Factors Affecting Holstein Cattle Fertility Traits in the Slovak Republic

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Abstract
We investigated the influence of the factors herd-year, breed-type, sire, and milk production and lactation length on the fertility traits of Holstein cattle (age at first calving, calving interval, days open, non return rate at 56, 72, and 90 day). The data were received from 87 230 Holstein cows first time calved in period 2000 and 2008 with three full-term lactations. Average age at first calving was 875 days and average milk production on first, second and third lactation was 6816 kg, 7524 kg and 6536 kg, respectively. Coefficient of determination estimated by linear model with factors as join herd-year effect and sire was 0.1164 *(P<0,001)* and 0.1145 *(P<0,001)* for variation of calving interval after 1st lactation and 2nd lactation, respectively. When the quadratic effect of milk production and lactation length was included to the linear model, coefficient of determination for calving interval variation increased significantly to 0.7049 *(P<0,001)* after 1st lactation and to 0.6297 *(P<0,001)* after 2nd lactation. Basically on these results including milk production and lactation length to the fertility genetic evaluation is needed.

Key words: fertility traits, milk production, genetic evaluation

1. Introduction

Fertility can be described as an ability to produce a living offspring during economically and physiologically approved period [7]. Female fertility is a complex trait. It is affected by different factors for example nutrition, breeding conditions, and season of calving, time to first heat and milk production.
Milk production and reproduction are major factors affecting on efficiency and profitability of dairy industry. In most countries breeding programs were mainly oriented towards yield traits. Selection for higher yields of dairy cattle has led to a decline in fertility due to unfavourable genetic correlations between yield and fertility [12, 13]. Because of that we have to respect these relationships and include it in national genetic evaluation and into the selection indices.

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The Scandinavian countries and North American countries were one of the first countries, whose selection indices included conformation together with production, fertility, longevity, and health traits in order to improve herd profitability [11, 14]. The aim of this study was to evaluate the influence of different factors on reproduction performance.

2. Materials and methods

Data for genetic evaluation of Holstein breed with first calving occurring between 2000 and 2008 were received from results of dairy milk recording in Slovak republic. We observed subsequent reproduction traits for 87230 Holstein cows: age at first calving (AFC) as age when cow was first time calved, calving interval (CI) as interval between two consecutive calving, days open (DO) as interval between calving and successful conception, and non return rate (NRR) at 56, 72 and 90 day. Non return rate was defined as the percentage of cows which did not return to service within 56, 72 and 90 days after insemination.

We divided cows by breed-type to subsequent groups:

H0 – cows with genetic proportion of pure Holstein blood into 93.75%

H1 – cows with genetic proportion of pure Holstein blood from 87.5% to 93.74%

H2 – cows with genetic proportion of pure Holstein blood from 75 to 87.4%

H3 – cows with genetic proportion of pure Holstein blood from 50 to 74.9%

Model equations (relationship between factors and calving interval after first lactation):

a) without including milk production and days in milk

$Y_{ijkl} = HY_i + BT_j + S_k + \mathbf{a_l} + e_{ijkl}$

b) with including quadratic effect of milk and days in milk

$Yijkl = HY_i + BT_j + S_k + b_1(milk)_{ijkl} + b_2(milk)^2_{ijkl} + c_1(dim)_{ijkl} + c_2(dim)^2{}_{ijkl} + \mathbf{a_n} + e_{ijklmn}$

Model equations (relationship between factors and calving interval after second lactation):

a) without including milk production and days in milk

$Y_{ijkl} = HY_i + BT_j + S_k + \mathbf{a_l} + e_{ijkl}$

b) with including quadratic effect of milk and days in milk

$Y_{ijkl} = HY_i + BT_j + S_k + b_1(milk)_{ijkl} + b_2(milk)^2_{ijkl} + c_1(dim)_{ijkl} + c_2(dim)^2{}_{ijkl} + \mathbf{a_n} + e_{ijklmn}$

where HY_i was a fixed effect of herd by year of birth; BT_j was effect of breed-type; S_k was effect of sire; a_l was a random animal additive genetic effect, and e_{ijkl} was a random error term; $b_1(milk)_{ijkl}$ was effect of milk production; $b_2(milk)^2_{ijkl}$ was quadratic effect of milk production; $c_1(dim)_{ijkl}$ was effect of days in milk; $c_2(ldni)^2{}_{ijkl}$ was quadratic effect of days in milk; $\mathbf{a_n}$ was a random animal additive genetic effect; e_{ijklmn} was a random error term.

Basic statistic analysis, factor analysis, distribution analysis and data edition was performed using program SAS 9.1 Enterprise Guide 3.0.

3. Results and discussion

Mean AFC in dataset was 857 days (28.5 months), mean DO after first and second calving was 114 days and 116 days respectively. Mean first and second CI was 399 days and 401days, respectively (Table 1).

Table 1. Average values of selected traits in dataset

Trait	Mean	Std. Deviation	Min	Max	N
Milk1 (kg)[1]	6816	2289	47	19776	87230
DO1 (days)[2]	114	55	15	250	87230
CI1 (days)[3]	399	55	300	535	87230
Milk2 (kg)[4]	7524	2528	56	19570	87230
DO2 (days)[5]	116	56	15	250	87230
CI2 (days)[6]	401	56	300	525	87230
Milk3 (kg)[7]	6536	3431	24	19991	87230

1 milk production at 1st lactation, 2 days open length after first calving, 3 first calving interval, 4 milk production at 2nd lactation, 5 days open length after second calving, 6 second calving interval, 7 milk production at 3rd lactation

Berry et al. [1] published in Ireland average AFC 840 days (28 months). They found that Montbeliard cows in compare with Holstein cows were older, while Jersey cows were younger. Average days open was 90 days. Average Age at first calving was 835 days, average DO was 132 days and average CI was 409.8 days in Poland [8]. Estrada-León et al. [3] reported for Brown Swiss cows bred in Mexico average AFC 937 days (31,25 months), average DO 172,8 days and average CI 453,9 days.

Figure 1 and 2 show average milk production and average DO length by breed-type. Heins et al. [6] published different days open length for purebred Holstein cows and their crossbreds. Purebred cows had DO 150 days while crossbred had DO 127 days. Average milk production of purebred cows was higher (7705kg) in compare with crossbred Holstein x Jersey (7147kg). Dechow et al. [2] reported higher milk production for purebred Holstein cows and shorter DO length for F1 crossbreds. We can confirm the findings of authors

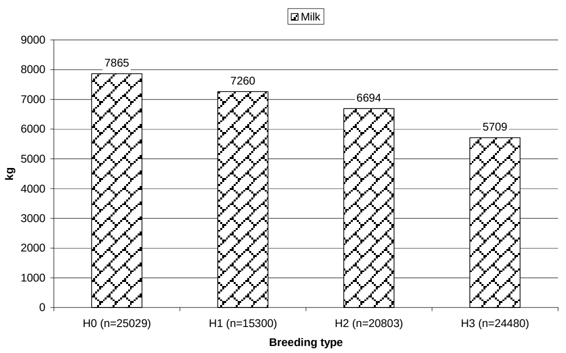

Figure 1. Milk production by breed-type

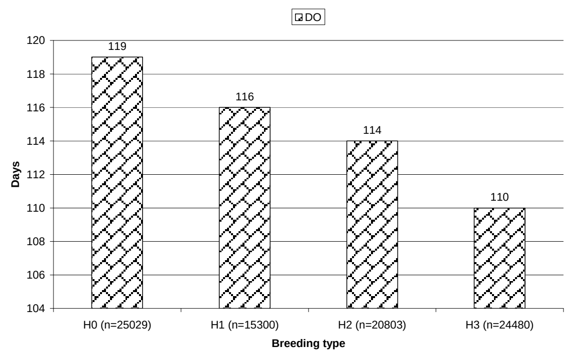

Figure 2. DO length by breed-type

In figure 3 we can observe development of days open and increasing level of milk production by years at first calving.

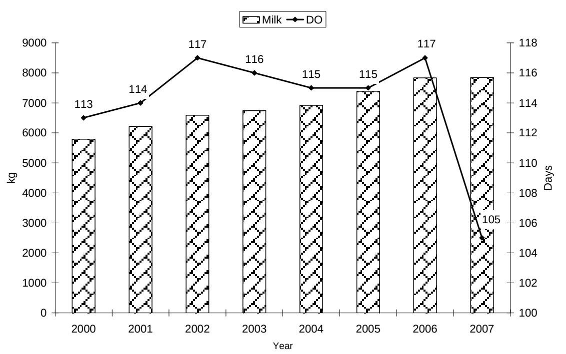

Figure 3. Development of milk production and DO length by year at first calving

Melendez and Pinedo [10] reached similar conclusions. They observed increase in milk production while reproduction performance decreased between years 1990 and 2003.

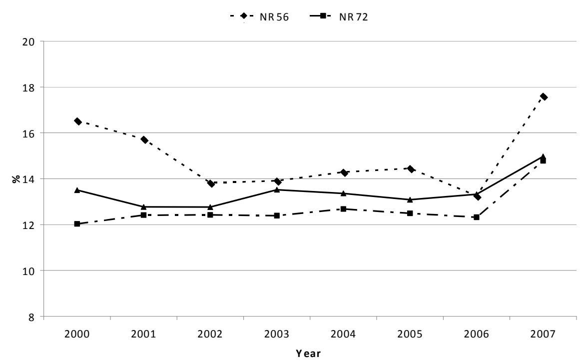

Figure 4. NRR development by year at first calving

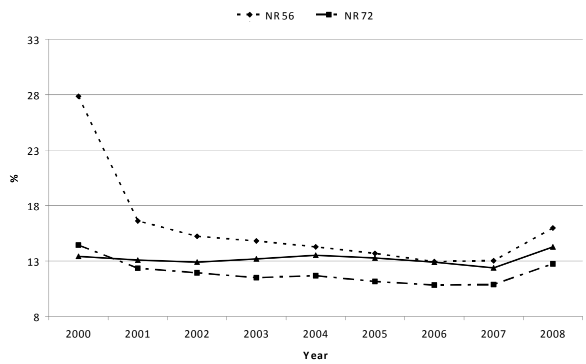

Figure 5. NRR developments by year at second calving

Non return rate level by year at first and second calving was very low (figure 4 and 5). We can conclude that these results are worse in compare with results of other authors. NR56 for Fleckvieh and Braunvieh heifers were 77.6% and 76.8% respectively and for cows these breeds were 65,6% and 66,7% [5]. NR56 for Danish Holstein cows 56.3% [15]. Fuerst, Egger-Danner [4] published NR90 for Simmental 61.8% and for Brown Swiss 60.9%. NR at 56 and 72 day witch found Jagusiak and Żarnecki [8] was 73% and 69%, respectively.

In figure 6 we can observe increasing trend of calving interval by milk production level. Melendez and Pinedo [10] reported increase in milk production together with extending calving interval.

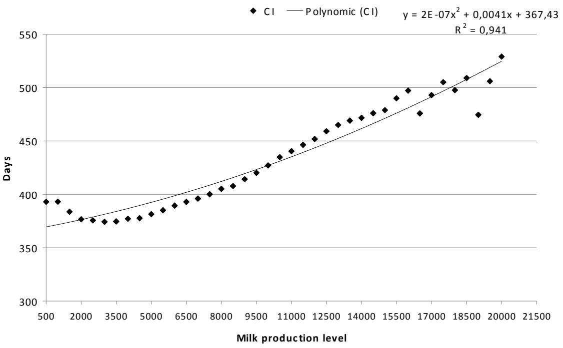

Figure 6. Calving interval lengths by level of milk produc

We observed statistically significant influence of herd-year at calving and sire on first and second calving interval (*P<0.0001)*. Coefficient of determination estimated by linear model with factors as join herd-year effect and sire was 0.1164 *(P<0.0001)* and 0.1145 *(P<0.0001)* for variation of calving interval after 1st lactation and 2nd lactation, respectively. When the quadratic effect of milk production and lactation length was included to the linear model, coefficient of determination for calving interval variation increased significantly to 0.7049 *(P<0.0001)* after 1st lactation and to 0.6297 *(P<0.0001)* after 2nd lactation. We found statistically significant correlations (P<0.0001) among first calving interval and kg production of milk (0.36), fat (0.34) and proteins (0.38). Statistically significant correlation on similar level we found among second calving interval and kg production of milk (0.33), fat (0.31) and proteins (0.34). Makgahlela et al. [9] found positive correlation with mentioned traits on level 0.69 for kg of milk, 0.66 for kg of fat and 0.68 for kg of proteins on 1st lactation. The results show, that relationship between milk production and reproduction performance is existing.

4. Conclusions

Genetic trends for female fertility and milk production among years 2000 and 2007 were similar as results reported elsewhere, but the level was lower in compare with findings of other authors. In our conditions decreasing trend of reproduction performance is not only influenced by increasing milk production but also by influence of different fixed and random effects. The aim of this study was to estimate influence of different factors on reproduction performance. We can conclude from results that effects herd-year and sire had influence on reproduction. When we included to the linear model quadratic effect of milk production and lactation length the influence of factors on reproduction performance was increased. So, including milk production and lactation length into the fertility genetic evaluation has importance.

Acknowledgements

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