5 INTERNATIONAL EVALUATIONS

Although due to the existence of extensive international evaluations through Interbull's evaluation services and the expected expansion of these services to new traits and breeds, the need to produce recommendations for international genetic evaluations is not as acute as at the time of publication of IBB 4, however, the need for such recommendations is both real and continues to exist for the foreseeable future.

5.1 Problems in Across Country Comparisons

Interpretation of national genetic evaluation results and an across country evaluation need to address the problems associated with genetic correlations for the same trait between two countries being less than one. The following can be mentioned as possible causes for this.

5.1.1 Differences in climatic conditions

Individuals of the same dairy cattle breed are kept in different herds under a variety of environmental conditions, from arid to humid, from lowlands to high mountains, from tropical to temperate, from equatorial to almost polar. It is very easy to postulate that there are a large number of bulls with daughters in diverse climatic conditions and the breeding values estimated from different localities may reflect different sets of genes or the same set of genes reacting differently to the climatic conditions prevailing in different localities.

5.1.2 Differences in management practices

Management practices also show much variation between different countries and even between different regions of a single country. One example is the extensive grazing system practiced in some countries, which may also bring about some inevitable consequences like the need for synchronization of pregnancies to a larger extent than in any intensive year-round feeding system. Another example is the intensive, highly concentrate-dependent herds with limited access to outdoor space / grazing. Such herds show much variation with regard to their sizes. It is also easy to postulate that in the smaller herds there is a higher risk of preferential treatment of daughters of some bulls.

5.1.3 Differences in trait definitions

All of the economically interesting traits considered in different countries' national GES have a rather complicated operational definition. As an example, the trait commonly referred to as "milk yield" may involve quite different sets of genes depending on how we get from a single milking measurement on a test day to the final value of "milk yield" that is used as the observation in the evaluation model. Obviously the final value of "milk yield" depends, among others, on measurement method, milking frequency, extension method, pre-adjustment effects, number of lactations used (*e.g.* first vs. all), and so on.

5.1.4 Differences in genetic evaluation systems

Results of the surveys conducted by Interbull clearly show that the raw data obtained from single milk recording events go through a large number of steps until they are summarized in a few estimated genetic parameters for a whole population and one or few EBVs for each animal. Some examples of such steps are estimation of 24-hour yields from milk samples, extension of records, age adjustments, pre-adjustment of the records to different environmental factors and so on. While we may have some biological justifications for our interest in knowing how different animals perform under different environmental conditions or production systems, however, it is in our interest to know that the same set of raw data will lead to the reasonably similar result if subjected to different evaluation procedures.

5.1.5 Other complicating factors

There are also a number of other issues which we still do not have a full understanding of their impact. Error in recording the right Animal ID is an example (for an example see the study by Banos *et al*., 2001). A mistaken identity may occur for a milk record or for an animal such as a bull or sire of a cow.

5.2 Comparison of Animal Evaluations

Number and proportion of the bulls that have progeny, and hence EBV, in more than one country is steadily increasing. Simultaneous publication of sire evaluations for the same bull in several countries, provided the bulls have been accurately evaluated in each country, is an important factor needed to convert breeding values from one country to another. It is therefore highly desirable that simultaneous and joint progeny testing of young bulls is promoted widely. To obtain an estimated (or converted) evaluation for the bulls in the countries where they have no evaluation several options are available, two of which are as follow:

5.2.1 Conversion equations

One procedure to obtain estimated breeding values in importing countries is to use conversion equations developed from simple regression analysis of bulls' progeny in the importing and exporting countries, that is a bull's performance in the importing country is predicted from its performance in the exporting country. In a simulation study (IBB 1, 1986) it was shown that the procedure earlier recommended by IDF (A-Doc 64, 1981), with modifications suggested by Goddard (1985) and Wilmink *et al.* (1986) would fairly accurately estimate the parameters of conversion equations (for more details and numerical examples see IBB 1 and IBB 4).

Ease of application is the major advantage of this method, which presupposes existence of a sufficient number of bulls with national evaluations in both countries; alternatively, related animals (full-sibs, sire-son) may be used. The main problem is that such bulls are often a selected sample of the population, therefore, estimated regression coefficients are not representative of the population to which they will be applied and the estimated a and b values will be either over- or underestimated. On the other hand only two countries at a time may be compared by this method. One other shortcoming of this method is that re-ranking of animals is not possible (see also Weigel and Powell, 2000 and references therein). Numerical examples of Goddard (1985) and Wilmink *et al*. (1986) methods can be found in IBB 4.

5.2.2 Multiple-trait across country evaluation

Another procedure, currently practiced at the Interbull Centre and commonly known as Multiple-trait Across Country Evaluation (MACE) is due to Schaeffer (1994; see also Sigurdsson and Banos, 1995, Sigurdsson et al., 1996 and Rozzi and Schaeffer, 1996) which proposed a model to combine results of national GES from various countries in a joint analysis. The main model, as implemented at the Interbull Centre (Banos and Sigurdsson, 1996), is as follows:

$$y_i = \mu_i 1 + Z_i Q g_i + Z_i s_i + e_i$$

where
y_i = Observation vector associated with the national evaluation of a bull in country i, there may be multiple observations per bull (though only one observation from each country);
μ_i = Country of evaluation effect, reflecting the definition of the genetic base in country i;
g_i = Genetic group of bull effect (phantom group effect), defined by birth year, population of origin, and selection path;
s_i = Genetic effect of bull with variance $A\sigma^2_s$, A is the numerator relationship matrix of bulls;

e_i = Residual effect with variance $R\sigma^2_e$, R^{-1} is a diagonal matrix with diagonals reflecting the accuracy of daughter contribution in country i to the national evaluation of the bull;
Z_i = Incidence matrix relating observations to sires; and
Q_i = Incidence matrix relating sires to phantom groups.

The above model develops to a multiple-trait model where performance in each country is considered as a different trait, allowing for different genetic parameters in different countries and genetic correlation of less than unity among countries (Schaeffer, 1994). This implies that different country scales and GxE are taken into account. Another advantage of MACE is its capability to utilize all known male relationships between animals. This is especially important when sons of a bull sire are tested in different countries. This can partly compensate for the low number of multiple evaluations of the bulls coming from several countries. A more detailed description of operational steps that are performed at the Interbull Centre is available through Interbull's home page at www.interbull.org.

5.2.3 Choice of method for international comparisons

Even based on the cursory presentation and comparison of the conversion equations and MACE in the two previous sections it is evident that, in the absence of joint international evaluations based on performance records, even for bilateral comparisons MACE offers a better theoretical ground, has more advantages and suffers from lower number of shortcomings (for a comparison of these two methods see: Banos, 1998). The empirical evidence in support of the claim that MACE can be used successfully for all sorts of traits is overwhelming (see Interbull Bulletins for numerous examples).

Interbull Recommendations
For those country-breed-trait combinations that an Interbull evaluation exists, utilization of the Interbull results is recommended.

For those country-breed-trait combinations that an Interbull evaluation does not exist, utilization of the MACE methodology is recommended.

5.2.4 Minimum correlations and trait harmonization

An issue of importance in international comparisons is that how useful are international comparisons if the correlation among countries (e.g. correlation of bulls' breeding values) are very different from 1.0. Low correlation, among other things, contributes to re-ranking of bulls and low reliability of estimated breeding values for foreign bulls. Moreover, the value of such evaluation results in achieving genetic gain by importation of superior genetic material from other countries is questionable (Banos and Smith, 1991). Reasons for the correlation being different from 1.0 have been outlined in 5.1 above (Problems in Across Country Comparisons) and will not be elaborated here.

Interbull Recommendation
If the correlation between two countries is lower than ≈ 0.70 the countries involved are recommended to investigate all possible causes of low correlation, especially to examine if trait definition, genetic evaluation model and problems associated with IDs are contributing to the low correlation. In such cases action to harmonize GES in the countries involved should be taken.

5.2.5 Validity of MACE results

Estimated breeding values for bulls by the MACE methodology obviously depend, among others things, on the national EBVs for bulls and genetic correlations between countries. Therefore, these should be re-estimated when ever new national evaluations are available.

Interbull Recommendation
Always the latest available national results should be used for the MACE analysis. New genetic correlations should be preferably estimated each time the breeding values are estimated, but certainly whenever:

- The change in sire variance in any of the countries involved is more than 5% compared to the previous evaluation;
- A change in methodology, base etc has occurred in either of the countries involved;
- There is a substantial increase / change in number of bulls with evaluations in either of the countries.

5.2.6 Publication of Interbull (MACE) evaluations

Status of the Interbull evaluations in each country, and whether they are considered official or not, is decided upon by national genetic evaluation centers. A summary of these policies can be found on the Interbull web site (www.interbull.org). However, publication and advertisement of Interbull evaluations is regulated by Interbull's "Code of Practice" and especially through the "Advertising Guidelines".

Interbull Recommendation
Publication of Interbull evaluation results, *i.e.* EBVs for all bulls (irrespective of their origin) in the domestic scale is the responsibility of the national genetic evaluation centers. These are expected to make the results available to all domestic and foreign interested parties in all countries participating in Interbull evaluations. As is the case for publication of national genetic evaluation results, it is Interbull recommendation that EBV's for all bulls be published together with the reliabilities for the estimates.