



**National Research Institute  
of Animal Production**

**Bartosz Szymik**

**Genetic analysis of workability traits in the  
Polish Holstein-Friesian cattle population.**

Doctoral Thesis

Dissertation advisor: Prof. dr hab. Wojciech Jagusiak  
Dissertation co-advisor: Piotr Topolski

Kraków, 2020

# **Abstract**

## **GENETIC ANALYSIS OF WORKABILITY TRAITS IN THE POLISH HOLSTEIN-FRIESIAN CATTLE POPULATION**

**Bartosz Szymik**

PHD DISSERTATION

Workability traits represent the group of functional traits that affect the economics of dairy production. The most important of them are milking speed (cow's ability to donate milk in a given time period) and temperament (cow's response to all treatments related to milking and staying in the milking parlor). Breeding value of these traits is estimated according to the Interbull in many countries and is often an important compound of breeding indexes. In Poland, the breeding value of workability traits has not been estimated so far. However, phenotypic data (in the scale points) of milking speed and temperament has been collected in Poland since 2016.

The aim of the study was to examine (1) the variation of workability traits, (2) estimation of genetic and phenotypic parameters of workability traits and between workability traits and production traits and other functional traits based on pedigree data as well as pedigree and genomic data. The final goal was to attempt to develop an optimal model for estimation the breeding value of workability traits considering phenotypic and genomic data of Polish Holstein-Friesian cattle population.

The data on workability traits was collected for 1 045 511 Polish Holstein-Friesian black and white cows born in between 2004 and 2013. The workability traits evaluation was carried out in between 2011 and 2015. Basic data set was created from the SYMLEK system which belongs to Polish Federation of Cattle Breeders and Dairy Farmers. For the purpose of the main analyses following data-points were removed: individuals with evaluation performed after the 100<sup>th</sup> day of lactation, herds where no variability was noticed in studied traits. Final data set consisted of 391,615 individuals. Linear model to test the significance of effects affecting workability traits accounted for the effects that are most often used in the recommended observation models in the scientific literature. The model included the fixed effects of herd-year-season (HYS), lactation stage, fixed regressions on percent of Holstein-Friesian genes and age of calving and random genetic effect. Next, the estimation of genetic and phenotypic parameters of workability traits was carried out, as well as genetic and phenotypic correlations with the conformation, fertility, production traits and somatic cell count in milk. All estimations

of genetic and phenotypic parameters were repeated considering not only conventional data and standard pedigree information in the calculations, but also information derived from bull-sires genotypes. Estimated coefficients of genetic correlations are large enough to be used as a tool of indirect selection for production.

Finally, the estimation of the animal breeding value of workability traits was performed. In the first stage, the breeding value was estimated using the conventional BLUP - animal model method. In the second stage, pedigree information and genome - derived information were used to assess the breeding value using the one-step method. Based on the obtained breeding values, genetic trends occurring in the examined population were estimated.

In this PhD dissertation, phenotypic characteristic of the studied population was carried out depending on the year of birth. In this way changes in the phenotype of Polish Holstein-Friesian cows considering workability traits have been investigated since the beginning of the registration of evaluations for this group of traits. The average grades for workability traits obtained in the work are close to 3 points for milking speed and 2 points for milking temperament, which matches to its optimal values. This shows that the Polish Holstein-Friesian breed has the desired average of milking speed and the corresponding moderate milking temperament. In order to examine the impact of various effects on workability traits, an analysis of variance was performed. The effects most commonly used while creating new observation models were included. The impact of environmental factors affecting the workability traits turned out to be highly significant. It has been shown that the milking speed differently than on temperament is influenced by the share of HF genes (highly significant or significant). The obtained results prove that the Polish Holstein-Friesian breed is characterized mainly by desirable forms of workability traits.

Bayesian methods in a multi-traits animal model based on a linear model including all the analyzed workability traits, enabled to use the three-dimensional observation models and full genetic and environmental covariance matrix between all tested traits. Breeding value estimation was also carried out using results from the genotyping of cow-sires. Distributions of breeding values and accuracy of estimates using genotypes were very similar.

As part of this study, the distribution of workability traits breeding values of both males and females was characterized. Considering milking speed and temperament most bulls obtained breeding values in the range from  $\bar{x} - 2SD$  to  $\bar{x} + 2SD$ . Analyzing the accuracy distribution of breeding values of males workability, it can be stated that they deviate from the normal distribution. Breeding values were estimated using a data set previously used to estimate components of (co)variance. Breeding values were estimated for a total of 13,280 cows and 258

bulls, which were their sires. Software implemented in the BLUPF90 package was used to estimate breeding value of both workability traits (Misztal, 2008). For both females and males, it can be stated that the standardized average breeding value is slightly higher than 100 for both groups of animals. In order to develop and improve the methodology of phenotypic and genetic evaluation of workability traits, the future work should aim at estimating of the breeding value and accuracy of the animals that were not conventionally evaluated.

**Date: 29.01.2020**