Impact of Imported Daughters on Evaluations of Their Sires

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ABSTRACT

Degree of bias in Modified Contemporary Comparison evaluations from including imported daughters was investigated to determine its impact on sire evaluation and subsequent development of conversion formulas between countries. Separate Modified Contemporary Deviations were computed from all daughters, only daughters with US dams, and only daughters with Canadian dams (daughters considered to be imported) for 31 Canadian Holstein bulls with a Repeatability of at least 40% in each subset. The deviations from daughters of Canadian dams were lower than those from daughters of US dams. Deviations weighted by product of Repeatabilities were significantly lower for both milk (113 kg) and fat (2.5 kg) for the subset of imported daughters. Lower evaluations for Canadian bulls did not affect conversion factors appreciably because 88% of daughters had US dams. However, demonstration of bias (apparently due to merit of mates) led to implementation of separate Canadian unknown-parent groups in animal model evaluations. For unknown dams of recently born cows, PTA for milk yield were about 250 kg lower for Canadian dams than for US dams. Daughter yield deviations averaged only 10 kg milk and .1 kg fat less for daughters of Canadian dams than for daughters of US dams. Correlations between subsets of daughters were near 1.
(**Key words**: sire evaluation, bias, merit of mates)

Abbreviation key: **DYD** = daughter yield deviation, **MCC** = Modified Contemporary Comparison, **MCD** = Modified Contemporary Deviation, **RPT** = Repeatability.

INTRODUCTION

Interest in genetic merit of bulls from other countries has resulted in many efforts to develop formulas to provide converted foreign evaluations comparable with native evaluations. Most of the methods rely on evaluations from two countries for a common group of bulls. Difficulties and limitations of such data have been related by many researchers, e.g., Philipsson (3). Despite these problems, conversion equations are useful because of a need for placing evaluations on a common scale by importers or marketers.

Genetic evaluation data from two countries, usually progeny tests of bulls in common, are used in developing conversion formulas. One limitation of such formulas is that bull evaluations in one or both countries may be biased unless merit of mates has been considered. This situation can occur if bulls are used selectively in the importing country. A special case of this problem exists if imported daughters are included in bull evaluations; e.g., if imported Canadian cows (those with Canadian dams) are included in their sires' US evaluations, those bulls' evaluations could be biased. The bias exists because merit of sires' mates (dams of daughters) differs from merit of mates for herdmates. An industry concern has been that many heifers brought from Canada to the US were chosen for conformation and that their dams were below average for yield. If so, the bull evaluation for yield in the US would be biased downward because of the inferior dams. Such a bias also is likely if dams are a random sample and a general genetic difference between countries exists.

Upward bias could result if some daughters of Canadian parents were imported after completion of one or more favorable lactation records. The Modified Contemporary Compar-

Received April 6, 1990.
Accepted August 27, 1990.

ison (MCC) accounted for culling bias in a general way by deviating lactation yield records after the first lactation from similarly selected records. This potential source of bias does not affect US animal model evaluations, because cows that lack first lactations in the US are excluded.

The MCC did not account for merit of mates, but Norman et al. (2) had shown this generally to be of little importance. This was interpreted to mean that within herds, dams of daughters were not appreciably different in genetic merit for yield from dams of contemporaries. However, for a few individual bulls, merit of mates was important. One way this could occur is for dams to be from herds other than where daughters were being milked. Even if the dams were a random sample of the possible dams in the other herds, they would not necessarily be of the same merit as dams of contemporaries in herds where daughters were milked. Such would be the case for imported daughters.

For conversion formulas, the importance of possible bias is that the intercept ("a" value) in the Canada to US conversion equation (4) would be biased downward if the US evaluation for a bull used in the calculations was biased downward. This study was undertaken to determine the degree of bias in MCC evaluations that could have an impact on development of conversion formulas. It also presents the basis for the decision to have separate Canadian unknown-parent groups to account for merit of mates in animal model evaluations if those mates do not have US genetic evaluations (5). The degree of difference in unknown-parent PTA between Canadian and US dams of cows and the resulting impact on daughter yield deviation (DYD) was examined.

MATERIALS AND METHODS

The group of bulls initially considered were the 226 bulls used in development of conversion formulas in a study by Powell (4). These bulls had evaluations in both the US and Canada with Repeatability (RPT) of at least 75%. Additionally, they were initially sampled in Canada and, therefore, were of Canadian registry. This group of bulls was chosen because they were likely to have daughters by both US and Canadian dams in US data. Daughters in the US were separated into those with US dams (dam_{US}) and those with Canadian dams (dam_{Can}). The dam_{Can} subset were considered to be imported daughters, and their dams were assumed to have remained in Canada because they had not been reidentified in the US. First lactation MCC bull evaluations were computed from these two groups of daughters and from all daughters.

Separate evaluations for each data set were calculated from a file that contained each lactation's Modified Contemporary Deviation (MCD) and data for weighting across herds. The two MCD and PD for each bull were computed following procedures reported by Dickinson et al. (1). Because this file was available only for bulls evaluated in July 1985 or later, many bulls were eliminated. This requirement may have resulted in selection of younger bulls, and none were born before 1970. Some bulls with US evaluations had few or no daughters by Canadian dams. A final requirement that evaluations for dam_{US} and dam_{Can} subsets for each bull each have a RPT of at least 40% reduced the number of bulls to 31. Although originally sampled and registered in Canada, 9 of the 31 bulls later were registered in the US; 14 had US sires, 8 had US dams, and 13 had US maternal grandsires. Most of the 14,873 daughters had US dams (88%).

Lactation records were those from daughters of the selected 31 bulls and were input data for January 1988 MCC evaluations. Means were calculated for RPT, MCD milk, MCD fat, PD milk, and PD fat for evaluations from all first lactations and dam_{US} and dam_{Can} first lactation subsets. Correlations and mean differences between MCD and PD of the full set and two subsets were computed.

To study effect of the separation of unknown-parent groups by country, DYD from July 1990 animal model evaluations were compared for the two subsets of daughters.

RESULTS AND DISCUSSION

Means for RPT, MCD, and PD are in Table 1. Mean RPT were in the moderate range (62 to 86%) with ranges from 42 to 99% for the dam_{US} subset and from 40 to 93% for the dam_{Can} subset. Because MCC RPT were computed only from daughter data, lower RPT would have been raised considerably if infor-

TABLE 1. Mean Repeatability (RPT), Modified Contemporary Deviations (MCD), and PD for 31 Canadian Holstein sires based on first lactations of all daughters, only daughters with US dams, or only daughters with Canadian dams.

Origin of daughter's dam	RPT	MCD Milk	MCD Fat	PD Milk	PD Fat
	(%)	(kg)			
All	86	−485	−11.1	−457	−10.2
US	79	−478	−11.1	−440	−9.8
Canada	62	−582	−13.0	−485	−10.8

TABLE 2. Correlations between Modified Contemporary Deviations (MCD) or PD for 31 Canadian Holstein sires based on first lactations of all daughters, only daughters with US dams (dam_{US}), or only daughters with Canadian dams (dam_{Can}).

Data sets	Correlations between MCD Milk	Correlations between MCD Fat	Correlations between PD Milk	Correlations between PD Fat
All, dam_{US}	.98	.98	.99	.99
All, dam_{Can}	.86	.92	.89	.93
Dam_{US}, dam_{Can}	.77	.86	.84	.89

mation from parents had been included, as is done for animal model reliability. Most data were in the dam_{US} subset, and mean evaluations were similar for this subset and all data. Mean MCD were lower for the dam_{Can} subset than for the dam_{US} subset by 104 kg milk and 1.9 kg fat. Differences were about half as large for PD: 45 kg milk and 1.0 kg fat, largely a reflection of RPT less than .99 for both subsets. The SE of differences also were much larger for MCD than for PD: 55 versus 39 kg for milk and 1.7 versus 1.4 kg for fat. These values illustrate the considerable variation in differences between evaluations. For both milk and fat, 12 of the 31 MCD were higher for the dam_{Can} subset than for the dam_{US} subset. The difference in MCD was significant ($P<.05$) for milk but not for fat. A one-tailed t test was used because the hypothesis was that evaluations for the dam_{Can} subset would be lower than for the dam_{US} subset.

Differences in evaluations because of differences in merit of mates would not be reflected fully in intercepts of conversion equations, because only a minor portion of daughters have foreign dams. For example, in these data, only 12% of daughters had Canadian dams. Therefore, little difference was found between evaluations based on all daughters and those from the dam_{US} subset that was unbiased by imported daughters. Further, the effect on such equations would depend on the conversion method employed (4). Use of MCD in conversion procedures would have a larger effect than would use of PD because of regression (i.e., RPT<1.00).

Correlations among MCD and PD for all data and the subsets are in Table 2. As expected, because the same ancestor merit was used for each of a bull's three evaluations, correlations were slightly higher among PD than among MCD. Correlations were extremely high between evaluations from all data and the dam_{US} subset because of the large relationship of part to whole. The generally higher correlations for fat than for milk were not expected but may result from relatively less genetic difference between country populations for fat than for milk.

Correlations between difference in MCD milk ($dam_{Can} - dam_{US}$) and MCD milk for the two subsets were +.29 (P=.11) for the dam_{Can} subset and −.38 (P=.04) for the dam_{US} subset. This shows an effect from sampling. If the difference resulted only from true bias that was consistent across bulls, no relationship with estimated genetic merit would exist.

Differences in MCD should be more reliable for pairs of evaluations in which each evaluation was estimated more accurately. To account for differences in accuracy, individual bull differences in MCD were weighted by product of RPT from the two subsets. Mean weighted differences for MCD were 113 kg milk and 2.5 kg fat, slightly larger than the unweighted value for milk but a proportionately larger increase for fat. Both differences were significant ($P<.05$).

Mean product of RPT used in calculation of weighted differences was .50. Its square root (.71) is the expected correlation between MCD for the dam_{US} and dam_{Can} subsets. Actual correlations were .77 for milk and .86 for fat (Table 2). The only explanation for the higher than expected correlations (other than sampling) is that some of the daughters in both sets occurred in the same herds and shared herdmates; thus, MCD were not totally independent.

These results suggest a possible problem because of inclusion of imported daughters in bull evaluations. Mean sizes of differences were large enough to be important and were significant. Although motivation for this study was the possible impact on conversion formulas, the practical importance probably is greater for accuracy of evaluations for individual bulls. The portion of this bias present in conversion equations would be restricted by the proportion of imported daughters and, with some conversion methods, the US RPT. Implementation of the animal model for US yield evaluations automatically included an adjustment for merit of mates (5). However, this is possible only if the mate's information is in the data, and it does not solve the problem of foreign dams. Potential bias from selection on daughters' own lactations completed prior to importation was eliminated by the requirement for the first lactation to be in the US. Based on results of this study, the animal model implementation in the US included separate Canadian unknown-parent groups to account for merit of mates without US evaluations.

Table 3 contains PTA for unknown dams of cows from July 1990 animal model evaluations by cow birth year. Number of unknown dams contributing annually to mean PTA ranged from 71,444 to 173,507 for US dams and from 786 to 2188 for Canadian dams. Thus, trend for PTA of unknown Canadian dams is not as smooth as for unknown US dams. The PTA for unknown Canadian dams were substantially lower than for unknown US dams. In more recent years, mean PTA milk of unknown Canadian dams were about 250 kg less than those of unknown US dams. These numbers should not be considered to be estimates of genetic differences between countries, because neither group of dams is a random sample nor are dams selected similarly. Canadian unknown dams have information from one daughter in US data but no lactation record of their own. Thus, Canadian data probably include most of the Canadian dams, because few would have evaluations in the US. The US data are primarily from unidentified dams of grade cows, and the unknown situation could be related to genetic merit. Table 3 shows the importance of separate unknown-parent groups for Canadian dams of cows. Without such groups, assumed merit of Canadian bull mates would be biased upwards with a resulting downward bias in bull's evaluation. Dam PTA milk was 239 kg less for daughters of Canadian dams than for US dams. This difference is close to that expected from Table 3 if US known and unknown dams are similar in genetic merit.

TABLE 3. Predicted transmitting abilities milk for unknown-parent groups from July 1990 animal model evaluations for Canadian and US dams of cows by birth year of cow.

Cow birth year	PTA US dam	PTA Canadian dam	Difference in PTA (Canadian – US)
	kg		
1970	−898	−918	−20
1971	−885	−908	−23
1972	−889	−894	−5
1973	−868	−946	−78
1974	−836	−931	−95
1975	−806	−826	−20
1976	−806	−953	−147
1977	−753	−844	−91
1978	−712	−829	−117
1979	−666	−723	−57
1980	−632	−824	−192
1981	−577	−801	−224
1982	−521	−718	−197
1983	−462	−708	−246
1984	−379	−715	−336
1985	−277	−657	−380
1986	−211	−413	−202
1987 to 1988	−199	−318	−119

Products of RPT and differences in MCD and DYD are in Table 4. The DYD of Canadian and US daughters were much more similar than were their MCD. The DYD for daughters of Canadian dams averaged only 10 kg less for milk and .1 kg less for fat compared with DYD for daughters of US dams. Correlations between the two DYD were .98 for milk and .99 for fat. These were higher than for MCD (.77 and .86, Table 2). Although an edit on birth year for daughters in the animal model evaluations produced nearly the same numbers of daughters as in the MCC, animal model evaluations included later lactation records and, therefore, had more information. Even considering this increase in information included, the decrease in difference between daughter deviations for the two subsets and the increase in correlation is impressive.

TABLE 4. Products of Modified Contemporary Comparison Repeatabilities (RPT) and differences[1] in Modified Contemporary Deviations (MCD) and daughter yield deviations (DYD) for daughters of Canadian and US dams by bull.

		Difference for MCC		Difference for animal model	
Bull	RPT × RPT	MCD Milk	MCD Fat	DYD Milk	DYD Fat
1	.90	−49	−6.0	+57	−.3
2	.25	−445	−9.8	−13	+1.2
3	.34	+464	+20.6	+158	+6.9
4	.72	+16	+3.2	+42	+3.7
5	.59	−123	−5.0	+21	+.4
6	.20	+410	+7.4	+12	.0
7	.55	−216	−1.0	+306	+12.4
8	.65	−308	−8.5	+16	−1.3
9	.60	−667	−17.1	−63	+.7
10	.43	+346	+18.6	+108	+5.5
11	.76	+179	+3.4	−9	−1.2
12	.55	−145	−3.5	−30	−.2
13	.64	+4	−5.5	+36	+2.8
14	.34	−73	+.3	+22	.0
15	.60	−196	−3.3	−32	−1.5
16	.48	+237	+7.3	+212	+4.5
17	.37	−105	−5.2	−59	−2.9
18	.61	+30	+4.7	+38	+2.2
19	.28	−271	−5.7	−162	−3.5
20	.85	−304	−12.1	−45	−2.0
21	.17	+172	+10.0	−131	−4.1
22	.38	−323	−3.3	−258	−8.6
23	.52	−590	−13.7	−135	−1.4
24	.63	+251	+5.2	+142	+2.8
25	.23	−336	−12.5	+95	+.5
26	.47	−431	−10.8	−384	−10.2
27	.53	−545	−11.0	−296	−9.2
28	.46	−380	−6.1	−177	−5.3
29	.49	+386	+14.8	+135	+5.4
30	.41	−299	−15.7	−44	−4.4
31	.45	+91	+2.8	+121	+3.9
All	.50	−104	−1.9	−10	−1.0

[1]Mean for daughters of Canadian dams minus mean for daughters of US dams.

CONCLUSIONS

Evaluations by MCC were biased downward for bulls that were initially sampled in Canada and that had Canadian mates for daughters with US data. Correlations were higher than expected between dam_{Can} and dam_{US} subsets, but mean MCD were lower for the dam_{Can} subset by 104 kg milk and 2 kg fat (113 and 2.5 kg if weighted by RPT). Effect on evaluations, and, therefore, on conversion formulas, is lessened considerably by most daughters' having US dams and weighting (RPT) less than 1. However, because this source of bias has been defined, it was accounted for to increase accuracy slightly overall and to prevent serious discrimination in rare cases. Use of separate unknown-parent groups for Canadian dams was prompted by results of this study and was shown to decrease bias, which should increase accuracy of evaluations in general with the subsequent benefit of more accurate conversion formulas. Implications arise for any country where animals or embryos are imported. The inherent accounting for mate merit by the animal model appears effective, but separate unknown-parent groupings are needed for full advantage.

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