ENVIRONMENTAL FACTORS AFFECTING VARIOUS PRODUCTIVE TRAITS IN SAHIWAL CATTLE

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ABSTRACT

Data on 8948 performance records of 2532 cows daughters of 213 sires maintained at Livestock Experiment Station, Jahangirabad district Khanewal (Pakistan) during 1939-98 were utilised in the present study. The least squares means for first lactation traits viz. milk yield, lactation length and dry period were 1579.04±18.17 kg, 260.52±2.64 and 221.68±5.20 days, respectively. The corresponding values for the traits considering all lactations were 1862.42±42.08 kg, 317.71±3.24 and 198.30±4.43 days, respectively. Age at first calving, lactation length and lactation number were significant (P<0.01) sources of variation for milk yield. The effect of calving interval on first lactation milk yield was significant (P<0.05). The influence of year and season of calving was significant (P<0.01) on all the traits under study. The milk yield was the highest (1688.00±35.46 kg) among the cows calving during autumn season and it was the lowest (1510.86±29.88 kg) among the cows calving during dry hot season. The cows calving during winter, spring and humid hot seasons yielded 1565.62±27.92, 1565.77±23.02 and 1564.95±30.22 kg of milk, respectively.

Keywords: Environmental factors, productive traits, Sahiwal cattle

INTRODUCTION

Sahiwal cattle is an indigenous breed of Pakistan having superior dairy characteristics "being the best zebu milch breed in the tropics"(Maule, 1990). It is famous for disease resistance and heat tolerance, but the animals of this breed produce far less milk than the well-defined dairy breeds of the temperate region like Holstein-Friesian and Jersey. Hence, they are unable to cope with the milk production demand on commercial scale (Ahmad, 1972). This inadequacy could be due to little attention in the past for improvement through selection and progeny testing (Ahmad et al, 1978; Talbott et al, 1997; Dahlin et al, 1998). Several environmental and genetic factors could be attributed to the productive in-efficiencies. The present study was thus planned to evaluate the performance of a purebred herd of Sahiwal cattle and to determine the influence of environmental factors on productive performance traits. It is envisaged that the information so generated would be helpful in formulating future breeding plans.

MATERIALS AND METHODS

Data on 8948 performance records of 2532 Sahiwal cows daughters of 213 sires maintained at Livestock Experiment Station Jahangirabad, Khanewal during the period 1939-98 were utilised for the present study. The data consisted of cow, service sire and calf identities, date of calving, date of drying, lactation milk yield and days in milk etc. Although lactation lengths and calving intervals were available in the original data set, new values were re-calculated from the calving and drying dates and used as a check for possible lactation length, calving interval, calving or drying date entry errors. All cases which could not be reconciled were dropped. Derived variables included age at first calving and dry period.

In addition to the basic edits of consistency for dates and animal identities, the cows which may have aborted, missed a year due to sickness or other reasons, were not used in the present investigation. The upper acceptable limit for lactation length and dry period was set at three standard deviations above the unadjusted mean. Lactation records of less than 150 days were also not considered in the analysis. Age at calving was computed from birth and calving dates, and all cows with obviously unacceptable ages were eliminated.

Effect of the environmental factors viz. year and season of calving, age at first calving, lactation length, calving interval and lactation number, as appropriate, on various performance traits was evaluated. Keeping in

view of the climatological data the year was divided into following five seasons, Winter, December to February; Spring, March to April; Dry hot, May to June; Humid hot, July to September; Autumn, October to November.

A year by season interaction was omitted from the model because the computer programme used had a limitation for degrees of freedom of fixed effects to be less than 99.

For evaluation of various environmental effects the mathematical model assumed was:

$Y_{ij} = \mu + F_i + e_{ij}$ **(Model 1)**

Where,

Y_{ij} = observation on any trait

μ = population mean;

F_i = effect of all fixed effects with the restriction that $\Sigma F_i = 0$

E_{ij} = random error associated with each observation.

Other repeated measures of performance traits viz. milk yield, lactation length and dry period were analysed assuming the mathematical model as:

$Y_{ij} = \mu + Cow_i + Fj + e_{ij}$ **(Model 2)**

where,

Cow = effect of ith cow having repeated records, other terms are as defined in Model 1.

For all analyses Mixed model least squares maximum likelihood (LSMLMW) computer programme (Harvey, 1990) was used.

RESULTS AND DISCUSSION

The least squares mean for first lactation milk yield was 1579.04±18.17 kg. The corresponding values for first lactation length and first dry period were 260.52±2.64 and 221.68±5.20 days, respectively. The least squares mean for milk yield considering all lactations was 1862.42±42.08 kg. The corresponding values for lactation length and dry period were 317.71±3.24 and 198.30±4.43 days, respectively. The influence of various environmental factors on first lactation milk yield, lactation milk yield, lactation length, dry period was studied as these traits show wide variation under varying sets of conditions. The influence of fixed effects viz. age at first calving, length of lactation, calving interval, lactation number and year and season of calving on lactation milk yield and other traits, as appropriate, was studied and these were included in the model for analyses to minimise these sources of variability in the production data for a valid comparison of all the lactation records.

Effect of age at first calving on first lactation milk yield

The regression coefficient of first lactation milk yield on age at first calving in the present study was 0.15±0.54 being significant ($P<0.01$) statistically. It meant that there was an increase of 0.15 kg in milk production with each day increase in age at first calving. These results were supported by Yadav and Rathi (1992) and Gandhi *et al.*(1995) who reported similar results in Indian Hariana and Sahiwal cows, respectively.

However, previous studies on Sahiwal, Red Sindhi, Tharparkar and Hariana cattle revealed that age at first calving and first lactation milk yield were independent of each other and reduction in age at first calving (within physiological limits) would have no deleterious effect on heifer yield (Sundaresan *et al.*, 1954; Mahadevan, 1955; Singh and Choudhary, 1961 and Singh and Acharya, 1969). Ahmad *et al.* (1971) studied the data on age at first calving and milk production of 928 Sahiwal cows and reported that there was no significant correlation between the two traits. Ahmad (1972) reported average first lactation milk yield as 2384.8±13.1 kg. The correlation between age at first calving and first lactation yield was 0.02 ± 0.033 which accounted for 0.07 percent of variability associated with these factors. Kimenye (1978) reported a non-significant effect of age at first calving on first lactation milk yield in Kenyan Sahiwals. These differences in various studies may be due to differences in breeds, herds, management or genotype X environment interaction.

Although there was an increase in milk yield with the increase in age at first calving but it is not desirable to have higher age at first calving as it reduces the lifetime production as well as less number of calves during animal's life span. The increase in age at first calving also results in higher cost of rearing of replacement stock. So breeders should strive for lesser age at first calving to have better and economical production system. The age at first calving is influenced by herd management, nutrition regime and climatic differences. All these factors have profound effect on the growth rate of heifers. Thus the animals raised under good managemental conditions show first sign of oestrous at an early age, which ultimately force the animal to enter in the production line at a younger age. Thus better feeding especially at breeding age and efficient breeding management system will be helpful in reducing the age at first calving, which ultimately affects the lifetime performance of an animal.

Effect of length of lactation on milk yield

The least squares mean for lactation milk yield considering all lactations was 1862.42±42.08 kg. The lactation length averaged 317.71±3.24 days. The correlation between length of lactation and lactation milk yield was 0.585, indicating a high relationship between the two traits. The least squares analysis of variance for milk yield revealed that regression of lactation milk yield on length of lactation was significant (P<0.01). There was an increase of 6.21±0.15 kg in lactation milk yield with each day increase in length of lactation. These results were substantiated by Ahmad (1972) and Ahmad (1998) who reported similar results in Sahiwals and Red Sindhi cows, respectively. However, Conceicao *et al.*, (1993) reported that length of lactation had a non-significant effect on milk yield in Holstein Friesian cows.

Although, milk yield increased with increase in lactation length yet it did not seem advantageous to have lactations exceeding one year. The daily milk yield in the later stages of lactation becomes low and hence affects the lifetime production. Moreover, longer lactations widen the calving interval, thereby increasing the generation interval and decreasing the number of calves that could be obtained during the life span of a cow. Therefore, attempts should be made to select cows on the regularity in breeding so that they should drop calves each year with a lactation period of about ten months.

Effect of calving interval on milk yield

The overall unadjusted mean for first lactation milk yield and first calving interval were 1693.05±733.30 kg and 455.03±118.36 days, respectively. The correlation between the two traits was 0.107. The regression of first lactation milk yield on first calving interval was -0.22±0.09 being significant (P<0.05) statistically. It meant that the milk yield decreased 0.22 kg with each day increase in calving interval. These findings were substantiated by the results of Tahir and Khan (1980), Ribas *et al.* (1984) and Khan *et al.* (1991) who reported similar findings in Sahiwal and Holstein-Friesian cattle.

However, in analysis using all lactations (model II), calving interval had a non-significant effect on milk yield. The results of the present study considering all lactations were in line with the findings of other workers who reported that calving interval had no effect on milk yield (Sundaresan *et al.*, 1954; Singh and Desai, 1961; Dansoury and Bayoumi, 1962, Acharya, 1966; Hussain, 1966; Ahmad, 1972). Ahmad (1972) reported a low correlation (0.06±0.03) between milk yield and calving interval in Pakistani Sahiwal cows. It was remarked that the two traits remained independent of each other and improvement in any trait would not exert any effect on the other trait.

Influence of year and season of calving

a) Milk yield

The results of least squares analysis of variance revealed that variability in lactation milk yield due to year and season of calving was significant (P<0.01). These results were supported by Rege *et al.* (1992), Gaur and Raheja (1996), Talbott *et al.* (1997) and Dahlin *et al.* (1998) who reported

Table 1: Analysis of variance for evaluation of environmental effects on lactation milk yield

S.O.V.	D F	M.S.	F Ratio
Year of calving	53	8503126.274	43.843**
Season of calving	4	3053424.563	15.744**
Lactation number	12	1349953.628	6.960**
Lactation length	1	350840070.488	1808.950**
Calving interval	1	686274.278	3.538NS
Cows	1710	530513.369	2.735**
Remainder	4998	193946.754	

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

Similar results in Sahiwals maintained in Kenya, India and Pakistan, respectively. However, Ahmad (1998) did not agree with the findings of the present study. The variation in milk yield observed in different years reflected the level of management as well as environmental effects. The level of management is bound to vary according to the ability of the farm manager, his efficiency in the supervision of the staff, his system of crop husbandry, method and intensity of culling (Ashfaq and Mason 1954; Basu and Ghai 1978; Khan, 1986).

The milk yield was the highest (1688.00±35.46 kg) among the cows calving during autumn and it was the lowest (1510.86±29.88 kg) among the cows calving during dry hot season. The cows calving during winter, spring and humid hot seasons yielded 1565.62±27.92, 1565.77±23.02 and 1564.95±30.22 kg of milk, respectively. The maximum number of calvings (36.33%) were recorded in spring followed by winter in which 19.86 percent of cows calved. The calvings were the lowest (10.93%) during autumn and it was 16.74 percent in dry hot and 16.15 percent in humid hot seasons. Although, the cows continued breeding through out the year yet about 70 percent of them calved during spring and summer.

The differences in the influence of season of calving on lactation milk yield may be attributed to the fact that the duration and number of seasons varies among different studies. Some workers divided the year into two, three or four seasons (Ahmad et al 1978). However, in the present study the year was divided into five seasons i.e. winter (Dec-Jan), spring (Feb-Apr), dry hot (May-June), humid hod (July-September) and autumn (October-November). Seasonal variation in animal performance in tropics is expected to be primarily a manifestation of variation in feed quality and quantity. The present results suggested that milk yield was sensitive to seasonal variation. Generally, the cows calving in spring produced the maximum milk, apparently due to low environmental temperatures and availability of good quality fodder. The animals that calved in winter were next in order of merit. The cows calving in dry hot and humid hot seasons were the poorest producers. The cows calving during summer season will have gone through the last trimester of the gestation period during the scarcity period of fodder and severe dry and humid hot season and are immediately confronted with the dry and scarcity of fodder period (November- December) as they approach peak lactation. Thermal stress may also explain seasonal variation in performance in the region where the present herd is being maintained, dry months are invariably the hottest months. Thus, a combination of nutritional inadequacy and thermal stress may well explain the seasonal variation in performance. This is even more likely given that ambient temperatures around 40° C or higher are not uncommon in this region and that dry periods longer than three months often do occur. These results indicated that calving in summer months was undesirable. Efforts should be diverted to the conservation of feed and feed supplements during the scarcity periods in addition to provision of shade etc for reducing the thermal stress. These results suggested that breeding should be in a way that most calvings should occur in late winter or early spring season. This may eliminate seasonal and nutritional stress on Sahiwal cows.

Lactation number had a significant (P<0.01) effect on milk yield. These findings were substantiated by the results reported by Trail and Gregory (1982). The trend of milk yield associated with parity followed a well established pattern (Wood, 1969) and peak lactation and subsequent fall was similar to the pattern observed in Sahiwal in Kenyan environment (Trail and Gregory, 1982). Lactation milk yield was 1963.02±72.72 kg in third lactation. However, lactation milk yield peaked in the fifth lactation (1985.26±72..20 kg). It is evident that milk yield remained fairy constant from third to fifth lactation. Thereafter there was a slight decline through the seventh and later lactations. This indicated that the cows of the herd under study attained their peak production at later age but at earlier lactation as compared to most dairy breeds of temperate zone. Evidently, the reasons for this difference was the delayed age at first calving and long calving interval prevalent among Sahiwal cows. The cows calving late for the first time attained almost their full growth with respect to body size and the active secretory tissues of the udder. Thus, the maximum production was attained during the earlier lactations but at later age. A relatively higher increase from the second to third lactation would be due to the increased functional activity of the secretory tissues of the udder and also due to the selection of such cows which gave better yields. A relatively slow decline from peak lactation onward could be due the expression of senescence accompanied by the diminishing secretory activity of the udder.

The lactational maturity in Sahiwals may also vary with the rate of development and increased functioning of the active secretory tissue of the udder, which could be greatly influenced by feeding and managemental practices. Good management leads to early maturity and hence the peak production would be attained much earlier than the cows kept on subsistence management

b) Lactation length

The least squares mean for lactation length was 317.71 ± 3.24 days. The least squares analysis of variance revealed that year and season of calving had a significant (P<0.01) effect on lactation length. These results were substantiated by the findings of Yadav and Rathi (1992), Gaur and Raheja (1996), Talbott *et al.* (1997), Ahmad (1998) and Dahlin *et al.* (1998).

Table 2: Analysis of variance for evaluation of environmental effects on lactation length

S.O.V	D F	M.S.	F. ratio
Year of calving	54	45098.743	22.086**
Season of calving	4	70170.395	34.364**
Lactation number	12	40404.391	19.787**
Cows	1903	4196.461	2.055**
Remainder	6471	2041.955	

The least squares mean for lactation length among the cows calving during dry hot season was the maximum (326.50 ± 3.53 days) and the minimum (306.83 ± 3.55 days) for the cows calved during

autumn. The lactation length of 325.56 ± 3.392 days was for the spring calvers. The cows calved during humid hot, and winter seasons had the lactation length as 318.75 ± 3.46 and 310.92 ± 3.43 days, respectively.

The lactation length was also influenced by lactation number. It was observed that there was an increasing trend in duration of lactation with the increase in lactation number. However, in later lactations the lactation length considerably decreased. Lactation number roughly indicates the age of the cow. It can be said that with the advancement in age of cow the length of lactation also increases. Long lactation length is not helpful in economical livestock production, because long lactation length widens the calving interval, hence increasing the generation interval and consequently the lifetime production decreases.

c) Dry period

There were much fluctuations in the duration of dry period for the cows calved during different years. The analysis of variance revealed that the year of calving had a significant effect

Table 3: Analysis of variance for evaluation of environmental effects on dry period

S.O.V.	D F	M.S.	F Ratio
Year of calving	54	52553.950	3.734**
Season of calving	4	104368.638	7.416**
Age at calving	1	25034.012	1.779^{NS}
Cows	1913	27243.760	1.936**
Remainder	6153	14073.208	

** = Significant^{NS} = Non-significant

(P<0.01) on dry period as obtained in the present study. These findings are supported by the findings of Gaur and Raheja (1996) and Talbott *et al.* (1997) who reported similar results in Sahiwals in India and Pakistan, respectively. However, Singh and Tomar (1991) and Ahmad (1998) reported that there was a non-significant effect of year of calving on dry period in Karan Fries and Red Sindhi cattle, respectively. Season of calving had a significant effect on dry period in the present investigation. Vij *et al.* (1992) and Talbott et al (1997) also reported similar findings in Tharparkars and Sahiwals, respectively. However, Paneerselvam *et al.* (1990) and Ahmad (1998) did not agree with the findings of the present investigation.

The length of dry period was the minimum (183. 181 ± 6.41 days) for the cows that calved during spring and the longest (212.48±6.98 days) among the cows calved during autumn. The dry period was 205.40 ± 6.42, 192.23 ± 6.73 and 198.21 ± 6.37 days among the winter, dry hot and humid hot calvers, respectively. The maximum number of calvings occurred during spring, the normal calving season and the cows calving in this season had, on the average shorter dry periods. This indicated that cows calving during normal calving season had comparatively shorter dry periods than those calving in the off-seasons. The regression of dry period on age of the cow at calving was 0.02±0.017 being statistically non-significant. Similar results were reported by Talbott *et al.* (1997) who reported that age of the cow at calving had no effect on days dry in Sahiwal cows in Pakistan.

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