LACTATION CURVE OF SAHIWAL CATTLE

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ABSTRACT

Milk yield recorded at a weekly interval throughout a lactation period of 40 weeks was utilized to model lactation curve of Sahiwal cattle. A gamma-type function was used to predict the shape of curves for different parities and calving seasons. The co-efficiants for the initial yield (alpha), increase towards peak (beta), and decline after peak (ceta), were estimated for 1084 lactations. The effects of year, season of calving and parity on these co-efficients were studied in a fixed effect model. About 36% of the lactations were atypical/abnormal (having negative beta or positive ceta). The overall estimates (in 681 normal lactations) for the alpha (in the log form), beta (per log of week), ceta (per week), and peak yield were 1.87, .202, 0.29, and 8.23 kg. Peak yield was obtained around 7th week of lactation. Out of the three parameters estimated, initial milk yield and decline from peak differed (P<0.01) among different parities while increase towards peak was statistically similar. Peak yield among parities was also different (P<0.01) among different parities while increase towards peak was statistically similar. Peak yield among parities was also different (P<0.01). Parameters were also different for the two seasons. Among parities, co-efficients were different for cows calving for the first time as compared to later parity cows. Highest peak yield (8.96 kg) was estimated for fifth parity cows while first parity cows had the minimum peak yield (7.54 kg). Lactation curves of first and later parity cows differed in shape and other attributes as well. Very high percentage of atypical/abnormal curves need further investigation.

INTRODUCTION

Lactation curves in diary animals have extensively been used for early prediction of milk yield and thus culling the low producers, forward planning for feed and farm resources and unbiased ranking of sires by using incomplete records of their daughters. Effect of environmental factors on lactation curve co-efficients have been studied for most of the temperate breeds. Wood (1969) reported calving month seasonality effects on lactation curve of Holsteins. Madalena *et al.* (1979) used Wood's equations to describe the lactation curve of purebred and crossbred Holsteins. Grossman *et al.* (1986) indicated possibility of changing the shape of the lactation curve by exploiting the non-additive genetic variance. Grossman and Koops (1988) examined the diphasic nature of the lactation curve and suggested that their parameters be used in feeding and selection of dairy cattle. Recent studies on lactation curve include comparison of models in Jersey (Roy and Katpatal, 1993) and Holstein (Sherchand *et al.*, 1995) cattle and environmental effects on lactation curve co-efficients in Nili-Ravi buffaloes (Khan and Gondal, 1996; Ali, 1996). Present study investigates the behaviour of lactation curve of Sahiwal cows with different parities and calving in different seasons.

MATERIALS AND METHODS

Daily milk yield data recorded at a weekly interval for 680 cows completing their lactations of 280 days during 1970-93 at Livestock Experiment Station, Bahadurnagar, Okara were used. A total of 1084 such lactations met the editing criteria of lactation length and other norms. Shape of the lactation curve was estimated through a gamma type function (Wood, 1967) as follows:

$$Y = ab^n e^{-cn}$$

where

Y daily milk yield (kg), recorded at a weekly interval
n week of lactation length (1 to 40)
a, b, c alpha, beta and ceta co-efficients

The logarithmic form of the model would be:

$$\ln(Y) = \ln(a) + b \ln(n) - cn$$

The above equation was fitted to each lactation curve to estimate the above co-efficients. Weeks to peak were defined as a ratio of b and c co-efficients (b/c) while peak yield was equal to $a(b/c)^b c^{-b}$. These lactation parameters were then fitted in a fixed effect model to analyze variation. Lactations with positive beta and negative ceta were only used for parity and season of calving effects. Lactations for which estimated peak yield was more than 20 kg were also not included. The fixed factors included in the model were: years, season of calving, their interactions and parities. Macros were defined in QPRO (Anonymous, 1993) to run the 1084 regression analyses.

RESULTS AND DISCUSSION

Out of the 1084 lactations modeled, 381 had a negative beta i.e. they did not rise towards a peak after the initial milk yield in the first week of the lactation (Table 1). Most of these lactations were for the earlier rather than later parities. Out of 380 lactations for the cows calving for the first time, more than 35% were estimated to have decline instead of rising after the initial milk production. When lactations were grouped on the basis of season of calving, about half of those calving in summer months did not rise towards peak. Lactations that did not show a decline after the peak (negative ceta) were 202, of which 170 were represented in the summer while 32 in the winter. Thirty six percent of the total lactations were atypical/abnormal and most were those initiated in the summer rather than winter months. These values were quite higher than 1.8% reported in Egyptian buffaloes (Mansour *et al.*, 1993) and 4.6% reported in Nili-Ravi buffaloes (Khan and Gondal, 1996).

Lactation curve co-efficients are presented in Table 2. The overall values for alpha, beta and ceta from the normal curves were 1.87, 0.202, and 0.029, respectively. The average peak yield for such lactations was 8.23 kg which was obtained in the 7th week of lactation. The so called normal lactations were 63% of the total lactations included in the study. The co-efficients thus do not represent the population averages. Also, lactations were required to be of 280 days which left many lactations out.

Year had significant effect on initial milk yield, peak yield, and decline from peak yield (Table 2). Season also affected all the co-efficients significantly ($P<0.01$). Parity effects were also significant ($P<0.01$) on initial milk yield, peak yield and decline from the peak. First calvers had the lowest initial milk yield (Table 3) but co-efficients for other parities were statistically similar. Increase towards peak was similar among different parities but decline from peak was different statistically, highest decline being in the third parity cows. Curves were different for the two calving seasons with respect to all the co-efficients. Significant effect of period, season of calving and parity on lactation curve co-efficients was reported by Cheema and Basu (1991). Mansour *et al.* (1993) and Khan and Gondal (1996) also reported different shapes of lactation curves for parities and seasons of calving.

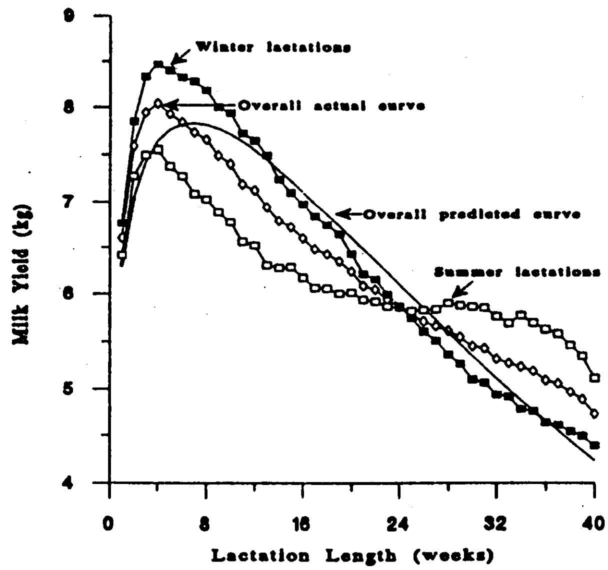

Fig. 1: Predicted and actual lactation curve of Sahiwal cows

The overall estimated lactation curve along with the actual curve is presented in Fig. 1. It may be observed that the overall yield around peak, estimated weeks to obtain peak a bit late, over estimated yield around mid of the lactation with some over estimation towards the end of the curve. The actual curves for cows calving in different seasons had different behavior, especially towards the end of the lactation period. Cows calving in summer had a rise towards the end while cows calving in winter had a decline. This probably was due to improvement or deterioration in seasonal conditions as well as changes in feed and fooder availability. As season would switch after six month, cows calving during summer may experience winter for the later part of their lactation. Similarly, milk yield of cows calving during winter may be adversely affected by the summer for at least some months towards the end of their lactation. Models have been suggested to account for such seasonal effects. The stimulus to milk production

Table 1: Distribution of lactations with respect of co-efficients of lactation curve in Sahiwal cattle.

	No.	b < 0	c > 0	b < 0 or c > 0	% abnormal
Parity					
1	380	144	78	148	39
2	249	95	47	97	39
3	191	64	37	66	34
4	145	42	23	42	29
5	119	36	17	38	32
Total	1084	381	202	391	36
Season					
Summer	501	250	170	260	52
Winter	583	131	32	131	22

Table 2: F-ratios of analysis of variance for lactation curve co-efficients, peak yield and weeks to attain peak.

Source of variation	DF	Alpha	Beta	Ceta	Peak Yield	Weeks to Peak
Year (Y)	23	5.0^{**}	1.3^{NS}	1.7^{*}	5.2^{**}	3.8^{**}
Season (S)	1	24.6^{**}	19.9^{**}	123.8^{**}	53.5^{**}	32.5^{**}
Y x S	21	2.2^{**}	0.9^{NS}	2.3^{**}	2.1^{**}	3.0^{**}
Parity	4	13.0^{**}	1.3^{NS}	5.2^{**}	18.1^{**}	0.9^{NS}
Error	631					

*Significant (P<0.05) **Significant (P<0.01) ^{NS}Non-significant

Table 3: Means* for different parameters of lactation curve, peak yield and weeks to attain peak for different parities and calving seasons.

	N	In a	b	c x 10	Peak Yield	Weeks to Peak
μ	681	1.87	0.202	0.293	8.23	6.94
Parity						
1	228	1.79b	0.202a	0.289ab	7.54c	6.81a
2	147	1.91a	0.185a	0.288b	8.36b	6.87a
3	124	1.88a	0.214a	0.315a	8.41b	7.04a
4	102	1.91a	0.210a	0.292ab	8.78ab	7.20a
5	80	1.94a	0.208a	0.299ab	8.96a	6.98a
Season						
Summer	232	1.82a	0.167a	0.212a	7.71a	8.05a
Winter	449	1.89b	0.221b	0.335b	8.50b	6.37b

*Means with different letters in a column differ significantly (P<0.05) associated with the season of production, called as 'spring hump seasonality' has been reported (Wood, 1969). Also, effect on the total yield, independent of the spring hump, associated with period of the year in which lactation occurs was reported, where winter calvers had higher average yield as compared to summer calvers. Grossman *et al.* (1986) suggested improvement in the original Wood's equation (Wood, 1967) by incorporating sine waves fitted to constants of month fresh. This was accomplished by having the combined effect of sine and cosine terms fitted over the 12 months of the year. The modified equations accounted on the average, 92.8% variation in log weekly yield as compared to 82.3% by Wood's equation. This substantial improvement in prediction could however, not be achieved in the study of Ali (1996) on 250 lactations of buffaloes and matter needs further exploration.

Some 36% of the lactations of Sahiwal cows could not be modeled by Wood's equation. The behavior of the lactations was different for different parities and coefficients depended on the season in which lactations were initiated. Very high percentage of atypical lactations for the summer calvings needs further investigations.

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