Breeding the Best Angus Cattle Begins with the Best Genomics Tools

A genotyping tool based on the BovineSNP50 BeadChip provides Three Trees Ranch with genomic data to make the best breeding decisions.

Introduction

Dick Beck learned a lot about raising cattle growing up on a cattle farm and family meat business in Pennsylvania. His desire for knowledge took him to Pennsylvania State University, where he excelled in deciphering the science behind optimal herd management. Graduating as the outstanding senior in the College of Agriculture, he became a strong proponent of carcass merit analysis technologies, such as ultrasound, to inform breeding decisions. Widely used since the mid-1980s, ultrasound measurements provide information about mature cattle (ribeye size, fat thickness, and intramuscular fat) and enable ranchers to make fat and muscle predictions in young calves.

Fast forward to 2005. After several years as a regional manager for the American Angus Association, and a few decades marketing seed stock for cattle operations, Dick became General Manager of Three Trees Ranch[1], headquartered in the rolling hills of Coweta County, Georgia. The multi-state operation runs herds in Georgia and Wyoming. With more than 3,500 head of cattle, the limitations of ultrasound technology became apparent. Despite its many advantages, the ultrasound process takes time and is prone to human and instrument error. By 2010, Dick began transitioning Three Trees Ranch to genomic tools. Today, Three Trees Ranch uses the Zoetis HD50K tool based on the Illumina BovineSNP50 BeadChip[2].

iCommunity spoke with Dick about the transition and what Three Trees Ranch and its customers are gaining from the use of genomics tools for breeding assessment.

Q: What's the history behind Three Trees Ranch?

Dick Beck (DB): The Three Trees Ranch herd started with purebred Angus. We've since introduced Brangus cattle into the herd.

Brangus are a cross between the Brahman and Angus breeds. The combination delivers the hardiness and disease resistance of the Brahman, with the superior fertility and meat quality (carcass traits) of the Angus.

Our Brangus cattle are from the Camp Cooley Ranch herd, a continuation of the famous Brink's herd developed by Glen Brinkman. Glen was a visionary and pioneered the collection of ultrasound data in live animals for measurements of rib eye area and fat dispersion (marbling) in meat. The Brink's herd has 20 continuous years of ultrasound carcass data, more than any other beef cattle herd in the world.

Three Trees Ranch uses varying percentages of Angus and Brangus to breed heat-tolerant, high-carcass–value cattle. We refer to these as Angus+ cattle, and they are in high demand in the southern U.S. right now and have great export potential.

Q: How severe has the drought been in the southeast United States?

DB: While not as severe as what Texas and Oklahoma have endured, we've been in drought conditions for more than five years. That puts stress on cattle seed stock programs, where we're trying to provide cattle with as much opportunity to express their genetics as possible.

Q: When did you start using genetic selection and why?

DB: I've been working with bovine genomic technologies as long as they've been available, and currently rely on the Zoetis HD50K tool manufactured by Illumina. Three Tree Farms ramped up its data

Dick Beck is General Manager of Three Trees Ranch, headquartered in Sharpsburg, Georgia.

Illumina BovineSNP50 BeadChip-based tools are enabling Three Trees Ranch to breed heat-tolerant, high-carcass–value Angus+ cattle.

collection in about 2005. We submitted our first genomic test to the American Angus Association in December 2010 using the Igenity IG384 platform. At the time, it was the only genomic platform for purebred Angus breeders. We were among the first to use genetic selection services from Pfizer using the HD50K tool when it became available. We were certainly the first ranch in Georgia to use genomics on a large-scale basis.

Q: How quickly did you transition to genomic selection tools to inform your breeding decisions?

DB: We deployed genomic technologies incrementally. Our management system is based on using the latest reproductive technologies, such as embryo transfer and in vitro fertilization (IVF), to multiply our superior genetics cattle. These, in turn, drove our implementation of genomic selection to improve the genetic base of our herd.

The first step was to evaluate our herd bulls. Since January 2011, we haven't bred a cow to a bull that was not HD50K-tested. The second step was to evaluate the donor females whose exemplary genetics we were multiplying with embryo transfer. Over the last three to four years, every cow at Three Trees Ranch that has been flushed (oocyte/egg collection) has been tested genomically. During the last few years we've added selection criteria, so some of the cows have been tested twice.

We are so committed to genomic selection that if a rancher wants us to purchase the genetics (sperm or egg) of one of their herd individuals, they need to profile it with the HD50K or we're not interested. We're no longer in the gambling business. We're in the predictability business and we think genomic tools give us that predictability.

Q: What are the benefits of using genomic and reproductive technologies in tandem?

DB: Genomics enables us to evaluate the genetics of our cattle at any age, and compare them to the genetics of the entire Angus population rather than simply a contemporary group that might skew the data. With high-accuracy genomic-enhanced data, we have an EPD* accuracy level of most traits for a baby heifer calf or a baby bull calf that is equivalent to a 10-year-old proven dam or a four-year-old sire, respectively. That enables us to make selection decisions when calves are just a few weeks of age.

We're collecting oocytes from 10- to 15-month-old heifers and semen from 10- to 15-month-old bulls, where both sets of parents possess genomic-enhanced, excellent high-accuracy genomic EPD data. Using IVF in pregnant donor cows and young virgin females determined superior through genomics, we can significantly shorten our generation interval.

Deploying genomics and IVF together allows us to turn generations faster and pick up the pace of beneficial genetic change in our herd. It changes the game altogether.

Q: Is EPD data one of the primary values that you use in assessing cattle for breeding?

DB: EPD is the primary objective measure that we use in breeding these cattle. We have 17 different traits and seven different indices that are calculated by the American Angus Association and provided to us today.

Q: Has genomic testing replaced ultrasound in providing data on the animals in your herd?

DB: For the last three years, every bull that we've sold, regardless of whether that bull is going to commercial use or purebred use, has been HD50K tested. We no longer use ultrasound technology, because it became a losing proposition. To achieve phenotypic weight and obtain good ultrasound data, ranchers need to feed cattle high-energy rations. That can be damaging to the long-term reproductive health and structural soundness of the animal.

Frankly, I was tired of feeding bulls to get meaningful ultrasound measures of marbling and rib-eye size. I decided it was much more reasonable and practical to feed those animals for maximum longevity and reproductive performance and use the genomic tools to tell me about their carcass characteristics. There are volumes of research that show that feeding rations with high energy levels to young bulls and females can adversely affect reproduction. We like the flexibility that genomics gives us to manage the cattle the way we think they need to be managed, while still providing meaningful genetic data for comparison.

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Q: Do you consider genomic data to be more objective than ultrasound technology in assessing cattle?

DB: Having worked in the American Angus Association and marketing for lots of different people, I know that the traditional collection of ultrasound data has the potential for a huge amount of human error. Since all ultrasound data is compared to a contemporary group, the data is only valuable and accurate if the group chosen is a realistic contemporary group. Financial incentives can sometimes bring out the worst in human nature, causing people to choose a group that makes an individual or a sire group look superior for a specific trait.

In contrast, genomics yields secure data that can't be manipulated. When we send a genomic sample to the American Angus Association, it's given a barcode ID. That sample goes to Zoetis where it's assayed with the BovineSNP50 BeadChip. The results are sent back to the American Angus Association, which then uses the barcode to associate the data back to the animal.

The results are an objective comparison of my animal to the 51,000 cattle to date that have been tested with BovineSNP50 BeadChip-based tools and are in the latest iteration of the American Angus Association database. That's invaluable for the long term. Genomics provides a level of accurate comparison that we could only dream of in the past.

* EPD = expected progeny differences

Beef Quality and Yield Grades

The U.S. Department of Agriculture (USDA) quality grade is a composite of factors that affect palatability of meat (tenderness, juiciness, and flavor)[3]. The USDA beef quality grades in descending order of quality include:

- Prime
- Choice
- Select
- Standard

Q: Is the Angus database as large as some of the dairy cattle databases?

DB: The dairy breeds have a huge head start on us, but the Angus database is growing. There are a lot of lessons that we're learning from dairy farmers about how they have used genomic data. Hopefully we'll avoid some of the pitfalls and will learn the shortcuts to make the most progress.

The American Angus genomic database is significantly larger than all the other beef breeds combined. It was initially developed to record the parentage of the animals. About 25% of the annual Angus production is documented genomically, so the predictive value of this database is growing. It's becoming more than just a historic record. It's evolving rapidly into a predictive tool.

Q: How has the use of genomic technology impacted the quality of Angus cattle herds in general?

DB: Genomic technologies are enabling us to make real progress in improving cattle and are providing us with the data to prove it. About 10 years ago, knowledgeable people in the industry said that the goal for a beef cattle operation was to produce 70% USDA Choice or Prime rated cattle. That means that 30% of the herd will be USDA Select and won't command a premium price (see Sidebar). With genomic tools like the BovineSNP50 BeadChip, those same people are now saying the goal should be 70% Premium Choice** or USDA Prime, a level of marbling that qualifies a carcass that meets the black hide color criteria for Certified Angus Beef.

During a recent commercial sale of bulls, Gardiner Angus Ranch introduced a customer who had closed out a pen of cattle that were 100% Premium Choice and USDA Prime, something that was absolutely unheard of before we had genomic tools. People used to say that cattle ranchers couldn't offer high quality on a consistent basis. I think genomic tools have changed that, enabling us to produce a beef product that's very predictable.

Q: How do genomic tools like the BovineSNP50 BeadChip help you ensure predictable product?

DB: Genomic tools provide higher accuracy assessment at a younger age. We're now going to the next generation of tools. The American Angus Association and Certified Angus Beef[4] offer a tool called GeneMax[5] that's based on SNPs derived from the BovineSNP50 BeadChip. It's designed specifically for the Certified Angus Beef and American Angus Association breeders for use in commercial cattle to evaluate marbling and feedlot performance. It enables ranchers to evaluate potential replacement heifers so they can continue to improve their commercial herds. Since our bulls are tested with the BovineSNP50-based HD50K tool, customers will get parentage data free of charge that matches that specific commercial animal back to its sire. That added accountability means my customers know the genetic impact of our bulls.

In cattle ranches throughout the American West, 20–30 bulls might get turned out in a huge group of cows. They'll scatter across hundreds of acres, making it impossible to track progeny. Today we have cost-effective tools that enable us to track every animal and know at the very least its sire. If it's superior, we'll be able to propagate that sire. If it's inferior, that sire will get replaced in the population by a better one.

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Q: With a herd of thousands of cattle, how do you keep track of the steers and cows?

DB: Every animal in our Three Trees Ranch breeding herds has a permanent tattoo in its ear that's applied at a young age. We use DNA to verify the parentage so we're absolutely sure that we know exactly who its sire and dam are. We have our own database in-house. In our case, 95% of our cattle are also in the American Angus Association database.

In the future, there's interesting radio-frequency identification (RFID) technology coming down the road. The new, smaller batteries can now power RFID technology at a reasonable cost. They've developed RFID tags for cattle that can be read from two miles away. At some point, the technology will become economically viable for progressive breeders to implement it.

Q: Do you still need to educate your customers about the value of genetics over phenotypic assessment?

DB: That's the biggest challenge that we have for the next five years. I think the technology has evolved and advanced faster than we have been able to educate people. These tools can make you a better breeder and that can improve your bottom line. Education remains a big part of seeing this technology used pervasively to assess the Angus population.

Q: How do you see genomics playing into the future at Three Trees Ranch?

DB: I see genomics as a primary tool going forward. It's how we're going to position and package our product. Things have come a long way since the mid-1980s. Today, Illumina is providing us the tools to accurately assess and accelerate improvement in our herds.

**Medium to High Choice

As the technology evolves, so will we. The dairy industry, with a few years more experience than we have, has recently begun looking at whole-genome mapping, and the identification of haplotypes†, SNPs, and gene interaction that single gene testing can't identify. They've identified haplotypes associated with excellent fertility and others with infertility. As we continue to grow the Angus database, we hope to add haplotype data for the traits that we can't identify with single markers.

We need new paradigms for a new generation of consumers that want assurances that the meat they consume has been sustainably raised. The beauty of Illumina BeadChip tools is that they will someday enable us to measure disease resistance and allow us to more rapidly eliminate some of the conditions that put our herds at risk. Genomic tools could be designed to identify cattle that are prone to certain diseases, such as bovine respiratory disease. We'll then be able to selectively mate around those markers and avoid them, rather than having to administer antibiotics to affected animals. Genome technology offers an elegant solution to solve these problems.

References

1. Three Trees Ranch, http://www.threetreesranches.com/ (5 June 2014)
2. Illumina BovineSNP50 BeadChip, illumina.com/products/bovine_snp50_whole-genome_genotyping_kits.ilmn
3. USDA Beef Quality and Yield Grades, Texas A&M Agriculture and Life Sciences, meat.tamu.edu/beefgrading/ (5 June 2014).
4. Certified Angus Beef, www.certifiedangusbeef.com (5 June 2014)
5. GMX GeneMax, www.cabpartners.com (5 June 2014)

†haplotypes = blocks of genes that are inherited together

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