Traditional genetic selection for fertility: indicator traits and potential antagonisms

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Relative Economic Weights for Traditional Beef Firm

Reproduction:Growth:End Product

10:5:1



(Melton, 1995)

Relative Economic Weights for Integrated Beef Firm

Reproduction:Growth:End Product

2:1:1



(Melton, 1995)

Improvement of Herd Efficiency

- [Dam Weight*Lean Value of Dam + **No. Progeny***Progeny Weight*Lean Value of Progeny] - [Dam Feed*Value of Feed for Dam + **No. Progeny***Progeny Feed*Value of Feed for Progeny].
- By simply increasing number of progeny per dam through either selection, heterosis from crossing, or better management, we will increase efficiency of production.

Adapted from Dickerson 1970

Maternal Traits of Importance

- Female fertility
- Maternal calving ease
- Maintenance requirements*
- Longevity
- Maternal weaning weight (Milk)*
- Disease susceptibility
- Adaptation
- Temperament

Raising Replacements Small Herds

- A small number of replacements makes managing heifers as a separate group challenging
- Night calving—Is it worth it to spend hours looking over a few heifers?

Raising Replacement Heifers Small Herds

- Fact is these herds produce a large fraction of all calves in the U.S.
- It seems logical that these herds could increase profit if they purchased replacement females
  - Females bred for 2nd (or later) calf
- Bulls selected for terminal traits and cows selected for maternal traits
  - True complementarity

Producing Maternal Replacements

- "Maternal" is more than "I didn't select for carcass"
- Culling open cows is not selecting for fertility
  - Improvement comes primarily from bull selection
- Presumably larger ranches
- Preferably composite cows
- Produce bred cows (2nd or later parity).
  - F1 cows bred to terminal bulls

Parsing Maternal v. Terminal

- Heavier calves and more product from smaller cows
  - Reduce industry-wide feed intake by smaller cows
- Less calving difficulty industry-wide
  - Maternal producers are the only ones calving heifers
- Increased uniformity industry-wide
  - Common objectives
- Focus objectives
  - Only trying to do one thing

Advantages of the crossbred cow

Trait	Observed Improvement	% Heterosis
Longevity	1.36	16.2
Cow Lifetime Production:		
No. Calves	0.97	17.0
Cumulative Wean. Wt., lb.	600	25.3

Adapted from Cundiff and Gregory, 1999.

Trait	h^2	No. of references
Age at first calving	<0.10	2
	0.20-0.30	3
Age at puberty	<0.10	1
	0.10-0.20	3
	0.40-0.50	4
	>0.60	3
Calving date	<0.10	4
	0.20-0.30	3
	0.40-0.50	1
Calving rate	<0.10	1
	0.10-0.20	1
Calving success	<0.05	1
	0.05-0.10	1
Calving to first insemination	<0.10	2
Days to calving	<0.10	2
First-service conception rate	<0.10	1
	0.20-0.30	1
Heifer pregnancy	<0.20	1
	0.20-0.30	1
Number of calves	<0.10	2
	0.10-0.20	2
	0.30-0.40	1
Pregnancy rate	<0.10	4
	0.10-0.20	4
	0.20-0.30	4
Probability of pregnancy	<0.10	1
	0.10-0.20	1
	0.20-0.30	3
	0.50-0.60	1
Scrotal Circumference	0.20-0.40	3
	0.40-0.50	8
	0.50-0.80	3

Adapted from Cammack et al., 2009

NBCEC Meeting Recap (2009)

- Candidate traits
  - Weaning success
  - First service conception rather than heifer pregnancy
  - Postpartum interval
- Limitations
  - Guidelines for recording phenotypes
    - Age windows
  - Collection of phenotypes
  - ROI

Trait Review

- Days to Calving
  - Breeding attempt to calving
  - Censored
- Heifer Pregnancy
  - ECP
- First insemination success (calving to fist insemination)
  - NS data--uncertainty
- Longevity
  - Reason for culling
- Age at puberty
- Indicators (i.e. AFC)
  - Cost of collection

Trait	Country[2]
Scrotal circumference	AU, NZ, SA, NA, AR, UK, IR, BR, FR, US, CA, ME
Days to calving	AU, NZ, SA, NA
Heifer pregnancy	US, VE, BR
Heifer calving success	FR
Age at 1st calving	IR, UK, BR
Calving interval	IR, DE, UK
Stayability/productive life	US, CA, VE, UK, FR, BR

Adapted from Johnston (2014).

Current Limitations

- Contemporary groups
- Quality data
- Quantity of data turned in
  - Not quantity collected

Suggestions--CG

- Yearling CG are not sufficient
- Need to know:
  - Breeding opportunity
  - When it occurred
  - Service sire
  - Breeding group

Suggestions-Traits

- Heifer pregnancy
  - Have a calf
- Days to calving
  - Conceive and do so early

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)

$$H_i = a_1 BV_{i1} + a_2 BV_{i2} + \ldots + a_n BV_{in}$$

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*

Terminal or Maternal?

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

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

Example

- Profitability per exposure
- HerdBuilder
  - Bull A: 134
  - Bull B: 110
- 30 cows/yr. over 4 yrs. = 120 exposures
- 120 exposures X (134-110) =
- $2,880 profit difference

Improving Indices

- Improvement in current indices can be made by increasing the number of ERT that have EPD
  - Input traits
  - Fertility

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.

Accuracy, h^2 and Progeny Counts

Approximate number of progeny needed to reach accuracy levels (true (r) and the BIF standard) for three heritabilities (h^2)

Accuracy		Heritability Levels		
r	BIF	h^2 (0.1)	h^2 (0.3)	h^2 (0.5)
0.1	0.01	1	1	1
0.2	0.02	2	1	1
0.3	0.05	4	2	1
0.4	0.08	8	3	2
0.5	0.13	13	5	3
0.6	0.2	22	7	4
0.7	0.29	38	12	7
0.8	0.4	70	22	13
0.9	0.56	167	53	30
0.999	0.99	3800	1225	700

Action Point #1

- The commercial cow-calf industry needs to utilize composite or F_1 females.
  - The majority of commercial producers should breed these to an unrelated terminal sire breed.
  - Larger commercial producers may take advantage of scale and serve as a multiplier, focusing on the production of commercial replacement females.

Action Point #2

- The genetic evaluation of fertility/reproduction needs to advance past the current metrics evaluated in NCE.
  - A tangible place to start would be to use a bivariate model jointly evaluating heifer pregnancy (early fertility) and days to calving (sustained reproduction).
  - These traits are very tractable and the joint evaluation of a threshold character and a continuous trait has the added advantage of alleviating Extreme Category Problems (ECP) sometimes associated with binary traits.

Action Point #3

- The effective use of economic selection indices in the development of maternal and terminal selection lines.

Additional Resources

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