

Genomics... ...Myth or Miracle?

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Confused about Genomics? Breed Research Executive Lucy Andrews begins a series of articles about this much-touted new breeding tool, aiming to de-mystify the subject and explain how it will suit our programmes here in the UK

Over the past few years, the word 'genomics' has become as synonymous with dairy cattle breeding as Simon Cowell has to our great 'talented' X-Factor nation. Whilst the benefits of Mr Cowell to our nation may be questionable, there is no doubt that genomics have landed and are here to stay. Genomic technologies are advancing at a rapid pace, with many companies flooding our shores with 'genomically evaluated' bulls.

The questions most asked by the membership are now: what is Genomics? Where can I get my cows/bulls tested? And how do I use it?

Holstein UK is going to provide you with clear answers to all these important questions and try to explain all aspects surrounding genomics and what it will mean to you as a UK breeder. In the interests of keeping things simple, and not sending you all to sleep, this will be achieved through a series of articles, starting with this, until the official release of genomic evaluations in the UK – aimed for 2011. Not all the answers will be covered at once; it is going to take time to understand the subject properly as there is no easy 'simple step guide'. However, we hope to build up a comprehensive guide to genomics and its application in the UK and cover many of those frequently asked questions over the coming few Journals. So, here goes....

The basics of Genomics

All animals have a genotype, which is a description of their basic genetic material. Each parent contributes half of the DNA that makes up the animals genotype. Genomics is basically the study and evaluation of genes to predict performance of an animal and its potential offspring. Using genetic information collected from an animal, we can process it and evaluate a predicted performance, based on knowledge we already have.

So how is genomics different to Parent Average?

- The traditional method for predicting performance is based on Parent Average
- This assumes that an equal half of each trait is passed on from each parent (see figure 1)
- Also, Parent Average may be manipulated, overestimated or underestimated

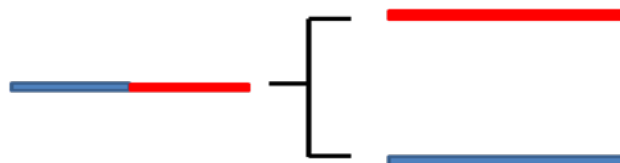


Figure 1: Illustrates how Parent Average (PA) also known as 'Pedigree Index' works on its most basic level

It's not as simple as that though...

Given that the genetic information of every animal is contained in its DNA, technology now available allows for genotyping males and females for over 58,000 different markers across the whole genome. The laboratory analysis provides a DNA profile for each animal, which is unique except for genetically identical siblings, such as twins produced from split embryos, for example.

For calculating genomic evaluations in the Holstein breed, countries such as Canada uses a group of sires that have an official proof in Canada plus another group of sires with only a MACE evaluation in Canada, which are mainly sires already proven in the United States. The genotypes for this pool of nearly 9,000 proven sires results from a joint research initiative between Canada and the USA with involvement from various major AI companies in North America. The basis for estimating genomic evaluations for young bulls, heifers and cows comes from a comprehensive analysis of associations between the DNA profiles for the 'pool' of reference proven sires and their proof for each trait of interest.

Reliability & Risk

While Canada and the United States are using a common pool of genotyped animals for estimating genomic evaluations, the final genomic results in each country around the world may often be different. These discrepancies come from different Parent Averages (PA) or Estimated Breeding Values (EBVs) for many animals in each country as well as slightly different technical details associated with calculation data and methods.

Gains in reliability with genomics vary by trait and sub-group of animal in the population, however on average reliabilities achieved for genomic evaluations on young bulls are currently around 60-65%, which is a gain of around 30-35 reliability points over the average of around 35% for traditional Parent Average. While this doubling of accuracy is significant and young sires with genomic evaluations can be used with a little more confidence than Parent Average young sires previously, caution is still warranted. The genomic evaluation reliability is less than an evaluation based on an actual progeny performance, which can be up to 99% reliability. As an animal accumulates actual progeny information, so the genomic (and parent average) component contributing to its index, gradually diminishes.

Table 1: Helps to summarise the differences in bull reliabilities:

Evaluation	Average % Reliability	No. Daughters/Herds	Explanation
PA = Parent Average	35%	0 dts/0 hds	This is a straight average of the genetic potential for both sire and dam. No daughters have been born, milked or classified
PA + Genomics	60-65%	0 dts/0 hds	The increase in reliability is said to be equivalent to approx: 10 daughters (on average over all traits), however - No daughters have been milked or classified
Progeny Test	70-99%	Start at approx 40 dts/25 hds upwards	At this stage the impact of the PA and genomic evaluation diminishes and is replaced by information taken from real cows milked by real

- *For more info on understanding 'Reliability', please see the fact sheet from Marco Winters of DairyCo published in this edition of the Journal*

So, is the UK on target for launching genomic evaluations in 2011?

It is expected that we will see a launch of UK genomic evaluations for British and international bulls during 2011. At a similar time, breeders can also expect to have a new and cost-effective service for genotyping their own cows, which could add useful information to their breeding decisions – for example in allowing them to keep the best from a choice of calves as future herd replacements and enhance the marketability of animals and embryos. Holstein UK has committed to providing the membership with an 'interim alternative service' for cows specifically, until we have actual UK genomic evaluations in place in 2011. This will involve working with Holstein USA to obtain USA 'GTPI' values for those farmers keen to move forward with genotyping their stock. A Q&A section regarding this service specifically is covered at the end of this article.

Current UK genomic development

The UK developments follow several years of investment and behind-the-scenes work by the UK industry. Work has been taking place at EGENES (Edinburgh Genetic Evaluation Services) and has been part-funded by DairyCo with the addition of other essential data and funding provided by key industry partners in a 'consortium' that includes Holstein UK, Genus ABS, Cogent Breeding, the Cattle Information Service and National Milk Records.

The UK has been working hard to co-operate and develop a genomic evaluation together, as it is clear that no one organisation in the UK can provide all the pieces to this extensive puzzle.

Marco Winters, Head of Genetics for DairyCo Breeding+, recently outlined his thoughts on UK genomic development in an article published in British Dairying, in which he said, "Hard decisions about funding have had to be taken along the way by both the UK and international dairy industries. North American governments and AI industries, for instance, took the decision to inject tens of millions of dollars into their project, partly on the strength of the potential commercial benefits they saw for their semen export industries, whereas here in the UK, our priority has been to decide how to get the best returns for the levy-paying milk producer."

"A lot of misunderstanding surrounds this process," continued Marco. "People sometimes think that because one country has produced a list of bulls with genomic evaluations, these can be converted into a 'UK equivalent' list. But without the UK's own SNP-key, this can't be achieved with sufficient accuracy."

"Contrary to some beliefs, no country in the world produces an 'international ranking', although several individual countries produce their own list."

However, Marco described how this is where the UK now stands to gain, as the British industry is now ideally placed to benefit from a wealth of international research and experience whilst applying these lessons to our own farming industry's advantage. In 2011, we not only expect to have our own UK genomic evaluations, but Interbull – the organisation responsible for conventional International genetic evaluations – will be in a position to provide the information needed to generate international genomic rankings across countries.

"Until this time, it is the UK industry group's judgement that it's counter-productive to provide a potentially inaccurate international ranking of 'genomic sires' and it would not represent value for levy and industry money", Marco explained.

“Inevitably, commercial companies importing ‘genomic’ semen are keen to attribute a value to their bulls that has some meaning to British farmers, and both DairyCo and Holstein UK have provided the industry with conversion formulae to help with this process. But it is important that we make it clear that until next year and the introduction of Interbull rankings, these ‘UK equivalent’ values will be based on fairly crude conversion procedures”, he says.

Meanwhile, as technology has advanced at a rapid pace, the icing on the cake for genomic development has come in the shape of the plummeting cost of tests which have exceeded even the most optimistic expectations.

Marco explained that, “A new high-density chip – which is a means of measuring genetic variation – has recently been launched which allows us to enter the market using the very latest innovations, but possibly more importantly, alongside this we’ve seen the introduction of a low-density chip, which will make genomic testing feasible to any dairy farmer interested in breeding, at an expected cost of as little as £50.”

(Holstein UK would like to thank DairyCo and Marco for offering these comments for use within this article, as they had already been published).

Genomics has given breeders and AI organisations an incredible tool with which to select and market animals more accurately, nationally and internationally. The most appropriate use of genomic information remains in combination with traditional evaluations using pedigree and performance data. It has been evident overseas that young animals tend to have a large variation in how their genomic indexes compares to their traditional Parent Average. On average, the genomic indexes in heifers and young bulls are lower than their Parent Average. Genomics pulls the breeding value of these young animals closer to how we would expect them to perform in the future long before their own or daughter performance can be recorded. At this stage it is important to remember that proofs, by nature of the very word, for domestically proven sires in any country are extremely reliable with or without the inclusion of genomic information – remember there is no such thing as a ‘genomic proof’, the proof of the pudding is always in the eating!

Six things to remember this time

1. NO genomic evaluations are currently available in the UK for bulls or cows on a UK base compared to a UK population.
2. All genomic values currently available for bulls or cows are based on foreign information against a foreign ‘Key’ or ‘Base’ and require conversion to a non-official UK value (values are only accepted as UK official if they are sent to us through Interbull or are produced in the UK).
3. DairyCo and Holstein UK have provided the industry with conversion formulae to help with this process - however it is important that, until next year and the introduction of Interbull rankings, these ‘UK equivalent’ values will be based on fairly crude conversion procedures.
4. Currently cow genomic values are evaluated overseas and are not compared to a UK base, therefore cannot be compared to other UK cow data. Due to demand, Holstein UK are providing members with a service to obtain a genomic US GTPI for cows if they so wish for management and promotional purposes, however these will not be publishable by Holstein UK.
5. Holstein UK along with DairyCo, CIS, NMR, Genus ABS and Cogent Breeding are all working very hard together to provide the UK with its own genomic evaluation in 2011 for bulls and cows.
6. Much has been said about speeding up the generation interval by using genomics. However it remains an evolving technology that we have to embrace - but embrace it properly and wisely.

It's far better to go steadily in the right direction than very quickly in the wrong one!

Questions and answers on the GTPI service through Holstein UK

Q. *Can I request a GTPI through Holstein UK for my cows?*

A. Yes, Holstein UK are providing a new service to members whereby a GTPI can be obtained from America for any female animal. TPI is the Holstein USA index, incorporating 42% production, 33% Health and Fertility and 25% Conformation. GTPI signifies that genomic information was used in the calculation of the individual PTAs and TPI. A good sample of the cow's DNA is needed for analysis, such as clean tail hair or DNAGenotek Performagene mucus swab. Ancestry details are also required to provide a GTPI, as evaluated animals must be dual registered in the Holstein USA herd book. Once the sample has been processed, you will receive a certificate with the GTPI on the USA base. GTPI results will not be published by Holstein UK as they are not calculated on the UK base. They will therefore not appear on certificates or on the Holstein UK or CDI websites. For further details, please contact Membership Services on 01923 659200 or email suzanneread@holstein-uk.org.

Q. *Why have Holstein UK decided NOT to print the GTPI on pedigree certificates?*

A. It is very important to recognise that whilst some of our members wish to access and pay for a genomic evaluation NOW to help with marketing and management, the UK DOES NOT currently have an official genomic evaluation or base. This means that the GTPI (produced in the USA and compared to USA females) is in no way comparable to the UK female population at this time. Therefore IS NOT publishable in any official capacity in the UK, just like a foreign bull proof from another country is in no way comparable to UK official figures. The GTPI that some of our breeders are requesting is being used by them for personal marketing of those animals and progeny – Holstein UK are providing a simple way to access this service, provided by Holstein USA, for the benefit of those members who wish to use it.

Q. *When will Holstein UK print genomic information on pedigree certificates?*

A. Once a UK genomic evaluation and key has been launched, Holstein UK will be changing the service to focus on the UK Genomic £PLI, TM etc, which will become official and will be printed, where available, alongside Parent Average (known as Pedigree Index).

Here is a taster of what's to come in the next issue:

Q. *If I pay for a GTPI from the US, can this information be transferred to the UK once we have a UK evaluation?*

Q. *If I re-run the genomic evaluation once my heifer is milking, will the value change?*

Q. *What is the difference between a 3k, 50k and high density chip?*

Q. *How do bull studs use genomics to aid bull selection?*

It is vital that the UK develops its own 'key' (known as a SNP-key) which translates the animal's DNA into something meaningful and relevant to UK farmers under UK conditions.

Genomic Evaluations are not the equivalent of a bull's proof

Genomic information added to a Parent Average gives a genomic evaluation equivalent to approximately 10 daughters (average over all traits).

In most countries, genomic information is combined with traditional proofs to give a 'blended' proof of genomic Information, pedigree Information and daughter information. As the animal gains more real progeny, the weighting of parent average (pedigree information) and genomics diminishes.

There are still only two types of bulls:

1. Progeny proven

- Can be used individually or in large volumes
- Ensures consistency of females and profit within a herd
- More likely to see the gains promised by the proof (especially high reliability)

2. Young sires

Addition of genomic data improves prediction, but

- Individual bulls should only be used in low volumes
- Lower reliability and higher risk than progeny tested proven sires