THE GLOBAL STANDARD FOR LIVESTOCK DATA

Section 9- Guidelines for Dairy Cattle Genetic Evaluation

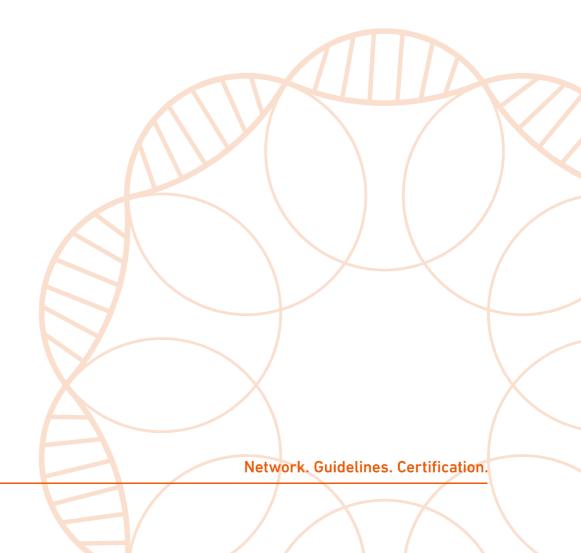Section 9 – Dairy Cattle Genetic Evaluation

Version October, 2017

Network. Guidelines. Certification.

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Change Summary

Date of Change	Nature of Change
August 17	Reformated using new template.
August 17	Table of contents added.

August 17	Heading numbers and heading text edited for clarity and removal of redundant text.
August 17	Stopped Track change sand accepted all previous changes.
August 17	Moved the file to the new template (v2017_08_29).
August 17	Punctuation of this summary.
August 17	Remove numbering from first paragraph in section 4.1.
September 17	Correct typo, and update to reflect current situation with Interbull evaluation runs.
September 17	Correct typo.
Oct. 2017	Updated the date of the version

1   Background

The present Guidelines are based on "Interbull Guidelines for National and International Genetic Evaluation Systems in Dairy Cattle with Special Focus on Production Traits" (Interbull Bulletin 28) and the Interbull survey (**that was published in** Interbull Bulletin 24), "National Genetic Evaluation Programmes for Dairy Production Traits Practiced in Interbull Member Countries 1999 2000" with information on GES in 36 organisations from 31 countries (available through www.interbull.org). They deal only with production traits but the same principles can in most cases be equally well applied to other traits.

In this document Genetic Evaluation System (GES) is meant to include all aspects from population structure and data collection to publication of results. Each and every statistical treatment of the data that has a genetic breeding motivation or justification is an integrated part of GES.

The purpose of this set of guidelines is to facilitate a higher degree of harmonisation in the things that can be harmonised and to encourage documentation of the things that can not be harmonised at this juncture of time. These guidelines should increase the quality and accuracy of evaluations at the national and international level. The aim is also to increase clarity in showing the biological and statistical reasons for what is done in national GES.

Recommendations presented here should also be viewed holistically as a coherent system. Every specific recommendation pre supposes acceptance and adherence to many other such specific recommendations. Therefore, and as an example, when "unique identification of all animals" is recommended in one section, then all further reference to "animals" is to be interpreted as "uniquely identified animals".

National genetic evaluation centres should keep official, up to date and detailed documentation on all aspects of their GES. Documentation on all aspects of GES should also be placed on the Internet. They should update their GES in a cost effective manner as the theoretical developments and computer capacity permit and place information on any change on Internet as soon as it has taken place.

2   Pre-evaluation steps

2.1   Assignment to a breed of evaluation

All countries are recommended to establish national GES for all of their locally and internationally recognised breeds. Assignment of an animal to a specific breed is justified if 75% of the animal's genes originate from that breed (or both sire and maternal grandsire are from the breed of evaluation).

2.2   Animal identification

a. All animals should be identified and registered in accordance with the ICAR Rules, Standards and Guidelines on Methods of Identification (Section 1.1 of the International Agreement on Animal Recording and ICAR Guidelines).

b. Each animal's ID should be unique to that animal, given to the animal at birth, never be used again for any other animal, and be used throughout the life of the animal in the country of birth and also by all other countries. The following information should be provided for each animal:

Breed code	Character 3
Country of birth code	Character 3
Sex code	Character 1
Animal code	Character 12

c. All parts of an animal ID should be kept intact. If, for any reason, modification of the original animal ID is necessary, it should be considered as a re-registration and fully documented by a cross-reference table relating the original (and intact) animal ID and the new animal ID.

2.3 Pedigree information

a. The parentage of an animal shall be recorded by identifying and recording the service sire and the served animal at the time of service, as provided for in ICAR Rules on Parentage Recording.

b. Genetic evaluation centres should, in co-operation with other interested parties, keep track and report percentage of animals with missing ID and pedigree information. The overall quantitative measures of data quality should include percentage of sire and dam identified animals or alternatively percentage of missing IDs.

c. The doubtful pedigree and birth information should be set to unknown (set parent ID to zero).

d. To ensure sufficient pedigree information it is recommended that, even if production traits/records are not available, the pedigree information from the animals born within a period equivalent to a Minimum of 3 generation intervals is included in the evaluations.

2.4 Genetic defects

The information that the animal is a carrier of genetic defects defined by the International Breed Association concerned should be made available internationally as soon as possible after their existence is discovered.

2.5 Sire categories

a. Countries should clearly and correctly describe different sire categories, that is to distinguish between domestically proven bulls vs. imported bulls, young bulls with first batch of daughters vs. proven bulls with second batch of daughters, and most important of all between NS bulls vs. AI bulls. Quantitative measures should be employed to define AI bulls. Responsible organisations are recommended to strive for establishing daughters in a large number of herds (preferably > 10) for young AI bulls.

b. Young bulls may be used in simultaneous progeny testing in two or more countries with large enough number of daughters in each country to warrant an independent official evaluation. These bulls should clearly be classified as "simultaneously progeny tested bulls".

2.6   Traits of evaluation

Direct measurement of traits and utilisation of the metric system is encouraged. Recording organisations should adopt recording schemes that ensure accurate collection and reporting of all data. It is recommended that national genetic evaluation centres provide detailed definitions of traits on their web sites. The definitions should include all data checks and edits, such as range of acceptable phenotypic values, age, parity, etc.

2.7   Data requirements for various traits of interest

a.   Records of all animals with known Animal ID should be included in the genetic evaluations.

b.   All records should be accompanied by relevant dates (birth, calving, etc.).

c.   All records should be accompanied by sufficient information for formation of contemporary groups, such as herd and geographical location of the herd (e.g. region). Information on internationally standardised methods of recording should be included. An example for the production traits is ICAR A4, A6, B4, etc.

d.   All other relevant information, depending on the trait of interest, should accompany the number of milkings per day, production system (e.g. Alpine pasture, total mixed ration (TMR) or grazing), methods for estimation of 24 hour and 305 day yields, extension methods, adjustment methods etc.

e.   Number of years of production data to be included in the evaluations should desirably be equal to at least 3 generation intervals (e"15 years) of consistently recorded data.

2.8   Number of lactations included

Number of lactations to be included in the evaluations is recommended to be at least three. Breeding values should be produced for the whole lactation period, separately for different lactations. Separate breeding values should then be combined into one single composite breeding value for each trait for the whole life, in which different lactations are given separate weights based on each lactation's economic value.

2.9   Data quality

It is desirable that all data related to all animals (herd book, insemination, milk recording, veterinary practices, etc.), irrespective of their sources, be available to the genetic evaluation centres in form of an integrated database. A complete documentation of data checks, including data edits conducted by milk recording organisations, is essential. All member organisations / countries should adopt quantitative measures of assessing data quality. National genetic evaluation centres should devise simple methods of checking for detection of outliers and exclusion of logical inconsistencies in the input data. Biological improbabilities should also be checked. Extra precautions should be employed so that no inadvertent selection of data or introduction of bias becomes possible. Poor quality data should be excluded from genetic evaluations. Complete documentation of all procedures to check and edit the data is very important. National genetic evaluation centres are encouraged to have quality assurance systems implemented.

2.10   Inclusion and extension of records

a.   Different kinds of lactations, i.e. records in progress, records from culled cows, records of dried off cows (i.e. lactations of cows remaining in the herd but terminated artificially because of a new pregnancy or any other management reasons), naturally

terminated lactations shorter than 305 days and finally, lactations longer than 305 days should be identified in the system and treated differently.

b. All records with ≥ 45 DIM or two test days should be included in the evaluations. Extension or lack thereof should be decided upon after enough scientific/empirical justifications have been established for each kind of lactation. Records in progress and short lactations from culled cows should normally be extended. Lactations of cows dried off before 305 days and naturally terminated lactations shorter than 305 days may be extended provided adjustment for days open and / or current calving interval have not been satisfactory. Data from lactations longer than 305 days should be cut at 305 days.

c. Extension methods and factors should be re evaluated continually to ensure that they are up to date and that no unplanned selection of data occurs. Extension factors should be re estimated at least every 5 years. Different kinds of lactations should be extended using the same extension method and different extension factors. Extension rules and methods should be the same across lactations. When ever the data span over many years the extension rules and factors should be appropriate and specific to the various time periods.

2.11 Pre-adjustment of records

All effects should preferably be accounted for in the evaluation model. If records are to be pre adjusted, it is more justifiable to do so for those environmental effects that are in need of multiplicative adjustments. Effects in need of additive adjustments should be considered in the model. In any case, adjustment should be made to the population mean and not to an extreme class. Pre adjustment factors should .be updated as often as possible (at least once per generation), and be specific to different time periods.

3 Evaluation step

3.1 Statistical treatment and effects in the genetic evaluation model

a. Organisations responsible for national GES should strive for simplicity of the analysis model and avoid amendments that reduce simplicity and clarity of the analysis model. The best model should be decided upon considering the fit and predictive ability of the model.

b. Decision on statistical treatments and effects in model should take into consideration several factors, such as:

- How large are (contemporary) group sizes?

- Are the estimates of parameters constant over time?

- Are multiplicative adjustment factors necessary?

- What are the consequences of the environmental effects being adjusted for or included in the model for components of variance?

- Is the effect to be estimated from data or from the main random effects included in the model (breeding values, residuals)?

- What are effects of different combiation of parameters on the degree of freedom and of the fit of the model?

    c.   In considering an effect as fixed or random the following should be taken into consideration:

- If there is enough evidence to suggest that the effect is non randomly associated with the main random effect;

- If number of levels is small;

- If size of groups is large ;

- If the effect has a repeating nature;

- If the effect is used to elucidate the time trend.

    d.   For the choice of evaluation model for milk production traits the following set of priorities is recommended:

- An animal model in contrast to a sire model;

- A within lactation multiple trait model in contrast to a within lactation single trait model;

- A multiple lactation model in contrast to a single lactation model;

- A multiple trait multiple lactation model in contrast to a single trait repeatability model;

- A test day model in contrast to a lactation model.

Explanatory note

The above recommendation almost exclusively deals with milk production traits and does not take into consideration many aspects of genetic analysis models for other traits. The guiding principle is to choose a model that is more capable of utilising (or exposing) the genetic variation. It translates into choice of models that have either theoretical superiority or enable us to obtain an estimate of an animal's breeding value that encompass a larger proportion of animal's genome and/or life time. Interbull recommends adherence to superior theoretical models and encourages identification of the practical circumstances under which the theoretical expectations are not realised.

3.2 **Model's unbiasedness**

For the purpose of international genetic evaluations unbiasedness should be considered as the most important single criteria, although some degree of compromise can be envisaged for the national genetic evaluation, for example to avoid high prediction error variance.

3.3 Genetic parameters

Phenotypic and genetic parameters should be estimated as often as possible and definitely, at least, once per generation. All aspects of estimation procedures for estimation of variance components (data structure, method and model of estimation, effects included in the model and so on) should be as similar as possible to the estimation procedures for breeding values.

3.4 Use of phantom parent groups

The evaluation procedure should be certain to group unknown parents according to breed, country of origin, selection path and birth date or some other method to establish time trends. The procedures used for formation of phantom parent groups must give special attention to imported animals in order to evaluate correctly these in the national GES.

Phantom parent groups should have a minimum size of 10 20 animals, although larger groups may be necessary for traits with low heritability.

4   Post-evaluation steps

4.1   Criteria for official publication of evaluation

In general, evaluation results should be accompanied by reliabilities for EBVs and considered as official for all animals entering national GES. For randomly sampled young bulls a minimum Effective Daughter Contribution (EDC, visit www.interbull.org for more information) of 10 is recommended. Official publications of individual EBV by national genetic evaluation centers should include the most recent figures or information on:

a. Effective daughters contribution or number of daughters and their distribution over herds (e.g. number of daughters and herds, highest percentage of daughters in a single herd, etc);

b. Number or percentage of freshened daughters being excluded from the evaluations and also the number 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 (RIP) should be given. For national GES practicing a test day model average number of days in milk (DIM) for daughters of a bull is considered to be equivalent to %RIP in a lactation model;

c. The theoretically expected reliability of the evaluation;

d. The type of evaluation, i.e. whether the evaluation is a result of regular Artificial Insemination service (i.e. planned progeny testing program) or not. For AI proofs a distinction must be made between (1) those of domestic young sampling bulls; (2) those of simultaneously progeny tested young bulls; (3) those based on the second batch of daughters of already proven bulls, and (4) those resulting from use of imported semen (see also the section on Sire categories);

e. Breed and definition of the genetic base.

4.2   System validation

a. GES should be validated by data checks, checks of phenotypic values, and comparisons of breeding values, etc

b. The three Interbull trend validation methods I, II and III should be used for validation of national evaluations. Monitoring and examination of Mendelian sampling and residuals could also be utilized.

4.3   Expression of genetic evaluation

a. The use of absolute EBVs is recommended, though the use of RBVs for domestic use and composite traits or indices may continue. However, in order to facilitate the international use of domestically published breeding values, in addition to the domestically used method of expression, all traits should be expressed as absolute Estimated Breeding Values (EBV), in the metric system (if applicable). Such values relate directly to the additive genetic value of the animal itself as well as to actual amounts of products.

b. Evaluation centers should provide detailed information on the definition and statistical properties (including descriptive statistics) of EBVs and RBVs on their web sites.

4.4   Genetic base

a. Interbull's recommendation for definition of genetic base at the national level for production traits is to utilize information of cows born at the onset of specific 5 year periods as is outlined below. Thus, member countries should endeavor to:

- Use cows.

- Use birth year.

- Use all animals that entered national GES.

- Use average genetic merit (EBV).

- Use stepwise change of genetic base.

- Change the base in the years ending with 0 or 5.

- Use cows born 5 years before the onset of the new 5 year period.

- Change the base in the first evaluation in the years ending with 0 or 5.

b. For designation of genetic base the following convention should be followed:

- A letter indicating breed of evaluation (e.g. A, B, G, H, J, or S for different breeds).

- Two digits indicating the year of base established (e.g. 00 for year 2000).

- A letter indicating type of animals included (e.g. C, or B, for cows or bulls).

- A letter indicating the event used (e.g. B, or C, for birth or calving); and finally

- Two digits to indicate the event's year (e.g. 95 for year 1995).

4.5   Number of evaluations per year

It is recommended that national GES be scheduled to be able to provide current and up to date inputs to the Interbull evaluations, which currently are performed three times per year (in April, August and December).

4.6   Advertising genetic merit

a. Genetic evaluation centres are encouraged to establish and enforce code of ethics for the use of their evaluations.

b. Publication of genetic evaluations should include at least the following:

- Source (genetic evaluation centre) of evaluation and country of scale, if appropriate.

- Date of evaluation and genetic base definition.

- Evaluation expression, e.g. EBV, PTA, RBV.

- Evaluation units, e.g. kg, lbs.

- Reliability.

c. Evaluations should be presented in the same units they are published in by the evaluation centre that provide them. In no case shall official units or expressions be manipulated.

4.7 Use of indexes

Countries are encouraged to have separate indices for different categories of traits, and for total economic merit.

4.8 Anticipated change

Genetic evaluation centers are encouraged to set up a long term, contingency timetable for possible future changes in all aspects of their GES. These timetables are expected to be announced world wide well in advance so that other genetic evaluation centers can accommodate to the changes.

4.9 Web site

National genetic evaluation centers and other relevant organizations should set up internet information sites that contain a complete documentation of the whole GES (including tables of overall statistics and EBVs of AI bulls). The information contents of these home pages are expected to be, at least, as detailed as the information published by Interbull in Interbull Bulletin 24 (visit www.interbull.org). Those parts of GES that are concerned with the processes (the way the data are treated) are recommended to be available in English in addition to the native language. National genetic evaluation centers should regularly update their links on the Interbull's home page.

5 International evaluation

5.1 Comparison of animal evaluations

a. Data used for comparison of animal evaluations across countries or international genetic evaluations should be checked for possible errors and/or inconsistencies by the national genetic evaluation centers involved.

b. International comparisons are recommended to utilize Interbull genetic evaluation results for all country-breed-trait combinations where such exists.

c. For those country-breed-trait combinations that an Interbull evaluation does not exist, utilization of the MACE (Multiple-trait Across Country Evaluation) methodology is recommended.

d. Ease of application may necessitate the use of conversion equations developed from simple regression analysis of bulls' progeny in two countries, i.e. a bulls' performance in one country is predicted from its performance in another.

e. A simultaneous sire evaluation for the same bull in several countries 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.

5.2 Minimum correlations and trait harmonization

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.

5.3   Validity of MACE results

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:

a.   The change in sire variance in any of the countries involved is more than 5% compared to the previous evaluation.

b.   A change in methodology, base etc has occurred in either of the countries involved;

c.   There is a substantial increase/change in number of bulls with evaluations in either of the countries.

5.4   Interbull evaluations

The specific requirements for participation in Interbull international genetic evaluations are regulated by the Interbull code of practice, with amendments.

5.5   Publication of Interbull (MACE) evaluations

a.   Status of the Interbull evaluations in each country and whether they are considered official or not, is decided upon by national genetic evaluation centers. Publication and advertisement of Interbull evaluations is regulated by Interbull's "Code of Practice" and especially through the "Advertising Guidelines".

b.   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, EBV's for all bulls should be published together with the reliabilities for the estimates.