

Genotyping Cattle for More Efficient Breeding and a Higher Quality Food Supply

GeneSeek uses Infinium[®] iSelect[®] BeadChip-based tools to help breeders measure genetic merit and select superior breeding stock.

Introduction

Founded in 1998, GeneSeek is focused on performing high-quality, cost-effective genotyping for animal agriculture. Based in Lincoln, Nebraska, the company originally offered STR-based parentage, coat color, and defect testing for the beef and dairy sectors until it partnered with Merial Animal Health in 2003, broadening its portfolio of products and services.

The real breakthrough for GeneSeek came in 2007 when the complete bovine genome was sequenced and the Bovine HapMap became a reality. Immediately, Illumina formed a consortium of individual, university, and government scientists to identify SNPs across the genomes of several major cattle breeds and later launched the BovineSNP50 BeadChip. GeneSeek recognized the impact this product was going to have on the marketplace. "We concluded that Illumina BeadChip-based SNP genotyping would be the leading application for the future," said Stewart Bauck, DVM, General Manager of GeneSeek. "That decision more than anything else turned the corner for GeneSeek and started it on its current path of expansion."

Dr. Bauck partnered with GeneSeek in 2003 bringing genomics experience tracing back to his days as a country manager for Merial in Canada. "I was looking at new opportunities in animal health and decided that we would be remiss if we didn't get into genomics," Dr. Bauck said.

GeneSeek is now a subsidiary of Neogen Corporation and has grown to become a leading provider of genetic diagnostics for identity and trait evaluation in the agricultural biotechnology industry. It currently performs these services using iSelect Custom BeadChips and will soon be offering sequence-based diagnostic capabilities on the MiSeq[®] and NextSeq[®] 500 Systems. iCommunity spoke with Dr. Bauck to learn more about how genomic diagnostics is changing the beef and dairy industry.

Q: What is the mission of GeneSeek?

Stewart Bauck (SB): Our primary goal is to provide high-quality, low-cost, robust genotyping services for the agricultural sector, primarily animals, but also plants. The three pillars of our business are reliability and accuracy



Stewart Bauck, DVM, is the General Manager at GeneSeek, part of Neogen Corporation.

of the results; turnaround time, with a goal of sending genotyping results to customers within 14 days; and cost-effective, value-added products and services.

Q: You've recently doubled the size of your laboratory in Nebraska. How does that enhance the services you provide to customers?

SB: We didn't just double the size of the laboratory, we also moved into a scalable building that enables us to conduct genomic testing efficiently. We now have a customized genotyping facility with room for expansion. The layout is designed to move samples efficiently from reception all the way through to genotyping and data analysis. We needed to expand our footprint to accommodate additional platforms such as sequencing. We're in the process of installing a NextSeq 500 System, alongside the MiSeq System, and iScan and HiScan[®] array scanning systems that we are running currently.

Q: Why did you choose the Illumina products and systems as your genotyping platform?

SB: Illumina has been agile in terms of expanding with us. We started with the BovineSNP50 BeadChip. The iSelect BeadChip has now enhanced our product offering, enabling us to expand from catalog to custom products. The flexibility allows us to build low-density, low-cost products for routine commercial genotyping, and high-density products for research applications. The processes are compatible with the high-volume throughput in our lab.

The iSelect BeadChip enables us to serve our mission of data reliability and accuracy with fast turnaround time. The quality of the product means that we can rely on Illumina to perform the QC on each iSelect BeadChip. After the BeadChip comes to us, we have a high degree of confidence that it will deliver time and time again. There's essentially no variability in performance.

"The great thing about Illumina technology is its reliability, accuracy, and robustness."

Q: Is the bulk of your genetic testing for bovine breeding associations?

SB: We service virtually every major breed association in North America and around the world, including the Holstein, Jersey, and American Angus associations. We think about the breed associations as a B2B (business-to-business) customer segment. Members send samples to their breeding associations, and the associations gather them up and send them to us for genotyping.

We also have a significant B2C (business-to-consumer) customer segment where we have a direct business transaction and information delivery to individual cattle producers. These range from ranchers that send us single samples for a low-density genotyping or parentage testing, up to the largest commercial ranching operations in North America. We offer services to virtually all of the major ranching operations in North America and many around the world, including Australia, New Zealand, and extensively throughout Europe. We even have business operations in Brazil and China. It's a diverse mix of customers, particularly on the bovine side.

In addition, we provide genetic testing services for various other species including dogs, fish, pigs, poultry, and horses. We also offer services for testing specialty crops, as well as trees that are used for pulp and paper production, such as eucalyptus and pine.

Q: How do they use the genetic information?

SB: Most of what we do is tied to genotyping of animals for the selection of superior breeding stock. It ranges from simple parentage testing to the development of a genomic-enhanced breeding program, where we use Illumina technology primarily. In the case of the cattle industry, there is a measure of genetic merit that's referred to as the expected progeny difference (EPD). This is a measure of the impact that a sire or dam will have on their offspring. It's used frequently for the selection of superior breeding stock. It greatly enhances the rate of genetic progress by removing animals from the breeding population that aren't contributing the desired mix of alleles. More breed associations are embracing the GeneSeek Genomic Profilers (GGP) built on the iSelect platform to develop and deploy tools to achieve genomically enhanced EPDs for individual traits.

Q: How are cattle traditionally evaluated?

SB: The conventional way to measure the genetic merit of progeny is to raise a cow, impregnate her, and have her raise progeny. It takes several years to evaluate the progeny and decide whether she's any good. With genomics, the producer can take a tail hair or other tissue sample when she's a day old and get exactly the same information.

If I have a young bull and I want to evaluate his genetic merit, traditionally I put him out with a group of heifers, he impregnates them, and they calve. Their progeny grow up, are weaned, and put into the feedlot, where they are evaluated as they're prepared for market. By the time I get the data on the first progeny that bull has sired another set of calves and he's out in the pasture working on his third set. That's a risk management situation. I want to know before I put him out the first time whether he's any good. I don't want to wait until he's 3 or 4 years old and sired three set of calves, before I realize I've made a mistake.

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Q: What are some emerging genotyping applications? SB: The part that is emerging is the concept of markerassisted management. We've seen increasing interest and investment into selecting the animal based on its genomic profile, and altering its management as a consequence.

For example, consider a steer that's going into the feedlot rather than for future breeding. What I do with him in the feedlot and how I manage him could be very different if he has the genetic potential to produce highly marbled, high-quality beef for a steakhouse, as opposed to hamburger for fast food. With marker-assisted management, we would know this essentially from birth. Soon, a steer will arrive at the feedlot, walk off the truck, and pass a reader that scans the electronic ID in their ear. Their record will pop up on the screen and the appropriate gate will swing open for the high-quality (Prime or Choice) or mid-quality (Select) beef pen based on their genomic profile.

Q: What percentage of cattle is being genetically tested now versus 10 years ago?

SB: Five years ago it was fractions of a percent of the total cattle population were being tested. Today we're probably in the range of about 5–6% and it is growing exponentially. Within the purebred sector, genetic testing is becoming commonplace for bulls sold to commercial producers. Many people are using some genomic profiling for their sire or dam selection programs. Increasingly, there are progressive, commercial producers who are using genomic profiling for producing beef for the marketplace. Within the poultry and pig industries, it's become virtually commonplace. Soon a producer won't be able to consider themselves to be a global player in those categories without a comprehensive genomic selection program.

Q: How do you partner with Illumina to meet the genetic testing needs of breeding associations?

SB: We've been working with Illumina around the concept of custom BeadChips. Because of our knowledge of the marketplace and the direct daily interaction we have with customers, we can anticipate their needs on a geographic basis, even by segment. We bring our custom designs to Illumina and work with them on the development of BeadChips, which we deploy within our lab. Illumina helps us meet the fast turnaround times and lower costs that our customers demand. It makes sure we're operational and able to process samples in a timely manner. Having a partner that can provide that level of focus and customer service enables us to be successful delivering genetic services to the marketplace.

Q: Is the BovineSNP50 BeadChip the foundation of the GeneSeek genomic profile test?

SB: Illumina developed a low-density version of the BovineSNP50 BeadChip (called the BovineLD BeadChip) containing approximately 7,000 SNPs that we use as the foundational product for most of our bovine genomic profiler products. We're now working on an iSelect 150,000 SNP custom array built with those original 7K SNPs of the BovineLD BeadChip as the foundation. Since the introduction of the BovineSNP50 BeadChip, we've learned more about the bovine genome and specific markers, and used that knowledge to build enhanced products.

Q: Did you evaluate other array technologies?

SB: We evaluated other microarray-based platforms. The Illumina BeadChips come in various sizes, ranging from 8–24 samples. It's a relatively simple process to obtain samples in combinations that allow us to run 24 samples. Other providers have 384-sample arrays, which are too large for many applications. We like the flexibility from Illumina, where a relatively small number of samples are required to complete a chip. Q: How is GeneSeek distinguished among its competitors? SB: We have several competitors in our space. If you were to query our customers, they would tell you we are distinguished by our focus and our flexibility. We process DNA and perform genotyping, and are capable of accommodating projects of various sizes. We work with our partners to deliver the data in a form that makes sense for them without proprietary limitations. Customers can get the data back in the form that they want, at the right price, in a timely fashion, and they can count on its reliability.

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Q: What are the trends in genetic testing?

SB: We definitely see a trend towards sequence-based applications. We see some of our microarray-based genotyping moving towards a genotyping-by-sequencing (GBS) application. We have a MiSeq System on hand and are installing a NextSeq 500 System. Going forward, our services will include BeadChip genotyping, as well as GBS and other sequencing applications.

Q: What are the next steps in GeneSeek's growth?

SB: We intend to keep growing geographically, replicating the GeneSeek model in other countries and for other applications. We are expanding our portfolio of products and our customer base by leveraging some of Neogen's core competencies in food safety. We'll also be building a range of product offerings to serve the agricultural sector effectively and intend to expand into more plant applications.

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