INDEX SELECTION 101 AND BEYOND

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WHY DO WE NEED SELECTION INDEXES?

"There is no easily accessible, objective way for breeders, particularly breeders in the beef and sheep industries where ownership is diverse and production environments vary a great deal, to use these predictions intelligently."

-- *R. M. Bourdon, 1998*

HOW TO BEGIN?

- What are my breeding/marketing goals?
- What traits directly impact the profitability of my enterprise?
- Are there environmental constraints?

ECONOMICALLY RELEVANT TRAITS

- Traits that are directly associated with a revenue stream or a cost
- Examples
  - BWT vs CE
  - REA vs YG
  - YWT vs CWT
  - MWT vs DMI
  - RFI vs FI

INDICATOR TRAITS

- Traits that are genetically correlated to an ERT
- Why use indicator traits?
  - Measured earlier in life
  - Cheaper/easier to measure
  - Measured on both sexes

METHODS OF MULTIPLE TRAIT SELECTION

- Tandem Selection
- Independent Culling Levels
- Selection Indices

WHAT IS A SELECTION INDEX?

- Selection on 'aggregate merit' (Hazel, 1943)
- List of traits that influence "satisfaction"
- Relative Economic Value (REV) of each trait
  - Increase in satisfaction with one unit change in a trait, all others held constant
- List of characteristics to be measured on animal
- Relationships between characteristics (phenotypes) and traits (genotypes)

SELECTION INDEX IN A NUTSHELL

- Tool to enable informed multiple-trait selection
- Based on:
  - Breeding objectives
  - Economic parameters
  - Relationships among traits
  - Population (herd) means
- Designed to improve commercial level profitability
- Not to be confused with breed (organization) specified trait goals
- New (~ 10 years) to the beef industry but "old hat" to other industries

WHAT IMPACTS SELECTION INDICES

- Changes to goal traits
- Changes to traits with EPD (index traits)
- Changes to genetic (co) variances
- Changes to component trait accuracy
- Changes to trait definitions (scaling)
- Changes to economic parameters/assumptions
- Changes to population (assumed) means

GENERAL FORM

- $b=P^{-1}Gv$

SIMULATION FRAMEWORK

- Stochastic Model
  - Allows for random variation in multiple traits
  - Variation based on fluctuation in historical data
- Simulated base herd
  - Multiple iterations

$$b = P^{-1}Gv$$

Economic values from simulation

GENERAL FORM FOR EPD (OR BREEDING VALUE)

- $b=G^{11}G_{12}v$

GENERAL FORM WHEN GOAL=CRITERIA

- b=v
- Rarely is this the case
- We make assumptions to force this case

EXAMPLE (TERMINAL)

- Hot carcass weight
- Yield grade
- Quality grade
- Feed intake
- Yardage
- Mortality
- Morbidity

- Carcass weight
- REA
- Fat
- Marbling
- DMI
- Days to Finish
- ?

This fits breeders who do not retain heifers from these matings and sell all calves on a grid

VALUE DISCOVERY OF ADDED INFORMATION

- Many ERTs are not currently evaluated nor collected routinely in the seedstock sector
- However, they drive value downstream
  - Reproduction phenotypes (longevity)
  - Disease (pulls, treatments, mortality)
  - “Routine” carcass data
  - Plant value—primal yield, dark cutters, blood splash, etc.

EXAMPLE

- Profitability per exposure
- Maternal Index
  - Bull A 100
  - Bull B 76
- 30 cows/yr. over 4 yrs. = 120 exposures
- 120 exposures X (100-76) =
- $2,880 profit difference
- If you follow the assumptions of the index!

TERMINAL OR MATERNAL?

Terminal

- $B, $F, $G (Angus)
- TI (Simmental)
- CHB$ (Hereford)
- MTI (Limousin)
- EPI and FPI (Gelbvieh)
- Charolais
- GridMaster (Red Angus)
- $T (Beefmaster)

Maternal

- $W, $EN (Angus)
- API (Simmental)
- BMI$, BII$, CEZ$ (Hereford)
- HerdBuilder (Red Angus)
- $Cow (Gelbvieh)
- $M (Beefmaster)

CHANGE TO ACCURACY

$$r_{HI} = \frac{\boldsymbol{b'G_{12}v}}{\sqrt{(\boldsymbol{b'G_{11}b})(\boldsymbol{v'Cv})}}$$

- Upper bound of accuracy (assumes EPD accuracy of 1)
- Replacing G_{11} with P gives the lower bound of accuracy (phenotypic selection)
- As component trait accuracy increases, so does r_{HI}

CHANGES TO ACCURACY

- Assume the simple linear index below:
  - $I = 0.9*EPD_1 + 0.1*EPD_2$
- If all animals in the population have accuracy of 0 for EPD_1, rank differences in the index will be caused by differences in EPD_2 only (regardless of weighting for EPD_1)
- As accuracy increases, EPD are dispersed allowing the trait to contribute more to ranking based on the index.

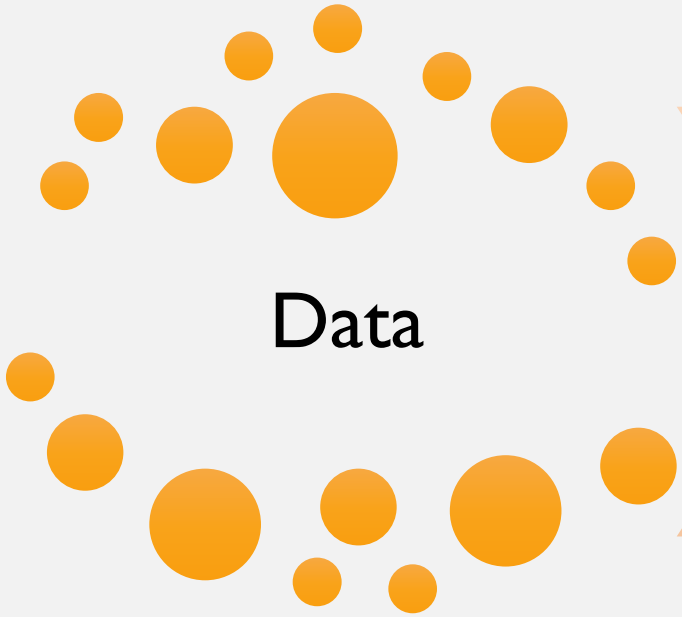
CHANGES TO TRAIT DEFINITIONS

- Seemingly the same trait may have vastly different scale and thus inference
- Examples:
  - Marbling
  - Reproductive longevity

- Scale (interpretation) of the EPD trait must match the scaling (interpretation) of v

CROSSED THE FINISH LINE?

- Releasing a single-step evaluation should allow the opportunity to turn organizational focus to other areas of NCE
  - Obviously additional improvement to be made overtime relative to ss
- Economic indices clearly misunderstood
- Effort now needs to be focused on
  - Phenotypes
  - Enabling (accurate) selection decisions



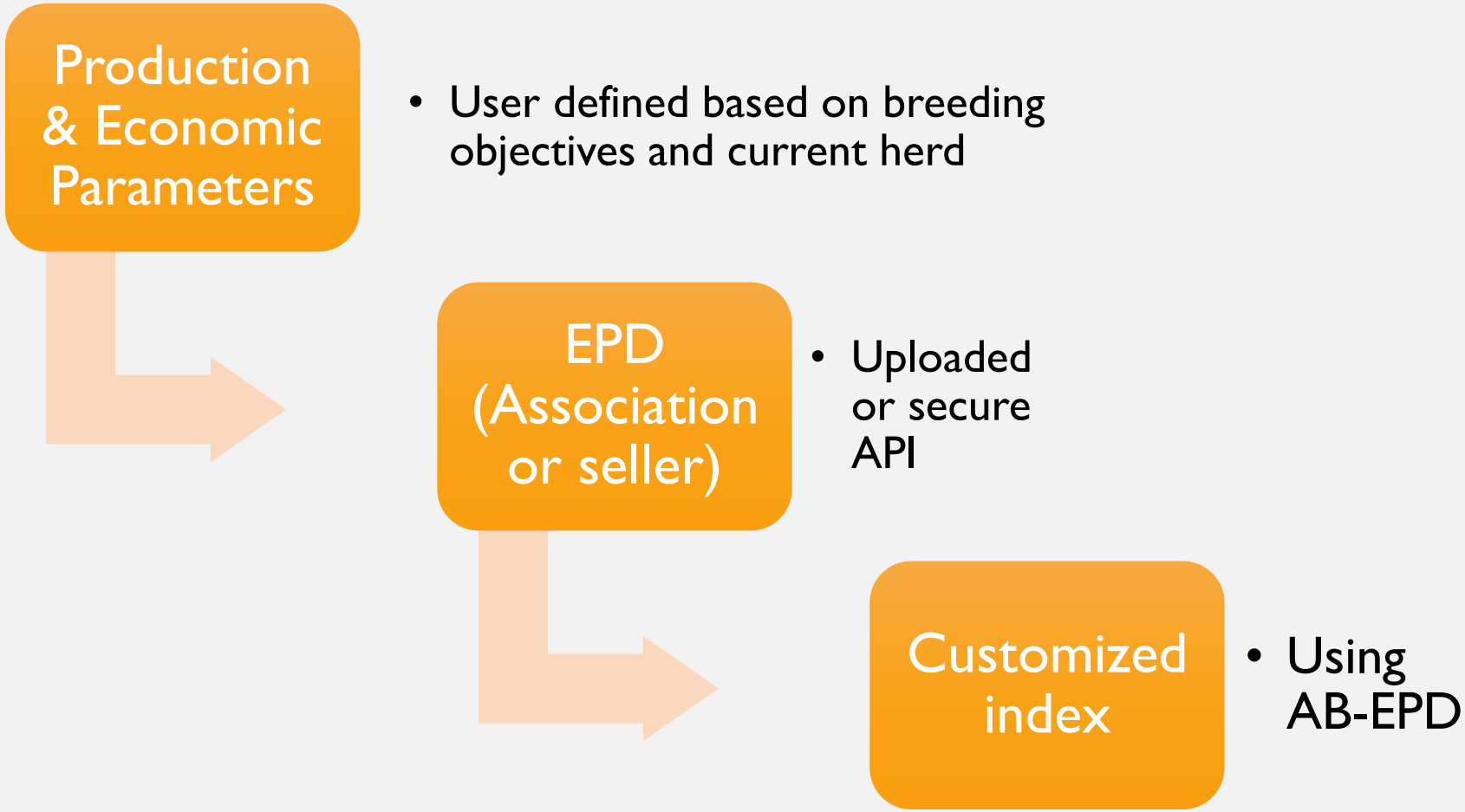
Data is constantly growing

(more animals, more traits, more genotypes, sequence data)

Requires turning data into tools

Increasing list of EPD

Requires turning tools into impactful decisions


Production & Economic Parameters
• User defined based on breeding objectives and current herd
EPD (Association or seller)
• Uploaded or secure API
Customized index
• Using AB-EPD

USE CASES

- Commercial buyer
- Seedstock seller
- Seedstock buyer

- All have different needs/objectives but all can refine decisions making process.

HELPFUL RESOURCES

- http://beef.unl.edu
- www.nbcec.org
- www.eBEEF.org