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Original Research

Prediction of First Lactation 305-Day Milk Yield by Test Day Simple and Multiple Regression Models in Holstein Friesian Crossbred Cattle

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Abstract

*The present study was carried out for prediction of first lactation 305-day milk yield (FL305DMY) using monthly test-day milk yield records of 466 crossbred cattle calved from 2000 - 2018 maintained at Directorate of Livestock Farms, GADVASU, Ludhiana were utilized. The best single, two, three and four test day combinations were selected for prediction of FL305DMY based on adjusted R2 and RMSE values. The equation: Y = 827.38+ 49.58*36D+ 66.49*96D+ 112.51*186D was identified as best (R2=74.91%) for predicting the 305-day milk yield based on monthly test day milk (early test days were selected without compromising much on accuracy). It was concluded that the combination of 2nd, 4th and 7th monthly test days can aid in making culling decisions and used for early genetic evaluation of HF crossbred sires based on progeny performances.*

Keywords: Crossbred Cattle, FL305DMY, R2, RMSE, Test Day Milk Yield

Introduction

The use of test day milk yield (TDMY) depends on the relative amount of genetic variation during lactation. Recording of TDMY reduces the cost of milk recording by making fewer measurements. It results in longer intervals between milk recording and less frequent collection of milk samples. In TDMYs, records from individual test days are used to determine lactation production instead of aggregating records. TDMYs are more flexible in handling records from different recording schemes. TDMYs reduce the generation interval through frequent genetic evaluations with the latest data compared to 305-day complete lactation. TDMYs can predict total production more accurately by accounting for time-dependent environmental effects (Swalve, 2000).

The selection on the basis of 305-day lactation milk yield is less accurate and reliable rather it gives under and overestimation of certain factors. It can be replaced with TDMY where age and stage of lactation is accounted for and is adjusted for these factors (Bilal and Khan, 2009). The test day model appears to be a better alternate of 305-day lactation model because early selection on the basis of test-days could reduce generation interval. It could economize the genetic evaluation of dairy animals and improve accuracy of evaluation.

Accordingly, the present study was done to predict the FL305DMY by test day regression models in Holstein Friesian × Sahiwal cattle.

Materials and Methods

The data of crossbred cattle (Holstein Friesian x Sahiwal) pertaining to 4415 first lactation monthly test day milk yield records of 466 cows and their first lactation 305-day milk yield (FL305DMY) during 2000 - 2018 maintained at GADVASU Dairy Farm was used for analysis. Cattle with abnormal or conditions such as abortion or premature birth, still birth, sickness, culling or death before completion of lactation period were excluded from the study. For FL305DMY only those crossbred cattle were considered which produced milk for at least 100 days.

Statistical Analysis

The monthly test day milk yields were used to predict first lactation 305-day milk yield (FL305DMY) by using R^2 selection method using SAS 9.3 software package.

$$\acute{Y}_i = a + b_i \sum x_i$$

$\acute{Y}_i$ = Estimated first lactation 305-day or less milk yield of the ith animal
xi = Test Day records of ith animal
a = Intercept
b_i = Regression coefficient of first lactation 305-day or less milk yield on test- day records

The accuracy of fitting the regression models were calculated by using coefficient of determination and root mean squares error.

Results and Discussion

The overall least squares mean of FL305DMY in the present study was 3818.17±103.26kg. Singh and Gurnani (2004) reported average FL305DMY as 3173±82kg and 2616±82kg, respectively in Karan-Fries and Karan-Swiss CB cattle. The least squares mean of the TDMYs ranged from 15.65±0.42 kg (TD-2) to 10.28±0.50 kg (TD-11). The best single, two, three and four test day combinations were selected for prediction of FL305DMY based on adjusted R^2 and RMSE values (Tables 1, 2, 3, 4). The estimated intercept values, regression coefficients, adjusted R^2 and RMSE values for prediction of FL305DMY by best prediction equations (early test days were selected without compromising much on accuracy) are presented in Table 5.

For single test day prediction, TD5 (126th day) and TD6 (156th day) predicted FL305DMY with almost similar accuracy of 58.70% and 58.99%, respectively (Table 1). The accuracy of prediction (R^2) of FL305DMY ranged from 11.28% (TD 11) to 58.99% (TD 6). Similar finding has been observed by Kokate *et al.* (2014) who reported

that the prediction accuracy of 305-day milk yield based on individual bimonthly test day milk yields varied between 19% (BTDY-1) and 59% (BTDY-4) in Karan Fries cattle. Sah *et al.* (2013) reported that the lactation yield can be predicted by 185th day of lactation with 67% accuracy. Singh and Rana (2008) reported that the accuracy of prediction (R^2) of 305-day milk yield based on monthly test-day milk yields varied between 42 (TD1) and 67% (TD6) in Murrah buffaloes. However, Sharma *et al.* (2019) reported that prediction equations based on 125th, 155th and 185th day would be quite useful and reliable for FL305DMY with 66.8%, 70.4% and 75.1% accuracies, respectively in crossbred cattle.

Table 1: Predictability parameters of FL305DMY based on single test-day milk yield records

S. No.	Single parameter/ TD models	R^2 value (%)	RMSE (kg)
1.	156D (TD-6)	58.99	590.26
2.	**126D (TD-5)**	**58.7**	**592.37**
3.	96D (TD-4)	52.4	635.9
4.	186D (TD-7)	51.08	644.65
5.	216D (TD-8)	44.05	689.43
6.	96D (TD-4)	41.84	702.9
7.	246D (TD-9)	32.85	755.27
8.	36D (TD-2)	30.07	770.75
9.	276D (TD-10)	27.23	786.24
10.	6D (TD-1)	16.32	843.13
11.	300D (TD-11)	11.28	868.17

The accuracy of prediction (R^2) of FL305DMY using two test day combinations ranged from 67.59% (TD 4 & 6) to 71.25% (TD 6 & 9). It is evident from Table 2 that the regression equation with two important variables TD-4 (96th day) and TD-7 (186th day) explained about 70 % variability with RMSE value of 503.11 kg, which was considered best prediction for two TD combinations. However, Kokate *et al.* (2014) reported that the regression equation with 2 important variables BTDY-3 and BTDY-5 explained about 78 % variability in 305- day milk yield with 9.36 per cent error in prediction of 305-day milk yield.

Table 2: Predictability parameters of FL305DMY based on two test-days milk yield records

S. No.	Two parameter/ TD models	R^2 value (%)	RMSE (kg)
1.	156D (TD-6) + 246D (TD-9)	71.25	495.13
2.	96D (TD-4) + 216D (TD-8)	70.4	502.44
3.	**96D (TD-4) + 186D (TD-7)**	**70.32**	**503.11**
4.	96D (TD-4) + 246D (TD-9)	70.04	505.48
5.	126D (TD-5) + 276D (TD-10)	69.94	506.3
6.	66D (TD-3) + 186D (TD-7)	69.42	510.65
7.	126D (TD-5) + 216D (TD-8)	69.17	512.75
8.	36D (TD-2) + 186D (TD-7)	68.55	517.89
9.	66D (TD-3) + 216D (TD-8)	68.27	520.15
10.	126D (TD-5) + 186D (TD-7)	67.73	524.59
11.	96D (TD-4) + 156D (TD-6)	67.59	525.72

Prediction accuracy (R^2) of FL305DMY using three test day combinations ranged from 74.91% (TD 2, 4 & 7) to 76.25% (TD 4, 6 & 9) (Table 3). The best three test day combination with the parameters being TD-2, TD-4 and TD-7 considered as the best with the accuracy 74.91% and RMSE 463.46 kg. Similar findings has been reports by Sah *et al.* (2013) taking 125th, 155th and 185th day of lactation can predict the lactation yield with 77.6% accuracy in Kankrej cows. However, Sharma *et al.* (2019) reported that prediction equations based on three best test day combinations 125th, 155th and 185th day can predict FL305DMY with 82.30% accuracy in crossbred cattle. The differences may be attributed due to different data sets taken under different time frame and environmental conditions.

Table 3: Predictability parameters of FL305DMY based on three test-days milk yield records

S. No.	Three parameter/ TD models	R^2 value (%)	RMSE (kg)
1.	96D (TD-4) + 156D (TD-6) + 276D (TD-10)	76.25	450.86
2.	96D (TD-4) + 156D (TD-6) + 246D (TD-9)	76.06	452.68
3.	36D (TD-2) + 156D (TD-6) + 246D (TD-9)	75.89	454.27
4.	96D (TD-4) + 126D (TD-5) + 246D (TD-9)	75.68	456.27
5.	36D (TD-2) + 156D (TD-6) + 246D (TD-9)	75.57	457.33
6.	36D (TD-2) + 156D (TD-6) + 216D (TD-8)	75.49	458.08
7.	96D (TD-4) + 186D (TD-7) + 246D (TD-9)	75.37	459.18
8.	66D (TD-2) + 126D (TD-5) + 246D (TD-9)	75.27	460.14
9.	96D (TD-4) + 186D (TD-7) + 276D (TD-10)	75.26	460.23
10.	36D (TD-2) + 156D (TD-6) + 276D (TD-10)	75.17	461.02
11.	**36D (TD-2) + 96D (TD-4) + 186D (TD-7)**	**74.91**	**463.46**

If one more variable is added (Table 4) then the parameters are TD-2, TD-4, TD-6 and TD-8 with an increase in accuracy of almost 3.5% i.e., 78.54% with the RMSE being 429.38 kg. The accuracy of prediction (R^2) of FL305DMY ranged from 78.15% (TD 2, 5, 7 & 10) to 79.71% (TD 2, 4, 7 & 9). However, Dass and Sadana (1999) reported that four test day yields taken from 2nd, 4th, 6th and 8th month of lactation predicted first lactation 305-day lactation milk yield with 89% accuracy (R^2) in Murrah buffaloes.

Table 4: Predictability parameters of FL305DMY based on four test-days milk yield records

S. No.	Four parameter/ TD models	R^2 value (%)	RMSE (kg)
1.	36D (TD-2) + 96D (TD-4) + 186D (TD-7) + 246D (TD-9)	79.71	417.61
2.	36D (TD-2) + 96D (TD-4) + 156D (TD-6) + 246D (TD-9)	79.46	420.08
3.	36D (TD-2) + 126D (TD-5) + 156D (TD-6) + 246D (TD-9)	79.11	423.74
4.	36D (TD-2) + 126D (TD-5) + 186D (TD-7) + 246D (TD-9)	78.96	425.2
5.	36D (TD-2) + 96D (TD-4) + 186D (TD-7) + 276D (TD-10)	78.9	425.83
6.	36D (TD-2) + 96D (TD-4) + 156D (TD-6) + 276D (TD-10)	78.75	427.35
7.	66D (TD-3) + 96D (TD-4) + 186D (TD-7) + 246D (TD-9)	78.55	429.36
8.	**36D (TD-2) + 96D (TD-4) + 156D (TD-6) + 216D (TD-8)**	**78.54**	**429.38**
9.	36D (TD-2) + 126D (TD-5) + 156D (TD-6) + 276D (TD-10)	78.43	430.52
10.	66D (TD-3) + 96D (TD-4) + 186D (TD-7) + 276D (TD-10)	78.31	431.72
11.	36D (TD-2) + 126D (TD-5) + 186D (TD-7) + 276D (TD-10)	78.15	433.31

For addition of another variable (5 TD combination), we have to go for TD-9 (246th day of lactation) and accuracy increased by another 2.5% i.e., about 81% with the RMSE being 400.58 kg which will be too late and will have little significance. The regression equation with four variables was able to predict the FL305DMY with about 80% accuracy before 3 months of completion of 305 days and therefore this model with four variables was considered the most appropriate. Singh *et al.* (2013) found third, sixth and seventh test day record to be optimum for predicting 305 days milk yield in Surti buffaloes.

Table 5: Best prediction equations and their accuracy for estimation of first lactation 305-day milk yield

No. of Test Days	Best Prediction Equation	R^2 value (%)	RMSE (Kg)
1	Y=2021.08+146.37*126D	58.7	592.37
2	Y= 1265.99+97.13*96D+107.22*186D	70.32	503.11
3	Y = 827.38+ 49.58*36D+ 66.49*96D+ 112.51*186D	74.91	463.46
4	**Y** = 685.70 + 44.31*36D + 50.82*96D + 65.53*156D + 85.16*216D	78.54	429.38

Conclusion

The results of the present study show that FL305DMY can be predicted by 126th day of lactation with about 59% accuracy and by 186th day with 75% accuracy. The FL305DMY can be predicted with 78.5% accuracy by taking into account the 216th day of lactation. The combination of 36th, 96th and 186th day of lactation was adjusted as the

best combination as we can predict the FL305DMY by 6months of lactation with considerable accuracy. It was concluded that the equation Y = 827.38+ 49.58*36D+ 66.49*96D+ 112.51*186D can be used for early genetic evaluation of HF crossbred sires based on daughter's performances and creates an opportunity for efficient use of the allocated resources.

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Conflict of Interests

There is no conflict of interest.

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