Accuracy of International Evaluations in Predicting French Estimated Breeding Values of Foreign Holstein Bulls

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Abstract

For foreign bulls, one of the first information available for breeding decision in France comes from international evaluations based on foreign daughters only. Our purpose was to investigate whether or not this information was an accurate predictor of the future French estimated breeding values (EBVs) of foreign bulls for 11 traits: 5 production traits, somatic cell scores and 5 conformation traits. The correlation and the mean difference between Interbull (before including French daughters) and French EBVs were computed for foreign "AI imported" Holstein bulls. The observed correlations were high (above 87%), especially for the production traits and stature (above 94%). The lowest correlations were for fore udder attachment (87%) and somatic cell count (88%). The French EBVs were generally smaller than Interbull EBVs, but differences were quite small (less than 10% of genetic standard deviation). These differences were generally not statistically significant except for the mean difference for stature that reached -20% of genetic standard deviation. Further investigations showed that the country of origin of bulls (Canada, United States or European Union) did not influence correlations and mean differences. In conclusion, this study revealed that Interbull evaluations were accurate French EBVs predictors of foreign bulls, and confirmed that they can be used for breeding decisions without moderation.

1. Introduction

Breeding decisions for foreign bulls are regularly based on information coming from the international evaluations, before they have national information. This information, provided by Interbull genetic evaluation service, comes from foreign milking daughters only. Those bulls are evaluated in France a few years after the decision to use their semen, when their French daughters are recorded. Powell *et al*. 2003 showed that for production traits Interbull evaluations based on foreign (out of USA) daughters only were generally good predictor of the later United States national estimated breeding values (EBVs). The average differences between both evaluations for milk, fat and protein yields were close to zero.

Our purpose was to investigate how accurate were the earliest available EBVs coming from Interbull to predict future French EBVs. Therefore, we compared Interbull EBVs based only on foreign daughters to latest French EBVs for production, health and conformation traits. These comparisons were done for foreign "AI imported" Holstein bulls.

2. Materials and Methods

Holstein bulls selected for this study had a French genetic evaluation (FRA EBV) in June 2005 (or in January for conformation traits[1]) and had the last International genetic evaluation (ITB EBV) between 2000 and 2005 when the bulls had less than 150 daughters in France. Three groups of traits were studied:

- production traits: milk, fat and protein yields in kg, and fat and protein contents in g/kg. As Interbull do not evaluate fat and protein content, ITB EBV for these traits were computed from ITB EBV of milk, fat and protein yields;

[1] The French genetic evaluation model for conformation traits changed in June 2005. In order to make comparison between Interbull and French evaluations possible, the EBVs from the January 2005 evaluation were used, before model change.

- udder health: somatic cell scores (SCC) (Interbull evaluation of this trait began only in 2001);
- conformation traits: fore udder attachment (FUA), rear udder height (RUH), udder depth (UD), udder support (US) and height at sacrum (HS) ;

The French official evaluation method integrated converted foreign EBV of the parents (for USA, Canada, Germany, The Netherlands and Italy), for production traits only. In addition, EBV without foreign information and based on French daughters only were also available for this study.

Bulls with low Interbull EBVs reliabilities (REL_{ITB}) or low French EBVs reliabilities (REL_{FRA}) were discarded. Only bulls with REL_{ITB} higher than 0.70 for production and conformation traits, and 0.50 for SCC (these criteria corresponded to the French rules of publication) were selected. In addition, bulls were required to have at least 150 French milking daughters for French evaluation (corresponding REL_{FRA} were all higher than 0.90 for productive and conformation traits, and higher than 0.82 for SCC).

All evaluations were converted to the FRA 2000 mobile base to allow the comparison of evaluations across time. Two criteria were computed to compare ITB EBV with FRA EBV:

- Correlations between ITB EBV and FRA EBV. These observed correlations were compared to expected correlations estimated as follows:

$$Corr_{\exp} = \sqrt{REL_{FRA} * REL_{ITB}} \ ,$$

- Average difference between ITB EBV and FRA EBV, expressed in trait unit and in percentage of genetic standard deviation (σ_g).

$$Difference(\%) = 100 * \frac{(FRA.EBV - ITB.EBV)}{\sigma_g}$$

Table 1. Number of bulls, distribution over country of origin and birth year, and mean reliabilities.

Traits	No bulls	Country of origin groups			Birth year classes				Mean reliability(%)	
		Canada	EU	USA	[83;86]	[87;89]	[90;92]	[93;96]	REL_{ITB}	REL_{FRA}
Production	291	76 26%	45 16%	170 58%	78 27%	60 21%	83 28%	70 24%	90	94
Somatic cell scores	79	25 32%	16 20%	38 48%		5 6%	23 29%	51 65%	89	92
Conformation	213	54 25%	31 15%	128 60%	65 30%	49 23%	59 28%	40 19%	93	95

3. Results

Description of the data

Repartition of bulls over different countries of origin and different birth year classes are presented in table 1. Sample sizes were relatively large, between 200 and 300 bulls for both productive and conformation traits, but much smaller, less than 80 bulls, for SCC. 48% to 60% of the bulls came from USA and 25 to 32% from Canada while 15 to 20% came from European Union (EU). Due to small sample size, it was not possible to analyse separately countries of the EU (bulls were born mainly in the Netherlands, Germany and Italy). The distribution over birth year classes was relatively constant, except for SCC where almost all the bulls were born in the 90's (because of the later international evaluation of this trait). Table 2 crosses country of origin with year of birth for production traits. We observed that birth year, country of origin and mean number of daughters were more or less related: The youngest birth year classes (90-96) had the lowest number of daughters compared to the other classes (83-90). European bulls were mainly in the youngest classes compared to the other countries of origin. On the other hand, the oldest European bulls (born in 83-92) had the highest mean number of daughters compared to Canadian and US bulls. Consequently, it was difficult to analyse these three factors (country of origin, birth year classes and number of daughters) separately.

Table 2. Number of bulls and mean number of foreign daughters (into brackets) by country of origin and birth year.

Country of origin	Birth year classes 83-86	87-89	90-92	93-96	**Total**
Canada	23 (35143)	10 (17470)	21 (9471)	22 (3917)	**76 (16685)**
EU	4 (97643)	9 (34585)	14 (15592)	18 (3219)	**45 (21735)**
USA	51 (21286)	41 (10126)	48 (6128)	30 (2552)	**170 (11008)**
Total	**78 (29287)**	**60 (15019)**	**83 (8570)**	**70 (3152)**	**291 (14150)**

Results by trait (table 3)

Correlations ranged from 87% (FUA) to 97% (Fat content) and almost all of them were higher than 90%. The highest ones concerned production traits, with correlations higher than 94% (for EBVs computed with the French official method), and one conformation trait, HS, with a correlation of 96%. For production traits, most of the correlations were 2 points higher for "official" EBV that included foreign information through pedigree than for EBV based only on French daughters, which was consistent. The correlations of production traits evaluated only on French daughters were comparable to those observed for conformation traits (excepted FUA), which were also evaluated only on French daughters.

Production traits and HS correlations were all higher than the expected ones, whereas it was the opposite for SCC and the other conformation traits. SCC correlation was expected to be the lowest one (91%) and the observed correlation was even lower with 88%.

Differences between FRA and ITB EBVs ranged in absolute value from 2% of genetic standard deviation for Protein Yield to 20% for HS. Most of the differences were smaller than 11% of genetic standard deviation and were not significantly different from zero, except for protein content FRA EBVs estimated without including foreign information (12%) and height at sacrum (-20%). Differences were mostly negative (FRA EBV lower than ITB EBV) except for protein content, FUA and UD.

Table 3. Correlations (observed and expected), mean differences (expressed in trait unit and in genetic standard deviation) and standard deviations for the differences (expressed in genetic standard deviation).

	Traits	Correlation (%) Observed	Expected[2]	Difference[1] Mean (trait unit)	Mean (% of σ_G)	SD (% of σ_G)
Official method of evaluation (including foreign information)	Milk kg	95		-58	-8%	28
	Fat yield kg	94		-3.4	-11%	27
	Protein yield kg	95	92	-0.5	-2%	28
	Fat content g/kg	97		-0.21	-7%	22
	Protein content g/kg	96		0.15	10%	24
Without foreign information	Milk kg	93		-20	-3%	32
	Fat yield kg	92		-2.0	-6%	30
	Protein yield kg	93	92	0.6	3%	32
	Fat content g/kg	97		-0.25	-8%	25
	Protein content g/kg	94		0.17	12%*	28
	Somatic cell scores	88	91	-0.06	-6%	50
	Fore udder attachment	87		0.06	6%	46
	Rear udder height	91		-0.11	-11%	43
	Udder depth	93	94	0.05	5%	37
	Udder support	92		-0.11	-11%	35
	Height at sacrum	96		-0.20	-20%*	33

[1] FRA.EBV – ITB.EBV.

[2] Expected correlation = $\sqrt{(REL_{FRA} * REL_{ITB})}$. REL for production traits= REL milk, REL for conformation traits=REL UD.

* Statistically different from zero at a significance level of 5%.

Results by country of origin of the bull (table 4)

For USA and Canada, correlations for production and conformation traits were really comparable to those observed in the global analyse: between 93% and 98% for production traits, between 88% and 98% for conformation traits. RUH is surprisingly high (98%) for the US bulls. On the other hand, European bulls had lower correlations than Canadian and US bulls, both for production and conformation traits, and they were almost all lower than the expected ones (except fat and protein content). The European bulls are also the youngest. FUA was still the conformation trait that had the lowest correlation for the three origins. Situation of SCC was variable: Canada bulls had a very low correlation (76%), whereas USA bulls had a higher one (93%), European bulls being in between with 86%.

Mean differences of US bulls for production and conformations traits were close to the differences observed in the global analysis. For European bulls, production and conformation traits differences were also similar, expect for protein content (14%) and HS (-32%). For conformation traits, Canadian bulls had higher differences in absolute value than global results for all the traits except FUA. And for production traits, they were quite similar, except protein content (as European bulls). Mean differences for SCC were comparable to the global results for Canada and EU, but much more important (-18%) for USA. The largest mean differences were observed for HS whatever the origin country group considered. For only two traits the origin country factor was found to be statistically significant: for protein content mean differences were statistically (at 5%) higher for Canadian bulls than for USA bulls (15% *vs.* 7% of σ_G), and for HS mean differences were statistically (at 5%) lower for European bulls than for USA bulls (-32% *vs.* -16% of σ_G).

Table 4. Correlations (observed and expected) and mean differences (in genetic standard deviation) for the three origin country groups.

Traits	Correlation (%)						Mean difference[1] (% of σ_G)		
	Canada		EU		USA		Canada	EU	USA
	Obs.[2]	Exp.[2]	Obs.	Exp.	Obs.	Exp.			
Productive traits (n°)[3] (Official method of evaluation)	*76*		*45*		*170*		*76*	*45*	*170*
Milk	95		87		95		-10%	-7%	-7%
Fat yield	96		89		93		-8%	-11%	-12%
Protein yield	95	92	88	92	94	92	-2%	0%	-3%
Fat content	97		96		98		-2%	-8%	-9%
Protein content	96		93		96		15%	14%	7%
Somatic cell (n°)[3]	*25*		*16*		*38*		*25*	*16*	*38*
scores	76	91	86	91	93	90	5%	7%	-18%
Conformation traits (n°)[3]	*54*		*31*		*128*		*54*	*31*	*128*
Fore udder attachment	88		83		88		0%	-3%	10%
Rear udder height	93		90		98		-15%	-7%	-11%
Udder depth	90	94	86	94	95	94	12%	1%	2%
Udder support	92		88		93		-17%	-11%	-8%
Height at sacrum	96		93		96		-23%	-32%	-16%

[1] FRA.EBV – ITB.EBV, σ_G = genetic standard deviation.
[2] Obs.: observed correlation, Exp.: expected correlation = $\sqrt{(REL_{FRA} * REL_{ITB})}$. REL for production traits= REL milk, REL for conformation traits=REL UD.
[3] n° = number of bulls.

4. Discussion

Future French EBVs for production traits are well predicted through Interbull EBVs: correlations were high (above 92%) and better than expected from the reliabilities. Mean differences were lower than 12% of genetic standard deviation. Obviously, FRA EBVs computed with the official method integrating some foreign information were closer to ITB EBV than the FRA EBV based only on French daughters. But it is important to notice that FRA EBVs based only on FRA daughters were also well predicted by ITB EBV, which demonstrates that Interbull and French evaluations are consistent.

Correlations were higher than those found by Powel *et al.* (2003), but mean differences were larger. Powel *et al*. worked with higher REL_{ITB} (80%) but were less severe on REL_{USA}.

FUA and HS appeared as the conformation traits the less well predicted by the Interbull evaluation, compared to the others almost as well predicted than production traits. We were not surprised by these results. FUA is a “young” trait, introduced in 1997 in the French Holstein type classification. That means that the oldest bulls had fewer daughters for this trait than for the other traits. HS hardly reached Interbull requirements for genetic trend tests with the model used before June 2005 (no adjustment for heterogeneous residual variances). Indeed, cows could be measured or noted for HS. Excellent young bulls for production were mostly measured, whereas others were noted. Therefore variability of the EBV was different between these two groups of animals introducing a bias. The new model introduced in France in June 2005 and that adjusts for heterogeneous residual variances should improve this situation.

The country of origin did not influence really the correlations and the mean differences between FRA EBV and ITB EBV. European bulls had lower correlations, but they are also the youngest and the number of bulls was quite small (45) and so correlations could be influenced by some particular animals.

The correlation for SCC was low, but it must be remembered that EBVs accuracies were also smaller for this trait and expected correlation was lower than for the other traits.

5.Conclusion

This analysis clearly showed that for production traits, SCC and studied conformation traits, the ranking of foreign bulls without French daughters based on Interbull evaluations is an accurate information that French breeding operators can use for bulls from any country.

6. Acknowledgements

Thanks to Tom Druet for his rereading.

7. References

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