

Genetic parameters and single step evaluation of sexual precocity traits in Charolais beef cattle

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Breeding a cow is an expensive process, especially due to its nonproductive period. Hence, decreasing the age at first calving may reduce the latter and improve economic efficiency of beef farms. Since 2018, a French network of 15 Charolais farmers gathered within a project called “FERTI38”, led by CHAROLAIS UNIVERS, equip their cows with neck tags (HEATIME® - MSD Animal Health Intelligence) to monitor cows behaviour. The collar collects hourly information as rumination, activity, eating time enabling detection of heat and health events. The latter are added to calving and pregnancy diagnosis information. Last, farmers are involved in validating the data collected, and recording additional information on tag replacement and cow management practices. These data were completed by insemination, gestation datasets and genotyped information. The goals of this project is to estimate genetic parameters of traits related to sexual precocity and reproductive traits in order to implement them in a single step evaluation. A dataset of 781 females with performances recorded was used. The mean age at first “Heat” was 14.8 months ranging from 8.6 months to 20.4 months. The heritability obtained for this trait is 0.36 with a standard error of 0.12. These results were implemented in a privative single step evaluation to estimate EBVs and reliability using HSSGBLUP software. The EBVs were standardized to obtain a mean of 100 and 10 points corresponding to a genetic standard deviation (21.6 days). For the 25 bulls evaluated with reliability higher than 0.30, EBVs ranged from 85 and 113 and the mean reliability is 0.52 with a maximum of 0.76.

Abstract

Keywords: sexual precocity, Charolais beef cattle, single step evaluation.

Non-productive periods are a loss of money for breeders, during this time, an animal is fed and raised without any possibilities to earn money. The time for a heifer to be sexually ready for insemination is one of these periods. Decreasing age at first calving could reduce a non productive period and improve economic efficiency of beef farms but also ecological impact of beef productions (Farrié *et al.*, 2008; Nguyen *et al.*, 2013).

In this study, we propose to analyse the data of a network of French beef farms in Charolais for sexual precocity traits, through genetic parameters calculations and implementation of Single Step evaluation for these traits, one of the first in France.

Introduction

Material and methods

Farm network and data collection

With the project « FERTI 38 », a French network of 15 Charolais farmers are involved in since 2018. Farmers were chosen with several criteria's, around one hundred of calving per year on small reproductive periods (less than 3 months), with more than 80% of artificial insemination, collection of birth and weaning phenotypes, and age at first calving between 24 and 30 months of ages. Each farmers had to equip their cows with neck tags (HEATIME® - MSD Animal Health Intelligence) to monitor cows' behavior. The collar collects hourly information as rumination, activity, eating time enabling detection of heat and health events. The latter are added to calving and pregnancy diagnosis information. Last, farmers are involved in validating the data collected, and recording additional information on tag replacement and cow management practices. These data were completed by insemination, gestation datasets and genotyped information.

In the current study, the first trait analyzed was the "Age at first heat" for heifers with a minimum of 1 month of neck tag equipment time in order to take into account the adaptation time. The data of 781 heifers were collected and used. The corresponding pedigree with up to 4 generations contains 3,631 individuals.

Genotypes

Available genotypes of animals with phenotypes or parents of these animals were included in this study. They consisted of 1,578 genotypes of purebred Charolais animals, 106 males and 1,472 females with 781 with phenotypes available. 53,498 autosomal SNP markers were retained from the Illumina 50K chips used routinely in France for genomic selection. Genotypes were imputed with FImpute (Sargolzaei *et al.*, 2014) with the pipeline used in the routine French national evaluation system.

Genetic parameters calculation

Estimation of genetic parameters for the traits studied were performed using the WOMBAT software (Meyer, 2006) and the following animal model:

$$y_{ijk} = \mu + h_j + b_k + \alpha a_i + g_i + e_{ijk}$$

With y_{ijk} the phenotype measured on animal i , μ a general mean, j h_j fixed effect of the Herd j in which animal i obtained his phenotype, b_k fixed effect of the birth year k of the animal i , α linear regression of the age a_i of animal i at neck tag equipment, g_i random genetic effect of animal i and e_{ijk} the residual of the model.

Single Step evaluation

Evaluation of animals were performed using a Single Step Evaluation (SSTEP) approach, using the HSSGBLUP developed by Tribout *et al.* (2020) in France. This software used the Hybrid Single Step model proposed by Fernando *et al.* (2016). All animals with phenotypes and the corresponding pedigree were included in the evaluation (781 heifers with phenotypes). All the relevant genotypes (1,578) were included in order to maximize genetic relationships between animals. The corresponding model of genetic parameters calculation was used for the SSTEP evaluation.

The mean age at first heat in our dataset is 14.6 months of age with a standard deviation of 2.2 months. The minimum and maximum values were 8.6 months and 20.4 months, respectively. Genetic parameters estimation showed an heritability of 0.36 for the trait age at first heat with a standard error of estimation of 0.12, in relation to the medium number of animals with phenotypes taken into account. The corresponding genetic variance of the trait is 0.50 month. These results were in accordance with the results of Mialon *et al.* (1998) with a value of 0.34 (0.09). Phocas and Sapa (2004) found a heritability of 0.15(0.03) for the trait first heat at 15 months (0/1) in accordance with our results of 0.26 (0.12) for this trait.

The SSTEP evaluation provided Estimated breeding values (EBVs) for the bulls of Charolais Univers linked to the animals with phenotypes. EBVs were standardized to obtain a mean of 100, corresponding to 14.8 months of ages, and 10 points corresponding to a genetic standard deviations (21.6 days). For the 25 bulls with a reliability higher than 0.30, EBVs ranged from 85 to 113, reliability ranged to 0.30 to 0.76 with a mean of 0.52.

In this study, we report results from one of the first applications of SSTEP evaluation in France in beef breeds on sexual precocity traits. This evaluation is permitted by the implication of farmers that collect regularly phenotypes since 6 years and continue.

The first steps are focused on more synthetic traits like age at first heat but the idea is to go further and to study traits describing HeatIndex curves from a genetic perspective in order to implement genetic selection on them.

Results and discussion

Genetic parameters calculation

Single Step Evaluation

Conclusions

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