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COMPARISON OF DIFFERENT PROCEDURES FOR LACTATION LENGTH ADJUSTMENT OF MILK YIELD IN SAHIWAL CATTLE

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ABSTRACT

The purpose of the present study was to compare three procedures for lactation length adjustment of milk yield. For this purpose, weekly milk yield records (n = 2039) of Sahiwal cows were used. Multiplicative adjustments using simple linear regression of milk yield on lactation length was the first procedure, in the second procedure last recorded milk yield was used to predict milk yield of unrecorded lactation, while the third procedure was similar to the second procedure except that predictions included average daily milk yield of the recorded lactation as well. The bias (the difference between actual and predicted milk yield) was lowest in the third procedure. The standard deviation of bias was 235 kg for milk yield adjusted by using last test day milk yield and average daily milk yield of the known lactation as compared to milk yield adjusted by linear regression i.e. 496 kg for lactation length of 56 days. The standard deviation of bias decreased to 23 kg of milk for the milk yield adjusted by using last test day milk yield and average daily milk yield of the known lactation as compared to 66 kg for the milk yield adjusted by linear regression towards the end of the lactation length. The correlation coefficient between actual and predicted milk yield was 0.881 for the milk yield predicted by using last test day yield and average daily milk yield of the known lactation length as compared to 0.10 for milk yield predicted by linear regression for the lactation length of 56 days. The correlation coefficient also increased with the increase in lactation length. Lactation length adjustment of milk yield should be done using last test day information along with average yield of the recorded lactation.

Key words: Lactation length, milk yield, prediction, Sahiwal cows.

INTRODUCTION

Lactations shorter than some standard such as 305-days can be deleted from any performance data set, can be used irrespective of lactation length (considering them the genetic potential of the animal) or can be adjusted for lactation length before breeding values for milk yield are estimated. Contradictory views are available in the literature as to which lactation should be declared short. Cut offs vary from 15 (Ahmad, 1999) to 285 days (Mandal and Mehla, 1996). Assumption that yield from a shorter lactation should be considered as the genetic potential of the cow (Madalena *et al*., 1992; Syrstad, 1993) is difficult to justify especially when reasons for a lactation to be short are rarely recorded or genetic control of lactation length is weak. Moreover, statistical procedures can be developed for precise adjustments even if the animal dried or if information on the reason of drying was not clear (Norman *et al*., 1985). Limited resources further necessitate that every recorded lactation, short or long, should be best utilized.

The Present study was planned to see how best lactation length could be adjusted so that shorter lactations could be utilized without sacrificing variation. Three lactation length adjustment procedures were compared for standard deviation of bias and correlation between actual and predicted milk yield.

MATERIALS AND METHODS

Milk yield records of Sahiwal cows (n= 2039), maintained at the Livestock Production Research Institute, Bahadurnagar, Okara, from 1990 to 2000 were used for this study. Lactations for cows having minimum lactation length of 8 weeks were retained and milk yield was truncated at 44 weeks. 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 consecutively, such records were excluded.

Lactation length adjustment procedures

Three different lactation length adjustment procedures were compared for standard deviation of bias and correlation between actual and predicted milk yield.

Simple linear regression procedure

In the first procedure, lactations shorter than 44 weeks were adjusted for milk yield by using a linear regression equation, as adopted by Talbott (1994). The regression equation was developed for predicting 308-day yield (kg) from lactation length (days). Multiplicative adjustment factors were then developed. Factor for a certain lactation length was calculated as a ratio of predicted milk yield at 308-days of lactation length and predicted milk yield at that lactation length (using the prediction equation). Lactations with lengths between 56 and 308 days were then adjusted by using these correction factors and 308-day adjusted lactation yield variable was named as MYLR.

Adjustment by using last test day information

In the second adjustment procedure, last test day milk yield information (last recorded milk yield available for any lactation) was used to predict future daily milk yield for unrecorded lactation period. All typical lactations of ≥ 308 days duration were used to develop these equations and for all lactation lengths (weeks) the 308-day milk yield was estimated as follows:

$\hat{Y}_{308} = Y_t + \hat{Y}_f\,(308 - DIM)$

Where,

$\hat{Y}_{308}$ Extended 308-day milk yield for lactation of any length

Y_t Total milk yield produced at the termination of lactation

$\hat{Y}_f$ Predicted daily milk yield for unknown part of lactation estimated as follows:

$\hat{Y}_f = \alpha + \beta X_i$ Where,

$\hat{Y}_f$ Predicted future daily yield at any lactation length

α Intercept

β Regression coefficient

X_i Available milk yield on the last test day at any lactation length

DIM Days in milk.

While regression equations were developed to predict future daily yield, lactation behavior was studied to see if lactations were normal (typical) or atypical, using gamma-type function (Wood, 1967). Lactations were declared atypical if there was a decline instead of an increase in milk yield after calving, or if there was an increase after the peak instead of a decline (Khan and Gondal, 1996). Only typical lactations were used to develop regression equations and the 308-day adjusted milk yield variable was named as MYLTD.

Adjustment by using last test day information and average yield of recorded lactation

To account for variation in the behaviour 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 but average daily yield of the known part of the lactation was also utilized (Khan and Chaudhry, 2001). The regression equation was as follows:

$\hat{Y}_f = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i}$

Where

$\hat{Y}_f$ Predicted future daily yield of any lactation length

α Intercept

β_1 and β_2 Regression coefficients

X_{1i} Available milk yield on the last test day of any lactation length

X_{2i} Average daily milk yield of known part of the lactation at any lactation length

The 308-day adjusted milk yield variable was named as MYLTAD

RESULTS AND DISCUSSION

Actual milk yield of cows for the period under study was 1475 kg, with standard deviation of 651 kg. Out of 2039 lactation, only 30% had a standard lactation length, some 57% were shorter than 40 weeks while 20% lactations were shorter than six months. Average milk yield varied with lactation length. Lactation length averaged 247.6 ± 66.7 days. Very short lactations (8-11 weeks) had average yield of 322 kg as compared with an average of 1999 kg when lactation length was 44 weeks. Standard deviation also increased with increase in milk yield, as expected.

There were 582 (28.5%) lactations which were atypical. Their distribution among different parities varied from 21% (Parity 7) to 34% (Parity 2). Out of 2039 lactations, 1153 belonged to first three parities having 350 (30%) atypical lactations. Of the total 582 atypical lactations, 350 in the first three parities represented 60% of atypical lactations. It is difficult to assign reasons for these lactations to be atypical because reasons were rarely recorded. Considering that such behaviour was due to some physiological or environmental factors such as disease, season and mistakes in recording, prediction equations were developed by using typical and complete (44 weeks) lactations only. Another reason for calculating atypical lactations was the practical use of such equations in the future.

Comparison of adjustment procedures

The simple linear regression equation to predict 308-day yield from lactation length was as under:

Predicted milk yield (kg)
= - 384.36 litres + 7.57 x lactation length in days

Multiplicative adjustment factors were then developed to adjust yields to 308-days. Problems with the adjustment for lactation length using such linear regressions have previously been discussed (Khan, 1996). It is evident from this equation that for shorter lactation length the predicted milk yield was very low due to negative intercept and consequently the multiplicative adjustment factors were very high. The predicted milk yields were thus very unrealistic and were restricted to be 4000 kg at the maximum. The unrealistic linear increase in milk yield for longer lactations predicted very high yields and correction factors were small in magnitude, consequently underestimating the adjusted 308-day yield.

In the other two methods, intercept generally decreased as the lactation length increased, while regression coefficient of future daily yield on last test day yield increased. When average daily yield was added as a predictor of the future daily yield, the extent of increase or decrease was comparatively less pronounced. Coefficient of determination (R^2) ranged from 30 to 65% and improved by about 8% when average daily yield of the recorded lactation was added as the predictor along with the last test day yield (Table 1). Unadjusted milk yield averaged 1475 ± 651 kg, while milk yield adjusted to 308-days by linear regression procedure averaged 1973 ± 601 kg. The adjusted milk yield by last test day procedure and last test day and average daily yield procedure averaged 1709 ± 496 and 1753 ± 484 kg, respectively. As discussed previously, the linear regression procedure over adjusted the shorter lactations. The variation of the adjusted yields was also inflated as indicated by the standard deviation of 606 kg. If adjusted yields in this procedure were not restricted to 4000 kg, inflation would have been much higher. The extended yields were higher than the actual yield due to a higher base (1475 vs 1709 to 1973 kg).

A more objective way to compare the three adjustment procedures was to calculate the correlation between actual and predicted milk yields ($r_{actual\ \&\ predicted}$) and to see how variance would change. The standard deviation of bias (SD of bias) was thus calculated, where bias was defined as difference between actual and predicted yield and these statistics are presented in Table 2. The difference between the two procedures

Table 1: Regression equations to predict future daily yield from last test day milk yield and average daily milk yield for extending shorter lactations

	Parity 1, summer calvers				Parity 1, winter calvers			
Weeks	**α^***	**β_1^{**}**	**β_2^{**}**	**R^2(%)**	**α^***	**β_1^{**}**	**β_2^{***}**	**R^2(%)**
8	1.93	0.030	0.590	0.575	2.58	0.282	0.130	0.544
16	1.81	0.286	0.327	0.611	1.90	0.226	0.247	0.579
24	0.87	0.437	0.321	0.678	1.72	0.240	0.238	0.587
32	1.01	0.318	0.396	0.667	1.03	0.352	0.257	0.555
40	1.03	0.461	0.256	0.609	0.75	0.496	0.211	0.514
	Parity ≥2, summer calvers				**Parity ≥2, winter calvers**			
	α^*	**β_1^{**}**	**β_2^{***}**	**R^2(%)**	**α^***	**β_1^{**}**	**β_2^{***}**	**R^2(%)**
8	2.75	0.153	0.335	0.578	2.37	0.219	0.242	0.632
16	2.23	0.255	0.284	0.577	1.87	0.291	0.186	0.681
24	1.78	0.315	0.267	0.631	1.28	0.246	0.280	0.669
30	1.60	0.265	0.313	0.566	1.25	0.291	0.251	0.614
32	1.61	0.264	0.308	0.547	1.11	0.347	0.226	0.610
40	1.60	0.481	0.097	0.375	0.67	0.580	0.128	0.629

* Intercept
** Regression of future daily milk yield (kg) on last test day milk yield
*** Regression of future daily milk yield (kg) on to date average daily milk yield (kg) of recorded lactation

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

Lactation length (weeks)	SD of bias			$r_{predicted, actual}$		
	MYLR[1]	MYLTD[2]	MYLTAD[3]	MYLR	MYLTD	MYLTAD
8	496.0	247.99	235.04	0.000	0.866	0.881
16	496.0	170.04	160.50	0.000	0.940	0.946
24	392.9	116.98	104.21	0.612	0.974	0.978
32	199.0	69.99	64.09	0.940	0.991	0.992
40	65.7	23.94	23.37	0.995	0.999	0.999

[1] Milk yield adjusted by linear regression of milk yield (kg) on lactation length (days)
[2] Milk yield adjusted by last test day procedure
[3] Milk yield adjusted by last test day yield and average daily milk yield of recorded lactation length

that used last test day information was not appreciable. The correlation coefficient between actual and predicted yield increased with increase in lactation length because less information was being predicted and more was available as lactations advanced. Similarly, bias narrowed down and variation of bias also decreased with increase in lactation length because actual and predicted yield got closer gradually. For linear regression adjustment, the predicted lactation yields (MYLR) were always higher than 4000 kg for the first 16 weeks and restricting them to 4000 made the correlation and bias unrealistic. Standard deviation of bias was still always higher for this method as compared to the other two methods. Standard deviation of bias was smaller when average daily yield was included as a predictor along with the last test day yield (MYLTAD) as compared to MYLTD, where last test day information was only used to predict the future average daily yield. The correlation between predicted and actual milk yield under the three adjustment procedures also had the similar trend. Correlation was zero for MYLR for the first 16 weeks because predicted yield was always higher than 4000 litres and was restricted to this level. After this stage, it started increasing and reached 0.998 at 43rd week. For other two methods, correlation coefficient was >0.8 at 8th week and reached unity towards the end. Coefficient was slightly better for MYLTAD as compared to MYLTD. This confirmed the earlier reports (Khan and Chaudhry, 2001), where this procedure was suggested for Nili-Ravi buffaloes.

Thus, it is concluded that milk yield adjustment for the lactation length was best when last test day milk yield and average daily milk yield of the known lactation length was used. The method is therefore recommended for the standardiza-tion of milk yield for lactation length.

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