Trending Genetic Tools

By Catherine Brown Associate Editor
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"In the 1950s, artificial insemination was developed," says Rod Geisert, beef genetics extension specialist at the University of Missouri, in Jared Decker's "A Steak in Genomics" blog. "In 1978, the first human [conceived] from in vitro fertilization was born. Both of these technologies were criticized at the time but now they are widely accepted."
Likewise cattle breeding technologies are being continuously refined.

More Accurate EPDs

EPD (Expected Progeny Differences) information is constantly evolving to be a lot more reliable on young animals, thanks to new technologies to collect and analyze data. Ultimately, all EPDs will be GE EPDs (Genomically Enhanced Expected Progeny Differences). The technologies to predict molecular breeding values will be more mature and more reliable, according to Dr. Michael MacNeil, an internationally recognized expert in the field of breeding and genetics research, formerly of the US Department of Agriculture's Agricultural Research Service (ARS), in an interview with the Canadian Hereford Digest.
Methodologies used are more certain and the breed is reaching a critical mass of information that allows for the best predictions, he says.
In other words, more animals are being genotyped and the methodologies used are better at using performance and marker information, according to Dorian Garrick, geneticist at Iowa State University who is integrally involved in the development and implementation of national animal evaluation programs and performance recording databases.
In the next few years, MacNeil expects that many more breeds will have garnered a critical mass of data and the discovery of yet more polymorphisms will help geneticists better pinpoint the factors that directly influence gene expression, rather than the traditional SNPs or markers.
After several years of analyzing hundreds of thousands of DNA markers, scientists can now identify multiple areas of the genome that have an influence on certain traits and can go and genotype that exact spot or mutation, instead of relying on a proxy (which, effectively, is what SNP markers are), explains Dr. John Crowley, director of scientific and industry advancement at Canadian Beef Breeds Council. These, and Quantitative Trait Loci (QTL), which mark the local region but not the exact mutation that contributes to phenotype differences, are being exploited in prediction models to generate more accurate EPDs.

BOLT Software

BOLT software will further increase the reliability of Hereford EPDs.
BOLT is an acronym for Biometric Open Language Tools. Dr. Bruce Golden and Dr. Dorian Garrick developed the new software and licensed its use through their company, Theta Solutions LLC. It is a collection of over 100 software tools to manipulate and interpret data.
BOLT allows for the use of many models. One such model is the single-step approach to generating GE-EPDs, which combines genotyped and non-genotyped animals in the same analysis. This single-step technology has been heralded as revolutionary. Until this technology is adopted, DNA information continues to be incorporated through a post-evaluation blending

process that combines the independent genomic data and the traditional EPD into one official EPD value.

This software has the ability to directly incorporate genomic data into EPD calculations. Breeding companies and organizations in many countries are currently converting their routine evaluations to use BOLT, including the Pan American Cattle Evaluation (PACE) used by the Hereford breed. Also using BOLT technology is the multi-breed International Genetic Solutions (IGS) evaluation of Red Angus, Gelbvieh, Limousin, Maine Anjou, Shorthorn and Simmental purebred and crossbred cattle from the U.S. and Canada, according to Golden and Garrick in their report to the 2016 Annual Meeting of the Beef Improvement Federation in Kansas. IGS is fitting an across-breed, genomically enhanced EPD with this system.

BOLT fits many models, including several forms of single-step evaluation systems but the one being adopted by Herefords and by IGS is referred to as the Super-Hybrid Model.

"Breeders should see higher accuracies of genomic predictions than is the case at present as the adoption of the software will enable all the genotyped animals to be used to help predict the selection candidates," says Garrick, "whereas right now, the genomic predictions being used were derived from the EPD and genomic data of just a few thousand bulls."

Garrick says he is not sure when the system will go live for Hereford. ABRI (the Agriculture Business Research Institute based in Australia) is doing the implementation and has to develop turnkey approaches that don't require all the data edits that used to be manually done, prior to the routine evaluation," he says.

The American Angus Association is currently testing a single-step analysis system using software developed by Ignacy Misztal of the University of Georgia.

"Like the name implies, this method incorporates the genomic, pedigree and performance information in one step," says Dr. Stephen Miller, Genetic Research Director at the American Angus Association.

The new single-step technology, along with the software developed at the University of Georgia, allows all available genotype (DNA), phenotype (birthweights, yearling weights and other performance information submitted by breeders) and pedigree information to be used optimally for these evaluations, so the information is always current, explains Miller.

The Canadian Hereford Association (CHA) aims to be changing over from the current analysis to the BOLT analysis by the summer of 2017 at the earliest, according to CHA Executive Director, Stephen Scott.

"Everything will depend on the preliminary testing runs that will hopefully be scheduled to happen later this fall," says Scott.

Among other benefits, Scott says BOLT will make more frequent EPD evaluations possible and will "better characterize the genomic portion of the evaluation."

IGS, for one, will reportedly be able to turn around results to their members and customers as frequently as daily.

Reproduction

MacNeil also talks about improved fertility in future beef and dairy herds through the discovery of loci (specific locations on genes) responsible for early embryonic mortality. It is essentially a genetic defect that is the causative factor involved. This will not affect herds that are crossbreeding, as Garrick points out, since the same recessives wouldn't exist in two or more breeds.

Stem Cell Research

Research involving stem cells, according to some reports, represent the next major frontier of reproductive technologies in livestock.

One example of this kind of research is the work of Georgia's Berry College animal science professor Kyle Caires. Caires is removing adult stem cells from bulls' testicles (spermatogonial cells) and transplanting them into a recipient bull or bulls, the result being that the recipient bull(s) produces sperm carrying only the genetics of the donor.

Think of the possibilities. As reported in Successful Farming magazine, "it can take eight or more years to find out if a bull's daughters are functional brood cows. By that time, he is usually long gone."

"Using Caires' techniques of freezing stem cells may be one way to propagate the bull's genetics long after his own productive life," says author Gene Johnston.

This can multiply the breeding power of an elite animal, he says.

The current cost for Caires to harvest stem cells, identify the correct ones, grow them and implant them is about $3,000 per procedure. His success rate is over 50 per cent and improving all the time. But it is still a couple years before Caires publishes his research results and he is cited as saying that it may be a few more years after that until the practice is widely in use.

The technology is being hailed as a potential alternative to cloning to produce superior animals.

Gene Editing

Geisert, beef extension specialist at the University of Missouri, says that a clone is simply an identical twin born on a different day. And while he says that cloning didn't change how we raise livestock, it did allow us to do additional things, like gene editing.

Gene editing involves turning on or off a gene that naturally exists in an animal already.

Geisert reports that gene editing is not technology that will impact the beef industry in 100 years from now [or] 50 years from now." It is right around the corner, he says.

"Gene editing animals is not transgenic," says Geisert. Transgenic involves importing DNA from one organism to another, unrelated organism. In other words, it is something that has been artificially introduced.

Nevertheless, Garrick says that gene editing is not yet recognized as being "acceptable". In other words, the industry still awaits an opinion as to whether or not it constitutes "genetic modification".

"Once that has been ascertained, if we have freedom to operate, it will lead to many new opportunities for selection," says Garrick.

The alternative to transgenics (or importing foreign genes), is gene editing the naturally occurring genome of cattle, which is gaining traction and could be a significant game changer, according to Miller as well.

Early applications might include changing coat colour to create better heat tolerance in cattle; making dairy cattle polled or eliminating genetic defects, according to Miller.

"These are the low hanging fruit," he says. Other applications involve more genes which could affect other related pathways within the animal's genome. In other words, many traits are affected by more than one gene. Many times, there are 10 to hundreds of genes that affect one trait, which will make gene editing challenging for practical application.

Scott says there was an open discussion to determine the groups initial feelings about gene editing at the most recent World Hereford Conference in Uruguay and most countries were in

favour of the idea of non-transgenic editing. Of particular interest, he says, was the possibility of modifying the horned gene so that breeders can maintain “horned” lines while removing the actual horns.

Epigenetics

Epigenetics is a great buzz word these days. Producers likely already know how an animal’s environment affects its growth, health and development. In other words, they know that environmental factors can override a genetic blueprint, which discredits a long-held belief that a creature’s DNA was its sole destiny.

Geneticists have long known that an animal’s phenotype or how it develops, is attributable to genetics by a fraction determined by the heritability, which varies from trait to trait but is often no more than 25 per cent, meaning that its environment has an impact of at least 75 per cent. In the next few years, environment may be factored into estimating better EPDs, according to Miller. But the science of epigenetics is more convoluted, he says. “It suggests that an animal’s environment modifies its DNA and that modifications impact subsequent generations,” says Miller.

“We will potentially begin to understand epigenetic control of some traits,” says MacNeil, who is not convinced that geneticists even know where to start with this one. This is an area that is further into the future, in terms of offering practical insights in day-to-day production.

“I’m not aware of any results that are amenable for ranchers to exploit,” agrees Garrick, about the obscure field of epigenetics. “Although, we do know that epigenetics is involved in determining individual performance.”

Feed Efficiency

Feed efficiency and an optimum way to improve it and measure it, is a priority for the Canadian Hereford Association and according to Crowley, will continue to exist as an industry priority. Through ongoing trials, the CHA, other breed associations and research facilities are helping develop a better database to analyze this trait.