Investigation of an Alternative Approach to International Evaluations

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Introduction

National evaluations routinely use best linear unbiased prediction (**BLUP**) animal models to combine information from all domestic relatives. Then, information from foreign daughters is added using a BLUP sire-maternal grandsire (**MGS**) model for bulls (Schaeffer, 1994). A combined animal model analysis of all cows and bulls would be preferred if possible, and that approach is being tested (Weigel and Rekaya, 2000). A simpler, alternative approach is to combine national evaluations of cows and bulls using selection index (**SI**) methods similar to those currently used to compute reliabilities (**REL**) reported by Interbull (Harris and Johnson, 1998).

Parent information from national evaluations could be included directly instead of the pedigree indexes (**PI**) now used to link evaluations. The approach is fast and could be applied to all cows or just to those for which international estimated breeding values (**EBV**) are needed (elite cows) or to those with foreign relatives that could provide an increase in REL.

Data

Bull evaluations for protein yield from eight countries were used to investigate differences in SI evaluations from current multiple-trait across-country evaluations (**MACE**). The Interbull Centre supplied national input records for February 2000, and eight national evaluation centers supplied sire and dam evaluations and sire and dam REL for their bulls. All countries could routinely supply such data by adding sire and dam fields to the format for submitting data to the Interbull Centre (format 10). Cow evaluations could also be submitted for MACE using format 10 with few additional changes.

Current Interbull methods were applied to the eight-country subset. A few bulls were not included in the SI approach because of missing sire or dam evaluations or REL. Comparisons of the two approaches included only those bulls with data in the same number of countries for both evaluations.

Approach

Format-10 data were matched with the added sire and dam fields and sorted by birth year and animal identification number within birth year. This sort allowed processing in age order so that a parent's international evaluation could be calculated first and included in progeny evaluations. Thus, the approach does not require iteration, but a little information is lost because foreign grandprogeny do not contribute back to grandparent evaluations.

The data file was processed in two passes. During the first pass, simple estimates were computed of genetic correlations, standard deviations, regressions, and intercepts as an aid in examining data properties but were not used and are not reported here. Instead, official February 2000 Interbull parameters were used to test agreement of the approaches. During the second pass, national evaluations were converted and combined into international evaluations.

Foreign Daughters

When more than one country reported daughters for a bull, information from the separate EBV was combined by SI methods and weighted according to REL and genetic correlations. Let **u** be a vector containing the EBV - parent average (**PA**) from each country that supplied data for the bull. The bull's improved EBV in a particular country can be constructed from his PA and a blended estimate of Mendelian sampling:

$$\text{EBV} = \text{PA} + \text{Cov}(\text{true BV} - \text{PA}, \hat{u})\text{Var}(\hat{u})^{-1}\,\hat{u}.$$

This method is fast and could be applied to improve cow EBV as easily as bull EBV. Total time needed to complete the above steps for the eight countries and 36,294 bulls cooperating in this test was 1.5 minutes per trait, about half for each step.

Foreign Dams

Often a bull's PA is not estimated accurately because the dam's records were expressed in a foreign country. Table 1 shows the percentage of bulls for each country's data that had foreign sires, dams, or daughters. Generally, many more bulls have foreign dams than foreign daughters, but current policy does not allow data from foreign dams to be included in EBV sent to Interbull. Higher REL would result if foreign EBV of dams were converted and used in computing bull EBV. This could be done by each country before sending data to Interbull or by Interbull if dam EBV is included in format 10.

Currently, a dam EBV from country j affects a bull's EBV in country i only if the bull also has daughters in country j. Foreign dam information is not used fully but only in proportion to the weight placed on daughters from country j. With the SI approach, converted dam evaluations were substituted if they provided higher REL than the domestic evaluations. In this test, dam evaluations were compared only when provided for the same bull, but the method can be extended to include dam REL reported for any maternal brother anywhere. Ideally, the female evaluations would be combined by MACE instead of simply choosing the evaluation with highest REL.

Table 1. Percentages of Holstein and Red and White bulls born from 1990 to 1995 with foreign relatives for each country submitting data to Interbull

		Percentage (%) with foreign		
Country	Bulls	Sires	Dams	Daughters
Australia	1365	97	61	24
Austria	52	100	69	67
Belgium*	355	100	84	68
Canada*	2297	52	33	21
Czech Republic	368	87	80	35
Denmark*	1964	99	37	2
Estonia*	110	91	32	17
Finland	214	66	3	0
France*	3085	96	58	13
France (Red)	29	100	97	21
Germany	4493	90	24	9
Great Britain	995	99	86	25
Hungary	217	93	27	2
Ireland	209	>99	100	1
Israel	228	54	1	1
Italy	1546	93	16	7
New Zealand	1249	78	36	22
Poland	1218	74	10	<1
Slovenia	21	100	33	0
South Africa	133	94	56	3
Spain	209	100	94	17
Sweden	465	97	34	13
Switzerland	146	100	12	12
Switzerland (Red)*	221	86	21	21
The Netherlands*	2377	69	41	17
United States*	7943	9	2	8

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Domestic Dams

Mean and maximum REL of the dams of bulls reported by each country are in Table 2. With current Interbull procedures, dam information is included in the deregressed evaluation but excluded from calculation of REL. National REL that include dam REL tend to be larger than international REL for bulls that have few daughters and well-evaluated dams. Maximum REL from PA is 50% as compared with 31% from PI. National REL from France do not include parent contributions and tend to be lower than Interbull REL, which include sire and MGS REL.

Table 2. Numbers of bulls and dam REL from each country

	Bulls		Dam REL	
Country	Total	Edited	Mean	Maximum
Belgium	1212	725	52	84
Canada	4585	4585	73	96
Denmark	4172	4149	41	93
Estonia	224	204	39	57
France	7419	7049	37	61
The Netherlands	5189	5053	71	96
Switzerland (Red)	452	432	35	80
United States	16,268	16,258	77	96

Bull REL from the alternative SI approach were higher than Interbull REL by an average of 6%, and REL from the two methods were correlated by only .908 to .977 on the eight country scales. As a test of differences, dam REL was limited to a maximum of 25%, which would have been the maximum possible if MGS REL had been used as a substitute for dam REL. Average difference in REL declined to about 3%, and the correlations increased greatly and ranged from .977 to .993. New procedures to calculate international REL have been announced by Interbull, but those procedures continue to ignore dam's contribution and will result in an underestimate of true REL.

Unknown Dams

Some dams and sires are unknown because pedigrees cannot be traced back forever. For the earliest ancestors, PA includes unknown-parent group solutions of the sire (**UNK_{sire}**) and dam (**UNK_{dam}**) instead of their EBV. If either parent is unknown, the progeny's EBV − PA includes both its Mendelian sampling and its parent's deviation from group average. If both parents are unknown and are assumed to be noninbred, only half the variance of EBV - PA is because of Mendelian sampling and half is because of parents' deviations from group average. If one parent is unknown, two-thirds of the variance is from Mendelian sampling.

Estimates of Mendelian sampling free of parents' deviations were obtained by predicting and removing actual merits of each unknown parent. An unknown parent contributes no information to its known progeny, but REL for an unknown parent is greater than 0, because known progeny contribute information about the parent. Let EBV_{sire} and EBV_{dam} be sire and dam EBV. If EBV_{sire} is missing and UNK_{sire} is reported instead,

$$EBV_{sire} = UNK_{sire} + (2/3)(EBV - .5UNK_{sire} - .5EBV_{dam}).$$

If EBV_{dam} is missing and UNK_{dam} is reported instead,

$$EBV_{dam} = UNK_{dam} + (2/3)(EBV - .5EBV_{sire} - .5UNK_{dam}).$$

If EBV_{sire} and EBV_{dam} are both missing,

$$EBV_{sire} = UNK_{sire} + (1/2)(EBV - .5UNK_{sire} - .5UNK_{dam})$$

and

$$EBV_{dam} = UNK_{dam} + (1/2)(EBV - .5UNK_{sire} - .5UNK_{dam}).$$

When reported REL of either parent was 0, its evaluation was assumed to be an unknown-parent group, and its actual EBV was substituted using the above formulas.

Results

Correlations between SI and BLUP protein evaluations of bulls ranged from .989 to .993 on the eight country scales. Mean, standard deviation, minimum, and maximum differences in each country's releasedunits are given in Table 3. An exception is that Danish data are reported as EBV instead of relative BV.

The SI evaluations were more consistent across countries; correlations for all country pairs ranged from .994 to .999 as compared with correlations of .987 to .996 with BLUP. The use of linear conversion formulas instead of estimating unknown-maternal granddam groups across time could explain this difference. Some other differences may deserve further investigation, but use of the SI approach to provide combined international evaluations for cows seems feasible.

Table 3. Differences between SI and BLUP protein evaluations for 35,414 bulls

	Differences (SI - BLUP)			
Country, scale	Mean	SD	Minimum	Maximum
Belgium, EBV kg	−.7	2.2	−13	+8
Canada, EBV kg	.4	3.8	−18	+18
Denmark, EBV kg	−.3	2.0	−9	+11
Estonia, EBV kg	−.4	2.3	−8	+10
France, EBV kg	−.5	3.1	−13	+13
Switzerland (Red), EBV kg	−1.6	2.1	−10	+10
The Netherlands, EBV kg	−.5	1.9	−13	+18
United States, PTA lb	1.1	3.1	−13	+18

Conclusions

Methods to combine national evaluations using sire and dam information with an SI were compared with current procedures that use sire and MGS information with BLUP procedures. Differences were fairly small, and correlations were about .99 for each country's scale. Bull REL that included dam contribution instead of only MGS information were higher and should agree more closely with national REL from animal models.

The SI approach could be used to provide MACE evaluations for cows. That method provides a closer connection between national and international evaluations. The current method includes information from foreign daughters but excludes information from foreign dams. However, many more bulls have foreign dams than foreign daughters. Centralized processing of female evaluations by Interbull should be more efficient than two-way exchange of data files between each of the national centers.

References

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