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Dr. Graser comes from Germany. He studied Agricultural Science at the University of Hohenheim with an emphasis on Animal Breeding, and received a Doctor degree from the University in 1980. He spend his postdoctoral time at AGBU developing the first genetic evaluation system for beef cattle in Australia based on BLUP. Dr Graser joined the NSW Agriculture in 1984 as a livestock scientist at AGBU. There he and his colleagues developed the programs for BREEDPLAN, Australia's beef cattle genetic evaluation system, which is delivered to the industry by ABRI.

After a four year term in Germany from 1988 to 1992, he returned to AGBU as Technical Director and now Director. He is responsible for the management of the Unit's scientific research and development program for the beef, pig, sheep industry in particular those programs who deliver improved genetic evaluation systems.

# ISSUES AND OPTIONS FOR GLOBAL EVALUATIONS

## Introduction

Although the occasional outbreak of a disease like FMD results in some restrictions, the international trade of beef cattle genetic material in form of semen, embryos and live cattle is increasing world wide and with it comes the exchange of information from the exporting country's genetic evaluation system. During the last 15 years the larger dairy breeding countries, with their huge market for semen, have developed across country evaluations for a number of breeds and nearly all economically important traits through an organisation called INTERBULL which operates out of Sweden. The beef industries don't want to stay behind and the question has been asked could beef cattle breeding benefit from global evaluations. As a consequence of this, discussions and research are under way to implement global evaluations for various breeds.

But let's ask another question first: Why do we in Australia performance record beef cattle and estimate breeding values?

1. We very regularly select young bulls for natural matings. We want these bulls to produce progeny that better fit diverse markets and production systems.
2. Our seedstock breeders want to make genetic progress within breed and so improve the profitability and sustainability of beef cattle production with their breed in Australia and maintain or even increase market share for their cattle, their breed and for beef in general.

These two objectives are not identical!

The beef breeding industry in pasture based production systems like Australia is very different to the major dairy industries, which use AI heavily, and where more than 80% of semen comes from proven sires. In contrast in Australia more than 95% of beef cows will be bred by natural mating. Therefore the selection of quality young bulls is important. This selection, which is within country, can only happen with any accuracy through quality performance recording at herd level and a good genetic evaluation system in that country. The beef industries can not import young bulls for natural service, while the dairy industries could import all required semen from proven sires. Thus a commercial beef producer who doesn't want to use AI, and these are the majority in this country, do not greatly benefit if the EBVs of young bulls in Australia can be directly compared with those in the US or Argentina. International beef cattle evaluation is not a tool to greatly increase the accuracy of EBVs of yearling bulls or a way to reduce the recording efforts.

To make things even more interesting many commercial beef producers do not only use one breed, they want to select across breeds to better fit their market & production environment system. Some producers want EBVs comparable across breeds to select their bulls. Currently we are ill equipped to do this for most breeds, we simply have not got sufficient head to head breed comparison data that is not confounded by heterosis.

Our seedstock breeders, mostly organised in breed societies, have different needs. They want to make genetic progress and maintain the competitiveness of their herd within their breed and generally the competitiveness of their breed on the domestic and international market. To achieve this seedstock breeders are prepared to use AI and select sires (and embryos) from populations of the same breed in other countries. For those breeders and the AI industry, which provides the semen, the availability of EBVs which can be directly compared across countries is of great benefit.

## Options to make breeding values comparable

### 1) Conversion equations

The development of conversion equations was the first proposal to allow breeders to compare EBVs in other populations on "their terms"; that means their definition of a base and definition of a trait. The general recommendation was that this should only be attempted with at least 20 common sires born during the preceding 10 ten years period having EBVs with reliabilities above 75% in both countries. We have tried this for a comparison of US -AUS/NZ EBVs following an approach by Goddard (1985). If we follow the recommendations only three weight traits have sufficient data to calculate a conversion equation. We relaxed the rule for the eye muscle area conversion.

Table 1. Conversion equations for some traits from AUS/NZ EBVs to US EPDs for Hereford cattle with number of sires used and standard error of intercept SE(I) and regression coefficient SE(b)

Trait	N sires	Conversion equation	SE(I)	SE(b)
Birth weight	88	$US_{EPD} = -0.12 + 1.24 * AUS_{EBV}$	0.56	0.10
Weaning weight direct	81	$US_{EPD} = 21.0 + 0.96 * AUS_{EBV}$	3.62	0.13
Weaning weight milk	37	$US_{EPD} = -1.22 + 1.20 * AUS_{EBV}$	3.01	0.24
Eye Muscle area heifers	30	$US_{EPD} = -0.39 + 0.13 * AUS_{EBV}$	0.15	0.04

\* Reliability > 0.50

Note, that what we are trying to do here is to convert EBVs in Australian metric units, into EPDs in US imperial units. That's why some of the value look a little odd (eg EMA). Also note that as we go down the table we have less and less sires which fulfil the requirements on accuracy so the standard errors of the predictors increase relative to the predictors themselves. This approach has never really been introduced to the beef industries due to a common lack of data and interest.

### 2) Inclusion of overseas information (as done in Australian-New Zealand - BREEDPLAN)

Beef cattle breeders from most breeds in Australia regularly purchase genetic material from overseas, particularly from North America. Due to the large size of the North American registered beef cattle herd many sires whose semen is imported have been well compared against each other directly or indirectly and have reliable EPDs for many traits available in North America. While this doesn't allow us to judge how good these animals are compared to the AUS/NZ genetics, only direct progeny comparisons in either North America or Australia/NZ for these sires will provide that information, the relative ranking of overseas sires in their home country can be used to provide a starting value for their relative ranking in Australia. A similar approach is used for the Simmental evaluation at Cornell University to utilise the information available on sires from other breeds in their multi-breed run.

After some research this has been implemented in our evaluation software. Given the overseas EPDs or EBVs and their accuracies and the knowledge about the evaluation model, single trait or multi-trait, we calculate progeny differences in one "phantom" herd for all animals from a common analysis. In the absence of any other data the ranking in another country is the best information even if there are considerable genotype by country interactions.

We found that the genetic correlation in Herefords between Australia and North America is less than one for all traits. Therefore an increasing number of progeny recorded in our region will decrease the weight given to the North American information in the extreme to zero if we have thousands of progeny records here.

While this method provides an excellent ranking for animals used in Australia it does nothing to allow Australian breeders to directly compare the US EMA EPDs in inch<sup>2</sup> with Australian EBVs in cm<sup>2</sup>. A further disadvantage is that it is a one-way street and works only as long as the outside countries we import EBVs from don't do the same and import Australian EBVs into their analysis, which contain some of their own data already. Every country would have to provide EBVs that do not include foreign data.

### 3) The MACE approach

MACE (Multiple-trait Across Country Evaluation) was proposed by the Canadian Scientist Larry Schaeffer (1994) for international evaluation of dairy sires. This approach can be extended to beef cattle, although it is a little more complex due to direct and maternal nature of some of the recorded traits. In the dairy industry de-regressed sire proof (speak EBVs or EPDs) from different countries are trait by trait accumulated at the INTERBULL centre in Sweden. They are then analysed with a model that allows for rankings in participating countries to differ and utilises, with appropriate weights, the information coming from all other countries. These weights depend on the estimated correlation between the countries, the lower the correlation the less weight is given to the data from another country. EBVs are returned to each country and published as INTERBULL EBVs. A huge amount of research has been done in nearly every country to improve the models and the underlying parameters to improve this international evaluation (INTERBULL Bulletins).

Research is now under way to expand these models and use the "Raw data" and more detailed relationships between animals to make better use of the data. Today INTERBULL also calculates across country evaluations for linearly scored structural traits. This is done at Holstein Association in the US.

#### **4) Combining the data in single analysis**

As outlined above, the MACE approach only uses progeny differences to rank sires in a multi-trait (multi country) evaluation trait by trait and provides a ranking for each country. Combining the raw data directly is the next step. This has already been done for the Hereford breed for Australia and New Zealand and for US and Canada. This can be done as their trait definition, the production/marketing systems are similar, and strong genetic linkage exists within the regions and possible re-ranking between countries is ignored.

However for a combined analysis we currently experience difficulties with the size of the data files. In Australia/ NZ we calculate EBVs in a multitrait model for 22 traits. Combining this 22 trait analysis with the North American and South American data and allowing for genotype \* country interactions is beyond the capacity of our commercial computers. Of course it can be done on big supercomputers but not at a price and speed the industry is accepting and I do not believe that the additional benefits to each country would currently justify the costs.

The next step will therefore be to divide the task into a number of manageable analyses, eg BW separately from growth and fertility. However some research is required to get this right. Genotype \* country interactions real or introduced through differences in trait definition and recording practices have to be carefully considered to make sure that breeders in all countries receive EBVs which are relevant for their production system. This will then allow us to also account for differences in heritabilities and genetic correlations.

#### **Genotype \* Country Interactions**

Genotype x Country (environment) interaction will limit the value of performance data recorded in one country to rank animals in another. What causes these interactions? Some of these interactions can be real. One would expect, that cows performing in Canada or northern part of the United States, where the ground is covered with snow for some months of the year need some different genetic qualities to perform their task, wean a healthy calf every year, than cows grazing in some part of Australia where summer temperatures can be for weeks above 40 Celsius (110 Fahrenheit). Other interactions are caused by slightly different definitions of traits eg different ages at recording, the models used for genetic evaluations and the way animals have been selected for recording. The last is particularly obvious for some carcass data. Of course, sloppy recording of pedigree and performance can also be a cause of genotype \* environmental interaction.

Of particular interest for Hereford breeders in North and South America is the work done by deMattos *et al* (2000). They have investigated genotype x environment interactions for weaning weights between United States of America, Canada and Uruguay and for some regions within the US. They found that the genetic correlations for direct and maternal effects were all between 0.8 and 0.9 for all combinations and were as similar for across country comparisons as for comparisons between regions within the US. Lee and Bertrand (2002) extended the work to birth weight and post-weaning gain and also included data from Argentina. Not surprisingly they found correlations above 0.9 for birth weight between all countries. However, the correlations for post-weaning gain were as low as 0.5 between North and South American countries. This GxE was caused by the different definition of the trait post-weaning gain, which was over

a 160- day period in the US and Canada and 345 days in Argentina and Uruguay. Such strong GxE needs to be considered in across country evaluation.

However to be able to estimate these correlations we need quality genetic linkages across participating countries. Such linkages are established by using groups of sires from various countries jointly and best at the same time in all participating countries. Performance recording of progeny should then not be restricted to only the standard traits (weight and scan data) but for a breed like Hereford has to include the reproductive data on females too. This leads us to the Hereford International linkage project.

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