Improving the stability of test day model evaluation for production traits in the Italian Holstein

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ABSTRACT - Genetic evaluation for production traits in the Holstein breed in Italy is based on a Random Regression Test Day Model (RRTDM) since November 2004. More specifically the model is a multiple lactation, multiple traits RRTDM, similar to the model used in Canada for official genetic evaluation. In order to improve stability, data were pre-adjusted for number of days pregnancy at test day and fixed regression curve effects include now the effect of year of production, four calving seasons instead of two and a general effect for days in milk (DIM) was added. The changes in the model improved stability of proofs over time, thus increasing the ability of the test day to accurately predict the breeding value of both bulls and cows. Trend validation results showed also improvements and residuals were positively affected by the changes. Trends in trait residuals previously detected with respect to DIM and month of calving did show a significant reduction. The new model was officially introduced in January 2009.

Key words: Test day model, Accuracy, Residuals, Proof stability.

Introduction - The use of a test day model was introduced for the official evaluation of production traits and somatic cell count for the Holstein breed in November 2004. More specifically, the model is a multiple lactation, multiple traits Random Regression Test Day Model (RRTDM) based on Legendre polynomials with the same approach and programs as the Canadian Test Day Model (Jamrozik et al., 1997, 1998; Schaeffer et al., 1999; Kistemaker, 2003) started in 2001.

Since then, research has been developed in order to identify areas of improvement, as for any other model used for genetic evaluation. One of the big differences between the old lactation repeatability animal model and the RRTDM is that the latter assumes a more dynamic way of expressing genetic capacity, along the lactation and across lactations, that brings with itself more variation over time in bull proofs and this aspect is perhaps the most challenging for users.

As part of the work to improve the accuracy of the model the stability of proofs over time is a very important parameter for the farmers and all the Artificial Insemination technicians responsible for selection of sires and bulldams. Stability in a way is the measure of the ability of the system to predict future values of bulls based only on first parity daughters’ information or on only first crop daughters.

The aim of this paper is to present the differences between the model used for the official genetic evaluation until August 2008 and the new model introduced in the genetic evaluation of January 2009.

Material and methods - Outputs from the official evaluations of August 2007, January 2008, April 2008, and August 2008 were used for the analysis on the stability, and the results of the official evaluation of November 2004 were used to validate the estimated genetic trend according to Interbull method III (Boichard et al., 1995). The model is a multiple trait, multiple lactation RRTDM, evaluation milk, fat, protein, and somatic cell counts in the first three lactations as described in Muir et al. (2007).
The structure of the fixed effects curves that account for time, region, age, parity, and season of calving effect (TRAPS) are as described in Canavesi et al. (2006). Data are preadjusted for heterogeneity of variance as described by Schaeffer et al. (2000).

Changes introduced were related to:
- pre-adjustment of single test day for number of days pregnancy at the test date;
- time effect in the fixed effect structure was changed from a group of 5 years to a single year effect;
- season of calving effect was moved from 2 to 4 levels in the regions where data structure made it possible;
- a separate single fixed effect for days in milk (DIM) from 5 to 305 was added with 301 levels.

The results of the four runs of genetic evaluation with the new model were compared to the results of the corresponding official genetic evaluation. On average in the three runs around 70 million test day records were used, related to around 5 million cows and 70,000 bulls with at least one daughter. No editing was applied to bull and cows data. Test day records were edited based on standards defined by the milk recording organisations and when daily variations exceeded the threshold of 3 SD compared to what expected based on standard curves and correlations across test days.

Residual effects were computed for each observation and their distributions were analyzed in general and according to the different fixed effects accounted for in the model in both the official and the new model. In addition to those also average residuals were computed for number of days of pregnancy at test date, and number of milkings per day. Residuals were compared between the official and the new model to estimate the improvement in accuracy.

**Results and conclusions** - Interbull method III validation did show an improvement in results, the potential bias is non significant and anyhow below the limit set by Interbull for all traits.

Figure 1a reports the average residual values plotted by month of calving in the official model and the new model in the genetic evaluation of January 2009. In the official model there is a clear trend in residuals from April to August that in the new model disappears or is limited now from April to June. More interesting are average residuals by DIM reported in Figure 1b. In the official model average residuals show values greater than 1 kg especially at the beginning of the lactation while with the new model values never go above 0.8 kg.

**Figure 1.** Average residual values for kg milk by month of calving (a) and DIM (b).

When looking at the stability of proof a very important indicator is the average variation of bulls from run to run. Figure 2a and 2b report the average variation for fat and protein kg of bulls proofs grouped by date of publication for milk and protein kg respectively. The same pattern of variation was observed for all traits. Bulls considered for the analysis were all Italian proven bulls, i.e. bulls with at least 20 daughters at 120 DIM and with at least 70% reliability. The figures shown refer to their published proofs that combine EBV for first, second, and third lactation. The new model has variations that are always below 40 kg of milk and 2 kg for protein and fat, while the official model has variations...
around 100 kg and above 2 kg on average especially when bulls are in their first year of publication which seems to suggest an overestimation of bull EBVs that the new model is able to correct. The average proof variation from run to run is expected to move around zero and to follow a straight line, which seems to be the case with the new model and not so with the old one.

Figure 2  Average variation of bull proofs by date of publication between April 2008 and August 2008 evaluation runs for fat (a) and protein (b).

All four changes applied to the model contribute to the improvement of the evaluation. The change that had the greatest impact on stability over time was the introduction of DIM, besides the pre-adjustment for number of days pregnancy (DP) had reduced the trend of the residuals by DP, the effect of the four seasons of calving is clearly visible in the reduced trend in residuals by month of calving and the effect of the year in the reduced trend in residuals by year of production. No significant effect was observed on the ranking of the bulls. Rank correlations among proofs were all higher than 0.99 both for cows and bulls.

As already mentioned, the new model has been adopted as official with the genetic evaluation of January 2009. Although there are some areas that can be further improved, it is a step forward in providing the farmers with a more accurate and more stable system.

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