

Hereford Genomics:



The first bovine to be whole genome sequenced was L1 Dominette 01449.

In June the American Hereford Association (AHA) transitioned all DNA testing from Maxxam Analytics to GeneSeek Inc., located in Lincoln, Neb.

With this move, AHA members have more testing options while the process of requesting DNA kits

and collecting samples remains unchanged.

Why DNA test

The DNA testing process is required to get a female donor dam permitted or a sire permitted for artificial insemination (AI).

Also all Hereford sires born after Jan. 1, 2011, must be DNA genotyped at the official AHA DNA laboratory before their progeny can be registered.

Producers can continue to use DNA testing to parentage verify an animal before registering when the sire of the animal is in question or to test for genetic abnormalities.

With the move to GeneSeek, Hereford breeders now have the option to utilize a 50k panel to obtain genomic information to enhance the accuracy of Hereford expected progeny differences (EPDs). The 50k panel testing will help AHA continue its work of genome discovery in order to continue to find SNP markers that will enhance the accuracy of EPDs.

The 50k results from each animal will be blended with the animal's current EPDs to enhance its EPDs as well as accuracies for young animals. This process will

Understanding genomic terms

Allele: Different forms or variants of a gene are known as alleles. Each animal inherits two alleles of each gene, one from its sire and one from its dam. These two alleles can be identical (making the animal homozygous), or different (making the animal heterozygous) for any given gene.

Discovery population: The population of cattle that was used to find an association between a DNA marker and the trait of interest.

DNA: Deoxyribonucleic acid (DNA) is a nucleic acid present in the cells of all living organisms. It is often referred to as the "building blocks of life," since DNA encodes the genetic material which determines what an organism will develop into. In addition to maintaining the genetic blueprints for its parent organism, DNA also performs a number of

other functions which are critical to life. The bases found in DNA come in four varieties: adenine, cytosine, guanine and thymine — often abbreviated as A, C, G and T, the letters of the genetic alphabet.

DNA marker testing (aka genotyping): A test to determine the genetic make-up of an animal using DNA markers, which are regions of DNA thought to be associated with different genes.

GE-EPDs: Genomic-enhanced expected progeny differences (EPDs) are derived from blending conventional EPDs with genomic data collected from DNA testing.

Taking the Next Step

generate genomic-enhanced EPDs (GE-EPDs).

According to Dorian Garrick, Iowa State University Lush Chair in animal breeding and genetics and National Beef Cattle Evaluation Consortium (NBCEC) executive director, the greatest benefit will be the increased accuracy on young animals at or before puberty compared to conventional, parent-average EPDs. (For more about genomic predictions, see “Hereford Genomic Updates” on Page 170 of the July 2011 *Hereford World*.)

Whole genome sequencing

Another piece of the genomic puzzle is whole genome sequencing. In 2009 the first bovine to be whole genome sequenced was a Line 1 Hereford cow from Miles City — L1 Dominette 01449. The process to sequence and analyze the domestic cattle genome took six years and

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About GeneSeek

Located in Lincoln, Neb., GeneSeek Inc. is a subsidiary of the Neogen Corporation.

Founded in 1998, GeneSeek has developed into a comprehensive agricultural biotechnology service provider. It provides comprehensive agrigenomic solutions for research and development and commercial applications.

GeneSeek provides customers with the services and expertise to assist in areas such as SNP profiling, marker assisted selection (MAS), disease diagnostics and identity management. According to the GeneSeek website, the company can provide ultrahigh throughput solutions at extremely competitive prices and is recognized as a leading global provider of DNA testing for farm animal improvement and veterinary diagnostic testing and surveillance.

GeneSeek serves as the laboratory partner for the leading breed registries in both beef cattle and dairy cattle. The company also works closely with the largest swine breeders worldwide and sheep breeders around the world, including Australia and New Zealand, and also is the major player in testing to verify canine parentage.

In May, Neogen acquired the Igenity animal genomics business from Merial Limited. Igenity will become part of GeneSeek.

Neogen develops and markets products dedicated to food and animal safety. The company’s food safety division markets dehydrated culture media and diagnostic test kits to detect foodborne bacteria, natural toxins, genetic modifications, food allergens, drug residues, plant diseases and sanitation concerns. Neogen’s animal safety division markets a complete line of diagnostics, veterinary instruments, veterinary pharmaceuticals, nutritional supplements, disinfectants and rodenticides.

SNP: (single nucleotide polymorphism – referred to as a “snip”) a type of a genetic marker where alleles differ from each other by the sequence of only a single nucleotide base pair. SNP genetic tests focus on detecting precise single nucleotide base pair differences among the three billion nucleotide base pairs that make up the bovine genome.

50k Panel: This is a DNA panel where more than 50,000 DNA markers are genotyped for each animal. This tool can help producers more dependably predict genetic merit in young, unproven cattle, as compared to non-parent EPDs.

Training analysis: The process of characterizing the EPDs of genomic fragments.

Validation: A study conducted to confirm a reported association between DNA-marker alleles and the trait of interest. Validation studies play an important role in ensuring that potential markers have a real association with the trait of interest in commercial cattle populations.

Whole genome sequencing: This process figures out the order of DNA nucleotides, or bases, in a genome — the order of As, Cs, Gs and Ts that make up an organism’s DNA.

involved more than 300 scientists from 25 countries and cost about \$53 million.

Garrick explains the purpose of whole genome sequencing is: 1) To improve the accuracy of genomic prediction because the 50k SNP panel is inadequate across breeds

or populations and 2) To find “broken” genes that have damaged “start” or “stop” signals or a change in their amino acid sequence that will cause loss of function.

“Important genes with loss of function will be deleterious in one-fourth of conceptions between

bulls and cows that carry the same loss of function mutation,” Garrick says. “When we identify loss of function mutations, we will inspect the performance of matings between carriers to see if fertility has been eroded.”

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The process: Hereford testing procedures

Before contacting AHA to request DNA test kits, Hereford breeders need to have registration numbers ready for the animals they plan to test and decide what tests they want to have done. Remember DNA testing is required to get a female donor dam permitted or a sire permitted for AI use. Also all Hereford sires born after Jan. 1, 2011, must be DNA genotyped at the official AHA DNA laboratory before their progeny can be registered.

When a breeder requests a test to get an AI sire permit, AHA staff will determine if the bull’s parents have been tested and are on file. If the bull’s sire and dam have not been tested, the breeder will need to collect and submit those samples as well. Note: Animals with microsatellite parentage results may have to be tested using SNP technology.

Hereford breeders can qualify for reduced bulk rate if ordering 50 or more kits. The breeder must submit all registration numbers when requesting kits, they cannot pre-order 50 kits for the year and submit numbers when ready to test.

The preferred testing sample collection is hair (see “Instructions for obtaining hair samples”). If hair is not available producers can submit semen using the same form. Semen does not have to be frozen. Put the semen straw in a ballpoint pen casing, capped and taped on the form where it indicates to put the hair shafts. This procedure prevents the semen straw from breaking while being mailed.

To order kits and for questions about the testing process, contact AHA customer service at 816-842-3757.

Here’s the step-by-step process:



Instructions for obtaining hair samples

- Pull hair samples above the tail switch. Do not cut the hair. The hair root contains the material needed for DNA testing.
- Pull 20-25 hairs evenly and directly from the tail so the hair does not break. The switch must be dry and brushed clean of all debris. The lab suggests wrapping the hair around a pencil and then pulling.
- Place the hair in a straight line across the center of the form from the AHA for DNA testing. Keep the hair together with the roots to the left, as noted on the form. Do not curl hair. Attach the center hair shafts to the form with tape.
- Fold the form as you would a business letter. Each sample has an individual envelope for mailing. If you have several to mail, put each sample in its individual envelope and then mail all the envelopes in one big envelope to save on postage. The address is located on the bottom of the form.

Note: It is important to only include hair from one animal in each kit. The lab cannot detect cross contamination of samples.

Hereford breeder contacts AHA to request DNA test kit. Must provide AHA registration number* and specify which DNA test(s) are to be performed. Breeders can receive reduced rate if they order more than 50 kits.

AHA generates test form with bar code and returns to breeder. Return options will include mail, fax or e-mail.

Hereford breeder then collects hair samples (preferred method). Breeder then mails sample and form to GeneSeek.

GeneSeek processes DNA and generates genomic results and returns data to AHA.

AHA returns results to breeder and incorporates 50k results into national cattle evaluation to produce GE-EPDs.

***Note:** A common misconception is that an animal must be registered before it can be DNA typed. The animal must be recorded in order to be DNA typed but the decision to be registered can be made at a later date. Animals that are recorded as unregistered animals still receive a registration number and utilizing that number is necessary so each animal has a unique identity so it can be tracked through the AHA system and at the lab.

Scientists also check to see if animals with one or two loss of function mutations at any particular gene (important or not) have any differences in any productive trait.

“We will use the sequence of individual bulls, when we have enough of them,” Garrick adds, “to impute the sequence of animals with 50k genotypes, and use this information to improve genomic prediction.”

Since 2009 there has been a dramatic improvement in technology. Six Hereford bulls are scheduled to be sequenced this summer. According to Garrick, the run will take eight days and cost approximately \$3,000 per head.

Jack Ward, American Hereford Association (AHA) chief operating officer and director of breed improvement, explains that by sequencing more Herefords, scientists might be able to identify genes that may have a big effect on a specific trait including genes that have big effects across breeds.

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— Dorian Garrick

“After we find these genes or areas, we may be able to use a much smaller and affordable panel to identify animals early in life to make genetic progress and quicker generational turns,” he says.

“Another benefit is that we might be able to identify problems like genetic abnormalities before they become a big problem.”

Moving forward

“It is important that we continue to get cattle 50k genotyped and

collect phenotypes on all traits,” Ward says. “This is important as we continue to train and discover the Hereford specific panel.”

Although the process to get to Hereford GE-EPDs has taken time, the process developed by AHA will greatly benefit the Association and members for years to come. AHA will be the first beef cattle breed association to develop and market its own genomic predictions, and according to Garrick, with this process in place, the Hereford breed will be able to continually add to its training data and improve the accuracy of Hereford genomic predictions.

Ward says the AHA is lucky to have members who have donated DNA and have helped defray the expense related to DNA and sequencing projects. Also assisting with the expenses has been the Hereford Research Foundation, which is supported by Hereford breeders and related industries.

“The AHA and its members have spent lots of resources and have worked with NBCEC, USMARC (U.S. Meat Animal Research Center) and other scientists to develop and lay out a plan for genomics within the Hereford breed,” Ward says. “Now it will be up to the membership to embrace the technology and move it forward.”

Watch for more information on GE-EPDs in future issues of the *Hereford World*. For more information about the DNA testing procedures, contact AHA customer service at 816-842-3757. **HW**

Hereford DNA testing fees

With the move to GeneSeek Inc. as the official DNA lab for the American Hereford Association (AHA), a new fee schedule and testing options have been announced.

- 1) AHA basic panel:** The panel tests for parentage, tenderness (calpain) and genetic abnormalities — hypotrichosis (HY) and idiopathic epilepsy (IE) and dilutor — \$30 per sample/\$20 bulk rate of 50 or more.
- 2) Bovine 50k:** Results will be blended with EPDs — \$85 per sample.
- 3) Bovine 50k plus basic** — \$100 per sample.
- 4) Horned/polled test (stand-alone test):** This test identifies homozygous or heterozygous polled genotypes. It does not identify the scur genes. — \$48 per sample.