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RESEARCH ARTICLE

# Genetic Factors Affecting Performance Traits of Sahiwal Cattle in Pakistan

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ABSTRACT

Data on 23925 lactations of 5897 Sahiwal cows in five Government herds of Punjab province were collected to estimate the genetic control and genetic correlations among performance traits. A repeatability animal model having herd-year-season and parity was used for this purpose. The repeatability estimates for 305-d milk yield, total milk yield, lactation length, dry period, calving interval and service period were 0.40±0.015, 0.40±0.016, 0.33±0.013, 0.14±0.005, 0.15±0.004, and 0.14±0.005 respectively. The heritability estimates for these traits were 0.10±0.016, 0.09±0.016, 0.06±0.013, 0.14±0.009, 0.15±0.010, and 0.14±0.010, respectively. The phenotypic, genetic and environmental correlation of 305-d milk yield with lactation length was 0.71, 0.48 and 0.70, respectively, with dry period was -0.31, -0.43 and -0.22, respectively while with calving interval and service period exhibited similar pattern (0.08, 0.25 and 0.08, respectively). The estimated breeding values ranged from -447 to 1254 kg, -442 to 1265 kg, -24 to 38, -78 to 116, -84 to 107 and -81 to 91, days for 305-day milk yield, total milk yield, lactation length, dry period, calving interval and service period, respectively. No specific genetic trend was observed for performance traits during the period under study. Cows have not improved in their ability to perform in various economic traits. Accurate recording of pedigree and performance is necessary for improving the performance traits of Sahiwal. Due to high repeatability estimates of yield traits selection or culling may be practised from first few records.



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## INTRODUCTION

Sahiwal is the most important dairy cattle breed of Pakistan. Due to its heat tolerance and disease resistant qualities, Sahiwal has gained international recognition. This may be evident from the eight synthetics (Australian-Friesian-Sahiwal, Australian Milking Zebu, Frieswal, Jamaica Hope, Karan Swiss, Mafriwal, Mpwapwa and Taurindicus) produced for tropical/subtropical conditions. In the homecountry, however, performance of the breed has not improved over the years (Dahlin *et al*., 1998). Lack of any breeding program and selection of breeding bulls on the basis of performance of their dams, instead of progeny performance may be some of the reasons for this situation (Bhatti *et al*., 2007).

Whether the performance of Sahiwal breed can be improved only through improvement in feeding and management or there is any scope for permanent improvement, requires estimates on genetic parameters. Selection on the basis of single or multiple records, identification of genetically superior animals and monitoring of genetic progress is also possible. Populations along with their size, models employed and other environmental sources of variation have been some of the factors responsible for the differences in productive and reproductive performance of Sahiwal cattle. Heritability estimates varied according to adjustment procedures in lactation length (Bajwa *et al*., 2004; Rehman and Khan, 2012). Other economic traits also have been reported to vary for genetic control. Khan *et al*. (2008a) reviewed that institutional records indicate weak genetic control for most of the economic traits but accurate recording of performance and pedigrees can improve these estimates. Repeatability estimates and genetic correlations among various traits have also been quite variable among various studies on Sahiwal breed.

The genetic trend in the population is another important aspect to monitor the success of a breeding strategy. Wide fluctuation in breeding values with zero genetic trends was reported by Javed *et al*. (2001) for the Sahiwal herd at Livestock Experiment Station Jahangirabad, Khanewal for the period 1937-1997. Ilatsia *et al*. (2011) indicated that the potential for genetic improvement and conservation of Sahiwal cattle in Kenya given their economic contribution to people's livelihoods. Sahiwal cattle and their crosses were generally perceived to be better with respect to productive traits and reproductive traits when compared to local zebu breed.

The present study was planned to estimate genetic parameters and genetic trends of economic traits in Sahiwal cows at five main Sahiwal cattle farms in Pakistan.

## MATERIALS AND METHODS

**Source of data:** Data on performance traits of Sahiwal cattle from five recorded herds i.e. Livestock Experiment Station (LES) Allahdad (1964-1990), LES Bahadurnagar (1964-2004), LES Fazalpur (1964-2004), LES Jahangir-abad (1964-2004) and LES Khizerabad (1967-2004) were collected for this study. The traits under study were 305-d milk yield, total milk yield, lactation length, dry period, calving interval and service period. Incomplete lactations for any recorded reason or lactations ending with abortion or other anomaly were not utilized. Lactation records of less than 60 days were not considered in the analysis.

In order to eliminate the effect of short dry period on subsequent production, all records preceded by a dry period of less than 30 days were omitted. The records of cows which had aborted or missed a year due to sickness or other reasons were eliminated. Age at calving was computed from birth and calving dates, and lactations with obviously unacceptable ages were eliminated. First 10 parities were considered and parities greater than 10 were pooled with $10^{th}$ parity. Initially, 23925 lactation records on 5897 cows sired by 300 males were available. The structure of data left at the end of the various edits for any trait is summarized in Table 1.

**Estimation of genetic parameters:** The repeatability, heritability and genetic correlations of all lactation traits were estimated using Restricted Maximum Likelihood procedure outlined by Patterson and Thompson (1971) fitting repeatability Animal Model. Herd-year-season of calving/birth (HYS) combinations was used as fixed effect along with parity. Permanent environment and breeding values were the random factors fitted in the model. A year was divided into winter (December to February), spring (March to May), summer (June to August) and autumn (September to November) seasons. Proceeding and/or preceding seasons were grouped together to have minimum of five observations for any HYS. All the known relationships were accounted for. For phenotypic and genetic correlations among some plausible combinations of traits, bivariate analysis was performed. The DFREML software (Meyer, 2000) was used to estimate genetic parameters and estimated breeding values (EBVs). The EBVs were then fitted in a fixed effect model having year of birth to get solutions for plotting the genetic trends.

## RESULTS AND DISCUSSION

**305-d milk yield:** Of the average deviation from mean performance of Sahiwal cows, the additive genetic proportion was found to be 0.10±0.016 (Table 2). The variance ($kg^2$) due to additive genes was 33128.2 while the phenotypic variance was 347791.6. The corresponding value for permanent environmental part was 105843.5 which gave 0.40±0.015 chances for repetition of same with average superiority/inferiority for 305-d milk yield. The estimates of phenotypic, genetic and environmental correlations suggested strong association with the other economic traits viz lactation length, dry period, calving interval and service period, the determinants of lactation yield, in general. The phenotypic correlation of 0.71 ($p<0.01$) with lactation length gave indication about co-dependents of the phenotypic expression of the traits. It proved to be of lesser weightage when association was studied at the common additive genetic control (0.48±0.026). The residual correlation of 0.70 also explained the commonality of temporary environment. The phenotypic, genetic and environmental correlation between 305-d milk yield and dry period were -0.31, -0.43±0.03 and -0.22, respectively, while the correlations for calving interval were low (0.08, 0.25 and 0.08, respectively). The bulls and cows breeding values ranged

**Table 1:** Percent records removed after applying the edit criteria for various traits under study

| Traits | Total records | Acceptable range | Records | | |
|---|---|---|---|---|---|
| | | | Removed | % | Utilized |
| 305-day milk yield (kg) | 23797 | ≥1 kg/day of LL* | 186 | 1.0 | 23611 |
| Total milk yield (kg) | 23894 | ≥1 kg/day of LL | 283 | 1.2 | 23611 |
| Lactation length (days) | 23925 | ≥ 60 | 755 | 3.0 | 22968 |
| Dry period (days) | 18817 | ≥ 30 to ≤ 730 | 629 | 3.3 | 18417 |
| Calving interval (days) | 19003 | ≥ 300 to ≤ 900 | 473 | 2.4 | 18675 |
| Service period (days) | 18215 | ≥ 30 to ≤ 600 | 541 | 2.9 | 17973 |

* LL: Lactation length.

**Table 2:** Means, phenotypic ($б^2_P$), additive genetic ($б^2_A$), permanent environmental variances ($б^2_{PE}$), heritability ($h^2$) and repeatability (R) estimates for lactation traits (±SE)

| Traits[1] | N | Means | ($б^2_P$) | ($б^2_A$) | ($б^2_{PE}$) | $h^2$ | R |
|---|---|---|---|---|---|---|---|
| 305-d MY(kg) | 23611 | 1449.7±4.45 | 347791.6 | 33128.2 | 105843.5 | 0.10±0.016 | 0.40±0.015 |
| TMY (kg) | 23611 | 1474.1±4.63 | 387532.7 | 35884.7 | 120494.6 | 0.09±0.016 | 0.40±0.016 |
| LL(d) | 22968 | 245±0.5 | 4543.8 | 256.2 | 1245.3 | 0.06±0.013 | 0.33±0.013 |
| DP(d) | 18417 | 231±0.9 | 13806.0 | 1877.6 | 102.6 | 0.14±0.009 | 0.14±0.005 |
| CI (d) | 18675 | 452±0.8 | 12586.7 | 1835.6 | 36.3 | 0.15±0.010 | 0.15±0.004 |
| SP(d) | 17973 | 167±0.8 | 12390.2 | 1685.6 | 15.1 | 0.14±0.010 | 0.14±0.005 |

[1]MY: milk yield, TMY: total milk yield, LL: lactation length, DP: dry period, CI: calving interval, SP: service period.

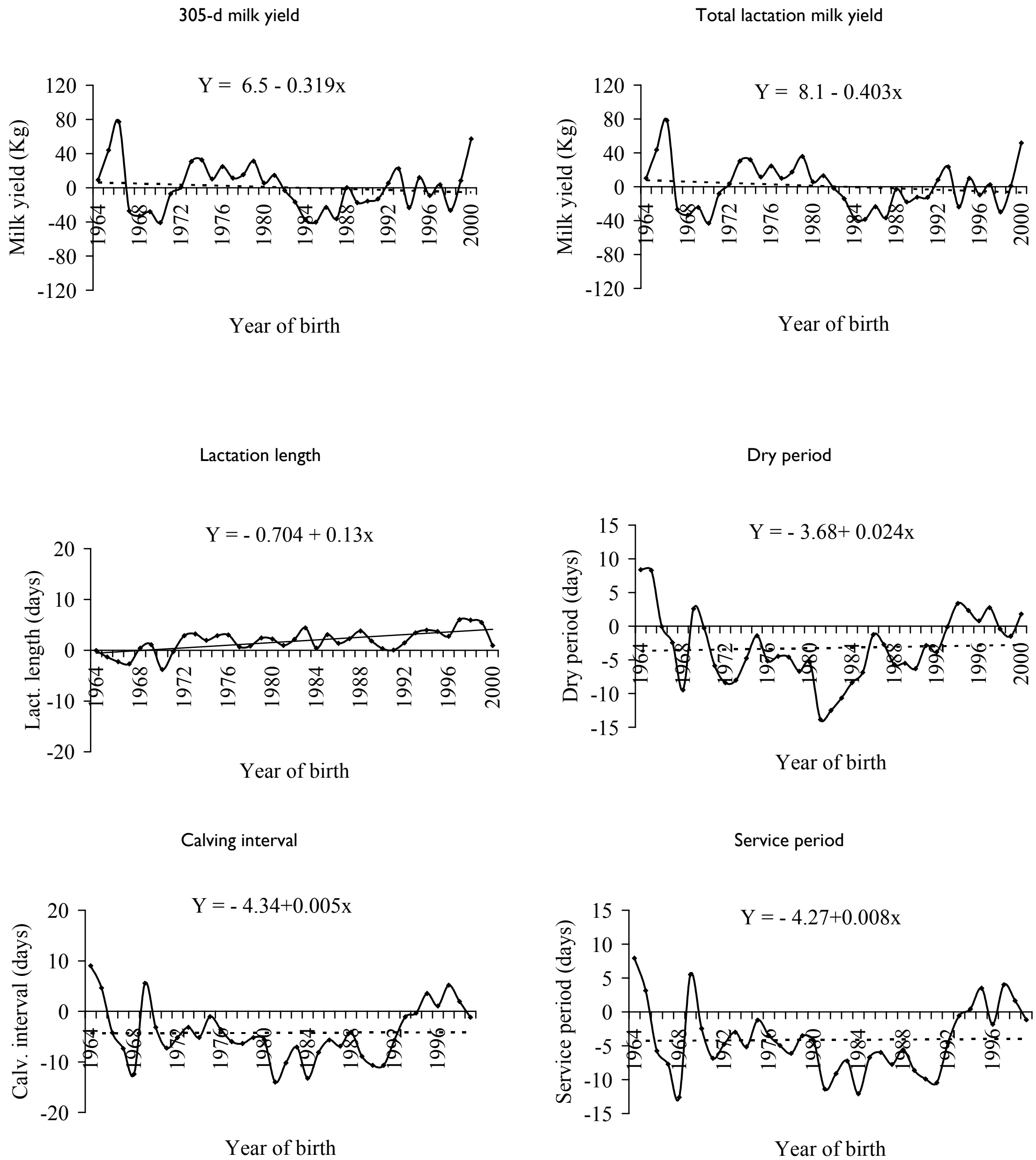


**Fig. 1:** Genetic trends in performance traits of Sahiwal cattle.

from -263 to 476 kg and -447 to 1254 kg, respectively. The genetic trend of 305-d milk yield was slightly negative (-0.32 kg per year) over the years (Fig. 1).

The lower estimates of heritability (0.013 to 0.18) for 305-d milk yield in zebu cattle are mainly due to environmental effects masking the gene expression (Javed *et al*., 2001; Ilatsia *et al*., 2007; Haile *et al*., 2009; Montaldo *et al*., 2010). Dahlin *et al*. (1998) reported that heritability of 305-d milk yield varied between 0.11 and 0.15 for first three parities. The repeatability estimate was towards the higher side of estimates reported (0.28 to 0.54) in literature (Talbott *et al*., 1997; Javed *et al*., 2001).

Association of 305-d milk yield with other traits of economic importance is quite variable in various studies in Sahiwal cattle (Talbott *et al*., 1997; Dahlin *et al*., 1998; Javed *et al*., 2001). However, association of 305-d milk yield with lactation length is generally high. Similar conclusion was drawn by Leclerc *et al*. (2008) and Khan *et al*. (2008). In contrary, Bilal and Khan (2009) suggested the test-day models for the analysis of milk yield traits in order to maximize the use of all available information. Lack of genetic improvement depicted by genetic trend over years indicated failure of selection programs during the years of study. Periodic genetic evaluations and choosing of genetically superior bulls is likely to give a positive direction to genetic trend in milk yield.

**Total milk yield:** The heritability for the total milk yield was 0.09±0.016 (Table 2) which was similar to that of 305-d milk yield. In Holstein cattle the average heritability estimate observed was 0.2 (Haile *et al*., 2009). The phenotypic, genetic and environmental variances for total milk yield were higher than 305-d milk yield due to scale effect. The repeatability estimate (0.40±0.016) was also similar to 305-d milk yield. Similar results were reported by Kumar *et al*. (2009). The genetic, phenotypic and environmental correlations with 305-d milk yield were 0.73, 0.98 and 0.87, respectively. The breeding values for the bulls (-274 to 482 kg) and cows (-442 to 1265 kg) were more spread and genetic trend was close to zero (Fig. 1).

There are many studies on Sahiwal cattle reporting similar genetic parameters for milk yield and related traits (Talbott *et al*., 1997; Dahlin *et al*., 1998; Javed *et al*., 2001; Bajwa, *et al*., 2004; Ilatsia *et al*; 2007; Kathiravan *et al*., 2009). The phenotypic, genetic and environmental correlations of total milk yield with 305-d milk yield were 0.98, 0.73±0.001 and 0.87, respectively. For total milk yield, no additional bivariate or multivariate analyses with other traits were carried out as its association with 305-d milk yield was very high. As lactation length was much below 305-days both traits were expected to behave alike. Choice of lactation length other than 305-days has previously been debated in favour of 305-days (Khan and Iqbal, 1999) even when average is below a standard length of 305-days. Previous reports indicate that most of the herds have either same (Dahlin *et al*., 1998; Javed *et al*., 2001) or have negative genetic trend (Talbott *et al*., 1997) for traits like milk yield. For Livestock Experiment Station Bahadurnagar (Okara), there was a decline of 61 kg every year in milk yield in the genetic ability for the period 1974-1989 (Talbott *et al*., 1997).

**Lactation length:** The heritability estimate for lactation length was 0.09±0.016 (Table 2). Phenotypic variance (days$^2$) was 4543.8. The repeatability of the trait was 0.33±0.013. The trait was positively associated with 305-d milk yield. The genetic, phenotypic and environmental correlations with 305-d milk yield were 0.48, 0.71 and 0.70, respectively. The breeding values for the trait were -24 to +36 days for bulls and -24 to +38 for cows. The genetic trend was not different from zero (Fig. 1).

Lactations shorter than 305-d is common in most of zebu cattle (Bajwa *et al*., 2004). Increase in lactation length on the other hand may increase the calving interval but such a situation may be theoretical at present because of very low average lactation length (235±1.4 days) observed in the breed at present. Javed *et al*. (2001) reported zero genetic control while Dahlin *et al*. (1998) reported it to be 15-20% heritable. Montaldo *et al*. (2010) have reported higher estimates. Some of these differences may be due to choice of model and very small data sets used in some of the referred studies.

**Dry period:** The dry period had relatively higher (0.14±0.009) heritability (Table 2). The permanent environment variance (days$^2$) was low resulting in similar repeatability (0.14±0.005). The trait was negatively associated with 305-d milk yield. The genetic, phenotypic and environmental correlations with 305-d milk yield were -0.43, -0.31 and -0.22, respectively. The breeding values for sires used ranged from -55 to +73 days and the corresponding values for cows were -78 to 116 days. The genetic trend in the trait did not show any direction over years (Fig. 1).

Dry period has previously been reported to have no genetic control in Sahiwal cows (Javed *et al*., 2001). Yet, some studies reported estimates similar to the present study (Talbott *et al*., 1997; Leclerc *et al*., 2008). The negative genetic correlation with milk yield was favorable. Variation was mostly due to temporary environment which needs to be improved.

**Calving interval:** The calving interval also had a genetic control (0.15±0.01) similar to dry period (Table 2). Permanent environmental variance was also small resulting in similar repeatability estimate (0.15±0.004). The genetic correlation between calving interval and 305-d milk yield was positive (0.25), while association at phenotypic (0.08) and environmental level (0.08) did not exist. EBVs for bulls (-60 to 90 days) and cows (-84 to 107 days) were in a narrow range compared to dry period indicating lesser genetic variation in the trait when means of the two traits were quite different. The genetic trend was also close to zero (Fig. 1) although phenotypic deterioration has been reported previously. Calving interval is generally believed to have low heritability (Haile-Mariam *et al*., 2008; Ilatsia *et al*., 2011). For Sahiwal cattle, wide variation exists in the reports on the trait but if bigger data sets are considered (Campos *et al*., 1994; Dahlin *et al*., 1998) estimates may be similar to cattle of advanced production setups. Dahlin *et al*. (1998) reported calving interval to have heritability of 0.05±0.02, which is lower than the present estimates. Absence of permanent environmental variance was unexpected and temporary environmental conditions for the trait may be so drastic that cows had to depend heavily on the managers.

**Service period:** The heritability for the service period was 0.14±0.01 (Table 2). Variance (days$^2$) in the trait (12390.2) was either due to additive variance (1865.6), or temporary environmental variance similar to calving interval and dry period. The repeatability estimate (0.14±0.005) was similar to heritability. The bivariate analysis indicated that genetic, phenotypic and environmental correlations with 305-d milk yield were 0.26, 0.09 and 0.09, respectively (Table 3). The breeding values for sires ranged from -59 to 73 days while EBVs for cows ranged from -81 to 91 days (Table 4). The genetic trend was close to zero (Fig. 1).

The additive control of the trait, similar to the present study has been reported in different populations of Sahiwal cows (Javed *et al*., 2002). The very small role of permanent environment and greater role of temporary

**Table 3:** Genetic, phenotypic and environmental correlations among various traits

| Traits | Phenotypic correlation | Genetic correlation | Environmental correlation |
|---|---|---|---|
| 305-d milk yield and lactation length | 0.71 | 0.48 | 0.70 |
| 305-d milk yield and total milk yield | 0.98 | 0.73 | 0.87 |
| 305-d milk yield and dry period | -0.31 | -0.43 | -0.22 |
| 305-d milk yield and calving interval | 0.08 | 0.25 | 0.08 |
| 305-d milk yield and service period | 0.09 | 0.26 | 0.09 |

**Table 4:** Estimated breeding values (EBVs) for sires and cows

| Traits | EBVs for Sires | EBVs for Cows |
|---|---|---|
| 305-day milk yield (kg) | -263 to 476 | -447 to 1254 |
| Total milk yield (kg) | -274 to 482 | -442 to 1265 |
| Lactation length (days) | -24 to 36 | -24 to 38 |
| Dry period (days) | -55 to 73 | -78 to 116 |
| Calving interval (days) | -60 to 90 | -84 to 107 |
| Service period (days) | -59 to 73 | -81 to 91 |

environment indicated that improved reproductive management may reduce the service period (Javed *et al*., 2001; Ahmad *et al*., 2001). In the absence of selection pressure for or against the trait, no trend in EBVs was expected at this genetic control (Fig. 1).

**Conclusions:** Productive and reproductive traits in Sahiwal cattle had adequate genetic variation but low genetic control. Milk yield had 10% heritability and 40% repeatability. Reproductive traits had low genetic control and were mostly governed by temporary environmental variation. There was no specific genetic trend for any of the traits under study. Cows have not changed for their abilities to perform over the last 35 years. Improvement in pedigree and performance recording and culling using first few lactation records may help improve the genetic control of the yield traits. Recently started field recording and progeny testing is a step in the right direction.

## REFERENCES

Ahmad M, JHJ Van der Werf and K Javed, 2001. Genetic and phenotypic correlations for some economic traits in dairy cattle. Pak Vet J, 21: 81-86.

Bajwa IR, MS Khan, MA Khan and KZ Gondal, 2004. Environmental factors affecting milk yield and lactation length in Sahiwal cattle. Pak Vet J, 24: 23-27.

Bhatti AA, MS Khan, Z Rehman, AU Hyder and F Hassan, 2007. Selection of Sahiwal cattle bulls on pedigree and progeny. Asian-Aust J Anim Sci, 20: 12-18.

Bilal G and MS Khan, 2009. Use of test day milk yield for genetic evaluation in dairy cattle: A review. Pak Vet J, 29: 35-41.

Campos MS, CJ Wilcox, CM Becerril and A Diz, 1994. Genetic parameter for yield and reproductive traits of Holstein and Jersy cattle in Florida. J Dairy Sci, 77: 867-873.

Dahlin A, UN Khan, AH Zafar, M Saleem, MA Chaudhry and J Philipsson, 1998. Genetic and environmental causes of variation in milk production traits of Sahiwal cattle in Pakistan. Anim Sci, 66: 307-318.

Haile A, BK Joshi, W Ayalew, A Tegegne and A Singh, 2009. Genetic evaluation of Ethiopian Boran cattle and their crosses with Holstein Friesian in central Ethiopia: milk production traits. Animal, 3: 486-493.

Haile-Mariam M, MJ Carrick and M E Goddard, 2008. Genotype by environment interaction for fertility, survival and milk production traits in Australian dairy cattle. J Dairy Sci, 91: 4840-4853.

Ilatsia ED, R Roessler, AK Kahi, HP Piepho and V Zarate, 2011. Production objectives and breeding goals of Sahiwal cattle keepers in Kenya and implications for a breeding programme. Trop Anim Health Prod (2011) Jul 28. PMID 21796425.

Ilatsia ED, TK Muasya, WB Muhuyi and AK Kahi, 2007. Genetic and phenotypic parameters and annual trends for milk production and fertility traits of the Sahiwal cattle in semi arid Kenya. Trop Anim Health Prod, 39: 37-48.

Javed K, G Mohiuddin and P Akhtar, 2001. Heritability estimates for some productive traits in Sahiwal cattle. Pak Vet J, 21: 114-117.

Javed K, M Abdullah and MA Khan, 2002. Estimation of breeding values and genetic trends in Sahiwal cattle in Pakistan. J Anim Plant Sci, 12: 1-6.

Kathiravan P, GK Sachdeva, RS Gandhi, TV Raja, PK Singh and A Singh, 2009. Genetic evaluation of first lactation production and reproduction traits in Sahiwal cattle. J Livest Biodiver, 1: 51-55.

Khan MS, G Bilal, IR Bajwa, Z Rehman and S Ahmad, 2008. Estimation of breeding values of Sahiwal cattle using test day milk yields. Pak Vet J, 28: 131-135.

Khan MS and J Iqbal, 1999. Lactation length adjustment for milk yield records - a review. Int. J Agri Biol, 1: 199-204.

Khan MS, Z Rehman , MA Khan and S Ahmad, 2008a. Genetic resources and diversity in Pakistani cattle. Pak Vet J, 28: 95-102.

Kumar A, RS Gandhi and A Haile, 2009. Estimation of variance components for milk yield of Sahiwal cattle using repeatability animal models. Ind J Anim Sci, 79: 1041-1044.

Leclerc H, D Duclos, A Barbat, T Druet and V. Ducrocq, 2008. Environmental effects on lactation curves included in a test-day model genetic evaluation. Animal 2: 344-353.

Meyer K, 2000. User's notes of DFREML Set of computer programmes version 3.1 β.

Montaldo HH, H Castillo-Juarez, M Valencia-Posadas, EG Cienfuegos-Rivas and FJ Ruiz-Lopez, 2010. Genetic and environmental parameters for milk production, udder health, and fertility traits in Mexican Holstein cows. J Dairy Sci, 93: 2168-2175.

Patterson HD and R Thompson, 1971. Recovery of inter-block information when block sizes are unequal. Biometrika, 58: 545-554.

Rehman Z and MS Khan, 2012. Environmental factors affecting performance traits of Sahiwal cattle in Pakistan. Pak Vet J, 32: 229-233.

Talbott CW, MZ Chauhdry, RE McDowell and BT McDenial, 1997. Potential to increase milk yield in tropical countries with indigenous dairy cattle. The Sahiwal Model. J Anim Plant Sci, 7: 1-10.