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ANALYSIS OF NON-RETURN RATE IN ITALIAN HOLSTEIN FRIESIAN BULLS

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ABSTRACT

Until recently non-return rate 56 days (NR56) for Italian Holstein Friesian bulls had been published only for artificial-insemination (AI) organizations. Since December 2015, the information about sire fertility has been published also for the farmers. The objectives of this research were to assess the importance of information about the cow's age at insemination and editing of age of bulls for improving prediction of bull fertility. The intent was to revise the old model, even if NR56 is a phenotypic assessment of bull's prospective fertility and not a genetic evaluation. Factors considered for the revision of the model were date of insemination, age of cows at the time of mating and number of matings. Data included 3,726,450 records from 3,210 bulls and 1,312,901 cows in 7,395 herds from January 2011 till January 2016. Results revealed that alternative models ignoring AI organization and using only last five years of insemination, multiple services and editing on age of bull improved accuracy of predictions.

Key words: cattle, breeds, Holstein Friesian, bull fertility, non-return rate

1 INTRODUCTION

Fertility is an important trait in the dairy herd and low reproductive performance is among the main reasons of involuntary culling (Miglior *et al.*, 1998). Fertility is a very complex trait, difficult to define, to record and to evaluate, mainly because it is influenced by a wide range of factors, the most important being, herd management and the environment. Genetics plays a small yet important role in fertility, the male for fertilization and the female for conception. Female fertility is routinely evaluated as a functional trait for genetic selection, whereas studies on male fertility have attempted to assess the relationship of field data with semen quality and processing and handling techniques (Reurink *et al.*, 1990; Schaeffer, 1993). Despite low, additive genetic variance for fertility exists, meaning that selection enhance reproductive efficiency of dairy cows is feasible.

Non-return rate (NRR) is a direct measure of fertility and it allows for a fast evaluation of reproductive performance, without the need of waiting for the subsequent calving (Tiezzi *et al.*, 2011). The NRR is defined as the proportion of cows that are not subsequently re-bred within a specified period of time after an insemination. The observed NRR is affected by many factors including herd, age of cow, month of insemination and artificial insemination (AI) center (Khun and Hutchison, 2008; Guita *et al.*, 1996). Other factors that may affect NRR are the misidentification of the cow at subsequent service, and the, inaccurate heating detection and recording (Rycroft and Bean, 1992). The NRR may be considered a reliable indicator of fertility if all these effects can be quantified

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or are random. The usefulness of NRR is dependent on the accuracy of data collection. In Italy, most of the inseminations are performed by herdsman technicians. NRR (at day 56 or 60 day) can be used as indicators for bull fertility. In Italy, since September 2013, bull fertility is evaluated using the ERCR (Estimated Relative Conception Rate). It may be interpreted as being the NRR at 56 days of the AIs performed using a bull in comparison to other bulls used for the same herd. ERCR is a measure of the fertility of an individual sire and is predictable and repeatable over the productive life of an AI sire if ample data have been collected (Clay and McDaniel, 2001). ERCR should identify low fertility bulls to avoid or high fertility bulls to select. The objective of the present study was to revise the current model used to evaluate bull fertility in the Italian Holstein Friesian sires population in order to improve the reliability of the predictions.

2 MATERIAL AND METHODS

The original data available for this study included all AI records of Italian Holstein Friesian bulls collected from January 2001 to January 2016. Only herdbook registered animals were considered. With genomics, very young bulls are used, but the number of inseminations and doses for these bulls are very limited. Low inseminations could influence the results so data were restricted to service sires with at least 100 inseminations, a minimum age at insemination of 15 months. In order to keep the NR56 evaluations current and more relevant information on AI data of maximum the previous 5 years were considered. Moreover, cows of parity 1 to 3 were considered, and maximum number of insemination per cow per parity was 3. After editing, there were 3,726,450 AI records from 3,210 bulls and 1,312,901 cows in 7,395 herds. For each inseminated cow, the following data were available: insemination date, age of cow at time of insemination, service sire, non-returnrate at 56 days (NR56) and daily milk production. The NR56 was defined as a binary trait, on the basis of whether (=1) or not (=0) the insemination had conceived the mate. The current model for the analysis of NR56 included herd-year-month of breeding, energy corrected milk, parity, days-open, AI center, status of bull as fixed effects and estimate relative conception rate permanent cow effect and residual as random effects (Biffani *et al.*, 2005). In the present study a new model for the analysis of NR56 was set up and data were analysed using the GLM procedure of SAS (SAS Institute Inc., Cary, NC). Models were constructed introducing possible combinations of predicting variables (and first order interactions) until those that best explained the variance in the dependent variable (NR56) could be selected. ERCR is an estimate of the difference of AI mating bull from the average AI mating bull of herdmates for rate of NRR in 56 d. The current model for computing ERCR was:

Table 1: *Descriptive statistics of ERCR of bulls from two model*

	Mean	SD	Min.	Max.
ERCR of bulls in new model	99.96	5.39	55	116
ERCR of bulls in current model	99.98	4.99	68	124

Table 2: *Numbers of bulls with reliability > 80 or < 80*

	New model	Current model
N° of bulls with reliability > 80	2252	967
N° of bulls with reliability < 80	340	1612

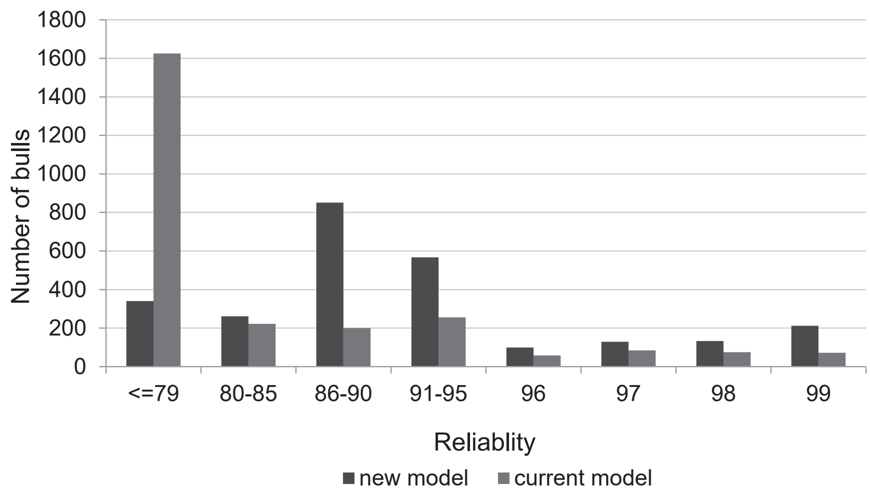

Figure 1: *Distribution of bulls based on reliability*

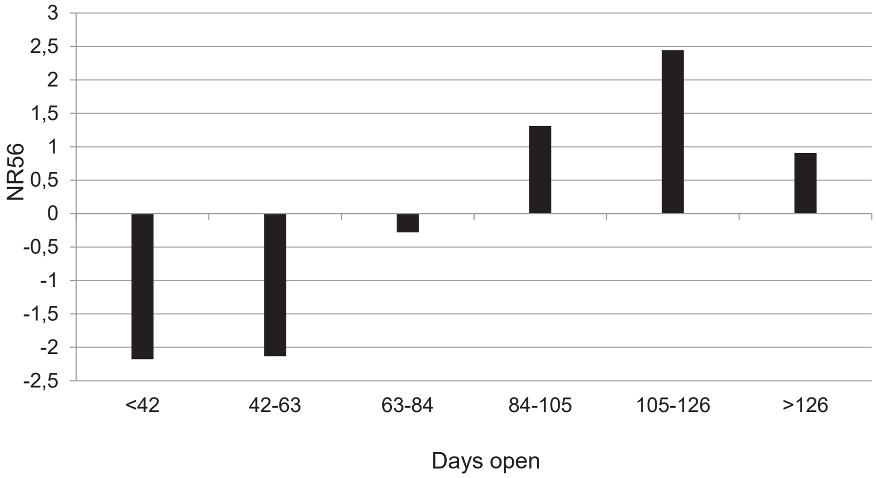

Figure 2: *Effect of days open on NR56*

$$y_{ijklmno} = HYM_i + DO_j + NS_k * STATUS_l + COW\_AGE_m + ERCR_n + PE_o + e_{ijklmno}$$

where

$y_{ijklmno}$ = NR56 (1 if no return; 0 if bred again);
HYM_i = ixed effect of herd-year-month of breeding;
DO_j = fixed effect of days open;
$NS_k * STUTUS_l$ = ixed effect of number of inseminations by status of bulls interaction;
COW_AGE_m = fixed effect of age of cow at time of insemination;
$ERCR_n$ = random estimate relative conception rate, which is an estimate of difference of AI mating bull from the average AI mating bull of herdmates for NR56;
PE_o = random permanent cow effect, and
$e_{ijklmno}$ = random residual with an average equal to 0 and σe.

Status of bulls represents the status of bull at time of insemination. Status of bull was grouped into 4 classes based on reproductive information and age (G = genomics young bull, R = progeny bull, P = Italian proven bull, E = non-Italian proven bull).

The model adjusted for a measurements of interval traits calving-conception by including 6 classes of DO (< 42, 42 to 63, 63 to 84, 84 to 105, 105 to 126, and > 126 d).

The model adjusted for the effect of age of cow at time of insemination by including 15 classes (18 to 26, 26 to 27, 27 to 28, 28 to 29, 29 to 31, 31 to 33, 33 to 37, 37 to 39, 39 to 41, 41 to 43, 43 to 47, 47 to 51, 51 to 55, 55 to 60, and > 60 months).

The NR56 for individual bulls was estimated with 95 % confidence level. Solutions were computed by Misztal's JAA program that incorporates iteration-on-data

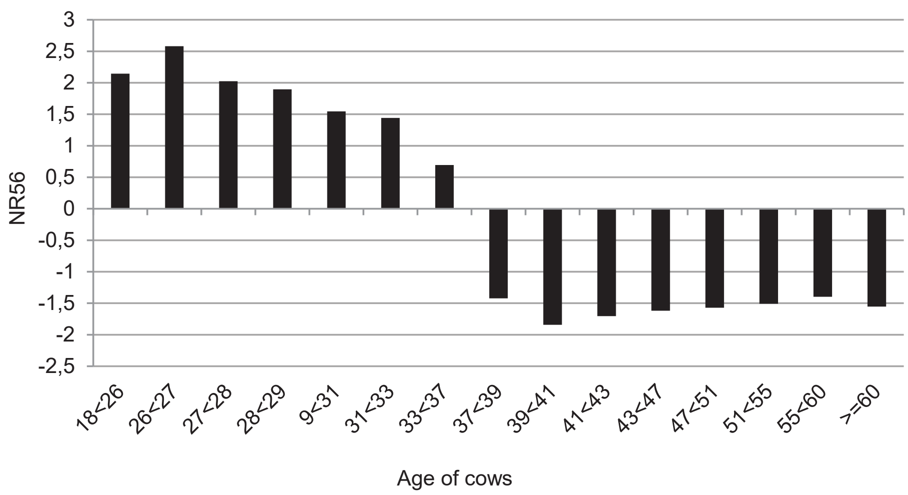

Figure 3: *Effect of age of cows on NR56*

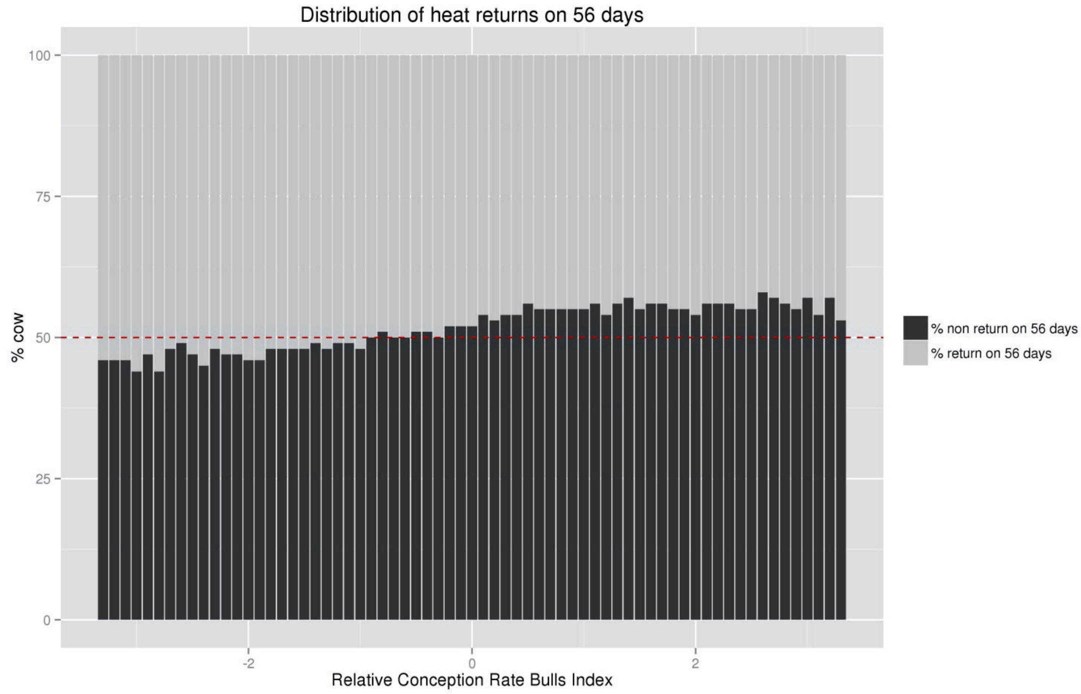

Figure 4: *Distribution of heat returns on 56 days*

using second-order Jacobi (Misztal, 1994). The average mating bull's solution was set to zero.

3 RESULTS AND DISCUSSION

Descriptive statistics of ERCR-prediction fertility of bulls in the two models are shown in Table 1. Although the average in the two models found not very different, the correlation between the two models was 0.73. For the publication of ERCR-prediction fertility the reliability should be > 0.80. With the new model reliability increased in fact, with the current model 1,612 bulls had reliability less than 0.80, while with the new model 1,290 of this bulls could had reliability greater than 80 as reported in Table 2. The distribution of bulls based on reliability of ERCR in the two different models is reported in Fig. 1.

Solutions of the current model showing the relative impact of days open on NR56 (Fig. 2), breeding cows before 84 days after calving had a negative impact on fertility. Similarly, cows bred at more than 126 days are expected to have less chance of being rebred. Fertility increased to the maximum value between 105–126 days. Similar results are reported by several studies (Clay and McDaniel, 2001; Berger *et al.*, 1981).

Figure 3 illustrated the relationship between NR56 and age of cows. As age of mate increased (indicated by parity) fertility declined. In particular for first parity, cows demonstrate the best fertility, then fertility decreasing gradually and it worsens over 3 years. Clay and McDaniel (2001), as well as Hillers *et al.* (1984) have found the same results. The results show a difference between the bulls, in terms of NR56, of ± 10 %, as reported in Figure 4. Therefore male fertility influences the final result.

4 CONCLUSIONS

The objectives of this research were to assess the importance of information about insemination and age of bull for improving prediction of bull fertility. Respect to the current model the prediction of fertility is better because 80 % of the bulls with reliability < 80 % in the current model, showed reliability > 80 % in the new model. The heritability of bulls NR56 is low and around 0.02 but it is offset by a relatively high estimate of the variability between bulls.

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