Journal of Animal and Veterinary Advances 2 (10): 548-553, 2003

Lactation Yield, Length and Persistency of Lactation in Holstein Cows under the Subtropical Environment of North West Frontier Province (NWFP)

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Abstract: Information on production and reproduction traits from 1982 through 1992 of imported anf farm-born Holstein cattle maintained at Government Cattle Breeding and Dairy Farm, Harichand, Charsadda were collected to investigate lactation length, dry period and persistency of lactation and some of the factors affecting these traits. Overall mean lactation length, dry period and persistency of lactation was 315.46 ± 3.62 days (coefficent of variation, 29.88%), 134.47 ± 5.65 (coefficient of variation of 93.38%) and 90.5 ± 0.01%, respectively. The lower and upper limits of 95% confidence interval for lactation length, dry period and persistency of lactation were 308.3, and 315.46 days, 123.30 days, and 45.65 days and 89.75%, and 90.82%, respectively. Imported cows had longer length of lactation and shorter dry period than in farm-born cows while persistency of lactation was same. Year and season of calving had a significant ($P<0.01$) effect on lactation length, dry period and persistency of lactation. Lactation length was found significantly ($p<0.01$) correlated with age at first calving ($r=-0.20$), milk yield per day of age at second calving ($r=0.26$) and lactation yield ($r=0.69$). Dry period had a significant ($p<0.01$) correlation with age at second calving ($r=0.43$), calving interval ($r=-0.78$) and lactation yield ($r=-0.13$). Persistency of lactation had a significantly ($P<0.01$) negative correlation with puberty age ($r=-0.23$). Efforts should be made to achieve optimal lactation lengths, shorter dry periods and appropriate calving interval by improving reproductive efficiency of the herd. Protection of animals from extreem of hot climates, availability of green fodder and possibilities of voluntry culling should be sorted out to aviod further deterioration in genetic potentials of the progeny.

Key words: Confidence interval, dry period, Holstein lactation length and persistency

Introduction

Lactation length, dry period and persistency of lactation are the relative traits amongst other milk production traits affecting overall efficiency of milk production. For maximizing profits, a 305-day lactation length is considered to be ideal; which allows for a two months dry period with a required calving interval of 365 days (Campbell and Marshall, 1975). Unduly longer lactation length would indicate poor reproductive efficiency of the herd resulting in less profitable dairy enterprise. This idea was also supported by Wood (1985) and Djmali and Berger (1992) stating that for economical productivity a cow should calve down each year attaing a 305-day lactation length and an optimal dry period of (43-60 days;). Syed *et al.* (1996) reported larger amount of 305-day milk yield, reduction in length of dry period and higher perssitency of lactation as the important factor for economical milk production. Any variation in the lactation length, persistency of lactation and length dry period would affect milk production performance in general and lifetime productivity in particular. Smaller lactation lengths and dry periods of less than 40 days markedly reduced milk in the commencing lactation (Coppock *et al.*, 1972 and Djmali and Berger, 1992). Similarly, increased length of dry period didn't improve lactation yield while cows that were more persistent in lactation yield higher milk (Syed *et al.*, 1996).

Management of the herd and seasonal influences could induce wide variability in length of lactation and dry periods. Shah (1986) and Syed *et al.* (1996) in Paksitan reported significant influences of season of calving on lactation lengths and length of dry period of Holstein cows. Holstein being native to temperate climate is expected to perform poor under inappropriate management and or in a hot climate. Morover, accumulation of inbreeding and poor selection planning would adversely affect milk production performance of these cows under a subtropical envirnoment. Keeping in view such constraints, the present investigation was undertaken to study the lactation length, dry period and persistency of lactation and some of the factors affecting these traits of Holstein cattle under subtropical envirnoment of NWFP, Pakistan.

Materials and Methods

Information on production & reproductive performance of farm-born and imported Holstein cows kept at the Government cattle breeding and dairy farm (CB&DF), Harichand Charsadda from 1982 through 1992 were utilized to study lactation length, dry period and persistency of lactation and some of the factors

affecting the aforementioned traits. Data on individual birth, service, calving and drying dates and milk yield were recorded for the study. The cows were categorized into two groups. Group I included the imported cows and Group 2 comprised farm-born cows. Service period for individual cows was determined from the date of calving and post-partum date of service. The age at first calving and first lactation length were calculated for each cow using the dates of conception, dates of calving and the dates dried. Calving intervals and days dry for each cow were found using consecutive drying and calving dates. The lactation terminated due to abortion, sale or death of the animal, were considered as abnormal and therefore not included in the analysis. Milk records were corrected for the age at first calving and the length of calving interval using the following quadratic equation for a second-degree curve.

$$\hat{Y} = b_o + b_1 x_1 + b_2 x^2_1$$

Where "$\hat{Y}$" was the predicted milk yield, "b_i" the regression parameters and "X_i" the variables affecting milk yield (the age at first calving or calving interval)
The correction factors R_i were equal to $\hat{Y}/Y_i$ where $\hat{Y}$ was the predicated milk for a particular age at first calving (or calving interval) and Y_i was the actual milk yield for that particular age at first calving (or preceding calving interval).
The data collected were analyzed using relevant statistical procedures. Mean ± standard error and coefficient of variation for each trait were computed. Considering both groups of cows collectively, a 95% confidence interval around the mean for each trait was constructed as follows;

$$95\%\ CI = \hat{\mu} \pm t_{0.05} (\hat{\sigma}/\sqrt{n})$$

Where "$\hat{\mu}$" was th e sample mean, "$\hat{\sigma}$" the sample standard deviation and "n" the number of observations. Proportion of cows in the two groups falling above and below the upper and lower limits of confidence interval for each trait was determined.
To investigate the effect of season of calving on various traits, a year was split into four seasons as follows:

1. Winter = December through February
2. Spring = March and April
3. Summer = May through August
4. Fall = September through November

The course of each lactation was divided into one-month intervals. Average monthly; yields based on all lactations were predicted from ascertaining the trend of lactation curve. Persistency index for each lactation was worked out by the numerical expression given by Ludwick and Petersen (1943) as follows:

$$P = \frac{\frac{X_2(n)}{X_1} + \frac{X_3(n-1)}{X_2} + \frac{X_4(n-2)}{X_3} + \frac{X_n[n-(n-2)]}{X_{n-1}}}{N(n-1) - \frac{[(n-1)(n-2)]}{2}}$$

Where, "P" was persistency index, "X" with the aid of subscripts designated the production of any Particular period after attaining the peak yield, "n" the nNumber of divisions into which lactation length was divided after attaining the peak yield
The persistency value calculated for each lactation was expressed in percentages. Maximum milk produced in a period of one month during lactation was designated as peak yield. Cows usually attain peak yield in second or third month of lactation. The effect of month peak yield on persistency of lactation was assessed. The peak yield in different lactations was divided into nine peak yield groups as follows:

Peak Yield Group 1 = peak yield ≤ 200 litres
Peak Yield Group 2 = peak yield from > 200 & ≤ 250 litres
Peak Yield Group 3 = peak yield from > 250 & ≤ 300 lires
Peak Yield Group 4 = peak yield from >300 & ≤ 350 litres
Peak Yield Group 5 = peak yield from > 350 & ≤ 400 litres
Peak Yield Group 6 = peak yield from > 400 & ≤ 450 lires
Peak Yield Group 7 = peak yield from > 450 & ≤ 500 litres
Peak Yield Group 8 = peak yield from > 500 & ≤ 550 lires
Peak Yield Group 9 = peak yield from >550

The effect of the amount of peak yield on persistency of lactation was estimated and the correlation between peak yield and persistency was worked out.
Cows in the herd were divided into three production groups namely; high yielders, medium yielders and low yielders on the basis of their 305/day standard yield. Average 305 days yield of all cows was considered and a 95% confidence interval was constructed around the mean 305 days yield. The cows producing above the upper limit of 95% confidence interval in 305 days

standard lactation were grouped as high yielders. Low yielders comprised the group of cows producing milk in 305 days below the lower limit of 95% confidence interval. The cows producing milk in 305 days within the 95 confidence interval were included in the medium group.

The effect of group (imported or farm-born), year and the season of calving on lactation length length was estimated by constructing the following statistical model adopting the procedure of Steel and Torrie (1981);

$$Y_{ijkl} = \mu + a_i + b_j + c_k + E_{ijkl}$$

Where "Y_{ijkl}" was the amount of trait measured onj-th cow in l_{th} group (imported or farm-born),

μ = the population mean, constant to all records,
a_i = the effect of l_{th} group i = imported, farm-born,
b_j = the effect of j_{th} year of calving; j = 1983..., 1992,
c_k = the effect of k_{th} season of calving; k = winter, spring, summer, fall,
E_{ijkl} = the residual term associated with each Y_{ijKL} assumed to be distributed normally and independently with mean zero and variance I $ó^2$.

A similar model was used to study the effect of group (imported or farm-born), year and the season of calving on dry period and persistency of lactation.

Correlations between traits considered were computed using the formula:

$$r_{X,Y} = \frac{Cov\ (X, Y)}{ó_x ó_Y}$$

Results and Discussion

Lactation Length: Overall mean lactation length of Holstein cows at CB&DF Harichand was 315.46 ± 3.62 days, with a coefficient of variation of 29.88% (Table 1). Average length of lactation in the present study was within the range reported for Holstein cows in various studies (Gual, 1982 ; Cheema, 1985 and Shah, 1986 and Campose *et al.*, 1994). Lactation length was found significantly ($p < 0.01$) correlated with age at first calving ($r = -0.20$), milk yield per day of age at second calving ($r = 0.26$) and lactation yield ($r = 0.69$). Delayed age at first calving was associated with shorter lactation length while cows having longer lactation length would be expected to produce more milk on lactation basis. For maximizing profits, a 305-day lactation length is considered to be ideal; which allows for a two months dry period with a required calving interval of 365 days (Campbell and Marshall, 1975). Unduly longer lactation length would indicate poor reproductive efficiency of the herd resulting in less profitable dairy enterprise. The observed mean lactation length of about 315.46 ± 3.62 day if retained would ensure relatively better performance of the herd maintained at CB&DF Harichand.

Lactation length of imported Holstein cows was longer (336 ± 6.30 days) than in farm-born (297.73 ± 3.47 days; Table 1). A 95% confidence interval was constructed around the mean lactation length of Holstein cows at CB&DF Harichand. The lower limit of 95% confidence interval was 308.3 days and the upper limit was 315.46 days. As shown in Table 2, more than 51% of the imported Holstein cows had shorter lactation length than the lower limit of 308.30 days. In the same group, a larger proportion (43.17%) of cows had longer lactation length than the upper limit of 315.46 days. Some 57% of the farm-born Holstein cows had shorter lactation length than the lower limit of 308.30 days. More than 37% of the cows in this group had longer lactation length than the upper limit of 315.46 days. In general, lactation length of imported cows was longer than cows born at the farm. If normal length of service period considered to be 60 days, then farm-born cows would have been remained dry for longer period of time. Farm-born cows had shorter lactation lengths and longer dry periods than imported cows. These cows were, therefore, relatively unprofitable than imported cows. The deterioration of various economic traits of farm-born cows could be partly because of practically zero voluntary culling at the farm and partly because the farm-born cows received relatively poor management. Also, the Holstein herd at CB&DF Harichand has been maintained as a closed herd in which few if any new sires were introduced during the period of study. Accumulation of inbreeding could therefore, be expected in the herd that was manifested in the deterioration of various traits of interest.

Year of calving had a significant ($P < 0.01$) effect on lactation length. Cows calved in 1992 had the shortest lactation length of 231.59 days followed by cows calved in 1991. Non-significant differences were found in lactation length of cows calved in 1990 and 1991. Cows calved during 1990 and 1991 had significantly ($P < 0.05$) longer lactation length than cows calved during 1985 through 1989. Cows calved during 1983 had the longest lactation length of around 397 days (Table 3). On the overall basis, cows calved in the initial years had longer lactation length than cows calved in the later years. The lactation length particularly shortened toward the end of the study period. These observations suggested declining of genetic capabilities of the herd as well as deterioration of management practices, linearly with the passage of

Table 1: Lactation length, dry period and persistency of lactation in imported and farm born Holstein cows

Traits	Overall	Imported	Farm-born
Lactation length (days)	315.46 ± 3.62	$336_{a} \pm 6.30$	$297.73_{b}241 \pm 3.47$
Dry period (days)	134.47 ± 5.65	$110.04_{b} \pm 7.00$	$159.01_{a} \pm 8.60$
Persistency of lactation (%)	90.5 ± 0.01	$0.90_{a} \pm 0.01$	$91.00_{a} \pm 0.01$

Means with differen subscripts across the columns for each row were significantly different at $\propto = 0.05$

Table 2: Proportion imported and farm-born Holstein cows falling above the upper and below the lower limit of 95% confidence interval

Traits	Above the upper limit of 95% confidence interval		Below lower limit of 95% confidence interval	
	Imported (%)	Farm-born (%)	Imported (%)	Farm-born (%)
Lactation length	43.17	37	51	57
Dry Period	13.31	39	81	60
Persistency of lactation	56.17	55	35	37

Table 3: Lactation length, dry period and persistency of lactation in imported and farm-born Holstein cows with respect to year of calving

Year of calving	Lactation length (days)	Dry Period (days)	Persistency of lactation (%)
1983	396.51_{a}	-	93.39_{a}
1984	318.49_{bcd}	442.07_{abcd}	90.11_{bc}
1985	325.20_{bc}	432.35_{bcd}	91.31_{ab}
1986	335.03_{bc}	411.00_{dc}	90.64_{bc}
1987	349.95_{b}	389.18d	90.37_{bc}
1988	312.62_{cd}	146.49_{b}	89.33_{bc}
1989	324.16_{bc}	139.79_{b}	88.40_{c}
1990	289.41_{de}	202.43_{a}	88.82_{bc}
1991	277.48_{e}	14.02_{a}	90.94_{abc}
1992	231.59_{f}	-	90.29_{bc}

Means with difference subscripts across the rows of each column seprately were significantly different at $\times = 0.05$

Table 4: Lactation length, dry period and persistency of lactation in imported and farm-born Holstein cows with respect to season of calving

Season of calving	Lactation length (days)	Dry Period (days)	Persistency of lactation (%)
Winter	310.71_{b}	140.27_{b}	89_{b}
Spring	325.11_{b}	185.03_{a}	92_{ab}
Summer	373.83a	119.04_{b}	95_{a}
Fall	309.714_{b}	161.23_{b}	91_{b}

Means with difference subscripts were significantly different at $\propto = 0.05$

time.

Seasonal influences on lactation length were significant ($p < 0.01$). Shah (1986) have reported influences of season of calving on lactation lengths of Holstein cows. Cows calved in summer in the present study, remained in lactation for longer period of time than cows calved during other seasons. Lactation lengths of cows calved in winter, spring and fall were, however, not different from each other (Table 4). Cows calved in summer were probably exposed to favorable environmental conditions (including fodder availability) relatively for longer period of time than cows calved in any other season.

Dry Period: Overall mean dry period of Holstein cows at the CB&DF, Harichand was 134.47 ± 5.65 days with a coefficient of variation of 93.38% (Table 1). Most of the research studies indicated shorter dry period in Holstein cows maintained under different environments than the findings of the present study (Fulsounder *et al.*, 1985, 50 ± 22 days; Shah, 1986, 70.14 ± 7.16 days and Correa *et al.*, 1990, 57.7 ± 17.9 and 61.4 ± 19.5 days). Conversely Cheeema (1985) reported longer dry period (146 ± 138 days) than the present findings. Significantly ($p < 0.05$) higher mean dry period was observed for farm-born (159.01 ± 8.60 days) than that for imported Holstein cows (110.04 ± 7.00). Dry period had a significant ($p < 0.01$) correlation with age at second calving ($r = 0.43$), calving interval ($r = -0.78$) and lactation yield ($r = -0.13$),

indicating that the cows having longer dry period produced smaller amounts of milk per lactation. The findings suggested that dry cows management at the CB&DF, Harichand was probably poor, which manifested in lower milk yield in the subsequent lactation. The cows exposed to faulty management during relatively longer dry period produced less milk in the following lactation, than the cows exposed to adverse management for shorter period of time. The present findings suggested that an increase in the length of dry period did not increase milk yield in the subsequent lactation. Similarly, shorter dry period had no adverse effect on milk yield in the subsequent lactation. Effort should, therefore, be made to achieve shorter dry period by improving reproductive efficiency of the herd at the CB&DF, harichand. Syed *et al.* (1996) also reported negative correlation of dry period with 305-day milk yield.

A 95% confidence interval was constructed around the mean dry period in Holstein cow at the CB&DF, Harichand. The lower limit of 95% confidence interval was 123.30 days and the upper limit was 145.65 days. As shown in Table 2, more than 81% of the imported Holstein cows had shorter dry period than the lower limit of 123.30 days. In this group, a proportion of 13.31% cows had longer dry period than the upper limit of 145.65 days. Some 60% of the farm-born Holstein cows had shorter dry period than the lower limit of 123.30 days. In the same group, nearly 39% of the cows had longer dry period than the upper limit of 145.65 days.

Year and season of calving had a significant ($p<0.01$) effect on dry period. The longest dry period was observed in cows calved during the year 1984, although not different from the dry period of cows calved in 1983, and 1985 through 1987 (Tables 3). The cows calved in spring had the longest dry period than those calved in other seasons (Tables 4). The longer dry period in spring calvers is attributable to seasonal breeding carried out at CB&DF, Harichand during the study period. Breeding was usually started in August and terminated at the end of March. Thus, cows calving in April would have been served later that could have resulted in a delay in calving calling for extended dry period.

Persistency of Lactation: Overall persistency of lactation showed a wide range (49 to 99%) between both group of cattle. Persistency of lactation among imported Holstein cows ranged from 63 to 99%, while in farm-born Holstein cows it varied from 49 to 99%. The mean values for persistency of lactation in imported ($90 \pm 0.01\%$) and farm-born Holstein cows ($91 \pm 0.01\%$) were however, statistically not different. Persistency of lactation had a significantly ($P<0.01$) negative correlation with puberty age ($r=-0.23$). Cows attaining puberty at delayed age tended to have lower persistency of lactation. Similar relationship was observed between persistency of lactation and age at first calving. Persistency of lactation had a positive and significant ($P<0.01$) correlation with milk yield per day of age at second calving ($r=0.34$), lactation yield ($r=0.17$) and lactation length ($r=0.28$). Correlation of persistency of lactation with service period was 0.20 ($P<0.01$), suggesting that better persistent cows tended to have longer service periods. Persistency of lactation had non-significant correlation with calving interval ($r=0.12$) and dry period ($r=0.04$).

A 95% confidence interval was constructed around the mean persistency of lactation of Holstein cows at CB&DF Harichand. The lower limit of 95% confidence interval was 89.75% and the upper limit was 90.82%. More than 35% of the imported Holstein cows had lower persistency of lactation than the lower limit of 89.75% (Table 2). In this group, a larger proportion (56.17%) of cows had higher persistency of lactation than the upper limit of 90.82%. Nearly 37% of the farm-born Holstein cows had lower persistency of lactation than the lower limit of 89.75%. In this group, some 55% cows had higher persistency of lactation than the upper limit of 90.82% (Table 2).

Year of calving had a significant ($P<0.05$) effect on persistency of lactation. Cows calved in 1983 were better persistent than cows calved in 1984 and 1986 through 1992 (Table 3). Persistency of lactation of cows calved in 1983 and 1985 was similar. Minimum persistency of lactation of 88.4% was observed in cows calved in 1989. No significant differences were found in the persistency of lactation of cows calved in 1984 through 1989. Season of calving had a considerable ($P<0.01$) effect on persistency of lactation. Cows calved in winter had persistency of nearly 89% and were less ($P<0.05$) persistent than cows calved in summer and equally persistent as cows calved in spring and fall (Table 4). Mahto *et al.* (1981) also reported significant influence of season of calving on persistency of lactation. According to Ghaffar *et al.* (1984) low persistency of lactation in autumn calvers was because of scarcity of fodder. During the present study, cows calved in summer were better persistent than cows calved in fall and winter. In other words, lactation curves of cows calved in summer was less steeper than cows calved in fall and winter. This could be due to lower mean ambient temperature prevailing during most part of lactation of cows calving in summer and also better availability of green fodder. The variation in findings of different research workers could be viewed in the context of the availability of feed and prevailing environmental stress in different locations, where the studies were conducted.

Conclusion

Imported cows had longer length of lactation and shorter dry period than in farm-born cows. These observations suggested declining of genetic capabilities of the herd as well as deterioration of management

practices, linearly with the passage of time. Cows calved in summer were probably exposed to favorable environmental conditions (including fodder availability) relatively for longer period of time than cows calved in any other season. Dry cows management at the CB&DF, Harichand was probably poor, which manifested in lower milk yield in the subsequent lactation. The cows exposed to faulty management during relatively longer dry period produced less milk in the following lactation, than the cows exposed to adverse management for shorter period of time. The present findings suggested that an increase in the length of dry period did not increase milk yield in the subsequent lactation. Similarly, shorter dry period had no adverse effect on milk yield in the subsequent lactation. During the present study, cows calved in summer were better persistent than cows calved in fall and winter. In other words, lactation curves of cows calved in summer was less steeper than cows calved in fall and winter. This could be due to lower mean ambient temperature prevailing during most part of lactation of cows calving in summer and also better availability of green fodder. Cows attaining puberty at delayed age tended to have lower persistency of lactation. Similar relationship was observed between persistency of lactation and age at first calving.

Efforts should be made to achieve optimal lactation lengths, shorter dry periods and appropriate calving interval by improving reproductive efficiency of the herd at the CB&DF, Harichand. Animals should be protected from extreme of hot climates and green fodder availability shall be ensured through proper planning. Possibilities of voluntry culling should be sort out to aviod further deterioration in genetic potentials of the progeny.

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