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PREDICTION OF LACTATION YIELD FROM LAST-RECORD DAY AND AVERAGE DAILY YIELD IN NILI-RAVI BUFFALOES

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ABSTRACT

Different adjustment procedures were compared to determine if prediction of lactation milk yield using last record day information could be improved by using information on the average daily milk yield of the recorded lactation. Weekly milk yield records of 993 Nili-Ravi buffaloes for 2704 lactations were used for the study. Comparison of different procedures of lactation milk yield adjustment from partial/incomplete or complete lactations indicated that milk yield predicted from a linear regression equation, or from last test day information, was higher as compared to actual milk yield due to extrapolation to a higher base. Simple linear regression procedure overestimated the yield, especially in the later part of the lactation curve. Most precise adjustments were obtained when last test day and average daily milk yield information were included as predictors. The standard deviation of bias decreased and correlation between actual and predicted lactation milk yield improved with inclusion of average daily milk yield as a predictor along with the last test day milk yield. Last recorded milk yield information along with average daily yield of the recorded lactation period are suggested to be used for standardization of milk yield data in Nili-Ravi buffaloes.

Key words: Nili-Ravi buffalo, prediction, lactation yield, last-record day.

INTRODUCTION

Lactation curve in buffaloes behaves similar to that in cattle. A standard lactation of 10 months is also defined similar to that in cattle (Khan, 1997) and procedures of estimating lactation milk yield are likely to be similar in both the species. Records shorter than the standard lactation should also be used to reduce the bias in estimating breeding values of sires due to differences in the culling rates among the progeny groups. Early estimates of sire's breeding values by extending lactations in progress can also help to reduce the generation interval as well as increase the intensity of selection. These projected records can be used to estimate milk yield of a buffalo while her lactation is still in progress. This early information can facilitate the farmer to decide if she should be kept for producing the offsprings. Furthermore, it helps in the allocation of resources such as feed supplies both for an individual cow or a herd.

To improve the genetic potential of Nili-Ravi buffaloes, genetic improvement programmes are underway in Pakistan. The data on milk production and other economical traits are being collected and milk production records are adjusted for shorter lactation length. Lactations abandoned due to abortion and sickness are, however, excluded from analysis considering them 'abnormal'. Lactation length adjustment factors for buffaloes have usually been developed from simple or multiple regression procedures. As the current recording systems do not require that last test day yield be available for every lactation, a cut off is generally assumed, beyond which milk yield is considered as from a normal lactation. The usually assumed cut-offs range from 60 to 180 days (Cady *et al*., 1983; Khan, 1986). Limits of 100 or 150 days are also common (Salah-ud-Din, 1989). Lactation records between the minimum days in milk (DIM) and the selected point, such as 305 days, are thus considered as the genetic potential of the buffalo and are not corrected for lactation length (Khan, 1986). The last test day adjustment procedure has previously been suggested (Khan, 1997) as it was found to be more accurate (Iqbal, 1996) than the other procedures in vogue. This procedure involves prediction of lactation yield from last record to the end of standard lactation (305 days) but does not account for differences in high and poor yielders with similar last test day yield.

Present study was planned to compare different procedures of adjustment and to see if prediction of lactation milk yield using last record day information could be improved by using information on the average daily milk yield of the recorded lactation.

MATERIALS AND METHODS

Milk yield records of 993 Nili-Ravi buffaloes maintained at the Livestock Experiment Station, Bahadurnagar, Okara were used for the present study.

Weekly milk yield and pedigree records were also collected and 2704 lactations recorded on these buffaloes were available with lactation length of at least 60 days. If milk yield was missing for any week, it was estimated by averaging previous and next available weekly record. However, if milk yield information was missing for more than eight weeks (56 days) consecutively, such records were excluded. Errors in data entry were minimized by deleting outliers and allowing a maximum of 100% increase or decrease between two consecutive weeks. Season of calving was defined as summer (April to September) and winter (October to March). For adjusting shorter lactations to 308-day yield, following five types of adjustments were considered:

a) Milk yield adjusted by using a simple regression equation proposed by Khan (1986). Adjusted milk yield using this simple linear regression was named as MYSRF.
b) Milk yield adjusted by using factors calculated on the basis of last test day procedures (Iqbal, 1996). All lactations of ≥308 days duration were used for the calculation of future milk yield factors and the adjusted milk yield was called MYATYP. In this adjustment procedure, 308-day milk yield was estimated using last test day yield information (milk yield of morning and evening milkings added together on the last week). The 308-day milk yield was estimated as sum of actual yield for the known/recorded lactation period and predicted yield for the remaining period (308 minus days in milk). The predicted yield was calculated by multiplying future daily milk yield (estimated from a regression equation having lactation length as a predictor along with the intercept) with days in the remaining period.
c) Milk yield adjusted by using factors calculated on the basis of last test day procedures similar to b) above but excluding lactations that were atypical. A gamma-type function (Wood, 1967) was used for atypical lactations. For this purpose, lactations were declared as atypical if there was a decline in milk yield after calving instead of an increase or if there was an increase after the peak (Khan and Gondal, 1996). There were 253 such lactations leaving 2451 lactations to be used for the development of regression equations. The factors developed were used to estimate 308-day milk yield and the estimated lactation milk yield variable was named as MYTP1.
d) To utilize short lactations (< 308 days) a ratio of the milk yield to be estimated and last test day yield was obtained [ratio = (308-day milk yield - milk yield for recorded lactation)/last test day milk yield] from the 308-day complete lactations and 308-day yield was estimated for the short lactations. In this way it was possible to estimate future daily yield and the regression equations could be developed from all the data set to predict future daily yield and then the 308-day yield. The predicted 308-day yields were called MYTP2.
e) To account for variation in the behavior of lactation curves for low and high producing animals with a similar last test day yield, regression equation to predict future daily milk yield was modified. Future daily yield for the short lactations was not only predicted from the last test day yield available (Iqbal, 1996; Akram, 1997) but average daily yield of the known part of the lactation was also utilized to predict future daily yield, as in b) above, there was an intercept and two predictors. The 308-day milk yield was then predicted as described above and the predicted 308-day milk yield was named as MYTP3.

All the regression analyses were performed using SAS® (1990).

RESULTS AND DISCUSSION

Out of 2704 lactations with more than eight weeks of duration, 59.2% had lactations shorter than 44 weeks duration (Table 1). If minimum was increased from eight to 16 weeks, this included 3.0% of all the lactations. Buffaloes with lactations of more than six months duration (>182 days) were 89.2% of the data set. It may be mentioned that lactations with lactation length (LL) of less than 2 months (56 days) were not included in the data set and the values in the Table 1 do not represent population averages. Such lactations were less than 5% of the total lactations included in the study.

Table 1: Frequency distribution of lactations by lactation length and averages of milk yield and lactation length

Lactation length (weeks)	N	%	Lactation length (days)	Milk yield (kg)
8-11	30	1.1	75.0 ± 12.00	347.1 ± 148.53
12-15	51	1.9	106.1 ± 24.82	549.1 ± 186.50
16-19	56	2.1	133.0 ± 25.40	704.0 ± 174.89
20-23	79	2.9	160.6 ± 19.41	858.0 ± 287.64
24-27	98	3.6	184.6 ± 14.21	1066.3 ± 308.29
28-31	207	7.6	213.0 ± 11.12	1326.7 ± 355.36
32-35	270	10.0	239.5 ± 14.39	1694.6 ± 471.03
36-39	422	15.6	267.8 ± 09.26	1954.2 ± 503.18
40-43	389	14.4	294.4 ± 08.30	2198.2 ± 622.37
≥ 44	1102	40.8	307.0 ± 08.07	2453.5 ± 618.78
Overall	2704	100.0	266.6 ± 55.15	1984.4 ± 773.43

Shorter lactations had lower milk yield as compared to the complete or longer lactations (Table 1). Milk yield averaged 1984.4 ± 773.43 kg when information up to 44 weeks was used. The overall average lactation length for these records was 266.16 ± 55.15 days. This average for completed lactations was 289.6 ± 82.12 days. Very short lactations (8-11 weeks) had average milk yield of 347.1 ± 148.53 kg. A visual appraisal of first and later parities for different lactation lengths revealed different behaviour. It also indicated that most of the lactations with shorter lactation duration were complete as the animals dried gradually. There were 253 atypical lactations (9.4% of total number of lactations) with a range from 0.4% (in 6th and 7th parity) to 2.7% (in first parity). About 70% of the atypical lactations fell in the first three parities, while rest of the 30% in the later parities. Considering that such a behaviour was due to some physiological or environmental factors (disease incidence, seasonal influences, mistakes in recording, routine or occasional suckling by the calves etc), prediction equations were developed both by including and excluding such lactations.

After establishing that the lactations of different duration behaved differently and that about 10% of the lactations did not behave as expected, regression equations were developed for adjusting lactations to a standard lactation length of 44 weeks (308-days) using the last test day information. Predicted yields were calculated both by including (MYATYP) and excluding (MYTP1) atypical lactations. Milk yield using the correction factors developed by Khan (1986) and currently being used were also predicted (MYSRF) and prediction equations were developed. The coefficients of equations for MYTP1 were slightly different from those reported by Iqbal (1996) because atypical lactations were excluded in developing them and also because interaction of last test day with lactation length was not included in model, as suggested by Akram (1997). Intercept decreased, while regression of milk yield on last test day yield increased, as lactation length increased. Coefficient of determination was better towards the end of the lactation as compared to prediction when weeks in lactation were smaller. When lactations initiated in winter, intercepts were higher but slopes were lower as compared to those initiated in summer. This was true for first, as well as later parities. For MYTP2, where complete data set had been used for prediction from last test day milk yield, intercept coefficients were reduced and regression coefficients increased. When average daily yield was added as a predictor of future yield (MYTP3), intercept was further reduced and regression of future daily milk yield on last test day yield also decreased because of inclusion of another predictor. Coefficient of determination improved by almost 1%.

The extended yields were statistically different from the actual lactation milk yield of 1984.4 kg for an average lactation length of 266.6 days (yield beyond 308-days excluded). Extended yields were higher on the average (2122.9 to 2139.7 kg) as compared to the actual milk yield because of extrapolation to 308-days. The difference between actual and predicted values reduced gradually with increased lactation length. Simple linear regression procedure overestimated the later half of the lactations as compared to the prediction by last test day procedure because of assuming that milk yield increased at a constant rate throughout the lactation. Such a procedure is likely to underestimate lactation yield for earlier part of the lactation curve when actual rate of increase is higher than estimated from a linear regression procedure. Khan (1996) used an Animal Model to estimate regression coefficients by simultaneously adjusting for age at calving but predicted lactation curves had increasing trend even towards the end of lactation curves. It was thus suggested that calculating regression coefficients from such information would be less accurate. Iqbal (1996) declared that the last test day procedure was more accurate as compared to other prediction procedures for Nili-Ravi buffaloes. Predicted milk yield was generally higher (except for 8-11 week of lactation length) when prediction equations included all the records (MYATYP) as compared to using typical lactations only (MYTP1). Difference between MYATYP and MYTP1, however, was small and reduced to almost zero for lactations with longer lactation length. So, the variable MYATYP was dropped for further analysis.

When shorter lactations were included for developing prediction equations, predicted milk yield (MYTP2, MYTP3) was lower as compared to predicted milk yield from equations using lactations with ≥308 days of duration (MYTP1). This was especially true for shorter lactation length groups. Predicted milk yield for 8-11 weeks lactation length group averaged 1417.1, 1137.4 and 1099.1 kg for MYTP1, MYTP2 and MYTP3, respectively. The difference among the three variables, however, reduced for higher lactation length groups. The standard deviation of bias and correlation between actual and predicted lactation milk yield indicate (Table 2) that inclusion of average daily milk yield as a predictor along with the last test day milk yield was a better choice when all lactation records were used (MYTP2 vs. MYTP3). It decreased standard deviation of bias and improved the correlation between actual and predicted milk yield. Lower values of bias and better correlation between actual and predicted milk yield for MYTP1 were because complete lactations were used only.

The credit given to any buffalo with different last test day yield and average daily yield of known lactation period was calculated. For different last test day milk yields, credit given to a lactation of certain length was different. At 56 days of lactation, for example, credit for MYTP1 would be 903 kg when last test day milk yield was one kg, while this credit for MYTP2 would be 401 kg. Credit decreased as lactation length increased. At 280 days for a last test day milk yield of 5 kg, credit would be 135 and 123 kg for MYTP1 and MYTP2, respectively. The credit given to a lactation of 56 days would be 280, 401, 522 and 643

Table 2: Standard deviation of bias and correlation ($r_{predicted,\ actual}$) between actual and predicted lactation yield using different adjustment procedures

Lact. Length (weeks)	Standard deviation of bias			Correlation between predicted and actual yield		
	MYTP1[1]	MYTP2[2]	MYTP3[3]	MYTP1[1]	MYTP2[2]	MYTP3[3]
8	308.9	379.5	372.6	0.867	0.838	0.844
12	264.8	325.3	318.8	0.904	0.882	0.887
16	223.8	272.1	266.2	0.933	0.916	0.920
20	188.7	227.0	221.6	0.953	0.941	0.943
24	155.3	178.9	174.8	0.969	0.962	0.963
28	123.9	140.8	137.5	0.980	0.975	0.976
32	92.0	103.6	102.3	0.989	0.986	0.986
36	58.1	63.9	63.2	0.996	0.995	0.995
40	27.8	29.2	28.8	0.999	0.999	0.999
43	7.3	7.0	6.9	1.000	1.000	1.000

[1]Prediction equations based on last test day procedure; only typical lactations of ≥308 days duration were used in calculations.
[2]Prediction equations based on last test day procedure; only typical lactations of ≥56 days duration were used in calculations.
[3]Prediction equations based on last test day procedure but having daily milk yield also; only typical lactations of ≥56 days duration were used in calculations.

kg, respectively for average daily milk yield of one, three, five and seven kg when last test day milk yield was one kg. The credit for the unknown (unrecorded) lactation did not depend on the last test day milk yield only but also on the performance of the animal for the known part of the lactation. Thus, even if animal dried naturally or if the reason of drying was unknown (as was the case for most of the data), extending such lactations by equations used for MYTP3 credited or discredited the animals appropriately. Using last test day information alone would overadjust the poor yielders. Last recorded milk yield information along with average daily yield of the recorded lactation period are suggested to be used for standardization of milk yield data in Nili-Ravi buffaloes.

Conclusions

The standard deviation of bias decreased and correlation between actual and predicted lactation milk yield improved with inclusion of average daily milk yield as a predictor along with the last test day milk yield. Last recorded milk yield information along with average daily yield of the recorded lactation period are suggested to be used for standardization of milk yield data in Nili-Ravi buffaloes.

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