RESEARCH ARTICLE

Non-genetic factors affecting economic traits in Sahiwal cattle at organized farm


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Abstract  Present study involved performance records of 1352 lactations from 462 Sahiwal cows, spread over a period of 15 years (1997-2011), maintained at Livestock Research Centre, National Dairy Research Institute, Karnal. Data were analyzed by least squares technique to examine the effect of non-genetic factors on various economic traits in zebu cattle. Overall least squares means of Age at first calving (AFC), Service period (SP), 305 days or less milk yield (305DMY), Lactation length (LL), Dry period (DP) and Calving interval (CI) were 1136.14±10.48 days, 150.79±4.59 days, 1677.31±28.54 kg, 260.12±3.08 days, 165.80±4.35 days and 434.13±4.26 days respectively. Effect of season of birth was significant (P<0.05) on AFC; while effect of season of calving was significant (P<0.05) on SP, 305DMY, DP and CI. Period of birth had significant (P<0.05) influence on AFC; while period of calving had significant (P<0.05) effect on 305DMY, LL and DP. Significant (P<0.05) effect of parity was observed on SP, 305DMY, DP and CI. The findings of this study revealed that most of economic traits in zebu cattle are significantly affected by environmental factors. Therefore management can play key role in improving both productive and reproductive performances in Sahiwal cows during adverse climatic conditions.

Keywords: Age at first calving, Calving interval, Sahiwal cattle, Service period

Introduction

Sahiwal is the native of Montgomery district of Pakistan and recognized as the best dairy breed in the tropics (Ilatsia et al., 2011). It is widely found in many warm humid countries of the world because of its well-known resistance to tropical diseases, endurance to hot climate of tropics, low cost of maintenance and higher percentage of milk constituents. Due to adequate productive and reproductive capabilities under tropics, it is most suited for production of synthetics like Australian Milking Zebu, Frieswal, Jamaica Hope, Karan Swiss, Mafriwal, Mpwapwa and Taurindicus etc. through cross breeding with European breeds and for improvement of local stock (Ilatsia et al., 2012). Environment has an important bearing not only on the productive performance but also on the reproductive efficiency of the dairy animals. Prolonged high ambient temperature coupled with high humidity under Indian conditions makes the animal uncomfortable and significantly affects the economic traits of Zebu cattle. In dairy animals both production and reproduction traits are low to moderately heritable, which indicates that the major part of variation in these traits is governed by environmental factors that can be minimized by efficient managemental practices. It has been reported that the traits of economic importance are significantly influenced by non-genetic factors in Sahiwal cattle (Raja, 2010; Rehman and Khan, 2012). Therefore, efficient management of animals during adverse climatic conditions is a key factor to maintain animal's productive and reproductive efficiency at optimum level.
Materials and Methods

The present investigation was conducted on Sahiwal cattle (n= 462) maintained at Livestock Research Centre of National Dairy Research Institute (NDRI), Karnal, Haryana. Study area is located at 29°42'N latitude and 72°02'E longitude with an altitude of 250m above the mean sea level in the bed of Indo-Gangetic alluvial plain. There are four major seasons in the year viz. winter (December to March), summer (April to June), rainy (July to September) and autumn (October and November). A subtropical climate with maximum air temperature during summer about 45-48°C and minimum temperature during winter near to 1- 4°C prevails in the area. In the study area relative humidity ranges between 41-85% and annual rainfall between 760-960mm.

Source of Data

The data for present study were collected from history sheets of Sahiwal cattle maintained at DCB Division of National Dairy Research Institute, Karnal. The data comprising of production and reproduction records of Sahiwal cattle spread over a period of 15 years (1997-2011) were utilized for this study. The performance traits examined were Age at first calving (AFC), Service period (SP), 305 days or less milk yield (305DMY), Lactation length (LL), Dry period (DP) and Calving interval (CI) of Sahiwal cattle. The data on the various performance traits were analyzed to evaluate the magnitude of various environmental sources of variation. Lactation records of less than 100 days and incomplete lactations for any recorded reason were not taken into the study.

In the present investigation for evaluating the effect of periods, the whole data were classified into 5 periods of 3 consecutive years. The periods were classified according to the year of birth for AFC and according to the year of calving for other remaining traits. Sixth and above lactations data were grouped together due to less number of observations after 5th parity.

The influence of various non-genetic factors on different production and reproduction traits was studied by least squares analysis of variance, using the technique described by Harvey (1987). The statistical models used for different economic traits are described below.

1. For Age at first calving

   \[ Y_{ijk} = \mu + S_i + P_j + A_k + e_{ijik} \]

   Where,

   \[ Y_{ijk} = \text{Dependent trait age at first calving of k}^{\text{th}} \text{ cow born in i}^{\text{th}} \text{ season, and j}^{\text{th}} \text{ period} \]

   \[ \mu = \text{Overall mean} \]

   \[ S_i = \text{Effect of i}^{\text{th}} \text{ season of birth} \]

   \[ P_j = \text{Effect of j}^{\text{th}} \text{ period of birth} \]

   \[ e_{ijik} = \text{Random error, assumed to be normally and independently distributed with mean zero and constant variance i.e. NID (0, } \sigma_e^2) \]

2. For other traits

   \[ Y_{ijkl} = \mu + S_i + P_j + A_k + e_{ijkl} \]

   Where,

   \[ Y_{ijkl} = \text{Dependent trait of l}^{\text{th}} \text{ cow born in i}^{\text{th}} \text{ season, j}^{\text{th}} \text{ period and k}^{\text{th}} \text{ parity} \]

   \[ \mu = \text{Overall mean} \]

   \[ S_i = \text{Effect of i}^{\text{th}} \text{ season of calving} \]

   \[ P_j = \text{Effect of j}^{\text{th}} \text{ period of calving} \]

   \[ A_k = \text{Effect of k}^{\text{th}} \text{ parity} \]

   \[ e_{ijkl} = \text{Random error, assumed to be normally and independently distributed with mean zero and constant variance i.e. NID (0, } \sigma_e^2) \]

The statistical significance of various fixed effects in the least squares model were determined by ' F ' test, wherever the effects were significant, the differences between pairs of levels of effects were tested for significance by Duncan's Multiple Range Test.

Results and Discussion

Age at first calving (AFC)

The overall least squares mean for AFC in the present study was 1136.14±10.48 days. Almost similar estimates of average AFC were observed by Singh et al. (2005) and Sentitula (2007) in Sahiwal cattle. This average estimate of AFC is higher than the values reported by Manoj (2009) and Raja (2010). However, Kushwaha et al. (2003) and Kathiravan (2009) have reported higher estimates of AFC than that of present finding in Sahiwal cattle. The difference in the estimates of average AFC in Sahiwal cattle reported by many researchers may be attributed to the difference in herds, reproductive management strategies and time/period considered.

We observed a significant (P<0.05) effect of season of birth on AFC (Table 1), which is in accordance with Kumar (2007) and Rehman et al. (2008); while non-significant influence of season of birth on AFC was reported by Manoj (2009) and Raja (2010). Highest value of AFC (1179.19±26.05 days) was observed in cows born in autumn season, whereas cows born during summer season had lowest AFC of 1104.97 ± 17.44 days (Table 2). The difference in AFC amongst the seasons of birth may be attributed to disparity in the availability of feed and fodder, and environmental conditions. Both summer
and rainy seasons born calves got chance of enjoying green fodder rich period of winter months during their post weaning period, which probably boosted their growth and helped in attaining early maturity. In this study the period of birth had shown a significant (P<0.01) influence on AFC (Table 1) which is supported by Sentitula (2007) and Raja (2010). The cows born during period of 2006-2008 found with maximum average AFC (1210.50±20.35 days), while the lowest least squares mean of AFC (1085.62±24.90 days) was observed in the cows born in the period of 1994-1996 (Table 2).

Service period (SP)

The average SP in Sahiwal cows was 150.79±4.59 days (Table 2). The present finding is found near to the estimates reported by Zafar et al. (2008) and Rehman and Khan (2012). Higher averages of first SP have been reported by Rehman et al. (2008) and Kathiravan (2009); whereas Sentitula (2007) and Manoj (2009) have reported lower estimates of average first SP in comparison to present study in Sahiwal cattle. The variation in SP reported by different workers may be due to variation in the managerial efficiency in estrus detection and timely breeding followed in different herds.

The findings of this study have shown that season of calving did influence the SP significantly (P<0.05) (Table 1). Similar findings were reported by Rehman and Khan (2012), whereas non significant values were observed by Zafar et al. (2008) in Sahiwal cattle. Maximum SP (172.85±12.27 days) was reported for autumn calvers, while summer calvers had lowest SP (136.48±7.38 days) (Table 2). Lactation number had significant (P<0.05) influence on SP, which is in accordance with Zafar

Table 1  Changes in Wei bull parameters for survival curves of *E. coli* O\textsubscript{157}:H\textsubscript{7} exposed to mild heat treatments due to vanillin supplementation

<table>
<thead>
<tr>
<th>Sources of variation</th>
<th>AFC</th>
<th>SP</th>
<th>df</th>
<th>305DMY</th>
<th>LL</th>
<th>df</th>
<th>DP</th>
<th>CL</th>
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<tr>
<td></td>
<td>df</td>
<td>F-value</td>
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<tr>
<td>Season</td>
<td>3</td>
<td>2.83*</td>
<td>3</td>
<td>3.05*</td>
<td>3</td>
<td>2.66*</td>
<td>0.88</td>
<td>3</td>
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<tr>
<td>Period</td>
<td>4</td>
<td>6.97**</td>
<td>4</td>
<td>0.47</td>
<td>4</td>
<td>17.75**</td>
<td>12.53**</td>
<td>4</td>
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<tr>
<td>Parity</td>
<td>-</td>
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<td>5</td>
<td>2.53*</td>
<td>5</td>
<td>10.91**</td>
<td>1.03</td>
<td>5</td>
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<tr>
<td>Error</td>
<td>292</td>
<td>1028</td>
<td>1339</td>
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*significant at 5% level (P<0.05); **significant at 1% level (P<0.01)

Table 2  Least squares means for performance traits in Sahiwal cattle

<table>
<thead>
<tr>
<th>Sources of variation</th>
<th>AFC</th>
<th>SP</th>
<th>df</th>
<th>305DMY</th>
<th>LL</th>
<th>df</th>
<th>DP</th>
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<tr>
<td></td>
<td>N</td>
<td>Mean±SE</td>
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<td>Mean±SE</td>
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<td>Season of birth/calving</td>
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<tr>
<td>Winter</td>
<td>141</td>
<td>1149.15 ±13.07b</td>
<td>470</td>
<td>139.01 ± 5.71a</td>
<td>580</td>
<td>1739.34±37.13b</td>
<td>260.32 ± 40.0</td>
<td>484</td>
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<tr>
<td>Summer</td>
<td>78</td>
<td>1104.97 ±17.44a</td>
<td>278</td>
<td>136.48 ± 7.38a</td>
<td>380</td>
<td>1523.70±45.70a</td>
<td>259.98 ± 4.93</td>
<td>288</td>
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<tr>
<td>Autumn</td>
<td>46</td>
<td>1111.24 ±22.46a</td>
<td>202</td>
<td>154.79 ± 8.24a</td>
<td>257</td>
<td>1751.23±53.56a</td>
<td>260.82 ± 5.78</td>
<td>208</td>
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<tr>
<td>Period of birth</td>
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<td>1994-1996</td>
<td>37</td>
<td>1085.62 ±24.90a</td>
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<td>1997-1999</td>
<td>41</td>
<td>1170.22 ±23.70b</td>
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<td>2000-2002</td>
<td>58</td>
<td>1110.70 ±21.07b</td>
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<td>2003-2005</td>
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<td>2006-2008</td>
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<tr>
<td>Overall</td>
<td>300</td>
<td>1136.14 ± 10.48</td>
<td>1041</td>
<td>150.79 ± 4.59</td>
<td>1352</td>
<td>1671.31 ± 28.54</td>
<td>260.12 ± 3.08</td>
<td>1079</td>
</tr>
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</table>

*Means bearing same superscript did not differ significantly*
et al. (2008) and Rehman and Khan (2012). Higher SP value (171.34±7.44 days) was found in cows under first lactation which decreased with parity up to fifth lactation. Averages of least squares means of SP for first and second parity cows were found significantly higher than that of other parities (Table 2). The probable cause behind the decline of SP across the parities may be attributed to the culling of poor performing and problematic animals in subsequent lactations.

305-Days milk yield or less milk yield (305DMY)

The overall least squares mean for 305DMY was 1677.31±28.54 kg (Table 2). The present finding is observed near to the average values of first lactation 305DMY, reported by Kumar et al. (2007) and Sentitula (2007). However, Manoj (2009) and Monalisa et al. (2010) have reported higher estimates of first lactation 305DMY in comparison to present study; while it is higher than the averages of first lactation 305DMY reported by Rehman et al. (2008) and Kathiravan (2009) in Sahiwal cattle. The differences in the estimates of average 305DMY in Sahiwal cattle reported by many researchers could have been due to variations in sampling, herd and chronology.

The 305DMY was found sensitive to seasonal variations (P<0.05) (Table 1), which is supported by Rehman and Khan (2012). The cows calved in autumn season had the highest 305DMY (1744.39±74.12 kg) followed by winter calvers (1739.34±37.13 kg), whereas rainy calvers had lowest 305DMY (1573.21±53.56). The higher value of 305DMY during winter and autumn might be due to availability of good quality green fodder in sufficient quantity during winter months. On the other hand, lowest 305DMY of rainy calvers may be correlated with hot and humid climatic conditions which not only induced stress to animals but also made them prone to infections. In the present study, significant (P<0.01) effect of period of calving on 305DMY (Table 1) is in agreement with the findings of Rehman and Khan (2012). The Highest average 305DMY (2061.57±66.83 kg) was found in animals calved during the period of 2000-02, whereas the lowest (1447.11±57.10 kg) value was observed for the period of 2000-02. Though there was sharp decline observed in 305DMY during second period (2000-2002), which was followed by significant increase in 305DMY in later periods. There was not any specific trend observed in 305DMY across different periods. The differences in 305DMY over the periods might be attributed to the differential culling levels on the basis of production and difference in feeding and managemental practices besides the changing genetic structure of the population. Lactation number affected 305DMY significantly (P<0.01) (Table 1); similar result was also reported by Rehman and Khan (2012). Averages of least squares means of 305DMY across parities indicated that 305DMY increased with increase of parity and maximum production was obtained at fourth lactation (1831.51±68.15) where after there was a decline in the next lactation (Table 2). The 305DMY of first lactation cows was found lowest (1354.28±49.31 kg) among different parities that might have been associated with the first exposure of primiparous animals to calving and lactation stresses along with suboptimal growth in comparison to plueriparous ones.

Lactation length (LL)

On an average cow produced milk for 260.12±3.08 days (Table 2). The present estimate of LL is found close to the averages reported by Rehman et al. (2006) and Zafar et al. (2008). Higher estimates than the present average of LL has been reported by Sentitula (2007) and Raja (2010) for first LL. On the contrary, present estimate of LL is higher than the averages reported by Khan et al. (1992) and Rehman and Khan (2012).

The results of the present study revealed that the LL was not influenced by season of calving. However, period of calving affected LL significantly (P<0.01) (Table 1), which is supported by Zafar et al. (2008); Rehman and Khan (2012). The average LL was highest (294.58±7.21 days) for the 1st period (1997-1999) and lowest (236.62±5.93 days) during third period (2003-2005) (Table 2). Average LL for first period (1997-1999) was found significantly higher than that of other periods, which could be due to better managemental proficiency along with favorable environmental factors. We observed that parity had no significant effect on LL, which is in accordance with Rehman et al. (2006) and Zafar et al. (2008).

Dry period (DP)

The overall least squares mean for DP was 165.80±4.35 days (Table 2). This average value of DP, in the present study, is near to the estimates of first DP reported by Sahota and Gill (1992) and Raja (2010). Mishra and Prasad (1994) and Singh et al. (2005) have observed lower averages of first DP than that of our findings. However, the present estimate of DP is lower than the estimates reported by Zafar et al. (2008) and Rehman and Khan (2012). The variation in average DP reported by different workers is justified as this trait is mostly influenced by seasonal variations. We observed that parity had no significant effect on DP, which is in accordance with Rehman et al. (2006) and Zafar et al. (2008).

The overall least squares mean for DP was 165.80±4.35 days (Table 2). This average value of DP, in the present study, is near to the estimates of first DP reported by Sahota and Gill (1992) and Raja (2010). Mishra and Prasad (1994) and Singh et al. (2005) have observed lower averages of first DP than that of our findings. However, the present estimate of DP is lower than the estimates reported by Zafar et al. (2008) and Rehman and Khan (2012). The variation in average DP reported by different workers is justified as this trait is mostly influenced by period of calving (P<0.01). Similar findings are also reported by Raja (2010) and Rehman and Khan (2012). The DP was shortest (149.65±7.03 days) for cows calved during summer, while autumn calver had longest average DP (188.72±11.47 days). In this study DP had significantly influenced by season of calving (P<0.01).
lactation length for the same periods. Influence of lactation number on DP was found significant (P<0.05) (Table 1), which is in agreement with Rehman et al. (2006) and Rehman and Khan (2012). Averages of DP across parities had shown that DP for first lactation was higher (185.63±7.06 days), which decreased along parity without showing any definite trend.

Calving interval (CI)

The average CI, observed in present study, was 434.13±4.26 days (Table 2). The average CI of present study is near to the estimates of Zafar et al. (2008) and Rehman and Khan (2012). This mean value of calving interval is higher than the averages of first CI reported by Manoj (2009). However, higher estimates of CI than that of present finding have been reported by Ahmad et al. (2001) and Rehman et al. (2008).

We observed a significant (P<0.01) effect of season of calving on CI (Table 1), which is in accordance with the findings of Zafar et al. (2008) and Rehman and Khan (2012). The cows calved during summer season had the lowest CI (420.50±6.89 days), while longest average CI (457.12±11.22 days) was found in case of autumn calvers (Table 2). Highest mean average of CI for autumn season calvers may be as a result of the higher mean value of service period for the same season, as any change in the service period is directly reflected in the CI owing to fixed duration of gestation period. In this study period of calving did not influence the CI, which is contrary to the findings of Rehman and Khan (2012). We observed significant influence of lactation number on CI, which is supported by Zafar et al. (2008). The longest CI (459.69 ± 6.95 days) was observed in first calvers, which further decreased in subsequent lactations, might be due to culling of poor performing and problematic animals in subsequent lactations.

Conclusions

The least squares means for economic traits, taken in the present study, were found to be comparable with findings of other studies. The findings of the present study had shown that all the traits, considered in study, except LL were found sensitive to seasonal variations; among different seasons, hot and humid season adversely affected the economic traits of Sahiwal cattle as compared to other seasons. All the economic traits were significantly affected by periods; animals of first period (1997-1999) excelled in performance than those of other periods. Across the parities variation was apparent in all traits except LL; both productive and reproductive performances of pluriparous animals were observed better than primiparous cows. The effect of various environmental factors, viz. season, period and parity on economic traits was found to be significant in most of the cases, which indicates increased role of management in optimum utilization of livestock resources particularly during adverse climatic conditions.

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