Emerging Technologies in Genetic Improvement

Convergence of Quantitative and Molecular Tools

Mike Tess
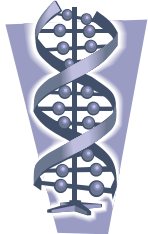

Outline

- DNA tests
- Accuracy
- Breeding value and selection decisions
- Questions
- Solutions
- A peak at the future
- Research highlights ☀

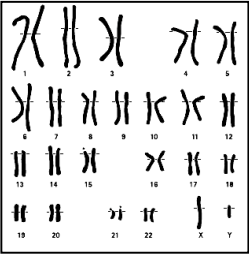## Types of DNA tests

- Traceability
    - Genetic ID tag
- Parentage verification
- Management
    - Predict a future phenotype of the animal tested
        - E.g., pre-sort feedlot animals into feeding groups
- Selection
    - Predict phenotype of offspring of the animal tested
    - Estimate of breeding value
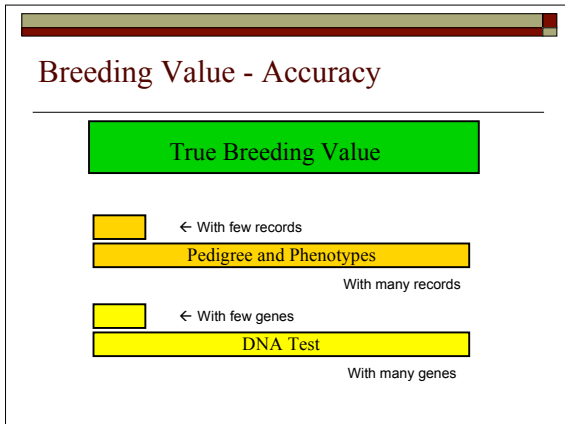

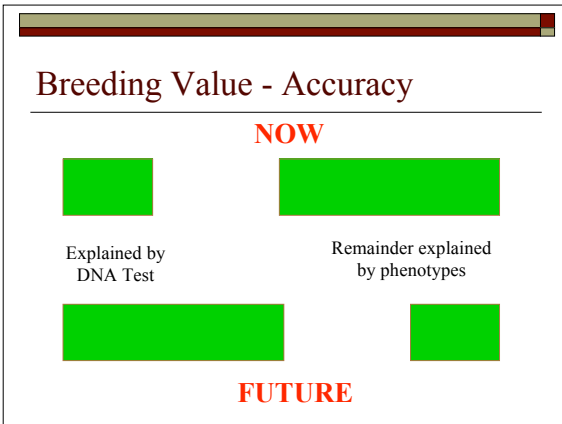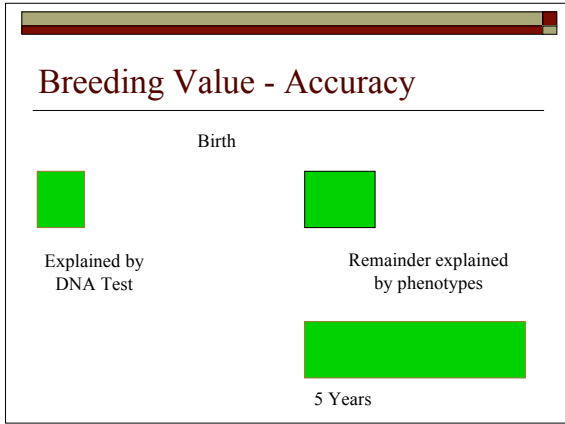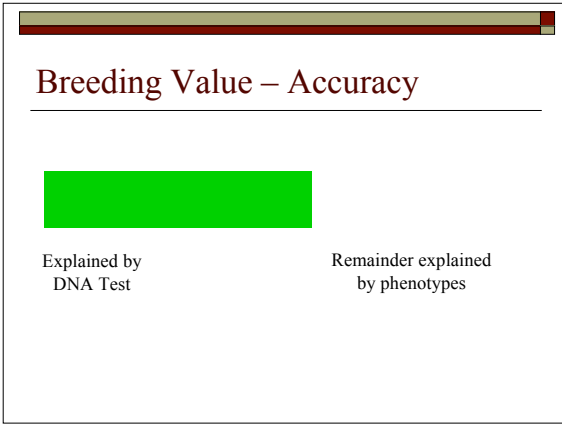## What does a DNA test measure?

Most economically important traits:

- Controlled by many genes scattered across the genome
    - Hundreds
    - Thousands
- Quantitative traits

What does a DNA test measure?

- Predicts differences in performance of animals based on differences in DNA genotypes

- **Accuracy = ??**

Breeding Value – Accuracy

Explained by
DNA Test

Remainder explained
by phenotypes

Breeding Value - Accuracy

Birth

Explained by
DNA Test

Remainder explained
by phenotypes

5 Years

Breeding Value - Accuracy

NOW

Explained by
DNA Test

Remainder explained
by phenotypes

FUTURE

Breeding Value - Accuracy

True Breeding Value

← With few records

Pedigree and Phenotypes

With many records

← With few genes

DNA Test

With many genes

Accuracy

- □ For traditional EPD based on phenotypes and pedigree relationships:
  - ■ Low acc → EPD likely to change with more records.
  - ■ High acc → EPD not likely to change with more records.

- □ For DNA tests:
  - ■ Low acc → it would take **many** progeny records for the progeny means to repeat the differences predicted.
  - ■ High acc → it would take very **few** progeny records for the progeny means to repeat the differences predicted.

Low accuracy

- □ For EPD of low accuracy:
  - ■ The true EPD (or breeding value) may be quite different from the estimate.

- □ For DNA tests of low accuracy:
  - ■ The true EPD (or breeding value) may be quite different from the estimate.

Confusion . . .

EPD   MBV

GPD   **?**   STARS

Profile   MGV

Confusion . . .

DNA Test – Company A

DNA Test – Company B

EPD

These are NOT independent measures of breeding value!

Confusion . . .

DNA Test – Company A

DNA Test – Company B

EPD

The information overlaps!

How much = ?

We need a common currency

True Breeding Value

Pedigree and Phenotypes

DNA Test

DNA Tests, Pedigree, and Phenotypes

We need a common currency

- □ A SINGLE estimate of breeding value based on ALL the information available
  - ▪ DNA markers
  - ▪ Pedigree
  - ▪ Phenotypes
- □ With a SINGLE measure of accuracy

Higher accuracy earlier in life

The breeder's dilemma . . .

- □ Accuracy?

- □ Do DNA tests work as claimed?

  Validation

The breeder's dilemma . . .

- How do competing DNA tests compare and overlap?
- How will selection based on a DNA test affect non-target traits?

Assessment

The breeder's dilemma . . .

- Accuracy?
- Do DNA tests work as claimed?
- How do competing DNA tests compare and overlap?
- How will selection based on a DNA test affect non-target traits?
- **What is the genetic currency for selection?**

A common currency for selection

		Phenotypes	
		NO	YES
DNA Tests	NO	----	EPD
	YES	EPD	EPD

Same units. Same measure of accuracy.

A common currency for selection

How do we get there?

		Phenotypes	
		NO	YES
DNA Tests	NO	----	EPD
	YES	EPD	EPD

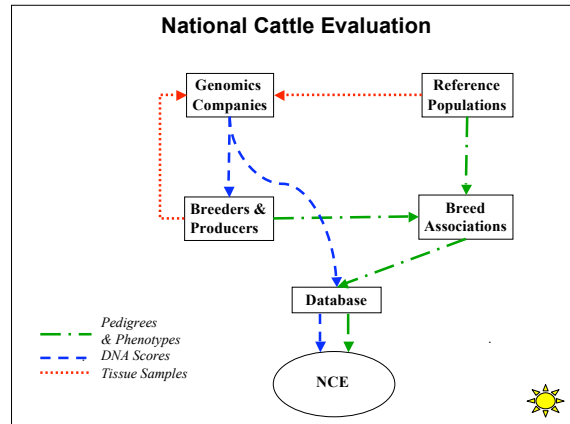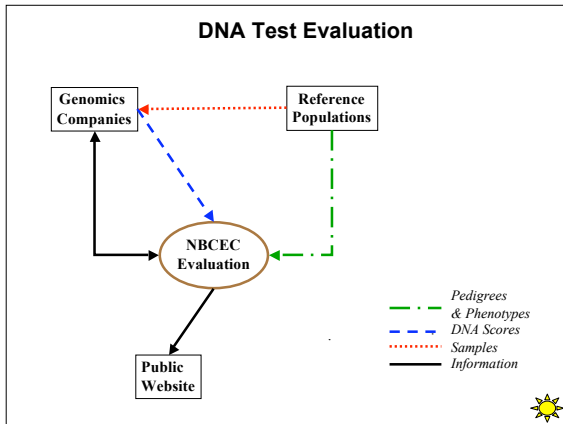**Same units. Same measure of accuracy.**

Solutions

A collaborative model

BIF Commission on DNA Markers

Position Statement (11-07):
"BIF believes that information from DNA tests only has value in selection when incorporated with all other forms of performance information for economically important traits in National Cattle Evaluation, and when communicated in the form of an EPD with a corresponding accuracy. For some economically important traits, information other than DNA may not be available. Selection tools based on these tests should still be expressed as EPD within the normal parameters of National Cattle Evaluation.**"**

DNA Test Evaluation

Genomics Companies — Reference Populations — NBCEC Evaluation — Public Website

Legend:
- *Pedigrees & Phenotypes*
- *DNA Scores*
- *Samples*
- Information

National Cattle Evaluation

Genomics Companies — Reference Populations — Breeders & Producers — Breed Associations — Database — NCE

Legend:
- *Pedigrees & Phenotypes*
- *DNA Scores*
- *Tissue Samples*

A look down the road . . .

A look down the road . . .

- Current DNA tests
  - Most = based on few genes
  - Accuracy = ??
- Future DNA tests
  - Hundreds of genes
    - SNP chips and whole genome scans
  - Higher accuracy
  - Specific to breeds, environments, systems

As markers improve . . .

True Breeding Value

← few genes, few records

DNA Tests, Pedigree, and Phenotypes

few genes, many records

← many genes, few records

DNA Tests, Pedigree, and Phenotypes

many genes, many records

Summary

- DNA tests offer great potential as early predictors of breeding value.
- DNA technology is changing at a rapid pace.
- A collaborative model must be implemented to incorporate DNA test information into the computation of EPD.
- Committee meetings → details & examples