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ENVIRONMENTAL FACTORS AFFECTING MILK YIELD AND LACTATION LENGTH IN SAHIWAL CATTLE

I.R. Bajwa, M. S. Khan, M. A. Khan[1] and K. Z. Gondal[2]
Department of Animal Breeding and Genetics, University of Agriculture, Faisalabad,
[1]Livestock production Research institute, Bahadurnagar, Okara
[2]Department of Livestock Management University of Agriculture, Faisalabad-38040, Pakistan

ABSTRACT

Weekly milk yield records on 661 Sahiwal cows calving during 1990-2000 at the Livestock Experiment Station Bahadurnagar, Okara were used to study how milk yield and lactation length were affected by different environmental factors. Lactation milk yield averaged 1475 ± 651 kg for an average lactation length of 248 ± 67 days (n=2039). Year of calving and season of calving both significantly (P<0.01) affected milk yield and lactation length. Age within parity also significantly affected the two traits. Winter calvers produced more milk (1546 kg) as compared to summer calvers (1362 kg). Milk yield gradually increased towards 4th and 5th parity and declined thereafter, while highest lactation length (263 days) was observed for first parity cows. The repeatability estimates for lactation length and milk yield were 0.326 ± 0.025 and 0.46 ± 0.041, respectively. When milk yield was adjusted for lactation length by different procedures, all the variation in milk yield due to lactation length could not be removed (weeks in milk effect remained significant). The environmental factors such as year, season of calving (and their interaction) and age at calving still affected milk yield significantly (P<0.01). The extent of season of calving effect however, reduced. Phenotypic trend for milk yield over the last 10 years was negative while lactation length had a positive trend which needs further exploration. The environmental factors under study were suggested to be incorporated in the models when variation in milk yield needed partitioning into genetic and non-genetic components.

Key Words: Lactation length, milk yield, phenotypic trend, Sahiwal cattle.

INTRODUCTION

Sahiwal cattle breed of Pakistan is considered as the best cattle breed for milk production in tropical conditions (Maule, 1990). Population of this breed is decreasing as crossbreeding for dairying remains a major threat to its survival (Payne and Hodges, 1997). Environmental factors such as year and season of calving and age affect its productivity and there is a need to delineate them for unbiased genetic evaluation. Similarly, lactation length, which is one of the main factors affecting milk yield, itself is influenced by other factors. The objective of the present study was to see the effect of various environmental factors including year of calving, season of calving, age at calving and lactation length or milk yield that affect milk yield and lactation length in Sahiwal cattle.

MATERIALS AND METHODS

Weekly milk yield records for 2039 lactations of 661 Sahiwal cows maintained at the Livestock Experiment Station Bahadurnagar, Okara, from 1990-2000 were used for this study. Lactations shorter than 56 days were discarded from data.

To estimate the effect of environmental factors, following model was assumed

$$Y_{ijklm} = \mu + Y_i + S_j + YS_{ij} + Age(P)_k + LL_l + e_{ijklm}$$

Where

- Y_{ijklm} Lactation length or milk yield
- μ Population mean
- Y_i Effect of year of calving, for i =1…11
- S_j Effect of season of calving, for j = 1…2; summer (for cows calving from April to September) and winter (for cows calving from October to March)
- YS_{ij} Year and season of calving interaction
- $Age(P)_k$ Age at calving defined within parity, for k = 1…31
- LL_l Lactation length duration in weeks, for l = 1…37
- e_{ijklm} Random error

For lactation length, model was similar to the above but lactation length was omitted and milk yield was used as a co-variable. Least squares means for milk yield were computed by omitting lactation length from the model as milk yield was pre-adjusted for lactation length.

Milk yield adjustment for lactation length

Milk yield was adjusted for lactation length by using the last test day yield and average daily yield of the known part of the lactation (Khan and Chaudhry, 2001). Future daily milk yield of unrecorded lactation was predicted using last recorded daily milk yield and average daily yield of the recorded lactation. The estimated yield of unrecorded lactation was then added to the yield of recorded lactation to get an estimate of lactation (308-day) milk yield.

RESULTS AND DISCUSSION

Lactation length

Lactation length averaged 289.8 days with standard deviation of 68.88 days when minimum was forced to be at least 56 days and there was no restriction on the maximum value. However, when longer lactations were truncated at 308 days, average reduced to 247.7 ± 66.70 days. Year of calving, season of calving and their interaction affected lactation length, as did the age of the cow (within parity) and milk production (Table 1). All the effects were statistically significant (P<0.01). The repeatability estimate of lactation length was 0.326 ± 0.025.

Table 1: F-values from analysis of variance for lactation length

Source of variation	df	F-value
Cow (random)	660	2.46
Year of calving	10	14.84**
Season of calving	1	11.67**
Year x season	10	3.42**
Age within parity	30	3.29**
Milk yield	1	2152.37**
Error	1326	

** Significant (P<0.01).

Year wise means indicated that there was an increasing trend in lactation length over the last 10 years although, for 1999 and 2000, average lactation length again decreased (Figure 1) which may partly be due to inclusion of incomplete lactations in these years. This trend is not favourable because if genetically there has not been any progress in the herd (Talbott, 1994), the increase in lactation length further deteriorates the situation, as calving interval would be expected to increase as well. Phenotypic trend in lactation length for Nili-Ravi buffaloes at the same farm was also reported positive (Khan and Chaudhry, 2000) and infrequent culling of cows at an early age was reported as one of the reasons for such deterioration (Ahmad *et al*., 1992).

As shown in Table 2, least squares mean was higher for summer calvers (251.0 ± 1.81 days) as compared to winter calvers (243.8 ± 1.70 days). When means were averaged over parities highest value was observed for first parity (263 ± 8.8 days), while lowest value was for 4^{th} parity (239 ± 5.8 days). Graphical representation of trend in lactation length by parity is presented in Figure 2. Lactation length decreased from first to 4^{th} parity and increased afterwards towards 8^{th} parity. Higher mean for the 8^{th} parity group may be due to pooling of parities greater than 8^{th} in this category.

Milk yield

Environmental factors affecting milk yield are presented in Table 3. Year of calving and season of calving affected the trait significantly (P<0.01). The interaction of year by season of calving effect was non-significant for actual milk yield. Weeks in milk had the highest F-value (62.14) justifying the attention lactation length should get in milk yield adjustment. When milk yield was adjusted to 305-days, using last test day milk yield and average daily milk yield of the known lactation, the extent of variation controlled by these environmental factors varied. F-values for season of calving reduced appreciably but its interaction with year of calving reached statistical significance. Still the weeks in milk effect was statistically significant although F-values reduced to 7.45 as compared to 62.14 when no adjustments were made for lactation length. Thus, although the lactation length adjustment procedure adjusted milk yield for this factor, not all the variation due to lactation length was removed.

Looking at the phenotypic trend for the last 10 years, it is clear that there was a negative trend in milk yield over the years (Figure 1 and Table 2). There was some positive trend in the last two years. Yet average milk yield has been decreasing while lactation length increased. Adjusting the lactations for lactation length improved the situation slightly but if data points for the last two years were omitted, decline would be substantial. It may be mentioned that a similar situation has been reported earlier for buffaloes at this experiment station (Khan and Chaudhry, 2000). Although, definite conclusions are difficult to draw for overall situation, as data were limited by the number of

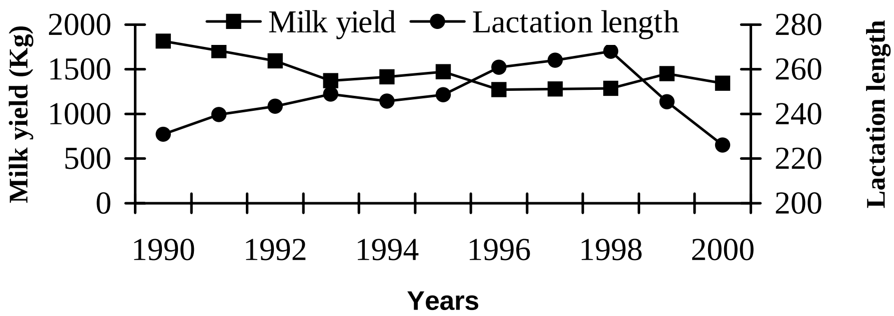

Fig. 1: Least squares means of milk yield and lactation length by year of calving

Table 2: Least squares means (±SE) of lactation length (days) and milk yield (kg) by year and season of calving

Years of calving	N	Lactation length	Actual milk yield	305 day milk yield*
1990	224	230.8 ± 9.82	1813.7 ± 136.24	2025.7 ± 96.66
1991	198	239.6 ± 8.07	1707.7 ± 112.39	1920.9 ± 79.82
1992	203	243.3 ± 6.25	1590.7 ± 87.62	1829.3 ± 62.36
1993	200	248.9 ± 5.03	1372.9 ± 71.25	1684.4 ± 50.84
1994	195	245.7 ± 3.58	1415.6 ± 51.93	1725.6 ± 37.32
1995	178	248.5 ± 3.32	1471.1 ± 48.52	1752.5 ± 34.94
1996	176	260.8 ± 3.49	1270.1 ± 50.40	1563.2 ± 36.25
1997	177	263.9 ± 4.79	1276.9 ± 67.86	1559.6 ± 48.47
1998	164	268.0 ± 6.59	1284.4 ± 92.33	1542.7 ± 65.67
1999	164	245.5 ± 8.43	1447.3 ± 117.51	1758.7 ± 83.43
2000	160	226.0 ± 10.22	1341.2 ± 141.96	1842.6 ± 100.69
Seasons of calving				
Summer	849	251.0 ± 1.81	1361.7 ± 29.40	1694.9 ± 21.78
Winter	1190	243.8 ± 1.70	1545.8 ± 28.15	1796.9 ± 20.94

N =Number of observations * Adjusted milk yield for lactation length

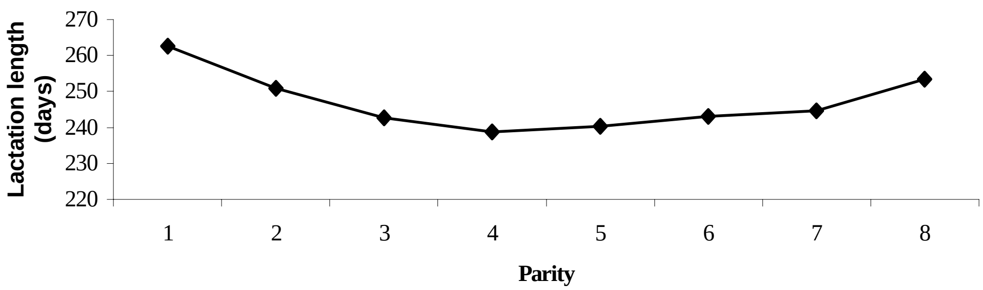

Fig. 2: Least squares means of lactation length by parity

Table 3: F-values from analysis of variance for various factors affecting lactation milk yield

Source	df	Unadjusted milk yield	Adjusted milk yield
Cow (random)	660	3.54	3.66
Year of calving	10	19.52**	21.84**
Season of calving	1	42.27**	17.95**
Year X Season	10	1.59^{NS}	2.51**
Age within parity	30	5.56**	5.07**
Weeks in milk	36	62.14**	7.45**
Error	1291		

** Significant (P<0.01), NS = Non-significant

years included and genetic trend was not worked out. However, if these results are read with the earlier reports on these animals (Talbott, 1994), situation needs immediate attention of the management as to why milk yield deteriorated over the years.

Season of calving affected both the lactation length and milk yield. Summer calvers had lactation length of 251.0 ± 1.81 days as compared to winter calvers where average lactation length was 243.8 ± 1.70 days. Milk yield on the other hand had the opposite trend. Summer calvers produced 184 kg less milk (1361 vs 1545 kg) as compared to winter calvers. Even after the adjustment for lactation length, winter calvers produced 1797 kg as compared to 1694 kg for summer calvers (Table 2). Many earlier studies on Pakistani Sahiwals reported that winter calvers produceds more than the summer calvers. Javed (1999) reported lowest milk yield of 1st parity Sahiwal cows calving in hot dry summer. When all parities were analysed, milk yield was maximum for winter calvers and minimum for those calving in hot and dry summer. Dahlin (1998) also reported that Sahiwal cows calving in winter season produced more milk than those calving in other seasons. Supply of abundant green fodder in winter as compared to summer season was given a plausible cause. Iqbal (1996), Talbott (1994), and Ahmad *et al.* (1978) also reported higher milk yield for Sahiwal cows calving in winter months than those calving in other seasons.

Age at calving across parities affected milk yield differently as least squares means for a certain age was in general different for different parities. For example, least square means of unadjusted milk yield for 67-72 months of calving were 1546.7±89.50 and 1506.2 ± 71.85 kg for 2nd and 3rd parities, respectively. Trend for age across parities was not consistent. For example adjusted milk yield had a negative trend for age at calving for first parity while for most of the other parities, trend was positive (milk yield increased with increase in age at calving). Averages of least squares means of milk yield across parities indicated that milk yield increased with increase in parity and maximum production was obtained around 4th and 5th parities where after there was a declining trend (Figure 3). Reports in the literature support these results. Earlier, Tahir *et al.* (1989) reported that milk yield was maximum in 5th lactation of Sahiwal cows. Dahlin (1998) and Ahmad (1999) also reported increase in milk yield towards third parity. But only three parities were included in these two studies. Javed (1999) reported increase in milk yield towards 5th parity and decline thereafter to 12th parity. In an Indian study on Sahiwal cattle (Deshpande and Sakhare, 1984), maximum milk yield was also reported for the 5th parity. A contradictory report that parity had no significant effect on milk yield (Dhumal *et al.*, 1989) is also available in the literature.

CONCLUSION

It is concluded that milk yield and lactation length are affected by year and season of calving. Adjusted milk yield (adjusted for lactation length) and lactation length are affected by year into season of calving interaction but actual milk yield is not affected by year by season of calving interaction. Age within parity also affected lactation length and milk yield. Negative phenotypic trend in milk yield is alarming and needs further investigations.

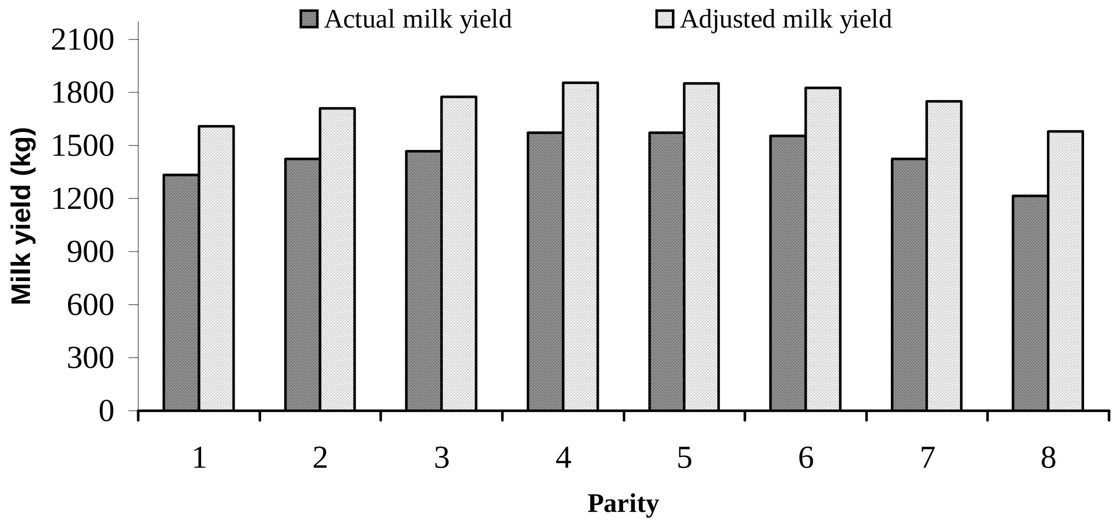

Fig. 3: Least squares means of milk yield by parity

REFERENCES

Ahmad, M., 1999. Genetic evaluation of native and crossbred dairy cattle in Pakistan. Ph. D. Thesis, Univ. New England, Australia.

Ahmad, Z., M.D. Ahmad, A.W. Qureshi, R.A. Gill and S.K. Fahmy, 1978. Genetic progress through selection in performance traits of Sahiwal cattle. Agric. Res. Rev., (Cairo) 56: 1-6.

Ahmad, Z., P.J. Berger and M.H. Healey, 1992. Estimated culling probabilities, age distribution, and expected herd life in Nili-Ravi buffalo. J. Dairy Sci., 75: 1707-1714.

Dahlin, A., 1998. Genetic studies on Sahiwal cattle in Pakistan. Ph.D. Diss. Swedish Univ. Agric. Sci., Uppsala, Sweden.

Deshpande, K.S. and P.G. Sakhare, 1984. Milk producing ability in Red Kandhari cows and its crosses. *Cherion.,* 13: 271-273 (Anim. Breed. Abstr. 53: 550).

Dhumal, M.V., P.G. Salhare and K.S. Deshpande, 1989. Factors affecting lactation milk yield and lactation length in Red Kandhari and crossbred cows. Indian J. Dairy Sci., 42: 102-104.

Iqbal, J., 1996. Sire evaluation on partial records in Sahiwal cattle and Nili-Ravi buffaloes. Ph.D. Thesis, Univ. Agric., Faisalabad.

Javed, K., 1999. Genetic and phenotypic aspects of some performance traits in a pure bred herd of Sahiwal cattle in Pakistan. Ph.D. Thesis, Univ. Agric., Faisalabad.

Khan, M.S. and H.Z. Chaudhry, 2000. Lactations length and its behavior in Nili-Ravi buffaloes. Pakistan Vet. J., 20(2): 81-84.

Khan, M.S. and H.Z. Chaudhry, 2001. Prediction of lactation yield from last record day and average daily yield in Nili-Ravi buffaloes. Buffalo Newsletter, 15: 7-10.

Maule, J. P., 1990. The Cattle of the Tropics. University of Edinburgh Center for Tropical Veterinary Medicine, Edinburgh.

Payne, W.J.A. and J. Hodges, 1997. Tropical Cattle. Origins, Breeds and Breeding Policies. Blackwell Science, Oxford.

Tahir, M., M.R. Qureshi and W. Ahmad, 1989. Some of the environmental factors influencing milk yield in Sahiwal cows. Pakistan Vet. J., 9: 173-175.

Talbott, C.W., 1994. Potential to increase milk production in tropical countries. Ph.D. Thesis, North Carolina State University, Raleigh, USA.