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

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Received: 17 August 2018; Accepted: 21 August 2018

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 (R²) was obtained for TD96. However, while predicting FLTMY, the highest R² 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 Hariana 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 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≤0.01) effect of season and period was observed on AFC. The calves born during summer season had significantly (P≤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 × 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 × 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 × 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 305 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 managemental conditions. The present findings were in agreement to the findings of Singh (2009) in Vrindavani cattle; Kokate (2009), Sharma

| Effect | N   | Mean±SE (kg) | Mean±SE (kg) | Mean±SE (kg) | Mean±SE (days) | Mean±SE (kg) |
|--------|-----|--------------|--------------|--------------|----------------|--------------|
| Season | 804 | 2825.86±26.04| 2976±39.12   | 335.29±2.73  | 8.20±0.10      |
| Rainy  | 144 | 2753.84±54.32| 2731.53±74.89| 332.94±5.76  | 8.10±0.15      |
| Winter | 286 | 2877.93±39.12| 3013.96±55.51| 338.70±3.76  | 8.17±0.10      |
| Period | 1080| 2883.40±35.91| 3004.72±49.39| 339.44±5.56  | 8.17±0.10      |
| 2012–14| 172 | 909.89±10.11  | 935.76±10.59 | 303.64±8.75  | 8.60±0.23      |
| 2009–11| 154 | 935.76±10.59  | 955.23±5.61  | 78.63±6.20   | 8.60±0.23      |
| 2006–08| 168 | 989.10±10.36  | 1012±9.32    | 85.82±0.17   | 8.60±0.23      |
| 2003–05| 183 | 997.73±9.85   | 1095.34±8.73 | 85.82±0.17   | 8.60±0.23      |
| 2009–02| 229 | 922.30±10.01  | 997.73±9.85  | 78.63±6.20   | 8.60±0.23      |
| 2015–17| 172 | 909.89±10.11  | 935.76±10.59 | 303.64±8.75  | 8.60±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 Phule Triveni 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 Phule Triveni 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≤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×Hariana. However, the non-significant effect of season of calving on FLTMY was reported by Nehra (2011) in Karan Fries and Ambhore et al. (2010) and Singh (2014) in Vrindavani cattle; Alex et al. (2013) and Singh (2014) in Karan Fries cattle. The effect of season of calving was highly significant on FLTMY. Ambhore et al. (2017) observed highly significant effect of period of calving on FLTMY in Phule Triveni 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≤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≤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≤0.01) of season on all the test day milk yields in Karan cattle.

**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 Mean±SE | TD36 Mean±SE | TD66 Mean±SE | TD96 Mean±SE | TD126 Mean±SE |
|-----------------|-------------|--------------|--------------|--------------|---------------|
| 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 |
| Season          |             |              |              |              |               |
| Rainy           | 164 7.55±0.25 | 165 9.90±0.26 | 166 9.99±0.24 | 166 9.97±0.23 | 163 9.69±0.23 |
| Winter          | 417 7.88±0.16 | 422 11.75±0.17 | 421 11.86±0.15 | 418 11.25±0.15 | 420 10.55±0.14 |
| Summer          | 325 8.36±0.18 | 321 11.65±0.19 | 317 10.79±0.17 | 318 9.95±0.17 | 325 9.11±0.16 |
| Period          |             |              |              |              |               |
| 2000–02         | 149 6.10±0.27 | 151 8.83±0.28 | 151 8.29±0.26 | 151 8.09±0.25 | 152 7.60±0.24 |
| 2003–05         | 213 7.40±0.24 | 211 10.46±0.25 | 207 9.87±0.23 | 206 9.23±0.23 | 213 8.56±0.21 |
| 2006–08         | 158 8.49±0.26 | 158 11.96±0.26 | 158 11.93±0.25 | 158 11.45±0.24 | 157 10.74±0.23 |
| 2009–11         | 166 7.96±0.25 | 167 12.09±0.26 | 167 12.37±0.24 | 167 11.73±0.23 | 167 11.27±0.22 |
| 2012–14         | 140 8.54±0.28 | 141 10.92±0.28 | 141 10.74±0.26 | 141 10.29±0.25 | 141 9.66±0.24 |
| 2015–17         | 80 9.10±0.36 | 80 12.35±0.37 | 80 12.10±0.35 | 79 11.54±0.34 | 78 10.88±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          | TD156 Mean±SE | TD186 Mean±SE | TD216 Mean±SE | TD246 Mean±SE | TD276 Mean±SE |
|-----------------|---------------|---------------|---------------|---------------|---------------|
| 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 |
| Season          |               |               |               |               |               |
| Rainy           | 163 9.64±0.22 | 163 9.02±0.21 | 159 8.92±0.22 | 157 7.92±0.20 | 144 7.35±0.21 |
| Winter          | 420 9.48±0.14 | 419 8.41±0.13 | 414 7.75±0.14 | 406 7.19±0.13 | 376 6.54±0.14 |
| Summer          | 325 8.67±0.16 | 325 8.58±0.15 | 323 8.60±0.15 | 309 8.60±0.15 | 280 8.62±0.15 |
| Period          |               |               |               |               |               |
| 2000–02         | 150 7.18±0.24 | 153 6.66±0.22 | 146 6.90±0.23 | 136 6.41±0.22 | 122 5.67±0.24 |
| 2003–05         | 214 8.26±0.21 | 213 7.59±0.20 | 213 7.19±0.20 | 208 6.84±0.19 | 186 6.66±0.20 |
| 2006–08         | 157 10.38±0.23 | 154 9.67±0.21 | 155 9.30±0.22 | 152 9.00±0.21 | 144 8.81±0.21 |
| 2009–11         | 167 10.58±0.22 | 167 9.83±0.21 | 166 9.50±0.21 | 160 8.84±0.20 | 152 8.58±0.21 |
| 2012–14         | 141 9.31±0.24 | 141 8.94±0.22 | 138 9.07±0.23 | 138 8.40±0.22 | 127 7.87±0.23 |
| 2015–17         | 79 9.87±0.32 | 79 9.33±0.30 | 78 8.57±0.31 | 78 7.94±0.29 | 69 7.41±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≤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 effect was close to FLL of 331.03±0.01 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 × 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≤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≤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≤0.01) on FLPY. The highest FLPY was observed during the winter season. Kumar et al. (2016) also reported highly significant (P≤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 × Deoni and Dhal et al. (2015) in Jersey crossbred.

The influence of season was highly significant (P≤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≤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), Kumhibare 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 × 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 h² 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 R² (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): 376–38.

Dutt T and Kumar S. 2000. Performance evaluation of FH, FBHI and FSH intercrosses. *Indian Journal of Animal Sciences* **70**(1): 80–81.

Gosu G, Singh H, Petersson K J and Lundehelm 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 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 Hubandry 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) | b1 | R²  |
|----------|------------------------|----|-----|
| TD6      | 2035.04±6.52           | 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   | 76.36 |
| MMY7     | 836.47±50.76           | 7.53±0.18   | 73.33 |
| 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.