



Effects of non-genetic factors on age at first conception and calving interval in Holstein cattle under subtropical conditions

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ABSTRACT

Fertility is a major trait and key factor to profitable dairy farming but at the same time often a limiting element in attempts to increase the milk production. Data on 517 lactation records of Holstein cattle maintained at Agricultural University Peshawar Dairy Farm in Pakistan from the period 1999 to 2010 were studied. The effect of various non-genetic factors i.e. sire, parity, season year of birth/calving on age at first conception (AFC) and calving interval (CI) were investigated using fixed effect model by GLM procedure of SAS 9.1. The effect of sire and season year of birth was highly significant ($P < 0.01$) on AFC, whereas, highly significant effect of parity ($P < 0.01$) and significant ($P < 0.05$) effect of season year of calving on CI was observed. Mean AFC and CI were 709.9 ± 71.9 days and 425.3 ± 97.7 days, respectively. Under subtropical conditions the focus is always on milk performance while reproduction is often overlooked, due to which reproductive traits were found considerably inferior to those of temperate conditions. Even under subtropical conditions improvement trends were observed across years for both the traits. Therefore, managerial interventions supplemented by improved genetic potential are proposed to optimize these important reproductive traits.

Key words: Age at first conception, Calving interval, Holstein, Subtropical conditions

In tropics and sub-tropics indigenous cattle breeds are slow maturing and low milk producers (Usman *et al.* 2013). Lifetime productivity of these animals is low due to low growth rate resulting in late maturity, light weight at the onset of production, long dry period and calving interval (Jabbar *et al.* 2000). In tropics and subtropics the ultimate focus had always been on milk production and reproduction traits are often ignored or least cared. This biased approach resulted in many reproductive anomalies and consequently fertility lowered. Reproduction traits show high variability under the influence of complex environmental factors (Lucy 2001).

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This case is even bluer in subtropical conditions. Poor growth rate of the dairy cattle in subtropics further aggravate the situation resulting in delayed age at maturity (Bhatti *et al.* 2007). In result, in subtropical conditions dairy farmers faces heavy losses due to reproductive mismanagement that results in late maturity of dairy cattle, late first calving age, longer generation interval and extra costs for rearing heifers.

Many genetic and environmental factors such as sire, parity, season and year of calving influence the performance traits of the dairy animals under different environmental conditions. Age at first conception and calving interval are the most important factors in determining the reproductive efficiency of the dairy cattle (Khan *et al.* 1992). The estimates of various parameters of reproductive efficiency are helpful in determining the economic feasibility of a particular dairy cattle breed or herd. After cost of feeding, rearing of heifers contributes considerably to the total costs of the dairy farm (Heinrichs *et al.* 1994). The ultimate approach to reduce the cost is to lessen the period of rearing of heifers before their first conception age. The present study was therefore, designed to investigate the effect of various non-genetic factors on age at first conception and calving interval, and to compare the performance of Holstein maintained under

different environmental conditions i.e. tropical, subtropical and temperate conditions, and with the local breeds of the study area under similar environmental conditions.

MATERIALS AND METHODS

Data on 517 lactation records of Holstein cows maintained at Agricultural University Peshawar dairy farm in Pakistan from the period 1999 to 2010 were used in the present study. The farm is located in the capital of Khyber Pakhtunkhwa (North West) province of Pakistan, and this part of the country features a semi-arid climate, with very hot summers and mild winters. The province has typical weathers (winter, spring, summer and fall). Summer is very harsh and the mean maximum temperature surpasses 40°C during the hottest months, whereas the mean minimum temperature during winter is 4°C. The Holstein cattle are extremely sensitive during July and August because of the hot and humid weather, and the production drops drastically. The data comprised reproduction records of 148 Holstein Friesian cattle sired by 11 sire each having at least 12 daughters, and 10 incomplete records were discarded from analysis that were less than 5% of the data available. Data collected were: identification number of the animal, sire, dam, date of birth, date of conception and date of calving. Age at first conception and calving interval were estimated from the available data. Age at first conception was defined as age from birth to first fruitful conception in days. Calving interval was the interval between two consecutive calving in days. The fixed effect of sire, parity and season year of birth on age at first conception and the fixed effect of sire, parity and season year of calving on calving interval were studied. Animal at the farm were mainly Dutch Holstein Friesian cattle imported from Netherland through government funded program. The farm is run by the technical staff of the university, and the artificial insemination (AI) is carried out by AI technician with semen taken from the elite bulls maintained at Cattle Breeding and Dairy Farm Harichand, Charsadda, Pakistan. The repeat breeders and hard conceivers are being mated with elite Holstein bull maintained at the farm. The cows are fed according to the standard ration fixed by the university authorities for dry and lactating cows, respectively. The farm is basically for research and teaching purposes for the students of veterinary and animal sciences of the Agriculture University Peshawar, Pakistan.

Data were analyzed using the Statistical Analysis System (SAS 9.1) by General Linear Model (GLM) procedure.

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

where, Y_{ijkl} , the n^{th} production record of each cow, daughter of i^{th} sire, j^{th} parity, calved in k^{th} season year of calving; μ , the population mean; α_i , the effect of i^{th} sire; i , 1,2,3 to—11; β_j , the effect of j^{th} parity; j , 1,2,3 to—6; δ_k , the effect of k^{th} season year of calving; year, 1999,2000 to—2010; season, winter, spring, summer and fall; e_{ijkl} , random residual term.

In the model for AFC fixed effect of parity (β_j) was not

considered and δ_k represent the effect of k^{th} season year of birth; k , 1999 to 2008; season, winter, spring, summer and fall.

Season was split into 4 seasons according to the local environmental conditions as: winter, December through February; spring, March to May; summer, June through August; fall, September to November.

Computer packages including M.S. Excel and SAS 9.1 (Statistical Analysis System, SAS Inc., 2002) were imputed for data handling and analysis.

RESULTS AND DISCUSSION

Age at first conception: AFC was 709.9±71.9 days ranging from 530 to 1076 days with coefficient of variation of 10.2%. Effect of sire and season year of birth was highly significant ($P<0.01$) on age at first conception (Table 1). Winter born heifers showed shortest first conception age of 628.8 days followed by spring and autumn, whereas, those born in summer showed highest AFC of 818 days. An improvement trend in AFC was observed from year 1999 to 2010 (Fig. 1).

Under subtropical condition of Pakistan, Rafique *et al.* (2000) reported higher AFC of 714.74±9.72 days in Holstein cows and a significant effect of year and non-significant effect season of birth on AFC. Results of Sattar *et al.* (2005) were

Table 1. Comparison of means of AFC and CI of Holstein Friesian cattle in relation to sire and parity

	N	AFC (days)	N	CI (days)
Sire				
1	66	795.5 ^A	47	440.5
2	34	692.9 ^{BC}	23	398.4
3	20	721.1 ^{BC}	13	407.0
4	16	663.4 ^C	12	403.6
5	24	749.4 ^B	18	429.4
6	26	722.3 ^{BC}	20	400.2
7	58	671.8 ^C	39	454.0
8	61	695.5 ^{BC}	46	426.1
9	97	729.5 ^{BC}	69	422.3
10	86	678.2 ^C	62	435.9
11	35	658.6 ^C	26	415.0
P Value		<0.01		0.73
Parity				
1	-	-	-	-
2	-	-	135	399.8 ^b
3	-	-	111	423.7 ^{ab}
4	-	-	75	433.8 ^{ab}
5	-	-	34	427.3 ^{ab}
6	-	-	17	484.2 ^a
P Value				<0.05
Season year				
P Value		<0.01		<0.05

AFC, age at first conception; CI, calving interval; N, number of observation. Means with different subscripts across the columns differ significantly (^{AB} Means differ at $P<0.01$, ^{ab} Means differ at $P<0.05$).

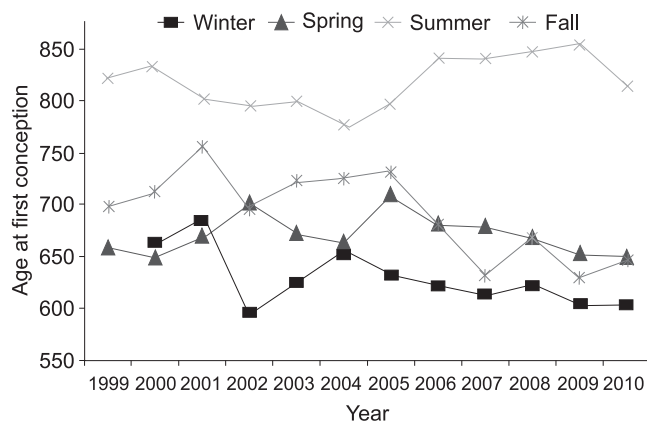


Fig. 1. Age at first conception of Holstein Friesian cattle from year 1999 to 2010.

in line with present study, the authors reported mean AFC of 697.51 ± 8.01 days and a nonsignificant effect of season of birth on AFC in Holstein cattle in Pakistan. Sandhu *et al.* (2011) reported a little lower AFC of 655.10 ± 10.44 days in Holstein cattle, whereas, a considerably higher AFC of 828.5 ± 233.1 days was reported in Holstein $\times$ Sahiwal cross bred cattle by Chaudhry and Ahmad (1994).

In present study, calves born in cooler months of the year showed shorter AFC (about half a year in winter) than those born in hot summer. The reason for this was probably the conducive environmental conditions that led these calves to faster weight gain and eventually got early sexual maturity compared to those born in hot season that were exposed to heat stress during the early age of their life, that probably render their growth slower. Due to comparative slow growth of summer born heifers, later in their life, they showed late sexual maturity, late conception and late first calving. Daughters of sire 11 had considerably lower AFC of 137 days than sire 1. This wide difference in performance of sires argues that under tropical and subtropical conditions the

judicious selection of sire is critical for improving the reproductive status of Holstein. Record keeping and evaluation system of elite sires containing information of daughters' reproductive performance should be developed, and strict breeding strategies of proper sire use should be ensured under these conditions. Although, year had non-significant effect on AFC but it showed an obvious improvement trend from the starting year of study towards the ending year depicting improvement in reproductive status of the herd. In these 12 years of study time, an improvement of 78 days and an average annual improvement of 6 days were observed in AFC. This improvement trend across years showed that even under subtropical conditions there is a room for further improvement by wise selection of sire from a well-established record and evaluation system.

In present study, AFC was in line with other studies under similar environmental conditions. Age at first conception is related to the body condition of the animal, the more the animal is healthy and fast gains weight, the early it reaches to sexual maturity and consequently will have shorter generation interval. The breeds of tropical and subtropical areas have low weight gain, slow maturing and noted for longevity. Sejrson and Purp (1997) reported that in case of heifers of high yielding breeds, sexual maturity is reached at the age of 9–11 months and average body mass of 250–280 kg. In temperate conditions where the dairy cattle produce first calving in about 24 months (Dobos *et al.* 2004), there in subtropical conditions cattle hardly get sexually maturity. As discussed earlier, the major reason for this mishap is that less attention has been paid to reproduction traits in these conditions. It is not only production but reproduction is also equally important and both should be kept balance for high economic returns. Proper sire selection, timely heat detection, in time insemination, better nutrition and husbandry practices are proposed to reduce the first conception age.

Calving interval: Mean calving interval was 425.3 ± 97.7 days ranging between 301 days to 721 days with coefficient of variation of 22.9%. Parity showed highly significant ($P < 0.01$), whereas, season year of calving showed significant

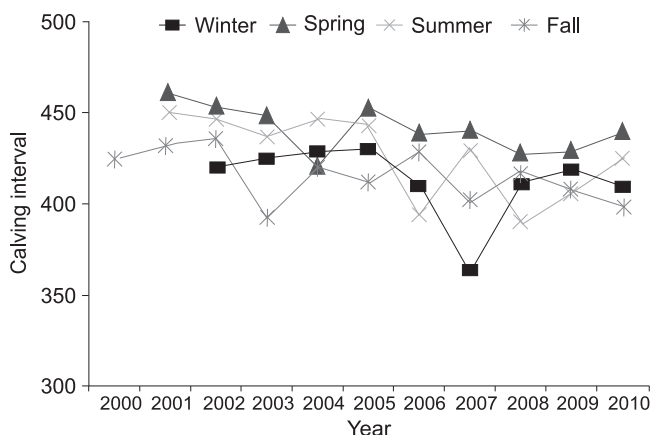


Fig. 2. Calving interval of Holstein Friesian cattle from year 2000 to 2010.

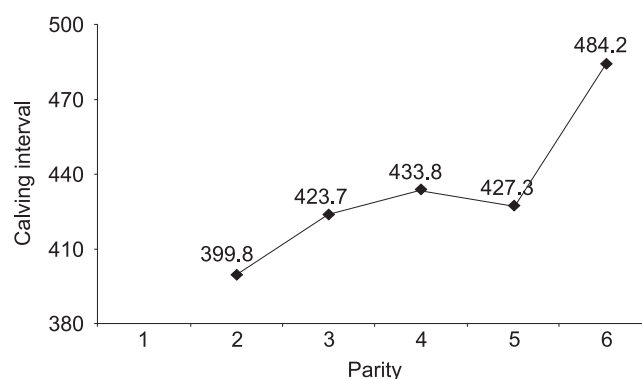


Fig. 3. Calving interval of Holstein Friesian cattle from parity 1 to 6.

($P < 0.05$) effect on calving interval. Shortest calving interval of 399.8 days was showed by cows in second parity, whereas, highest calving interval of 484.2 days was found in last recorded parity (Table 1). Cows calved in fall depicted shortest CI of 393.2 days followed by winter, summer and spring calvers. Season year trend for CI across years was seen with improvement (Figure 2), whereas, CI was noticed with increasing trend from parity 1 to 6 (Fig. 3).

The results of present study were in line with the reported average CI of 417, 462.4 ± 8.7 , 433.12 ± 6.70 and 408 days in Holstein cattle maintained under tropical and subtropical conditions of India, Ethiopia, Sudan and Malawi by Juneja *et al.* (1991), Effa *et al.* (2011), Gader *et al.* (2007) and Chagunda *et al.* (2004), respectively; moreover, the authors found significant effects of sire, parity, season and year of calving on CI.

In present study, first parity cows showed shortest calving interval followed by parity second and third, whereas, longest calving interval was found in the last (6th) parity. The probable reason for this may be less reproductive problems associated with early parities, and with advancements in parities, reproductive problems i.e. anestrus, repeat breeding and many other confined the cows from timely fruitful insemination and conception that resulted in longer calving intervals. The results reported by Hare *et al.* (2006) and Nieuwhof *et al.* (1989b) of increase in CI from parity 1 to parity 6 in the US dairy population was in line with the present study, whereas, on the other hand the reported trends of CI across years by Hare *et al.* (2006) was contradictory to the present findings. Although, milk yield increases across parities and highest yield is achieved in parity 5, but in the present study only 14.4% of the cow survived till they attain their highest lactation stage (fifth parity). A sharp increase in CI occurs after lactation 5 and also a small number of cows remained in production after fifth parity, therefore, strict culling decision should be taken at fifth parity. Cows calved in fall, winter and spring were probably easily conceived and thus resulted in shorter calving interval. Cows calved in summer were not easily conceived possibly due to multiple stresses common in this season. In the present study CI was in line with other studies under similar conditions but was inferior to those of temperate areas. Average calving interval of 12 months is proposed by Younas *et al.* (2008). Decreasing the days open, timely heat detection, timely insemination and better reproductive care would improve CI of the cattle. Confining breeding of cows to the winter and spring will help to improve this trait.

Age at first conception and calving interval were in normal range with other studies under similar environmental conditions. In temperate zones when the cows reach first calving age, there cows of the same age in tropical and subtropical conditions hardly get first conception. In tropical and subtropical conditions besides production, reproduction and fertility needs devoted attention to optimize these

important performance traits. Improvement trends across years showed that even under subtropical conditions there is room for progress in these traits. A proper genetic evaluation system of sire and systematic fertility record keeping of daughters can contribute to optimize these reproductive traits for profitable dairy farming. Therefore, management interventions must be accompanied by improved genetic potential to achieve enhanced reproductive performance in Holstein cattle under subtropical conditions.

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