Level of Connectedness and Reliability in International Beef Evaluation

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Abstract

This paper addresses two aspects of the reliability in the frame of international beef evaluation: connectedness between countries and increase of bulls' reliability. Connectedness was measured by the potential bias between genetic levels of countries, while bulls' reliability was computed following MTEDC method. These methods were applied to a Limousine dataset combining weaning weights of purebred calves from three countries (France, Ireland and United Kingdom). The levels of connectedness were low compared to values computed for dairy genetic evaluations.

Merging together data and pedigree of these countries leads to a small increase of reliability for France and a much larger one for Ireland and United Kingdom. The results highlight the main interests in Interbeef evaluation: providing EBVs of foreign bulls without local progeny and increasing EBV reliability of bulls already used in the country.

1. Introduction

Since the initial EUropean BEef EVALuation (EUBEEVAL) project initiated by Ireland in 2001, great progresses have been achieved in the development of international genetic evaluation of beef breeds: the first major practical work consisted in standardizing data exchanges between countries and validating the international identification of the exchanged animals. Meanwhile, scientific analyses have been carried out to identify the best model to apply on the beef cattle data and to estimate the genetic parameters (Journaux *et al.*, 2006). Based on these results and with the help of the French software developed by Institut de l'Elevage and INRA for multi-traits evaluation with maternal effects, a first joint genetic evaluation have been conducted between France (FRA), Ireland (IRL) and United Kingdom (UK) in 2007 for pure bred Limousine weaning weights (Venot *et al.*, 2007). The final output of this process was a country specific bulls ranking. However, no reliability measure was associated to the breeding values at this stage of the Interbeef project.

To be reliable, an international evaluation must involve countries that are connected between each other. If it is the case, sires EBV should be more reliable, because of the increase in the amount of information related to bulls.

The aim of this paper is to study both aspects,

(i) connectedness in the Limousine international evaluation,
(ii) increase in the reliability of bulls.

2. Material and Methods

2.1. Data

The data considered for this study are the same than the one used for the Limousine joint genetic evaluation between France (FRA), Ireland (IRL) and United Kingdom (UK) in 2007 for weaning weight: their description can be found in Venot *et al.* (2007). As a reminder, it includes 1 428 050 FRA, 6 160 IRL and

28345 UK adjusted weaning weights, associated with 2 697 227 FRA, 88 232 IRL and 136823 UK animals in the pedigree. The reduced amount of performances in IRL and UK can be explained by the exclusive selection of pure bred animals.

2.2. Genetic parameters

For the sake of simplicity, no maternal genetic effect but only a common maternal effect was taken into account in the genetic evaluation model in 2007. However, in the present study, we've chosen to keep the complete model with maternal genetic effect and a common permanent one. Table 1 gives the details of the parameters used.

Table 1. Genetic parameters.

(variances below the diagonal, correlations above)		*Direct genetic effect*			*Maternal genetic effect*		
		FRA	IRL	UK	FRA	IRL	UK
Direct genetic effect	FRA	210	**0.94**	**0.80**	**-0.21**	**-0.20**	**-0.21**
	IRL	178	172	**0.87**	**0**	**0**	**0**
	UK	169	167	212	**-0.22**	**-0.20**	**-0.22**
Maternal genetic effect	FRA	-26	0	-28	73	**0.91**	**0.96**
	IRL	-15	0	-15	40	26	**0.97**
	UK	-27	0	-28	71	43	73

	FRA	IRL	UK
Maternal permanent var.	63		
Residual variance	402	962	476
Phenotypic variance	722	1223	797
h^2d	0.29	0.14	0.27
h^2m	0.1	0.02	0.09
h^2c	0.09	0.05	0.08

2.3. Connectedness assessment

Until now, connectedness between FRA, IRL and UK was assessed only by a rough count of the common bulls with progenies in the different countries. We used here a new method based on a measure of the potential bias between genetic levels of countries (Fouilloux *et al.,* 2006 and 2008).

The main steps of this method are as following: by simulation, a systematic difference between true genetic levels of countries is introduced. A single trait sire evaluation based on true pedigrees is then run on the simulated performances. The percentage of the initial difference that is found back between the estimated genetic levels of the countries is measured. The better 2 countries are connected, the higher is the percentage of the genetic difference that is reestimated. This method takes into account all relationships between the sires of the different countries.

2.4. Reliabilities

During the last decade, lots of works have been carried out on Effective Daughter Contribution (EDC) used as weighting factors for bulls in the Interbull Multiple Traits Across Country Evaluation (MACE). Through theoretical and programming developments, computations of EDC have been progressively improved and extended to complex models such as multiple traits model with maternal effects. Sullivan (2007) described a new method that combines the advantages of several approaches already developed and programmed a general software called MTEDC, in order to facilitate and standardize EDC computations for the different countries participating to MACE: through a large panel of options, this software can compute EDC following different methods, including multiple traits model with maternal effects.

The MTEDC software has been used in the current study to obtain the EDC and approximated reliability values for each sire in FRA, IRL or UK. The increase of reliability is measured by comparison between multiple traits reliability compared to the reliability obtained with the same model but with correlations between countries set to 0.

3. Results

3.1 General description of the data

This study concerns 39 527 sires altogether. The number of common bulls between FRA, UK and IRL are given in Table 2 (output from Fouilloux *et al.* software with sire model option (36 349 sires and paternal grand sires)).

Table 2. Number of common bulls and proportion of their progenies in the performance file (between brackets).

	FRA	UK	IRL
FRA	32636	186 (12%)	70 (11%)
UK	186 (6%)	3335	61 (4%)
IRL	70 (36%)	61 (43%)	378

FRA has about 10 times more pure bred Limousine bulls than UK and about 100 times more than IRL. In this dataset, UK has more common bulls with France than with IRL. However, the proportion of progenies sired by the common bulls is larger in the IRL population than in the UK one. 242 bulls have progenies in at least 2 countries and only 48 bulls in the three countries.

It can be noticed that all the common bulls between these 3 countries are French bulls, except two UK bulls exported to France in the 90's on the occasion of a collaborative project between breeders associations, as mentioned in Journaux *et al.* (2006). Only one Irish bull has been traced back in the UK pedigree but with no progeny. This point reveals that until now, the validation of international identification has been only performed between FRA and UK on one side and between FRA and IRL on the other side but not yet between IRL and UK. The current developments for building up the central cross reference file at the Interbull Center will certainly make these counts change in the future.

3.2. Connectedness measure

Along with a measure of connectedness between countries, Fouilloux *et al.* method (2006) provides interesting information on the genetic exchanges between the participating countries: 41% of the UK and 74% of the IRL paternal genes of the animals with performances are French. On the other hand, only 0.03% of the French population comes from UK. No IRL paternal genes can be found in FRA or UK populations, and very small amount of UK paternal genes is detected in FRA and in IRL.

However, even if the proportion of foreign paternal genes gives a good indication of the genetic constitution of the population, it can't be considered as a connectedness measure: a French bull can indeed be often used in IRL but never used in France. The real connectedness measure provided by this method is the average proportion of the true difference re-estimated after the different 2-by-2 joint genetic evaluations between the countries: we obtained **17%, 16% and 22% for FRA, UK and IRL respectively**.

These values are quite low compared with the ones computed for dairy international genetic evaluation (Fouilloux *et al.*, 2008).

3.3. Reliability measure

In this paper, we will only focus on direct EBV reliability increase due to Interbeef joint genetic evaluation.

Breeders can have two kinds of expectations with regards to Interbeef results: increasing reliability for the bulls that have already but not enough local progenies or providing EBVs for foreign bulls that are not yet used in their country. As shown in table 3, Interbeef evaluation have quasi no impact on the FRA bulls reliability but larger impact on the IRL and UK ones (reliability of 50% of the bulls used in UK and IRL increases by 0.15 and 0.25 respectively). And this increase is even larger for bulls with no local progeny: +0.12, +0.34

and +0.46 in average for FRA, UK and IRL. These increases are very different from one bull to another depending on the data and pedigree associated to each bull. Figures 1 and 2 present the distribution of these increases in both cases.

Thanks to Interbeef, breeders of the participating countries will have access to a much larger panel of new bulls with country specific EBV associated with reliability information: 4 135, 34 986 and 38 185 new bull EBV for FRA, UK and IRL.

Table 3. Reliability increase in FRA, UK and IRL for bulls with or without local progeny.

Country	Number of bulls	Number of bulls with reliability increase (>0.001)	Median	First quartile	Third quartile	Min	Max
Sires with at least 1 progeny in the country							
FRA	33 649	303	0.0025	0.002	0.006	0.001	0.41
UK	3 382	468	0.15	0.07	0.37	0.001	0.66
IRL	384	135	0.25	0.12	0.58	0.001	0.87
Sires with no progeny in the country							
FRA	5 878	4135	0.07	0.03	0.19	0.001	0.62
UK	36 145	34986	0.35	0.23	0.47	0.001	0.67
IRL	39 143	38185	0.48	0.29	0.66	0.001	0.94

4. Discussion

This study concerned only pure bred Limousine animals leading de facto to a limited number of performances in IRL or UK and therefore an overestimation of the FRA information impact. The larger reliability increase for IRL can also be explained by its lower direct heritability.

Besides, the constitution of a cross reference file between UK and IRL through the Interbeef validation process will certainly facilitate in the future the genetic parameters estimation and enhance the reliability of the common bulls.

This study mainly reflects the reliability gain for IRL and UK EBVs due to the inclusion of French data and especially French pedigree: even if we only keep the French pedigree in the analysis, IRL and UK reliabilities slightly increase due to connection through French bulls with progenies in both countries. In this case, the proportion of re-estimation computed with Fouilloux *et al.* method is 4% for UK and 3% for IRL.

5. Conclusion

The complete process of the Interbeef joint genetic evaluation has now been fulfilled on the Limousine pure bred example: data exchanges, genetic parameters estimation and genetic evaluation, connectedness assessment and reliability computation, considering a multiple countries model including maternal effects. All the tools are now available for the routine evaluation. However, these different steps have to be rerun on the basis of new files, especially the cross reference file between the different participating countries.

Figure 1: Reliability increase from uni to multiple country model for bulls with at least one progeny in the country

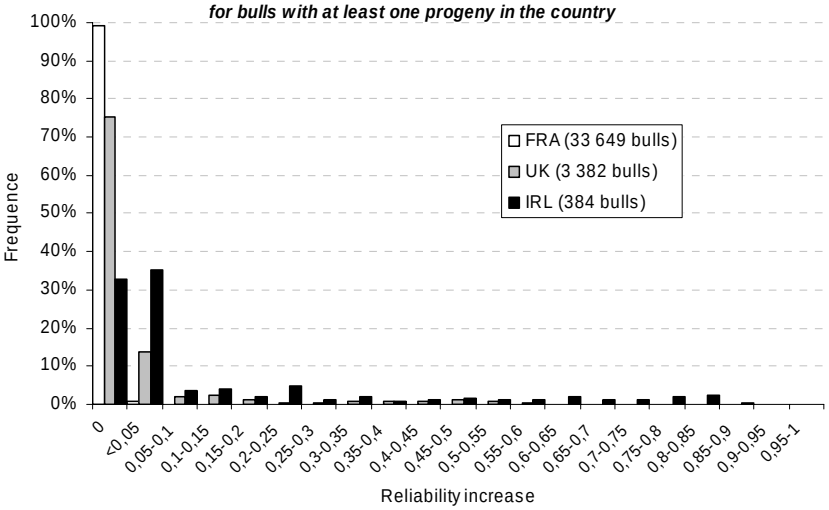
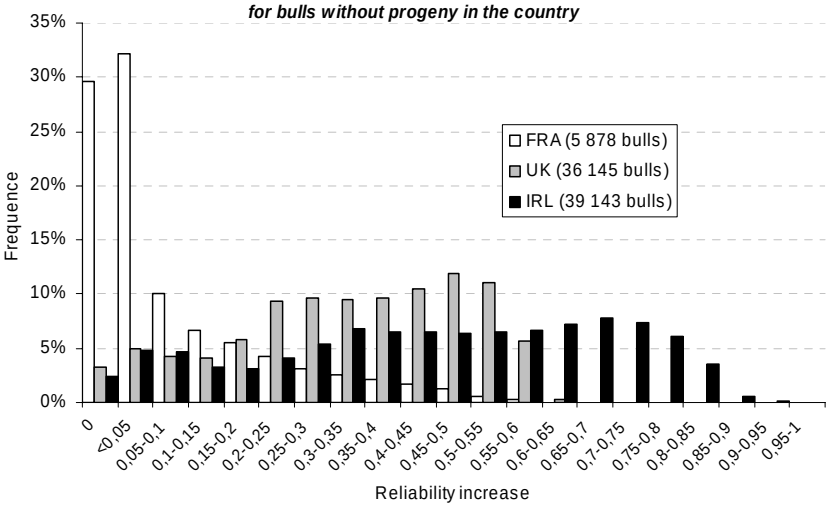


Figure 2: Reliability increase from uni to multiple country model for bulls without progeny in the country



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