Decoupling Feed Intake and Gain Measures of Gain in Feed Efficiency Trials to Improve Selection

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USDA KANSAS STATE UNIVERSITY

SimGenetics PROFIT THROUGH SCIENCE

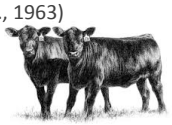
Profit increase for producer

- 10% increase in gain increases profit by **18%** (Fox et al., 2001)
- 10% increase in efficiency increases profit by **43%** (Fox et al., 2001)

Selecting for FE

Derive FE with two Parameters:
- Gain Data → Average Daily Gain (ADG)
- Average Daily Feed Intake (ADFI) Data

Possible to select for FE (Koch et. al., 1963)
- Parameters used to derive FE are moderately heritable



BIF Current Standards

70 Day test for both Gain and Feed Intake

0 70

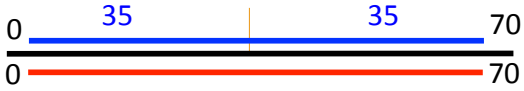
0 70

Decreasing Test Lengths

- Studies support shortened a 35 d intake test (Archer et al., 1997; Wang et al., 2006)
- Loss in accuracy would occur but the increase in selection intensity should compensate for that loss (Archer et al., 1996)

BIF Current Standards

70 Day test for both Gain and Feed Intake



Allows for an increase in the number of animals to be tested for feed intake:

- Decreases testing cost per animal
- Increases selection intensity = Increases overall rate of genetic improvement

Saving on Testing Costs

Roughly save $27 USD per head per week *(Archer et al., 1999)*

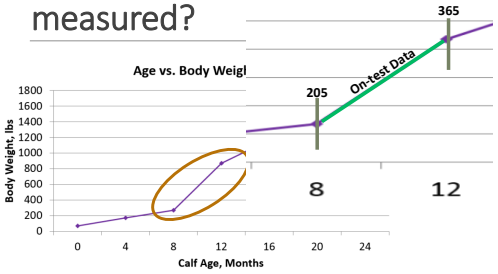
Feed Intake Testing Costs		
No. of Head	70 d Test	35 d Test
25	$8,500	$5,125
50	$17,000	$10,500
100	$34,000	$20,500
150	$51,000	$30,750
300	$102,000	$61,500

**Cut the collection period from 10 weeks to 5 weeks plus $70 fixed cost per head for 21-d warm up period.*

Probable Gain Sources

1. **On-test average daily gain:**
   Multiple weights used to regress body weight on time then use predicted final and start weights to derive ADG
2. **Postweaning gain:**
   Gain as derived by national cattle evaluations where an weaning and yearling weights adjusted for calf age are used to predict gains

Where are gain sources measured?



Ensminger, 1989

Two Parts: Intake & Gain

Can we use PWG in replace of or in complement to on-test ADG?

How does using either of these two gain parameters in an index with intake differ the response to selection of feed efficiency?

Select for FE

- Find another way to select for feed efficiency: shortened 35 d ADFI test and another gain source
- Combining parameters in a properly weighted index: 35 d intake + gain data
- Increase genetic change in FE per year

Can we use PWG in replace of or in complement to on-test ADG?

-Quantifying the relationship between PWG and on-test ADG

Materials & Methods

Data collection: 2003 -2012 (USMARC)

5,606 total observations
- Dry matter intake, test weights, adjusted weaning weights, adjusted yearling weights
- **3,212** Steers and **2,394** Heifers

Six Trait Animal Model
- 2 different gain records
- Intake records
- Separate for males and females

Parameter Notation

PWG: Postweaning gain as derived by NCE

PWG = (Adj. Yearling Weight – Adj. Weaning Weight)/ 160 days

ADG: On-test average daily gain

ADG = (Predicted final weight – Predicted initial weight)/ days

ADFI: Average daily feed intake

ADFI: Total DMI/ (End date on test – start date on test)

Results & Findings

Descriptive Statistics

Trait	Number	Mean (kg)	Standard Deviation
Steer ADFI	3,212	4.30	0.67
Steer ADG	3,212	0.90	0.26
Steer PWG	3,211	1.39	0.19
Heifer ADFI	2,394	3.52	0.58
Heifer ADG	2,394	0.46	0.22
Heifer PWG	2,392	0.88	0.21

Heritability Estimates & Genetic Correlations

Trait	SADFI	SADG	SPWG	HADFI	HADG	HPWG
Steer ADFI	**0.43** (0.05)	0.46 (0.03)	0.70 (0.03)			
Steer ADG	0.73 (0.12)	**0.09** (0.03)	0.35 (0.03)			
Steer PWG	0.58 (0.06)	0.81 (0.14)	**0.36** (0.05)			
Heifer ADFI	0.71 (0.09)	0.66 (0.20)	0.65 (0.09)	**0.39** (0.05)	0.32 (0.04)	0.49 (0.04)
Heifer ADG	0.51 (0.15)	0.39 (0.27)	0.71 (0.15)	0.64 (0.12)	**0.14** (0.04)	0.37 (0.04)
Heifer PWG	0.47 (0.09)	0.67 (0.20)	0.91 (0.08)	0.77 (0.05)	0.65 (0.12)	**0.42** (0.05)

Steer Breed Differences Relative to Angus

Breed Differences Among Steers							
Breed	ADFI	ADG	PWG	Breed	ADFI	ADG	PWG
AN	0	0	0	BV	-1.46	-0.16	-0.45
HH	-0.80	-0.05	-0.12	CH	-0.53	0.07	-0.10
AR	-0.29	-0.16	-0.11	CA	-1.23	-0.11	-0.35
SH	-0.97	-0.12	-0.25	GV	-1.03	-0.16	-0.31
DS	-1.88	-0.39	-0.77	LM	-1.25	-0.01	-0.32
BM	-0.77	0.09	-0.31	MA	-1.64	-0.17	-0.44
BR	-1.31	-0.27	-0.72	SA	-1.18	-0.13	-0.41
BN	-0.18	0.02	-0.30	SM	-0.04	0.04	0.35
SG	-0.57	0.15	-0.20	TA	-1.21	-0.30	-0.36

Heifer Breed Differences Relative to Angus

Breed Differences Among Heifers							
Breed	ADFI	ADG	PWG	Breed	ADFI	ADG	PWG
AN	0	0	0	BV	-1.84	-0.32	-0.61
HH	-0.96	-0.07	-0.12	CH	-0.89	-0.09	-0.19
AR	-0.67	-0.04	-0.15	CA	-1.05	-0.17	-0.27
SH	-1.01	-0.12	-0.24	GV	-0.72	-0.06	-0.24
DS	-1.56	0.11	-0.02	LM	-1.47	-0.15	-0.35
BM	-1.55	-0.15	-0.31	MA	-1.10	-0.10	-0.22
BR	-1.35	-0.19	-0.51	SA	-1.17	-0.19	-0.33
BN	-0.57	-0.18	-0.30	SM	-0.52	-0.04	-0.15
SG	-1.03	-0.07	-0.28	TA	-1.94	-0.39	-0.58

How does using these two gain parameters in an index with intake differ the response to selection of feed efficiency?

Materials & Methods

Materials & Methods

On-test ADFI & ADG = **91 d test**
On-test ADFI & PWG = **56 d test** (Shortened 35 d intake test + 21 d warm-up)

Indices combined EBVs (Lin, 1980):
- $I_{ADG, ADFI}$ = ADGebv + (v)ADFIebv
- $I_{PWG, ADFI}$ = PWGebv + (v)ADFIebv

Efficiencies of the alternative indices:
- Heritability of efficiency
- Number of animals tested: (100 animals/91 d test)
- Relative costs per year
- Genetic change per generation

Results & Findings

Index Correlations

Variable	Mean	Maximum	Minimum	Pearson	Spearman
Heifer $I_{ADG, ADFI}$	0.0004	0.183	-0.131	**0.45**	**0.43**
Heifer $I_{PWG, ADFI}$	0.0002	0.307	-0.345	P < 0.001	P < 0.001
Steer $I_{ADG, ADFI}$	-0.0026	0.484	-0.363	**0.96**	**0.96**
Steer $I_{PWG, ADFI}$	-0.0050	1.060	-0.855	P < 0.00)	P < 0.001

More **positive** value = more desirable efficiency, **more** efficient animal

More **negative** value = less desirable efficiency, **less** efficient animal

Steer Unrestricted Index

	91 d Test[a]	56 d Test[b]
Heritability of gain trait	0.09	0.36
Genetic correlation (Gain, Feed Intake)	0.73	0.58
Relative number tested/year	1.00	1.62
Heritability of efficiency	0.15	0.48
Relative cost/tested animal	100%	62%
Selection Intensity (N = 5)	5% i = 2.06	3% i = 2.27
Genetic Change in index per generation	9%	33%

Steer Restricted index

	91 d Test[a]	56 d Test[b]
Heritability of gain trait	0.09	0.36
Genetic correlation (Gain, Feed Intake)	0.73	0.58
Relative number tested/year	1.00	1.62
Heritability of efficiency	0.03	0.27
Relative cost/tested animal	100%	62%
Selection Intensity (N = 5)	5% i = 2.06	3% i = 2.27
Genetic Change in index per generation	5%	25%

**Intake held constant (i.e. Residual gain.)*

Heifer Unrestricted Index

	91 d Test[a]	56 d Test[b]
Heritability of gain trait	0.14	0.42
Genetic correlation (Gain, Feed Intake)	0.64	0.77
Relative number tested/year	1.00	1.62
Heritability of efficiency	0.10	0.27
Relative cost/tested animal	100%	62%
Selection Intensity (N = 5)	5% i = 2.06	3% i = 2.27
Genetic Change in index per generation	6%	15%

Heifer Restricted Index

	91 d Test[a]	56 d Test[b]
Heritability of gain trait	0.14	0.42
Genetic correlation (Gain, Feed Intake)	0.64	0.77
Relative number tested/year	1.00	1.62
Heritability of efficiency	0.06	0.12
Relative cost/tested animal	100%	62%
Selection Intensity (N = 5)	5% i = 2.06	3% i = 2.27
Genetic Change in index per generation	6%	15%

**Intake held constant (i.e. Residual gain.)*

Breed Differences Steer Efficiency – Unrestricted Index

Across breed comparisons of efficiency for steers					
	ADG, ADFI	PWG, ADFI		ADG, ADFI	PWG, ADFI
Angus	0	0	**Braunvieh**	0.02	0.14
Hereford	0.13	0.11	**Charolais**	0.06	0.18
Red Angus	-0.02	-0.11	**Chiangus**	0.03	0.14
Shorthorn	0.06	0.08	**Gelbvieh**	0.02	0.05
South Devon	-0.18	-0.01	**Limousin**	0.07	0.24
Beefmaster	-0.07	0.24	**Maine-Anjou**	0.08	0.16
Brahman	-0.30	0.00	**Saler**	-0.04	0.11
Brangus	-0.24	0.05	**Simmental**	0.05	0.05
Santa Gertrudis	-0.02	0.27	**Tarentaise**	0.02	-0.05

Breed Differences Heifer Efficiency – Unrestricted Index

Across breed comparisons of efficiency for steers					
	ADG, ADFI	PWG, ADFI		ADG, ADFI	PWG, ADFI
Angus	0	0	Braunvieh	-0.08	-0.15
Hereford	0.06	0.12	Charolais	0.03	0.03
Red Angus	0.04	0.02	Chiangus	-0.04	-0.01
Shorthorn	0.01	0.01	Gelbvieh	0.03	-0.06
South Devon	0.31	0.37	Limousin	0.04	0.01
Beefmaster	0.04	0.07	Maine-Anjou	0.04	0.05
Brahman	-0.02	-0.17	Saler	-0.04	-0.04
Brangus	-0.11	-0.15	Simmental	0.03	-0.02
Santa Gertrudis	0.06	-0.02	Tarentaise	-0.14	-0.10

Conclusions

- Moderate heritability estimates of PWG and ADFI suggests improvement in feed efficiency through selection is possible
- Strong correlations between on-test ADG and PWG suggests PWG is a good proxy for on-test ADG
- Significant breed effects for ADG, ADFI, and PWG in this population

Implications

- Literature estimates a 35 d intake test is long enough to test ADFI without severe loss in accuracy
- Propose combining a 35 d intake test & postweaning gain as calculated by NCE is suffice to test for feed efficiency
- Using this would cut the current testing standard in ½ allowing for more animals to be tested per year per facility
- Using an unrestricted linear index allows for maximum genetic progress of feed efficiency

Future Research

Future Research

1. Are these conclusions applicable in another population?
2. Would regressing the testing days back to a standard test interval change the results?
3. What stage in the growing phase is most applicable to test for feed intake?
4. Could adding in test weights collected throughout the 35 day intake test increase the amount of explained variation?

Thank you. Questions?