Estimation of Genetic and Phenotypic Trends for Age at First Calving, Calving Interval, Days Open and Number of Insemination to conception for Isfahan Holstein Cows

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ABSTRACT

For the current research the records of 62 farms in Isfahan province were available. To estimate genetic and phenotypic trends of reproductive traits such as age at first calving, calving interval, days open and number of insemination to conception rate the records of 63,866 cows including 167793 reproductive records were employed. Farms were covered by Vahdat industrial Agriculturists and Dairymen Cooperative of Isfahan during 1986 to 2012. Genetic parameters estimated by linear animal model using Restricted Maximum Likelihood Method (REML). Genetic and phenotype trends were estimated by using regression of average breeding values and phenotype values on calving year. Heritability of age at first calving (0.19±0.007), calving interval (0.06±0.005), days open (0.041±0.004) and number of insemination to conception (0.071±0.004) were estimated. Phenotypic trends of age at first calving, calving interval, days open, number of insemination to conception in first parity and number of insemination to conception in second parity onward were estimated to be -3.48±1.08, -0.41±0.4, 0.013±0.0025 and 0.031±0.01 respectively. Estimated genetic trends for age at first calving, calving interval, days open, for number of insemination to conception in first parity and number of insemination to conception in second parity onward were estimated to be 0.07±0.06, -0.56±0.5, -0.02±0.06, 0.0015±0.001 and 0.0005±0.005, respectively.

Key word: phenotype and genetic trends, age in first calving, days open, calving interval, number of insemination to conception

INTRODUCTION

Profitability of dairy herds strongly depends on reproductive performance. Reproductive efficiency of a cow is measure by factors such as age at first calving, calving interval, days open and number of services per conception (Nilforooshan et al 2004). Age at first calving includes the period that a cow needs to reach maturity and to reproduce for the first time, calving intervals reflect the periods that a cow
reproduces again (Hare et al 2006). Days open is calving interval to pregnancy again. Most breeding programs give more weight to yield and type traits than the reproductive performance in selection indices. Use of these programs has caused genetic improvements in yield and depresses in reproductive traits (Faraji-Arough et al 2011). Estimating genetic and phenotypic trends in a population allow the assessment of the effectiveness of the selection procedure and gives the opportunity for monitoring management conditions. It also supplies the animal breeder with essential information to develop more successful programs in the future. Reproductive traits heritability range between 0.03 and 0.05. Lower heritability is partly affected by the existence of a very important environmental influence on these traits (Gawwan et al 2011). Genetic analysis for age at first calving, calving interval, days open and number of insemination to conception is studied in different countries. Nilforooshan et al (2004) reported that mean age at first calving for Iranian Holstens was 26 months. Means days open for US Holstein cow was 113 days. (Oseni et al 2004). Heritability estimates for days open in Ethiopian Boran cattle and their crosses with Holstein Friesian in central Ethiopia 0.047 and 0.1, respectively, by Hali et al. (2009). Deljoo Isaloo et al (2012) analysed over 10891 records collected from 23 years (1988 to 2010) by animal breeding center Iran. Heritability estimates for age at first calving, calving interval, open days and number of insemination to conception for Iranian Holstein cows were 0.016, 0.051, 0.023 and 0.01, genetic trends were -0.004, -0.04, -0.002 and 0.0001 and phenotypic trends were -0.08, -0.04, 0.006 and 0.0001, respectively. The objectives of this study was to estimate the heritability, genetic and phenotypic trend for age at first calving, calving interval, days open and number of insemination to conception in Iranian Holsteins in the Isfahan province.

MATERIAL AND METHODS

Data, for this study, data were provided by the Animal Breeding Center of the Ministry of Agriculture in the Isfahan Province. The reproduction traits were age at first calving (AFC), calving interval (CI), days open (DO) and number of insemination to conception (INS). The original set had a total of 167793 record calved between 1986 and 2012 in 62 herds. Data editing was based on Deljoo Isaloo et al (2012) and Shirmoradi et al (2010). AFC was required to be between 19 and 39 mo, and DO (data of pregnancy-data of calving) ranged from 30 to 200 d. If INS was greater than 10, then INS was assigned to 10, and CI (data of current calving-data of previous calving) was required to between 300 and 700 d. Descriptive statistics for the edited data set used for analysis are shown in Table 1. Calving difficulty (dystocia) was defined as 1 (no problem), 2 (slight problem), 3 (needed assistance), 4 (considerable force) and 5 (extreme difficulty).

Table 1. Descriptive statistics (number of records, mean, min, max and standard deviation(SD)) for the edited data set used for analysis.

<table>
<thead>
<tr>
<th>trait</th>
<th>No of records</th>
<th>Mean</th>
<th>Min</th>
<th>Max</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFC</td>
<td>46768</td>
<td>763.53</td>
<td>572</td>
<td>1170</td>
<td>75.14</td>
</tr>
<tr>
<td>CI</td>
<td>65252</td>
<td>406.65</td>
<td>300</td>
<td>700</td>
<td>80.96</td>
</tr>
<tr>
<td>OD</td>
<td>69154</td>
<td>109.22</td>
<td>30</td>
<td>200</td>
<td>54.02</td>
</tr>
<tr>
<td>INS 1</td>
<td>66213</td>
<td>1.71</td>
<td>1</td>
<td>10</td>
<td>1.15</td>
</tr>
<tr>
<td>INS 2</td>
<td>101579</td>
<td>2.7</td>
<td>1</td>
<td>10</td>
<td>1.68</td>
</tr>
</tbody>
</table>
Statistical analysis, The following statistical model was applied to estimate genetic parameters:

\[
y_{ijk} = \mu + b(A_{ijk} - \mu) + B_i + a_j + e_{ijk} \quad \text{(for age at first calving)}
\]

\[
y_{ijklm} = \mu + b(DFS_{ijklm} - DFS_i) + P_i + CD_j + INS_k + a_l + p_{em} + e_{ijklm} \quad \text{(for calving interval)}
\]

\[
y_{ijklm} = \mu + P_i + CD_j + a_k + p_{el} + e_{ijklm} \quad \text{(for days open)}
\]

\[
y_{ijklm} = \mu + HYS_i + P_i + M_j + a_k + p_{el} + e_{ijklm} \quad \text{(for number of insemination)}
\]

Where

- \(\mu\) = overall population mean,
- \(A_{ijk}\) = pregnancy day,
- \(B_i\) = Herd-year-season of birth, insemination,
- \(DFS_{ijklm}\) = days from calving to first insemination,
- \(P_i\) = Parity,
- \(CD_j\) = calving difficulties,
- \(INS_k\) = number of insemination to conception,
- \(HYS_i\) = Herd-year-season of calving,
- \(M_j\) = season of insemination to pregnancy,
- \(a_j, a_l, a_k\) = random additive genetic effects,
- \(p_{em}, p_{el}\) = permanent environmental effect,
- \(e_{ijklm}\) = random residual effects.

DMU software AIREML method (Jenson and Madsen 2005) was used to fit the linear mixed model based on Residual Maximum Likelihood (REML) and breeding values were estimated by best unbiased prediction (BLUP) procedure. Yearly genetic changes of cows EBVs for AFC, CI, DO and INS were computed to study genetic trend between 1986 and 2012. Genetic and phenotypic trends were computed as a linear regression of yearly means on year birth the REG procedure of the Statistical Analysis System (SAS 9.1).

RESULTS AND DISCUSSION

Table 1 present the structure and descriptive statistics of traits used in the analyse. Mean of age at first calving was 763.53 days. This mean is less than the mean of AFC in Brown Swiss cow in the tropics of Mexico (937.6) (Estrada-Leon et al 2008) but these results agree with results of Iranian Holstein (Faraji-Arough et al 2011 and Deljoo Isaloo et al 2012). Mean of calving interval was 406.65 days. Estrada-Leon et al (2008), Hammoud et al (2010), Shirmoradi et al (2010), Ghiasi et al (2011) and Gunawan et al (2011) reported mean of calving interval in Brown Swiss (453.9), Friesian cow (403.1), Iranian Holstens (368.5), Iranian Holstens (393.8) Bali Cattle (360.9), respectively. Mean days open of this population 109.22 days. This mean is less than the mean of DO in Friesian cow (130.7) (Hammoud et al 2010) and agree with results of Iranian Holstein (Ghiasi et al 2011 and Deljoo Isaloo et al 2012). Number
of insemination to conception is another widely used index of fertility. Mean of number of insemination to conception in first parity and number of insemination to conception in second parity onward were 1.7 and 2.7, respectively. This result similar with results of Japanese Black cows (Nishida et al 2006).

Estimates of variance components and heritability shown in table 2. Estimates of additive genetic variance were less than residual variance. The residual variance effects consist of a large proportion of the total variation in AFC, CI, DO and INS. Therefore estimates for heritability for these traits were low. Heritability estimated for AFC, CI, DO and INS were estimated to be 0.19±0.007, 0.06±0.005, 0.041±0.004 and 0.071±0.004, respectively. These estimates in agreement with the results obtained by (Faraji-Arough et al 2011 for AFC), (Mostert et al 2010 for CI), (Nishida et al 2006 for INS) and (Haile et al 2009 for DO). Deljoo Isaloo et al. (2012) reported lower heritability for AFC, CI, DO and INS in Holstein cows. These estimates in larger with the results obtained by Estrada-Leon et al (2008), Gunawan et al (2011) and Ghiasi et al (2011). Comparison two models (linear and poisson models) for estimates heritability of INS in Iranian Holstein cows, the linear model performed better than the poisson model according to goodness of fit statistics, but these two models showed the same predictive ability (Abdollahi-Arpanahi et al 2013). Different values for heritability in this study could be due to several factor such as: breed of animal, management system, environmental factors, size of structure of data, model of analyses and statistical methods employed. Low estimates of heritability for reproductive traits indicated that these traits might be greatly influenced by environmental conditions. Therefore, improvements in nutrition and reproductive management would likely have a larger impact on reducing AFC, CI, DO and INS than the genetic selection (Faraji-Arough et al 2011).

### Table 2. Variance components and heritability estimates (SE) for reproduction traits

<table>
<thead>
<tr>
<th>Trait</th>
<th>VA (SE)</th>
<th>VR (SE)</th>
<th>VP (SE)</th>
<th>h² (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFC</td>
<td>782.981 ± 33.6</td>
<td>3256.77 ± 33.02</td>
<td>_</td>
<td>0.19 ± 0.007</td>
</tr>
<tr>
<td>CI</td>
<td>144.575 ± 12.3</td>
<td>1995.69 ± 16.37</td>
<td>84.817 ± 15.437</td>
<td>0.06 ± 0.005</td>
</tr>
<tr>
<td>DO</td>
<td>121.368 ± 12.24</td>
<td>2643 ± 19.49</td>
<td>140.753 ± 17.26</td>
<td>0.041 ± 0.004</td>
</tr>
<tr>
<td>INS</td>
<td>0.139 ± 0.245</td>
<td>1.694 ± 0.226</td>
<td>0.1163 ± 0.24</td>
<td>0.071 ± 0.004</td>
</tr>
</tbody>
</table>

VA = Additive genetic variance; VR = Residual variance; VP = Permanent environmental variance, h² = Heritability
Table 3. Genetic trend and phenotype trend for reproduction traits

<table>
<thead>
<tr>
<th>Traits</th>
<th>Genetic trend(SD)</th>
<th>Phenotype trend(SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFC</td>
<td>0.07 ± 0.06&lt;sup&gt;n.s&lt;/sup&gt;</td>
<td>-3.48 ± 1.08&lt;sup&gt;**&lt;/sup&gt;</td>
</tr>
<tr>
<td>CI</td>
<td>-0.56 ± 0.5&lt;sup&gt;**&lt;/sup&gt;</td>
<td>-0.41 ± 0.5&lt;sup&gt;n.s&lt;/sup&gt;</td>
</tr>
<tr>
<td>DO</td>
<td>-0.02 ± 0.06&lt;sup&gt;n.s&lt;/sup&gt;</td>
<td>-0.42 ± 0.2&lt;sup&gt;n.s&lt;/sup&gt;</td>
</tr>
<tr>
<td>INS 1</td>
<td>0.0015 ± 0.001&lt;sup&gt;n.s&lt;/sup&gt;</td>
<td>0.013 ± 0.0025&lt;sup&gt;**&lt;/sup&gt;</td>
</tr>
<tr>
<td>INS 2</td>
<td>0.0005 ± 0.005&lt;sup&gt;n.s&lt;/sup&gt;</td>
<td>0.031 ± 0.01&lt;sup&gt;**&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>n.s</sup> = No significantly different from zero.  <sup>**</sup> = Significant(p<0.01), SD: Standard Deviation

The phenotypic and genetic trend for reproductive traits included AFC, CI, DO and INS between 1986 and 2012 are shown in figure 1, 2, 3 and 4, respectively. The AFC, phenotypic levels were increased from 1996 to 1999 and decreasing phenotypic levels from 1999 to 2012. Decreasing the levels could be due to the selection for low age at first calving. Faraji-Arough et al. (2011) reported that age at first calving decreased from 877 days in 1985 to 800 days in 1987 for Iranian Holsteins. Reductions in age at first calving were also found in Bali cattle (Gunawan et al. 2011) and Iranian Holsteins (Deljoo Isaloo et al. 2012). The phenotypic trend of CI and DO, increased from 1996 to 2003 (for CI) and 1986 to 1989, 1997 to 2006 (for DO) and decreasing phenotypic trend from 2003 to 2012 (for CI) and 2006 to 2012 (for DO). These trends show that CI and DO in Iranian Holstein is improving. Ansari-Lari et al. (2009) reported in Iranian Holstein in Fars province decreased from 435 days in 2000 to 389 days in 2005 and decreasing trend for days open in Iranian Holstein was reported by Deljoo Isaloo et al. (2012). Genetic trend for AFC, CI, DO and INS have irregular trends some years positive and some years negative. Linear regression coefficient of yearly means of breeding value and phenotypic value for AFC, CI, DO and INS are showed in table 3. Regression coefficient for EBV and phenotypic trend was negative for all trait (except for phenotypic and genetic trend of INS1 and INS2 and genetic trend of AFC). Genetic trend for CI and phenotypic trend for AFC, INS1 and INS2 were significant (p<0.01). However, they were not significant for other traits (p>0.05). A possible cause of this undesirable trend is intense selection to increase daily gain giving much attention on fertility. The low degree of genetic progress for the reproductive traits can be explained mainly by two factors. First, in this selectin program, the greater emphasis was on the performance traits rather than on the reproductive traits. Second, these traits generally have a low heritability and this may slow down genetic progress.
CONCLUSION

Estimated heritability of reproductive traits included AFC, CI, DO and INS were very low. The low heritability for these traits suggested that their genetic improvement would be slow. For improving these traits, improvements in nutrition and reproductive management could be useful. The trend for these traits (except for phonotypic and genetic trend of INS1 and INS2 and genetic trend of AFC) were negative. This could be attributed, partly to better management and improvement in nutrition during this period and also to the fact that large genetic trend for milk which has been observed in countries with decreasing reproductive performance has not occurred in Isfahan Holstein Cows.
REFERENCES


