Estimation of Fertility Breeding Values for Holsteins

Introduction
There are two separate evaluations for maiden heifers and cows in the Czech Republic.
Traits:
- Male fertility: Conception rate (heifers and cows)
- Female fertility: Conception rate (heifers and cows)

Data
- Insemination effect after 3 months from the performed AI is evaluated. Binary measurements are used – pregnant (1) or non-pregnant (0). Data are collected by AI service technicians by rectal examination for pregnancy.
- Inseminations since 1 January 1995 are included.
- ET Donors and recipients have whole reproduction cycle excluded.
- First 3 inseminations for first 3 lactations are considered. The other inseminations are assumed to be determined by a number of non-detectable or not genetically conditioned impacts.
- Excluded are also cows/heifers inseminated 16 days after, before or within the period, when cow/heifer was in a herd together with the bull.

Model
ST- BLUP-AM
(Single Trait - BLUP – Animal Model)

Heifers model:
- herd-year-season of insemination
- herd-year-season of birth
- insemination order
- age at the time of insemination
- AI service technician-year of INS.
- Inseminated heifer (female fertility)
- AI bull (male fertility)

Cows model:
- herd-year-season of insemination
- herd-year-season of last calving
- insemination order
- age at the time of first calving
- lactation order
- DIM
- relative milk yield in first 100 days within herd
- AI service technician-year of INS.
- Inseminated cow (female fertility)
- AI bull (male fertility)

Description of the effects
HYS
Herd Year Season is a fixed effect. The season is defined as a month. At least two inseminations of two different cows (heifers) must be within HYS to include HYS into the evaluation. In every HYS, there must be cows (heifers) by at least two different sires, inseminated by at least two different bulls.

Herd-year-season of birth
Similar to HYS effect; the season of birth is defined as two months.

Herd-year-season of last calving
Similar to HYS effect; the season of last calving is defined as two months.

Insemination order
It is fixed effect. Only first three inseminations are considered. Re-inseminations are not considered because their application is by hazard and does not have many regularities.

Age at time of insemination
It is fixed effect. This effect is evaluated by estimation of the effect of the group of animals with a similar age at insemination. There are 13 groups of heifers. Animals with unknown age at insemination are excluded.
The groups are following:

group	range (days)
1	< 364
2	365-426
3	427-456
4	457-486
5	487-517
6	518-548
7	549-580
8	581-611
9	612-642
10	643-703
11	704-765
12	766-827
13	>827

Age at the time of first calving
It is fixed effect. This effect is evaluated by estimation of the effect of the group of animals with a similar age of first calving. There are 13 groups of cows. Animals with unknown calving date are excluded.
The groups are following:

group	Age of 1st calving (days)
1	<= 669
2	670 – 731
3	732 – 763
4	764 – 795
5	796 – 827
6	828 – 858
7	859 – 889
8	890 – 921
9	922 – 952
10	953 – 1014
11	1015 – 1076
12	1077 – 1138
13	>= 1139

Inseminated heifer/cow (female fertility)

It is random effect of female fertility. Daughters of sires used in natural covering are not included. The effect is using the pedigree based relationship matrix with the full 4-generations form. Assumed heritability of this effect is for heifers 0.039 and for cows 0.044.

AI bull (male fertility)

It is random effect of male fertility. Bulls used in live covering service are not included. The effect is using the pedigree based relationship matrix with the full 4-generations form.

Assumed heritability of this effect is $h_2 = 0.015$.

AI service technician - year of insemination

It is the last random effect.

Lactation order

It is fixed effect. It is determined by parity. Three classes are used, fourth and higher lactations are not assumed.

DIM - Days in milk

It is fixed effect. This effect is evaluated by estimation of the effect of the group of animals with similar days in milk while inseminated. There are 13 groups of cows.

The groups are the following:

group	DIM (days)
1	<= 39
2	40 – 49
3	50 – 59
4	50 – 69
5	70 – 79
6	80 – 89
7	90 – 99
8	100 – 109
9	110 – 129
10	130 – 159
11	160 – 189
12	190 – 219
13	>= 220

Relative milk yield in first 100 days within herd

It is fixed effect. Relative milk yield performance of the cow to the average of the herd. There are 8 groups of cows.

The groups are following:

group	Relative yield (%)
1	<= 50
2	51 – 70
3	71 – 90
4	91 - 110
5	111 - 130
6	131 - 150
7	151 =<
8	N/A

Final Breeding Value

Breeding value for 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 overall fertility breeding value − BVoverall (heifers + cows). BVoverall is created as weighting average. Weights are effective numbers of inseminations for heifers and cows.

BVoverall = (SWheifers * BVheifers + SWcows * BVcows) / (SWheifers + SWcows)

Relative breeding values (RBV) are calculated according to this formula:

$$RBV = [(BV - x) / s * 12] + 100,$$

x average BV for birth year 2005
s standard deviation for birth year 2005
RBVs are standardised in parameters (100; 12) for bulls born in 2005.

Publication of results

Each type of breeding values is published when 20 inseminations in specific type are reached. Overall fertility breeding values are published if at least 20 inseminations of heifers as well as 20 inseminations of cows were included in to evaluation. Only bulls born since 1992 are evaluated by the current model. Breeding values of older bulls were estimated in 2005 for the last time and their fertility breeding values have not been changed.