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RESEARCH ARTICLE

Prediction of Standard lactation Milk Yield from Completed Lactations of Longer Duration in Cattle and Buffaloes

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ABSTRACT

The aim of this study was to develop a procedure to adjust lactations of longer duration to a standard such as 305-days when standard lactation milk yield for such lactations could not be recorded. For Sahiwal cattle and Nili-Ravi buffaloes, information on completed lactations for duration of more than 305-days was used for 3054 and 3927 lactations, respectively. Final regression equations to predict standard lactation milk yield (305-day milk yield) (SLMY) from completed lactation milk yield (CLMY) and lactation length (LL) were obtained using multiple regression analysis.

Species	Regression equations	R^2 (%)	VIF
Sahiwal Cattle	Predicted SLMY = 1239 + 0.967 (CLMY) - 3.80(LL)	96.5	0.035
Nili-Ravi Buffaloes	Predicted SLMY = 1604 + 0.925 (CLMY) - 4.75 (LL)	96.1	0.039

Thus, standard lactation milk yield can be fairly adequately predicted from total milk yield of longer lactations and lactation length using linear regression technique both in Sahiwal cattle and Nili-Ravi buffaloes with reasonable accuracy.

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INTRODUCTION

Utilization of all available records helps reduce bias in evaluating dairy animals. Performance of Cows and buffaloes are recorded on Government farms for routine audit and administrative purposes. The generated reports are used to monitor the progress of the personnel involved and allocate feed and other resources. In recent years, these records have however, been used for evaluation of animals in the assessment of productivity and selection of future parents and therefore new formats and procedures are needed for changing requirements (Khan, 2000).

For milk yield, any cow may have complete and incomplete records. The terms complete and incomplete are also subjective unless a standard/reference point is considered. For dairy cattle, a standard lactation is considered on the basis of 10-month (305-days). However, animals may get dry before this deadline or may continue to produce milk beyond this point. While shorter lactations may be due to multiple reasons (Khan and Chaudhry, 2001), longer lactations are not uncommon especially in buffaloes. Tendency to calve during a particular season requires that reproductive and feeding management be up to mark for the next pregnancy. This requires that animals should be bred within 2-3 months after their calving otherwise chances of their getting pregnant diminish rapidly (Khan *et al*., 2009), resulting in longer lactations. Farmers keep milking buffaloes because a low producing non-pregnant animal is likely to be more economical than a dry animal especially when culling is not an option.

For recording purpose, longer lactations should have both standard lactation milk yield (SLMY) and complete lactation milk yield (CLMY) when lactations are longer than the standard lactation. Practically, total lactation milk yield records are invariably available at the Government farms while SLMY are missing. Deletion of lactations of longer duration will result into a huge data loss while assuming their length to be a standard length is erroneous as it will mean selection for higher lactation length (LL). Regressing these lactations to a standard lactation by assuming a linear relationship is also wrong because of curvilinear association between the two traits both in Sahiwal cattle and Nili-Ravi buffaloes (Khan, 1997; Anwar *et al*., 2009).

Recent debate on accuracy of bull ranking necessitated that standard operating procedures be developed to standardize performance recording and genetic evaluation so that authenticity and transparency is owned by different stakeholders. The present study was designed to develop a procedure to adjust lactations of longer duration to a standard lactation based on 305-d-milk yield, especially when milk yield for such lactations could not be recorded in Sahiwal cattle and Nili-Ravi buffaloes.

MATERIALS AND METHODS

Two data sets were used to predict standard lactation milk yield (SLMY) from complete lactation milk yield (CLMY) and lactation length (LL) recorded in kg and days, respectively. The data on Sahiwal cattle pertained to lactation records of cattle used by Rehman (2006), while data on Nili-Ravi buffaloes was previously used by Bashir (2006). These data represented lactations of cows and buffaloes reared at the main Government Livestock Farms in Punjab. Lactations were required to be more than 305 days having both 305-day and total milk yield recorded. The average daily milk yield for period before 305-days was required to be more than the average daily milk yield after 305-days. This check was required to make sure that a longer lactation was not continuation of previous lactation with missing date of calving. To exclude very low lactation yields, a minimum of 1000 litres was also required for any lactation to be included in the analysis. This yielded 3927 lactations of Nili-Ravi buffaloes and 3054 lactations belonging to Sahiwal cattle.

In the present study, SLMY was considered as a dependent variable, and CLMY and LL were used as independent variables. SLMY was predicted from CLMY and LL traits with the following Multiple Linear Regression model. Coefficient of determination (R^2) was used to determine the accuracy of prediction in the two models assumed. Root of Mean Square Error (S) values of the regression models were also found.

Statistical analysis was performed using Minitab® 13 (2007).

Multiple Linear Regression Model can be written as follows:

$$SLMY = a + b_1*CLMY + b_2*LL + e$$

Where,

a: intercept
b_1 : regression of SLMY on CLMY
b_2 regression of SLMY on LL, and
e: random error term.
Variance Inflation Factor (VIF) was used for each independent variable in Multiple Linear Regression Model (Eyduran *et al*., 2010).

RESULTS AND DISCUSSION

The general statistics for milk yield and LL for the two species were found similar for the available information on the two species. Table 1 presents descriptive statistics of 305-day milk yield, total milk yield, and lactation length for Sahiwal cattle and Buffaloes. The 305-day milk yield, total milk yield and LL were estimated as 2061 litres, 2217 litres and 348 days, respectively (Table 1) for Sahiwal cattle. For buffaloes, corresponding values were 2123 litres, 2408 litres and 360 days. In the original data set, proportion of buffaloes with LL longer than the standard of 305 days was 27%while this proportion was obtained as 16.1% for the cattle. The higher average for such lactations is related to longer calving interval in buffaloes than cattle as reported previously (Khan *et al*., 2007; Khan *et al*., 2008).

Graphing the lactations of longer duration for LL and milk yield did not provide any clue if milk yield beyond 305-days could be predicted from LL, both in cattle and buffaloes (Figs 1 and 2). This was mainly due to wide variation in the behavior of cows and buffaloes in their lactation curves beyond a standard LL.

Relationship between SLMY and CLMY in cattle and buffaloes is depicted in Fig 3 and Fig 4, respectively. The linear regression of SLMY on CLMY had 88.4 and 83.4 % accuracy in cattle and buffaloes, respectively. This may be considered reasonable prediction accuracy. However, when LL was added as a predictor along with total milk yield, accuracy improved. The mean sum of squares along with other statistics are presented in Table 2. Very high F-value obtained in the analysis was expected due to part-whole relationship between the two variables. Regression equation to predict SLMY from CLMY and LL are presented in Table 3. The prediction accuracy increased from 88.4 to 96.5% in cattle and from 83.4 to 96.1% in buffaloes which indicated that inclusion of LL in predicting SLMY was justified.

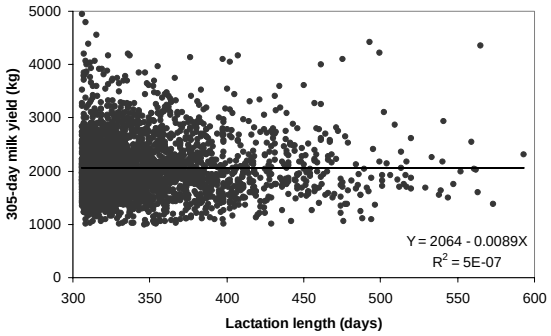

Fig. 1: Relationship between lactation length and 305-day milk yield in Sahiwal cattle

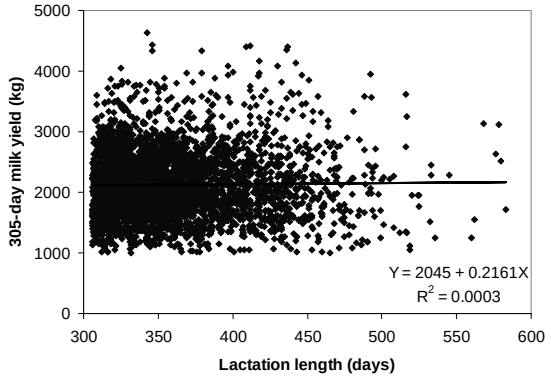

Fig. 2: Relationship between total lactation length and 305-day milk yield in Nili-Ravi buffaloes

Table 1: Descriptive statistics for milk yield (kg) and lactation length (days) traits for Nili-Ravi buffalo and Sahiwal cattle

Species	Trait	N	Mean	Min.	Max.	StError
Cattle	305-day milk yield	3054	2061	1001	4951	9.87
	Total milk yield	3054	2217	1031	4954	10.48
	Lactation length	3054	348	306	593	0.78
Buffalo	305-day milk yield	3927	2123	1005	4635	8.59
	Total milk yield	3927	2408	1020	5331	9.84
	Lactation length	3927	360	306	583	0.70

Table 2: Regression analysis to predict standard lactation milk yield from total milk yield and lactation length (LL)

Species	Source of variation	d. f	Mean squares	F-Value
Cattle	Regression	2	438545581	41841***
	Residual error	3051	10481	
Buffalo	Regression	2	546781389	48503***
	Residual error	3924		

*** = P<0.001

Table 3: Regression equations to predict standard lactation milk yield (SLMY) from complete lactation milk yield (CLMY) and lactation length (LL) in cattle and buffaloes

Species	Regression equation	R^2 (%)	VIF
Cattle	SLMY = 1239 + 0.967 (CLMY) - 3.80 (LL)	96.5	0.035
Buffalo	SLMY = 1604 + 0.925 (CLMY) - 4.75 (LL)	96.1	0.039

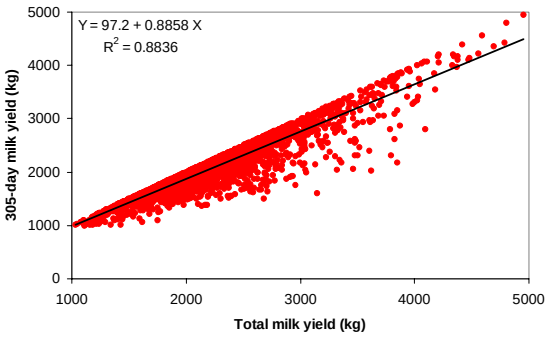

Fig. 3: Relationship between total milk yield and 305-day milk yield in Sahiwal cattle

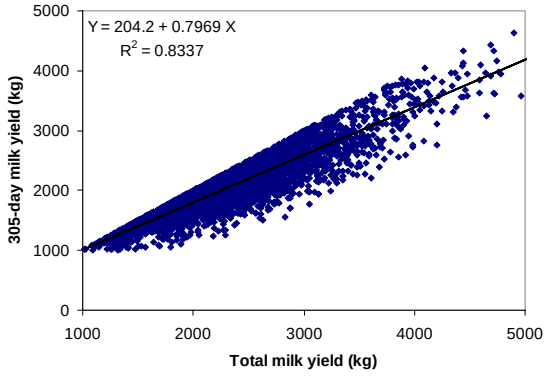

Fig. 4: Relationship between total milk yield and 305-day milk yield in Nili-Ravi buffaloes

These equations may be used in the prediction of SLMY in Sahiwal cattle and Nili-Ravi buffaloes when CLMY is available along with actual LL. The graphical relationship of predicted yield from available milk yield for two lactation lengths (350 and 450 days) is presented in Fig 5. Predicted yields were higher for Sahiwal cattle as compared to Nili-Ravi buffaloes, it may be possible that for Sahiwal the lactations of longer duration generally represented high producing animals as compared to Nili-Ravi buffaloes most of who had produced for longer period because they could not get pregnant. Predicted yields for 305-days lactation length were more than those predicted for 450-days for the same reason (Fig 5). These predictions may look accurate but should not replace the need for development and enforcement of standard recording procedures at Government farms so that need to do such predictions can be minimized. Need for recording at international standards can not be overemphasized (Khan, 2000).

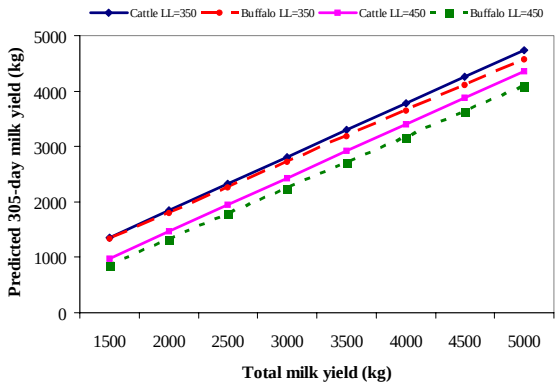

Fig. 5: Predicted 305-day lactation milk yield for two different lengths of lactations (350-days and 450-days).

In conclusion, standard lactation milk yield can be fairly adequately predicted from total milk yield of longer lactations and lactation length using linear regression technique both in Sahiwal cattle and Nili-Ravi buffaloes with reasonable accuracy.

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