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Development of standard lactation milk yield prediction models using monthly milk yield records in Marathwadi buffalo

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Maharashtra state of India is rich in livestock diversity with three well recognized buffalo breeds. Marathwadi buffalo breed represents the very ancient indigenous type characterized with larger built and long flat horns. These buffaloes has breeding tract in Marathwada region of Central India especially in Parbhani, Nanded, Beed, Hingoli, Jalna and Latur districts. Average lactation milk yield is 1,118 kg and average milk fat is 8.8% ranging from 6.25–10.50%. The average total milk yield across different lactations of this breed is 1118.4 litres (Kataria *et al.* 2012) with average fat percent of around 8.8 ranging from 6.25–10.50%. Prediction of milk yield in early stage of lactation is important for better nutritional management and framing breeding plan. Earlier study in cattle and buffalo revealed high association between test day milk yields and standard lactation milk yield (Chakraborty *et al.* 2010). Therefore, the present investigation was carried out to develop different models for prediction of lactation milk yield in Marathwadi buffalo breed by using monthly milk yield records.

The data was collected from the history sheets and daily milk record registers of Marathwadi buffalo maintained at Cattle Breeding Farm, College of Veterinary and Animal Sciences, Udgir spread over a period of 9 years (2008–2016). The farm is located in semi-arid tropical region which lies on 17º35' N latitude and 72º40' E longitude in deccan platue zone. The temperature ranges between 12– 45ºC. The annual rainfall is about 500 to 1,100 mm; out of which most of the rainfall is received during the months of July and August. The records of the animals with normal lactation were considered for this study. Culling, disposal in middle of lactation, abortion, stillbirth and other pathological conditions which affected the lactation yield were considered as abnormalities and hence such records were excluded from analysis.

Multiple regression method was used for deriving a prediction model as follows:

$$\hat{Y}_i = a + b_i \sum X_i$$

where, $\hat{Y}_i$, estimated first lactation 305 day or less milk yield of the i^{th} animal; X_i, monthly milk yield record of i^{th} animal; a, intercept; b_i, regression coefficient of first lactation 305 day or less milk yield on monthly milk yield day records.

The per cent coefficient of determination (R^2) or the accuracy of fitting the regression model was calculated by using the following formula

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

The error in prediction was estimated as a square of the deviation of estimated milk yields from actual milk yield:

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

where, E_i, error in prediction; $\hat{Y}_i$, estimated first lactation 305 day or less milk yield of the i^{th} animal; Y_i, actual first lactation 305 day or less milk yield of the i^{th} animal.

$$\text{Percentage error} = \left[\frac{\bar{Y}}{\bar{E}}\right] X100$$

where, Y, average first lactation 305 day or less milk yield; E, average error in prediction and estimated as:

$$E = \frac{\left(\sum_{i=1} \bar{E}\right)}{N}$$

N, number of observations.

The descriptive statistics revealed that monthly milk yield of Marathwadi buffalo was highest (129.66±3.75 kg) in 2nd month while least milk yield was observed in 11th month (22.71±5.31 kg).

The monthly milk yields were used to predict standard lactation milk yield by stepwise backward multiple linear regression analysis. The estimated intercept values, regression coefficients and coefficient of determination (R^2) for prediction of standard lactation milk yield using monthly

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test day milk yields by simple linear regression. In prediction of standard lactation milk yield from monthly milk yields using multiple linear regression analysis, the intercepts showed a consistently increasing trend from MMY 6 up to MMY 11. However, no consistent trend in the intercepts was noticed in earlier milk yield records (Table 1). However, regression coefficient does not follow a consistent trend for all monthly milk yield records.

The coefficient of determination or accuracy of prediction of standard lactation milk yield ranged from 14.00 (MMY-1) to 74.29 (MMY-8). However, slightly higher estimates of accuracy of prediction in the middle portion of lactation in bimonthly test day milk yields were observed. Similarly, Kokate *et al.* (2014) also reported the accuracy of prediction in the middle of lactation to be higher in Karan Fries cattle for bimonthly test day milk yields. The highest correlation was observed amongst eighth monthly milk yield with standard lactation milk yield. However, amongst monthly milk yields, second and fourth monthly milk yields had highest correlation (Table 2).

Table 1. Estimated intercepts (a), regression coefficients (b_i) and coefficients of determination (R^2) for prediction of standard lactation milk yield using monthly milk yield in Marathwadi buffalo

Monthly milk yield	a	b_i	R^2 value	SE
MMY-1	922.04	–0.18	14.00	1.121
MMY-2	–32.49	7.27	38.47	1.218
MMY–3	267.68	5.05	27.38	1.090
MMY-4	123.77	6.69	54.42	0.811
MMY-5	257.20	6.12	58.50	0.682
MMY-6	249.03	6.79	68.66	0.608
MMY-7	371.00	6.37	69.86	0.553
MMY-8	553.10	5.80	74.29	0.452
MMY-9	637.93	6.17	68.24	0.557
MMY-10	730.13	6.13	54.19	0.746
MMY-11	791.77	5.31	40.01	0.861

Table 2. Correlation amongst selected monthly milk yields and standard lactation milk yield used as prediction model

	TMY	MY1	MY2	MY4	MY8
TMY	1.000	-.021	.620	.738	.862
MY1	-.021	1.000	.174	-.059	-.169
MY2	.620	.174	1.000	.637	.431
MY4	.738	-.059	.637	1.000	.610
MY8	.862	-.169	.431	.610	1.000

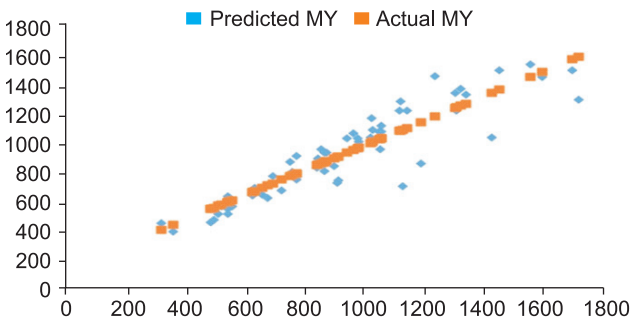

Fig. 1. Regression amongst predicted and actual milk yield.

The accuracy of prediction increased with addition of monthly milk yields till 4th model, thereafter no significant increase in accuracy of prediction was observed. Therefore, the best prediction model with four monthly milk yield records viz. 1st, 2nd, 4th and 8th monthly milk yields which gives highest accuracy of prediction with lesser prediction error could be the best model for prediction of standard lactation milk yield of Marathwadi buffalo (Table 3).

SUMMARY

A study was carried out on 538 monthly milk yield records of Marathwadi buffalo breed of Cattle Breeding Farm, College of Veterinary and Animal Sciences, Udgiri, Dist- Latur, Maharashtra spread over a period of nine years. The monthly milk yield was recorded at 6th, 36th, 66th and so on till standard lactation with thirty days interval. Multiple linear regression analysis was performed for prediction of standard lactation milk yield from monthly milk yields which revealed that the intercepts showed a consistently increasing trend from sixth monthly milk yield up to 11th monthly milk yield. However, no consistent trends in the intercepts was noticed in earlier milk yield records. The accuracy of prediction of standard lactation milk yield with regression analysis ranged from 14.00 (1st monthly milk yield) to 74.29 (9th monthly milk yield). The highest association was observed amongst 8th monthly milk yield with standard lactation milk yield. The best prediction model with four monthly milk yield records viz. 1st, 2nd, 4th and 8th monthly milk yields gave 84.30% accuracy of prediction with 1.39% prediction error and was considered as the best

Table 3. Best prediction models and their accuracy for estimation of standard lactation milk yield under various monthly milk yield records with best combination record by stepwise backward regression method in Marathwadi buffalo

Model No.	Monthly milk yield record	Model developed	Accuracy of prediction (%)	Error in prediction (%)
1	2	$143.76 + 3.58X_2 + 4.91\ X_8$	81.87	1.46
2	3	$101.253 + 2.425X_2 + 1.948X_4 + 4.318X_8$	83.80	1.40
3	4	$84.978 + 0.608X_1 + 2.105X_2 + 2.041X_4 + 4.442X_8$	84.30	1.39
4	5	$74.052 + 0.593X_1 + 2.123X_2 + 1.839X_4 + 0.782X_7 + 3.904X_8$	84.40	1.39

prediction model for standard lactation milk yield of Marathwadi buffalo.

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