Evaluating PAP as a Genetic Prediction Tool

Angus Genetics Inc. pooled multiple data sets to develop an EPD for PAP evaluations.

by Kaci Foraker, editorial intern

Kelli Retallick, genetic service director of Angus Genetics Inc. (AGI), updated attendees of the 2019 Beef Improvement Federation (BIF) symposium, held June 18-21 in Brookings, S.D., on her continuous work to develop a production expected progeny difference (EPD) for yearling high-altitude pulmonary arterial pressure (PAP).

AGI staff started collecting PAP scores in 2013 and began a collaborative research effort with Colorado State University (CSU) in 2016. Their goal was to answer three questions: Is there a relationship and value in taking PAP measurements at lower elevations? Does PAP have a relationship with growth traits? Is PAP affected by varying carcass traits?

Retallick referenced a recent study published by CSU's Rachel Pauling analyzing Angus cattle. The first main outcome from the study was determining high altitudes from moderate altitudes.

"Rachel analyzed all of our PAP data together and came up with 147 distinct elevation locations," Retallick said. When analyzing these varying locations, Pauling found that when elevation reached 1,620 meters, (roughly 5,250 feet), PAP numbers started to increase as a result.

Once high- and moderate-altitude levels were designated, correlations between the two were analyzed. Heritability was 0.30 for high elevation and 0.29 for moderate elevation, respectively. This result was similar to past projects with PAP, but the most important aspect was the 0.83 correlation between the two different elevations.

"There is a very large positive correlation," Retallick said. "That basically allows us to start thinking about how we fit these two different traits in a two-trait model that would allow us to capture the variation that we are collecting at these moderate elevations and use them to predict high-elevation PAP. We actually have a higher correlation using moderate-elevation PAP as a predictor than we do using ultrasound measurement to predict carcass traits."

However, when growth traits were analyzed alongside PAP, there was no strong correlation found. She said there is no direct finding that the industry's increasing weaning weights and yearling weights are causing PAP issues.

Since the release of a research EPD in February, AGI has added about 3,000 weaning PAP records to its database. After incorporating and working with these additional records, AGI hopes to release a production PAP EPD by the end of 2019, Retallick said.

She acknowledged that this type of EPD is "not a replacement for an actual PAP score." She stated in an example about an Illinois bull with the best PAP EPD. He should not be expected to survive in a hypoxic environment at high altitudes.

Kelli Retallick explained AGI's progress on a fairly new EPD: PAP.

"However, being able to identify that Illinois bull as a prominent sire through artificial insemination, that's a great opportunity," Retallick said. "There is definitely progress that can be made and allow our high-altitude breeders to identify animals that pose less risk."

Gene Editing the Polled Allele

Advances in gene editing allow for introduction of useful alleles.

by Kaci Foraker, editorial intern

Researchers are using beef cattle genetics to solve an animal welfare issue in dairy cattle.

Alison Van Eenennaam, extension specialist in animal biotechnology and genomics at the University of California–Davis (UCD), presented her latest work in genetic editing at the 2019 BIF symposium in Brookings, S.D., June 18-21.

"The overall drive of our selection programs hasn't changed," Van Eenennaam said. "Our breeding objectives have remained the same. We are still interested in disease-resistant animals. We are interested in productive animals and trying to go after some welfare traits, but our overall objectives haven't changed."

Genetic solution

Van Eenennaam's group focused recent work on addressing the welfare issue of horned Holsteins. The presence of horns can create a dangerous environment for employees and other cattle, so young cattle must be dehorned.

To create a solution for this problem, a small company, Recombinetics of Minnesota, introduced the polled gene from Angus cattle to Holstein embryos to produce polled animals. The UCD group collaborated on the phenotypic evaluation of the gene-edited cattle.

There are already Holsteins that are polled. However, Van Eenennaam stated that homozygous polled Holsteins net approximately $150 less profit compared to a horned animal. This decrease is partially due to the negative effects of inbreeding; but producers still don't want to take a profit decrease, so they stay away from those genetics.

Van Eenennaam's group tested a data model that projected requiring all Holsteins to be polled. The results of this projection showed the frequency of horned cattle would significantly decrease, but rapid growth in the occurrence of inbreeding would be a consequence of that decision.

"Genetic variation is a breeder's friend," Van Eenennaam said. "If you have a really big increase in inbreeding, you are basically taking away your future possibility of genetic improvement, as you are becoming less genetically diverse."

To solve the negative economic impact that is seen in many polled Holsteins, Van Eenennaam predicted editing the top 1% of sires' genes would decrease the occurrence of horns while still keeping the same possibility of future genetic gain.

At UCD, a gene-edited homozygous polled bull was bred to horned Herefords and produced offspring without horns. This outcome was expected, as the polled gene is dominant in comparison to the horned allele.

Approaches

There are two main ways to edit cattle. The first is to edit a somatic cell from an elite animal and then clone that. To do this, DNA is first taken from a donor oocyte. Then the diploid nucleus from the edited somatic cell is moved into the oocyte and implanted into a surrogate dam, Van Eenennaam said. Nine months later, a homozygous non-mosaic edited animal will be produced.

The second approach is to introduce the edit into the developing embryo. In-vitro maturation of the ovocyte uses the DNA from the female, inseminates the egg, produces a zygote and then editing reagents are introduced into the zygote. Seven days later the developing embryo can be transferred into a surrogate dam. The offspring of this approach will most likely be a heterozygous or mosaic animal, and a homozygous animal can be developed through generations of breeding, Van Eenennaam said.

"Genome editing is like sprinkling on top dressing," Van Eenennaam said. "It's a little bit of a cherry on top of a breeding sundae. Nothing about our traditional breeding programs is going to go away because of editing, but what it does do is offer the opportunity to introduce useful alleles into cattle breeding programs without linkage drag, and enable the precise and rapid transfer of useful genetic variants between different breeds of cattle."

Van Eenennaam summarized:

Gene editing offers an approach to precisely introduce useful genetic variation into food animal breeding.

Gene editing is distinct from

Continued on page 94

BIF Coverage *continued from page 93*

genetic engineering because it is targeted and does not always involve the introduction of foreign DNA.

It opens up new opportunities for breeders to address critical problems such as disease resistance, animal welfare and resilience, and product quality traits.

Improved DNA Testing for Cattle

Rare variation may be the silver bullet cattle producers never knew they needed.

by Lindsay King, assistant editor

A new genotyping assay may be able to find the variation researchers have been searching for all along, said Jerry Taylor, Curators' Professor of Genetics and Animal Sciences and Wurdack Chair of Animal Genomics at the University of Missouri (MU). He spoke on the topic at the 2019 BIF symposium in Brookings, S.D.

"There are some incredible opportunities for beef cattle breeding using genotype imputation," Taylor said. The process of imputation is twofold: (1) sort alleles on each chromosome, which is called phasing; and then (2) estimate the missing genotypes.

"GGP F-250 is a new genotyping assay that was developed in collaboration with GeneSeek and the University of Missouri," he said. "It's a very different assay compared to the ones that exist today."

There are two types of variation on a chromosome: common variant and rare variant. Current assays measure common variants, while the GGP -F250 assay does not. He was designed specifically to measure the rare variant.

"This is important because most variation in the genome is caused by the rare variants," Taylor said. "This accounts for differences in EPDs (expected progeny differences), for example. We are not currently capturing that with the assays we have available."

The genome is made up of 24,000 genes, and only 10% of those are required for sustaining life. That leaves a lot of room for mutations to occur and wreak havoc on an animal.

"As an example, I have a 50K genotype on EXT, and I want to see if I can estimate his whole genome sequence and every variation within that," Taylor said. "That's very aggressive, but it can be done."

Imputing rare variance is incredibly difficult and inaccurate for a number of reasons, but Taylor boils it all down.

"The assays we are using don't have rare variance on them, they are all common variance," he said.

Troy Rowan, a fellow MU researcher, has been addressing this issue for the last year. He recently released an online "imputation pipeline" to make rare variance imputation a breeze. Taylor and his students have been routinely sending the data from an animal genotyped with a 50K chip through the pipeline. Out the other end comes a genome with all the gaps basically filled in.

"Using this tool we can take the 50K data that every breed association has and put it through this free tool to get 850,000 variants," Taylor said. "Over 100,000 of those variants are the rare type."

Through this endeavor, Taylor said, he has found that heritability is higher when rare variation is included. This essentially gives producers and breed associations the opportunity to increase the accuracy of EPDs and subsequent selections.

The practical application of this innovative technology pertained mostly to embryonic loss for Taylor. His research revealed strong evidence that 76 regions on the Angus genome are responsible for embryonic loss. Using the imputation method, tests and EPDs could easily be developed to find the answer.

"We need to consider how much diversity we have in our breeds," Taylor said. "People are always worried that we are inbreeding too much and losing all the diversity."

They just might be right, but the proof is in the genome.

A Matter of Perception

Checkoff contractor shares consumer perceptions of beef and beef production.

by Troy Smith, field editor

It is a competitive marketplace, but beef remains a popular protein choice for today's consumers. Rick Husted offered that assurance to attendees of the 2019 BIF symposium hosted June 18-21 in Brookings, S.D. He ought to know. Husted is vice president of strategic planning and market research for the National Cattlemen's Beef Association (NCBA), a beef checkoff contractor that monitors and measures consumer attitudes on a monthly basis.

"The U.S. per-capita consumption of beef is about 58 pounds (lb.)," Husted said, noting continued growth in beef demand during the last several years. The current consumption level represents significant recovery from the historic low of 55 lb. per capita in 2015.

According to Husted, market research suggests two-thirds of consumers have a positive perception of beef, but even more consumers hold a positive attitude toward chicken. Based on perceptions of nutrition, health and how well it fits a food-buying budget, chicken often ranks higher than beef.

Regarding perceptions of how food is produced, Husted said 40% of consumers have a generally positive attitude toward beef production, with 44% being neutral. Only one in five consumers claims to be knowledgeable about how cattle are raised.

"This suggests a lack of awareness," Husted said. "They don't know what happens between a calf in the pasture and a steak on the plate. About 43% think cattle live their whole lives in confinement (feedlots)."

Husted said evidence suggests increased consumer interest in how and where their food is produced. They have questions about antibiotic and growth-promotant use, and whether production systems are environmentally friendly and sustainable.

When informed about the industry-driven Beef Quality Assurance (BQA) program, consumers generally respond postively, though some remain skeptical. Husted said beef checkoff-funded programs for consumer education are designed to counter misinformation and present clear facts to assure consumers that beef is raised responsibly.

Commenting on the attention given to meat-substitute products, Husted said a NCBA investigation shows that plant-based alternatives represent "a tiny fraction of protein products sold" — about one-half of 1% of total market share.

"And consumers still view beef as one of the best sources of protein," Husted stated, adding that beef definitely is the best-tasting choice.

Precision Livestock Management

Precision livestock management is paving the way for cattlemen.

by Julie Mais, Angus Journal *editor*

Precision agriculture may be common in the cropping sector, but what happens when the philosophy, tools and systems are applied to livestock? Mark Trotter, Central Queensland University, is working to answer that question for Australia's industries that rely on grazing.

"I saw that there's a lot of opportunities to take some of the thinking [in precision agriculture] and bring that into the grazing community, which hadn't progressed at the same rate as the comparable industries with precision agriculture," Trotter said.

As part of a precision livestock management group, Trotter and his team consider efficiency, reducing cost while increasing production utilizing tools like GPS trackers, satellite mapping and sensors.

Continued on page 97

"Our research is really given by matching a need or desired outcome with a technology focus," he said.

The Australian beef industry ranks about seventh in the world, with 25 million head of cattle on the continent at any one time. In contrast to U.S. beef production, much of the slaughtered cattle in Australia are finished on grass — and Trotter said pasture utilization might be as low as 30%.

"If we could improve feed budgeting and matching stocking rates, both long- and short-term, to what's actually available on the ground, there's some real big opportunities to increase productivity," he said.

Trotter said tracking cattle location and behavior, and managing the large sums of data, will pave the way for precision livestock management practices.

New developments in satellite-based sensing systems, as well as proximal sensors, he said, will deliver key information on the amount of grass available in pastures.

To monitor animal behavior, Trotter explained, in Australia there is excitement around the "smart ear tag" concept. A device on an animal ear tag gives you biometric information and the location and behavior of the animal, then delivers that to your smartphone, tablet or computer. It provides remote access to the details of an animal.

The key information he finds producers are interested in includes location, behavior and biological state — health, reproductive activity, weight gain.

"It turns out there's a whole bunch of different applications out there that producers could use this for," he said. "Everything from just knowing that animals are about to water, all the way through the calving, land detection, predatorial detection, and even some strange things like refining fertilizer application, landscape management and feed-base management."

Trotter added that with this technology, it isn't one single application that will draw uptake.

"We think in Australia at least, it's sort of a cumulative effect of all these little applications that sum up to a value proposition," he concluded. AJ