Female Fertility Expression For Walloon Dairy Cattle

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Introduction

A genetic evaluation system for pregnancy rate (**PR**) in Holsteins has been used in Walloon Region of Belgium since September 2007 which allows participating at the INTERBULL genetic evaluations. Fertility traits definition differs greatly across the various populations. Jorjani (2007) regrouped the traits in 5 groups for INTERBULL evaluations. The Walloon Region of Belgium participates in three of these five evaluations (groups 2, 4 and 5); in return from 1 to 3 international proofs are provided for bulls on the Walloon scale.
The main purpose of this paper was to present a useful method to take advantage of these international proofs to express female fertility for Walloon dairy cattle in a way that it reflects the common part in female fertility definitions Moreover, an investigation was carried out to find good predictors of female fertility through the other traits evaluated in Walloon Region of Belgium and to combine this indirect female fertility information with the direct one into an overall useful index for Walloon breeders.

Material and methods

Female Fertility evaluation in the Walloon region. Genetic evaluations of female fertility were obtained from PR data of the April 2009 routine run. Data consisted of 1,604,630 PR records on 606,328 Holstein (at least 75% Holstein or Red-Holstein genes) cows. Proofs of 671 bulls were submitted to INTERBULL, and results for 88,496 bulls were returned.

Principal Component Analysis (PCA) on foreign Female Fertility indexes. Six countries (Canada (**CAN**), Germany (**DEU**), France (**FRA**), Italy (**ITA**), Netherlands (**NLD**), and **USA**) provided their own female fertility indexes for bulls published in the country. These countries were chosen as they represent major import countries of genetic materials for the Walloon Region of Belgium. More information concerning these indexes can be found in Minery et al. (2008) and Rensing et al. (2008). Relationships among these female fertility indexes were analyzed by principal components analysis (PCA) on the common bulls between these countries. Only female fertility indexes from five countries were used for this analysis in order to have a sufficient number of bulls in common, i.e. 812 bulls instead of 43 bulls if FRA index was not excluded.

Combining international proofs to direct female fertility (DFF). The first principal component, obtained during the PCA was used to estimate the regression coefficients needed to predict a direct female fertility value (**DFF**) from the international proofs in function of their availability (one, two or three proofs), for bulls sent back by INTERBULL. Reliability of DFF was computed using an approach similar to the one proposed by VanRaden (2010); however the three traits were considered completed independent. For cows, breeding values

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and associated reliabilities coming from national genetic evaluation of female fertility were considered as direct female fertility information.

Female fertility index for Walloon Region of Belgium. For young bulls, only information of daughter fertility through the first lactation is available which limits the accuracy of DFF. For such animals, the use of correlated traits to estimate an indirect female fertility (**IFF**) may be as accurate as, or more accurate than the DFF estimated from daughter information. Furthermore, there are also bulls without international proofs for each of the three groups in which Walloon Region participates but having international proofs in the two others. In such case, prediction of IFF could be also a good solution to provide an indication about the female fertility of these bulls. The best predictors of female fertility among traits evaluated in the Walloon Region were found by a multiple regression method on the first principal component using the reliability of DFF as weight. Based on selection index theory, DFF and IFF were combined afterwards in a global index called combined female fertility index (**CFF**). Reliabilities of CFF were estimated according VanRaden (2010). The same strategy of computation was applied to CFF for cows combing local breeding values for PR from own records with IFF from correlated traits. Breeding values for CFF were then updated by foreign information (i.e. CFF for INTERBULL sires), if available, using the procedure presented by VanRaden (2001).

Results and discussion

Principal Component Analysis (PCA). The first component explained about 80 percents of the total variance and showed approximately equal coefficients on all foreign indexes. Therefore, the first component seemed to be a good compromise on female fertility expression, which could be represented as a linear combination of the five foreign indexes.
Correlations of the six foreign indexes with the first component ranged from .86 to .94. So, the exclusion of FRA index could be considered as not a major problem according to its good correlation, which was equal to the correlation with ITA index (.86).

Table 1: R-square and coefficients of regression of the first component

	Bulls	R^2	Regression coefficients		
			T2	T4	T5
T2	791	.525	.399		
T4	811	.684		.454	
T5	790	.682			.445
T2-T4	790	.703	-.283	.714	
T2-T5	790	.683	-.407		.825
T4-T5	790	.729		.133	.315
T2-T4-T5	790	.730	-.407	.138	.691

Combining international proofs to direct female fertility (DFF). The standardized international proofs (T2, T4 and T5) were combined, in function of their availability, to DFF using as weights coefficients of regression of the first component on the international proofs (see Table 1). Variance of DFF was harmonized with variance of local breeding values for PR. As expected, the best R^2 was observed when the three international proofs were available. Some regression coefficients were negative as observed for T2 with T4 and/or T5. This could be interpreted as compensation between highly correlated traits. DFF showed positive correlations with only six other traits evaluated in the Walloon Region; the highest was with BCS (.40) followed by percent of fat (.19) and percent of protein (.17). These results seemed consistent with results found in literature (VanRaden (2006)) and simplified the search of good predictors of the female fertility.

Combined female fertility index (CFF) for the Walloon Region of Belgium. An index to predict female fertility based on official Walloon bull proofs for ten traits was derived using milk yield, fat percent, protein, SCS, stature, body depth, overall udder score, overall feet and legs score, final conformation score and BCS.

However, BCS is only recorded in Walloon Region for a few years, as in several countries. Not all bulls (and few cows) have a proof for BCS consequently a second index was developed. This index was composed by the same traits as the first index but BCS was replaced by angularity, which presented also a high but negative correlation with DFF (-.49). The first index was called IFF_{BCS} and the second called $IFF_{ANG.}$

According to high correlation between T4 and T5 displayed in Table 2, same range of correlations with DFF and IFF were not surprising. Correlation between both IFF was close to unity, so IFF_{BCS} and IFF_{ANG} could be considered very similar. Moreover, both indexes had the same range of correlations with T2, T4, T5 and DFF but, as expected, slightly higher for IFF_{ANG}. Also correlations with T2 were lower with all traits.

Table 2: Correlations between female fertility proofs and indexes for publishable bulls in Walloon Region

	T2	T4	T5	DFF	IFF_{BCS}	IFF_{ANG}
T4	.90					
T5	.95	.97				
DFF	.83	.97	.96			
IFF_{BCS}	.42	.48	.50	.51		
IFF_{ANG}	.51	.57	.58	.59	.99	
CFF	.80	.92	.93	.96	.76	.82

Coefficients to combine DFF with IFF into CFF obtained were, if BCS was available:

$CFF= .751 * DFF + .381 * IFF_{BCS}$

Otherwise, as:

$CFF= .763 * DFF + .373 * IFF_{ANG}$

Correlation between the first component of PCA and CFF (.86) was very close of the one with DFF (.85). Thus, there was no loss of information to combine DFF with IFF into CFF. Moreover, as illustrated in Figure 1, CFF presented, in average, higher reliabilities than DFF principally for bulls having a reliability of DFF below 80%. On the 88,496 sires from INTERBULL, 82,757 bulls had a reliability of DFF > 34% (rule of publication) and 86,776 had a reliability of CFF > 34% which leads to extra 4,019 bulls with publishable female fertility information.

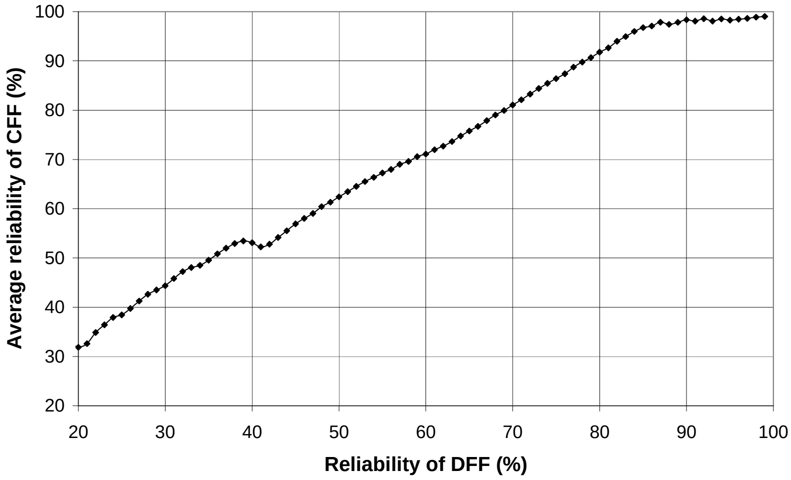

Figure 1: Average reliability of CFF as a function of reliability of DFF for bulls

Conclusion

A useful method to express female fertility in our dairy cattle using international female fertility proofs of bulls and indirect information was developed and tested in this study.
As said by results, the combination of DFF and IFF into CFF could be considered as a pretty good expression of this female fertility leading to a better accuracy for young bulls and to a useful first indication of female fertility potentiality for bulls without international proofs. CFF was, also, calculated for Walloon cows according to the same strategy as for bulls and results seemed to be consistent but they must be study more in detail in the next months.
The next step will be to integrate CFF into the Walloon economic index system and therefore to improve our global economic index.

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