



Testing of traditional ways of predicting lactation yield for selecting dairy cattle

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There are many conventional methods for predicting the first lactation milk yield in 305 days (FLMY) based on fortnightly part milk yield data in dairy cattle. The different methods used are based on data available over different years as implicated under farm and field conditions. These fortnightly test day milk yields could be utilized in the estimation of 305-day milk yield by ratio method and multiple regression methods. The Sahiwal cattle can be selected for higher FLMY utilizing fifth fortnightly day milk yield (FTDY-5), FTDY-6, FTDY-7, FTDY-8, FTDY-11, and FTDY-18 test day yields. Selection can be carried out for higher first lactation milk yield based on fortnightly test day milk yields in the case of Sahiwal and its crossbred cattle.

Keywords: Fortnightly milk yields, Part lactation milk yields, Prediction equations

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Cattle rearing is an important occupation in the rural economy and provides livelihood to the majority of small and marginal farmers. Over time, due to anthropogenic selection, large genetic diversity of cattle has emerged as evidenced by 53 breeds of cattle and many locally known groups of animals. The present study highlights the issue of testing of traditional ways of predicting lactation yield. The cattle owners, based on their traditional knowledge, use to select the best animals for sustained productivity by adopting methods based on acquired knowledge in many ways like highest milk in a day, part milk yields, may be milk yield on 6th day, 21st day, 43rd or at any other interval¹⁻⁷. The farmers do not follow much complicated mathematical approaches. They do not have detailed records of the milk yield but know the highest milk produced by a cow in any lactation. The higher milk producer cows could be selected using simply peak milk yield trait for explaining significantly large variation for first lactation milk yield. The present investigation was carried out to test scientifically these approaches of using different part milk yields in the prediction or evaluation of the total lactation yield. In the case of Sahiwal and crossbred cattle, the part test day milk

yields were utilized to estimate the 305-day first lactation yield (305-day FLMY) or first lactation milk yield (FLMY). The prediction of FLMY based on part yields and mathematically named as Ratio factors, regression method and stepwise regression method were applied to test the efficacy.

Materials and Methods

Data of 30 years period were utilized, available at the university dairy farm on 166 Sahiwal cattle which were spread over a period of 30 years, and on 799 crossbred cattle which were spread over forty years, for studying the part records generally used in the selection of dairy cows for higher FLMY. The different fortnightly test day milk yields have been used as the part yields under various methods. The first fortnightly milk yield has been shown as FTDY-1. The second fortnightly milk yield and fortnightly milk yields up to twenty-one fortnightly milk yields (FTDY-21) have been shown as FTDY-2, FTDY-3, FTDY-4, FTDY-5, FTDY-6 and so on. The simple multiple regression equations used were:

$$\hat{Y} = a + b_1X_1 + b_2X_2 + b_3X_3 + \dots + b_nX_n$$

Whereas, $X_1, X_2, X_3, \dots, X_n$ = lactation milk yields and Y = expected 305 day FLMY. The accuracy was accessed by the formula:

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$$R^2 (\%) = \frac{\text{Sum of squares due to regression}}{\text{Total sum of squares}} \times 100$$

The percentage of average error was calculated as: Percentage error = $\frac{E_i}{Y_i} \times 100$, Where, Y_i = Average 305- days milk yield, and E_i = Average error in prediction.

Results and Discussion

Prediction of FLMY from part milk yields

Fortnightly milk yields

The fortnightly milk yields were taken to predict 305-day FLMY/FLMY by ratio factors, regression method, and stepwise regression method in Sahiwal cows. The ratio factors of the fortnightly test day milk yields ranged between (222.57) and (686.4). The ratio factors showed a steadily increasing trend with the increase in successive test day yields except FTDY-1⁸. These ratio factors are used in estimating the milk yield. The regression coefficients of 305-day yield on

FTDY were highly significant. The precision of prediction (R^2) of 305-day FLMY on the basis of individual TDY ranged between 13.67 (FTDY-1) and 66.56 (FTDY-8). The higher value of R^2 was found in the middle part of lactation (FTDY-8 to FTDY-10) as presented in the Table 1. Using stepwise multiple regressions, the regression equation applying 8 variables (FTDY-2, FTDY-3, FTDY-6, FTDY-10, FTDY-11, FTDY-15, FTDY-18 and Peak yield) predicted the first lactation milk yield with 92.56% accuracy. The linear regression equation using variables- FTDY-2, FTDY-3, FTDY-6, FTDY-10 and FTDY-11, FTDY-18 and Peak yield predicted the first lactation yield up to the extent of 90%. By considering only 6 variables (FTDY-2, FTDY-3, FTDY-6, FTDY-10, FTDY-11 and Peak yield), the R^2 value was found as 89.57%. The different best prediction equations are detailed in the Table 2.

In the case of crossbred cattle too, the part yields were taken to predict 305-day FLMY by ratio factors, regression method and stepwise regression method. The ratio factors of the part test day milk yields ranged from 283.10 to 602.23. The ratio factors showed a steadily increasing trend with the increase in successive test day yields except first fortnightly test day milk yield. This ratio factor has been utilized to predict the FLMY. The regression coefficients of 305-day FLMY on part test day yield were found to be highly significant. The value of R^2 for estimating 305-day milk yield based on individual fortnightly test day milk yields ranged between 18.45 (FTDY-1) and 53.24 (FTDY-8) percent. The higher R^2 values were found in the middle part of lactation (FTDY-7 to FTDY-11) as presented in the Table 3. The regression equation having 8 variables predicted milk yield with 90% accuracy. The combination having 7 variables predicted the first lactation milk yield up to the extent of 89.29% accuracy level. The combination with 6 variables predicted the first lactation milk yield with 87.12% accuracy level. The three best equations for predicting the FLMY are detailed in Table 4.

The accuracy of estimation of FLMY based on part milk yield by ratio method was highest at 11th (68%)

Table 1 — Estimated intercepts (a), regression coefficients (b_i) and coefficients of determination (R^2) for prediction of 305-day FLMY using fortnightly part milk yields in Sahiwal cattle

Test day milk yield	Estimated intercepts (a)	Regression coefficients (b _i)	coefficients of determination (R^2)
FTDY-1	435.59	261.82	13.67
FTDY-2	-113.70	348.86	47.92
FTDY-3	-73.1265	252.83	51.72
FTDY-4	22.912	215.77	36.04
FTDY-5	61.18	212.57	35.02
FTDY-6	-724.84	290.26	39.72
FTDY-7	-919.69	326.45	58.95
FTDY-8	-1301.31	431.74	66.56
FTDY-9	-330	289.39	55.3
FTDY-10	-688.23	366.81	51.5
FTDY-11	514	163.09	47.7
FTDY-12	415.23	174.2	48.15
FTDY-13	516.42	192.1	50.30
FTDY-14	406.14	228.3	57.8
FTDY-15	402.12	249.40	61.82
FTDY-16	637.25	224.1	41.37
FTDY-17	365.85	355	47.28
FTDY-18	110.18	310.64	46.12
FTDY-19	458.55	405.22	35.85
FTDY-20	675.2	326.4	33.01
FTDY-21	868.5	327.8	23.52

Table 2 — Prediction equations for first lactation 305-day FLMY based on part milk yields (backward elimination method) in Sahiwal

Serial No.	Prediction Equation	R^2 value (%)
1	$\hat{Y} = 113.54 + 35.91X_0 + 31.98X_2 + 45.14X_3 + 31.47X_6 + 25.67X_{10} + 32.24X_{11} + 29.45X_{15} + 28.45X_{18}$	92.56%
2	$\hat{Y} = 158.54 + 38.91X_0 + 33.14X_2 + 46.87X_3 + 33.87X_6 + 28.74X_{10} + 33.41X_{11} + 28.45X_{18}$	90.12%
3	$\hat{Y} = 204 + 40.87X_0 + 46.78X_2 + 48.41X_3 + 37.47X_6 + 29.67X_{10} + 32.24X_{11}$	89.57%

Where, X_0 = Peak yield; X_2 = FTDY-2; X_3 = FTD-3; X_6 = FTDY-6; X_{10} = FTDY-10; X_{11} = FTDY-11; X_{15} = FTDY-15; X_{18} = FTDY-18; \hat{Y} = Predicted 305 -day FLMY.

Table 3 — Estimated intercepts (a), regression coefficients (b_i) and coefficients of determination (R²) for estimation of 305-day FLMY using fortnightly part milk yields in crossbreds

Test day milk yield	Estimated intercepts (a)	Regression coefficients (b _i)	coefficients of determination (R ²)
FTDY-1	1587.24	94.54	18.45
FTDY-2	1247.57	127.29	45.21
FTDY-3	1149.18	137.35	48.45
FTDY-4	1037.29	148.47	41.69
FTDY-5	1109.97	143.47	42.17
FTDY-6	1008.49	154.28	48.11
FTDY-7	1047.24	144.87	52.45
FTDY-8	887.56	169.24	47.14
FTDY-9	986.24	188.56	48.27
FTDY-10	1007.24	185.41	53.24
FTDY-11	986.24	171.24	49.25
FTDY-12	1124.68	162.3	46.21
FTDY-13	1034.41	159.4	47.78
FTDY-14	1241.98	145.6	40.21
FTDY-15	1259.21	139.8	46.87
FTDY-16	1347.24	128.7	44.57
FTDY-17	1459.54	129.54	44.2
FTDY-18	1549.57	154.62	42.15
FTDY-19	1623.12	143.67	39.45
FTDY-20	1724.21	124.59	34.47
FTDY-21	1889.54	112.14	25.45

Table 4 — Prediction equations for first lactation 305-day FLMY based on part milk yields using backward elimination method in crossbred cattle

Serial No.	Prediction Equations	R ² value (%)
1	$\hat{Y} = 357.89 + 38.45X_0 + 34.14X_2 + 48.49X_6 + 51.24X_8 + 51.67X_{10} + 56.37X_{13} + 49.56X_{15} + 57.59X_{21}$	90.42%
2	$\hat{Y} = 468.16 + 41.12X_0 + 36.51X_2 + 65.23X_6 + 54.67X_8 + 55.48X_{10} + 58.67X_{13} + 64.25X_{15}$	89.29
3	$\hat{Y} = 484.45 + 52.11X_0 + 59.67X_2 + 68.67X_6 + 65.24X_8 + 59.45X_{10} + 59.84X_{15}$	87.12

Where, X₀ = Peak yield; X₂ = FTDY-2; X₆ = FTDY-6; X₈ = FTDY-8; X₁₀ = FTDY-10; X₁₃ = FTDY-13; X₁₅ = FTDY-15; X₂₁ = FTDY-21; \hat{Y} = Predicted first lactation 305- day FLMY.

and 9th (71%) test day in Karan Fries and Karan Swiss cows, respectively & by regression method was highest at 12th (68%) and 13th (67%) test day in Karan Fries and Karan Swiss cattle, respectively⁷. The R² values were found to be between 55.35% and 93.07% in Haryana cattle by using monthly test day milk yield². The efficacy of estimating 305-day FLMY by taking individual bimonthly test day yield found between 19% (BTDY-1) and 59% (BTDY-4). Addition of one more variable BTDY-2 increased the predictability to 83% in Karan fries cattle³.

The accuracy of estimation, as evidenced by R² value, was maximum (90.28%) for MTDY-3 in all 10 linear regression equations by taking only one variable. By combining two variables (MTDY-2 with MTDY-5), the R² value was maximum (93.38%) in Haryana cattle⁹. The prediction equation having 3 variables, *i.e.*, first, second and seventh monthly test day milk yield could give adequate accuracy (78.42%) in estimating 300 days milk yield in Rathi cows¹⁰. The precision of estimation of 305-day FLMY

by taking individual test day yields ranged between 19% (MTDY-1) and 61% (MTDY-6) in Karan Fries cow¹¹. The coefficient of determination (R²) by using only one variable such as TD1 was 4.92% and 39.89% for TD8 using 10 prediction equations having only one variable and minimum value of R² was obtained for TD2 in Sahiwal cattle¹.

Conclusion

The Sahiwal cows can be selected for higher FLMY utilizing FTDY-5, FTDY-6, FTDY-7, FTDY-8, FTDY-11 and FTDY-18 test day yields. Selection can be carried out for higher FLMY based on fortnightly part milk yields in case of Sahiwal and crossbred cattle. The regression coefficients for FLMY milk yield were highly significant in both the genetic groups. The multiple regression equation by taking 6 variables (peak yield, FTDY-2, FTDY-6, FTDY-8, FTDY-10 and FTDY-15) in case of crossbreds; and peak yield, FTDY-2, FTDY-3, FTDY-6, FTDY-10, and FTDY-11 in Sahiwal cows

were found more accurate for estimation of 305- day FLMY. The part milk yields can be used for the selection of dairy cows for higher FLMY.

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Conflicts of Interest

There is no conflict of interest among the authors for this research publication.

Authors' Contributions

DGG has collected and analysed the data. DK conceptualized the study and helped in writing the manuscript. BNS and SK helped in editing the paper and data analysis.

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