Stability of International Dairy Bull Evaluations

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Introduction

One desirable objective of genetic evaluation is consistency (or stability) over time. The International Bull Evaluation Service (INTERBULL) evaluations for Holsteins in August 1995 and February 1996 were both by the methodology of Schaeffer (2). Two countries were added (Great Britain and Switzerland), and there were minor changes in estimates of sire genetic variances and genetic correlations. Expected changes between evaluations should be only those due to addition of data; mean evaluations for groups of the same bulls in both evaluations should be stable.

The objective of this study was to examine the stability of results of the February 1996 INTERBULL evaluation for Holsteins. The three parts of the study were 1) examination of changes in INTERBULL evaluations over time by country, 2) analysis of deviation of evaluations from parent average (PA) by country, and 3) calculation of conversion equations by birth year.

Data

Data included August 1995 and February 1996 INTERBULL evaluations for milk, fat, and protein for Holstein bulls from Canada, France, Germany, Italy, The Netherlands, and the United States. Pedigree data were obtained from national evaluations from Canada, France, Germany, The Netherlands, and the United States. Any reference to country for a bull indicates the country of most daughters for the INTERBULL evaluation. Evaluations on a U.S. basis are reported in kilograms of predicted transmitting ability (PTA); evaluations on other countries' bases are reported in kilograms of estimated breeding value (EBV).

Changes in INTERBULL evaluations

August 1995 and February 1996 INTERBULL evaluations for milk, fat, and protein were compared by country for Holstein bulls from France, Germany, Italy, The Netherlands, and the United States. Canadian bulls were not included because of the many changes in Canadian national evaluation procedures between the August and February evaluations. Because no substantive changes occurred in the other countries' national or INTERBULL evaluation procedures, individual bulls with added data might change, but groups of bulls (such as from an individual country) should be stable. All evaluations were expressed on a U.S. basis (kilograms of PTA).

As shown in Table 1, August 1995 and February 1996 INTERBULL evaluations on a U.S. basis were similar for all bulls with both evaluations within a country. Evaluations increased slightly more for European bulls; evaluations for U.S. bulls were essentially unchanged. For the top 50 bulls from each country based on August 1995 protein INTERBULL evaluations, evaluations for bulls from The Netherlands changed little, but evaluations for other countries' bulls tended to decrease; evaluations for U.S. and German bulls dropped substantially. According to the German evaluation center (Reents, 1996, personal communication), a few of the top

German bulls declined in their national evaluations; therefore, the declines in the INTERBULL evaluations for the top bulls were expected. A comparison of national evaluations for the top 50 bulls from each country showed similar results to those in Table 1.

Bulls with the same parentage

Evaluations of bulls of equal genetic merit are expected to have the same evaluations regardless of where their daughters are located, even across countries. The most similar genetic background is identical twins. However, as those are rare across countries, full brothers and bulls with U.S. parents and U.S. PA were studied. Dam identification for bulls was obtained from national evaluation data because it was not included in INTERBULL evaluation data. The U.S. evaluations for sires and dams were used to create PA on a U.S. basis for all bulls.

Theoretically, groups of bulls with the same parents (or PA) should have the same INTERBULL evaluation regardless of country of sampling. Three analyses of bulls with U.S. parents were completed to check that assumption. In the first analysis, February 1996 INTERBULL evaluations on a U.S. basis had the PA's subtracted to provide an estimate of Mendelian sampling, which should average 0 (or at least equal across countries). As seen in Table 2, bulls' INTERBULL evaluations generally were below PA's, especially for U.S. bulls for milk and protein yields. For fat yield, French bulls had the largest discrepancy between PA's and INTERBULL evaluations.

The second analysis fit a model with country of bull and PA protein to February 1996 INTERBULL evaluations for protein yield from each country:

$$y = \text{country} + \text{U.S. PA} + \text{error}$$

where y was the evaluation on a particular country's basis. Bulls were from Canada, France, Germany, The Netherlands, and the United States. Too few Italian bulls had U.S. parents to be included. Bulls were born during 1985 or later. Reliability for PA was required to be at least 35%. Table 3 shows each country's solutions relative to U.S. solutions. Differences between countries were generally small and similar on a U.S. basis to mean differences for protein yield in Table 2 relative to the United States except for Canada. Although genetic merit of parents was accounted for in the model, evaluations for U.S. bulls tended to be lower than those from France, Germany, and The Netherlands and slightly higher than those from Canada on a U.S. basis. Relative to U.S. bulls and accounting for PA, evaluations for Netherlands bulls were higher on French (P=.06) and U.S. (P<.01) bases; evaluations for German bulls were significantly lower on a German basis and significantly higher on a U.S. basis. This contrast may be due to differences in genetic correlations between countries; the genetic correlation is lowest between Germany and the United States. Multiple correlations squared (R^2) were .41 for Canada, .45 for France, .33 for Germany, .44 for The Netherlands, and .53 for the United States. Addition of a quadratic term for PA protein increased R^2 by less than .001.

The third analysis used a subset of the second analysis' data that consisted of 464 bulls in 145 full-brother families with members in both the United States and France. A previous study (1) had shown that France had the most full-brother families in common with the United States. Solutions for 258 French bulls relative to their 206 U.S. full brothers were obtained from:

$$y = \text{country} + \text{family} + \text{error}$$

where y was the February 1996

INTERBULL evaluation for protein yield, country was either France or the United States, and family (sire-dam combination) was absorbed. Solutions for French bulls were significantly higher than for their U.S. full brothers for milk and protein yields expressed on either country's basis (Table 4).

Conversions by year

Bulls of a given genetic merit should have the same merit regardless of when used as a sire within a country or across countries. One way of examining this assumption relative to INTERBULL evaluations is to determine if conversion equations differ by bull birth year. Conversion equations were computed by the least-squares regression of the evaluation on a U.S. basis on the evaluation on the exporting country's basis. As is the practice with calculation of conversion equations by the INTERBULL Centre, bulls included were initially sampled in the exporting country. Information was not directly available to determine initial country of sampling; therefore, the country of most daughters was used.

Intercepts and regression coefficients for conversion of protein yield evaluations to a U.S. basis are in Table 5 by birth year. The regression coefficients for Canada, France, and Germany fluctuated without a directional trend, which suggested sampling variation, but there was an increase for Italy and The Netherlands. Intercepts for each country increased with later birth years. Birth year had a significant positive linear effect in prediction of a U.S. evaluation from evaluations in each country. Prediction equations of other countries' evaluations from a U.S. evaluation (not shown) all had significant negative year effects. Again, the yearly regression coefficients were similar, but the intercepts showed a negative trend. Yearly equations for converting protein evaluations from The Netherlands to France (not shown) also showed increases in both intercepts and regressions. However, equations from France to The Netherlands (not shown) did not show trends with birth year. Regression coefficients proposed by the INTERBULL Centre were less favorable to the United States than were theoretical coefficients regardless of conversion direction (i.e., to or from the United States). However, the coefficients for 1990 (Table 5) generally were similar to theoretical coefficients except for The Netherlands.

Conclusions

Mean evaluations on a U.S. basis were essentially unchanged for U.S. bulls between INTERBULL evaluations in August 1995 and February 1996, whereas evaluations for bulls from other countries increased about 14 kg for milk and .4 kg for fat and protein (Table 1). Except for The Netherlands, evaluations for top bulls tended to decline, especially for the United States and Germany (Table 1). For bulls with both August and February INTERBULL evaluations, relative standing of U.S. bulls overall and among top bulls declined. Although changes are normal for individual bulls and latest results are assumed superior because of additional data, a change for a group of thousands of bulls is not easy to interpret.

Mean genetic merit of U.S. parents of bulls sampled in five countries tended to overestimate bull merit, but the differences tended to be largest for U.S. bulls (Table 2). Solutions for country of bull generally were not significantly different for other countries relative to the United States. On a U.S. basis, both German and Netherlands bulls were significantly higher than U.S. bulls from a model that accounted for PA (Table 3). However, these differences were less than 1 kg of PTA protein. Of greater importance was the finding that French bulls that were full brothers to U.S. bulls had significantly higher evaluations for

milk and protein yields on either country's basis (Table 4).

Intercepts for conversion equations to a U.S. basis increased by bull birth year (Table 5) and correspondingly decreased for conversions from a U.S. basis. Both intercepts and regression coefficients increased by birth year for equations from The Netherlands to France but showed no trend in the other direction. That bulls of a given apparent merit but born in different years convert to different values on another country's basis is disconcerting. Perhaps refinements to the INTERBULL evaluation procedure can be made such that year differences are removed in the main processing and then reintroduced to make results on each country's basis comparable to that of data received.

Improvements in methodology that would increase consistency of evaluations across time and location may be possible. Alternatively, users may need to accept that a degree of uncertainty and error must be accepted in international evaluations because of current methodology.

References

1. Powell, R.L., and G.R. Wiggans. 1995. Holstein conversion equations based on population variances and a full-brother model. J. Dairy Sci. 78:1362.
2. Schaeffer, L.R. 1994. Multiple-country comparison of dairy sires. J. Dairy Sci. 77:2671.

Table 1. Changes from August 1995 to February 1996 INTERBULL evaluations on a U.S. basis for all Holstein bulls from different countries and the top 50 bulls for protein yield in August from each country

	All bulls from each country					Top 50 bulls from each country				
Trait	France	Ger-many	Italy	Nether-lands	United States	France	Ger-many	Italy	Nether-lands	United States
Milk (kg)	12	16	14	14	3	-15	-98	-17	8	-89
Fat (kg)	.3	.4	.6	.3	.1	-.5	-3.3	-.1	-.3	-2.0
Protein (kg)	.3	.4	.4	.4	.1	-.4	-3.3	.3	.1	-2.6
Bulls (no.)	9,873	7,687	2,264	5,610	15,370	50	50	50	50	50

Table 2. Mean differences between February 1996 INTERBULL evaluations and PA on a U.S. basis for Holstein bulls

Trait	Canada	France	Germany	Netherlands	United States
Milk (kg)	-18	-11	13	9	-44
Fat (kg)	-2.1	-2.9	-1.9	-1.5	-1.9
Protein (kg)	-1.2	-1.1	-.4	-.9	-1.4
Bulls (no.)	252	1,241	430	765	7,207

Table 3. Solutions for country of bull for February 1996 INTERBULL evaluations for protein yield on each country's basis[1] relative to U.S. bulls from a model that included country and PA for Holstein bulls

Country of scale	Country of bull				
	Canada	France	Germany	Netherlands	United States
Canada	.0	.3	.6	-.1	.0
France	.1	.1	.2	.4	.0
Germany	-.1	.0	-.8*	.0	.0
Netherlands	.0	.2	.1	.2	.0
United States	-.2	.2	.8*	.6*	.0

* Significantly different from U.S. bulls at P=.05.
[1] Solutions reported in kilograms of EBV for all countries except United States; U.S. solutions reported in kilograms of PTA.

Table 4. Solutions for 258 French full brothers for February 1996 INTERBULL evaluations on each country's basis[1] relative to 206 U.S. full brothers from a model that included country and 145 bull families for Holstein bulls

Trait	France	United States
Milk	97*	55*
Fat	1.1	.7
Protein	2.4*	1.5*

* French bulls significantly different from U.S. bulls at P=.05.
[1] Solutions reported in kilograms of EBV for France and kilograms of PTA for the United States.

Table 5. Intercepts (a) and regression coefficients (b) by birth year for conversion of protein yield evaluations to a U.S. basis

Birth year	Canada		France		Germany		Italy		Netherlands	
	a (kg)	b	a (kg)	b	a (kg)	b	a (kg)	b	a (kg)	b
1980	-7.3	.389	-1.2	.528	-16.4	.628	-8.7	.527	-4.0	.561
1981	-6.6	.391	-.6	.540	-14.9	.641	-8.1	.533	-3.9	.570
1982	-6.2	.394	-.2	.559	-15.8	.640	-8.2	.532	-3.6	.590
1983	-5.9	.385	-.1	.532	-15.6	.664	-8.2	.554	-3.3	.603
1984	-5.7	.382	-.8	.530	-14.7	.653	-7.8	.548	-3.3	.592
1985	-5.5	.390	-.4	.522	-14.0	.644	-7.8	.540	-2.6	.618
1986	-5.3	.387	.4	.530	-13.2	.666	-7.7	.567	-2.5	.637
1987	-5.4	.389	1.0	.544	-11.5	.672	-7.6	.560	-1.1	.657
1988	-3.6	.392	1.5	.531	-10.7	.664	-7.0	.559	-.2	.660
1989	-3.3	.382	2.4	.498	-10.7	.648	-6.4	.546	.3	.656
1990	-2.2	.387	3.1	.502	-9.3	.624	-6.4	.552	.6	.671