Impact of Second-Country Data of Foreign Bulls on International Evaluations of Dairy Bulls

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ABSTRACT

Second-country data of foreign bulls are a primary source of information for international genetic comparison of dairy sires. Potential problems exist with this data, because imported semen is expensive, and progeny may receive preferential treatment. The extent of potential bias in international sire evaluations from inclusion of second-country data of imported bulls was examined using data from 25,205 Holstein bulls evaluated in the US, Canada, Italy, Holland, and Germany. Mean changes in international evaluations of potential candidates for export from inclusion of second-country data were <50 kg EBV for milk and <3 kg EBV for fat and protein, and changes in the international evaluations of imported bulls were <100 kg EBV for milk and <3 kg EBV for fat and protein. These changes suggest that bias from preferential treatment of progeny of foreign sires was not a significant problem for the countries examined. Application of reduced weight to second-country data of foreign sires can further reduce the chance of bias from preferential treatment. Based on this study, inclusion of second-country data of foreign bulls in international sire evaluations is appropriate, and problems due to preferential treatment are few.
(**Key words**: international sire evaluation, foreign bulls, preferential treatment)

Abbreviation key: **ACD** = evaluation based on all data, **FCD** = evaluation based on first-country data only, **INTERBULL** = International Bull Evaluation Service, **MACE** = multiple across country evaluation, **PT** = preferential treatment, **R80** = evaluation based on limiting SCD to 80% reliability, **R90** = evaluation based on limiting SCD to 90% reliability, **SCD** = second-country data.

INTRODUCTION

The extensive international exchange of dairy cattle, semen, and embryos among countries during the past 25 yr has led to the need for accurate methods to compare the genetic merit of bulls from different countries. Methods developed by Goddard (5) and Wilmink et al. (13) were based on statistical regression procedures and used data from bulls that had been evaluated in two countries, usually foreign progeny-tested bulls with imported semen, to calculate equations for converting PTA or EBV from the genetic base and units of an exporting country to the base and units of the potential importing country. These methods have proved useful for approximating the relative genetic merit of sires from different countries, but several limitations have existed, including insufficient numbers of bulls with evaluations in two countries, use of highly selected bulls, instability of equations over time, inaccuracies when estimation was against the gene flow (8), and lower accuracy of converted evaluations of bulls with extremely high or low genetic merit. Methods based on evaluations of full siblings that were progeny tested in more than one country (7) might be less sensitive to direction of the gene flow and effects of preferential treatment (**PT**), but the number of full siblings might be limited, and information from other types of relatives (including half siblings, cousins, and bulls progeny tested in two countries) is ignored.

Schaeffer (9) developed a procedure based on BLUP methodology to evaluate dairy sires from several countries simultaneously. This method, the linear model comparison (9), can utilize data from all bulls tested in each country because all types of genetic relationships among sires are considered. Each bull receives an international evaluation that is standardized to the genetic base and units of measurement of each participating country, regardless of whether the bull has daughters in that country. However, the linear model comparison relies on the assumption that the genetic correlation between daughter performance in different countries is unity (i.e., no interaction exists between sire genotype and the production system, trait definition, or genetic evaluation procedures within each country).

In 1994, Schaeffer (10) extended the procedure for linear model comparison by treating daughter performance in different countries as separate traits. This

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TABLE 1. Source and description of sire evaluation data.

Country	Evaluation date	Bulls	Estimated sire variance Milk	Fat	Protein
		(no.)	(kg²)		
US	January 1995	12,767	105,768	139.8	81.6
Canada	January 1995	3184	157,534	226.9	125.9
Italy	January 1995	1940	69,365	95.6	65.6
Holland	September 1994	3115	69,075	98.2	51.7
Germany	December 1994	4198	62,164	94.9	44.5

procedure, the multiple across country evaluation (**MACE**) method, can accommodate genetic correlations less than unity, which might be caused by interaction of genotype and environment or by differences in measurement or interpretation of traits, data editing, or statistical models among countries. Therefore, bulls can rank in a different order based on MACE evaluations in each of the participating countries. The International Bull Evaluation Service (**INTERBULL**, Uppsala, Sweden) conducts semiannual international evaluations of sires for milk, fat, and protein using the MACE procedure (1).

An important question regarding international sire evaluations has been whether or not to include second-country data (**SCD**) of foreign bulls that were first evaluated in another country. Applications of the procedures of Goddard (5) and Wilmink et al. (13) typically include SCD for calculation of equations for international conversion. Although MACE evaluations could be calculated without SCD by using genetic relationships among sires across countries, inclusion of SCD would strengthen ties between countries, enhance acceptance of international evaluations by dairy producers, and allow more reranking of sires via expression of interactions of genotype and environment (6). However, SCD might be biased by PT of progeny resulting from expensive imported semen. Banos et al. (2) reported that inclusion of SCD caused large biases in international evaluations of North American bulls in Italy and other European countries. For this reason, SCD were excluded from routine INTERBULL evaluations in February 1995. Underestimation or overestimation of genetic trends within a country can bias international conversions (4). Corrections for genetic trend have occurred in several countries, including the US, since completion of the study of Banos et al. (2); genetic trend problems were probably responsible for many of the biases that had previously been attributed to PT.

The objective of the current study was to examine the effect of including SCD of foreign bulls in international genetic evaluations using MACE procedures with sire evaluation data from five countries.

MATERIALS AND METHODS

Data

Genetic evaluations for milk, fat, and protein yields were obtained from 25,204 Holstein bulls in five countries, as summarized in Table 1. Evaluations were expressed in terms of kilograms of PTA (US), ETA (Canada), or EBV (Italy, Holland, and Germany). Sires that were included in the analysis were born during 1980 or later, and genetic evaluations were based on a minimum of 15 daughters in 10 or more herds. Genetic relationships through sires and maternal grandsires were included. Maternal granddams were considered to be unknown, but data regarding their year of birth and country of origin were used to construct unknown parent groups (10). Sire evaluations from each country were deregressed as described by Banos et al. (3) to account for the effect of reliability on the variance of EBV.

Genetic Parameters for International Evaluation

Sire variances for each country were estimated from deregressed sire evaluations using the simple iterative procedure described by Schaeffer et al. (11); SCD of foreign bulls were included during parameter estimation. Three genetic correlations among countries were considered in the MACE analysis: 0.95, 0.975, and 0.99. For simplicity, results calculated with genetic correlations of 0.95 and 0.99 are reported for foreign bulls with second-country daughters only.

SCD of Foreign Bulls

Treatment of SCD of bulls with imported semen occurred as follows. First, all SCD were excluded so that MACE evaluations were based entirely on data from the country in which each bull was first evaluated (**FCD**). The FCD evaluations were considered to be a control, because they were not influenced by SCD. Second, SCD were fully included so that MACE evaluations were based on data from all countries where a bull had an official evaluation (**ACD**). Third, the impact of SCD was limited to 90% reliability (**R90**) by placing a cap of 100 on the number of daughters in each country other than the country of first evaluation. This cap of 100 daughters was chosen because a bull with 100 daughters would have approximately 90% REL for a trait with 30% heritability, and the mean heritability of yield traits in the countries included in this study was about 30%. For this scenario, national evaluations were deregressed using the actual number of second-country daughters, and the number of second-country daughters used to set up the matrix $\mathbf{D}_i$ (described in the next section) was limited to 100 for bulls that had ≥100 second-country daughters. Finally, the impact of SCD was limited to 80% reliability (**R80**) by placing a cap of 45 on the number of second-country daughters in $\mathbf{D}_i$. Scenarios R90 and R80 were expected to limit the influence of second-country daughter information when data from randomly tested sons and other relatives became available in the second country.

Estimation of International EBV

International EBV were estimated using the MACE procedure described by Schaeffer (10), in which daughter performance for each trait in each country is described as follows:

$$\mathbf{y}_i = u_i\mathbf{1} + \mathbf{Z}_i\mathbf{Q}\mathbf{g}_i + \mathbf{Z}_i\mathbf{s}_i + \mathbf{e}_i$$

where

$\mathbf{y}_i$ = vector of deregressed sire evaluations from country i;
u_i = scalar for genetic base effect for each country i;
$\mathbf{1}$ = vector of ones;
$\mathbf{g}_i$ = vector of genetic group effects for unknown parents, defined by country of origin, genetic pathway, and year of birth;
$\mathbf{s}_i$ = vector of random sire PTA;
$\mathbf{e}_i$ = vector of residuals; and
$\mathbf{Z}_i$ and $\mathbf{Q}$ = incidence matrices.

$$\text{Var}(\mathbf{e}) = \text{Var}[\mathbf{e}_1, \mathbf{e}_2, \ldots, \mathbf{e}_t]' = \text{Diag}(\mathbf{D}_i\sigma^2_{ei})$$
$$\text{Var}(\mathbf{s}) = \text{Var}[\mathbf{s}_1, \mathbf{s}_2, \ldots, \mathbf{s}_t]' = \mathbf{A} \otimes \text{G}$$

where ⊗ denotes Kronecker product. The matrix $\mathbf{D}_i$ is diagonal, and elements are equal to the inverse of the number of daughters of each bull in country i, σ^2_{ei} is the residual variance in country i, $\mathbf{A}$ is the additive genetic relationship matrix among sires, and $\mathbf{G} = \{\sigma_{sij}\}$ is the sire (co)variance matrix among countries.

Measurement of SCD Impact

The effect of SCD inclusion on international sire evaluations was measured as the mean change in MACE for each scenario in which SCD were included: the mean of ACD – FCD, R90 – FCD, and R80 – FCD. These quantities were considered as estimates of potential bias from PT of daughters of imported semen. Two groups of bulls were considered, as shown in Table 2. First were export candidate bulls, all bulls from a given country born since 1988 with daughters within the home country only. This group represented those bulls that were currently available for export and therefore of most interest for international conversion. Bulls that had been progeny tested simultaneously in more than one country were excluded from this group. Mean values for changes in MACE evaluations of export candidates from inclusion of SCD were calculated in each of the four potential importing countries. Second, mean values for changes in MACE evaluations of foreign bulls that already had second-country daughters were calculated. Those bulls were older, and most were no longer of commercial interest, but potential biases for these bulls would have been large if their daughters had received PT. Because the number of bulls with second-country daughters was small, mean values for change were calculated for all foreign bulls with daughters in a particular country, regardless of their country of origin.

RESULTS AND DISCUSSION

Estimated sire variances reported in Table 1 are consistent with estimates of Schaeffer et al. (11), but variance estimates for the US and Canada are lower

TABLE 2. Number of export candidate bulls and foreign bulls with second-country daughters in the countries considered.

Country	Export candidates	Foreign bulls with second-country daughters
	(no.)	
US	3261	65
Canada	556	110
Italy	531	96
Holland	732	102
Germany	689	85

than those reported by Banos (1). In the current study, data were restricted to bulls born during 1980 or later, but Banos (1) used all data provided by INTERBULL member countries. As a result, estimates by Banos (1) were larger than those of the current study for the US and Canada, which have had pure Holstein cattle longer, and similar to those of the current study for Italy, Holland, and Germany, which have more recently improved their native Friesian populations using North American Holsteins. Schaeffer et al. (11) reported that sire variance estimates, which were used to standardize EBV from participating countries, had a very large impact on international evaluations, making it necessary to determine whether variance estimates should come from recent data only, in which prior selection is ignored, or from all data, even though the base population in some countries might not be representative of the current population.

Table 3 presents mean values for changes in MACE evaluations of foreign bulls with second-country daughters from inclusion of SCD. Bulls with semen imported into the US were of Canadian origin, bulls with semen imported into Canada were of US origin, and bulls with semen imported into Holland, Italy, and Germany were nearly all of North American origin. Changes in milk evaluations of bulls imported into the US and Italy because of inclusion of SCD were minimal. International evaluations for milk of bulls imported into Canada, Holland, and Germany increased by 32, 60, and 94 kg, respectively, when SCD were used with a genetic correlation of 0.975. Evaluations for protein of bulls imported into Canada and Germany increased by 1.2 and 1.3 kg, respectively, and evaluations for fat of bulls imported into Holland decreased by 2.9 kg. Evaluations calculated for scenarios R90 and R80 were closer to FCD evaluations. Differences between ACD and FCD evaluations of bulls imported into Canada, Holland, and Germany were larger when a genetic correlation of 0.95 was used and were smaller when a correlation of 0.99 was used; a lower genetic correlation led to greater emphasis on SCD. Results in Table 3 suggest that daughters of North American bulls in Germany, Holland, and Canada might have received some PT for milk yield. However, changes in evaluations for fat and protein were not always consistent with changes in evaluations for milk, so these differences might have been partially due to factors other than PT.

Tables 4, 5, 6, 7, and 8 present mean values for changes in MACE evaluations of export candidate bulls from inclusion of SCD. As shown in Tables 4 and 5, changes in MACE evaluations of US and Canadian export candidates for milk were positive because of inclusion of SCD in Holland and Germany, although all changes were less than 50 kg. These differences

TABLE 3. Mean change in international evaluation of foreign bulls with second-country daughters from inclusion of second-country data of foreign bulls.

Weighted[1] trait	r_g[2]	Importing country				
		US	Canada	Italy	Holland	Germany
		(kg of PTA)	(kg of ETA)	——— (kg of EBV) ———		
Milk						
ACD	0.95	−6	+42	+19	+77	+111
ACD	0.975	−9	+32	+16	+60	+94
ACD	0.99	−10	+23	+14	+46	+77
R90	0.975	−19	+24	+6	+45	+60
R80	0.975	−17	+18	+4	+31	+40
Fat						
ACD	0.95	+0.9	−0.1	+0.9	−2.9	+1.0
ACD	0.975	+0.8	−0.3	+0.6	−2.9	+0.5
ACD	0.99	+0.8	−0.6	+0.3	−3.0	0
R90	0.975	−0.1	−0.1	0	−1.6	0
R80	0.975	−0.3	0	−0.1	−0.9	−0.2
Protein						
ACD	0.95	−0.2	+1.5	+0.5	+0.5	+1.7
ACD	0.975	−0.3	+1.2	+0.3	+0.2	+1.3
ACD	0.99	−0.3	+0.9	+0.3	−0.1	+1.0
R90	0.975	−0.7	+0.9	0	+0.3	+0.7
R80	0.975	−0.6	+0.6	0	+0.3	+0.5

[1]ACD = Evaluation based on all data, R80 = evaluation based on limiting second-country data to 80% reliability, and R90 = evaluation based on limiting second-country data to 90% reliability.

[2]r_g = Genetic correlation among countries.

TABLE 4. Mean change in international evaluation of US export candidate bulls from inclusion of second-country data of foreign bulls.[1]

Weighted[2] trait	Importing country			
	Canada	Italy	Holland	Germany
	(kg of ETA)	———	(kg of EBV)	———
Milk				
ACD	+18	+5	+34	+49
R90	+13	+2	+26	+28
R80	+10	+2	+18	+19
Fat				
ACD	−0.4	+0.3	−2.1	+0.5
R90	−0.1	+0.1	−0.8	+0.2
R80	0	+0.1	−0.4	+0.1
Protein				
ACD	+0.7	+0.2	−0.2	+0.9
R90	+0.6	+0.1	+0.2	+0.5
R80	+0.5	+0.1	+0.2	+0.4

[1]Genetic correlation among countries = 0.975.

[2]ACD = Evaluation based on all data, R80 = evaluation based on limiting second-country data to 80% reliability, and R90 = evaluation based on limiting second-country data to 90% reliability.

might be due to PT of daughters of expensive North American sires in those countries, or they might reflect differences between the countries in systems of data recording and genetic evaluation. For example, if pedigree information used in German or Dutch national evaluations were incomplete for some bulls of North American ancestry, inclusion of SCD would provide more complete ties between countries, and evaluations of some bulls might increase. Alternatively, if daughter identification was more accurate in the second (importing) country than in the country of initial progeny testing, then the SCD might be higher, and inclusion of SCD then would increase MACE evaluations of imported bulls. Furthermore, imported semen might be used in herds with within-herd variances that were higher or lower than average; this use would affect SCD if herd variance adjustments were not applied within every country. Thus, PT is one possible explanation for discrepancies between ACD and FCD evaluations, but other factors could also lead to such differences. Mean changes in MACE evaluations of North American bulls for fat and protein were much smaller, generally <1 kg of EBV. The single exception was a mean change of −2.1 kg of fat EBV for US bulls in Holland. When the weight applied to SCD was limited to 90% REL, this difference was reduced to −0.8 kg. Evaluations of US bulls in Canada and of Canadian bulls in the US were not affected by inclusion of SCD, presumably because two-way genetic exchange between these countries has been long-standing.

Table 6 presents changes in MACE evaluations of Italian export candidates. As for North American bulls, ACD evaluations of Italian export candidates for milk tended to be slightly higher than FCD evaluations in Holland and Germany. Canadian and US MACE evaluations of Italian bulls were not affected by SCD. Evaluations of Italian bulls for fat decreased

TABLE 5. Mean change in international evaluation of Canadian export candidate bulls from inclusion of second-country data of foreign bulls.[1]

Weighted[2] trait	Importing country			
	US	Italy	Holland	Germany
	(kg PTA)	———	(kg of EBV)	———
Milk				
ACD	−1	−9	+47	+33
R90	−5	−4	+22	+17
R80	−4	−4	+15	+11
Fat				
ACD	+0.8	+0.6	−0.4	+0.6
R90	+0.3	+0.4	−0.4	+0.2
R80	+0.1	+0.2	−0.2	+0.1
Protein				
ACD	0	−0.4	+0.2	+0.4
R90	−0.2	−0.3	0	+0.1
R80	−0.2	−0.2	0	0

[1]Genetic correlation among countries = 0.975.

[2]ACD = Evaluation based on all data, R80 = evaluation based on limiting second-country data to 80% reliability, and R90 = evaluation based on limiting second-country data to 90% reliability.

TABLE 6. Mean change in international evaluation of Italian export candidate bulls from inclusion of second-country data of foreign bulls.[1]

Trait[2]	Importing country			
	US	Canada	Holland	Germany
	(kg PTA)	(kg ETA)	—— (kg of EBV)	——
Milk				
ACD	−4	+8	+29	+28
R90	−3	+8	+24	+22
R80	−2	+7	+17	+15
Fat				
ACD	+0.1	−0.8	−2.5	−0.5
R90	+0.1	−0.2	−0.9	−0.1
R80	0	0	−0.4	−0.1
Protein				
ACD	0	+0.5	−0.3	+0.3
R90	0	+0.5	+0.2	+0.3
R80	0	+0.4	+0.2	+0.2

[1]Genetic correlation among countries = 0.975.

[2]ACD = Evaluation based on all data, R80 = evaluation based on limiting second-country data to 80% reliability, and R90 = evaluation based on limiting second-country data to 90% reliability.

TABLE 7. Mean change in international evaluation of Dutch export candidate bulls from inclusion of second-country data of foreign bulls.[1]

Weighted[2] trait	Importing country			
	US	Canada	Italy	Germany
	(kg of PTA)	(kg of ETA)	(kg of EBV)	
Milk				
ACD	−16	+1	−22	+23
R90	−14	+3	−22	+8
R80	−10	−1	−15	+6
Fat				
ACD	+1.2	+0.9	+2.3	+1.7
R90	+0.4	+0.3	+0.6	+0.6
R80	+0.2	+0.2	+0.3	+0.3
Protein				
ACD	+0.1	+1.0	+0.5	+0.9
R90	−0.2	+0.5	−0.2	+0.2
R80	−0.2	+0.4	−0.2	+0.2

[1]Genetic correlation among countries = 0.975.

[2]ACD = Evaluation based on all data, R80 = evaluation based on limiting second-country data to 80% reliability, and R90 = evaluation based on limiting second-country data to 90% reliability.

by 2.5 kg in Holland when SCD were included, although ACD evaluations for protein did not differ from FCD evaluations.

Evaluations of Dutch export candidates for milk were slightly higher using ACD than FCD in Germany and slightly lower in US and Italy, as shown in Table 7, but differences were small. Evaluations for fat increased in the other four countries when SCD were included. The cause of this discrepancy is unknown. Evaluations for fat for scenarios R90 and R80 were much closer to FCD evaluations. Evaluations of Dutch bulls for protein were similar using ACD and FCD procedures.

German export candidates had slightly lower ACD evaluations for milk in Italy and North America, as shown in Table 8, although ACD and FCD evaluations for fat and protein were similar, except for a 1.7 kg decrease for fat in Holland.

CONCLUSIONS

International sire evaluations calculated using MACE procedures were not affected substantially by inclusion of SCD. Evaluations for milk yield of North American bulls with daughters in Canada, Holland, and Germany increased slightly when SCD were used, but evaluations for fat and protein did not always change correspondingly. Changes in evaluations of foreign bulls from inclusion of SCD increased as the genetic correlation among countries decreased because of increased weight on SCD. Bias in international evaluations of export candidates from PT of daughters of expensive foreign sires was not a significant concern for the countries examined in this study. For situations in which discrepancies between ACD and FCD evaluations of export candidates existed, such as in evaluations of US bulls for fat yield in Holland or milk yield in Germany, application of a reduced weight, corresponding to a 90% REL cap on SCD, reduced these differences substantially. Use of a lower weight on SCD would create a self-correcting system in which SCD contributed substantially to second-country MACE solutions only when SCD were the only data available in the second country. For example, if data became available from sons of an imported bull that were progeny tested in the second country, and if those data conflicted with the evaluation of the bull based on second-country daughters, his MACE evaluation in the second country would have changed to accommodate the new information from his sons. Differences in the evaluations of foreign bulls with second-country daughters using ACD versus FCD were larger than for new export candidates in the present study, but differences or biases in evaluations of the imported bulls do not contaminate evaluations of their sons and other younger bulls. This result agreed with results of Weigel and Lawlor (12), who showed that biases from SCD were minimal in MACE evaluations for total conformation score of US and Dutch bulls. The biases in MACE evaluations of North American bulls for milk, fat, and protein from SCD that were reported by Banos et al. (2) were apparently primarily from genetic trend problems of participating countries rather than PT. In

TABLE 8. Mean change in international evaluation of German export candidate bulls from inclusion of second-country data of foreign bulls.[1]

Weighted[2] trait	Importing country			
	US	Canada	Italy	Holland
	(kg of PTA)	(kg of ETA)	(kg of EBV)	
Milk				
ACD	−16	−13	−29	+5
R90	−11	−9	−20	+4
R80	−9	−5	−14	+4
Fat				
ACD	+0.3	−0.6	+0.1	−1.7
R90	+0.1	−0.2	0	+0.6
R80	+0.1	−0.1	0	−0.8
Protein				
ACD	−0.1	+0.1	−0.5	−0.4
R90	−0.2	+0.1	−0.3	−0.1
R80	−0.1	+0.1	−0.2	0

[1]Genetic correlation among countries = 0.975.

[2]ACD = Evaluation based on all data, R80 = evaluation based on limiting second-country data to 80% reliability, and R90 = evaluation based on limiting second-country data to 90% reliability.

practice, requiring a minimum number of second-country daughters might also be necessary for a bull to be included in international genetic evaluations. Such a requirement would ensure that SCD are primarily from second-country daughters of imported semen rather than from second-country daughters imported as embryos or live animals. The earliest second-country daughters of popular foreign bulls are often imported as embryos or as live animals, and PT of those cows has been a problem in some countries because of the large financial investment in those animals (Gordon Swanson, 1995, personal communication).

Inclusion of SCD of imported bulls can offer several advantages. First, acceptance of INTERBULL results by dairy producers may be enhanced by inclusion of SCD, because producers are more interested in performance of foreign bulls in their own country than in converted foreign evaluations. Second, use of SCD can increase international ties and therefore improve accuracy of international EBV and genetic parameters, particularly estimates of genetic correlations between countries (1). Finally, inclusion of SCD allows greater reranking of animals across countries because of interaction of genotype and environment and differences in data recording and genetic evaluation procedures across countries (6), which is one of the primary advantages of the MACE procedure.

Several questions remain regarding procedures for international genetic evaluation. First, it is unclear whether data from all bulls evaluated in each country should be used for sire evaluation and for parameter estimation or whether only more recent data, such as data from bulls born in the past 15 yr, should be used. Use of all bulls to account for the effects of genetic selection seems advantageous, but older bulls in some countries might be of Friesian or mixed breed inheritance and thus might not be representative of the current Holstein population. Second, the effect of errors or inaccuracies in national evaluations on international sire rankings should be further examined. Bonaiti et al. (4) identified underestimation and overestimation of genetic trend from outdated age adjustment factors within countries as a major source of bias in international comparisons, but other areas of concern may also exist. For example, differences in other adjustments to the data prior to genetic evaluation, definitions of contemporary and unknown parent groups, or handling of effects such as heterosis or interaction of herd and sire within certain countries could lead to problems when data from several countries are combined. Finally, the optimal interaction of national and international genetic evaluation systems must be determined. Goddard (6) and Banos (1) suggested possible scenarios in which, for example, countries might use INTERBULL evaluations of foreign animals as prior pedigree information in their national evaluation systems, and each country would send only the contribution of daughters of each bull in their own country back to the INTERBULL Centre for the next international evaluation.

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