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Analysis of non-genetic factors influencing monthly test day milk yield records in Sahiwal cattle

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ABSTRACT
The present research was carried out to determine the effect of non-genetic factors on first lactation test day milk yields of Sahiwal cattle. Data were collected on 392 cows maintained at NDRI, Karnal, Haryana; spanning over a period of 31 years (1986-2017). Total 3953 monthly test day milk yield (MTDMY) records were collected at an interval of 30 days, with first MTDMY recorded on 6th day and last MTDMY on 305th day. Least squares analysis was done using statistical Harvey (model 1), considering season of calving, period of calving and age at first calving as fixed effects. Least squares mean of test day milk yield ranged from 4.73 ± 0.15 to 8.11 ± 0.22 Kg. The season of calving had non-significant effect on all MTDMYs whereas the effect of period of calving was found to be highly significant on all test day milk yields. Age at first calving had significant effect on TD2, TD3, TD4, TD8, TD9 and TD10.The significant effect of non-genetic factors on test day milk records signifies the need of adjustment of these records against non-genetic factors for use in further analysis.
Key words: test day milk yield, indigenous, non-genetic factors, Sahiwal

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INTRODUCTION
India is rich and diversified in terms of livestock population. India ranks number one in milk production with an annual output of 163.6 million tons in 2017. India also stands first in cattle population. It has 190.9 million cattle (19th livestock census). The indigenous breeds of cattle are now a days' given more emphasis as far as conservation and genetic improvement is concerned. Sahiwal being one of the important indigenous breed was chosen for the study. Sahiwal produces the highest milk among all zebu breeds.
Breed improvement through successful breeding program depends on accurate and early selection of superior animals. In India mostly first lactation 305 days or less milk yield is used as a criteria to select or cull the animals which is time and money consuming, leads to increased generation interval, decreased genetic gain per unit of time and also is based on less number of records. All these constraints may be taken care of by using test day milk yield records at monthly interval. Various non-genetic factors affect test day milk records. Hence, it is important to analyze their effect through least square analysis methods and adjust the test day records against significant non genetic factors. The adjusted records can then be used for further analysis based on test day milk records.

MATERIALS AND METHODS
Data collection:
The data for the present study was collected from the history sheets and daily milk record registers of Sahiwal cattle maintained at ICAR – National Dairy Research Institute (NDRI), Karnal, Haryana. The first lactation monthly test day milk records of Sahiwal spread over a period of 31years (1986-2017) were recorded.
NDRI livestock farm is located at an altitude of 250 meters above the mean sea level. Sahiwal cattle maintained in the farm get exposed to extreme climatic conditions with temperature ranging from 0°C in winter months to 45°C in summer months, annual rainfall of about 760 to 960 mm and relative humidity from 41% to 85%.

Statistical analysis:

The present study was done with the objective of analyzing the effect of non genetic factors on the test day milk yield in Sahiwal cattle. First lactation test day milk yields of 392 cattle were recorded spreading over a period of 31 years (1986- 2017). Total 3953 monthly test day milk yield (MTDMY) records were collected. The following fixed model was used to analyze the data via least square analysis [1].

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

Where,

Y_{ijkl} = test day milk yield of l^{th} individual belonging k^{th} age group in j^{th} period and i^{th} season of calving;

μ = is the overall population mean;

S_i = fixed effect of i^{th} season of calving;

P_j = fixed effect of j^{th} period of calving;

A_k= fixed effect of k^{th} age group;

e_{ijk} = is the random error associated with each observation which is assumed to be normally and independently distributed with mean zero and variance $ó_e^2$.

The season of calving was classified as; S_1= winter (December to March), S_2= summer (April to June), S_3= rainy (July to August), S_4= autumn (September to November). The total span of 31 years was divided into ten periods of calving (P1 to P10) of three consecutive years with last period having 4 consecutive years. The age at first calving was coded as A1 ≤ 961 days to A7 ≥1367 days with a class interval of 80 days.

The trait considered in the study was first lactation monthly test day milk yields. These were taken at an interval of 30 days, with first MTDMY recorded on 6^{th} day and last MTDMY on 305^{th} day. The analysis was carried out using Least-squares and maximum likelihood computer program of Harvey [1].

RESULTS AND DISCUSSION

The least squares mean of first lactation test day milk yields are presented in table 1.

TABLE1. Least squares mean and standard error of first lactation test day milk yield in Sahiwal cattle

Source	Code	No. of observations	TD1 (Kg)	TD2 (Kg)	TD3 (Kg)	TD4 (Kg)	TD5 (Kg)
Overall mean	μ	392	4.73 ± 0.15	7.93 ± 0.22	8.11 ± 0.22	7.69 ± 0.21	7.26 ± 0.21
Season of calving	S_1	181	4.40±0.16	8.44 ± 0.25	8.65 ± 0.24	8.00 ± 0.23	7.48 ± 0.23
	S_2	135	4.69 ± 0.17	7.86 ± 0.27	8.15 ± 0.26	7.54 ± 0.25	6.92 ± 0.25
	S_3	57	4.81 ± 0.25	7.48 ± 0.38	7.76 ± 0.38	7.64± 0.36	7.45 ± 0.36
	S_4	19	5.02 ± 0.44	7.94 ± 0.68	7.87 ± 0.66	7.60 ±0.64	7.17 ± 0.62
Period of calving	P_1	41	4.88 ± 0.31^{d}	8.03 ± 0.47^{de}	8.48 ± 0.46^{de}	8.27 ± 0.44^{d}	7.40 ± 0.43^{c}
	P_2	19	4.52 ± 0.46^{bc}	8.74 ± 0.69^{f}	8.80 ± 0.67^{ef}	8.86 ± 0.65^{e}	7.95 ± 0.64^{d}
	P_3	34	5.51 ± 0.35^{e}	9.27 ± 0.53^{g}	9.16 ± 0.51^{f}	8.78 ± 0.49^{e}	8.41 ± 0.48^{e}
	P_4	34	5.19 ± 0.34^{e}	8.79 ± 0.52^{f}	8.80 ± 0.50^{ef}	8.37 ± 0.48^{d}	7.86 ± 0.48^{d}
	P_5	31	4.55 ± 0.36^{bc}	7.34 ± 0.55^{c}	7.29 ± 0.53^{b}	6.95 ± 0.51^{b}	6.41 ± 0.50^{b}
	P_6	23	5.26 ± 0.41^{e}	6.06 ± 0.62^{a}	6.31 ± 0.60^{a}	5.43 ± 0.58^{a}	5.91 ± 0.57^{a}
	P_7	35	4.77 ± 0.35^{cd}	7.80 ± 0.52^{d}	8.04 ± 0.51^{c}	7.00 ± 0.49^{b}	5.96 ± 0.48^{a}
	P_8	76	4.61 ± 0.24^{bcd}	8.25 ± 0.36^{e}	8.16 ± 0.35^{cd}	7.52 ± 0.34^{c}	7.45 ± 0.34^{c}
	P_9	58	3.60 ± 0.26^{a}	6.88 ± 0.40^{b}	7.38 ± 0.39^{b}	7.27 ± 0.37^{bc}	6.76 ± 0.37^{b}
	P_{10}	41	4.44 ± 0.32^{b}	8.15 ± 0.48^{de}	8.68 ± 0.47^{e}	8.54 ± 0.45^{de}	8.47 ± 0.44^{e}
AFC group	A_1	34	4.68 ± 0.36	6.55 ± 0.54^{a}	6.92 ± 0.53^{a}	6.31 ± 0.51^{a}	6.29 ± 0.50
	A_2	68	4.44 ± 0.26	7.68 ± 0.40^{b}	7.79 ± 0.39^{b}	7.24 ± 0.38^{b}	6.86 ± 0.37
	A_3	123	4.88 ± 0.21	7.59 ± 0.31^{b}	7.85 ± 0.30^{b}	7.66 ± 0.29^{c}	7.21 ± 0.29
	A_4	73	5.08 ± 0.25	8.57 ± 0.38^{c}	8.52 ± 0.37^{c}	8.09 ± 0.36^{d}	7.44 ± 0.35
	A_5	40	4.62 ± 0.31	8.69 ± 0.46^{c}	8.68 ± 0.45^{c}	8.39 ± 0.43^{de}	7.69 ± 0.43
	A_6	23	4.87 ± 0.41	7.81 ± 0.62^{b}	7.79 ± 0.60^{b}	7.53 ± 0.58^{bc}	7.22 ± 0.57
	A_7	31	4.57 ± 0.36	8.62 ± 0.54^{c}	9.21 ± 0.53^{d}	8.67 ± 0.51^{e}	8.09 ± 0.50

Dissimilar superscript indicates significant ($P<0.01$ and $p<0.05$) difference of means.

Source	Code	No. of observations	TD6 (Kg)	TD7 (Kg)	TD8 (Kg)	TD9 (Kg)	TD10 (Kg)	TD11 (Kg)
Overall mean	μ	392	6.90 ± 0.19	6.69 ± 0.19	7.93 ± 0.23	7.74 ± 0.20	7.69 ± 0.21	7.26 ± 0.21
Season of calving	S_1	181	6.66 ± 0.22	6.47 ± 0.20	8.45 ± 0.25	7.50 ± 0.23	8.00 ± 0.23	7.48 ± 0.23
	S_2	135	6.61 ± 0.23	6.37 ± 0.22	7.86 ± 0.27	7.02 ± 0.25	7.54 ± 0.25	6.92 ± 0.25
	S_3	57	6.92 ± 0.34	7.07 ± 0.33	7.49 ± 0.39	6.54 ± 0.13	7.64 ± 0.36	7.45 ± 0.36
	S_4	19	7.42 ± 0.59	6.85 ± 0.57	7.94 ± 0.68	6.42 ± 0.22	7.60 ± 0.64	7.17 ± 0.62
Period of calving	P_1	41	7.39 ± 0.41^{d}	6.74 ± 0.39^{c}	8.03 ± 0.47^{de}	7.22 ± 0.32^{d}	8.27 ± 0.44^{d}	7.40 ± 0.43^{c}
	P_2	19	7.35 ± 0.61^{d}	7.46 ± 0.58^{d}	8.74 ± 0.70^{f}	7.45 ± 0.56^{de}	8.86 ± 0.65^{e}	7.95 ± 0.64^{d}
	P_3	34	7.59 ± 0.46^{d}	7.88 ± 0.44^{e}	9.27 ± 0.53^{g}	8.25 ± 0.45^{f}	8.78 ± 0.49^{e}	8.41 ± 0.48^{e}
	P_4	34	7.94 ± 0.45^{e}	7.77 ± 0.44^{de}	8.80 ± 0.52^{f}	7.28 ± 0.24^{d}	8.37 ± 0.48^{d}	7.86 ± 0.48^{d}
	P_5	31	5.99 ± 0.48^{a}	5.93 ± 0.46^{b}	7.34 ± 0.55^{c}	6.19 ± 0.45^{b}	6.95 ± 0.51^{b}	6.41 ± 0.50^{b}
	P_6	23	5.68 ± 0.54^{a}	5.06 ± 0.52^{a}	6.06 ± 0.63^{a}	5.22 ± 0.58^{a}	5.43 ± 0.58^{a}	5.91 ± 0.57^{a}
	P_7	35	5.73 ± 0.46^{a}	5.91 ± 0.44^{b}	7.80 ± 0.53^{d}	7.12 ± 0.41^{c}	7.00 ± 0.49^{b}	5.96 ± 0.48^{a}
	P_8	76	6.87 ± 0.32^{c}	6.47 ± 0.31^{c}	8.25 ± 0.37^{e}	7.04 ± 0.26^{bc}	7.52 ± 0.34^{c}	7.45 ± 0.34^{c}
	P_9	58	6.46 ± 0.35^{b}	5.93 ± 0.34^{b}	6.88 ± 0.40^{b}	6.38 ± 0.32^{b}	7.27 ± 0.37^{bc}	6.76 ± 0.37^{b}
	P_{10}	41	8.02 ± 0.42^{e}	7.77 ± 0.40^{de}	8.15 ± 0.48^{de}	7.47 ± 0.42^{de}	8.54 ± 0.45^{de}	8.47 ± 0.44^{e}
AFC group	A_1	34	6.30 ± 0.47	5.79 ± 0.45	6.55 ± 0.54^{a}	5.45 ± 0.53^{a}	6.31 ± 0.51^{a}	6.29 ± 0.50
	A_2	68	6.53 ± 0.35	6.43 ± 0.33	7.69 ± 0.40^{b}	6.21 ± 0.39^{b}	7.24 ± 0.38^{b}	6.86 ± 0.37
	A_3	123	6.98 ± 0.27	6.59 ± 0.26	7.60 ± 0.32^{b}	6.16 ± 0.30^{b}	7.66 ± 0.29^{c}	7.21 ± 0.29
	A_4	73	7.16 ± 0.34	6.91 ± 0.32	8.58 ± 0.39^{c}	7.54 ± 0.37^{c}	8.09 ± 0.36^{d}	7.44 ± 0.35
	A_5	40	7.32 ± 0.40	6.97 ±0.38	8.69 ± 0.46^{c}	7.21 ± 0.45^{c}	8.39 ± 0.43^{de}	7.69 ± 0.43
	A_6	23	6.74 ± 0.54	6.92 ± 0.52	7.81 ± 0.62^{b}	6.48 ± 0.60^{b}	7.53 ± 0.58^{bc}	7.22 ± 0.57
	A_7	31	7.30 ±0.47	7.22 ±0.46	8.62 ± 0.54^{c}	8.12 ± 0.53^{d}	8.67 ± 0.51^{e}	8.09 ± 0.50

Dissimilar superscript indicates significant ($P<0.01$ and $p<0.05$) difference of means

Overall performance

The overall least square mean of test day milk yield ranged from 4.73 ± 0.15 Kg (TD1) to 8.11 ± 0.22 Kg (TD3). Ilatsia *et al*.(2007)[2] and Bilal *et.al*. (2008)[3] reported minimum least squares mean on TD-8 (3.0 ± 0.00 Kg) and TD10 (4.3 ± 0.18 Kg) respectively and maximum least squares mean on TD2 (6.4 ± 2.6 Kg) and TD2 (6.4 ± 0.12 Kg) respectively. Gupta (2013)[4] reported that the mean of test day milk yield ranged from 5.41 ± 0.09 Kg (TD1) to 8.22 ± 0.11 Kg (TD2).According to Ved Prakash (2015)[5], it ranged from 5.12 ± 0.09 (TD1) 8.14 ± 0.11(TD2).

Effect of season of calving

The effect of season of calving on all test day milk yields was found to be non significant. Effect of season of calving was reported to have significant effect on TD1, TD6 by Debbarma *et.al.* [6]; on TD4, TD5, TD7, TD8 by Gupta [4] and on TD2, TD5, TD7, TD9 by Ved Prakash [5].

Monthly test day milk yield i.e.TD2, TD3, TD4, TD5, TD8, TD9, TD10, TD11 showed highest milk yield in winter season. TD7 showed highest milk yield in rainy season. In case of TD1 and TD6 highest milk yield was observed in autumn season. Not even a single test day milk yields was found to be at peak in summer which confirms the decrease in performance of animals in summer season due to summer stress.

Effect of period of calving

The effect of period of calving was found to be highly significant on all the eleven test day milk yields. Similar results were reported by Debbarma *et.al.* [6] and Gupta [4]. The significant effect indicated the change in manage mental practices and the environmental changes during these periods which caused the variations in first lactation test day milk records

Effect of age at first calving group

Age at first calving had significant effect on TD2, TD3, TD4, TD8, TD9 and TD10. In all the other test days the effect of age at first calving was found to be non significant. AFC had significant effect on TD2, TD3 and highly significant effect on TD10 as reported by Gupta (2013). Highly significant effect of AFC on test days is also reported by Mundhe [7].

CONCLUSION

The least squares mean of test day milk yield ranged from 4.73 ± 0.15 Kg to 8.11 ± 0.22 Kg. The season of calving had non-significant effect on all test day milk yields whereas the effect of period of calving was found to be highly significant on all test day milk yields. Age at first calving had significant effect on TD2, TD3, TD4, TD8, TD9 and TD10. The animals calving at the age of around 1367 days were found to have the highest milk yield. The minimum milk yield in summer season highlights the importance of better management of herd and also development of breeds that are more heat tolerant so that our herds can perform better in near future where temperature will further increase due to global warming.

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