Olds Bull Test Genetic Evaluation Procedures

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Objectives:

1. Provide genetic evaluation for traits related to intake and efficiency in the Olds Bull Test (2002 – 2005).
2. Compute a phenotypic index that optimizes progeny net revenue using information on efficiency and growth.

Outline:

1. Phenotypic summary statistics
2. Derivation of serially measured traits
3. Index calculations
4. Genetic evaluation model
5. Parameters
6. Accuracy calculations
7. EPD summary statistics

Table 1. Phenotypic summary 2002 – 2005 (n = 221).

Trait	Mean	Min	Max	SD	CV
WT0[a]	800	442	1124	126	15.79
MIDWT	986	576	1334	135	13.79
WT365	1138	760	1388	109	7.56
ADG[b]	3.26	1.85	4.81	0.49	15.12
DDMI[b]	19.34	12.68	26.11	2.82	14.60
FCR[c]	5.98	3.90	9.00	0.83	13.88

[a] Average age at start of test = 260 d.
[b] Calculated by regression of serial measures on test day.
[c] Feed conversion ratio (FCR) = DDMI ÷ ADG.

Notes:

1. WT365 is adjusted yearling weight computed according to Beef Improvement Federation guidelines.

2. Live weight and daily intake were measured serially throughout the test. Regression of these serial measurements on test day gives a more stable and error-free estimate of daily intake and gain.

3. Feed conversion ratio (i.e., feed to gain ratio) is a classical measure of efficiency, but does not lend well to genetic evaluation because it is a ratio trait and because it is highly related to size and growth rate.

Additional Measurements and Calculations

1. Serial ultrasound measurements of back fat and ribeye area were taken. These values were used to compute gain on test in fat (FATGN) and muscle area (REAGN). These are standard measures of body composition.

2. Residual feed intake (RFI) was the target measure of efficiency. RFI is calculated as the difference between measured and predicted dry matter intake. Intake was predicted based on knowledge of growth rate (ADG), body weight (MMWT), and changes in fat (FATGN) and muscle area (REAGN).

3. Using measurements of ADG, MIDWT, and body composition, we can account for nearly 60% of the variation in daily dry matter intake. The remaining 40% is RFI.

4. RFI measures that amount of intake that is NOT attributable to gain, maintenance, or body composition deposition. Therefore, RFI is more closely related to efficiency of feed utilization.

5. RFI is phenotypically unrelated to ADG, MIDWT, FATGN, and REAGN. Bulls with negative RFI *"eat less than expected based on weight and production"* whereas bulls with positive RFI *"eat more than expected…"* and are therefore ***less efficient***.

Table 2. Correlations of intake and efficiency with performance

Performance Trait	Rp (DDMI)	Rp (RFI)
Start Weight	0.62	0.00
Mid-Test Weight	0.73	0.00
Yearling Weight	0.67	0.00
Daily Gain	0.56	0.00
Gain in Back Fat	0.23	0.00
Gain in Ribeye Area	0.21	0.00
FCR	0.43	0.64
Dry Matter Intake	**1.00**	0.65
RFI	0.65	**1.00**

Notes:

1. Dry matter intake is expected to be related to growth and performance, but most performance measures share part-whole relationships. The RFI procedure sorts through the relationships of dry matter intake with measurable performance, and the remaining variance allows for sorting animals on efficiency regardless of body size, growth rate, and body composition.

2. The implication is that RFI allows for evaluating the efficiency differences among animals independent of production. Therefore, we can identify animals of vastly different size and growth rate that are either more or less efficient.

Multiple Trait Selection Including Efficiency

1. Feed efficiency is not the only trait that defines profitability although feed represents more than 60% of costs. Producers are still paid for weight and growth rate.

2. Define net revenue of market progeny in the feedlot as ***gross revenue minus costs***. More than 70% of net revenue differences in steers are due to: ***intake***, ***feedlot gain***, and ***slaughter weight***.

3. Using multiple trait selection index procedures, we defined an index that optimizes genetic progress in feedlot net revenue using information collected in a bull test.

4. The index improves net revenue in market progeny by selection on ***yearling weight***, ***growth rate***, and ***RFI*** in bulls.

Table 3. Correlations of the index with performance

Bull Trait	Rp (index)	Interpretation of high (>100) index
WT365	-0.01	No relationship with weight
ADG	0.28	Higher growth rate
DDMI	-0.18	Lower intake
FCR	-0.43	Better feed conversion
RFI	-0.51	More efficient

5. Higher index values (mean = 100, range = 78.6 – 165.1) are associated with bulls with higher growth rate, lower daily intake, and higher efficiency. This has been verified in three unrelated data sets.

Genetic Evaluation Procedures

1. Model
   1.1 Standard 4-trait animal model: $\mathbf{y} = \mathbf{Xb} + \mathbf{Zu} + \mathbf{e}$
   1.2 WT365 (1), ADG (2), DDMI (3), RFI (4)
   1.3 n = 221 bulls with data
   1.4 n = 3,000 animals in pedigree

2. Fixed Effects
   2.1 Breed (n = 8)
   2.2 Contemporary group (year × pen, n = 6)
   2.3 (Herd of origin)
   2.4 (Start of test age)

3. Random Effects
   3.1 Animal (direct only)
   3.2 Mean EPD

$$E(u) = 0$$

   3.3 Genetic parameters

$$\mathrm{Var}(u) = A \otimes \begin{bmatrix} \sigma_1^2 & \sigma_{1,2} & \sigma_{1,3} & \sigma_{1,4} \\ & \sigma_2^2 & \sigma_{2,3} & \sigma_{2,4} \\ & & \sigma_3^2 & \sigma_{3,4} \\ & & & \sigma_4^2 \end{bmatrix} \equiv \begin{bmatrix} 0.366 & & & \\ 0.662 & 0.344 & & \\ 0.546 & 0.558 & 0.423 & \\ -0.104 & -0.038 & 0.680 & 0.419 \end{bmatrix}$$

   3.4 Heritability and genetic correlation estimates were from a weighted-average estimation procedure.

4. Best Linear Unbiased Prediction (BLUP) solutions for breeding values and prediction error variances.

EPD and Accuracy Computations

1. EPD (expected progeny differences) were derived as half of breeding value (i.e., EPD = ½EBV).

2. Accuracy was computed from prediction error variance as the correlation between true and estimated breeding value:

$$r_{TI} = \sqrt{1 - \frac{PEV}{(1+F)\sigma_g^2}}$$

where PEV = prediction error variance, F = inbreeding coefficient, and σ_g^2 = genetic variance.

Table 4. EPD summary (n = 221)

Trait	Mean	Min	Max	SD
WT365, lb	0.00	-51.97	43.28	17.79
ADG, lb/d	0.00	-0.20	0.18	0.07
DDMI, lb/d	0.00	-1.32	0.95	0.46
RFI, lb/d	0.00	-1.15	0.94	0.33

3. Accuracy values for all traits ranged from 0.21 to 0.65 with an average of approximately 0.59. As accuracy increases toward its maximum of 1.00, more confidence is placed in the EPD.

4. It is important to note that these EPD are not directly comparable to the EPD from breed-wide (inter)national cattle evaluation. These EPD are specific to this test population.

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