Accuracy of Conversion of Proofs Using Wilmink's and Goddard's Methods[1]

J.A.B. Robinson and J.P. Chesnais
Agriculture Canada

ABSTRACT

Conversions between the U.S. and Canada have been harmonized using common selection criteria and computations using Wilmink's method. Recently the USDA adopted Goddard's method for computation of the 1993 Canada to U.S. conversion. Differences in the equations lead to a study to investigate the accuracy of the two methods. Conversions were computed using Wilmink's and Goddard's methods for the January 1993 Agriculture Canada and USDA-AIPL production genetic evaluations. Differences in these equations were studied. Conversions were also replicated in a follow-up study to verify the accuracy of both conversion methodologies. From the replication study, both Wilmink's and Goddard's methods were found to be accurate under those circumstances.

INTRODUCTION

Agriculture Canada and the USDA developed harmonized procedures for selection of bulls for calculation of conversion equations using Wilmink's method for production proofs between the United States and Canada. In January 1993, the USDA adopted Goddard's method as described by Powell and Seiber (1992). Changes in the conversion equations prompted research at Agriculture Canada into the relative accuracy of these two conversion methodologies. The INTERBULL guidelines (INTERBULL Bulletin 4, 1990) recommend procedures for calculating conversions with both methods.

1992 Canada to U.S. Conversions for Holsteins

In 1992, the USDA and Agriculture Canada had fully harmonized their conversion computations. Bulls were selected based upon augmented INTERBULL criteria as follows:

i) bulls must have at least 75% repeatability (REP) or reliability (REL) and daughters in at least 20 herds,

ii) bulls from the exporting country must have 90% REP or REL,

iii) bulls must be born in a ten year period in which sufficient number of bulls are represented in each year but bulls born in more recent years are included,

iv) bulls' countries of origin are determined based upon earliest year of first daughter birth or calving (bulls which appear simultaneously in both countries are used in both conversion computations),

v) bulls must be determined to be A.I. sampled or have a proof based upon at least 100 herds.

Both organizations were able to independently compute conversions for either country and

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of bulls are used to compute the conversions and the correlations between the Canadian and American proofs are not unity. However, should reciprocity be achieved, it would be an independent verification of the conversion equations.

Study of the Accuracy of the Wilmink and Goddard Methods

One means of comparing conversion methods is the use of split datasets as demonstrated by Powell and Seiber (1992). They used a single split dataset trial to verify the accuracy of the conversions by computing conversions using half of the dataset and verifying the conversions with the other half of the dataset. Initial work in this study showed that splitting the dataset different ways resulted in slightly different results when computing and applying conversion formulae. Several approaches to dataset splitting were considered for this study based on algorithms to create repeated samples by assigning bulls to different datasets including computing the conversion equation using (n-1) bulls and apply the equation to the i-th bull which was not included in the conversion computation. The algorithmic approach proved difficult to manage in terms of computing enough replicates while avoiding duplicating a replicate and ensuring that all bulls received the same number of predicted proofs. The n-1 bull approach is really one case of the algorithmic approach whereby the number of replicates and the number predicted proofs for each bull is constrained by design. By looping through the entire dataset, all n bulls receive a converted proof using all the other bulls' proofs to compute the conversion. This replicated analysis included computation of the mean difference between actual proof and predicted proof for both the U.S. to Canada conversion and the Canada to U.S. conversion using the Wilmink and Goddard II methods. The mean and standard deviation of the conversion parameters were also computed.

RESULTS AND DISCUSSION

1993 Canada to U.S. Conversion Results

Canada to U.S. conversions were computed using the Wilmink, Goddard I and Goddard II methods and the resulting conversion parameters and sample conversions of +24 BCA are shown in Table 2.

Table 2 January 1993 Canada to U.S. Conversion Calculations by **Agriculture Canada**

Trait	AC Wilmink			AC Goddard II			AC Goddard I		
	a-value	b-value	Sample	a-value	b-value	Sample	a-value	b-value	Sample
Milk	-70	121	+2834	-77	113	+2635	-70	121	+2834
Fat	3.31	4.01	+100	3.40	3.69	+92	3.31	4.01	+100
Protein	-1.55	3.63	+86	-1.69	3.30	+78	-1.54	3.64	+86

From the Sample columns in Tables 1 and 2 the differences in Goddard II and Wilmink conversion formulae are readily apparent. The change in the a-value has a small effect compared to the change in the b-value since the effect of the b-value is multiplicative. The calculation of the b-value is the difference between the two methods.

The Goddard II method yielded the same b-values but slightly different a-values between Table 1 and 2. The differences may result from a different interpretation of what constitutes the

Table 6a Mean and standard deviation of the difference (actual minus predicted) in ETA BCAs for **U.S. to Canada** conversion

Trait	Wilmink Method		Goddard II Method	
	Mean difference	Std. Dev. difference	Mean difference	Std. dev. difference
Milk yield	-0.0004	2.7450	0.0011	2.7478
Fat yield	0.0050	2.8601	0.0021	2.8639
Protein yield	-0.0062	2.4497	0.0049	2.4353

Table 6b Mean and standard deviation of the difference (actual minus predicted) in PTA lbs for **Canada to U.S.** conversion

Trait	Wilmink Method		Goddard II Method	
	Mean difference	Std. Dev. difference	Mean difference	Std. dev. difference
Milk yield	-0.0714	311.0991	0.1562	300.0939
Fat yield	0.0080	11.4382	0.0153	10.8216
Protein yield	0.0032	8.3960	0.0065	7.9499

Table 7a Mean and standard deviation of the conversion equation parameters for the **U.S. to Canada** conversion

Trait	Wilmink Method				Goddard II Method			
	a-value		b-value		a-value		b-value	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Milk yield	1.1894	0.0023	0.0087	0.00002	1.1842	0.0256	0.0087	0.00002
Fat yield	-0.7240	0.0023	0.2446	0.0006	-0.7345	0.0247	0.2450	0.0006
Protein yield	1.0593	0.0196	0.3006	0.0006	1.1315	0.0212	0.2972	0.0007

Table 7b Mean and standard deviation of the conversion equation parameters for the **Canada to U.S.** conversion

Trait	Wilmink Method				Goddard II Method			
	a-value		b-value		a-value		b-value	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Milk yield	-70.1806	1.9116	121.0347	0.2422	-76.6498	1.8315	113.2400	0.2666
Fat yield	3.3106	0.0694	4.0120	0.0059	3.3983	0.0657	3.6874	0.0067
Protein yield	-1.5471	0.0511	3.6275	0.0064	-1.6865	0.0481	3.3012	0.0078

From Table 6a, both the Wilmink and Goddard II methods performed equally well for the U.S. to Canada conversion. The figures show a slight trend for Goddard II to underpredict the bull's

APPENDIX 1

Computation Details

Wilmink's Method

Wilmink's method is computed using proofs from the exporting country adjusted for the accuracy of the proof of the bull in the importing country as the independent variable and the importing country proof as the dependent variable as follows (INTERBULL, 1990):

Compute $ETA^{*}_{exp} = (ETA_{exp} - \overline{ETA_{exp}}) * Repeatability_{imp}$ *for each bull.*

Compute a regression using ETA^{*}_{exp} *as the independent* (x) *variable and* ETA_{imp} *as the dependent* (y) *variable.*

Using the slope of the above regression as the b-value , compute the a-value as:

$$a = \overline{ETA_{imp}} - b \times \overline{ETA_{exp}}$$

where $\overline{ETA}$ *is the average ETA, and* exp *and imp denote the exporting and importing country.*

Goddard I Method

Powell and Sieber (1992) discuss an approximate Goddard procedure referred to here as Goddard I.

$$\text{Compute } ETA^{*}_{imp} = \frac{(ETA_{imp} - \overline{ETA_{imp}})}{Repeatability_{imp}} \text{ for each bull.}$$

Then compute a regression with ETA^{*}_{imp} *as the dependent variable* (y), *and* ETA_{exp} *as the independent variable* (x).

Using the resulting slope (b) *compute the intercept* (a) *as*

$$a = \overline{ETA_{imp}} - (b \times \overline{ETA_{exp}})$$

where the quantities are defined as above.