



Performance evaluation and prediction of first lactation milk yield in Vrindavani cattle

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ABSTRACT

The present investigation was carried out using first lactation milk records of 1,084 Vrindavani cows spread over a period of 17 years (2000–2017). The overall performance, effect of non-genetic factors on the first lactation test day (TD) milk yields, age at first calving (AFC), first lactation length (FLL), first lactation peak yield (FLPY), first lactation average daily yield (FLADY), first lactation 305 days milk yield (FL305MY) and first lactation total milk yield (FLTMY) were investigated. The overall least squares mean for FL305MY, FLTMY, FLADY and FLPY were 2825.86 ± 26.04 , 2883.40 ± 35.91 , 8.48 ± 0.07 and 14.37 ± 0.11 kg, respectively. The effect of season was highly significantly affecting AFC, FLADY, FLPY, FLTMY, FLL and all the test day milk yields. The influence of period was highly significant on AFC, FL305DMY, FLTMY, FLL, FLPY, FLADY, all the test day milk yields. The heritability estimates of FL305DMY, FLTMY and test day milk yields were low to moderate. While predicting FL305MY, the highest coefficient of determination (R^2) was obtained for TD96. However, while predicting FLTMY, the highest R^2 value was observed for TD246.

Key words: Cattle, Heritability, Test day milk yield, Vrindavani

Crossbred cows contribute 54% (31.07 million tonnes) of the total cow milk produced in India which is more than the milk produced by the indigenous cattle breeds (26.69 million tonnes). Hence, despite their small number, crossbred cows have significant contribution to the country's milk pool. Vrindavani is a synthetic crossbred cattle strain developed at Indian Veterinary Research Institute having exotic inheritance of breeds namely, Holstein Friesian (H), Brown Swiss (B) and Jersey (J) between 50 and 75% and zebu inheritance of Harijana between 50 and 25% (Singh *et al.* 2011). To maintain and further improve the level of milk production, proper selection of animals of high genetic merits is needed. This requires the adjustment of the records for non-genetic factors to improve the selection procedures after accurate estimation of heritability. Hence the present research was conducted to study the effects of non-genetic factors affecting the first lactation traits and FL305MY and FLTMY was predicted on the basis of the test day milk yields.

MATERIALS AND METHODS

Source of data: The data were collected from the history

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cum pedigree sheets and daily milk record registers of the Vrindavani crossbred cows maintained at the record room of Livestock Production and Management Section of the Institute. The cows were milked twice or thrice a day and the daily milk yield was calculated by adding the three milk yield records in a particular day. A total of ten individual milk yields were collected at an interval of 30 days from 6th day to 276th day of lactation. The colostrum yield for the first five days after calving was excluded from the study. The animals having less than 500 kg of milk production in a lactation and lactation length below 150 days were excluded from the present study.

Classification of data: The entire duration of study was classified into 6 periods of birth (1997 to 2014) and 6 periods of calving (2000–2017) where each period comprised 2 years. Each year was divided into three seasons (rainy: July to September, winter: October to February and summer: March to June) on the basis of rainfall, temperature and humidity over the years.

Least squares analysis: The data were subjected to the least squares analysis of variance by using the technique described by Harvey (1990). Duncan's multiple range test as modified by Kramer (1957) was used for testing differences among the least squares means (using the inverse coefficient matrix).

Estimation of heritability: Paternal half-sib correlation (Intra-sire correlation among daughters) method was used to estimate heritability of different traits after adjusting with least squares constants of significant effects.

Prediction of 305 days milk yield: A simple linear regression analysis with only one independent variable at a time and stepwise forward multiple linear regression analysis was carried out. The test day milk yields were taken as explanatory variables for prediction of FL305MY and FLTMY were taken as the dependant variables.

RESULTS AND DISCUSSION

Age on first calving (AFC): In the present study, the overall least squares means for AFC was 975.02 ± 4.28 days (Table 1). The present estimate was lower than that of 1012 ± 9.32 days AFC observed by Singh *et al.* (2011) in the same population and farm but across different years. The lower age at first calving observed in the present study compared to the previous study indicated towards the improvement in the management of the farm across the years. A highly significant ($P \leq 0.01$) effect of season and period was observed on AFC. The calves born during summer season had significantly ($P \leq 0.05$) higher age at first calving than the calves born during rainy and winter season. The calves born during the period 2000–02 had the highest AFC while the calves born during the period 2012–14 had the lowest AFC. Also, a decreasing trend in AFC was

observed from the period 2003–05 to the period 2012–14. This indicated that AFC may be optimized by improving the management practices in the farm. Singh (2009) reported significant effect of season and period of birth on AFC in Vrindavani cattle. However, in contrary to the present findings, Vinothraj *et al.* (2016) observed non-significant effect of both season and period of birth on AFC in Jersey $\times$ Red Sindhi. A nonsignificant effect of season but a significant effect of period of birth on AFC was reported by Zewdu *et al.* (2015) in HF $\times$ Deoni; Kumar *et al.* (2015) in Frieswal and Ambhore *et al.* (2017) in PhuleTriveni cattle.

First lactation 305 days milk yield (FL305DMY): The overall least squares means for FL305DMY was 2825.86 ± 26.04 kg (Table 2). Singh *et al.* (2011) reported a lower estimate (2744.3 ± 45.7 kg) of FL305DMY in Vrindavani cattle. However, comparatively higher least squares means for FL305DMY were observed by Singh (2014) and Tripathy *et al.* (2017) in Karan Fries cattle. Lower estimates for FL305DMY were reported by Lakshmi *et al.* (2010) in Frieswal cattle; Zewdu *et al.* (2013) in HF $\times$ Deoni crossbred; Patond and Gulhane (2014) in Jersey cattle; Dhal *et al.* (2015) in Jersey crossbred and Kumar *et al.* (2016) in HF crossbred cattle.

The effect of season of calving was non-significant on FL305DMY. This indicated that the milch animals were adequately managed during the different seasons by providing favourable farm conditions. The non-significant effect of season of calving on FL305DMY was in agreement with the findings of Rashia (2006) in Karan Fries cattle; Patond and Gulhane (2014) in Jersey cattle. However, in contrary to our findings, the significant effect of season of calving on FL305DMY was reported by Tripathy *et al.* (2017) in Karan Fries cattle. Ambhore *et al.* (2017) found significant effect of season of calving on first lactation 300 days milk yield in PhuleTriveni cattle. The effect of period of calving was highly significant on FL305DMY. The variation in FL305DMY over period may be attributed to the changes in climatic and other managerial conditions. The present findings were in agreement to the findings of Singh (2009) in Vrindavani cattle; Kokate (2009), Sharma

Table 1. Least squares means and standard errors for age at first calving (AFC) in Vrindavani cattle

Effect		N	Mean $\pm$ SE (days)
Season	Overall	1080	975.02 $\pm$ 4.28
	Rainy	298	977.16 ^b $\pm$ 7.60
	Winter	548	955.23 ^b $\pm$ 5.61
	Summer	234	992.68 ^a $\pm$ 8.68
Period	1997–99	174	922.30 ^c $\pm$ 10.01
	2000–02	229	1095.34 ^a $\pm$ 8.73
	2003–05	183	997.73 ^b $\pm$ 9.85
	2006–08	168	989.10 ^b $\pm$ 10.36
	2009–11	154	935.76 ^c $\pm$ 10.59
	2012–14	172	909.89 ^c $\pm$ 10.11

The least squares means with same superscripts do not differ significantly.

Table 2. Least squares means and standard errors for first lactation 305 days or less milk yield (FL305MY), first lactation total milk yield (FLMY), first lactation peak yield (FLPY), first lactation length (FLL), and first lactation average daily yield (FLADY)

Effect		FL305DMY		FLTMY		FLPY		FLL		FLADY	
		N	Mean $\pm$ SE (kg)	N	Mean $\pm$ SE (kg)	N	Mean $\pm$ SE (kg)	N	Mean $\pm$ SE (days)	N	Mean $\pm$ SE (kg)
Season	Overall	804	2825.86 $\pm$ 26.04	976	2883.40 $\pm$ 35.91	1014	14.37 $\pm$ 0.11	976	335.29 $\pm$ 2.73	976	8.48 $\pm$ 0.07
	Rainy	144	2753.84 ^b $\pm$ 54.32	185	2731.53 ^b $\pm$ 74.89	191	13.31 ^b $\pm$ 0.24	185	332.94 ^{ab} $\pm$ 5.70	185	8.10 ^b $\pm$ 0.15
	Winter	374	2845.81 ^a $\pm$ 35.16	443	2904.72 ^a $\pm$ 49.39	461	15.08 ^a $\pm$ 0.15	443	338.70 ^b $\pm$ 3.76	443	8.77 ^a $\pm$ 0.10
	Summer	286	2877.93 ^a $\pm$ 39.12	348	3013.96 ^a $\pm$ 55.31	362	14.73 ^a $\pm$ 0.17	348	344.53 ^a $\pm$ 4.21	348	8.57 ^a $\pm$ 0.11
Period	2000–02	122	2274.26 ^d $\pm$ 60.03	168	2136.35 ^c $\pm$ 79.99	184	11.33 ^c $\pm$ 0.24	168	311.59 ^c $\pm$ 6.09	168	6.66 ^d $\pm$ 0.16
	2003–05	195	2527.12 ^c $\pm$ 50.27	224	2638.98 ^b $\pm$ 73.10	227	13.48 ^d $\pm$ 0.23	224	339.44 ^b $\pm$ 5.56	224	7.74 ^c $\pm$ 0.15
	2006–08	149	3169.19 ^a $\pm$ 53.42	168	3285.18 ^a $\pm$ 78.41	172	15.03 ^{bc} $\pm$ 0.25	168	344.39 ^b $\pm$ 5.97	168	9.53 ^a $\pm$ 0.16
	2009–11	153	3161.87 ^a $\pm$ 53.25	180	3365.74 ^a $\pm$ 76.45	184	15.94 ^a $\pm$ 0.24	180	344.65 ^b $\pm$ 5.82	180	9.72 ^a $\pm$ 0.16
	2012–14	128	2873.60 ^b $\pm$ 58.08	158	3181.56 ^a $\pm$ 81.49	161	15.64 ^{ab} $\pm$ 0.26	158	368.63 ^a $\pm$ 6.20	158	8.63 ^b $\pm$ 0.17
	2015–17	57	2949.11 ^b $\pm$ 86.11	78	2692.61 ^b $\pm$ 115.01	86	14.81 ^a $\pm$ 0.35	78	303.64 ^a $\pm$ 8.75	78	8.60 ^b $\pm$ 0.23

The least squares means with same superscripts do not differ significantly.

(2010) and Tripathy *et al.* (2017) in Karan Fries cattle; Patond and Gulhane (2014) in Jersey cattle; Ambhore *et al.* (2017) in PhuleTriveni cows. In contrary to the present findings, a non-significant effect of period of calving on FL305DMY was reported by Singh (2014) in Karan Fries cattle.

First lactation total milk yield (FLTMY): The overall least squares means for FLTMY was 2883.40±35.91 kg (Table 2). Similar values for FLTMY were observed by Singh *et al.* (2011) in Vrindavani cattle; Alex *et al.* (2017) in Frieswal cattle and Ambhore *et al.* (2017) in PhuleTriveni cattle. Comparatively, lower least squares means for FLTMY were observed by Lakshmi *et al.* (2010) in Frieswal cattle; Zewdu *et al.* (2013) in HF × Deoni cattle; Dhal *et al.* (2015) in Jersey crossbred and Thorat *et al.* (2016) in HF × Deoni crossbred. However, comparatively higher least squares means for FLTMY were recorded by Sahana and Gurnani (2000) in Karan Fries cattle.

The influence of season was highly significant ($P \leq 0.01$) on FLTMY. The present results were in agreement to the findings of Sahana and Gurnani (2000) in Karan Fries and Dutt and Kumar (2000) in HF × Haryana. However, the non-significant effect of season of calving on FLTMY was reported by Nehra (2011) in Karan Fries and Ambhore *et al.*

(2017) in Phule Triveni cows. The effect of period of calving was highly significant on FLTMY. Ambhore *et al.* (2017) observed highly significant effect of period of calving on FLTMY in PhuleTriveni cows. Kumar *et al.* (2016) reported significant effect of period of calving on FLTMY in HF crossbreds. However, Nehra (2011) reported nonsignificant effect of period of calving in Karan Fries cattle.

Test day milk yields: The overall least squares means for the test day milk yields (TDMY) varied between 7.50±0.10 kg for TD276 to 11.10±0.12 kg for TD36. The highest test day milk yield was observed on the 2nd test day (TD36) (Tables 3 and 4). Similar findings were reported by Kokate *et al.* (2013) and Singh (2014) in Karan Fries cattle. The lowest test day milk yield was recorded towards the end of the lactation i.e. on the 276th day (TD276). The effect of season of calving was significant ($P \leq 0.05$) on TD6 (1st monthly test day) and TD186 (7th monthly test day) while on the other test day milk yields, whereas, it was highly significant ($P \leq 0.01$). In the present study, the highest test day milk yield (11.86±0.15 kg on TD66) as well as the lowest test day milk yield (6.54±0.14 kg on TD276) were observed during the winter season. Kokate (2009), Rashia (2010) and Singh (2014) observed a highly significant effect ($P \leq 0.01$) of season on all the test day milk yields in Karan

Table 3. Least squares means and standard errors for first lactation 305 days or less milk yield (FL305MY), First lactation total milk yield (FLMY), first lactation peak yield (FLPY), first lactation length (FLL), and first lactation average daily yield (FLADY)

Effect		TD6		TD36		TD66		TD96		TD126	
		N	Mean±SE	N	Mean±SE	N	Mean±SE	N	Mean±SE	N	Mean±SE
Season	Overall	906	7.93±0.12	908	11.10±0.12	904	10.88±0.11	902	10.39±0.11	908	9.78±0.11
	Rainy	164	7.55 ^b ±0.25	165	9.90 ^b ±0.26	166	9.99 ^c ±0.24	166	9.97 ^b ±0.23	163	9.69 ^b ±0.23
	Winter	417	7.88 ^{ab} ±0.16	422	11.75 ^a ±0.17	421	11.86 ^a ±0.15	418	11.25 ^a ±0.15	420	10.55 ^a ±0.14
	Summer	325	8.36 ^a ±0.18	321	11.65 ^a ±0.19	317	10.79 ^b ±0.17	318	9.95 ^b ±0.17	325	9.11 ^c ±0.16
Period	2000–02	149	6.10 ^d ±0.27	151	8.83 ^c ±0.28	151	8.29 ^c ±0.26	151	8.09 ^d ±0.25	152	7.60 ^d ±0.24
	2003–05	213	7.40 ^c ±0.24	211	10.46 ^b ±0.25	207	9.87 ^b ±0.23	206	9.23 ^c ±0.23	213	8.56 ^c ±0.21
	2006–08	158	8.49 ^{ab} ±0.26	158	11.96 ^a ±0.26	158	11.93 ^a ±0.25	158	11.45 ^a ±0.24	157	10.74 ^a ±0.23
	2009–11	166	7.96 ^{bc} ±0.25	167	12.09 ^a ±0.26	167	12.37 ^a ±0.24	167	11.73 ^a ±0.23	167	11.27 ^a ±0.22
	2012–14	140	8.54 ^{ab} ±0.28	141	10.92 ^b ±0.28	141	10.74 ^b ±0.26	141	10.29 ^b ±0.25	141	9.66 ^b ±0.24
	2015–17	80	9.10 ^a ±0.36	80	12.35 ^a ±0.37	80	12.10 ^a ±0.35	79	11.54 ^a ±0.34	78	10.88 ^a ±0.33

The least squares means with same superscripts do not differ significantly.

Table 4. Least squares means and standard errors for test day milk yields (TD156 to TD276)

Effect		N	TD156	N	TD186	N	TD216	N	TD246	N	TD276
Season	Overall	908	9.26±0.10	907	8.67±0.10	896	8.42±0.10	872	7.90±0.10	800	7.50±0.10
	Rainy	163	9.64 ^a ±0.22	163	9.02 ^a ±0.21	159	8.92 ^a ±0.22	157	7.92 ^b ±0.20	144	7.35 ^b ±0.21
	Winter	420	9.48 ^a ±0.14	419	8.41 ^b ±0.13	414	7.75 ^b ±0.14	406	7.19 ^c ±0.13	376	6.54 ^c ±0.14
	Summer	325	8.67 ^b ±0.16	325	8.58 ^b ±0.15	323	8.60 ^a ±0.15	309	8.60 ^a ±0.15	280	8.62 ^a ±0.15
Period	2000–02	150	7.18 ^d ±0.24	153	6.66 ^d ±0.22	146	6.90 ^d ±0.23	136	6.41 ^d ±0.22	122	5.67 ^d ±0.24
	2003–05	214	8.26 ^c ±0.21	213	7.59 ^c ±0.20	213	7.19 ^c ±0.20	208	6.84 ^c ±0.19	186	6.66 ^c ±0.20
	2006–08	157	10.38 ^a ±0.23	154	9.67 ^a ±0.21	155	9.30 ^a ±0.22	152	9.00 ^a ±0.21	144	8.81 ^a ±0.21
	2009–11	167	10.58 ^a ±0.22	167	9.83 ^a ±0.21	166	9.50 ^a ±0.21	160	8.84 ^a ±0.20	152	8.58 ^a ±0.21
	2012–14	141	9.31 ^b ±0.24	141	8.94 ^b ±0.22	138	9.07 ^a ±0.23	138	8.40 ^b ±0.22	127	7.87 ^b ±0.23
	2015–17	79	9.87 ^b ±0.32	79	9.33 ^{ab} ±0.30	78	8.57 ^b ±0.31	78	7.94 ^b ±0.29	69	7.41 ^b ±0.31

The least squares mean with same superscripts do not differ significantly.

Fries cattle. The effect of period of calving was a highly significant ($P \leq 0.01$) on all the test day milk yields. Kokate (2009) also observed highly significant effect of period of calving on all the test-day milk yields in Karan Fries cows. However, in contrary to the present findings, Singh (2014) reported nonsignificant effect of period of calving on all the test day yields except on 125th day, 155th day and 215th day in Karan Fries cattle. Rashia (2010) also reported a nonsignificant effect of period of calving on 1st, 2nd, 3rd, 6th and 10th monthly test day milk yields in Karan Fries cattle.

First lactation length (FLL): The overall least squares means for FLL was 335.29 ± 2.73 days (Table 2). Singh *et al.* (2011) had observed slightly higher FLL of 344.3 ± 3 days in Vrindavani cattle. However, the present estimate was close to FLL of 331.03 ± 3.01 days reported by Ambhore *et al.* (2017) in Phule Triveni cattle. Comparatively, lower least squares means for FLL were reported by Lakshmi *et al.* (2010) in Frieswal cattle; Zewdu *et al.* (2013) in HF $\times$ Deoni; Dhal *et al.* (2015) in Jersey crossbred cattle and Alex *et al.* (2017) in Frieswal cattle.

The effect of season of calving was significant ($P \leq 0.05$) on the first lactation length. Cows calving during summer had longer first lactation length (FLL) of 344.53 ± 4.21 days, whereas winter calvers had shorter lactation length of 338.70 ± 3.76 days. Similar to our findings, Singh and Gurnani (2004) observed maximum lactation length for the summer calvers and minimum lactation length for winter calvers. The nonsignificant effect of season of calving on FLL was also reported by Kumar *et al.* (2016) in HF cross, Saha *et al.* (2010) in Karan Fries, Lakshmi *et al.* (2010) in Frieswal; Nehra (2011) in Karan Fries and Ambhore *et al.* (2017) in Phule Triveni cattle. The effect of period of calving was highly significant ($P \leq 0.01$) on FLL. This was in agreement to the findings of Singh and Gurnani (2004) in Karan Fries; Nehra (2011) in Karan Fries and Ambhore *et al.* (2017) in Phule Triveni cows.

First lactation peak yield (FLPY): The overall least squares means for first lactation peak yield was 14.73 ± 0.11 kg (Table 2). Singh *et al.* (2011) also reported similar estimates (14.0 ± 0.2 kg) for peak yield in Vrindavani cattle. Comparatively, lower least squares mean for first lactation peak yield were observed by Lakshmi *et al.* (2010) in Frieswal, Kumar *et al.* (2016) in HF crossbred cattle and Alex *et al.* (2017) in Frieswal cattle.

The influence of season of calving was highly significant ($P \leq 0.01$) on FLPY. The highest FLPY was observed during the winter season. Kumar *et al.* (2016) also reported highly significant ($P \leq 0.01$) effect of season of calving on FLPY in HF crossbred cattle.

First lactation average daily yield (FLADY): The overall least squares means for FLADY was 8.48 ± 0.07 kg (Table 2). Similar estimates for FLADY were reported by Singh *et al.* (2011) in Vrindavani cattle and Lakshmi *et al.* (2010) in Frieswal cattle. However, lower estimates of FLADY were reported by Zewdu *et al.* (2013) in HF $\times$ Deoni and Dhal *et al.* (2015) in Jersey crossbred.

The influence of season was highly significant ($P \leq 0.01$) on FLADY. Significant effect of season of calving on FLADY was also reported by Nehra (2011) in Karan Fries cattle. The effect of period of calving was highly significant on FLADY and the present findings were in agreement to the findings of Nehra (2011) in Karan Fries cattle. The effect of age at first calving (AFC) was significant ($P \leq 0.05$) on FLADY. Nehra *et al.* (2011) also found significant effect of AFC on FLADY in Karan Fries cattle.

Heritability estimates of FL305DMY, FLTMY, test day milk yields: The heritability estimates of FL305DMY was 0.172 ± 0.08 . The present estimate was higher than that of 0.07 ± 0.05 reported by Singh *et al.* (2011) in Vrindavani cattle. However, the present findings were comparable to the heritability estimates of 0.20 ± 0.06 reported by Rashia (2006) in Karan Fries cattle. Comparatively, higher heritability estimates for FL305DMY were reported in Karan Fries cattle by Singh and Gurnani (2004), Kumbhare and Gandhi (2007), Kokate (2009), Sharma (2010), Singh (2014) and Tripathy *et al.* (2017). Goshu *et al.* (2014) reported higher heritability estimates for FL305DMY in HF. Ambhore *et al.* (2017) reported higher heritability estimates for first lactation 300 days milk yield and Phule Triveni cattle.

The heritability estimates of FLTMY in the present study was 0.175 ± 0.07 . Comparatively, lower estimate of 0.06 ± 0.05 was reported by Singh *et al.* (2011) in Vrindavani cattle. However, the present estimates were close to that of 0.20 ± 0.08 reported by Lakshmi *et al.* (2010) in HF $\times$ Sahiwal. Comparatively, higher estimates of FLTMY were reported by Sharma (2010) in Karan Fries cattle; Goshu *et al.* (2014) in HF; Kumar *et al.* (2016) in HF crossbred cattle and Ambhore *et al.* (2017) in Phule Triveni cattle.

In the present study, the h^2 estimates of the test day milk yields were 0.138 ± 0.07 , 0.130 ± 0.07 , 0.142 ± 0.07 , 0.170 ± 0.08 , 0.160 ± 0.08 , 0.105 ± 0.06 , 0.089 ± 0.06 , 0.174 ± 0.08 , 0.153 ± 0.08 and 0.158 ± 0.08 for TD6, TD36, TD66, TD96, TD126, TD156, TD186, TD216, TD246 and TD276 respectively. Singh (2014) estimated the heritability of the monthly test day milk yields in Karan Fries cattle, were 0.14 ± 0.05 , 0.20 ± 0.06 , 0.26 ± 0.07 , 0.17 ± 0.06 , 0.23 ± 0.06 , 0.34 ± 0.07 , 0.27 ± 0.07 , 0.21 ± 0.06 , 0.22 ± 0.06 and 0.21 ± 0.06 for 6th day, 35th day, 65th day, 95th day, 125th day, 155th day, 185th day, 215th day, 245th day and 275th days test day milk respectively. In the present study, lowest heritability was recorded on 186th day (0.089 ± 0.06). However, Singh (2014) reported lowest heritability on 305th day (0.11 ± 0.05) and the highest heritability on 155th day (0.34 ± 0.07) in Karan Fries cattle.

Prediction of FL305DMY using test day milk yields: While predicting FL305MY using single test day milk yields, the highest R^2 (68.18%) for TD96 indicates that 96th day milk yield could be used as the most effective predictor to predict FL305DMY (Table 5). However, when TD96 (4th test day), TD156 (6th test day) and TD246 (9th test day) were used together for predicting the FL305DMY, the accuracy of prediction increased to 87.16%. Thereafter, not

much gain in accuracy was obtained on incorporation of the additional test day milk yields in the prediction equation. However, Njubi *et al.* (2010) reported that the prediction equation with four variables, i.e., first, second, third, and fourth test milk yield, gave adequate accuracy (79.0%) in estimating the FL305DMY from test day milk yield in Kenyan Holstein Friesian cows. Kokate (2009) reported that the regression equation with four variables comprising 2nd, 4th, 6th and 9th test day was 86% accurate for prediction of first lactation 305-day milk yield in Karan Fries cows.

Prediction of FLTMY using test day milk yields: While predicting FLTMY using test day milk yields, the highest coefficient of determination (56.22%) was obtained for TD246. The highest accuracies obtained towards the end of the lactation period indicated that prediction of FLTMY using early in the lactation variable cannot yield adequate accuracy.

The highest coefficient of determination for TD96 ($R^2=68.18\%$) in the present study indicated that 96th day milk yield could be utilized as the most effective predictor to predict FL305MY early in the lactation period. The early prediction of 305 days milk yield using the test day milk yield would be useful under the field conditions where there is a lack of infrastructure and recording facilities due to which the milk recording on daily basis is a tedious job. The use of test day records in predicting the 305 days milk yield would also result in reduced cost of recording as less frequent collection of milk samples would be required. This would also help in early selection of sires on the basis of test day milk yields of their daughters in commercial dairy farms. Thus, the selection of the animals on the basis of

their test day milk yields would lead to a reduced generation interval besides being cost effective.

REFERENCES

- Alex R, Kumar S, Singh U, Deb R, Alyethodi R R, Prakash B and Singh G. 2017. Evaluation of non-genetic factors affecting lactation traits of Frieswal cows in northern zone of India. *Indian Journal of Animal Sciences* **87**(4): 520–22.
- Ambhore G S, Singh A, Deokar D K, Gupta A K, Singh M and Prakash V. 2017. First lactation production and reproduction performance of Phule Triveni cattle in hot arid region of Maharashtra. *Indian Journal of Animal Sciences* **87**(1): 105–08.
- Dhal S K, Mishra S, Ray S and Dash S K. 2015. Influence of non-genetic factors on milk production traits of Jersey crossbred cows in coastal Odisha. *International Journal of Agriculture Sciences* **7**(10): 736–38.
- Dutt T and Kumar S. 2000. Performance evaluation of FH, FBH and FSH interse crosses. *Indian Journal of Animal Sciences* **70**(1): 80–81.
- Goshu G, Singh H, Petersson K J and Lundeheim N. 2014. Heritability and correlation among first lactation traits in Holstein Friesian cows at Holeta Bull Dam Station, Ethiopia. *International Journal of Livestock Production* **5**(3): 47–53.
- Harvey W R. 1990. Mixed model least squares and maximum likelihood computer program (LSMLMW). PC-1 version.
- Kokate L S. 2009. 'Genetic evaluation of Karan Fries sires based on test-day milk yield records.' MVSc Thesis, NDRI (Deemed University), Karnal, India.
- Kokate L, Singh A, Banu R, Gandhi R, Chakravarty A, Gupta A and Sachdeva G. 2013. Genetic and non-genetic factors affecting monthly test day milk yields in Karan Fries cattle. *Indian Journal of Animal Sciences* **83**(4): 385–89.
- Kramer C R. 1957. Extension of multiple range tests to group correlated means. *Biometrics* **13**: 13–18.
- Kumar J, Singh Y P, Kumar S, Singh R, Kumar R and Kumar P. 2015. Genetic analysis of reproductive performance of Frieswal cattle at Military Farm, Ambala. *Veterinary World* **8**(8): 1032–37.
- Kumar S, Dalal D S, Pander B L and Patil C S. 2016. Genetic evaluation of crossbred cattle for production traits. *Haryana Veterinarian* **55**(2): 137–40.
- Kumbhare A G and Gandhi R S. 2007. Heritability estimates of first lactation trait from time series adjustment in Karan Fries cattle. *Indian Journal of Dairy Sciences* **60**(4): 274–77.
- Lakshmi B S, Gupta B R, Prakash M G, Sudhakar K and Sharma S. 2010. Genetic analysis of the production performance of Frieswal cattle. *Tamil Nadu Journal of Veterinary and Animal Sciences* **6**(5): 215–22.
- Nehra M. 2011. 'Genetic analysis of performance trends in Karan Fries cattle.' MVSc Thesis, NDRI (Deemed University), Karnal, India.
- Njubi D M, Wakhungu J W and Badamana M S. 2010. Use of test-day records to predict first lactation 305-day milk yield using artificial neural network in Kenyan Holstein–Friesian dairy cows. *Tropical Animal Health and Production* **42**(4): 639–44.
- Patond M N and Gulhane V M. 2014. Effect of non- genetic factors on 305 days milk yield in jersey cattle. *Research Journal of Animal Husbandry and Dairy Science* **5**(1): 47–48.
- Rashia B N. 2006. 'Selection criteria for young dairy Karan Fries bulls.' MVSc Thesis, NDRI (Deemed University), Karnal,

Table 5. Regression for prediction of first lactation 305 days milk yield (FL305MY) using test day milk yields (TDMY) and monthly milk yield (MY)

TDMY/MY	Intercept constant (a)	b ₁	R ²
TD6	2035.04±65.28	108.50±7.47	24.62
TD36	1194.94±67.19	148.06±5.53	52.63
TD66	996.66±60.69	168.17±5.10	62.69
TD96	936.44±55.72	183.42±4.95	68.18
TD126	2175.30±55.32	71.56±4.83	25.34
TD156	1095.97±55.54	189.15±5.52	64.50
TD186	1145.98±57.88	197.13±6.17	61.37
TD216	1281.97±60.43	187.79±6.63	55.65
TD246	1337.06±62.45	190.84±7.21	52.37
TD276	1604.41±65.23	165.07±7.77	42.42
MMY1	2666.14±44.58	1.79±0.26	6.77
MMY2	884.34±63.46	5.91±0.18	62.72
MMY3	692.07±56.57	6.33±0.16	71.67
MMY4	692.59±50.64	6.75±0.15	76.01
MMY5	652.28±46.73	7.24±0.14	79.42
MMY6	693.53±49.87	7.56±0.16	76.56
MMY7	836.47±50.76	7.53±0.18	73.53
MMY8	940.39±54.36	7.50±0.20	68.68
MMY9	1014.33±57.08	7.53±0.22	64.85

b₁, Regression of FL305DMY on TDMY; R², Coefficient of determination.

- India.
- Rashia B N. 2010. 'Genetic evaluation of the lactation curve in Karan Fries cattle.' PhD Thesis, NDRI (Deemed University), Karnal, India.
- Saha S, Joshi B K and Singh A. 2010. Generation-wise genetic evaluation of various first lactation traits and herd life in Karan Fries cattle. *Indian Journal of Animal Sciences* **80**: 451–56.
- Sahana G and Gurnani M. 2000. Performance of crossbred cattle and comparison of sire evaluation methods under organized farm condition. *Indian Journal of Animal Sciences* **70**(4): 409–14.
- Singh R R. 2009. 'Phenotypic characterization of Vrindavani a synthetic crossbred cattle strain.' MVSc Thesis, IVRI (Deemed University), Izatnagar, India.
- Singh A. 2014. 'Genetic evaluation of Karan Fries cattle using test milk yields by random regression models.' MVSc Thesis, NDRI (Deemed University), Karnal, India.
- Singh M K and Gurnani M. 2004. Performance evaluation of Karan Fries and Karan Swiss cattle under closed breeding system. *Asian Australasian Journal of Animal Sciences* **17**(1): 1–6.
- Singh R R, Dutt T, Kumar A, Tomar A K S and Singh M. 2011. On-farm characterization of Vrindavani cattle in India. *Indian Journal of Animal Sciences* **81**(3): 267–71.
- Thorat B N, Thombre B M and Bainwad D V. 2016. Effect of non-genetic factors and sire on lactation milk yield in Holdeo. *International Journal of Tropical Agriculture* **34**(5): 1215–25.
- Tripathy S S, Chakravarty A K, Mir M A, Singh A P, Jamuna V and Lathika S. 2017. Genetic and non-genetic parameters of first lactation milk yield, composition and energy traits in Karan Fries cattle. *Journal of Animal Research* **7**(1): 49–57.
- Vinothraj S, Subramaniyan A, Venkataramanan R, Joseph C and Sivaselvam S N. 2016. Genetic evaluation of reproduction performance of Jersey × Red Sindhi crossbred cows. *Veterinary World* **9**(9): 1012–17.
- Zewdu W, Thombre B M and Bainwad D V. 2013. Effect of non-genetic factors on milk production of Holstein Friesian × Deoni crossbred cows. *African Journal of Dairy Farming and Milk Production* **1**(4): 79–84.
- Zewdu W, Thombre B M and Bainwad D V. 2015. Studies on some non genetic factors affecting reproductive performance of Holstein Friesian × Deoni crossbred cows. *African Journal of Agricultural Research* **10**(12): 1508–16.