Why Should Commercial Cattlemen be Interested in Genomics?

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MacG Jul '16

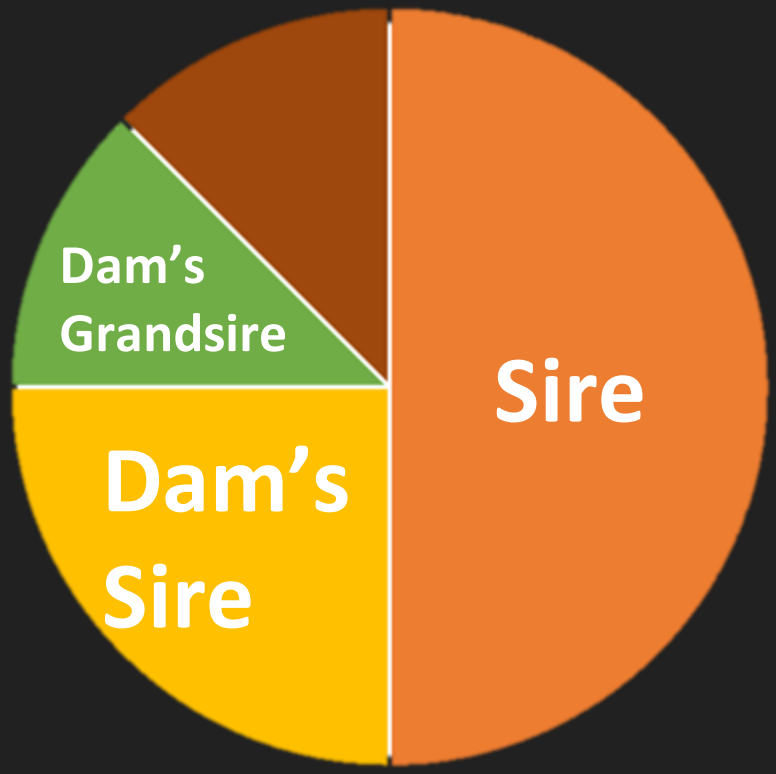
What one place should every commercial herd be using genomics?

SIRE SELECTION!

The bull purchase is one of the *riskiest* decisions that a commercial cattle operation makes

Bull selection plays an outsized role in genetic progress

In a one-bull herd, the last three bull purchases account for 87.5% (on average) of the genetics of current calf crop!



Young sires do not have progeny information to back up EPDs

What is our goal in animal breeding?

In a large population of highly related individuals…

Across a range of unique environments and management…

How do we identify animals with the best genetic potential?

$$\Delta G$$

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The "Breeder's Equation"

$$\Delta G/year = \frac{r_{BV,\hat{BV}}\, i\sigma_{BV}}{L}$$

ΔG = Genetic Progress

$r_{BV,BV}$ = accuracy of selection

i = intensity of selection

σ_{BV} = genetic variation

L = generation interval

How well does our "selection metric" represent the animal's actual genetic merit?

How often do we make the "correct" selection decision

Dissecting phenotypes for more accurate selection

Phenotype = **Genotype** + **Environment**

Heritable Genetic Variation

Environmental Variation

Dissecting phenotypes for more accurate selection

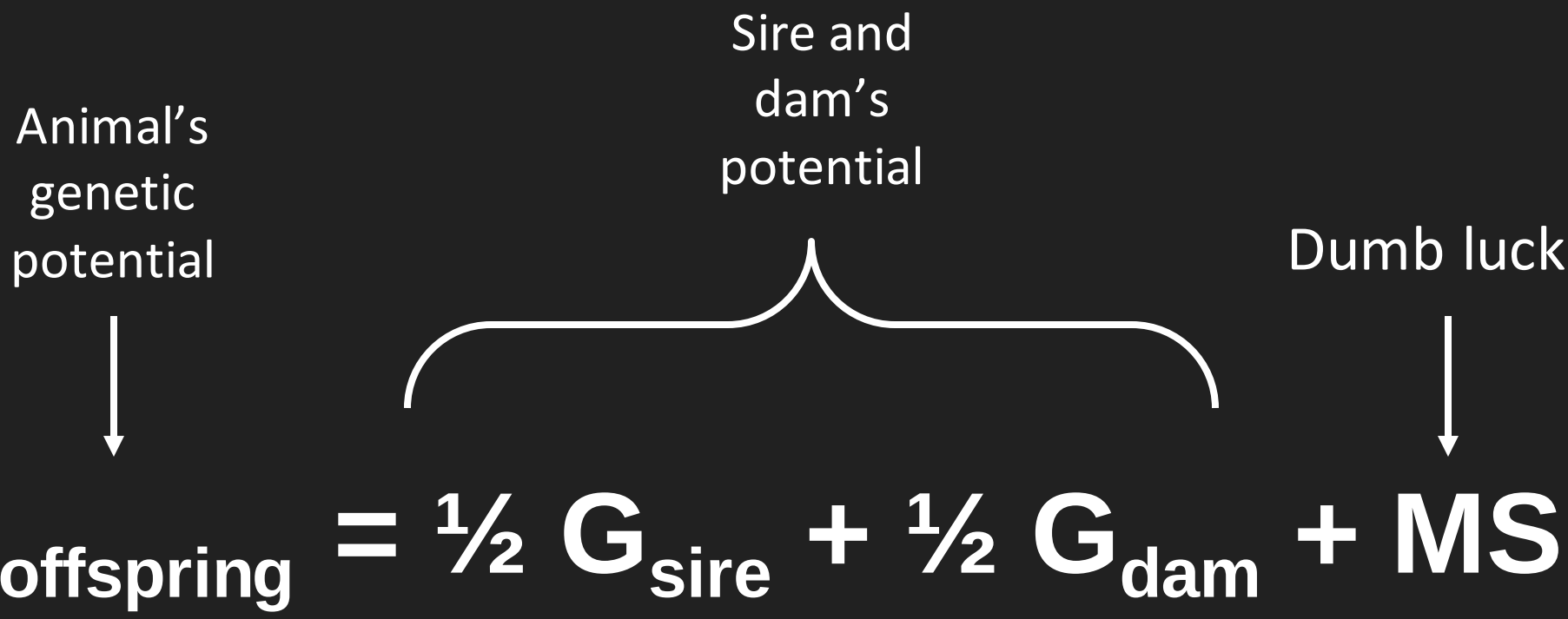
Phenotype = **Genotype** + **Environment**

EPDs

Contemporary Groups

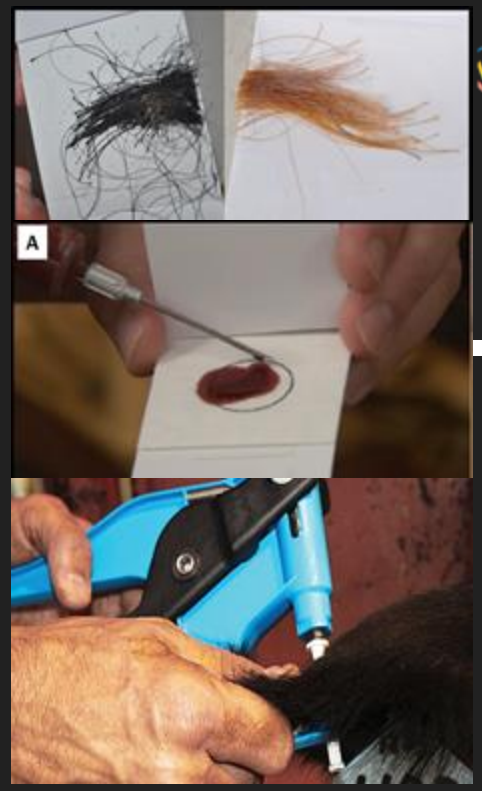
Once we have removed environmental variation from a phenotype, then we can start to figure out **WHICH** genetics an animal inherited from its parents.

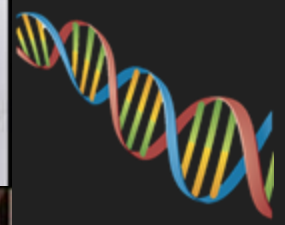
Random chance complicates things further…



Mendelian sampling (MS) can account for over 50% of genetic variation in complex traits!

DNA Sample/Extraction





Observe genetic polymorphisms

Represent relationships between animals better

$$
\begin{array}{c} \\ h_1^1 \\ h_1^2 \\ h_2^1 \\ h_2^2 \\ h_3^1 \\ h_3^2 \\ h_4^1 \\ h_4^2 \end{array}
\begin{array}{c}
\begin{array}{cccccccc} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 \end{array} \\
\left[\begin{array}{cccccccc}
0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \\
0 & 1 & 1 & 0 & 0 & 1 & 1 & 1 \\
0 & 0 & 0 & 1 & 1 & 0 & 0 & 1 \\
1 & 0 & 0 & 0 & 1 & 0 & 1 & 0 \\
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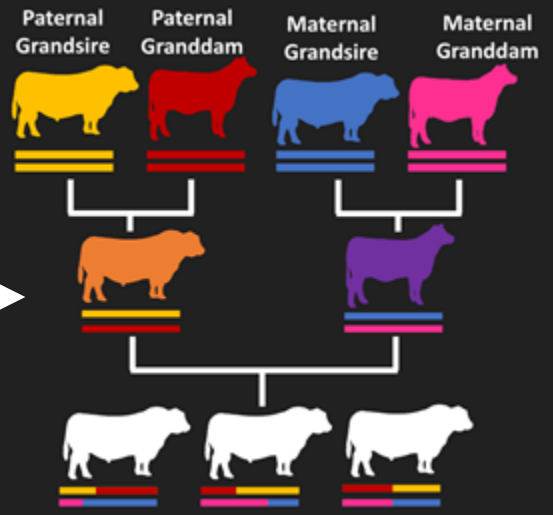

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Animal's genetic potential

Sire and dam's potential

Dumb luck

$$G_{offspring} = \frac{1}{2} G_{sire} + \frac{1}{2} G_{dam} + MS$$

Calves outperforming parental expectation

=

Likely that bull got favorable "random sample" of parent's genes

Genomic tests increase EPD reliability in UNPROVEN animals

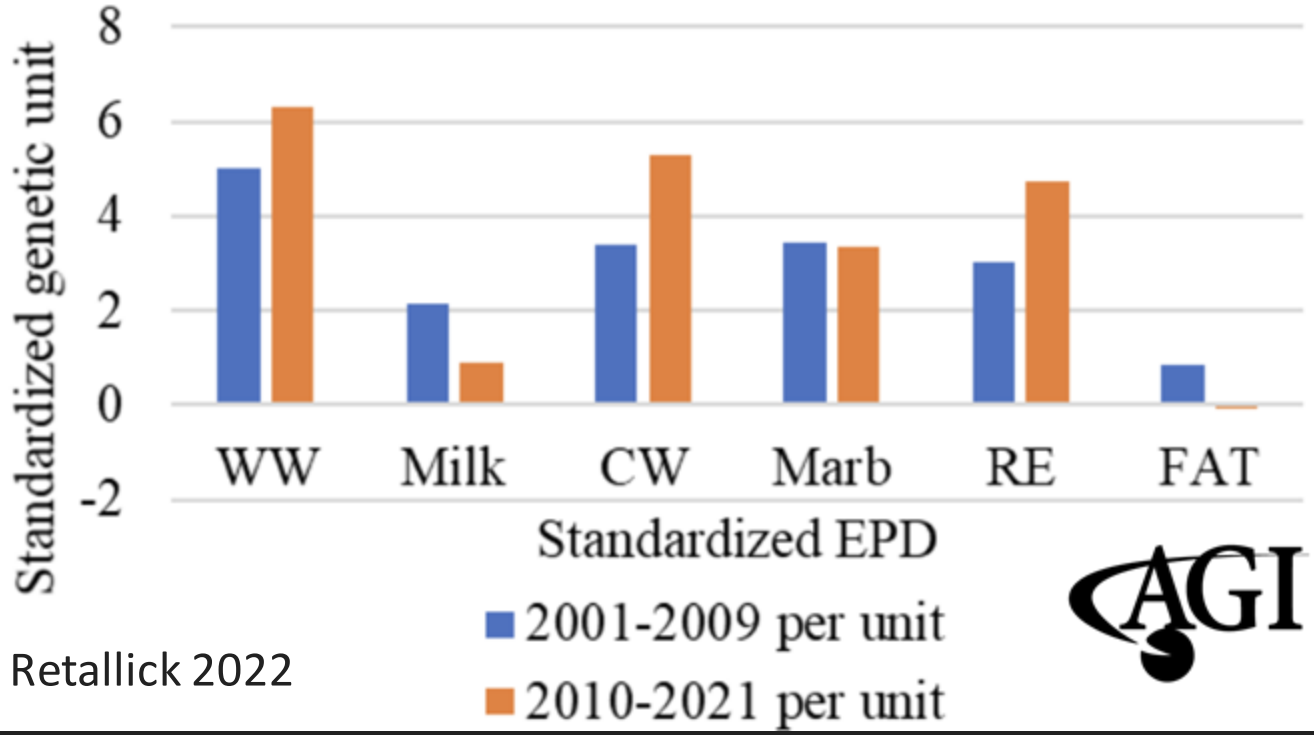
Trait	PE	Trait	PE
Calving Ease Direct	28	Heifer Pregnancy	17
Birth Weight	23	Calving Ease Maternal	18
Weaning Weight	27	Milk	35
Yearling Weight	22	Mature Weight	14
Dry Matter Intake	11	Carcass Fat	13
Yearling Height	15	Carcass Weight	4
Scrotal Circumference	13	Carcass Marbling	10
Docility	11	Carcass Ribeye	16

The bottom line for commercial producers:

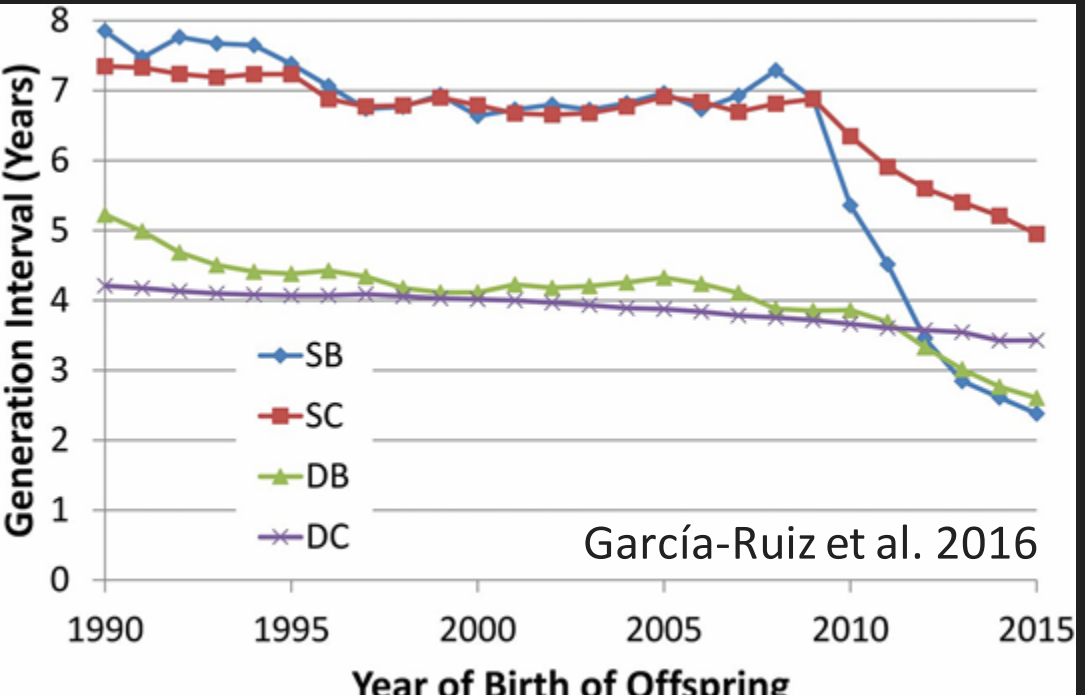
Genomic testing reduces risk when purchasing unproven bulls

Genomics works!

Accelerates genetic gain across populations



Retallick 2022



García-Ruiz et al. 2016

Reduces generation interval

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Remember, regardless of whether GE-EPD improves or gets worse, it is ALWAYS better than an un-enhanced EPD

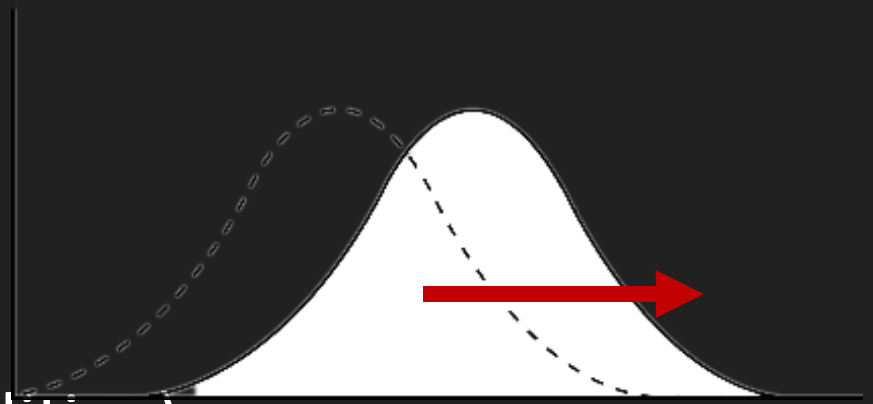
The increase in accuracy gets us closer to the "true" genetic merit of an animal

Genomics for the commercial herd

Managing Expectations

What genomics do:

- Help estimate genetic merit
- Increase EPD accuracy in unproven animals
- Accelerate population genetic gain



What genomics don't do:

- Predict phenotypes for individuals
- Account for non-heritable (or non-additive) components of traits

Genomic testing for commercial producers

Genetic evaluations

The ASA Performance Records

Red Navigator+

Straight-bred commercial tests

Igenity® Brangus®

GMX GENEMAX Advantage

Multi-breed commercial tests

Igenity®

INHERIT™ select

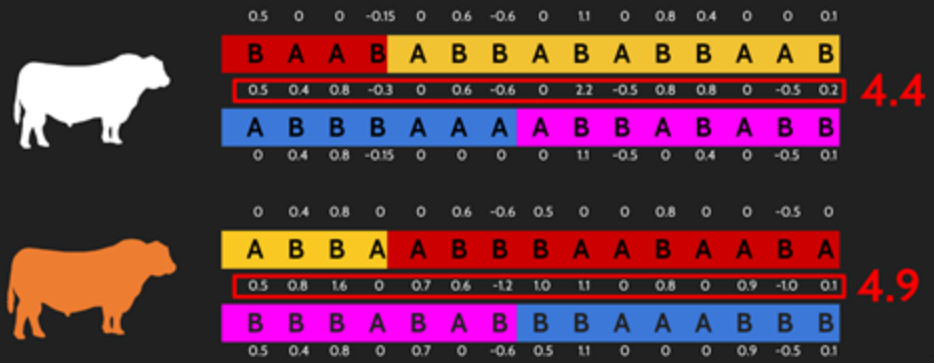
Genomic testing for commercial producers

Single-Step GBLUP

$$\begin{bmatrix} X'X & X'Z \\ Z'X & Z'Z + H^{-1}\lambda \end{bmatrix} \begin{bmatrix} \hat{b} \\ \hat{u} \end{bmatrix} = \begin{bmatrix} X'y \\ Z'y \end{bmatrix}$$

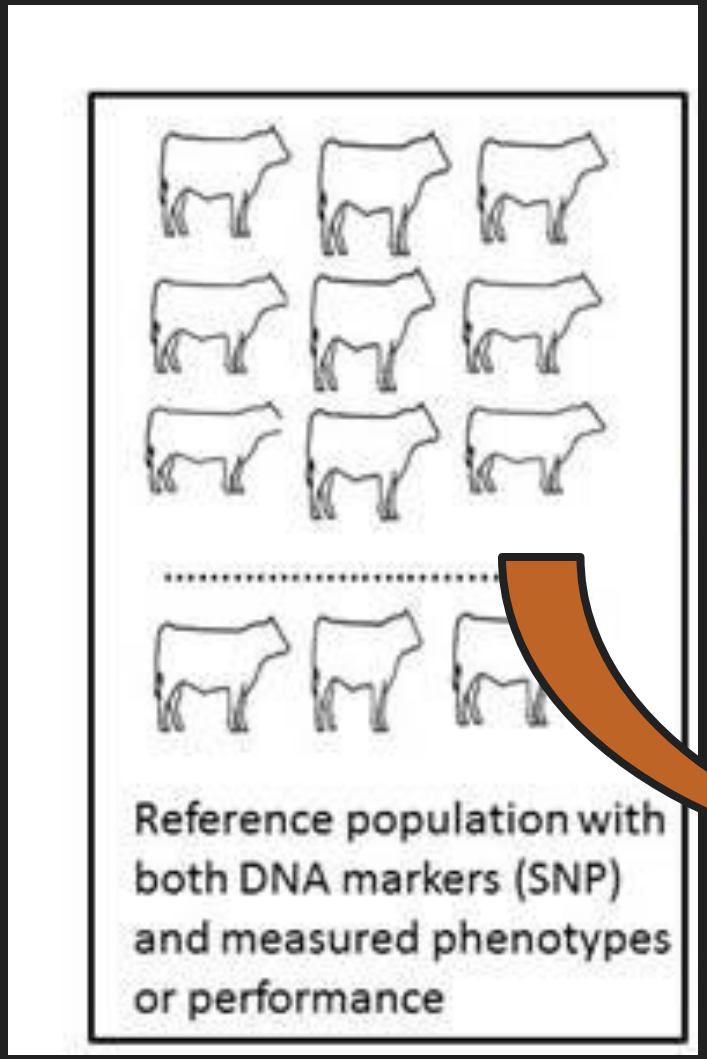
- Treated as animals in a “true” genetic evaluation
- Genomics allow integration into single-step
- Typically more accurate

Marker Effects (MBV)



- Marker effects estimated from “training population”
- Summed over genome
- Accuracy relies heavily on relationship to training animals

Relationship to Training Population is Essential



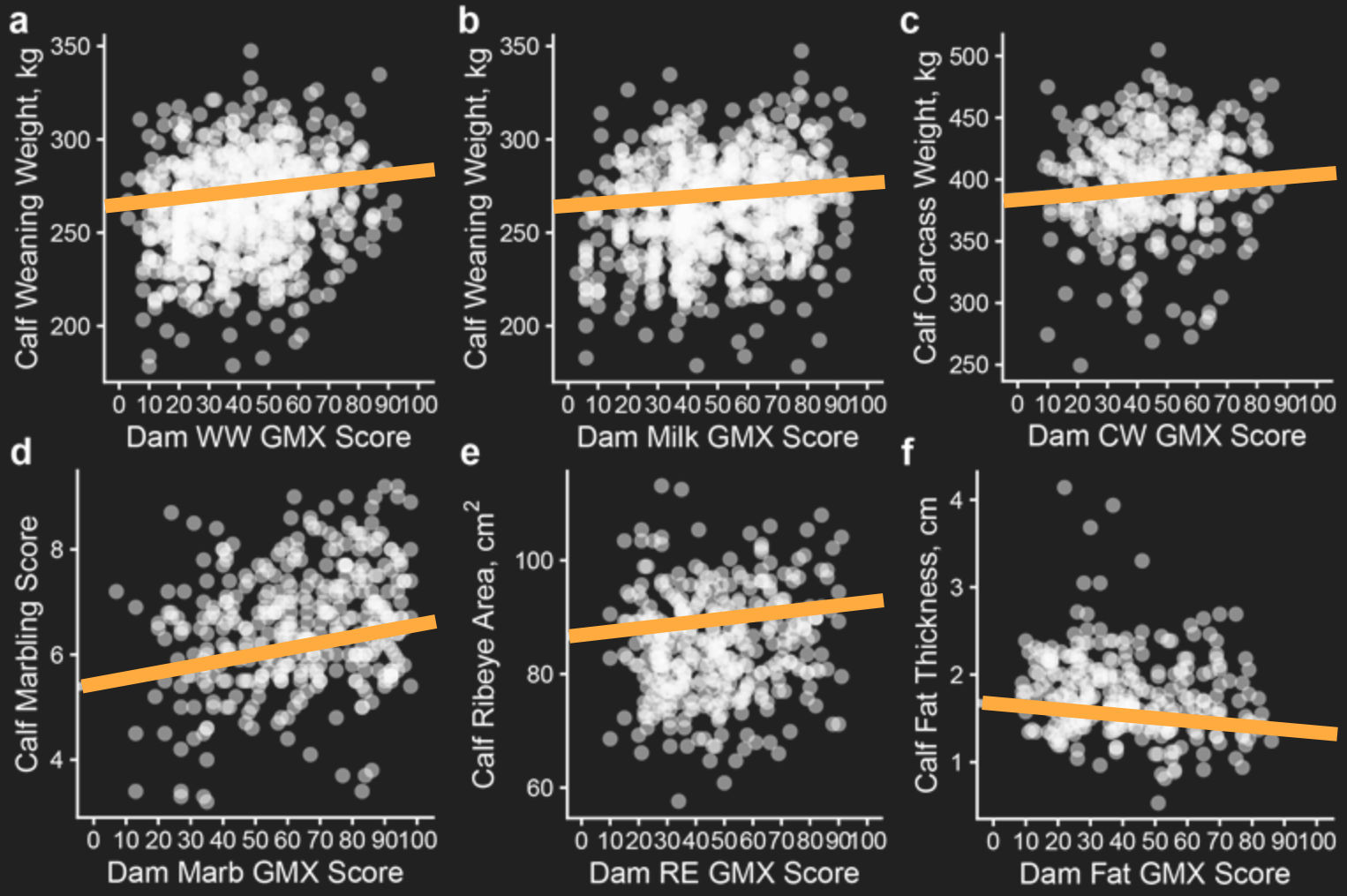
How similar are these populations??

https://beefgenomicprediction.ca/html/What-is-genomic-prediction.html

Commercial genomic tests work!

Multi-year commercial genomic test validation

Dam genomic scores vs. actual calf phenotypes



Arisman et al. 2022

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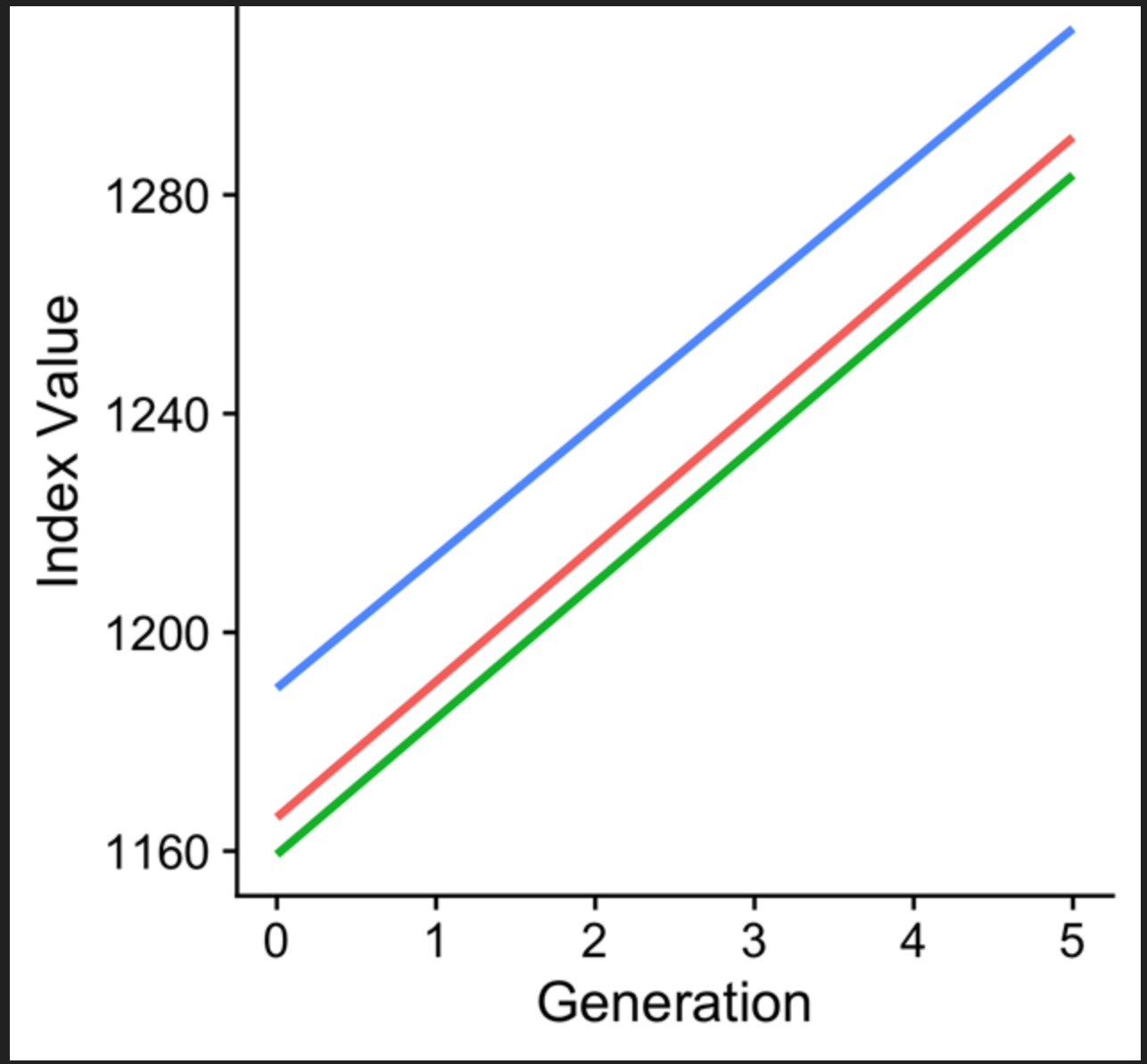
How well does our “selection metric” represent the animal’s actual genetic merit?

What proportion of animals make it to the next generation?

Do genomics move the needle?

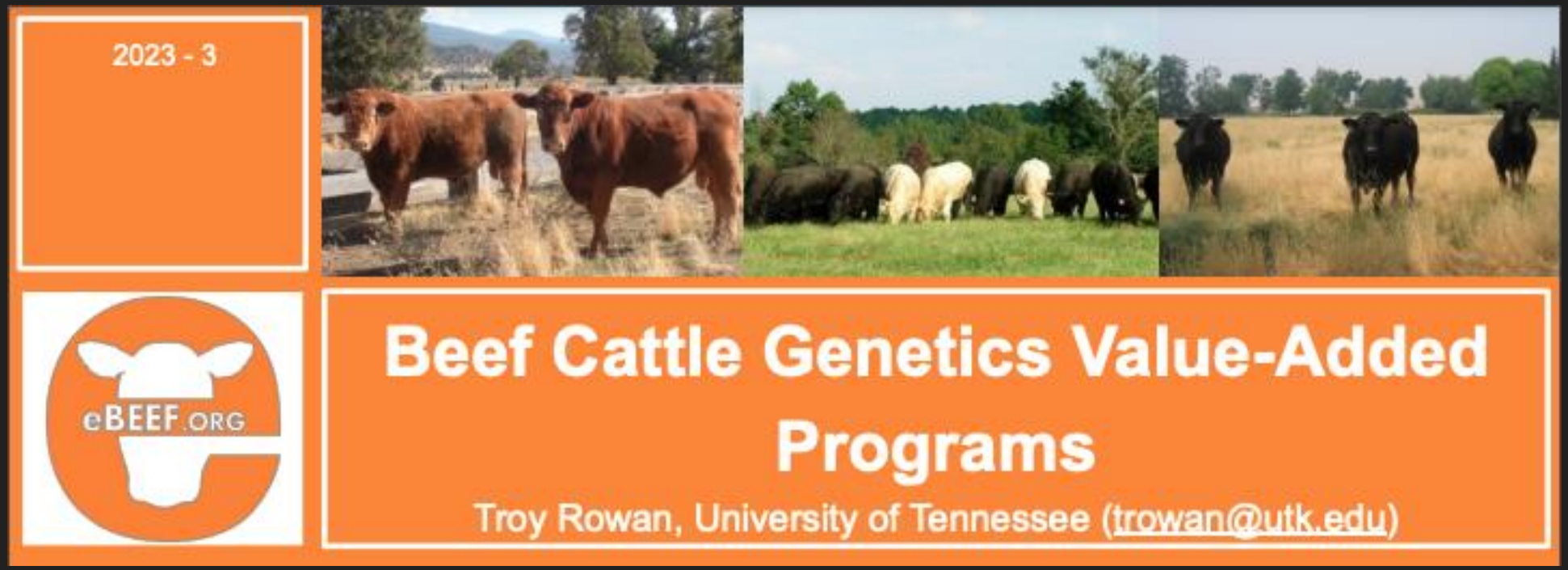
- Seedstock animals drive the genetic trends in commercial cattle sector
- Genomic test does generate some added genetic merit
- Overcoming genetic lag?



We MUST test more heifers than we plan to keep

Testing only heifers we already know we'll keep is just expensive confirmation bias

Genomics for feeder calf marketing



We can add value to feeder cattle through genomics and/or sire verification

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https://tinyurl.com/commercialgenetics

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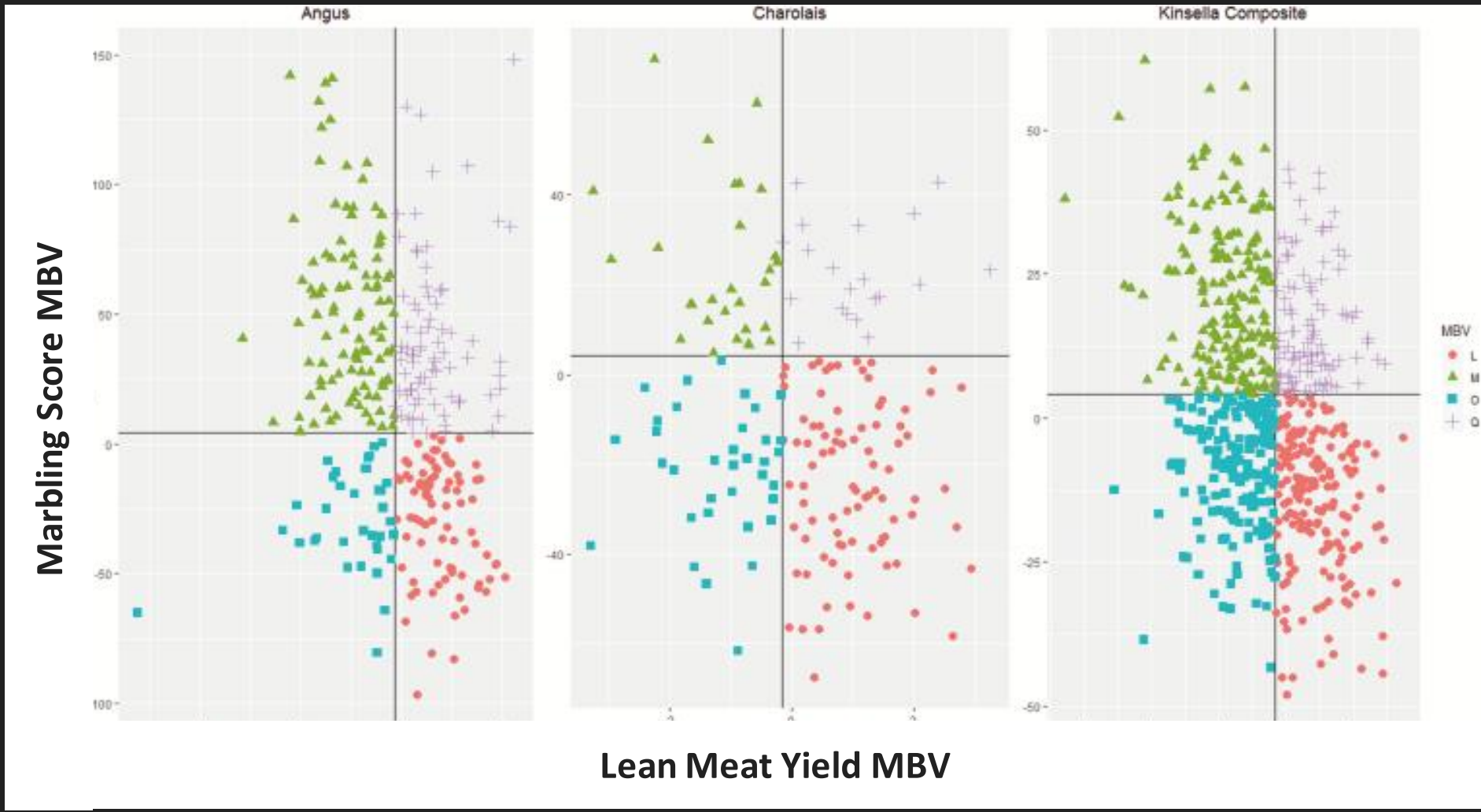
Feeder calf genomic testing works

Trait	r	h^2
HCW	0.53	0.43
FAT	0.59	0.39
REA	0.58	0.45
LMY	0.58	0.43
MAR	0.58	0.43



Akanno et al. 2019 JAS

The big question: Return on Investment

- Trait heritabilities matter for utility of prediction with regards to predicting animal's future phenotype
- ROI depends on development costs/variation amongst tested individuals
- Use of genomics in marketing?
  - Will buyers pay more for genetic potential?
- Genotyping cost per replacement
- Accuracy in tested population
- Opportunity cost:
  - Would this extra $$ be better spent on a better bull?

The “Next Frontier”

What happens when we have a <$5 genomic test?

How do we leverage traceable commercial data into genomic evaluation phenotypes?

Beef x Dairy?

Genomics are an essential tool for bull selection

Commercial producers now have affordable genotyping products

Commercial producers can take advantage of genomics for heifer selection and feeder calf marketing, but ROI remains a bit unclear

Reach out with questions!

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