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## GENETIC EVALUATION FOR FEMALE FERTILITY IN ESTONIA

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### ABSTRACT

*A multiple trait animal model was applied to two fertility traits: non–return rate to 56 days (N56) and interval from calving to first insemination (TPP). Insemination data was used up to 7 lactations and inseminations of later lactations were treated as repeated measurements. Genetic parameters and breeding values were estimated by VCE4 and PEST, respectively. Results of model validation by Interbull validation methods (Method I and Method III) were presented. Joint routine evaluation for Estonian Red breed (ER) and Estonian Holstein breed (EH) will be introduced in August 2008 and breeding values will be published for bulls only.*

**Key words:** cattle, fertility traits, genetic evaluation, trend validation

### INTRODUCTION

In many countries breeding values of several reproduction traits have been used for years in breeding dairy cows. The fact that since 2004 regular international evaluations of bulls include longevity, calving ease and stillbirth, and that from February 2007 evaluation for female fertility traits was added, supports their importance.

Although no genetic evaluations have been made officially in Estonia, the Estonian Animal Recording Centre (EARC) has carried out several analysis and genetic evaluations since 2003 in order to get an overview of data and information in the field and to monitor changes.

The analysis of dairy cattle has revealed similar unfavourable trends in Estonia as in many other countries: cows with higher yield have longer interval from calving to first service and lower conception rate than their contemporary age group (Table 1). For many years, dryness has been the main reason for culling (>20%).

Table 1. Correlation between milk production and fertility traits by breed						
Milk (kg)	Fertility					
	EH			ER		
	#cows	N56	TPP	#cows	N56	TPP
1.lact	203076	-0.11	+0.04	77543	-0.10	+0.04
2.lact	143283	-0.12	+0.05	57094	-0.11	+0.05
3.lact	95042	-0.13	+0.08	39679	-0.13	+0.06

Fertility in the herd can be influenced when the breeding values of fertility traits of bulls are known. This was the reason why in the beginning of this year EARC, with the encouragement of breeding organisation, decided to publish the breeding values of fertility traits starting from the evaluation of this August. The objective of the research was to develop a suitable system of genetic evaluation of fertility traits for Estonia that would be in compliance with the international requirements set for the reliability of evaluation.

## MATERIALS AND METHODS

**Breeding traits.** For historic reasons, countries consider different female fertility traits [4]. The most frequently used are:

- 56-day non-return rate (N56) (in some countries 90-day)
- Interval from calving to first service (TPP)
- Age at first service
- Number of inseminations
- Interval from first to last inseminations
- Days open
- Calving interval

Drawing on literature and previous analysis, most fertility traits have low heritability estimates, for example for N56 it is only 1–5%. Heritability of TPP is significantly higher – up to 10% in different countries. These two traits were chosen for the multiple-trait animal model of genetic evaluation where TPP increases the reliability of N56. According to the definition of N56 there is no repeat insemination if within 5 to 56 days after the first insemination there is no record of a second one.

**Data.** Data of all EH and ER on pedigree, lactations and inseminations recorded by EARC since 1995 were represented. A dataset was formed where date of calving, first insemination, service sire and technician, date of second insemination and service sire, date of last insemination and service sire, number of inseminations, result of N56 on up to 7 lactations of each cow were recorded (Table 2).

Table 2. Row data for the evaluation of fertility traits (result of N56 is known)				
Breed	#cows	#records	Average	
			N56 (%)	TPP(days)
ER	71674	190103	66.6	82
EH	183803	460590	63.1	85

In the interest of reliability and accuracy of the results, the following restricting requirements were applied when gathering data:

- If a cow was recorded pregnant after the first insemination and culled after that due to dryness, then for the first lactation the data on the cow was not retained, for the following lactations the data on the last lactation was not retained.

- Abortions and other too short pregnancies were not retained [7]

(i.e. pregnancy less than 265 (280–15) days)

- Where there was calving interval, it was checked whether the pregnancy following insemination had a normal length. It was revealed that in 7.3% of the total number of records suitable insemination was missing. Background: in 2006 due to missing suitable inseminations, 12% of calves born were left without a sire. The result of N56 was incorrect and 6.3% of the records were changed. As for 0.5% of records, the first insemination was successful instead of recorded repeat insemination, and in the rest of the cases the repeat insemination was probably not recorded if the first insemination was unsuitable.

- The distributions of herd\*year of calving were left out of the evaluation where the number of heifers was <10. Due to this the number of herds was decreased on an average by 62%, the number of cows was decreased by 5.7% and the number of sires of a cow in evaluation decreased by 3.6%.

After the described requirements were applied, data on 593259 lactations of 208592 cows were considered eligible.

The EHs and ERs were evaluated jointly as for yield traits. The additional reason for joint evaluation was the fact that 10.3% of ER cows have a Holstein bull as their sire.

**Model.** As an evaluation model, a multiple–trait BLUP animal model was used as follows

$$\mathbf{N56} = \mathbf{hy+sm+birth+ltp+pv+ssire+technician+pe+animal}$$

$$\mathbf{TPP} = \mathbf{hy+pm+birth+pv+pe+animal},$$

where the description of effects is shown in Table 3.

Table 3. <b>Effects (F–fixed; R–random; A–additive) used in the evaluation model</b>		
Effect	N56	TPP
pm – month*year of calving	–	F
sm – month*year of insemination	F	–
ltp – lactation (2: 1.,>1.)*interval calving to first service (7 groups)	F	–
pvl – 3 calving age groups within 1 <sup>st</sup> lactation, 1 group within other lactations	F	F
birth – year of birth (20)	F	F
ssire – service sire	R	–
hy – herd*year of first insemination (min 10 heifers)	F	F
technician	R	–
pe	R	R
animal	A	A

**Variance component estimation.** To estimate the parameters VCE4 [3] was employed, for which suitable fails were generated by PEST [2]. Four samples were formed from the source data with the number of cows between 50000 and 62000 that were used to create the model to get a dataset that would be manageable for the computer. To evaluate the parameters taken into use, a sample combined from the data of four counties presented in Table 4 was used.

Table 4. <b>Data characteristic for variance component estimation</b>	
Number of cows	95847
Number of sires	1544
Number of animals	192679
Number of records	244999
Number of herds	308
Number of herd*year	3159
Number of service sires	959
Number of technicians	275

## RESULTS AND DISCUSSION

**Results.** The results of the estimation of genetic parameters are presented in Table 5.

Trait	$\sigma_e^2$	$\sigma_g^2$	$\sigma_{pe}^2$	$\sigma_{tech}^2$	$\sigma_{s.sire}^2$	$\sigma_{total}^2$	$h^2$
N56	2178.5	17.6	39.1	48.4	4.7	2288.3	0.008
TPP	659.1	34.7	37.4			731.2	0.048
corr	0.02		0.41				0.55

Heritability coefficients of breeding traits are lower than in Canada [9] and in Switzerland where similar model was applied [8] but similar to the results estimated in Germany [6]. The genetic correlation of 0.55 between variables is much stronger than in other countries [5]. The research did not uncover what caused this difference and it requires additional analysis.

**Validation test of the model.** Suitability of the model was tested by the Interbull genetic trend validation procedure [1].

Where Method I is used, breeding values evaluated on all lactations are compared only with the breeding values evaluated based on first lactation.

Breed	Trait	$b_t$	$b_1$	r	$\sigma_t$	$\sigma_1$	$\Delta$	$\sigma$
ER	N56	-0.059	-0.015	0.83	2.83	2.42	0.04	0.08
	TPP	-0.80	-0.65	0.88	6.91	6.34	0.15	0.15
EH	N56	-0.32	-0.26	0.84	3.28	3.35	0.06	0.08
	TPP	-0.55	-0.45	0.88	6.19	6.20	0.10	0.14

$\Delta = |b_t - b_1|$ , where  $b_t$  and  $b_1$  are estimated genetic trends of trait considering all lactations data and first lactation data respectively

r is genetic correlation between first and all lactations

$\sigma = 0.02 * (\sigma_t * \sigma_1) ** 0.5 / r$ , where  $\sigma_t$  and  $\sigma_1$  are genetic standard deviations for all lactations and first lactation respectively

The result is positive as in all events  $|\Delta| < \sigma$ .

Method III estimates the effect of new daughters on evaluation results. As described in [10], in Method III the current genetic evaluation of each bull is analysed as a function of its genetic evaluation four years ago, where the analyses model is:

$$Y_i = a + bX + \delta t_i + e_i \quad (1)$$

The  $\delta$  factor is a function of the number of new daughters per bull during the past four years. If the evaluations are unbiased, the expectation of  $\delta$  is zero. Expected correlation between results of these two evaluations by trait and breed should be between 0.95 and 0.99. The official Interbull criterion for Method III acceptance is  $|\delta| < 0.02 * \text{genetic SD}$  considering bulls with first crop daughters. According to the results in Table 7, the criterion is met only for N56 of the Estonian Red breed. Correlations between results were in range 0.88 and 0.92 only. Results of model validation for Interbull evaluation indicated some problems and therefore additional research for model development is needed.

Table 7. Results of validation test for fertility traits by breed (Method III)					
Breed	#sires	Trait	b	$\delta$	$\sigma$
ER	34	N56	1.04	0.001	0.065
		TPP	0.85	-0.56	0.078
EH	62	N56	1.02	-0.21	0.049
		TPP	1.05	-0.37	0.098

$\sigma = 0.02 * \text{genetic SD}; b \text{ and } \delta \text{ are from (1)}$

## CONCLUSION

The genetic parameters and evaluation model presented in this paper will be used for genetic evaluation of fertility traits in Estonia starting from August 2008. Female fertility breeding values for bulls that have at least 50 daughters in three herds at minimum under evaluation will be published.

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## ZUCHTWERTSCHÄTZUNG FÜR DIE FRUCHTBARKEIT IN ESTLAND

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### Zusammenfassung

Ein Zuchtwertschätzmodell mit Merkmalen Non-Returne-Rate 56 und Rastzeit (das Intervall zwischen der Abkalbung und der ersten Besamung) für die Fruchtbarkeitsmerkmale wurde eingeführt. Die Datengrundlage enthält alle Kalbungs- und Besamungsdaten bis 7 Laktationen, wobei die Beobachtungen von späteren Laktationen als Wiederholungen betrachtet wurden. Für die Schätzung der genetischen Parameter wurde das Programmpaket VCE4 und für die Zuchtwertschätzung das Programmpaket PEST verwendet. Die Ergebnisse der Zuverlässigkeitsanalyse des Schätzmodells wurden präsentiert. Eine gemeinsame Zuchtwertschätzung für Fruchtbarkeitsmerkmale wird für die Rassen Estnisches Holstein und Estnisches Rotvieh im August 2008 implementiert. Veröffentlicht werden die Zuchtwerte nur für Bullen.

**Raktažodžiai:**

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