FROM WHY TO HOW:
Understanding Genomic Tools

Population genomics use the past to create a better future.

by Megan Silveira, associate editor

Across the country, cattlemen wake up with a common goal: making their herd better. Replacement heifers are chosen carefully, bulls are thoughtfully matched with females — all in hopes of a successful calving season.

It's been the driving idea behind beef production for decades, but today's producer is more equipped to take the challenge on than ever before. There's a wide array of selection tools in a modern world; but expected progeny differences (EPDs) and dollar value indexes ($Values) are familiar to most in the industry.

There's many who might study the numbers in hopes of finding their standouts, but what if there's more to the science than just analysis of individual animals?

A LOOK BACK

It was the early 1970s when the American Angus Association first employed quantitative genetics as the first estimated breeding values were released.

As the industry and the breed progressed, Kelli Retallick-Riley, president of Angus Genetics Inc. (AGI), says so has the Association's application of quantitative genetics.

"[EPDs and $Value indexes] use these same principles to guide the mating and selection decisions of Angus breeders and their commercial customers," she explains.

Today, the Angus cattleman has access to 22 EPDs and nine $Value indexes. The acronyms and numbers listed at the bottom of a registration paper are familiar, but the science that guides daily life at the Saint Joseph, Mo., office for the AGI team is not.

Concepts like quantitative genetics are not unique to the Angus breed, however. They're principles well known by researchers in the genetic field.

"We're using large amounts of data to make predictions of an animal's genetic merit," says Jared Decker, associate professor at the University of Missouri's Animal Sciences Research Center. "Quantitative genetics is really forward-looking. We are trying to make predictions to change populations into the future."

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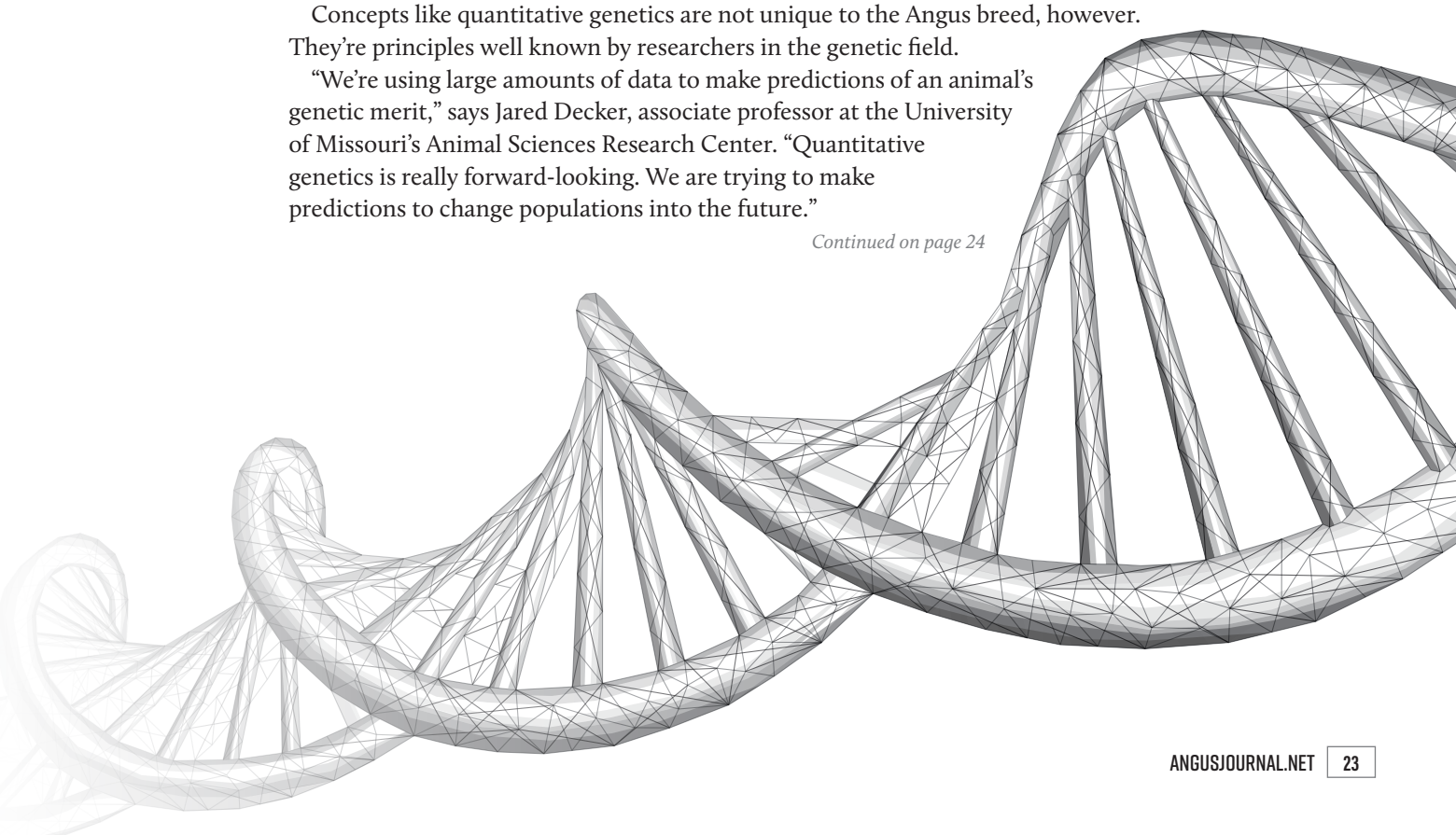

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For the most part, Decker says quantitative genetics have been kept in a separate "sphere of influence" from their scientific counterpart, population genetics, an approach that looks instead at the past by focusing on the diversity of the DNA sequence in a population.

"Population genetics is more looking back in time," he explains. "With population genetics, we're looking at genetic diversity and how forces in the past have affected that genetic diversity. … By understanding what's changed in the past, it can actually allow us to make better tools going into the future."

Decker and his counterparts are attempting to bring the strengths and weakness of these population and quantitative genetics together to better help understand the modern cattle population and push future generations to new heights.

"These tools have been used to move the entire Angus population in a positive direction to make the desired genetic change needed for profitable cow-calf operations," Retallick-Riley adds.

MODERN MINDS, MODERN SCIENCE

In 2001, it cost nearly $100 million to sequence an animal's DNA. Today, that price is less than $800.

Decker says this reflects the buying power of researchers in the current decade. There are hundreds of thousands of Angus animals that have their entire DNA sequenced, and population genetics can sift through that endless pool of data.

2009 was the dawn of a new era for *The Business Breed* specifically, as Retallick-Riley says it marks the start of genomics being added inside of EPDs.

"Now, with affordable testing and increased accuracy of genomics, DNA testing is commonplace for most Angus breeders wanting to make use of EPDs and $Values as tools for selection," she explains.

The weekly genetic evaluation released by AGI uses more than 1.7 million genotypes. Beyond highlighting the dedication Association members have to collecting phenotypes, Retallick-Riley says this level of genotyping has allowed for increased prediction accuracy in young, unproven animals. The data is a powerful research tool capable of generating new understanding of the current population, she adds, but the sheer volume of data available can seem intimidating.

"Simply because we have such a large data set available, it becomes attractive to use population genetics to better understand that data and that population," Decker explains.

Population genomics have already been used to help control the rate of inbreeding by managing diversity and identifying haplotypes, Decker says, but the ability of this genetic approach to improve the selection tools available to beef producers is great.

By identifying DNA sequences that have changed in frequency over time because of producers' selection decisions, for example, Decker says researchers can prioritize which DNA variants to put on a DNA test. With

the improvement of the tests, Decker explains that we would also be refining genomically enhanced EPDs.

There's also the possibility to better understand interactions between an animal's genotype and the environment, he says. Genotype effects are dependent on the context they're expressed in, and looking back to past populations can help showcase that relationship.

AGI has ongoing efforts surrounding the identification of haplotypes (a set of DNA variations) that may affect fertility and other performance traits. Retallick-Riley says the research has the potential to lead to additional tools capable of providing breeders with an opportunity to make more informed selection and mating decisions.

There are other, bigger questions to be asked, too, as Decker looks to possibilities beyond a single breed. How has the entire cattle population mixed over time? Which species of bovine have mixed to create new populations? Where is more genetic diversity needed? What about less?

It might seem like a lot of open-ended questions, but Decker says that's what makes genomics so great. Other industries — other protein competitors — are already utilizing this technology, so in Decker's mind, there's no reason not to take these accurate tools and use them to improve breeds as a whole or entire cow herds.

"My concern as a researcher and as an educator is the tradition that we value as family-owned, family-run farms and ranches, that tradition becomes in jeopardy if we're not more progressive about making sure we're doing things in a profitable and long-term manner," Decker says. "So genetics, whether it's genomic predictions, indexes, whatever it may be, is simply a resource, a tool for breeders to make more informed decisions."

The key comes in separating the noise from the signal, he adds. Mistrust in the science comes most often when people try to find the "all-star cow."

"We've done lots of demonstration projects, we've done lots of validation projects of EPDs, indexes, genetic prediction, and guess what? Every time, those are validated," Decker says.

That means they work.

Decker reminds producers these genetic tools are made for populations, not individual animals, and if that mindset is applied the question is no longer if the tools work. The question becomes, "How can these tools work for me?" AJ

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