Comparison between breeding values for milk production and reproduction of bulls of Holstein breed in artificial insemination and bulls in natural service

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ABSTRACT
Breeding values of bulls in artificial insemination (AI) and bulls in natural service (NS) in the Czech Republic were evaluated. Examined bulls were of Holstein breed, born between the years 1996 and 2001. Concerning a breeding value for kg of milk (AI = 177.54; NS = 50.12) and a relative breeding value (EBV) for kg of protein (AI = 100.03; NS = 97.23) significant higher values (p > 0.05) in AI bulls compared to NS bulls were shown. Other indicators of milk production (kg, % of fat and protein) showed not significant values. NS bulls showed not significant more positive breeding values of reproduction indicators compared to AI bulls. Reproduction indicators involved in the research were: male fertility (AI = -0.45; NS = -0.02), female fertility (AI = -0.91; NS = 0.08) and a relative breeding value for fertility (AI = 99.95; NS = 102.1). Breeding values of AI bulls compared to NS bulls were significant higher in case of the milk production (kg Milk and RBV) but not significant lower in case of the fertility.

Keywords: milk production, reproduction, natural service, artificial insemination, Holstein bulls

INTRODUCTION
Milk production is a key factor in breeding and economics of Holstein cattle. Using the best bulls for artificial insemination (AI) plays an important role in the Czech Republic. Increasing milk production often causes worse reproduction and thus many breeders solve this problem by using herd bulls in natural service (NS). This work has evaluated Holstein bulls in artificial insemination and bulls in natural service in the herds, where both methods of breeding are being used.

Several studies have compared reproductive performance between AI and NS breeding systems. Williamson et al., 1978 analyzed dairy herds in Victoria (USA). Pregnancy rates obtained from dairy herd records of cows bred by AI or NS were not different (57.5%; 58.0%) but pregnancy rates from NS were more
variable in NS herds. Vries et al., 2005 observed dairy herds in Florida and Georgia (USA) and compared efficiency of bulls in artificial insemination and in natural service. Although milk production was less in the natural service herds (7180 ± 135 kg/cow per year), the use of natural service bulls did not necessarily limit increases in herd milk production over the study period (artificial insemination herds 8513 ± 177 kg/cow per year). The results indicated that use of natural service bulls did not result in significant disadvantages in terms of pregnancy rates and changes in milk production over time. Cassell et al. (2002) reported that cows sired by proven artificial insemination sires produced 1400 kg more herd lifetime actual milk and were $148 more profitable when compared with daughters of non artificial insemination sires. Very important are unfavorable genetic correlations between yield and fertility and also low heritability of fertility.

Abbreviation key: NS = natural service breeding system, AI = artificial insemination, BV = breeding value, RBV = relative breeding value

MATERIAL AND METHODS
In the Czech Republic calculation of breeding values of Holstein bulls is being made by the Czech Moravian Breeders Corporation Inc. and its being updated on a regular basis on a website (www.plemdat.cz).

Milk production traits: In the Czech Republic there are two separate evaluations of breeding values - for Holstein population and Czech Fleckvieh population. In the model for Holstein breed there are cows included with at least 75% of Holstein or Red-Holstein blood proportion. Routine evaluation for milk production traits is performed quarterly. The same frequency is for publication of results. TDM results are used and published for all bulls born since 1992. Final breeding value for bulls is calculated as an average of all 3 lactations if bull has at least 20 daughters at 3 lactations with at least the 3rd test day records. Breeding values for content of fat and protein are first calculated individually for each lactation. Averages used in equations are lactation averages for corresponding breed. Currently base for the 1st lactation is set to the year 2000, for the 2nd lactation to the year 1999 and for the 3rd lactation to the year 1998. Relative breeding values are calculated from average breeding values for milk and protein yield and protein content (%). Fertility: there are two separate evaluations for maiden heifers and cows in the Czech Republic (male and female fertility - conception rate of maiden heifers and cows). A breeding value for a bull can be estimated only separately for maiden heifers and cows. If both the breeding values (for maiden heifers as well as for cows) are estimated they can be joined into an overall fertility breeding value. The overall breeding value is created as a weighting average. Breeding values of bulls are published if at least 20 inseminations of heifers or cows separately are included individually.
for male fertility and female fertility. Only bulls born since 1992 are evaluated by the current model.

The actual comparison of breeding values between bulls in artificial insemination and natural service has been made by standard mathematical methods using a SPSS 15.0 for Windows, Release 15.0.0 (6 Sep 2006) program. Bulls born between the years 1996 and 2001 were included in the evaluation. A minimal rate of the breeding value for milk production reliability in the examined bulls was 65%. The breeding values of the bulls were counted by April 2007.

Table 1 Number of bulls in natural service in the Czech Republic recorded in the Herdbook.

<table>
<thead>
<tr>
<th>Year</th>
<th>Czech Fleckvieh</th>
<th>Holstein</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of bulls recorded in the Herdbook</td>
<td>Number of bulls recorded in the Herdbook</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>Bulls in natural service</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>2001</td>
<td>124</td>
<td>21</td>
</tr>
<tr>
<td>2002</td>
<td>143</td>
<td>22</td>
</tr>
<tr>
<td>2003</td>
<td>167</td>
<td>60</td>
</tr>
<tr>
<td>2004</td>
<td>166</td>
<td>45</td>
</tr>
<tr>
<td>2005</td>
<td>173</td>
<td>39</td>
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<tr>
<td>2006</td>
<td>176</td>
<td>56</td>
</tr>
<tr>
<td>Mean</td>
<td>158,17</td>
<td>40,50</td>
</tr>
</tbody>
</table>

### RESULTS AND DISCUSSION

Between the years 2000 and 2006 number of bulls in natural service registered in the Herdbook increased in the Czech Republic (Tab. 1). It concerns both the most prevalent dairy cattle strains – Czech Fleckvieh and Holstein cattle.

From the point of view of kg of milk production, AI bulls showed higher breeding values than NS bulls, especially in kg of milk (177.54 kg; 50.12 kg), where significant differences were proven (p > 0.05). In case of kg of fat (5.65 kg; 4.06 kg) and kg of protein (6.19 kg; 4.12 kg) the differences were not significant. Concerning a proportional content of milk elements (percentage of fat and protein) AI bulls showed not significant lower values than NS bulls (AI = 0.02%; 0.05; NS = 0.03%; 0.05%), which may be caused by lower milk production in kg of milk in NS bulls. The overall relative breeding value of kg of protein was in AI bulls significant higher (RBV = 100.03) than in NS bulls (RBV = 97.23). Also other authors have noticed lower milk production in
daughters of NS bulls. Vries et al. (2005) found in dairy herds in Florida and Georgia (USA) milk production of NS bulls' daughters 7180 ± 135 kg/cow per year and milk production of AI bulls' daughters was 8513 ± 177 kg/cow per year.

Table 2 Average breeding values of Holstein bulls in artificial insemination and natural service (R > 64.9%)

<table>
<thead>
<tr>
<th></th>
<th>R (%)</th>
<th>Daughters</th>
<th>Herds</th>
<th>BV - Somatic cells count</th>
<th>BV - kg Milk</th>
<th>BV - % Fat</th>
<th>BV - % Protein</th>
<th>BV - kg Protein</th>
<th>Relative breeding value (kg Protein)</th>
<th>Male fertility</th>
<th>Female fertility</th>
<th>Relative breeding value (Fertility)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Artificial insemination</strong></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>90.53</td>
<td>277.8</td>
<td>67.72</td>
<td>0.13</td>
<td>177.5</td>
<td>0.02</td>
<td>0.03</td>
<td>5.65</td>
<td>6.19</td>
<td>100</td>
<td>-0.45</td>
</tr>
<tr>
<td></td>
<td>s_\alpha</td>
<td>6.61</td>
<td>572.3</td>
<td>72.53</td>
<td>3.92</td>
<td>585.6</td>
<td>0.28</td>
<td>0.14</td>
<td>22.02</td>
<td>17.81</td>
<td>11.98</td>
<td>3.01</td>
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<tr>
<td><strong>Natural service</strong></td>
<td></td>
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<tr>
<td></td>
<td>Mean</td>
<td>75.28</td>
<td>38.34</td>
<td>2.6</td>
<td>-0.01</td>
<td>50.12</td>
<td>0.05</td>
<td>0.05</td>
<td>4.06</td>
<td>4.12</td>
<td>97.23</td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>s_\alpha</td>
<td>6.84</td>
<td>22.36</td>
<td>1.94</td>
<td>3.89</td>
<td>569.1</td>
<td>0.28</td>
<td>0.15</td>
<td>21.55</td>
<td>17.81</td>
<td>11.45</td>
<td>1.28</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>83</td>
<td>83</td>
<td>83</td>
<td>74</td>
<td>83</td>
<td>83</td>
<td>83</td>
<td>83</td>
<td>83</td>
<td>40</td>
<td>73</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td>Mean</td>
<td>15.25</td>
<td>239.5</td>
<td>65.12</td>
<td>0.14</td>
<td>127.4*</td>
<td>-0.03</td>
<td>-0.02</td>
<td>1.59</td>
<td>2.07</td>
<td>2.8*</td>
<td>-0.4</td>
</tr>
</tbody>
</table>

* p > 0.05

Cassell et al. (2002) came to similar conclusions. This author reported that cows sired by proven artificial insemination sires produced 1400 kg more herd lifetime actual milk and were $148 more profitable when compared with daughters of non artificial insemination sires. Evaluated reproduction indicators showed slightly more positive results in NS bulls compared to AI bulls but these differences were not significant. Breeding values of AI bulls where lower in case of male fertility (-0.45; -0.02), female fertility (-0.91; 0.08) and overall relative breeding value for reproduction (99.95; 102.1), too. Williamson et al., 1978 also proved not significant worse reproduction values in AI bulls compared to NS bulls. When pregnancy rates in dairy herds in Victoria (USA) were analyzed, AI and NS cows showed pregnancy rates 57.5%; 58.0% but pregnancy rates of NS were more variable in NS herds. Smith et al., 2004 reported shorter calving interval in herds that used NS bulls. However, the
advantage of a shorter actual calving interval was lost by longer dry days for herds using NS sires and fewer dry periods in the desirable range of 40 to 70 days. Van Raden et al. (2004) found the heritability of days open in first lactation, calculated by calving interval, also 0.037. Genetic correlations with first lactation milk, fat, and protein were 0.38, 0.33, and 0.32, respectively, indicating that selection for yield reduces fertility. Genetic correlation with productive life was −0.59, indicating that cow fertility plays a major role in longevity. Cow fertility was negatively correlated with milk yield but is a major component of longevity.

CONCLUSIONS
Concerning a breeding value for kg of milk (AI = 177.54; NS = 50.12) and a relative breeding value for kg of protein (AI = 100.03; NS = 97.23) significant higher values (p > 0.05) in AI bulls compared to NS bulls were shown. Other indicators of milk production (kg, % of protein and fat) showed not significant differences. NS bulls showed not significant more positive breeding values of reproduction indicators compared to AI bulls. Reproduction indicators involved in the research were: male fertility (AI = -0.45; NS = -0.02), female fertility (AI = -0.91; NS = 0.08) and a relative breeding value for fertility (AI = 99.95; NS = 102.1). The NS bulls bring a considerable advantage of conception of problematic cows, calving and start of the next lactation.

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SPSS 15.0 for Windows, Release 15.0.0 (6 Sep 2006)
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