

GENOMIC TOOLS IN BEEF CATTLE BREEDING

Raluca Mateescu | Associate Professor of Quantitative Genetics & Genomics

Email: Raluca@ufl.edu
Website: www.ralucamateescu.com

Department of Animal Sciences
UF UNIVERSITY of FLORIDA

Impact of genomics in beef cattle

- Most – if not all – economically important traits are complex (quantitative) traits

1. Controlled by **many genes**

- Genomic tests - subset of these genes (and most times, not the genes themselves)
- Accuracy associated with how much of the underlying genetics the test accounts for

2. Under **environmental** influence

- Same genetics will perform differently in different environments
- Accuracy associated with the environmental variation

Rate of genetic change

- Depends on 4 factors:
 - Selection **intensity**
 - How choosy we are in selecting individuals as parents
 - Can improve (increase) through management
 - **Accuracy** of genetic prediction
 - How close the EBV is to the true BV
 - Can improve (increase) through more/better records
 - **Generation interval**
 - Time between 2 generations
 - Can improve (decrease) through management or genomic selection
 - Amount of **genetic variation** in the trait
 - Genetic variation in a population (constant over short period of time)

Potential Benefits of Genomics

- Benefits are greatest for economically important traits that:
 - Are difficult or expensive to measure
 - Measured late in life or after death
 - Not currently selected for because are not routinely measured
 - Have lower heritability
- Benefits:
 - Determine the value of animal at birth
 - Increase accuracy of selection
 - Reduce generation interval
 - Increase selection intensity
 - Increase rate of genetic gain

Genetic Evaluations for Beef Cattle

- Majority – carried out by breed associations
 - Different genetic evaluation providers
 - Different methods to calculate EPDs



Different EPDs reported for each breed

challenging to compare data from different evaluations

- Within a breed - EPDs can be directly compared
- Historically - “across-breed” EPD adjustment factors, developed by USDA-MARC

Genomic Testing

- Incorporation of DNA information into genetic evaluations – stepwise evolution since 2000.
- Goal: **increase the accuracy** of predicting genetic merit (EPD)

For breeders to make the **best use of genomic** data, it needs to be **combined** with traditional sources of information (i.e. phenotypes and pedigrees) into traditional genetic evaluations.

Incorporation of genomic information

Which traits?

- Traits **with** routine genetic evaluations obtained from phenotypic and pedigree information.
 - Enhanced **accuracy** of genetic evaluations
- Traits **without** routine evaluations.
 - Will allow selection for **novel** but economically important traits

Traits with current genetic evaluation

- Traits **with** routine genetic evaluations obtained from phenotypic and pedigree information.
 - Enhanced **accuracy** of genetic evaluations

Pedigree estimated EPDs, no ultrasound scan data

OLD	CWT	MARB	RE	FAT
EPD	+15	+79	+41	-.001
Acc	.05	.05	.05	.05

Genomics added

NEW	CWT	MARB	RE	FAT
EPD	+18	+71	+50	+004
Acc	.30	.38	.35	.28

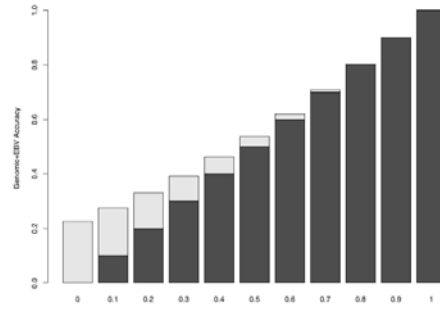
Traits with current genetic evaluation

Enhanced accuracy of genetic evaluations

- More pronounced in **young** animals with no recorded progeny – high value for selection of replacement animals.
- The increase in **accuracy** will depend on:
 - Available records on relatives
 - Heritability of the trait
 - Proportion of variation accounted for by the test

Adding Genomic Information

- Increase in accuracy from integrating genomic information that explains 40% of the genetic variation into EBV



M. Spangler, Integrating molecular data into NCE: expectations, benefits, and needs

Population specific tests

- Current marker panels (genetic tests) are likely to work best in the populations where discovery occurred
- Predictive power decreases as the target population becomes more genetically distant

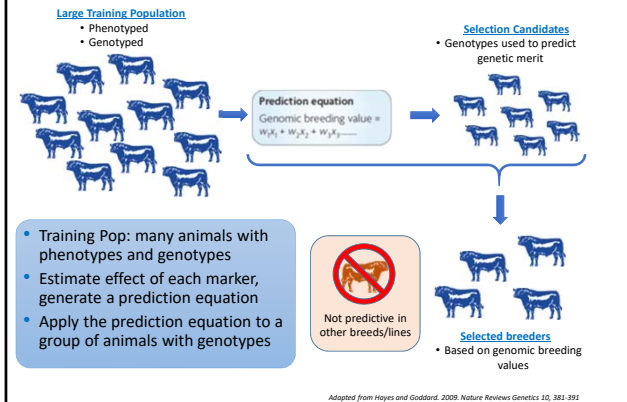
Discovery	Target	
Angus	Angus	Closest relationship
Angus	Charolais	↓
Angus	Bos Indicus	Most distant relationship

- Same erosion will occur over time (over generations if panels are not retrained).

Novel traits

- Genomic information (SNPs)
 - Increase the accuracy of EPDs
 - Add “novel” traits to our suite of available EPD (cattle health – BRD, feed efficiency, healthfulness, nutritional value, disease resistance, thermotolerance, reproductive traits)
- Large resource populations with phenotypes are required for discovery and validation.
- Need breed specific prediction equations.

Principles of Genomic Selection



Challenges for the Beef Cattle Industry

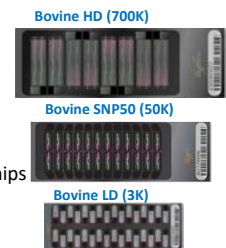
- Little use of AI
- Relatively few high accuracy sires for training
- Multiple competing selection goals – cow/calf, feedlot, processor – little data/value sharing between sectors
- Few/no records on many economically-relevant traits
- Many breeds, some small with limited resources
- Crossbreeding is important
- No one wants to pay, as value is not recovered by breeder



Available Genomic Tests

Genomic testing

- Available through breed associations, partnered with companies providing genotyping services (Zoetis, Neogen/GeneSeek)
- Several types of tests main difference is the number of genetic markers included
 - 50K = 50,000 SNP
 - \$75-90 for the high-density chips
 - \$45-55 for the low-density imputation chips
- Breed assoc. includes genomic info into genetic evaluations



genomic-enhanced EPD

Other tests

- Simple genetic conditions
 - Horned/polled
 - Coat color
 - Genetic abnormalities
- Costs vary, large number of labs providing the tests, price range **\$22 - 45**
- Stand alone test for parentage: **\$18 - 30**
- Many of these simple genetic tests can be purchased less expensively as an **add-on** to the higher density genotyping tests.

Commercial cattle testing

- Several tests marketed for use on commercial cattle
- Not directly part of a breed association genetic evaluation program
- No independent, peer-reviewed papers in the scientific literature documenting the field performance.

Angus Genetics Inc. (AGI)

- Marketed by Zoetis, designed for animals at least 75% Black Angus
- Not intended for use in registered Angus females or bulls
- Predictions - not incorporated into the AAA NCE and will not influence the GE-EPDs of registered animals.



GeneMax™ Advantage



- Heifer selection and mating tool
- Three economic **index** scores:
 - **Cow Advantage** - predicts differences in profitability due to heifer development, pregnancy and calving, and sale of weaned progeny
 - **Feeder Advantage** - predicts differences in net return of feeder calf progeny due to growth, feed efficiency and CAB carcass merit
 - **Total Advantage** - diff in profitability across all traits in Cow and Feeder Advantage index scores

Trait Score
Calving Ease Maternal
Weaning Weight
Heifer Pregnancy
Milk
Mature Weight
Cow Advantage Score
Gain
Carcass Weight
Marbling
Ribeye Area
Fat Thickness
Feeder Advantage Score
Total Advantage Score

GeneMax™ Focus



- Genomic predictions for feedlot gain and marbling, in addition to sire assignment (\$17)
 - **GMX Score** – combined, economically weighted value for marbling and gain
 - **GMX Marbling & GMX Gain** – the genomic prediction for each trait is ranked against the GeneMax™ database (top 20% - score 5).
- Rankings – relative to Angus populations in the GeneMax™ database (purebred & crossbred)
- Not a comparison of all genetics in the U.S. cowherds, only high percentage Angus cattle.

PredicGEN



- Marketed by Zoetis® - heifer selection tool for **straight-bred** or **crossbred** British/Continental animals that are less than 75% Black Angus.
- **Carcass** traits predicted: marbling score, USDA yield grade, grid merit and tenderness.
- **Grid merit index** represent underlying economic index values for combined marbling and yield grade.
- Data reported on a 0 to 100 scale (50 is average)

Correlation of **0.31, 0.34, 0.45** for tenderness, yield grade and marbling phenotypes

Supports sire verification

Igenity/Neogen/Geneseek

DNA profiles for **75%** Angus and higher

- Igenity Angus Silver
- Igenity Angus Gold

DNA profiles for **crossbred** and purebred cattle

- Igenity Gold
- Igenity Silver



Igenity® – Confident Selection

Igenity Breed-Specific Tests

- **Igenity Angus Silver** (\$25): includes calving ease maternal, heifer pregnancy, docility, milk, average daily gain, marbling
- **Igenity Angus Gold** (\$40), additionally includes birth weight, mature weight, residual average daily gain, weaning weight, tenderness, ribeye area, back fat thickness and carcass weight.

Igenity Gold and Silver

- Marketed by Neogen® as “DNA profiles for crossbred and purebred cattle.”
- **Igenity Silver** (\$25) evaluates six traits (calving ease maternal, stayability, residual feed intake, average daily gain, tenderness, marbling)
- **Igenity Gold** (\$40) includes an additional 7 traits (birth weight, calving ease direct, heifer pregnancy, docility, milk, ribeye area and back fat thickness).

Neogen - development of these tests involved large populations with phenotypic data and/or EPDs comprising tens of thousands of animals of various biological types.

The six main datasets in the training data set were from six breed associations: Black Angus, Hereford, Gelbvieh, Limousin, Red Angus, and Simmental.

Training population - impact

- The **accuracy drops** when utilized in a **crossbred** commercial cattle population
- Correlation between test and true BV ~ **0.3** when estimating the genetic merit of commercial crossbred animals.
- Correlation likely to be **even lower** in animals comprised of breeds **not in the original training** set.

The lower the correlation, the more possible inaccuracy there is in the ranking based upon that test.