The influence of oestrus synchronization on estimation of EBV for the trait of fertility

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Summary

The objective of the study was to determine the influence of oestrus synchronization on the estimation of breeding value for the binary trait of fertility in Holstein cattle in the Czech Republic. For computations 2 318 976 records on cow conception rates from the years 1996-2014 were used. Information on oestrus synchronization is not included in performance testing in the Czech Republic and therefore it had to be estimated. This estimation was done on the basis of two conditions – numbers of inseminations in a day in comparison with herd average and length of inter-insemination interval. Significance of fixed effects was tested by the least-squares method in SAS programme. Breeding values were estimated by the BLUP-AM method using the blupf90 programme. The control model, unlike the tested model, did not contain a synchronization effect. There was no statistically significant difference between breeding values estimated by the model with oestrus synchronization effect and by the control model. The correlation between the maternal components of breeding values of cows from both models was 1. A reason for a very low amount of variance expressed by the oestrus synchronization effect can be that some individuals were indicated as synchronized even though these individuals were not subjected either to oestrus synchronization or to timed artificial insemination, low or no influence of the estimated synchronization effect on estimated breeding value, or the influence of synchronization effect is already expressed by the environmental effect of herd-year-season of insemination

Keywords: dairy cattle, EBV, fertility genetic analysis, oestrus synchronization

Introduction

Well known is a negative genetic correlation between performance and fertility (Dematawewa and Berger, 1998, Pryce et al., 2004). Freeman et al. (1986) predicted that the ongoing selection for production traits could lead to a decrease in fertility and that selection for reproductive traits could be essential in future. A question has been raised whether reproduction biotechnologists will develop new methods that will make reproductive performance more effective to such an extent that selection for reproductive traits will not be necessary. Royal et al. (2000) concluded that an annual decrease in fertility in dairy cattle herds caused by breeding for production traits was 1%.

There have been developed new methods of reproduction management such as oestrus synchronization, but it has become necessary to begin to perform genetic selection for reproductive traits because cow fertility continues decreasing (Lucy et al., 2001). In the sixties of the 20th century the conception rate of cows after artificial insemination was 50%. Currently, it is approximately 35% (Lucy, 2001).

In many countries with advanced cattle management various mathematical and statistical models are used for genetic evaluation of fertility. The inclusion of synchronization effect in existing models could be one of the possibilities how to make these estimates more accurate. In the past genetic parameters of fertility of dairy cattle were estimated using the categorical effect of oestrus synchronization that was created on the basis of performance testing of a relatively small number of animals. This procedure provided more accurate estimates of some traits (Goodling et al., 2005).

The objective of the present study was to evaluate the effect of synchronization protocols on estimated breeding value (EBV) on a large national-wide population size.

Material and methods

This evaluation consisted in a comparison of EBV for two models. Unlike the control model, the effect of oestrus synchronization was added to the tested model. For the computation of EBV the input data had to be arranged into the form required for the application of least-squares method and BLUP method. Such arrangement of data consisted in data adjustment for nonsense or undesirable records and in the creation of fixed and random effects. The data arrangement was followed by testing the significance of particular fixed effects by the least-squares method. Subsequently, the BLUP method was used to compute breeding values for both models and to make their mutual comparison.

The input data were supplied by the Czech-Moravian Breeders Society through mediation of the PLEMDAT. The data were collected in the years 1984-2014.

The set of data on conception originally contained 4 851 405 records on conception from 842 661 cows with different lactation number. Effects essential for a model equation were created. It was necessary to estimate a synchronization effect. The first step was a division of records according to insemination frequency on a given day in a given herd. In case that the number of inseminations on a given day in a given herd was higher than 1.5 of the standard deviation of the average number of inseminations per month in a given herd, the value of synchronization effect of all inseminated individuals on a given day in a given herd was set to “synchronized”, in an opposite case to “unsynchronized”.

In the second step the records were divided according to insemination and inter-insemination interval. If the inter-insemination interval was longer than 9 days and at the same time shorter than 18 days, the record was set to “synchronized”. Then these two conditions were combined and the resultant synchronization effect was created.

In the next part of data arrangement data belonging to a class with the too low frequency of occurrence of cases were removed. For this purpose an iteration algorithm written in the SAS programme (2011) was run that removed unsuitable records. Data stabilization occurred after 14 cycles were run. Unlike the control model, a synchronization effect was included in the tested model. Effect e is a residual error.

The control model was as follows:

$$Y = MDG + PDG + IA + IAsq + II + IIsq + TY + MPE + LN + HYSi + HYSb + AFC + IR + e$$

where:
MDG - maternal direct genetic effect , PDG - paternal direct genetic effect , IA - effect of age of cow at insemination, IAsq - second power of IA , II - effect of insemination interval,

IIsq - second power of II, TY - effect of technician – year, MPE - maternal permanent environmental effect , LN - effect of lactation number, HYSi - effect of herd-year-season of insemination, HYSb - effect of herd-year-season of birth, AFC - effect of age at first calving, IR - effect of rank of insemination.

Results and discussion

The coefficient of determination computed by the least-squares method comprising the fixed effects HYSb, HYSi , TY, II, IIsq, IA, IAsq, synch, LN, AFC and IR was 16.1%. Although the amount of variance expressed by some effects (insemination interval, its second power, insemination age, its second power, lactation number, age at first calving) was low, all effects included in the least-squares method were also used in the BLUP method because the significance of effects between the least-squares method and BLUP method may differ. At the same time, all used effects were evaluated as statistically significant.

Variability was determined using values of evaluated and predicted effects in tested and controlled models. It is applicable to both models used when tested by the BLUP method that the variance of the maternal component of EBV is by two orders higher than the variance of EBV of the paternal component. The distribution of frequencies of the maternal component of EBV has two peaks: one for EBV -0.09 and the other for EBV 0.015. This could indicate that historically, in previous generations, two populations of animals were combined into the current population.

Table 1 describes differences between model 1 and 2 and mutual correlations. The values of correlations between model 1 and model 2 for the maternal component of EBV and for the overall value of an individual, which was created by combining the maternal EBV and maternal permanent environment. These were determined for a sampling set which consisted only of records from animals with own performance and for a set consisting only of records indicated as synchronized. Table indicates high correlations between model 1 and 2 for the both maternal component of breeding value and overall value of an individual.

Table 1. Differences between model 1 – without synchronization effect and model 2 – with synchronization effect

	Model	Sampling set	Number of cases	Correlation coefficient
Maternal EBV	1	All individuals with own performance	463 872	1
	2			
	1	Synchronized individuals with own performance	318 303	1
	2			
Overall value of an individual (EBV + maternal permanent environment)	1	All individuals with own performance	463 872	0.99998
	2			
	1	Synchronized individuals with own performance	318 303	0.99999
	2			

In case that effect of oestrus synchronization is included in a model equation for the estimation of genetic parameters of fertility traits and breeding values for fertility, an increase in the accuracy of these estimates was expected (Goodling et al., 2005). With increasing accuracy of estimates an economic contribution of animal breeding is also enhanced because genetic gain increases.

In our case the correlations of maternal components of breeding values and overall values of an individual between model 1 and 2 computed by the BLUP method are 1 and 0.99998, which is also given by the fact, that reproduction has low heritability and that EBV includes also values of relatives, which not necessarily were under hormonal treatment. No significance of the estimated synchronization effect follows from comparison of two models, which differ only by inclusion of SE effect. Breeding values estimated by model 1 were slightly higher than breeding values estimated by model 2 using the synchronization effect.

Both models suggest a trend of an improvement in conception rate with increasing the order of insemination. It is to assume that it is caused by worse health status, body condition and negative energy balance just after calving. With increasing insemination number since calving these negative factors are diminished, this leads to a better conception rate at later inseminations. For the trait of age at first calving the trend of declining fertility with increasing age at first calving can be explained by the higher body condition at first calving, which negatively influences also later reproductive performance. Lactation number also negatively affects reproductive performance. It is to assume that this is due to gradual exhaustion of the animal organism caused by long-term intensive load.

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