

## CAN BEEF SEEDSTOCK PRODUCERS AFFORD GENOMICS?



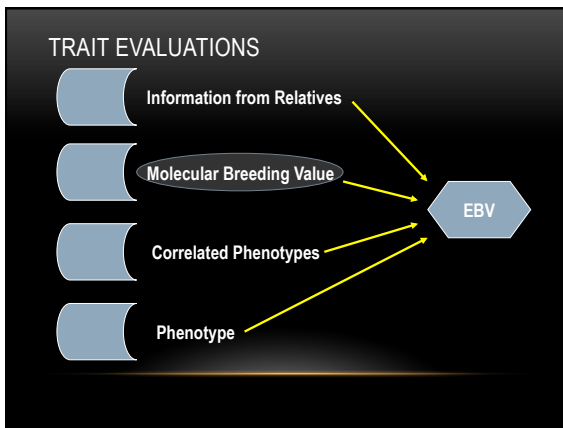
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### COMPONENTS

- Genomic prediction
- Estimation of variance components
- Systems analysis
- Breeding objectives and selection index
- Genetic improvement

*Applied result*



### ADVANTAGES OF GENOMIC PREDICTION

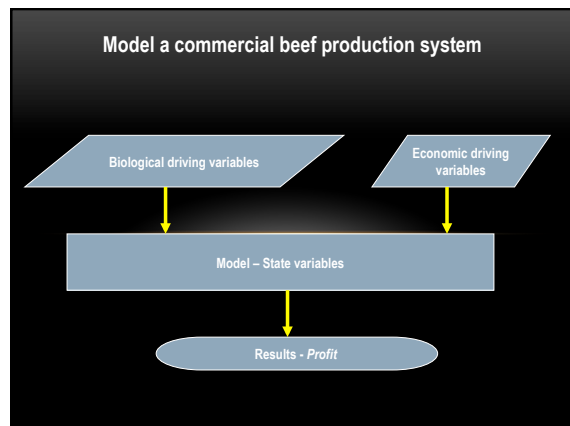
- Increase accuracy of evaluation
- Incorporate additional traits
  - Costly or difficult to measure
  - Measured late in life (after the time of selection decisions)
  - Sex-limited
- Avoid prolonged generation intervals
- Reputation

### WHAT CONSTITUTES IMPROVEMENT?

- Consider what traits make up the breeding goal
- Industry-wide markets for many inputs and products

$$\frac{\text{Expense}}{\text{Income}} = \frac{\text{per breeding female}}{P_d V_d} \left[ R_d + I_d + F_{md} + F_{pd} + N_o \right] + \frac{\text{per her offspring}}{N_o P_o V_o} \left[ D_o (I_o + F_{mo} + F_{po}) + S_o \right]$$

- Profit = Income - Expense



### Model a commercial beef production system

- Abstraction of any actual system
- Capture sources of income and expense
- Economic parameters reflect *future* expectation
- Income and expense streams may be discounted
- Biological parameters are data-driven

### BREEDING OBJECTIVES (Profit = *Income* - *Expense*)

- Biological "efficiency" based on Lin (1980)
- "Terminal" based on MacNeil and Herring (2005)
  - Straightbred Angus
  - Direct genetic effects
  - Growth, days to finish, and feed consumption weaning to harvest
  - Grid pricing of carcasses based on weight, quality, and yield
- "Maternal" based on MacNeil (2015, unpublished)
  - Two-breed rotation of Hereford and Angus dam lines
  - Direct and maternal genetic effects
  - Equilibrium age distribution of cow herd
  - Income from weaning weight

### A SIMPLE OBJECTIVE - FEED EFFICIENCY

$I = EBV_1 - 0.2EBV_2$     Trait 1 = ADG, Trait 2 = DFI

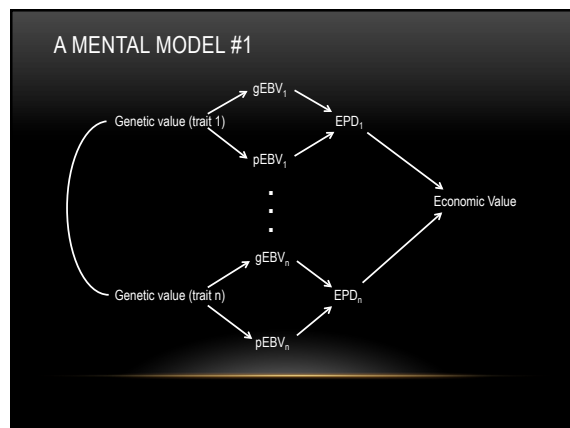
$ADG/DFI = 0.2$     5kg of feed to gain 1 kg weight

$$V = \begin{bmatrix} 0.01259 & 0.04287 \\ 0.04287 & 0.33152 \end{bmatrix}$$

$r_g = 0.66 \pm 0.08$ ;  $h_{ADG/DFI} = 0.25 \pm 0.05$ ;  $h_{DFI/DFI} = 0.37 \pm 0.05$

(MacNeil et al, 2013)

Simulate many animals



### A SIMPLE OBJECTIVE - FEED EFFICIENCY

No. 2

$r_{1,1} = \text{Accuracy}(pEBV_1)$      $r_{1,2} = \text{Accuracy}(gEBV_1)$   
 $r_{2,1} = \text{Accuracy}(pEBV_2)$      $r_{2,2} = \text{Accuracy}(gEBV_2)$

Because accuracies < 1.0

Phenotypic EBV:  $V(pEBV_1) = r_{1,1}^2 V_{1,1}$      $V(pEBV_2) = r_{2,2}^2 V_{2,2}$   
 Genomic EBV:  $V(gEBV_1) = r_{1,2}^2 V_{1,1}$      $V(gEBV_2) = r_{2,1}^2 V_{2,2}$

### "BLENDED" EBV

$$EBV_1 = \frac{1-r_{1,2}^2}{1-r_{1,2}^2 r_{1,1}^2} pEBV_1 + \frac{1-r_{1,1}^2}{1-r_{1,2}^2 r_{1,1}^2} gEBV_1$$

$$EBV_2 = \frac{1-r_{2,2}^2}{1-r_{2,1}^2 r_{2,2}^2} pEBV_2 + \frac{1-r_{2,1}^2}{1-r_{2,1}^2 r_{2,2}^2} gEBV_2$$

Kachman, 2013

### FEED EFFICIENCY SIMULATIONS

$[r_{J1,1f}, r_{J1,2f}, r_{J2,1f}, r_{J2,2f}]$

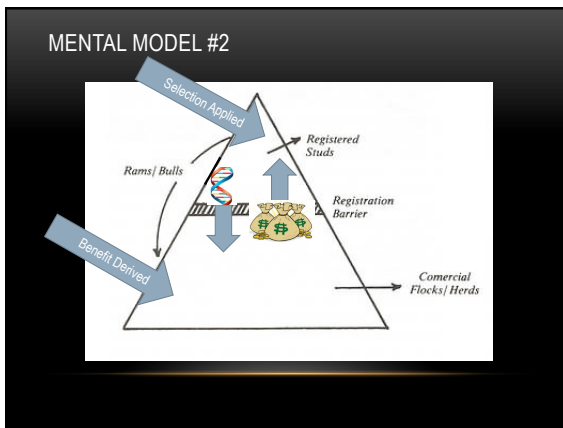
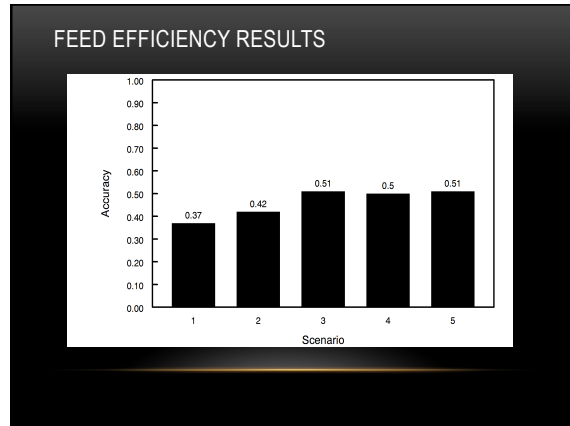
Scenario 1: [0.50, 0.00, 0.61, 0.00]  
 - Phenotypes only (accuracy =  $2\sqrt{h^2}$ )

Scenario 2: [0.50, 0.40, 0.61, 0.40]  
 - Phenotypes + low accuracy genomic prediction

Scenario 3: [0.50, 0.60, 0.61, 0.60]  
 - Phenotypes + higher accuracy genomic prediction

Scenario 4: [0.60, 0.40, 0.70, 0.40]  
 - (Phenotypes + sibs) + low accuracy genomic prediction

Scenario 5: [0.60, 0.60, 0.70, 0.60]  
 - (Phenotypes + sibs) + higher accuracy genomic prediction



### ONE OBJECTIVE or MANY?

Different markets for both inputs and outputs

Genotype x Environment interaction

Different production systems and practices

VS

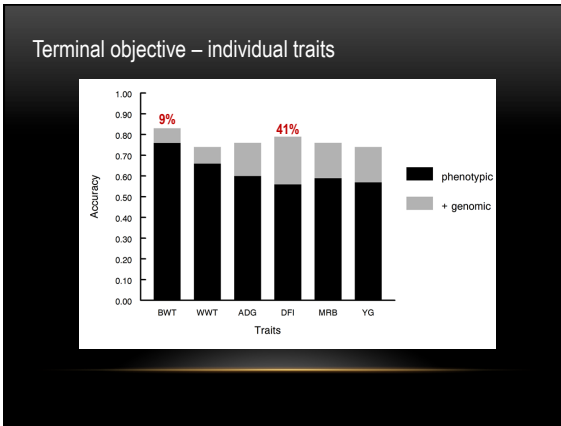


Estimates of mean ( $\mu$ ), phenotypic standard deviation ( $\sigma$ ), heritability ( $h^2$ ), economic weights ( $\partial P/\partial t$ ), and accuracies for traits relative to terminal sire breeding objective.

**Current American Angus Assoc. 2014 born bulls w/o genotypes 2014 genomic accuracies**

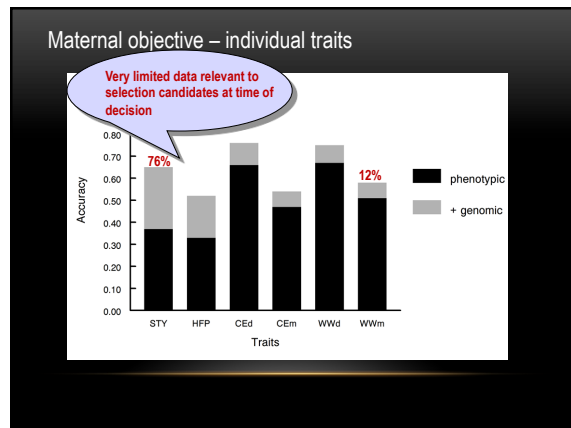
Trait	$\mu$	$\sigma$	$h^2$	$\partial P/\partial t$	relative value, %	Accuracy	
						.EBV	.EBV
Birth weight, kg	35.4	5.00	0.41	-1.86	8.8	0.68	0.76
Weaning weight, kg	194.	39.5	0.23	0.90	25.4	0.56	0.66
ADG, kg/d	1.32	0.18	0.36	104.29	16.9	0.66	0.60
DFI, kg/d	9.2	1.00	0.41	-22.05	21.1	0.74	0.56
Marbling score <sup>b</sup>	5.8	1.00	0.26	13.54	10.3	0.67	0.59
Yield grade	3.4	0.70	0.22	-35.28	17.4	0.65	0.57

MacNeil and Herring (2005)



Estimates of mean ( $\mu$ ), phenotypic standard deviation ( $\sigma$ ), heritability ( $h^2$ ), economic weights ( $\partial P/\partial t$ ), and accuracies for traits (t) included in a breeding objective for an Angus specialized dam line

Trait	$\mu$	$\sigma$	$h^2$	$\partial P/\partial t$	Relative value, %	Accuracy	
						.EBV	.EBV
Stayability, %	55.1	16.2	0.21	8.00	50.6	0.58	0.37
Heifer pregnancy, %	91.0	22.6	0.14	1.61	11.6	0.45	0.31
Calving ease (d), %	85.5	28.6	0.12	1.90	16.0	0.62	0.65
Calving ease (m), %	-	-	0.13	1.90	16.7	0.32	0.46
Weaning weight (d), kg	256.7	49.6	0.30	0.19	4.4	0.56	0.66
Weaning weight (m), kg	-	-	0.14	-0.05	0.8	0.36	0.51



### ANSWERING THE QUESTION

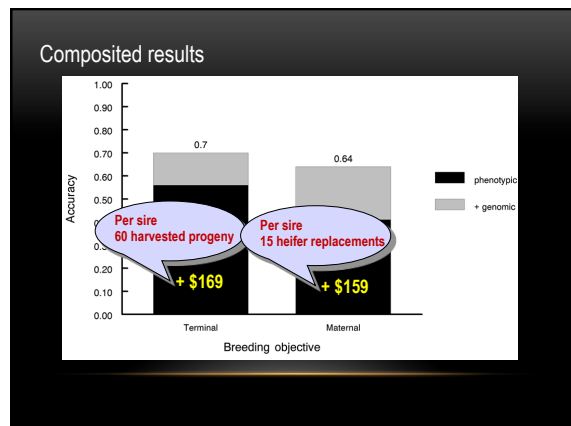
**Breeder's objective:**

$$O = \sum \partial P / \partial t_i EBV_i$$

**Breeder's equation:**

$$R = h \sigma a i$$

$R$  = response to selection  
 $h$  = square root of heritability or accuracy  
 $\sigma a$  = genetic standard deviation, and  
 $i$  = selection intensity



#### TAKE AWAY MESSAGES

- Breeding objectives greatly facilitate multiple-trait selection
- Genomic predictions for component traits add substantial accuracy to prediction of breeding objectives
- Genomic technology has greatest promise for traits that are infrequently recorded or recorded after the selection decision point
- With reasonable transfer of economic benefits from commercial sector to seedstock sector, it indeed does appear that seedstock producers can afford genomics, *provided they use rational breeding objectives*

