

DNA Testing in Beef Cattle

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What data should I use when making selection decisions on my farm?

- Visual appearance
- Performance data (e.g., 205-d WW)
- Ratios
- Expected progeny differences (EPDs)
- Selection indices (e.g., \$EN, \$B, CEZS)
- DNA testing (e.g., GeneSTAR, Genemax)
- Genomic enhanced EPDs
- Genomic selection indices (e.g., \$MVP^{FL})
- Flip a coin
- Pray for a "sign from above"




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What is DNA?

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How does DNA store information that can be used to build a cow?



ACCGGTATCCGGAATTCGAA

↓

Make a cow ear!

TGCAGAATTCGAAACCGGAT

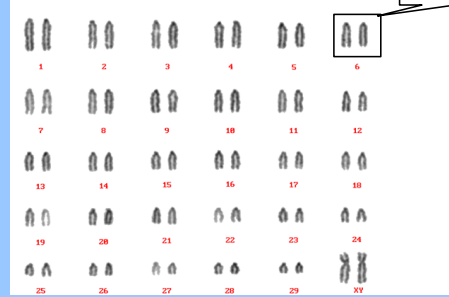
↓

Make a cow tail!

- Unlike a blueprint, information is not stored in letters and numbers!
- Only four "letters" in DNA: A, C, G, and T
- These "letters" can spell out a specific function in the cow

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A picture of the cattle genome



Two copies are present at each chromosome!

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DNA has a "backup" copy!

ACCGGTAT

ACCGGTAT

Make a cow ear!

One DNA copy comes from the mother and the other DNA copy comes from the father.

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Is DNA all the same?

DNA copy 1: ACCGGTATCCGGAATTCGAA } Both copies of DNA are identical.
 DNA copy 2: ACCGGTATCCGGAATTCGAA }

DNA copy 1: ACCGGTATCCAGAATTCGAA } DNA is not identical!
 DNA copy 2: ACCGGTATCCGGAATTCGAA }

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Is DNA all the same?

DNA copy 1: ACCGGTATCCGGAATTCGAA } Both copies of DNA are identical.
 DNA copy 2: ACCGGTATCCGGAATTCGAA }

Allele 1: ACCGGTATCCAGAATTCGAA } DNA is not identical!
 Allele 2: ACCGGTATCCGGAATTCGAA }

Alleles are therefore **A** and **G**

"Genotypes"		
AA	AG	GG
ATCCAGAAT ATCCAGAAT	ATCCAGAAT ATCCGGAAT	ATCCGGAAT ATCCGGAAT

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So what??

- Differences in the DNA sequence among animals can cause changes in economically important traits in an animal
- Different alleles can have an effect on many different traits
- Black/red coat color
- Weaning weight
 - AA: + 10 lbs.
 - Aa: + 5 lbs.
 - aa: 0 lbs.

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Complex vs. simply-inherited traits

- Some traits (e.g., red/black coat color in Angus cattle, many genetic defects) are determined only by a single gene.
- Assume two alleles **A** and **G**, where **G** is responsible for a genetic defect.

ATCCAGAAT ATCCAGAAT	ATCCAGAAT ATCCGGAAT	ATCCGGAAT ATCCGGAAT
Non-carrier	Carrier	Has genetic defect

- Most traits are **complex**, controlled by hundreds of genes and environmental factors.

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What factors affect weaning weight in a calf?

Health of the calf

Milk production of dam

Stress

Genetics!

Management (e.g., creep feeding?)

Diet

Age at weaning

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What is a DNA test?

- A **DNA test** directly examines genes that are associated with a trait.
- A producer submits a DNA sample (e.g., hair follicle) and the DNA testing company “tests” the animal’s DNA for traits of interest to the producer.
- DNA testing for **simply-inherited traits** are relatively straightforward.
- DNA testing for **complex traits** are, well, more complex!

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DNA testing for weaning weight

- The following DNA test is examining only four genes

Gene 1: A allele = + 10 lbs.
T allele = - 10 lbs.

Gene 2: A allele = + 5 lbs.
G allele = - 5 lbs.

Gene 3: C allele = + 5 lbs.
G allele = - 5 lbs.

Gene 4: G allele = + 1 lb.
T allele = - 1 lb.

	Gene 1	Gene 2	Gene 3	Gene 4	Genomic Value
Bucky	AA = +20	AG = 0	GG = -10	GG = +2	+ 12 lbs.
Jackrabbit	AA = +20	AA = +10	CC = +10	GG = +2	+ 42 lbs.
Bison	TT = -20	GG = -10	GG = -10	TT = -2	- 42 lbs.

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Is the DNA test any good?

- If only five genes affected weaning weight, then this DNA test is probably a good predictor of weaning weight
- What if 200 genes affected weaning weight? Then this DNA test may not be a good predictor of weaning weight
- Need to ask **what percentage of genetic variation** does the DNA test explain? (Higher percent is better.)

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Why use a DNA test for a complex trait?

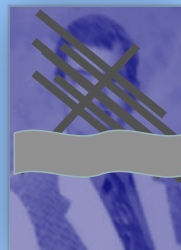
- What is wrong with EPDs?
- Nothing is wrong with EPDs. Producers should almost always use EPDs when available.
- EPDs for some traits, however, will not be very accurate for young animals.
- DNA testing increases the accuracy of our EPDs (or genetic estimates) at a younger age.

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Who is this individual?

This example is analogous to having only pedigree information on a calf. Your “guess” is really not that good.



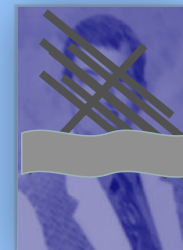
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What happens if you use DNA testing?



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Who is this individual?

This example is analogous to having only pedigree information on a calf. Your "guess" is really not that good.

What happens if you use DNA testing?

Depending on the quality of the DNA test, we can obtain a better "estimate" the calf's genetic merit.

Remember, DNA does not change within an individual!



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What about now?

This example is analogous to a proven bull. We already have a highly accurate EPD for many traits for proven bulls. Does it make sense to DNA test a proven animal?



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DNA Tests for Complex Traits

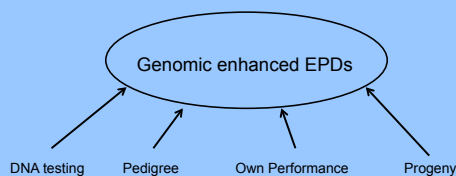
- Breed-specific DNA tests
 - Genomic enhanced EPDs
 - Black Angus, Red Angus, Hereford, Limousin, Gelbvieh, Maine Anjou
- Non-breed specific DNA tests
 - GeneSTAR
 - Igenity
- Generally, breed-specific DNA tests are "better" (i.e., explain a higher % genetic variation)

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Genomic-enhanced EPDs

- Incorporates genomic information into the calculation of EPDs



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Interpreting DNA test results

- Can be used to compare animals for genetic potential in measured traits

Animal ID	Tenderness MVP
A	0.3 lbs
B	0.08 lbs
C	0.05 lbs

- In this example, animal "C" is most tender and animal "A" is least tender (negative values are more favorable)

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Interpreting DNA test results

- Sometimes DNA test results are reported as 1-10 numerical scores.
- Higher scores (i.e., 10) are usually, but not always, better than lower scores (i.e., 1).
- Genomic test results are **NOT** EPDs!!
 - Comparing the progeny of animals with an EPD
 - Comparing the individuals themselves with DNA tests currently available
 - DNA tests only consider genes in their testing panel

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GeneMax (Certified Angus Beef DNA test)

- > 75% Angus cattle sired by registered Angus bulls
- GMX Score (1 to 100 score) – Gain and marbling; higher scores are more favorable
- GMX Gain (1 to 5) – score of 5 is more favorable (top 20% for gain of animals tested)
- GMX Marbling (1 to 5) – score of 5 is more favorable (top 20% for marbling of animals tested)

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What traits can be tested for with DNA?

- Most of the traits that have EPDs
 - Growth
 - Energy maintenance & Feed efficiency
 - Calving ease
 - Carcass traits
 - Scrotal circumference
 - Docility
- Novel traits are in the pipeline (e.g., BRD susceptibility)

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Take home message

- **Genomic-enhanced EPDs** are going to be the standard for most breeds
 - Higher accuracies
 - Weights genomics information more appropriately
- Older DNA tests (e.g., Igenity PROFILE, GeneSTAR) will still be available for crossbred individuals
- Most of the breed-specific tests will cost about \$60-\$80/head

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Acknowledgements

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- Thanks to all of you for your attention.



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