



# A New Generation

The GeneSeek® Genomic Profiler™ (GGP) portfolio empowers your selection, management and marketing of beef seedstock



# Each new GGP generation gives you more advantages

Our GeneSeek Genomic Profiler (GGP) products and services empower your decisions in selecting, raising and selling elite cattle, enhancing profit and protecting your reputation for high-quality seedstock.



Beef genomics is evolving fast. Neogen gives you the most advanced, widest range of DNA testing for the real world of cattle production. Why Neogen?

- From partnering with all major breeds...to the industry's broadest line of genomic profilers
- From faster, easier DNA sampling at chute side...to world-class achievements like genotyping embryos
- From running millions of DNA samples...to driving down the cost of genomic testing
- From advanced data pipelines...to ongoing discovery on the genomic frontier
- From field support for your operation...to global collaborations with world-renowned scientists
- From defect and condition screening...to customized profiles for your breed

***If you want to be generations ahead, go with GGP.***

## How to obtain GGP products and services

GGP products are available through partner breed associations and genetics companies. GGP data are used to genomically enhance Expected Progeny Differences (GE-EPDs), test parentage and screen for genetic conditions. GGP data are transmitted to partners via secure, industry-leading bio-informatic tools and backed by our data experts and quality control team.



	October 1990	March 1998	July 2001	July 2001
A Timeline of Genomic Milestones	Human Genome Project begins a 13-year, \$2.7 billion effort, world's largest research collaboration	Abe Oommen and Daniel Pomp found GeneSeek	National Beef Cattle Evaluation Consortium funded to improve beef genetics	Jim Gibb launches Frontier Beef Systems



# The generational timelines of GE-EPDs & traditional bull test evaluation

Collecting good quality phenotype data is very important. Genotyping draws on phenotype data to train DNA tests. Genomic tests are now widely available, affordable and useful on young cattle, even embryos. Today, genotype and phenotype collections are an important resource for breed association members.

	Embryo	Birth	Year 1	Year 2	Year 3	Year 4
<b>Growth/ Carcass EPDs</b>		Bull calf weight	Get yearling weight Mate bull for progeny testing	Get birth weights Wean progeny, place on feed	<b>Get Growth EPDs</b>	Slaughter progeny <b>Get Carcass EPDs</b>
<b>Maternal EPDs</b>			Mate bull for maternal EPDs	Birth of progeny Wean and sort heifers	Breed heifers for first calf	Rebreed heifers for second calf to obtain Maternal EPDs
<b>GE-EPDs</b>		Collect DNA on bull calves and heifers <b>Get GE-EPDs</b>	Market yearling bulls with GE-EPDs Keep heifers with the best GE-EPDs			
<b>Genotyping embryos</b>	Flush dams and DNA test embryos <b>Get GE EPDs</b> ET best embryos of desired genders	Confirm calf parentage	Produce more elite bulls on fewer cows Select elite heifers before they are born	Repeat for next generation		

*Genotyping embryos is a specialized practice that enables a selection decision at minus-8 months of age. EPDs that once took many years to pin down can now be done before birth.*

## How does GGP help you?

Measuring genetic merit. Predicting traits in a sire or dam's offspring. Enabling you to improve each generation of your herd.

### Advantages:

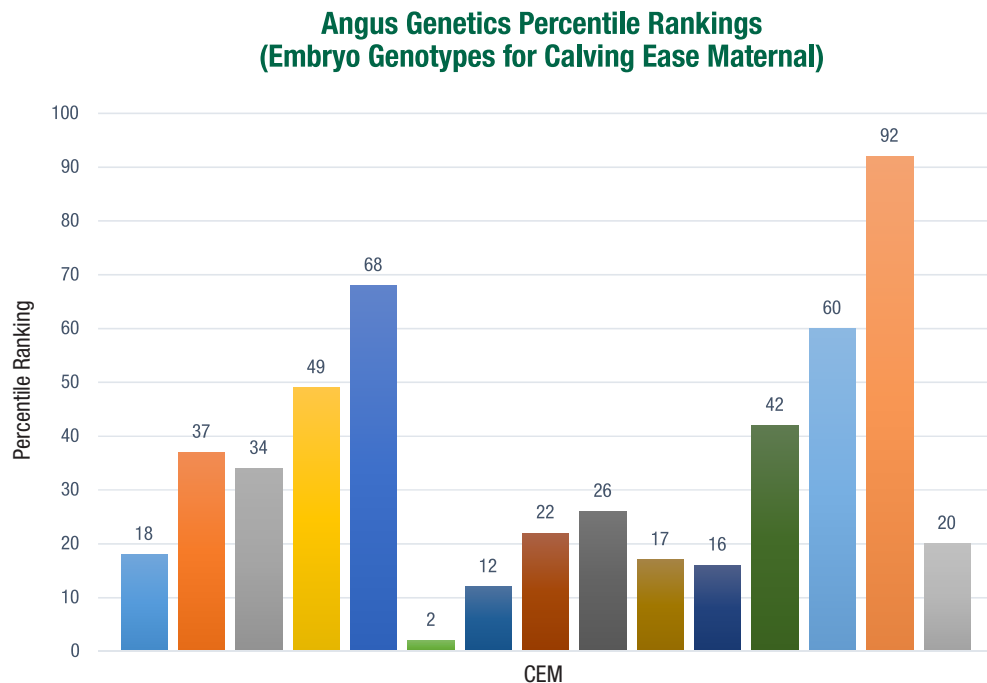
- Measure maternal, performance and carcass traits in one report
- Profile bull and heifer calves at any age
- Save money by developing your best bulls
- Retain elite heifers for your cow lineage



March 2003	April 2003	September 2003	January 2004	August 2004
Human Genome Project puts \$50 million into Cow Genome Project	Human Genome Project completes human genome sequence two years early and under budget	Stewart Bauck, Merial, launches Igenity DNA testing	GeneSeek identifies source of BSE outbreak	Merial acquires Jim Gibb's Frontier Beef Systems

# Each new GGP generation gives you more advantages

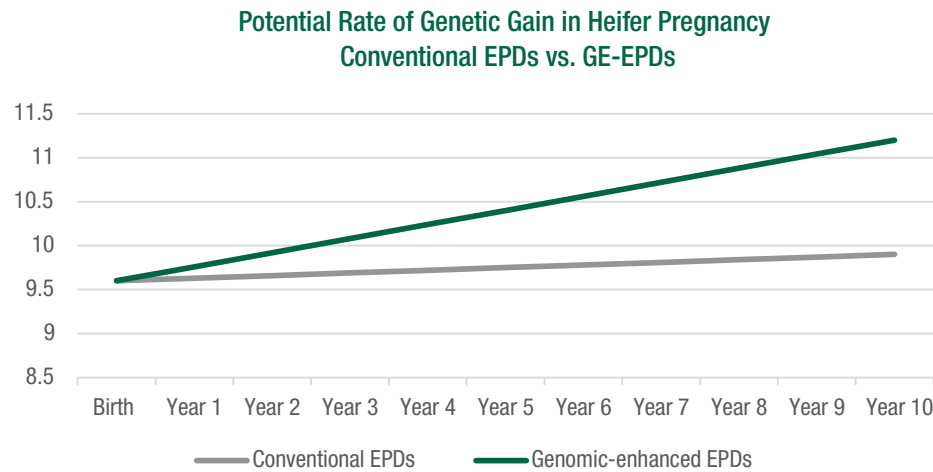
## Managing genetic variation within a generation



This table shows variation in maternal calving ease among half-sibling embryos sired by a single high \$B Angus bull. These results were run independently by Angus Genetics Inc. and provided as percentile rankings. Similar variation was found on other traits. This shows closely related siblings differ greatly on key traits, even in well-established seedstock lineages.

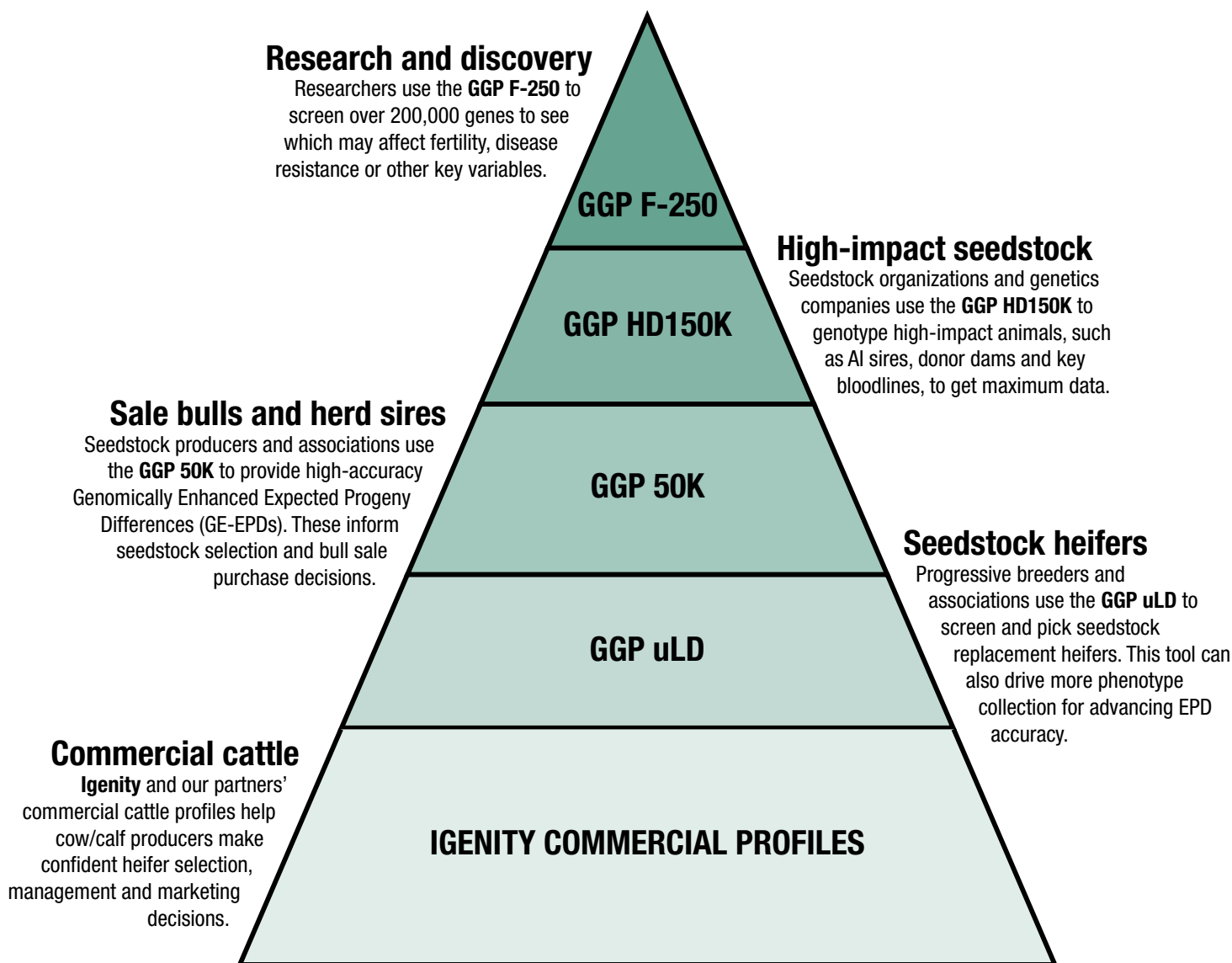
## Improving traits across generations

This example of heifer pregnancy improvement from one generation to the next is based on using GE-EPDs to make decisions instead of conventional EPDs. Whether using GE-EPDs to select male or female breeding stock, or using commercial profiles in a cow/calf operation, genomic-assisted selection with today's improved testing accuracy helps producers improve with each new generation of cattle.



January 2006	April 2006	May 2006	December 2007	January 2008
USDA announces completion of bovine sequence at NCBA	Merial introduces Igenity upgrade	Merial meets with AGI on SNP parentage	GeneSeek is first mover adopting Illumina SNP50 array	Illumina launches SNP50 at Plant Animal Genome conference

# The GGP Portfolio – Each product serves a role in improving your herd



## How beef genomics helps you better serve your customers

By using the GGP portfolio to select, manage and market your bulls and heifers, you are relying on the industry's most advanced genomics toolbox to deliver more accurate performance predictions to your customers.

When your customers use Igenity to select their commercial replacement heifers, they can accurately predict future performance in their cow herd.

July 2008	November 2008	April 2009	June 2009	September 2009
Merial has SNP parentage seminar at BIF	Arthrogryposis Multiplex recognized as a breed defect	Nature Magazine publishes bovine genome, the work of 300 scientists in 25 countries over 6 years	Neuropathic Hydrocephalus (NH) recognized as a breed defect	AGI launches first genomic-enhanced EPD in beef cattle based on Igenity

# Powered by Neogen – The GGP Portfolio

## Efficient selection of seedstock replacement heifers



Never before has such power been so practical. As breed associations add the GGP uLD to their DNA services, you can genomically screen and select replacements for your herd while adding value to heifers you sell.

- **Profile replacement heifers** – Use genomics to select the best and sell the rest
- **Raise elite cows** – Superior nucleus cows are the source of superior bulls
- **Market quality heifers** – Sell heifers with GE-EPDs helpful to commercial cattle producers
- **Verify parentage** – Confirm parentage of heifers for registration and marketing

## The best 50K ever – Effective, affordable power to select, manage and market sale bulls



An ideal tool to test a crop of bull calves, the new GGP 50K is the most advanced 50K ever. Highly accurate. Highly affordable. Very versatile with built-in parentage and genetic-health screening. Nearly all major breed associations offer the GGP 50K as their workhorse profiler for routine use.

- **Genomic-assisted selection** – Identify the best bull calves for sire development or AI studs
- **Profiling bull calves for sale** – Affordable accuracy with GE-EPDs adds value in the sale ring
- **Reputation builder** – Verify quality for local customers and distant buyers
- **Fits modern methods** – Uses markers enhancing new “single-step” GE-EPD calculations

## Setting a gold standard for the best of the breeds



The most powerful commercial seedstock profiler, the GGP HD150K is ideal for AI studs, donor dams and elite bloodlines. With its strategically chosen content, running the GGP HD150K on elite bloodlines improves imputation accuracy of pedigree genotypes.

- **Smart Design** – Contains 150,000 markers, filling in genetic details other tests miss
- **Modern** – Works synergistically with other GGP products in the “single-step” system
- **Imputation standard** – GGP HD150K data on parent and grandparent animals can sharpen GE-EPDs on their progeny
- **Unique content** – Impactful new markers for cattle performance, reproduction and quality

January 2010	April 2010	April 2011	April 2011	April 2012
AGI launches first genomic enhanced EPD based on SNP50	Neogen acquires GeneSeek for \$14 million, based on sales of \$12.5 million and staff of 36	USDA funds 5-year, \$10-million DNA study on BRD using GeneSeek technology	USDA funds \$5-million DNA study on feed efficiency using GeneSeek technology	GeneSeek founders win Nebraska Governors Bioscience achievement award

# Searching the genomic frontier for new ways to empower your decisions



## A discovery tool for scientists exploring the bovine genome



The GGP F-250 is a discovery tool used by researchers to investigate fertility, health and performance in cattle. As new traits are validated, they are adopted into the GGP portfolio.

- **Candidate markers** – Contains over 220,000 functional markers in analysis for impact on key traits
- **GE-EPDs** – Over 35,000 highly informative markers included for GE-EPDs
- **Efficiency** – USDA and Land Grant university researchers have scrutinized 20,000 cattle for “functional variant” genes that affect fertility, stayability, feed efficiency and resistance to bovine respiratory disease complex
- **Environment/genetic interaction** – A University of Missouri/USDA study is using the GGP F-250 to examine genetic adaptation to regional conditions

May 2012	December 2012	January 2013	January 2013	February 2013
Neogen acquires Merial's Igenity line	Simmental Association updates EPDs with GeneSeek 50K	Neogen licenses Cargill BeefGen patents	Neogen acquires Scidera, a Celera spinoff testing cattle, dogs, poultry and swine	Neogen introduces GGP HD80K

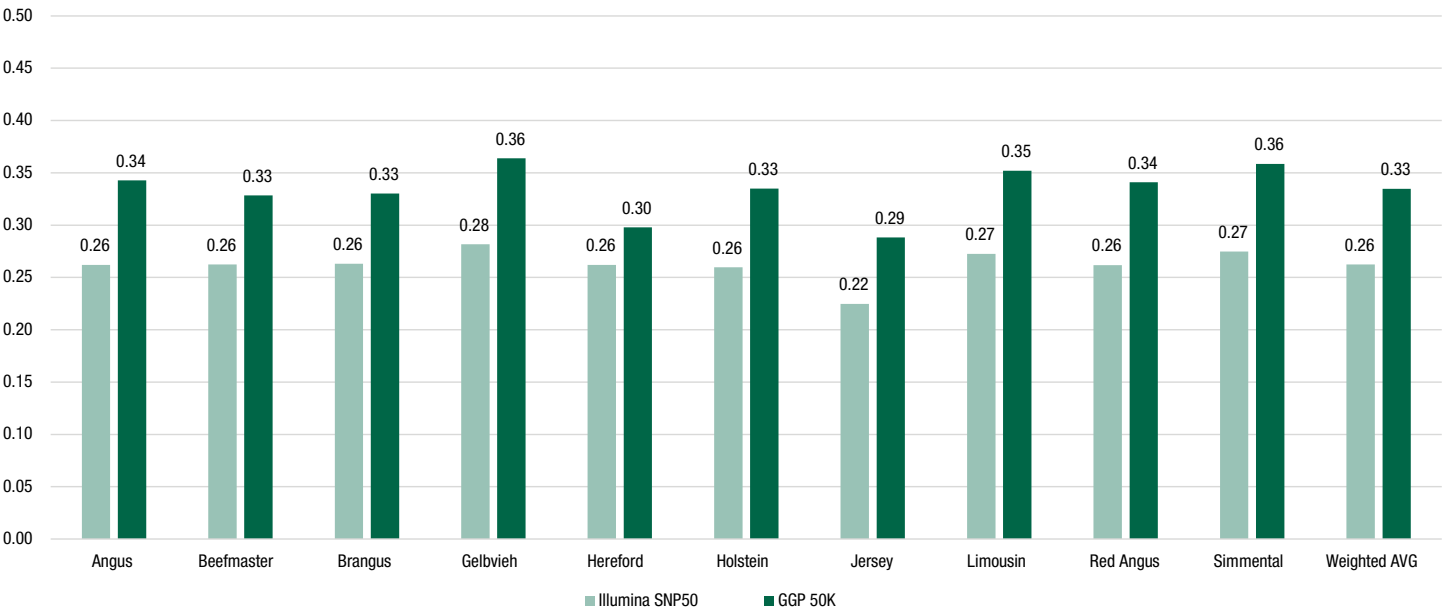
# Smart Design builds better DNA-testing products

## What is Smart Design? How does it help you?

Smart Design is how we select markers and testing systems. Highly active regions of the chromosome are key targets. So are genes causing health effects and conditions. Smart Design also uses a statistical pattern analysis called imputation, using high-density products to make lower-density tests highly accurate. The result for you is fast, affordable and accurate genotyping using the latest research.

- **Synergy** – Smart Design ensures GGP products work in harmony with each other
- **Global standard** – GGP products use globally recognized USDA and ISAG parentage markers
- **Customization** – Associations use GGP to design customized tests for specific breeds

Comparing Minor Allele Frequencies (MAF) between the GGP 50K and Illumina Bovine SNP50



## What is minor allele frequency? Why does it matter to you?

When designing gene tests, minor allele frequency data (MAF) is used to detect variations in a population. Neogen uses Smart Design to pick out the minor alleles that matter most for economic trait predictions. Higher MAF increases imputation accuracy, enhancing GE-EPDs.

September 2013	February 2014	June 2014	August 2014	September 2014
AGI and Neogen launch DD test	Neogen launches new Igenity product line	Neogen GeneSeek Operations dedicates new Lincoln lab housing 90 staff	Brangus selects Neogen as service provider	Merck agrees to market Neogen Igenity dairy products



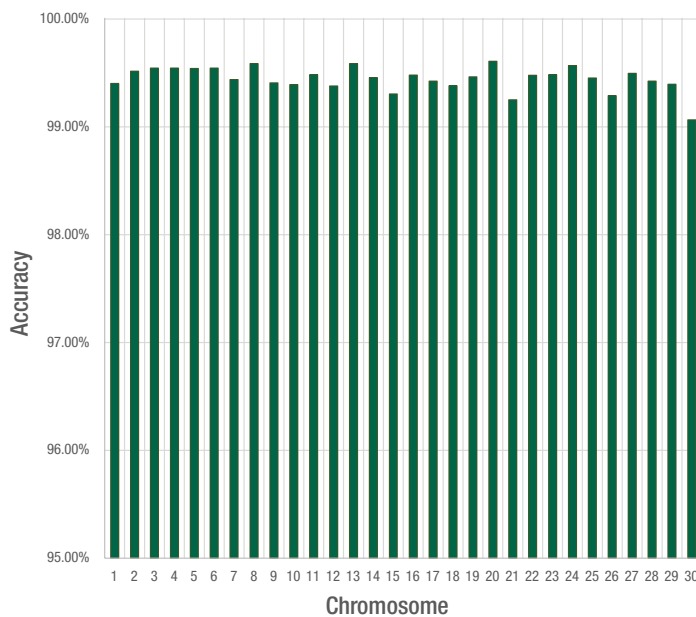
# The promise of the next generation



## What is imputation accuracy?

Imputation in gene tests is used to fill details missing in low-density data by using known patterns from higher-density data. With GGP, Smart Design uses markers that cross over or compare well from one test to another. The GGP 50K, using imputation, is over 99% as accurate as the GGP HD150K. This means the GGP 50K is a very powerful tool for your herd selection, management and marketing practices.

GGP 50K average imputation accuracy



February 2015	July 2015	October 2015	October 2015	November 2015
Neogen launches GGP HD150K	Illumina signs agreement to sell GGP arrays worldwide	Neogen opens genomics office in Guelph, Ontario	Neogen launches GGP LD	Neogen sponsors first Angus Genomics Symposium

# Pulling it all together – how to Go GGP

GGP and other Neogen genetic testing services are sold through breed associations and cattle genetics suppliers.

Breed associations working with Neogen	
American Angus Association/Angus Genetics Inc.	American Brahman Breeders Association
American Hereford Association	American Chianina Association
American Gelbvieh Association	American-International Charolais Association
American Simmental Association	American Maine-Anjou Association
International Brangus Breeders Association	American Salers Association
North American Limousin Association	American Wagyu Association
Red Angus Association of America	Beefmaster Breeders United
American Shorthorn Association	Santa Gertrudis Breeders International
American Akaushi Association	American Aberdeen Association

## When we put you first, that's where we finish too

As you represent your seedstock with accuracy, integrity and confidence, know that Neogen is with you every step of the way, with products that are first in the field.

- First to offer a 50K profile
- First with commercial cattle profiles
- First with an 80K profile
- First with an LD profile
- First with a 150K profile
- First with a 250K profile
- First with a uLD profile
- First with targeted *Bos indicus* product
- First with archived Tissue Sampling Units (TSU)
- First with a TSU robot
- First with an industry-leading Lab Information System
- First with a commercial beef dashboard

**You're great at what you do. We help you be even better.**

**Field support** — If you need to tap into our expertise, your main point of contact is with our team of territory managers. These local experts can help you assess your genomic selection program, assist in training on DNA sampling and support your marketing efforts through meetings, seminars and product education. We also provide access to bull sale merchandising and education materials.



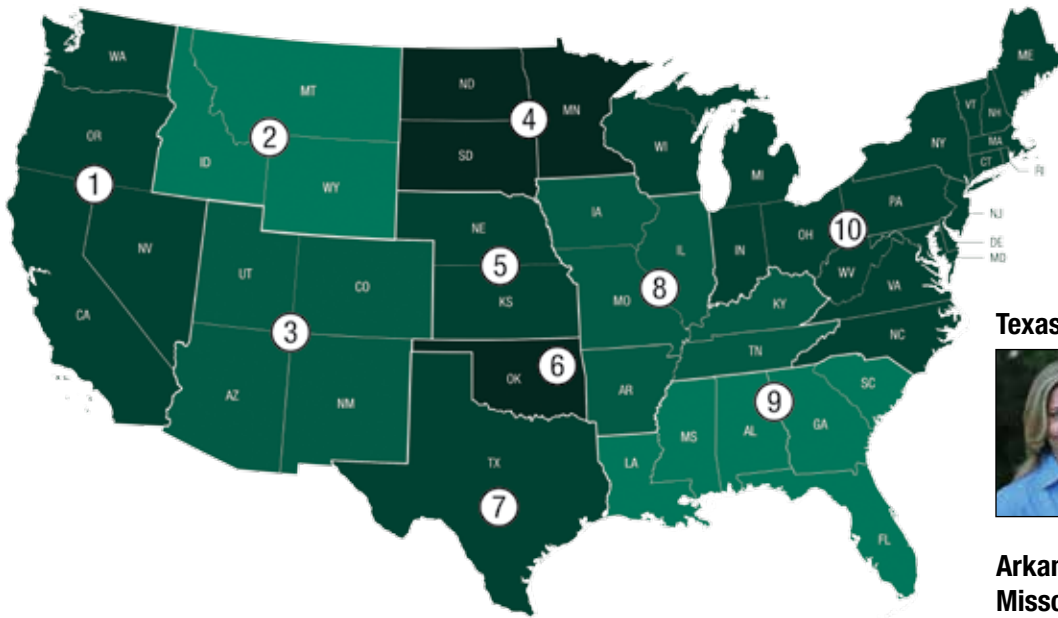
November 2015	April 2016	May 2016	June 2016	October 2016
Top Dollar Angus accepting Igenuity tests for steer qualification	Neogen acquires DeOxi genomics in Brazil	USDA grants \$2 million to study beef genetics/environment adaptation	Neogen introduces GGP F-250 at BIF	Scotland picks Neogen Europe for national beef genomics program





October 2016	February 2017	March 2017	February 2017	A Timeline of Genomic Milestones
Neogen launches new GGP uLD	Neogen launches new GGP 50K	Neogen announces new data services group	Neogen and the IBBA launch Igenity Brangus	

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