PREDICTION OF FIRST LACTATION 305 DAY MILK YIELD
FROM MONTHLY TEST DAY MILK YIELD USING
MULTIPLE LINEAR REGRESSION MODEL IN JAFFARABADI BUFFALOES

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ABSTRACT

The records first lactation monthly test day milk yields of 213 Jaffarabadi buffaloes spread over a period of 24 years (1991 to 2014) maintained at Cattle Breeding Farm, Junagadh Agricultural University, Junagadh were used to predict first lactation 305 day or less milk yield using multiple linear regression model with backward elimination procedure. The data were collected at 30 days interval from 4th day till 304th day post calving. The accuracy of prediction model was calculated by estimating R^2-value. Analysis carried out revealed that when all the monthly test day records (1 to 11) were incorporated in an equation to predict first lactation 305 day or less milk yield, the accuracy (R^2-value) was maximum with 97.06%. However, early best prediction of 305 days milk yield based on monthly test day milk yields was found up to 6th monthly test day milk record. The optimum equation had total four variables *viz.* 2nd, 4th, 5th and 6th monthly test day milk yield records, which gave an accuracy of prediction of 78.28%. Therefore, it is concluded that first lactation 305 days smilk yield could be predicted as early as 6th month of lactation with higher degree of accuracy.

INTRODUCTION

Being the treasure-house of domestic livestock, India owns world's best buffalo germplasm with the population of about 108.7 million, which is around 57.3% of total world buffalo population[1]. However, a vast majority of buffaloes are low milk producers. Utilization of this large germplasm for its genetic improvement and better economic return with the help of modern scientific tools would be a great importance. Early prediction of expected lactation milk yield can be time saving and cut down the expenditure cost incurred by different breeding plans. This helps dairy farmer in decision making as to whether to retain the low producers in the herd or cull the low or non-productive animals at an earliest possible age. This type of recording and analysis

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is very useful especially in field progeny testing programme.

Genetic evaluation of dairy animals on the basis of 305 days lactation milk yield as a standard lactation yield is commonly adapted. However, the main constraint is daily milk recording under field condition is neither economically nor physically feasible as large number of buffaloes are required to be recorded. It is, therefore, important to explore the possibility of designing an appropriate test-day recording system applicable under prevailing field conditions in India without sacrificing the reliability of results. By using the test day milk yield parameter, there is no need to extend the lactation period for those animals which are not reaching 305 lactation days due to abnormal influences. The accuracy of prediction depends on the regression coefficients and on the quantity of the available information during the lactation or milk yield records. In addition, dairy animal evaluation using test day milk yield has significant advantages over 305 days milk yield because of high correlation between lactation yield and test day milk yields[2].

The information on the use of test day milk yield records for prediction of standard 305 days milk yield in Jaffarabadi buffalo is lacking. Hence, present investigation was planned to study the inter-relationship between monthly test day milk yields with that of first standard lactation yield to develop suitable prediction equation for early prediction of first lactation 305 days milk yield (FL305DMY).

MATERIALS AND METHODS

Source of data

For the present study, data on first lactation milk records of 213 Jaffarabadi buffaloes spread over a period of 24 years (1991 to 2014) were collected from the history-cum-pedigree registers of Jaffarabadi buffaloes maintained at Cattle Breeding Farm, Junagadh Agricultural University, Junagadh located in the South Saurashtra region.

Prediction of FL305DMY using multiple linear regression method

The first lactation 305 days milk yield was attempted to be predicted on the basis of monthly test day milk yields by fitting multiple linear regression (MLR) models using backward elimination procedure as described by Draper and Smith (1998). This procedure first develops a multiple linear regression equation incorporating all the independent variables and test their significance of contribution to total variability in dependent variable by partial 't' test. The independent variable not contributing significantly having lowest partial 't' value is removed and again a fresh linear regression equation is reconstituted incorporating rest of the independent variables. This procedure continues till the best combination of independent traits is obtained, all of which significantly contribute to the variability in dependent variable.

First lactation monthly test day milk yields were incorporated in the model as independent variables to predict the first lactation 305 days milk yield in Jaffarabadi buffalo. For the sake of arriving at précised conclusion, the lactation length was partitioned into 10 strata/groups using 30 days interval i.e. first to eleventh test-day starting from 4th day after calving (4th, 34th, 64th, … , 294th and 304th). The milk yield (morning and evening) of a single day was considered as test day milk yield. The different combinations of all these test day yields were utilized to predict the lactation yield to find the optimum equation with all possible

combinations of independent variables using following model:

$$\hat{Y} = a + b_i \Sigma X_i$$

Where; $\hat{Y}_i$ = Estimated first lactation 305 day or less milk yield of the ith animal

X_i = Monthly test day record of ith animal

a = Intercept

b_i = Regression coefficient of first lactation 305 day or less milk yield on i^{th} test day records

The accuracy of regression in the prediction model was obtained by estimating percent coefficient of determination (R^2). It was calculated by using the following formula.

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

Estimation of error in prediction

The absolute error in prediction was estimated as a square root of squared deviations of estimated milk yields from actual milk yield:

$$E_i = \sqrt{(Y_i - \hat{Y}_i)^2}$$

Where; E_i = Error in prediction

$\hat{Y}_i$ = Estimated first lactation 305 day or less milk yield of the ith animal

Y_i = Actual first lactation 305 day or less milk yield of the ith animal

Percentage of average error

$$\text{Percentage Error} = \frac{\bar{E}}{\bar{Y}} \times 100$$

Where; $\bar{Y}$ = Average first lactation 305 day or less milk yield

$\bar{E}$ = Average error in prediction and estimated as:

$$\bar{E} = \frac{\sum_{i=1}^{N} E_i}{\sum_{i=1}^{N} Y_i}$$

; N = number of observations

RESULTS

A linear regression model was fitted by incorporating all 11 monthly test day milk yield (MTDMY) records with different combinations to predict the standard lactation yield (FL305DMY) as early as possible. The results are presented in the following Table 1.

DISCUSSION

Analysis carried out revealed that when all of the 11 monthly test day records (1 to 11) were incorporated in an equation to predict FL305DMY, the accuracy (R^2-value) was highest with 97.06%. The reported estimate was in agreement with the estimates reported by Garcha and Dev (1994), Appannayar *et al.* (1995); Tailor and Singh (2014); Galsar (2015). On contrary, low R^2-value were reported by Chakraborti *et al.* (2010); Singh and Tailor (2013); Sangwan *et al.* (2015). In the present equation, all the test day records were found to be highly significantly correlated (P<0.01) with FL305DMY (Table 1). Thus, it could be indicated that FL305DMY was highly dependent on all the test day records incorporated in the equation, which might be the reason of the higher accuracy of the prediction. However, the contents of Table 1 further revealed that when backward elimination method was applied to the regression equation to predict the FL305DMY as early as possible with higher accuracy (R^2-value), the trend of gradual

Table 1. Prediction equation for different test day combinations. (TD = test day).

Sr. No.	Prediction equations	R² (%)	Error (litre)	Percent error
1	$\hat{Y} = 28.53+(9.78)TD1+(29.69)TD2+(31.07)TD3+(43.53)TD4+(16.14)TD5+(24.51)$ TD6+(38.64)TD7+(26.09)TD8+(34.56)TD9+(23.27)TD10+(23.03)TD11	97.06	89.92	6.15%
2	$\hat{Y} = 34.80+(10.27)TD1+(27.73)TD2+(33.97)TD3+(39.94)TD4+(15.81)$ TD5+(24.49)TD6+(38.50)TD7+(27.40)TD8+(38.39)TD9+(39.88)TD10	96.69	95.41	6.52%
3	$\hat{Y} = 68.01+(9.50)TD1+(28.08)TD2+(27.33)TD3+(39.19)TD4+(14.99)TD5+(27.45)$ TD6+(40.80)TD7+(27.84)TD8+(67.03)TD9	95.19	115.03	7.86%
4	$\hat{Y} = 89.05+(12.13)TD1+(27.33)TD2+(16.11)TD3+(44.91)TD4+(16.54)$ TD5+(25.24)TD6+(54.47)TD7+(70.17)TD8	91.16	155.95	10.66%
5	$\hat{Y} = 129.16+(15.93)TD1+(29.50)TD2+(-2.44)TD3+(55.68)TD4+(19.66)$ TD5+(27.72)TD6+(107.85)TD7	86.99	189.27	12.94%
6	$\hat{Y} = 226.47+(4.37)TD1+(30.23)TD2+(-8.46)TD3+(41.29)TD4+(50.47)$ TD5+(105.58)TD6	78.34	244.20	16.69%
7	$\hat{Y} = 227.51+(31.82)TD2+(-7.43)TD3+(40.86)TD4+(50.80)TD5+(105.08)TD6$	78.31	244.32	16.70%
8	$\hat{Y} = 219.69+(29.48)TD2+(37.52)TD4+(50.20)TD5+(105.18)TD6$	78.28	244.52	16.71%

decline in accuracy of the prediction was found after each step of the eliminations.

Using the backward elimination method of MLR the final equation was formulated with only first 6 monthly test day records with R^2-value of 78.33% having sufficient higher accuracy to predict the FL305DMY. Further elimination steps for formulation of new equations reported drastically declined R^2-value below 70%, which was not suitable for prediction due to higher estimates of error component i.e. more erroneous for prediction. Therefore, if one had decided to work with more than 75% accuracy use of first six monthly test day records would be the ideal approach.

However, in the final equation, non-significant effect of 1st and 3rd MTDMY records was observed on FL305DMY, which might lead to erroneous estimation of predicted values. Hence, these variables were dropped step by step by checking the effect of removal of these test day records from the equations for better predictability. First removal of 1st TDMY record was carried out due to its smallest partial 't' value, thereafter 3rd TDMY record was dropped from the equation. This lead to a trifling reduction in R^2-value with 78.31 and 78.28%, respectively. So, it could be indicated that these variables have little effect in the prediction of FL305DMY. Subsequent formulation of different equations by stepwise backward elimination of MTDMY records finally derived an optimum equation using 4 test day records (2nd, 4th, 5th and 6th MTDMY) that inferred an accuracy of prediction as 78.28%. The reported estimate of R^2-value was in close agreement with the estimates reported by Appannayar et al. (1995); Rana (2008) reported 67.4 to 85.5 and 76% R^2-value having first 6 monthly test day records in Surti and Murrah buffalo, respectively.

CONCLUSION

From the present investigation, it could be inferred that the prediction of FL305DMY in Jaffarabadi buffaloes, using four test-day records i.e. 2nd, 4th, 5th and 6th MTDMY with more than 75% accuracy (R2>75%) would be worth as well as test day milk yields from all the three phases of lactation curve (ascending, persistent and descending) were more important for prediction of FL305DMY with higher accuracy.

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