



Prediction of first lactation 305-days lactation milk yield from peak yield and test day milk yields in crossbred cattle

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ABSTRACT

Lactation yield (LY) of dairy animals have high relationship with peak yield and test day milk yield. The present study was carried out for prediction of 305 days lactation yield based on peak yield and test day milk yield. Data on 384 first lactation test day milk yield records of crossbred cattle maintained at GADVASU dairy farm over a period of 25 years from 1991–2015 were utilized for the study. Test day milk records were taken at 30 days interval. The simple regression analysis using peak yield (PY) revealed that peak yield alone could predict the lactation yield with 47% accuracy. Prediction of LY based on TDY₁₂₅, TDY₁₅₅ and TDY₁₈₅ would be quite useful and reliable with 66.8%, 70.4% and 75.1% accuracy, respectively. The multiple regression equation indicated that R² values showed increasing trend when more number of test day milk yields were included in prediction. The best suggested equation was $LY = -121.674 + 80.58 PY + 5.477 TDY_{155} + 14.097 TDY_{185}$ with 86.3% accuracy. Prediction equations derived through step-wise regression for predicting the 305-days milk yield from monthly test-day milk yields showed that the average error and residual mean sum of squares continuously declined in prediction of 305-days milk yield with the increase in number of variables up to six, however there was no use of increasing the variables beyond five. It was concluded that the third, sixth and ninth test-day milk yield should be pooled for prediction of the 305-days milk yield with accuracy of 91.94% in crossbred cattle.

Key words: HF × Sahiwal, Peak yield, Prediction of milk yield, Test day

The main aim of animal breeder is to enhance genetic improvement in important economic traits. Low replacement rate, high generation interval, improper record keeping and cost of maintaining low productive animals are some of the constraints of the traditional breeding programmes due to which the genetic improvement of crossbred dairy animals is very slow in India. Animal breeders have realized the importance of record keeping as records are extensively used for the estimation of the breeding value and in other selection programmes. Proper recording of milk is one of the essential criteria for better management of herds, selection of animals with higher genetic potential and for culling of low producing animals.

The constraints associated with maintenance of complete records can be overcome by selection on the basis of test day milk records in the early part of lactation. Machado *et al.* (2000) observed that test day milk yield records in mid lactation have high genetic and phenotypic correlations with lactation yield. Prediction of the lactation yield can be done more precisely and accurately using peak yield and monthly test day traits. So, the present study was undertaken to identify the day which can be considered as most precise to estimate the lactation yield. The previous studies conducted in cattle and buffaloes (Garcha *et al.* 1992, Ptak and Schaffer 1993, Appannayar *et al.* 1995, Dass and Sadana 2003, Saini *et al.* 2005, Singh *et al.* 2008 and Sah *et al.* 2013) have revealed fairly large predictability by the use of test-day milk yields because of high association between test-day milk yields and 305-days milk production records. The information on the use of monthly test day milk yield records for prediction of standard lactation 305-days yield in crossbred cattle is scanty. Therefore, an attempt have been made to predict the 305-days milk yield in crossbred cattle using peak yield and monthly test day milk yield records.

MATERIALS AND METHODS

Data regarding first lactation peak yield and test day milk

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yield records of crossbred cattle maintained at GADVASU dairy farm over a period of 25 years from (1991–2015) were utilized for prediction of 305-days lactation yield from peak yield and test day milk yield in crossbred cattle. The data on test day milk yields at 30 days interval starting from fifth day of lactation were calculated from the records of first lactation. A total of 384 first lactation milk yield records (305 days/less) were collected for crossbred (HF × Sahiwal) cows sired by 81 bulls maintained at Directorate Livestock Farm, GADVASU, Ludhiana. The normal lactation was considered as the period of milk production by a cow for at least 200 days. Data were adjusted for significant non-genetic factors. Simple and multiple regression equation aimed at predicting the lactation yield on the basis of one or more test day yields as independent variables were considered as follows:

$$Y = a + \sum b_i X_i$$

where Y, 305 days lactation yield; a, intercept value; b_i , regression coefficient of 305 days lactation yield (Y) on various test days yield or peak yield (X_i) and X_i , independent variables (various test days yield or peak yield).

The coefficient of determination (R^2) was calculated on the basis of following formula:

$$R^2 = \frac{\text{Regression sum of squares}}{\text{Total sum of squares}} \times 100$$

Estimation of error in prediction was done.

RESULTS AND DISCUSSION

The peak yield milk yield and yields at different test days (TDY) were considered as independent variables for prediction of lactation yield. The constants, regression coefficients and coefficients of determination obtained are presented in Table 1. Peak yield alone could predict the lactation yield with 47% accuracy. Similar results have also been reported by Sah *et al.* (2013) in Kankrej cattle that peak yield can alone predict the lactation yield with 49% accuracy. Prediction equations developed for predicting first lactation 305-days milk yield on the basis of single test day yields revealed that the prediction based on TDY₁₂₅, TDY₁₅₅ and TDY₁₈₅ would be quite useful and reliable with 66.8%,

Table 1. Regression equations for prediction of lactation yield using simple regression analysis

X	a	b	R ² (%)
LY= PY	244.01	172.70	47.10
TDY ₅	2138.59	13.33	27.80
TDY ₃₅	1031.206	16.70	52.40
TDY ₆₅	935.92	18.19	61.20
TDY ₉₅	1100.466	18.32	64.30
TDY ₁₂₅	1113.198	19.65	66.80
TDY ₁₅₅	1101.567	21.67	70.40
TDY ₁₈₅	1082.31	22.77	75.15
TDY ₂₁₅	1236.629	22.03	72.32
TDY ₂₄₅	1384.914	21.44	68.33
TDY ₂₇₅	1510.493	20.83	64.00
TDY ₃₀₅	1948.915	17.70	51.60

70.4% and 75.1% accuracies, respectively. The results obtained were in agreement with the findings of Roy *et al.* (1994). They reported that milk yield up to 5th and 6th test day predicted lactation milk yield accurately in Holstein Friesian cattle. Singh *et al.* (2008) reported highest accuracy of prediction of 305-days milk yield for TDY₆ in Murrah buffaloes. The accuracies of predictions were comparable with those reported by Tahir *et al.* (1983) and Godara *et al.* (1991) in Nili Ravi and Murrah buffaloes. Similar results have also been reported by Sah *et al.* (2013) in Kankrej cattle. They also reported that the prediction of LY based on TDY₁₂₅, TDY₁₅₅ and TDY₁₈₅ would be quite useful and reliable with 66.7, 66.8 and 67% accuracies, respectively. However, Mandal and Mehla (1997) predicted LY on the basis of TD yield of third, fourth, fifth, sixth and seventh month of lactation with more than 64% accuracy. Masselin *et al.* (1991) reported that third monthly test day yield was most important to predict lactation milk yield.

The coefficients of determination (R^2) for different test day milk yields showed increasing (27.8 to 75.1) trend from TD₅ to TD₁₈₅ while R^2 decreased (72.3 to 51.6) from TD₂₁₅ to TD₃₀₅. Mandal and Mehla (1997) also reported similar trend of increase and decrease in accuracy of prediction of LY on the basis of monthly test day milk yields in Murrah buffaloes. Similar results have also been reported by Singh *et al.* (2008) that regression coefficients of 305-days milk yield on monthly test day milk yields showed an increasing trend up to TDY₄ in Murrah buffaloes. Dass and Sadana

Table 2. Regression equations for prediction of lactation yield using Multiple Regression Analysis (two trait combinations)

X	a	b ₁	b ₂	R ² (%)
PY+TDY ₅	229.74	142.04	5.80	50.80
PY+TDY ₃₅	301.62	83.38	11.0	57.20
PY+TDY ₆₅	410.98	57.77	14.18	63.40
PY+TDY ₉₅	435.47	62.85	14.35	67.50
PY+TDY ₁₂₅	145.20	80.14	15.18	73.50
PY+TDY ₁₅₅	46.009	83.02	17.07	78.29
PY+TDY ₁₈₅	-149.04	90.29	18.33	85.20
TDY ₅ +TDY ₃₅	943.65	3.949	14.573	53.89
TDY ₅ +TDY ₆₅	811.22	3.87	16.272	62.80
TDY ₅ +TDY ₉₅	849.47	5.226	16.168	67.90
TDY ₅ +TDY ₁₂₅	823.40	5.533	17.388	70.70
LY= TDY ₅ +TDY ₁₅₅	732.46	6.240	19.258	75.60
TDY ₅ +TDY ₁₈₅	714.57	6.049	20.42	80.00
TDY ₃₅ +TDY ₆₅	689.55	6.68	12.92	64.42
TDY ₃₅ +TDY ₉₅	728.49	6.92	13.35	68.59
TDY ₃₅ +TDY ₁₂₅	513.605	8.38	14.383	75.23
TDY ₃₅ +TDY ₁₅₅	394.38	8.78	16.33	80.68
TDY ₃₅ +TDY ₁₈₅	338.90	8.71	17.65	85.62
TDY ₆₅ +TDY ₉₅	795.363	8.770	11.21	68.87
TDY ₆₅ +TDY ₁₂₅	663.48	9.20	12.67	74.06
TDY ₅ +TDY ₁₅₅	526.41	9.493	14.78	80.01
TDY ₆₅ +TDY ₁₈₅	416.08	9.59	16.31	86.15
TDY ₉₅ +TDY ₁₂₅	887.94	9.089	11.70	71.70
TDY ₉₅ +TDY ₁₅₅	756.82	9.105	14.01	77.55
TDY ₉₅ +TDY ₁₈₅	637.21	9.143	15.68	83.91
TDY ₁₂₅ +TDY ₁₅₅	877.18	9.455	13.32	75.45

Table 3. Regression equations for prediction of lactation yield using multiple regression analysis (three trait combinations)

	X	a	b ₁	b ₂	b ₃	R ²
LY=	PY+TDY ₅ +TDY ₃₅	288.47	77.59	2.87	9.84	57.90
	PY+TDY ₃₅ +TDY ₆₅	406.791	36.72	5.30	11.47	65.10
	PY+TDY ₆₅ +TDY ₉₅	463.22	37.69	6.85	10.38	69.70
	PY+TDY ₉₅ +TDY ₁₂₅	239.08	61.52	5.28	11.59	74.70
	PY+TDY ₁₂₅ +TDY ₁₅₅	61.93	69.44	6.601	11.994	80.30
	PY+TDY ₁₅₅ +TDY ₁₈₅	-121.674	80.58	5.477	14.097	86.30
	TD ₅ +TDY ₃₅ +TDY ₆₅	648.28	2.36	5.737	12.50	64.90
	TD ₃₅ +TDY ₆₅ +TDY ₉₅	641.02	4.58	6.131	10.06	70.20
	TD ₆₅ +TDY ₉₅ +TDY ₁₂₅	657.24	7.23	4.13	10.54	74.60
	TD ₉₅ +TDY ₁₂₅ +TDY ₁₅₅	729.60	7.02	4.46	11.82	78.20
	TD ₁₂₅ +TDY ₁₅₅ +TDY ₁₈₅	731.31	7.80	3.85	13.13	82.30

Table 4. Step-wise regression equations for prediction of 305-days milk yield on the basis of monthly milk yield

Step	Variable	a	b	Average error	Residual mean square	R ²
1.	TDY ₃	308.79	11.88	323.57	104701.3	89.05
	TDY ₉		15.37			
2.	TDY ₃	250.36	9.14	277.61	77068.82	91.94
	TDY ₉		12.05			
	TDY ₆		6.966			
3.	TDY ₃	90.69	5.58	247.748	61379.08	93.50
	TDY ₉		11.76			
	TDY ₆		6.86			
	TDY ₂		4.75			
4.	TDY ₃	73.68	5.39	245.49	60267.4	93.70
	TDY ₉		11.65			
	TDY ₆		6.91			
	TDY ₂		4.30			
	TDY ₁		1.148			
5.	TDY ₃	53.40	5.31	222.36	49444.63	94.83
	TDY ₉		8.16			
	TDY ₆		4.76			
	TDY ₂		4.28			
	TDY ₁		1.25			
	TDY ₈		5.88			
6.	TDY ₃	55.89	5.23	218.03	47539.23	95.03
	TDY ₉		7.72			
	TDY ₆		3.59			
	TDY ₂		4.20			
	TDY ₁		1.23			
	TDY ₈		4.73			
	TDY ₇		2.95			

(1999) also used monthly test day milk yields for prediction of LY by simple regression method in Murrah buffaloes and observed increasing trend in the accuracy of prediction of LY from monthly test milk yields up to fourth month. They found that the increase in the accuracy was negligible thereafter up to seventh month of TDY. Appannayar *et al.* (1995) reported that R² value of prediction based on first 3 to 6 sequential test day milk yields, taken at last day of each calendar month in Surti buffaloes, varied between 64.4 and 85.5%. Further, they also reported an increasing trend of R² when more number of test day observations were included in prediction equation. Joshi *et al.* (1996) also observed R² value ranging from 55.35 to 93.07% when one to seven test day records were considered in Harijana cattle.

Sah *et al.* (2013) in Kankrej cattle also reported similar increasing trend of R² when more number of test day observations were included in prediction equation.

Multiple regression analysis was carried out using different two trait combinations as presented in Table 2. The R² value ranged from 50.80 (PY+TDY₅) to 85.20% (PY+TDY₁₈₅) for combination of peak yield and test day. On considering test days, R² value for different test days using two trait combinations ranged from 53.89 (TDY₅+TDY₃₅) to 86.15% (TDY₆₅+TDY₁₈₅) in the present study.

It is evident from the Table 3 that the best suggested prediction equation based on peak yield and test day yield records using three traits combination is: LY = -121.674 +

80.58 PY + 5.477 TDY₁₅₅ + 14.097 TDY₁₈₅ with 86.3% accuracy. Sah *et al.* (2013) found best suggested equation with 78% accuracy as: LY = -118.62 + 81.12 PY + 85.20 TDY₁₅₅ + TDY₁₈₅. However, in the present study, little early prediction of LY with 80.3% accuracy can also be made using the following equation: LY = 61.93 + 69.44 PY + 6.601 TDY₁₂₅ + 11.994 TDY₁₅₅. Sah *et al.* (2013) reported similar findings for early prediction of LY with 75.8% accuracy in Kankrej cattle. Dass and Sadana (1999) also indicated that for the early prediction of lactation yield, fifth month test day (125th day) yield would be ideal.

Predicting 305-days milk yield using step-wise regression procedure: Prediction equations derived through step-wise regression for predicting the 305-days milk yield from monthly test-day milk yields are presented in Table 4. It is evident that the regression equation with two important variables TDY₃ and TDY₉ explained about 89.05% of the variability in 305-days first lactation milk yield. Addition of one more variable TDY₆ increased the predictability to 91.94% i.e. an increase of 2.89%. Thereafter minor improvement (1%) in R² was noticed by successively adding TDY₂, TDY₁, TDY₈ and TDY₇. Hence, the regression equation with three variables TDY₃, TDY₉ and TDY₆ was considered most appropriate for prediction of 305-days first lactation milk yield with 91.94% accuracy. The average absolute error and residual mean sum of squares also showed continuously declining trend in prediction of 305-days milk yield with the increase in number of variables. However, there was no use of increasing the variables beyond three due to minor improvement in R². It was concluded that the milk yield in 3rd and 9th month should be pooled for prediction of the 305-days milk yield with accuracy of 91.94% in crossbred cattle. The estimates of accuracy of predictions were comparable with those reported by Appannayar *et al.* (1995), Dass (1995), Dass and Sadana (2003) and Saini *et al.* (2005).

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