lactation 305-day milk yield (SL305DMY) was higher than the milk yields reported by Rehman and Khan (2012) and Gupta (2013) in Sahiwal cattle. The third lactation 305-day milk yield (TL305DMY) was higher than those reported by Rehman and Khan (2012) and Gupta (2013) in Sahiwal cattle. The differences in the estimates of 305-DMY reported by researchers could were due to sampling variations or herd to herd differences or differences that have occurred in time depending on the period to which the data pertained and effect considered in the model for least squares analysis.

Effect of non-genetic factors on 305- day milk yield

Effect of season of calving: The season of calving has

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highly significant effect (P≤0.01) on SL305DMY and non-significant effect on FL305DMY and TL305DMY. The cows calved in autumn season had the maximum FL305DMY. On the contrary, the cows calved during summer had the lowest FL305DMY. The non-significant effect of season of calving on FL305DMY was also reported by many workers like Debbarma *et al.* (2010), Dongre (2012), Mundhe (2012) and Gupta (2013). Contrary to the present study, significant effect of season of calving on FL305DMY was documented by Rehman *et al.* (2008) in Sahiwal cattle. The cows calved in winter had the maximum SL305DMY and cows that calved in rainy season had lowest SL305DMY. Similar, to present study Rehman and Khan (2012) reported highly significant effect of season of calving (P<0.01) on SL305DMY in Sahiwal cattle. The cows that calved in autumn had the maximum TL305DMY and animals calved during rainy season had lowest TL305DMY. In agreement to present study, Gupta (2013) also reported non-significant effect of season of calving. However, Rehman and Khan (2012) reported significant effect of season of calving on TL305DMY in Sahiwal cattle. The non-significant effect of season of calving indicated that animals are adequately managed in different season by providing favorable farm conditions to combat adverse seasonal effects. Comparatively low milk production in rainy season may be attributed due to the hot and humid climatic conditions and availability of lesser green fodder during the summer season.

Effect of year of calving: The year of calving significantly affected (P≤ 0.01) first, second and third lactation 305-day milk yield. Similar, to present findings Singh *et al.*(2005), Debbarma *et al.* (2010), Dongre (2012) and Gupta (2013) also found significant effect of period/ year of calving on FL305DMY. However, Mundhe (2012) reported that the effect of period on FL305DMY was not significant. The present finding for SL305DMY and TL305DMYwas in accordance with the reports of Rehman and Khan (2012) and Gupta (2013) in Sahiwal cattle. The differences in 305-day milk yield of over the years may be attributed to the differential culling levels on the basis of production, differences in feeding and management practices besides the changing genetic structure of the population.

Effect of age group: The age at calving had non-significant effect on the first, second and third lactation 305-day milk yield. This finding was similar to the results reported by Debbarma *et al.* (2010), Dongre (2012) and Gupta (2013) for FL305DMY in Sahiwal cattle. Gupta (2013) also find non-significant effect of age group on SL305DMY and TL305DMY in Sahiwal cattle. The non-significant effect of age groups may be attributed to uniform management of animals during different part of their life and adequate compensation for various growth stages through management and nutritional supplementation.

Effect of service period: Service period has highly significant (P≤0.01) effect on FL305DMY, TL305DMY and significant effect on (P≤0.05) on SL305DMY. Maximum FL305DMY was obtained for animals having service period between 361–390 days and the yield was minimum for less than 60 days service period. The significant effect of service period on FL305DMY was also reported by Rehman *et al.* (2008) and Dongre (2012) in Sahiwal cattle. The animals with 241–270 days service period has highest SL305DMY and with 61–90 days service period has lowest SL305DMY. In general animals with service period of 120 days or less have lower TL305DMY and animals with service period greater than 240 days has higher TL305DMY. It can be inferred that the animals having shorter service period had lesser 305DMY. It may be due to the fact that early conceivers become dry earlier to facilitate the subsequent calving and the late conceivers may be in milk for a comparatively longer period.

Monthly test day milk yields: The least squares means of first lactation monthly test day milk yields (FLTDMY) varied from 5.24±0.15 kg to 8.31±0.18 kg (Table 1), which was similar to the test day milk yield reported by Debbarma *et al.*(2010) and Gupta (2013) in Sahiwal cattle. The least squares means of second lactation monthly test day milk yields (SLTDMY) ranged from 5.29±0.16 kg to 10.49±0.22 kg and from 5.48±0.19 kg to 11.58±0.25 kg (Table 1) for third lactation monthly test day milk yields (TLTDMY). Gupta (2013) reported similar yield for SLTDMY and TLTDMY in Sahiwal cattle.

Table 1. Least squares mean (kg) for test day milk yields and 305-day milk yield in Sahiwal cattle

Traits	First lactation		Second lactation		Third lactation	
	N	Over all mean	N	Over all mean	N	Over all mean
TD1	635	5.24±0.15	425	8.37±0.20	306	8.78±0.25
TD2	635	8.31±0.18	425	10.49±0.22	306	11.58±0.25
TD3	635	8.12±0.17	425	9.91±0.21	306	10.54±0.24
TD4	634	7.60±0.16	424	9.19±0.21	306	9.61±0.24
TD5	614	7.24±0.16	417	8.45±0.21	304	8.71±0.24
TD6	598	6.71±0.14	405	7.49±0.19	298	7.75±0.21
TD7	583	6.41±0.14	392	6.87±0.17	287	7.02±0.21
TD8	557	6.29±0.14	361	6.37±0.18	275	6.60±0.19
TD9	535	6.15±0.13	332	5.80±0.17	255	5.93±0.18
TD10	464	5.75±0.14	278	5.29±0.16	209	5.48±0.19
305- DMY	635	1994.34±41.47	425	2188.22±47.94	306	2369.82±56.36

Effect of non-genetic factors on test day milk yield

Effect of season of test day recording month: The season of test day recording month has significant effect on all test days except TD1, TD8 and TD10 of first lactation, TD1, TD5,TD6,TD7,TD8 and TD9 of second lactation and TD1, TD5, TD8 and TD10 of third lactation. Debbarma *et al.*(2010) and Gupta (2013) also reported significant effect of season of calving on majority of the FLTDMY in Sahiwal cattle. Gupta (2013) found statistically highly significant (P≤0.01) effect of season on second lactation TD2, TD3 and TD4 and non-significant effect on rest of the SLTDMY and significant effect of season of calving on some TD and non-significant effect of season on some TLTDMY in Sahiwal cattle. In general test day milk yields recorded during winter and summer were comparatively higher than test day milk yields recorded during rainy season and autumn for all lactation.

Effect of year of calving: The effect of year of calving was highly significant (P≤0.01) on all FLTDMY. The present findings were similar to the earlier reports of Debbarma *et al.* (2010) and Gupta (2013) in Sahiwal cattle. The effect of year of calving was significant on all SLTDMY except TD2, TD3, TD4 and TD5 and on all TLTDMY except TD5, TD6 and TD10.

Effect of age group: The age at first calving had highly significant (P≤0.01) effect on TD10, significant (P≤0.05) effect on TD2 and TD6 and non-significant effect on rest of the FLTDMY. Debbarma *et al.* (2010) reported significant (P≤0.05) effect of age at first calving on TD2, TD6 TD10 and Gupta (2013) found significant effect of age at first calving on TD2, TD3 and TD10 Sahiwal cattle. The age at second calving had significant (P≤0.05) effect on TD3 and TD7 and non-significant effect on rest of the SLTDMY. The age at third calving had non-significant effect on all third lactation test days. However, Gupta (2013) found highly significant (P≤0.01) effect on TD10, significant (P≤0.05) effect on TD9 and non-significant effect on rest of the TLTDMY. There was no definite trend for variation in test day milk yields among different age groups in different lactation.

Effect of service period: The service period had highly significant effect (P≤0.01) on TD9 and TD10, significant effect (P≤0.05) on TD2 and TD8 and non-significant effect on rest of the FLTDMY. Dongre (2012) also found variable effect of service period on weekly test day milk yields in Sahiwal cattle. The service period had significant effect (P≤0.05) on TD8 only and non-significant effect on rest of the SLTDMY. In general cows with less than 120 days service period have lower test milk yield and greater than 240 days service period had higher test day milk yield. The service period has highly significant effect (P≤0.01) on TD10, significant (P≤0.05) effect on TD4 and TD9 and non-significant effect on rest of the TLTDMY. The cows with service period greater than 150 days has higher TLTDMYcompared to cows with service period less than 150 days. This may be attributed to longer lactation length in these animals.

Comparison of 305-day milk yield and test day milk yield in different lactation: The 305-day milk yield as well as test day milk yield showed increasing trend with increase in lactation number. In comparison to first lactation, second lactation has 9.92% higher and third lactation has 19.04% higher 305DMY. There was sharp decline in TD9 and TD10 yield for second and third lactation compared to first lactation (Table 1) indicating higher milk yield persistency for first lactation. First parturition occurs in the process of continuous body and udder development as a result of which primiparous cows have limited milk production capacity compared to pluriparous cows which could be the reason for lower yield in first lactation.

SUMMARY

The records on first to third lactation test day and 305-day milk yields spread over a period of 52 years (1961–2012) were collected to examine the milk yield variation in different lactation and factors affecting monthly test-day milk yield and 305-day milk yield in Sahiwal cattle. The 305-day milk yield depicted progressive increase with increasing parity. For all lactations significant effect of year of calving and service period and non-significant effect of age group was seen on 305-day milk yield. For test day milk yield the effect of different factors did not follow any fix pattern. From the study it can be concluded that as the lactation order increased milk yield increased and non-genetic factors influence the 305-day milk yield and test day milk yield in Sahiwal cattle.

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