ADJUSTMENT OF MILK YIELD FOR LACTATION LENGTH IN NILI-RA VI BUFFALOES

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Normal lactations (n=2353) of buffaloes from four institutional herds and four field data collection centers involved in a progeny testing progranune in Pakistan were used for the development of correction factors for lactation length. adjusted to 305 days, by simultaneously accounting for age at calving. A single trait animal model was employed and regressions were estimated for first and later parity groups. Estimated milk yield increased linearly with increase in lactation length. coefficients being different with inelusion or exelusion of records for a certain lactation length. More precise recording of lactation information and changes in the methodology of lactation length adjustment are emphasized for future milk yield predictions and evaluation of animals.

Key words: milk yield, lactation length. buffaloes

INTRODUCTION

Incorporation of Nili-Ravi breed of buffaloes as a vital component into the sustainable integrated farming system of Pakistan requires that detailed studies be conducted so that the animal remains competitive with other options of animal products procurement. Pressure to increase per animal productivity on a permanent basis i.e. through genetic selection has always been a challenge. There are very limited genetic studies both due to less developed recording systems in the field and lack of models that evaluate animals in the given production systems,

Milk yield is the most important economic trait of a fertile buffalo that has been studied extensively. As yield in a given lactation depends on number of days the animal was milked. therefore incomplete lactations are traditionally extended to a 305-day basis. Inclusion of such extended records reduces the bias in estimating breeding values of sires due to differences in the culling rates among the progeny groups and such early extension of in-progress lactations can help to reduce the generation interval. Projected records are also used to estimate lactation yield while lactation is still in progress. This facilitates the farmers to decide if the buffalo should be kept for producing further offsprings or not. Furthermore, it helps in the sagacious allocation of resources for feed supplies.

Various methods of extending partial records have been used in the past. The ratio-method (ratio of 305-day milk yield and part-lactation yield at any stage of lactation) has been popular for its simplicity in late 50's and early 60's. Multiple linear regression and modi tied regression techniques were developed later. Miller et £1,1.(I 72) compared ratio factors, multiple regression, modi tied regression. and regression of the remainder of the lactation on last test. They concluded that records could be more accurately extended if the production on the last sample day rather than the cumulative yield was used to predict the unknown remaining yield. This method of extending lactations is currently being used in most of the cattle production testing programmes in advanced countries (Wiggans

and Dickinson, 1985).

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 £1.1.. 1983; Khan, 1986). Limits of 100 or 150 days are also common (Salah-ud-Din, 1(89). 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. Also, most of these studies involve small data samples from institutional herds and employ least squares estimation procedures.

The purpose of this study was to estimate regression coefficients of milk yield on lactation length under an animal model using lactations of different length, and simultaneously adjusting for age at calving in Nili-Ravi buffaloes.

MATERIALS AND METHODS

A total of 3892 milk yield records on 1235 Nili-Ravi buffaloes (calving between 1969 through 1993) at the Livestock Production and Research Institute, Bahadurnagar (Okara) were used. Data on the daughters of the bulls being progeny tested were also used from three other institutional herds and four field data collection centers (progressive private farms and village populations) involved in the project. Records were edited to remove lactations ending due to abortion or sickness. Lactations in which the first part of lactation was not recorded, were also deleted.

Two data sets with two different lactation lengths were constructed. Minimum lactation length was 60 days in the first data set and 180 days in the second data set. Dates of birth of the offspring were matched with the dates of calving of the darns to contirm the pedigrees, where possible. Most of the buffaloes in the field data and some purchased buffaloes in the

farm data did not have date of birth and were not used in the analyses. After editing, 2571 lactation records from 934 buffaloes had information on milk yield, lactation length (> 60 days) and age at calving. For the second data set, since lactation length was required at least to be 180 days, thus only 2353 lactation records from 901 buffaloes were available.

A single trait linear model was employed, where milk yield was assumed to have fixed effects of two parity groups (1st and later parities). herds. year-season, and random effects of animal's breeding value, permanent environment, and temporary environment. Linear and quadratic effects (regression coefficients) were estimated for deviations of age at calving from 60-months, and days in milk from 305-days, both for 1st and later parity groups. Estimation of effects for age and lactation length through regression was (due to the limited number of observations) done only for a specific age and stage of lactation. Mathematical representation of the model is:

$$Yi'klll =, i + Gi + Hi + YS_k + A, + PE, + b,(DIM_F-305) + b/DIM_I-305)' + b,(DIM_L-305) + b_4(DIM_L-305)2 + b,(Age_F-60) + b(,(Age_F-60)' + blAge_L-60) + b\sim(AgeL-60)2 + ei,kllll$$

Where.

Yi'klllll	=	the rnth lactation milk yield on the [th buffalo calving during kth year-season combination in jth herd in the ith parity group,
.,	=	overall mean,
G,	=	fixed parity group effect; 1 for first lactation and 2 for second and later lactations,
H,	=	fixed effect of herds (four institutional herds and four data collection centers),
YSk	=	fixed effect of year-season subclass, 26 years and two seasons (I., summer i.e. May to October; 2, winter i.e. November to April),
A,	=	effect of additive genetic merit (random),
PE,	=	permanent environmental effect (random),
bi's	=	regression coefficients,
DIM1	=	days in milk in first parity group,
DIM,	=	days in milk in later parity group,
Age,	=	age at calving in first parity group.
Age,	=	age at calving in later parity group, and
e"kl,"	=	temporary environmental effects (random).

Expectations and variances for random effects were assumed to be:

$$E \begin{bmatrix} a \\ p \\ e \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} Var \begin{bmatrix} a \\ p \\ c \end{bmatrix} \begin{bmatrix} A4!a\sim & 0 & 0 \\ 0 & 1!1a\sim p & 0 \\ 0 & 0 & INa; \end{bmatrix}$$

A and I are additive relationship imd identity matrices; $a2_a$, $a2_p$ and a^2 are additive genetic, permanent environmental, and temporary environmental variances; q,. q", and N were 1440, 934, and 2571 for the first data set and 1030, 90 I, and 2353 for the second data set. Lower values of q, in the second data set were due to exclusion of animals from the pedigree that did not contribute to the relationships.

For the relationship matrix. phantom parents were assigned, when one or both parents of any buffalo with a production record were missing (Westell and Van Vleck, 1987). A single trait restricted maximum likelihood (REML) package using a sparse matrix solver (Misztal, 1992) was used.

Grouping of months into seasons was similar to Khan (1994). Choice of 60 months as base age at calving was due to its simplicity and correspondence to the end of first lactation when most of trle selection decisions of buffaloes can be taken. As the age was observed both in the first and second parity groups, it helped avoid extrapolation to an age which was not observed in the data (Khan, 1994). Choice of age of highest production (mature equivalent) would have been unrealistic, because most of the animals do not produce to that age (Miller. 1973). Adjustment to an average age at first calving, average age for all calvings or age of average yield could have been some of the other options. Because ranking of animals is not affected by the choice of base age, the choice of a base is arbitrary. A younger base, however, lowers the frequency and magnitude of adjustments of lactation records for selection purposes (McDaniel, 1973). Additionally. the purpose of this study was to see the effect of lactation length. whereas inclusion of age at calving was for completeness of the model. Grouping of second and later parities was due to a few number of observations. First parity was kept separate due to its different behaviour as compared to the other parities (Khan and Gondal, 1996).

Solutions from the above model were used to develop adjustment factors for lactation records to 305 days when lactation duration was less than 305 days, both for first and later parity groups, using the following equation:

$$F_{ij} = k_i / (k_i + c_{ij})$$

Where, Fij is a correction factor for level j of lactation length in parity group i, cij was the effect of lactation length j for parity group i, and k_i is constant for parity group i and was calculated as follows:

$$k, = ,Li* + g*, + h* + ys* + a*$$

Where, $u*$ denotes estimate of overall mean, g*i is the estimate for parity group i, h* is average estimate of herds, ys* is average estimate for year-seasons, and a* is the average estimate of breeding values.

RESULTS AND DISCUSSION

Means and standard deviations (SD) for milk yield, lactation

length, and age at calving for the two data sets are presented in Tables I and 2. Mean values for various traits, especially the milk yield varied with the choice of the lactation length. When lactatious recorded for as low as 60 days of length were included (Table I). the milk yield ± SD was 2022 ± 751.3 kg for 273 davs of lactation length. Whcn lactations were expanded to at least 180 days, average lactation length increased hy 10 days while milk yield averaged 2\14 kg with a SD of 689.7 k,!! Higher milk yield in the second data set was dill' to the increased lactation length. while reduction in SD was due to a narrower range of values included. The animals calved for the first time at about an age of four years. Mean age at calving for the later parity group was about eight years with a range from four 10 19 years. The averages for the three traits I11I,!!hnot he biologically real because of lack of information that whether a lactation ended due to sale or sickness of the animal or otherwise. Also. the age at calving information was required which was not available for all the animals and thus all the lactations could not be used.

Linear and quadratic regressions of milk yield on lactation length for first and later parity groups are presented in Table .' Predicted milk yields by lactation length are drawn in Fig. I The 305 days predicted ~ields for first and later parity buffaloes were 1890 and 2097 kg when lactation length included was at least (10 days. Similar averages for a minimum lactation length of 180 days were *2168* and 240 I kg for the two parity groups. Predicted yield was always higher for the later parity group (Fig. I) and consequently the correction factors were lower for this group (Table 4). As expected, predicted milk yields were higher when predictions were based on lacrations having 180 days or more length as compared to the shorter laclations.

The acljustlllenl factors developed for adjusting to 305 days in later parity group (Tahlc 4) were different from those reported by Khan (1986) where a simple linear regression was used to ohtain prediction equation. Regression estimate (5.96 kg) used was lower than the estimates of the present study (Table 3). A possible reason for this difference. other than the use of simple linear regression could he longer lactation length (up to 532 days) in the study referred to above. Also, the age at calving was not taken into account while developing correction factors for lactation length: other fixed and random effects were also ignored. Correction factors reponed by Zafar et at. (1986) also had similar deficiencies. A simple linear regression was employed and rcgression value was estimated as 6.8 kg. Factors from both these studies highly underestimate the yields in the early part of the lactation i.e. when lacrations of smaller length arc to he projected, and would overestimate lactations of greater length. Applying a single set of correction factors both I'm lirst and later parities as suggested in the two studies (Khan, 11)86: Zalar et al., 1986) would also exaggerate the milk yields of first calvers. Differences due to unrealistic intercepts of the prediction equations would also affect the
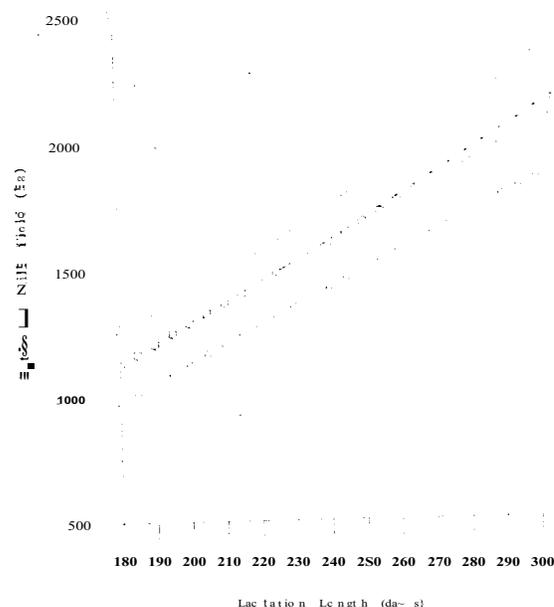
trend of milk yield.

Fig. I. Estimated milk yield for first and later parity groups from lactations with at least 60 and 180 days in milk (+ first parity. ISO days: later parities. 180 days; ~ first parity. 60 days: O later parities, 60 days).

The rate of change in milk yield such as 5.9 or 6.8 kg with increase in lactation length after 180 days to the end of lactation is unrealistic as animals had already been milked for six months. Using a second degree polynomial helped to reduce the yield estimates in the present. study by having negative coefficients when lactations of 60 days or more in length were used. Restricting lactations to 180 days did not help as the second degree coefficients for regression were also positive (Table 3). Present models. although. were theoretically much more relined, yet did not help compensate the lack of information on how a lactation was ended or whether the lac tat ions of shorter length were abandoned due tosickness. death, sale of the animals or the animals really dried normally. In the absence of such information on factors that caused a lactation to be of shorter length, which appears ra normal practice under the present data recording systems, extension of shorter lactations to a 305 day standard may he prohibitive.

If calves are not separated at birth. and milk let down of buffaloes is mainly due to the presence of their calves, the death of the calf is likely to disturb the buffalo and gelling milk from her would be difficult. As death rate in buffalo calves under the age of one year is as high as 40% (Afzal et al., 1983), there is a possibility that most of the records of shorter lactations are due to the death of their calves. Now if the death of the calf was because of an environmental reason. penalizing her for shorter lactation may not bejustitied.

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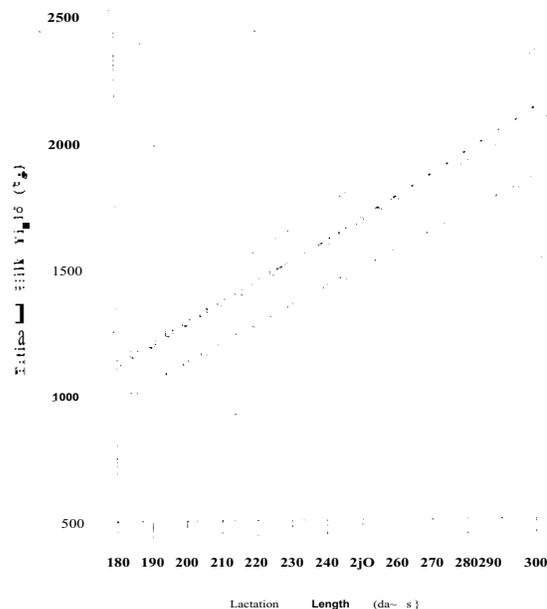
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Table. 1. Means and standard deviations (SD) of traits by parity from lactations having length of at least 60 days

Trait	1st parity	2nd and later parities	Overall
	Mean ± SO	Mean ± SO	Mean ± SO
Milk yield (kg)	1922 ± 665.8	2078 ± 789.7	2022 ± 751.3
Lactation length (days)	2746 ± 49.5	272.4 ± 50.2	2732 ± 50.0
Age at calving (months)	49.0 ± 9.0	99.2 ± 33.6	81.1 ± 36.S
No. of observations	924	1647	2571

Table. 2. Mcans and swndard deviations (SD) of traits by parity from lactations having kngth of at least ISO days

Trait	1st parity	2nd and later parities	Overall
	Mean ± SD	Mean ± SO	Mean ± SO
Milk yield (kg)	2013 ± 596.5	2173 ± 7314	2114 ± 6SLJ7
Lactation length (days)	2S46±31.8	2814 ± 32.2	2S2.5±32.1
:\gc at calving (months)	4S.9 ± <).0	9<).7 ± 33.6	SI.2 ± 36.7
No. of observations	855	1498	2353

Table. 3. Regression coefficients for milk yield on days in milk for lac tat ions of different. lengths.

Minimum Lac t. lcng rh	Covariab1e	Regression coefficients (kg)	
		1st parity	2nd and later parities
00	DIM - 305	6.9560	7.3764
	(DIM - 3(5)'	-0.0026	-O.(}()33
18()	DIM - 305	8.7982	11.1599
	(DIM - 3(5)2	0.00ⅠⅠ	0.0159

DIM = Days in milk.

Table. 4. Correction factors for adjusting milk yield to 305 days for first and later parity groups from lactations with at least 60 and ISO days in milk

DIM	Lactations with DIM 60		Lactations with DIM ISO	
	1st parity	2nd and later parities	1st parity	2nd and later paritieS
ISO	2.14	1,87	2.16	1,<)I
1<)0	1.9<)	1,74	2.01	1,81
200	1,85	1,63	1,88	1,71
2!O	1,74	1.53	1.77	1,62
220	1.64	1,45	1,67	1.53
230	1,55	1.37	1,58	1,45
240	1,47	1.31	1,49	1,38
250	1,40	1.25	1,42	1,31
200	1.33	1,19	1,35	1,24
270	1,28	1,14	1.29	1,18
280	1.22	I. 10	1,23,	1, 13
290	1.17	1.06	1,18	1.07
300	I.n	1.02	1,13	1.02
305	1.11	1.00	1.1 I	1.00

DIM = Days in milk.

As one of the objectives of field recording is better reliability of the breeding values of buffaloes and sires, lactation length adjustments are likely to affect genetic component of milk yield variance. Different views are available on the issue. Das and Balainc (1<)85) suggested to use all records regardless of lactation length. Sharaby et al. (1987) on the other hand argued that projection of incomplete records in buffalo. could be misleading and that sire selection on the basis of actual lactation yields (no adjustments. for incomplete records) would be more efficient than on the basis of standardized lactation

records (standardized to 335 days). This conclusion was based on higher heritability of actual yield and thus higher sire breeding values for actual as compared to standardized lactation records. In Friesian, Norman et al. (1985) demonstrated that adjustment of completed records of less than 305 days was a better choice. Higher heritability and repeatability estimates were obtained when all records were projected as compared to projection of incomplete records only. The difficulty in determining that why lactations were terminated was the basic reason for suggesting that all lactations of less than 305 days be projected. But as the methodology used for such extensions was based on last test day yield. additional credit that a completed lactation gets depends on the last available monthly record, magnitude of which is very small. Different heritability estimates of milk yield in buffaloes from lactations of different length have also been reported (Cady et al., 1983; Metry et al., 1994).

The method of adjustment is also important as simply ignoring a degree or two of polynomials might adjust the lactations differently especially when lactations are extremely short. Care is needed in the interpretation of results also. The best option would be to have exact reason(s) for short lactations to be recorded for use in data analysis and realistic interpretation. As the new methodology of animal evaluation requires the use of all available information, as old as a few generations back, future recording procedures should be tuned to these requirements.

In the present situation, solutions suggested earlier (Khan and Gondal., 1996) to develop correction factors from models similar to that of Wood (1967) may still be a better alternate. However, if information on lactation is complete and last test day method of correction is used (Iqbal, 1996), the prediction of milk yield for unknown part of lactation only would be a better choice. This, of course, would cause the formats of daily/monthly sheets and history sheets to be changed. At field level it might be difficult to record a lot of information. Thus accurate recording for the first few months would be more meaningful. Predicting 305 days yield from last test day yield, common in developed production recording schemes of intensively raised cattle, may be a better alternative.

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