Description of Model for Estimation of Breeding Values for Fertility

Simmental breed

Introduction

There are two separate evaluations for maiden heifers and cows in the Czech Republic.
Traits:

- Male fertility: Conception rate (maiden heifers, cows)
- Female fertility: Conception rate (maiden heifers, cows)

Data

- Insemination effect after 3 months since performed AI is evaluated. Binary measurements are used – pregnant (1) or non-pregnant (0). Data are collected by AI service technicians after rectal examination for pregnancy.
- Inseminations since January 1st 1993 are included.
- Donors and recipients are excluded.
- First 3 inseminations for first 3 lactations are considered. The other inseminations are assumed to be determined by a lot of non-detectable or not genetically conditioned impacts.

Model

ST- BLUP-GSM
(Single Trait - BLUP - Grand Sire Model)

Effects considered
Maiden heifers and Cows
- HYS (Herd Year Season)
- insemination number
- age at insemination
- sire (female fertility evaluation)
- AI used bull (male fertility evaluation)
- AI service technician * year

Cows only
- lactation number
- calving first insemination interval
- milk yield of 100-days lactation * lactation number

HYS
Herd Year Season is fixed effect. Season is defined as a month. At least two inseminations of two different cows (heifers) must be within HYS to include HYS into evaluation. These cows (heifers) must be daughters of two different sires, inseminated by two different bulls.

Insemination number
It is fixed effect. Re-inseminations are not considered because their application is too accidental and hasn't much regularities.

Age at insemination
It is fixed effect. This effect is evaluated by estimation of effect of group of animals with similar age at insemination.
There are 10 groups of heifers. For cows this effect is evaluated in interaction with number of calving (lactation). So there are 12 groups for first calved cows, 14 groups for second and third calved cows. Age in number of finished months is decisive parameter for inclusion into relevant group. Age in days is divided by constant 30.42 to receive age in finished months. Animals with unknown age at insemination are not excluded, but included into groups with the highest age.

- List of groups according to age at insemination (in finished months)

Group	Heifers	Cows 1st lact.	Cows 2st lact.	Cows 3st lact.
1	< 15	< 27	< 38	< 50
2	< 16	< 28	< 39	< 52
3	< 17	< 29	< 40	< 53
4	< 18	< 30	< 41	< 54
5	< 19	< 31	< 42	< 55
6	< 20	< 32	< 43	< 56
7	< 21	< 33	< 44	< 57
8	< 23	< 34	< 45	< 58
9	< 25	< 35	< 46	< 59
10	>= 25	< 36	< 47	< 60
11		< 38	< 49	< 61
12		>= 38	< 51	< 63
13			< 53	< 66
14			>= 53	>= 66

Sire
It is random effect of female fertility. Sires used in natural service are not included. Breed of sire is not considered. This effect is realized by relationship matrix in the form animal-sire-maternal grand sire (Grand Sire Model). Assumed heritability of this effect is $h^2 = 0.03$.

AI used bull
It is random effect of male fertility. Bulls used in natural service are not included. Breed of sire is not considered. This effect is realized by relationship matrix in the form animal-sire-maternal grand sire (Grand Sire Model). Assumed heritability of this effect is $h^2 = 0.04$.

AI service technician * year
It is random effect. Assumed heritability of this effect is $h^2 = 0.08$.

Lactation number
It is fixed effect. It is determined by parity. Three classes are used according to correspond parity.

Calving - first insemination interval
It is fixed effect. Groups are used to classify this effect similarly as age at insemination.

- List of groups according to calving – first insemination interval (days)

Group	1st insemination	2nd insemination	3rd insemination
1	<= 44	<= 72	<= 91
2	45 - 51	73 - 79	92 - 112
3	52 - 58	80 - 86	113 - 142
4	59 - 65	87 - 93	143 - 155
5	66 - 72	94 - 100	>= 156
6	73 - 79	101 - 110	
7	80 - 86	111 - 120	
8	87 - 93	121 - 130	
9	94 - 100	131 - 140	
10	101 - 110	>= 141	
11	>= 111		

Milk yield of 100-days lactation * lactation number
It is fixed effect. Groups are used to classify 100-days milk yield.

- List of groups according to 100-days milk yield (kg)

Group	1st lactation	2nd lactation	3rd lactation
1	<= 1750	<= 1800	<= 1800
2	1751 - 2000	1801 - 2100	1801 - 2100
3	2001 - 2200	2101 - 2300	2101 - 2300
4	2201 - 2400	2301 - 2500	2301 - 2500
5	2401 - 2600	2501 - 2700	2501 - 2700
6	2601 - 2800	2701 - 2900	2701 - 2900
7	2801 - 3000	2901 - 3100	2901 - 3100
8	3001 - 3200	3101 - 3300	3101 - 3300
9	3201 - 3400	3301 - 3600	3301 - 3500
10	3401 - 3600	3601 - 3900	3501 - 3750
11	3601 - 3800	3901 - 4200	3751 - 4000
12	3801 - 4000	4201 - 4500	4001 - 4250
13	>= 4001	>= 4501	4251 - 4500
14			>= 4501

Genetic groups, relationship matrix
Genetic groups are used. They are classified according to relationship matrix separately for sires (female fertility) and AI used bulls (male fertility).
Pedigree is traced back to the 3rd generation. Sire and maternal-grand-sire are assigned to every bull. If some ancestor is unknown, such one is substituted by genetic group. Both the 4th generation ancestors are always substituted by genetic group even in case their offspring is registered.
Genetic groups for sires and maternal-grand-sires are independent, so different.
Genetic groups are defined according to breed of known oldest ancestor and his birth years. These main 4 genetic groups are defined:

- USA and CAN bulls with HOL + RED blood proportion >= 75%
- The other countries bulls with HOL + RED blood proportion >= 75%
- Bulls with SIM blood proportion <= 50%
- Bulls with SIM blood proportion > 50%

These main groups are further classified according to birth year. Year classes with low number of bulls are merged. Merging is performed from the youngest bulls (classes). In most cases only 2 year classes are merged. The aim is to have at least 12 bulls in 1 group but the highest number of merged year classes can be 8.

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 – $BV_{overall}$ (heifers + cows). $BV_{overall}$ is created as weighting average. Weights are effective numbers of inseminations for heifers and cows.

$$BV_{overall} = (SW_{heifers} * BV_{heifers} + SW_{cows} * BV_{cows}) / (SW_{heifers} + SW_{cows})$$

Then standardization is executed so that standard deviation for all bulls born since 1992 is value of 3.

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

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

x average BV for birth year 1995
s standard deviation for birth year 1995

RBVs are standardized in parameters (100; 12) for bulls born in 1995.

Publication of results

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. Overall fertility breeding values are published if at least 20 inseminations of heifers as well as 20 inseminations of cows were included.

Only bulls born since 1992 are evaluated by current model. Breeding values of older bulls were estimated in 2005 for the last time and their fertility breeding values haven't been changed.