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Estimation of Genetic Parameters of Reproductive and Milk Yield Traits Using Multiple-Trait Animal Model in Holstein Under Subtropical Conditions

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Abstract: The present study was aimed at estimation of the genetic parameters and the effect of season and year of birth on performance traits of Holstein Friesian cattle maintained at Agricultural University Dairy Farm Peshawar, Pakistan from the period 1999 to 2008. Genetic parameters for studied traits were estimated using multiple-trait animal model by DMU Software package with year and season of birth as fixed effects. The effect of year and season of birth was found significant on all the traits under study. Mean Puberty Age (PA), Age at First Calving (AFC) first lactation 305 Days Milk Yield (305 DMY) and Reproductive Efficiency (RE) were 794.32±45.35 days, 1172.27±79.65 days, 3553±423.26 kg and 62.50±3.56%, respectively. Heritability estimates of PA, AFC, RE and first lactation 305 DMY were 0.17, 0.11, 0.12 and 0.22, respectively. Genetic correlation of PA with AFC was highly positive (0.67) whereas, genetic and phenotypic correlation of RE with PA and AFC was moderately negative. Genetic correlations of 305 DMY was highly negative with AFC and RE and moderately negative with PA. In the present study, Holstein outperformed indigenous breeds in terms of performance and genetically inheritable potential under the prevailing subtropical conditions of Pakistan. RE parameter studied is useful indicator for moderately inheritable reproductive traits and should be considered in future studies using large dataset. Interestingly, the genetic parameters of holstein in the present study were in normal range but the production was markedly lower than other studies in the temperate environmental conditions.

Key words: Puberty, reproduction, heritability, genetic correlation, Holstein, China

INTRODUCTION

Pakistan being an agricultural country is very rich in animal genetic resources and has handsome number of animal breeds usually kept for milk, draught or dual purposes. Pakistan is the 4th largest milk producing country in the world (Tanvir, 2007) with annual 44,977 thousand tonnes milk production (Economic Survey, 2009). The per capita availability of milk and milk products in Pakistan is considerably low as compared to developed countries despite of having a large livestock population. This may be attributed to poor production of indigenous dairy animals as a result of unplanned breeding inadequate feeding poor health status and management practices (Sandhu *et al*., 2011). Holstein Friesian shows much faster rate of improvement and results significant increase in milk production as compared to local breeds. In order to increase milk production in the country in 1970's the government of Pakistan decided to establish herds of exotic dairy breeds, i.e., Holstein Friesian and Jersey cattle with the objective of either to maintain them as pure-bred or to be used for upgrading the production potential of indigenous non-descript animals (Bilal *et al*., 2008a, b). Agricultural University Dairy Farm Peshawar, Pakistan is one of the exotic breed herds established in 1998. The farm is primarily a research and demonstration farm rather a commercial farm.

Environmental and genetic factors like sire, parity, season and year of calving are known for exerting influence on the performance traits of dairy animals. Improvement of various production and reproduction traits requires estimation of relevant genetic parameters so these traits could be monitored and effectively introduced into the evaluation schemes. Although, Holstein Friesian is considered to be the best dairy breed of cattle in terms of milk production in the world but their performances in

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subtropical environmental conditions are mostly inferior to the temperate regions (Javed *et al*., 2004; De-Vaccaro, 1990). Keeping in view the dissatisfactory performance of Holstein (an exotic dairy breed in Pakistan) to show their full genetic worth in subtropics, a necessary urge was felt to evaluate their performance level in subtropical environmental conditions of the study area and to compare their performance in terms of milk yield and reproduction with the indigenous dairy breeds. Therefore, the present study was designed to investigate the effect of various environmental factors (most importantly the effect of season and year of birth) to estimate the genetic parameters and to study the genetic and phenotypic correlations of various performance traits of this breed under sub-tropical conditions at the North West of Pakistan.

MATERIALS AND METHODS

Source of data: Production and reproduction records of Holstein Friesian cattle maintained at Khyber Pakhtunkhwa Agricultural University Dairy Farm from the period 1999 to 2008 were utilized in the study. The data comprised of 150 first lactation records of Holstein related to 9 sires each having at least 6 daughters and six incomplete records were omitted. Animals at the farm were Dutch Friesian transferred from cattle breeding and dairy farm Harichand, Charsadda in 1997 and were originally imported from Netherlands through government funded program. Artificial insemination was carried out by technical hands of the university with the semen taken from elite bulls maintained at cattle breeding and dairy farm Harichand, Charsada, Pakistan by crossing Dutch Friesian with the imported semen from USA whereas the hard conceivers and repeaters were mated with elite Holstein bull maintained at farm. Source of data was historical recording sheets of individual cows including pedigree, milk yield, artificial insemination and calving information. The following data were collected from the records available identification number of each animal date of birth, sire, dam, service date, calving date, monthly milk yield and drying date. Monthly milk yield was obtained by the sum of weakly milk yield. Following traits were worked out from the collected data Puberty Age (PA), Age at First Calving (AFC), Reproductive Efficiency (RE) and first lactation 305 Days Milk Yield (305 DMY). First lactation 305 days milk yield was truncated at 305 days if the lactation was longer than 305 days for lactations shorter than 305 days milk yield was predicted based on lactation curve. Puberty Age (PA) was defined as age in days from birth to the first observed heat. Age at First Calving (AFC) was defined as age in days from birth to the first calving. Reproductive efficiency was calculated using the following equation (Sharma and Bhatnagar, 1975):

$$\text{Reproductive efficiency} = \frac{\left[700+(n-1)365\right]\times 100}{AFC+Z}$$

Where:

700 = The standard age in days at first calving
n = Number of calving
AFC = Actual Age at First Calving (days)
Z = Total number of days from first to last lactation

In the study RE was calculated for culled cows.

Statistical analysis

Model: Genetic parameters for PA, AFC, RE and first lactation 305 DMY were estimated using Multiple Traits Animal Model by DMU Software package.

$$Y_{ijk} = \mu + \alpha_i + \beta_j + \delta_k + e_{ijkl}$$

Where:

Y_{ijkl} = The ith production of the cow, born in jth year and kth season of birth
μ = The population mean
α_i = The additive genetic effect of ith individual, i = 1, 2, 3...
β_j = The effect of jth year of birth, j = 1999, 2000 to 2008
δ_k = The effect of kth season of birth, k = Winter, Spring, Summer and fall
e_{ijkl} = Random residual term

To study the effect of season of birth on various performance traits, the year was split into four seasons according to local environmental conditions as follows: Winter (December to February), Spring (March to May), Summer (June to August) and Fall (September to November). Heritability (h^2) genetic correlation (r_a) and phenotypic correlation (r_p) were calculated as follows:

$$\hat{h}^2 = \frac{\hat{\sigma}_a^2}{\hat{\sigma}_a^2+\hat{\sigma}_e^2};\ \hat{r}_a = \frac{Cov(a_1,a_2)}{\sigma_{a1}\sigma_{a2}};\ \hat{r}_p = \frac{Cov(p_1,p_2)}{\sigma_{p_1}\sigma_{p_2}}$$

Where:

$\hat{\sigma}_a^2$ = Additive genetic variance
$\hat{\sigma}_p^2$ = Phenotypic variance
$\hat{\sigma}_e^2$ = Residual variance

Computer packages: Computer packages including MS Excel and DMU Software (Madsen and Jensen, 2008) were used for data handling and genetic analysis.

RESULTS AND DISCUSSION

Puberty age: Mean Puberty Age (PA) of Holstein Friesian cows was 794.3±36.4 days ranging from 522-848.3 days, with a coefficient of variation of 6.7% (Table 1). Both season and year of birth, showed significant ($p<0.01$) effect on PA (Table 2). Cows born in fall showed lowest mean PA of 775.5 days followed by those born in Summer, Winter and Spring. The cows born in the year 1999 had the smallest mean PA while those born in the year 2007 had highest mean PA. Heritability estimated for PA was 0.17 (Table 1). Genetic correlation of puberty age was highly positive (0.67) with AFC and moderately negative with RE (-0.36) and 305 DMY (-0.49) whereas the phenotypic correlation was slightly positive with AFC and slightly negative with RE and 305 DMY (Table 3).

Age at first calving: The average Age at First Calving (AFC) in Friesian cows was 1172.3±59.6 days, the values ranged between 1021.8-1471.1 days with coefficient of variation of 9.2% (Table 1). Analysis of variance revealed that season and year of birth had a significant ($p<0.05$) effect on AFC (Table 2). Cows born during fall had lowest average AFC of 1131.9 days while summer born cows showed highest average AFC of 1375.8 days. Cows born in year 2008 had lowest average AFC of 1021.8 days. Heritability values estimated for AFC were 0.11 (Table 1). Genetic correlation of AFC with PA was highly positive (0.67) while highly antagonistic with 305 DMY (-0.75) and moderately antagonistic with RE. The phenotypic correlation of AFC was faintly positive with PA while faintly negative with RE and 305 DMY (Table 3).

Table 1: Range mean±SD co-efficient of variation and heritability of performance traits of Holstein cows

Traits	N	Mean±SD	Range Min.	Range Max.	CV (%)	Heritability
PA (days)	150	794.3±36.4	522.0	853.0	6.7	0.17
AFC (days)	150	1172.3±59.6	967.0	1578.0	9.2	0.11
RE (%)	150	62.5±3.6	49.9	70.4	4.7	0.12
305 DMY (kg)	150	3553±423.3	1746.0	3793.0	19.8	0.22

PA = Puberty Age, AFC = Age at First Calving, RE = Reproductive Efficiency, 305 DMY = 305 Days first lactation Milk Yield, N = No. of observation

Table 2: Comparison of means of performance traits of holstein friesian cattle in relation to season and year of birth

Comparision	N	PA (Days)	AFC (Days)	RE (%)	305 DMY (kg)
Season					
Winter	48	802.1^{ab}	1359.5^{a}	61.1^{ab}	3514.4^{b}
Spring	25	786.3^{b}	1231.8^{ab}	65.6^{a}	3617.6^{a}
Summer	36	843.1^{a}	1375.8^{a}	58.9^{b}	3431.2^{c}
Fall	41	775.5^{b}	1131.9^{b}	63.5^{ab}	3554.6^{b}
Year					
1999	7	622.0^{c}	1327.0^{bc}	57.9^{c}	3683.2^{a}
2000	13	754.5^{b}	1172.4^{cd}	61.1^{ab}	3230.4^{a}
2001	16	772.3^{b}	1471.1^{a}	61.4^{ab}	3395.7^{a}
2002	19	749.5^{b}	1314.8^{c}	62.6^{ab}	3418.1^{a}
2003	18	786.7^{ab}	1268.8^{c}	64.6^{a}	3521.1^{a}
2004	22	806.2^{ab}	1261.5^{c}	65.0^{a}	3643.2^{a}
2005	20	839.4^{a}	1390.3^{b}	63.1^{ab}	3349.3^{a}
2006	19	796.8^{ab}	1103.5^{cd}	62.9^{ab}	3547.6^{a}
2007	12	848.3^{a}	1163.0^{cd}	61.7^{ab}	3673.8^{a}
2008	4	792.4^{ab}	1021.8^{d}	59.2^{b}	3746.6^{a}

PA = Puberty Age, AFC = Age at First Calving, RE = Reproductive Efficiency, 305 DMY = First lactation 305 Days Milk Yield, N = No. of observation (Means with different subscripts across the columns differ significantly ($p<0.05$) and with similar subscripts differ non-significantly)

Reproductive efficiency: Mean Reproductive Efficiency (RE) was 62.50±3.4%, ranging from 49.9-65.6% with a coefficient of variation of 4.7% (Table 1). Analysis of variance revealed that RE was significantly ($p<0.01$) influenced by both season and year of birth (Table 2). Highest mean RE of 65.6, 65 and 64.6% was observed for cows born in spring, years 2004 and 2003, respectively. Heritability estimates for RE were 0.12 (Table 1). Genetic correlation of reproductive efficiency was found highly influenced by both season and year of birth (Table 2). Highest mean RE of 65.6, 65 and 64.6% was observed for cows born in spring, year 2004 and 2003, respectively. Heritability estimates for RE were 0.12 (Table 1). Genetic correlation of reproductive efficiency was found highly negative (-0.81) with 305 DMY and moderately negative with PA and AFC whereas phenotypic correlation of RE was found moderately negative with AFC and slightly negative with PA and 305 DMY (Table 3).

First lactation 305 days lactation milk yield: Average first lactation 305 Days Milk Yield (305 DMY) was 3553±423.3 kg ranging between 3230.4-3746.6 kg with a coefficient of variation of 19.8% (Table 1) 305 DMY was significantly ($p<0.01$) influenced by season of birth (Table 2). Cows born in spring had highest mean 305 DMY of 3617.6 kg followed by those born in fall Winter and Summer. Heritability of 305 DMY was found to be 0.22 (Table 1). Genetic correlation of 305 DMY was highly negative with AFC and RE and moderately negative with PA whereas phenotypic correlation of 305 DMY with all other traits was slightly negative.

Puberty age: Qureshi *et al.* (2002) and Sattar *et al.* (2005) reported lower mean PA of 743±51 days and

Table 3: Genetic (in the lower diagonal) and phenotypic correlation (in the upper diagonal) among various performance traits of holstein friesian cattle

Parameters	PA (Days)	AFC (Days)	RE (%)	305 DMY
PA (days)	-	0.31	-0.20	-0.24
AFC (days)	0.67	-	-0.52	-0.03
RE (%)	-0.36	-0.45	-	-0.06
305 DMY	-0.49	-0.75	-0.81	-

PA = Puberty Age, AFC = Age at First Calving, RE = Reproductive Efficiency, 305 DMY = 305 Days first lactation Milk Yield

652.70±6.98 days in Friesian cows in Pakistan. Sattar *et al.* (2005) reported non-significant effect of season of birth of puberty age. Azam *et al.* (2001), Mustafa *et al.* (2002) and Islam *et al.* (2004) reported much higher average puberty age of 987.22±14.77, 1043.02±31.46 and 1223.60±62.47 days in Baghnari, Red Sindhi and crossbred cattle maintained under the subtropical environmental conditions of Pakistan and Bangladesh. In the present study age at maturity was found sensitive to season and year of birth. Early maturity means the cow have more chances for longer productive life than late maturing cows. Puberty age is related to growth and development of an animal. Fast growing heifers reach puberty earlier than slow growing and fast growth of the heifer is the outcome of better nutrition and good management. The puberty age of Holstein Friesian in the present study was in line with other studies under subtropical conditions but was obviously lower than the indigenous dairy breeds of Pakistan. Das *et al.* (2003) reported slightly lower heritability estimates for 305 DMY of 0.14±0.17 for Friesian cattle in Bangladesh whereas the reported values of 0.31 by Effa *et al.* (2011) in the tropical conditions of Ethiopia were higher than the findings of the present study. The moderate heritability estimates for puberty age indicated that this trait was influenced by non-genetic factors therefore good management along with better nutrition should be taken into consideration for improving this important reproductive trait.

Suhail *et al.* (2009) reported positive genetic correlation of puberty age with AFC and 305 DMY and the phenotypic correlation of PA was reported positive with AFC but negative with 305 DMY. In the present study, genetic and phenotypic correlation of puberty age with AFC and RE revealed that early maturity was positively associated with early age at first calving and simultaneously antagonistically with RE.

Age at first calving: Grosshans *et al.* (1997), Dobos *et al.* (2004), Cienfuegos-Rivas *et al.* (2006) and Portillo and Pollott (2011) reported much lower AFC of 732.0±22.6, 763±0.121, 820 and 850 days in New Zealand, Australia, USA and UK, respectively. Chagunda *et al.* (2004), Qureshi *et al.* (2002) and Tadesse *et al.* (2010) reported lower average age at first calving of 975, 1106±76.4 and 1191±7.5 days in Friesian cattle under tropical and subtropical conditions of Malavi, Pakistan and Ethiopia, respectively. Ilatsia (2007), Rehman *et al.* (2008) and Kathiravan *et al.* (2009) reported higher mean calving interval of 1345, 1390±3.9 and 1281.18±19.67 days in Sahiwal cows in Kenya, Pakistan and India, respectively. Moreover, Rehman *et al.* (2008) found significant effect of season of birth on AFC and on the other hand Kathiravan *et al.* (2009) found non-significant effect. Age at first calving was also found equally sensitive to the factors of fixed effect under study. In the present study age at first calving was considerably lower than indigenous cattle breed depicting that Holstein outperform local breeds in term of reproductive traits. Age at first calving is a crucial reproductive trait that accounts for life time production. Early age at first calving is an indication for more births in the life span of an animal and longer productive life. AFC depends on reproductive management of the farm. The higher mean AFC in the present study indicated that beside inadequate sub-tropical environment late age at maturity, improper detection of heat and missing heats might be the possible reasons for higher age at first calving.

Although, the reported mean value for AFC by Grosshans *et al.* (1997) was much lower than the present study but interestingly, their reported heritability values of 0.13 and 0.12 for first and second lactations were in very close agreement with the findings of the present study. Chagunda *et al.* (2004) and Gwaza *et al.* (2007) reported a bit higher heritability of 0.20 and 0.15±0.06 in Holstein cattle in Malavi and Cameron, respectively.

Amani *et al.* (2007) reported slightly lower heritability estimates of 0.098±0.104 in Friesian cows in Sudan. Much lower heritability of 0.037±0.026 and 0.04 in Sahiwal cows was estimated by Javed *et al.* (2002) and Ilatsia (2007) in Pakistan and Kenya, respectively. Heritability estimate of Holstein in the present study was in close agreement with other studies across the world but was markedly higher than heritability estimated for the indigenous dairy breeds. This showed that the inheritable potential of Holstein remains same across different climatic conditions but their performance remain inferior due to the prevailing environmental and mangemental conditions. Moreover, Holstein inheritable potential of the reproductive traits was found better than the local breeds of cattle. Heritability estimates in the present study indicated that age at first calving was highly influenced by environmental factors. Therefore, efforts should be made to improve sub-tropical environmental conditions to get progress in this crucial trait of economic importance. The lower the AFC the higher will be the life time productivity.

Positive genetic correlation of AFC with PA and 305 DMY and positive phenotypic correlation of AFC with PA but negative with 305 DMY was reported by Suhail *et al.* (2009). Positive genetic and phenotypic correlation in the present study indicated that early age at first calving was the result of early puberty and both, early maturity and age at first calving could result in increase in RE. Negative genetic and phenotypic correlation of AFC with 305 DMY is a good indication and further study using large dataset should be conducted to evaluate this useful association in more detail in the prevailing subtropical conditions.

Reproductive efficiency: Ageeb and Hayes (2000) and Hammound *et al.* (2010) reported higher mean reproductive efficiency of 74.9±11.23 and 90.1± 0.6% in Holstein Friesian cows, respectively. RE was significantly influenced by both season and year of birth indicating that RE is a sensitive parameter and is sensitive to managmental and environmental variations. Wolfenson *et al.* (2000) pointed out that reproductive traits are highly sensitive to heat stress due to the high metabolic rate associated with milk production. In another study Al-Katanani *et al.* (1999) reported that in high milk producing cows' infertility was high in summer than other seasons. According to Oseni *et al.* (2005) Holstein performance in terms of production and reproduction was unsatisfactory in tropical southern United States and the cattle suffered great losses although special efforts were made to reduce the environmental stresses by implementation of special dairy houses use of sprinklers, air conditions, etc. In the subtropical conditions of Pakistan where ambient temperature often rises above 40°C in Summer may suggest the poor reproductive performance of the Friesian cows under investigation. The low reproductive efficiency reported in the present study can be improved by better reproductive care good nutrition and improved management.

Haile *et al.* (2009) reported high heritability estimates for RE of 0.6±0.16. Low heritability estimates for RE in the present study showed that 12% variation in this trait was due to additive gene action. Animal performance is the combination of additive gene action and the environment to which it is subjected. Thus, 88% variation in RE is modified by environment or non-additive gene action.

The negative genetic and phenotypic correlation of RE with PA, AFC and 305 DMY indicated that high RE would be probably the outcome of early puberty and early age at first calving. Thus, by decreasing PA and AFC, the desired high RE could be achieved.

First lactation 305 days lactation milk yield: Abe *et al.* (2009), Hultgren and Svensson (2007) and Evans *et al.* (2002) reported a higher first lactation 305 days milk yield of 10069, 7249.4±1420.2, 8006, 8564±1942 and 6572 kg in USA, Japan, Sweden, Spain and Ireland, respectively. Hyder and Ullah (2002) reported a bit lower first lactation 305 DMY of 3356±244.25 kg in imported Friesian and 2493±106.89 kg in Pakistani born Friesian cows. Higher 305 DMY of 5076±64 and 4557±1620 kg was reported by Khattab *et al.* (2000) and Ojango and Pollot (2001) in Egypt and Kenya, respectively. Raja and Narula (2007) and Monalisa *et al.* (2010) reported average first lactation 305 days milk yield of 1756.41±47.61 and 1834.87±36.89 kg, respectively and non-significant effect of season of birth on 305 DMY in Sahiwal cattle in two different farms in India. Average 305 DMY of 1393 and 1440.8 kg and significant effect of season and year of birth on Sahiwal cows in Pakistan was reported by Rehman *et al.* (2008) and Bhatti *et al.* (2007), respectively. The 305 DMY was found sensitive to seasonal variations. High 305 DMY in Spring and Fall was most probably due to suitable environmental temperature and availability of bulk green fodder that is scarce in Winter and Summer. In the present study, although average 305 DMY of Holstein was noticeably lower than the temperate regions but their production performance was in line with other studies in tropics and subtropics. Moreover, the production performance of Holstein under study was found better than the indigenous dairy breeds in topics and subtropics.

Evans *et al.* (2002) reported higher mean values for 305 DMY in Irish dairy cows but the heritability values were exactly the same as found in the present study. The findings of the present study of heritability estimates for 305 DMY were in line with reported heritability estimates of 0.21, 0.22 and 0.2 by Bakir *et al.* (2004), Khattab *et al.* (2005) and Dematawewa and Berger (1998), respectively. Abe *et al.* (2009), Ojango and Pollot (2001) and Rekaya *et al.* (2000) reported a little higher heritability estimates for 305 DMY of 0.285, 0.29 and 0.26, respectively. Lower heritability values of 0.013±0.022, 0.082 and 0.11±0.029 were reported in Sahiwal cows by Javed *et al.* (2001), Bilal *et al.* (2008a) and Rehman *et al.* (2008), respectively. Moderate heritability estimate for 305 DMY in the present study indicated that larger proportion of the phenotypic variation was due to temporary environment. Although, heritability estimates for 305 DMY were moderate, still it is suggested to consider this important trait in selection program as milk production is most important economic trait in the dairy herd. Improvement in this trait could be made faster through selection accompanied with balanced nutrition and good management. Literature review revealed that Holstein performance vary under different environmental conditions and there was a substantial gap in milk yield between the temperate and tropical regions although the inheritable potential was the same. This indicates that environment and management plays a vital role in the expression of the genetic worth of the animals and under inadequate environment the animals would not show their full genetic potential. Noticeably, the genetic potential of Holstein to inherit milk yield was obviously better than the indigenous breeds.

Oltenacu *et al*. (1991) and Grosshans *et al*. (1997) reported antagonistic genetic association between production and reproduction traits. Genetic correlation of 305 DMY with PA and AFC was reported positive while the phenotypic correlation with these traits was reported negative by Suhail *et al*. (2009) in Nili Ravi buffaloes in subtropical conditions of Pakistan. Antagonistic genetic and phenotypic correlation of 305 DMY with all other reproductive traits depicted that early maturity and first calving age could increase the milk yield. This is highly desirable association but is not usually in practice. The probable reason for this unusual association may be less number of data. Moreover, high puberty age and age at first calving were probably due to unavailability of adequate feeding that resulted in poor body conditions consequently late maturity, this debilitating condition of the animals probably later on led to lower 305 days milk yield.

Dataset and genetic model: A large quantum of data is pre-requisite for quantitative and population genetics studies. In the present study data quantum was less due to the unavailability of precise and complete bulk data especially for purebred herds under the prevailing system of the country. In under developed countries like Pakistan where the data collection system is not commonly in practice, the population studies are hard to carry out. Keeping in view the above mentioned fact, an effort was made to genetically evaluate the dairy herd of the Khyber Pakhtunkhwa Agricultural University Dairy Farm to highlight the genetic and environmental influences on the imported Dutch Friesian cattle under subtropical conditions of Pakistan. Although, the data available for the present study was less and is not comparable to the technologically advanced countries where there is a well-established data collection system but the data available was reliable because the farm under study is a government farm run by university authorities and the data is collected by trained technical persons.

In dairy cattle genetic analysis, Sire Model, Animal Model and Test-Day Model are widely applied. In the present study, the data was scrutinized, incomplete records were excluded and finally the most reliable data with complete pedigree were analyzed by Advance Model, i.e., multiple trait animal model to genetically evaluate all the traits under study. The present effort was made to evaluate the adoptability and genetic status of the Dutch Friesian in subtropical conditions of Pakistan thus the results of this study will equally be beneficial for policy makers of the country and in other parts of the world regarding performance of imported dairy breeds in sub-tropics.

CONCLUSION

The mean values for all the reproductive and milk yield traits in the present study were in normal range with other studies in tropics and sub-tropics. Although, the performance of Holstein in terms of milk yield and reproduction was markedly lower than Holstein maintained under temperate regions but the genetic parameters were found in similar range with other studies in tropics, subtropics and temperate regions. It showed that there is room for Holstein to improve their production even under tropics and subtropics. Season and year of birth exerted significant effects on all the traits under study depicting that these traits were sensitive to environmental and managemental influences. Efforts should be made on part of the management to minimize environmental stresses especially in extreme weathers and green fodder scarce seasons that badly affect animal productive and reproductive traits due to which animals can't show their full genetic worth. RE a composite trait is useful indicator of moderately inheritable reproductive traits therefore should be further studied under similar environmental conditions using large dataset. Cattle can be selected for relatively moderate heritability estimates for first lactation 305 days milk yield and faster improvement can be brought about in this trait by direct selection coupled with better nutrition good management and husbandry practices under the prevailing sub-tropical conditions.

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