

2. INTERBULL RECOMMENDATIONS

2.1. Sire evaluation methods in general

2.1.1. Requirements of data

In order to provide an accurate basis for sire evaluation the data on the daughters need to meet the following criteria:

- a) the *sire identification* of the officially milk-recorded cows should be as complete as possible and should be definitely recorded in the data base with milk records without any change, at latest at the first monthly milk-recording test after first calving.
- b) *records of culled cows should be included* in the sire evaluation as early as possible and extended to the standard lactation length used, depending on the definition of the trait, but usually 305 days.

- c) when evaluations are based on more lactations than the first it is suggested that the individual cow records are age adjusted to the national breed average calving age.

2.1.2. Traits to be included

For milk production it is essential that yield as well as composition traits are evaluated. As a minimum the following traits recorded in one or more lactations should be generally evaluated and sire proofs should be given separately for:

- a) milk yield
- b) fat yield
- c) fat %
- d) protein yield
- e) protein %

2.1.3. Choice of method

As regards the domestic sire evaluation method to be used, also as a basis for international use, a *Best Linear Unbiased Prediction (BLUP) procedure* is generally recommended. The model applied must reasonably well consider non-genetic factors influencing production records, fit the structure and distribution of records on herd-year-seasons and the methods of bull sampling in order to avoid any bias in the proofs.

Countries that are moving towards updates in their sire evaluation system should consider the individual animal model as the most desirable, provided the necessary computer capacity is available and the data structure calls for its specific possibilities: its key advantages over the BLUP sire or maternal grandsire models are that it makes the most efficient use of all records and the most appropriate adjustments for non-random choice of mates. The latter is a major problem when semen is exported from country to country. The method of second choice would be a *BLUP sire/maternal grandsire model*. The method of third choice would be a *BLUP sire model*. When this is chosen, a preadjustment for the genetic level of the mates (i.e. the dams of the daughters) should be made if the necessary data are available.

The evaluation procedure should be certain to group the sires according to country of origin and according to birth date or some other method to establish time trends. The procedures of grouping bulls, especially the imported ones, must be given special attention in order to correctly evaluate these in the regular domestic evaluation procedure. Caution must be taken when large discrepancies exist between group means and bases.

2.1.4. Expression of proofs

In order to facilitate the international use of domestically published proofs it is recommended to express all traits as *absolute Breeding Values (BV)*, yield traits in kgs and milk composition traits in per cent. Such values relate directly to the additive genetic value of the bull itself as well as to actual amounts of products.

2.1.5. Definition of genetic base

In accordance with 2.1.4 it is recommended that each country

- a) should endeavour to define its evaluation base as the *average genetic merit of all cows with records that were born in a specific year*
- b) should endeavour to use a *step-wise base changing every 5 years* as follows: the "1990" base to include all cows born in 1985, the "1995" base to include all cows born in 1990, and so on.
- c) should publish a minimum of two evaluations a year. If the base should be changed, this should be done on the first evaluation of that year.

Thus, the evaluation base proposed is a *cow base* rather than a *sire base*.

2.1.6. Accuracy and publication of proofs

There are obvious differences between countries in the levels of repeatability or accuracy of sire evaluations required for publication of these evaluations in the home country. It must generally be emphasized that the daughters of each bull should be spread over many herds in order to get accurate sire-proofs. In particular, a sire evaluation based on a small number of herds (less than 5), with unusual distributions of daughters over these herds, may not be an accurate predictor of the bull's future progeny evaluation.

While INTERBULL does not presume to dictate minimum levels of accuracy for individual countries consensus seems to be that sires should not get official evaluations until they have daughters in a reasonable number of herds. Generally speaking, a repeatability value of 50% (based on complete lactations) and 15 daughters in 5 or more herds, would fit these absolute minimum standards.

It is the *recommendation of INTERBULL that the official publications of individual proofs always should include the most recent figures or information on:*

- a) no. of daughters and their distribution over herds (e.g. no. of effective daughters, highest percentage of daughters in a single herd, etc).
- b) no. or percentage of freshened daughters being excluded from the evaluations and also the no. or percentage of evaluated daughters being culled before 305 days in the first lactation or alternatively before the second lactation. When lactations in progress are extended and used, the percentage of records in progress should be given.
- c) the theoretically expected repeatability of the proof, at least when results are going to be used internationally.
- d) the type of proof, i.e. whether the proof is a result of regular Artificial Insemination service or not. For AI proofs a distinction must be made between (1) those of domestic young sampling bulls, (2) those based on the second batch of daughters of already proven bulls, and (3) those resulting from use of imported semen.
- e) breed and year of basis for comparison.

It is recommended that countries that do not yet fulfill these standards move towards these as they change national publication policies.

2.2. General requirements in the use of sire—proofs across countries

2.2.1. International publication of proofs

The publishing of sire—proofs for international use in e.g. internationally distributed bull catalogues should consider the general recommendations given in 2.1.6 and always include:

- a) *general information on the evaluation* practised and the description for evaluation of each trait should follow the standards given in Bulletin no. 3 (see appendix 1). An exact definition of the genetic base used is a necessity.
- b) *the original official domestic herd—book or registration number including a breed code, added with a prefix reflecting the country (see 2.2.2.), and pedigree information* covering at least two generations.
- c) *the most recent officially published proofs* of the individual bull.
- d) *type of proofs* and measures of accuracy of the individual proofs.
- e) *annual statistics* (means and stand.dev.) on specified bull proofs and phenotypic production levels should be given as laid out in appendix 2.

Individual proofs should always be given as estimated genetic values relative to the presently used genetic base.

Whenever the purpose is to express sire proofs for international use, *it is recommended to transform the proofs to be expressed as absolute Breeding Values (BV)*, given in kg for yield traits and per cent for milk composition traits, if this is not already done domestically as proposed in 2.1.4.

2.2.2. International identification codes of bulls

In order to accurately identify the same bulls being used in other countries it is recommended to use a standardized procedure as follows:

The original official domestic herd—book or registration number should be used also for international numbering by adding a prefix identifying the country of origin. The country code table of the international standardizing organization (ISO) is proposed. Such a numbering system is presently being worked out by the Black & White breed societies around the world and ICRPMA.

In case other identification numbers for technical reasons must be used in the importing country a cross—reference list should be kept available with both the international (original) number as given above and the new number.

2.3. Across country evaluations in different situations

2.3.1. Simultaneous use of bulls in different countries utilizing the same definitions and scales of traits

In such situations where bulls in two or more countries are used more or less simultaneously and the traits recorded are defined and expressed in the same way or

are easily transformed to that, *it is recommended that a BLUP-procedure where the data includes information from both or all countries is used for a joint evaluation of the bulls* according to the methodology presented by Schaeffer (1985) and Rozzi et al. (1990). The proofs will be expressed in each country considering any genetic differences between the bases of the populations in question.

2.3.2. Estimation and use of conversion factors when the same bulls are used in two or more countries with varying definitions or scales of traits

2.3.2.1. General procedures

The IDF method (A-Doc. 64, 1981), modified according to Goddard (1985) and Wilmlink et al. (1986) is recommended by INTERBULL for computation of a- and b-values for general conversions of sire proofs across countries in situations where the application of the method in 2.3.1. is not feasible because of technical reasons, e.g. computer capacity, availability of appropriate data etc. For numerical examples, see appendices 3 and 4.

In INTERBULL Bulletin No. 1 (1986) methods to compute a- and b-values were described. Goddard's method uses the deregressed proof of bulls in the importing country. In the linear model approach, presented by Schaeffer (1985), deregressed proofs are used as well. Once the Animal Model is in place, unregressed daughter averages, free from all kind of fixed effects, adjusted for genetic merit of mates and free of effects of the relationship matrix are available. Suppose the following general animal model is used.

$$y = m + a + pe + E$$

where

- y = the record for each cow;
- m = effect of herd-year-season;
- a = additive genetic effect of the animal;
- pe = permanent environment effect for each cow;
- E = residual.

The unregressed contribution of each record to cow's breeding value is estimated as:

$$c = y - m - pe$$

which is free from the effect of grouping and the relationship matrix. Its weighted average over the records of a daughter and weighted average of daughters of a bull adjusted for their dams (the so called daughter-yield-deviation, DYD), can be used for conversion purposes. The weighting is based on the number of records of each cow and on the accuracy of each record (records in progress may receive a weight of less than 1).

In order to compute the theoretical b-values (see below) the genetic variances in two countries for each trait is required. Estimates of genetic variances may be derived from the analysis of variance for the proofs of young bulls in each country. These variances can be estimated by restricted maximum likelihood (REML) or approximated by the variance of the proof weighted for the reliability.

The following information sources are recommended to be available on request for derivation of conversion factors and to interested third parties such as INTERBULL:

- the information sources listed under 2.1.6 and 2.2.1
- the genetic variance of each trait;

For bulls, used in the derivation of the conversion factors:

- the DYD of each bull in each country if animal model evaluations are used. If a sire model is used and DYD's are not available, then group identification of each bull and average genetic merit of the bulls in each group should be made available instead.

These information sources can be used for computation of conversion formulae from country A to country B. However, conversion formulae are not reciprocal and separate a- and b-values should be computed for conversion from B to A.

2.3.2.2. Responsibilities and selection of data set

Estimation of a- and b-values and conversion of proofs are the responsibilities of the importing country. Only one organization per country and breed should be authorized to convert breeding values. The following specific conditions should be met in selection of bulls to be included in data sets for derivation of conversion factors:

- only data from most recent official proofs* should be used. When sufficient numbers of bulls are available from two-way exchange of semen, it is recommended that data be limited only to bulls with initial proofs in the exporting country.
- bulls should be born within a 10-year period ending with the most recent birth year in which sufficient number of bulls with reliable proofs are available.
- the *number of pairs of bulls* should be a minimum of 20 with regular AI-proofs based on daughters in at least 20 herds in each country *and* having proofs with repeatabilities of at least 75% in both countries.

2.3.2.3. Validity of conversion factors

With regard to validity of conversion factors a- and b-values should be re-estimated whenever a change in methodology, base etc has occurred in any of the two countries involved or a substantially increased number of bulls with proofs in the two countries are available. When estimating the a- and b-values the following checks should be carried out:

- correlations (r) between the proofs of the two countries should be calculated and exceed 0.75 to be satisfactory.
- comparison of the estimated b-values with the theoretical b-values.
- comparison of the b-values to previous estimates. The b-values are not expected to change significantly from one estimation to the next.
- the consistency in relationships between yield and milk composition traits between domestic and converted proofs.
- the consistency in converted proofs of the same bulls when proofs are converted from different countries to the same importing country, when such type of data is available.
- the results and description of data and methods used for estimation of conversion factors should be published and kept available for the exporting country as well as INTERBULL.

2.3.2.4. Application of conversion factors

In applications of conversion factors the following conditions should be considered:

- a) the minimum correlation between the proofs in the two countries should be 0.75.
- b) conversion factors are only applicable on the same type of data (e.g. population, area, age group, production level) as from which they were estimated.
- c) conversion factors are only applicable as long as no change of the base or methodology or data adjustments that might affect the level or scaling of sire evaluations in any of the two countries has taken place.
- d) only official domestically published proofs should be converted.
- e) converted proofs should always be clearly marked, e.g. with an asterisk (*) and the year for conversion.
- f) estimated repeatabilities of converted proofs should always be given (for procedure see Appendix 4) and whether the proofs are regular AI-proofs or not.

In some instances, conversion formulae have been promoted without adequate regard for their limitations and the fact that they vary greatly depending on criteria for bull selection, conversion methods etc. Despite the attempts to standardize all these aspects, the possibility of biases due to non-random matings, preferential treatment etc still exist. Therefore conversion formulae and converted proofs, whenever they are published or distributed to interested parties, should be accompanied by a statement indicating their limitations, especially to the effect of non-random use of imported sires.

2.3.2.5. Extensive random use of the same bulls

The procedure outlined in 2.3.2.1 should be used if not a simultaneous evaluation as presented in 2.3.1 is applicable. It is generally assumed that the bulls are randomly used in both countries or that any important deviations from this are adjusted for.

2.3.2.6. Non-random use of bulls

In cases where effects of non-random matings with imported semen or preferential treatments of daughters of foreign sires are obvious, and can not be accounted for in the sire evaluation procedures, *it is recommended that the data to be used for estimation of a- and b-values should be based on adequately sampled sons of bulls from which semen was imported*, utilizing the regression of the proofs of the sons on their sires. The same minimum number of sires as before would be required and the expected minimum correlation between the exporting country sire proofs and those of their sons in the importing country will be halved.

2.3.2.7. Unreliable relationships between proofs or limited number of bulls for comparison of proofs

When only a smaller number of bulls than 20 with reliable proofs in both countries are available, or the correlation between the proofs is lower than 0.75, it is recommended to use the data only for a separate estimate of the differences between the bases (a). A theoretical estimation of b from the standard deviations of the sire proofs in the two countries, adjusted to equal repeatabilities, could then be performed as follows:

$$b = \text{S.D. proofs (imp.)} \cdot \bar{r}_{TI}(\text{exp.}) / \text{S.D. proofs (exp.)} \cdot \bar{r}_{TI}(\text{imp.})$$

Sire proofs converted with such factors should be marked and a note given on the method used. It should be noted that b-values derived in this way do not consider any possible genotype x environment interaction nor effects of differing definitions of traits.

2.3.2.8. No or very limited use of common bulls

In situations where there is no or very limited information on proofs of the same bulls in both countries *it is recommended that the proofs are only scaled to the importing country units of measurement for sire proofs in this country.* Thus, any genetic difference between the bases is neglected and the scaling only ranks the bulls within each population without any real possibility of comparing the individual bulls across the populations.

Such transformed proofs should be marked in official publications that they are only scaled and considered preliminary without notice of any possible genetic difference between the populations or bases in question.

2.3.2.9. Indirect comparisons and other approaches

For some situations, similar to those just above, where the information for direct comparisons is limited, other procedures are being tried for temporary use until reliable conversion factors could be established. Procedures for utilizing a common third country for indirect estimation of conversion factors have been presented by Claus (1986), Goddard & Smith (1987), Powell (1989), Swanson (1989) and Wilmlink et al. (1987). These procedures will by definition be less reliable than any direct conversions but had generally been giving acceptable results.

In a promising approach, suggested by Goddard & Smith (1987), the information on the proofs in both the exporting and importing countries are combined into a BLUP-procedure. The concept of the methodology approaches the one suggested by Schaeffer under 2.3.1.

Further evaluations of these methods are required before any recommendations about their general use can be made by INTERBULL.

2.4. International base

For the future it is highly recommended that an international base will be developed for presentation of genetic evaluations in a standardized way, such that this information can be used by each country. International bases should be formed per breed. For each breed the base should be formed by bulls or cows in the major exporting countries. In order to reflect the average of all populations a quantity could be subtracted or added.