Between country conversion factors for multitrait selection indices

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Introduction

Conversion factors are computed by comparing genetic evaluations of specific animals for individual traits in two different countries. Yet, nearly all countries rank animals by a multitrait selection index. Three possible alternatives were considered to compute between country conversion factors for multitrait selection indices.

1. Compute conversion factors for each trait included in the index, and then compute index values using the standard selection index weights (Method 1).
2. Compute conversion factors using index values in both countries as a single trait (Method 2).
3. Estimate the index value in the importing country by multiple regression on the individual trait values in the exporting country (Method 3).

The objectives were to compare these three alternatives by generating simulated data sets. Criteria for comparison were coefficients of determination, residuals, and predicted values.

Description of simulations

For each parameter set, ten samples of 200 bulls each were generated to compute the three conversion functions. A second independent sample of 200 bulls was generated to test the conversion functions. The two traits had unit variance in both countries. The following parameters were varied:

1. Genetic correlations between the two traits in each country.
2. Genetic correlation of each trait in the two countries.
3. Relative weights of the two traits in the selection index.

Genetic correlations were always positive, but both positive and negative index weights were simulated. Four selection indices were tested:

$$I_1 = X + Y$$
$$I_2 = X - Y$$
$$I_3 = X + 2Y$$
$$I_4 = X - 2Y$$

Where X and Y are the two traits included in the index.
Four genetic correlations were considered:

r_1 = correlation between countries A and B for trait X

r_2 = correlation between countries A and B for trait Y

r_3 = correlation between X and Y in country A

r_4 = correlation between X and Y in country B

Bases for comparison

Bases for comparison were:

1. Coefficients of determination for each index in the importing country based on bull sample with evaluations in both countries.
2. Residuals and predicted values computed from the second bull sample based on the conversion function derived from the first sample.

Results

Coefficients of determination computed with all correlations equal to 0.9 are given in Table 1. All coefficients of determination were very similar and approximately equal to 0.8 for all three methods and all four indices.

Table 1. Coefficients of Determination ($r_1 = r_2 = r_3 = r_4 = 0.9$)

	Indices			
Method	1	2	3	4
1	0.81	0.80	0.81	0.80
2	0.81	0.80	0.81	0.80
3	0.82	0.80	0.81	0.80

Coefficients of determination computed with all correlations equal to 0.9, except for the correlation between traits X and Y in country A, which was set to 0.7, are given in Table 2. All R^2 values are close to 0.8, except for methods 1 and 2 with index 4. With the index X - 2Y, R^2 for method 3 was significantly higher.

Table 2. Coefficients of Determination ($r_1 = r_2 = r_4 = 0.9$, $r_3 = 0.7$)

	Indices			
Method	1	2	3	4
1	0.79	0.80	0.78	0.71
2	0.79	0.80	0.78	0.71
3	0.79	0.80	0.79	0.79

Prediction error variances (PEV) and variance of the predictor (Var P) in the importing country computed from a second sample of 200 bulls with all correlations = 0.9, except for $r_3 = 0.7$ are given in Table 3 for index 4. PEV was lowest, and Var P was highest for method 3. Similarly, PEV was highest, and Var P was lowest for method 1.

Table 3. Prediction error variances and variance of the predictor for index 4 ($r_1 = r_2 = r_4 = 0.9$, $r_3 = 0.7$)

Method	PEV	Var P
1	0.89	0.90
2	0.85	1.08
3	0.71	1.23

Coefficients of Determination computed from simulations with all correlations equal to 0.9, except for the correlation between countries A and B for trait Y, which was set to 0.8, are given in Table 4. R^2 values are close to 0.7, for the indices 1 and 3, 0.6 for index 2 and only 0.5 for index 4. Differences between the three methods were slight, but method 3 was always highest.

Table 4. Coefficients of Determination ($r_1 = r_3 = r_4 = 0.9$, $r_2 = 0.8$)

	Indices			
Method	1	2	3	4
1	0.73	0.63	0.71	0.50
2	0.72	0.62	0.71	0.52
3	0.74	0.64	0.72	0.52

Conclusions

The multiple regression conversion function was always best by all three criteria. Direct conversion based on index values generally gave the worst results. Differences between the three methods were small, unless:

1. Index values were in opposite direction to the genetic correlations,
2. Index weights were "asymmetric", that is the two trait had different weights, and
3. Genetic correlations between traits were different in each country