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SOME FACTORS AFFECTING THE SHAPE OF LACTATION CURVE IN PAKISTANI DAIRY BUFFALOES

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The lactation curve constants derived from gamma type model $Y = A\, n^{b}\, e^{-cn}$ (Wood, 1967) expressed in logarithmic form fitted to 707 lactation records of dairy buffaloes maintained at two different military dairy farms in Pakistan, were subjected to least squares analysis. The constant a showed a significant effect of season of calving, lactation length (both $P<0.01$) and farm ($P<0.001$). Both constants (b and c) differed significantly for buffaloes calving in different seasons, with different lactation lengths (both $P<0.001$) and of different lactation numbers ($P<0.05$).

INTRODUCTION

The rate of milk secretion in dairy animals displays a trend throughout the lactation period. It increases to maximum in a few weeks following parturition and decreases thereafter until the animal goes dry. This trend can be expressed by a curve, namely the lactation curve. While the lactation curve gives indication of total lactation yield, the analysis of the shape of lactation-curve provides valuable estimates of the output of milk at different stages of lactation which help in the management and forward planning of a dairy herd.

Animals differ in the duration of the period of increase in milk production, in the rate at which it occurs and in the maximum level it attains. Differences are also found in the rate at which the decline occurs. These differences may be attributable to different factors like farm, season of calving, age of animal, parity, etc. (Wood, 1969; Ragab et al. , 1973; Bhat and Kumar, 1978; Rao and Sundaresan, 1981).

In most of the countries, the buffaloes have been used for draught purpose but in Pakistan buffaloes of Nili- Ravi breed have a reputation for high milk yield. Chaudhary and Ahmed (1978) reported the average lactation yield of Nili-Ravi buffaloes at an experiment station in Pakistan to be 2071 kg with some outstanding buffaloes producing 4090 kg in 305 days. An attempt has been made in this study to investigate the shape of the lactation curve and factors influencing it in Pakistani dairy buffaloes.

MATERIALS AND METHODS

Data on buffalo herds maintained at two different military dairy farms in Pakistan were collected. Daily production records of over a thousand lactations were available. The incomplete records and those affected by disease were excluded. The remaining 707 lactation records of not less than 182 days duration were used in the study. The buffaloes on these farms were recorded to be of Nili-Ravi breed. Data comprised calving throughout calendar year, parities 1-8 and lactation lengths varying from 182-385 days.

The IBM 370/168 computer in the computing laboratory University of Newcastle Upon Tyne was used for storage and analysis of data. The Statistical Package for Social Sciences (SPSS, 1976) was used for handling and analysis of data.

The lactation curve model $Y_n = A\ n^{b}\ e^{-cn}$ proposed by Wood (1967) expressed in logarithmic form was fitted to the data. In this model Yn is the average yield in the week and A, b and c are con-

stants. The constant A is a general scaling factor associated with the average daily yield at the start of lactation, b is a constant representing the rate of increase to peak production and c represents the rate of decline thereafter.

To study the influence of environmental factors a least squares analysis was carried out. Because of the unequal class numbers, Harvey (1968) least squares and maximum likelihood general purpose program was used. The significance of variance shown by certain factors was tested by Duncan's Multiple Range Test (DMR) as modified by Kramer (1956).

RESULTS AND DISCUSSION

The overall mean and standard deviation for the a,b and c constants of the lactation curve $Y = A\, n^b\, e^{-cn}$, expressed in logarithmic form were:

a,	37.453	S. D.	10.003
b,	0.300	S. D.	0.162
c,	0.037	S. D.	0.017

The analysis of environmental factors when studied individually may not be adequate, because of the possibility of interrelationship. The data were therefore, analyzed with farm, lactation number and season of calving as main effects and lactation length as continuous independent variable.

Table 1 presents the least squares mean lactation curve constants derived from the model. The analysis of variance for least squares mean lactation curve constants is presented in Table 2.

Table 1. Least squares mean lactation curve constants

Main effect	a constant	S.E.	b constant	S.E.	c constant	S.E.
Overall mean	36.885	0.583	0.3108	0.0090	0.0388	0.000898
Lactation No.						
1.	35.000	0.883 z	0.2855	0.0136 z	0.0353	0.001359 z
2.	36.635	0.696 z	0.3282	0.0107 y	0.0404	0.001071 y
3.	37.003	0.790 z	0.3350	0.0122 y	0.0411	0.001216 y
4.	36.521	1.009 z	0.3401	0.0156 y	0.0404	0.001553 y
5.	38.501	1.325 z	0.3380	0.0205 zy	0.0397	0.002039 zy
6.	37.317	1.713 z	0.3223	0.0266 zy	0.0401	0.002637 zy
7.	38.357	2.211 z	0.2654	0.0342 zy	0.0342	0.003402 zy
8.	35.745	2.587 z	0.2721	0.0401 zy	0.0388	0.003981 zy
Seasons:						
1. Summer (Jun.- Aug.)	40.158	0.816 y	0.2284	0.0126 y	0.0325	0.001255 z
2. Autumn (Sep.- Nov.)	35.642	0.716 z	0.2716	0.0110 x	0.0343	0.001101 z
3. Winter (Dec. - Feb.)	34.446	0.918 z	0.3669	0.0142 z	0.0409	0.001414 y
4. Spring (Mar.- May)	37.293	1.113 z	0.3765	0.0172 z	0.0475	0.001714 x

Table 1. continued

Farms:						
Rawalpindi	39.694	0.631 z	0.2989	0.0098 z	0.0381	0.000970 z
Peshawar	34.077	0.791 y	0.3228	0.0123 z	0.0396	0.001218 z

Least squares constants connected by the same letters are not significantly different from each other.

Table 2. Analysis of variance for least squares mean lactation curve constants

Source of variation	d. f.	Mean squares		
		a	b	c
Lactation number	7	86.368 NS	0.0461 *	0.000473 *
Season of calving	3	1052.505 **	0.7438 ***	0.005718 ***
Farms	1	4172.769 ***	0.0758 NS	0.000307 NS
Regression				
Lactation length	1	722.749 ***	0.4084 ***	0.027886 ***
Remainder	694	90.827	0.0218	0.000215

(NS) Non-significant; (*) P< 0.05; (**) P < 0.01; (***) P<0.001.

Lactation number: Although the variation in the initial yield among different lactations was not significant, the rate of both the increase and decrease in milk yield varied significantly between different lactations. A trend of a gradual increase from the first to the fourth lactation existed for both constants b and c; heifers being more persistent than older buffaloes. Bhat and Kumar (1978) reported similar findings in Indian buffaloes. In dairy cows, Wood (1969) also reported that young cows start their lactations from a lower level, rise more slowly to peak yield and are more persistent. Higher persistency in first lactation in cattle and buffaloes may be attributable to the fact that they do not attain very high peaks and their level of milk production is low, which is thus easy to maintain.

Season: The effect of season of calving is largely dependent on the availability of green fodder and managemental practices adopted to protect the animals against adverse climatic conditions.

The cropping pattern in Pakistan is such that during certain parts of the year e.g. November and December, and also March and April, abundant green fodder e.g. berseem, shaftal, lucerne, maize, sorghum and barley,is available, but there is an acute shortage during summer and early autumn due to the dry hot weather.

Buffaloes calving in spring were probably in higher body condition at the time of calving, had the advantage of abundant green fodder in early lactation and therefore rapidly rose to a high peak yield, while the fodder scarcity in summer resulted in a rapid decline.

The autumn calving buffaloes on

the other hand, suffered the adverse conditions of summer before calving and thus did not attain very high peak milk yields. Because of better feeding conditions during December to April, the rate of decline in milk yield was, however, reduced.

The winter calvers showed relatively high peaks followed by relatively slow rates of decline in milk yield for most of the remainder of the lactation. This was probably due to mild weather conditions and the availability of abundant green fodder during the middle of the lactation in spring.

The rate of increase to peak and decline thereafter in summer calvers was slower than for those calving in any other season. It is likely that buffaloes calving in summer had the advantage of being in better body condition at calving as a result of favourable feeding conditions in spring. The poor quality of the summer fodder probably contributed towards the slower rate of increase to peak. The adverse effect of poor feeding in early lactation was carried through the rest of the lactation and the improved feeding conditions during autumn probably helped to arrest the rate of decline in production.

Farm: The analysis of the lactation curve constants showed a significant variation in constant a (initial milk yield) between the buffaloes of the two farms, those at Rawalpindi giving higher initial yields.

Constant a is a scaling factor and relates to the initial production level of the herd and the specific potential of individual buffaloes. Generally, additions and replacements of the herds under study were with farm-produced heifers but on occasions they were purchased from outside, their selection being on the basis of the Nili-Ravi breed phenotype and high milk production characters. Because of its location, the Rawalpindi farm probably received the buffaloes with high initial yield, purchased from outside.

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