Heifer Intake and Feed Efficiency as Indicators of Cow Intake and Efficiency

Dr. Dan Shike
University of Illinois

Why all the buzz about efficiency?

- **Increasing world population**
- **Competition for resources**
- **New era of feed prices**

Feed costs and profitability

- Feed costs have historically been 50-70% of the cost of production in beef enterprises
- When corn price exceeded $7 per bushel, feed costs were nearly 80% of the cost in many feedlot operations
- A feed efficiency improvement of approximately 10% across the entire feedlot sector would reduce feed costs $1.2 Billion in 2011 (Weaber, 2011)

- **Yet – there has been little to no improvement in last 15 years**
    - **WHY???**

Why no improvement?

- **Focused on outputs**
    - Weaning weight
    - Yearling weight
    - Carcass traits
    - PRICE
- **Inputs difficult to measure**
    - Feed intake
    - Grazing intake

Measures of feed efficiency

- **Gross feed efficiency: ratio of live-weight gain to dry matter intake (DMI)**
    - 0.12 – 0.22 (higher number better)
- **Feed conversion ratio (FCR): DMI to gain ratio**
    - 4.5 – 7.5 (lower number better)
- **FCR is a gross efficiency measurement – DOES NOT attempt to partition feed inputs into portions needed to support maintenance and growth requirements**

Risks of selecting for FCR

- **Selecting for improved FCR will indirectly:**
    - Increase genetic merit for growth
    - Increase cow mature size
    - Increase feed costs for the cow herd

Measures of feed efficiency

- **Residual Feed Intake (RFI)**
  - **The difference between actual intake and predicted intake based on animal's gain, maintenance requirements for its body weight, and composition**
  - **NEGATIVE RFI IS GOOD!**
    - **Required less feed then predicted**
  - **Independent of growth and mature size**
  - **Linked to biologically relevant traits associated with feed efficiency**
    - **Digestibility, heat production, protein turnover**

Measures of feed efficiency

- **Residual Body Weight Gain (RG)**
  - **The difference between actual gain and predicted gain based on animals intake, maintenance requirements for its body weight, and composition**
  - **POSITIVE RG IS GOOD!**
    - **Gained more weight than predicted**
  - **Correlated to growth**

Does Feed Efficiency = Cow Efficiency?

- **Efficiency in feedlot is simple**
  - **We buy feed**
  - **We sell pounds of beef**
- **Cowherd efficiency is NOT simple**
  - **Cows graze and/or we buy feed**
  - **We do still sell by the pound BUT….**
    - **Weaned calf?**
    - **Retained ownership?**
    - **Cull cow value?**

Defining Beef Cow Efficiency

- **Pounds of calf weaned per unit of feed intake**
- **What else needs to be considered?**
  - **Fertility/ reproduction**
  - **Longevity**

This debate is not new…

- **In 1984, Michigan State University and Colorado State University sponsored the "Beef Cow Efficiency Forum"**
  - **Definition of efficiency, both in biological and economic terms**
  - **Identification of factors contributing to observed differences**
- **Harlan Ritchie, 1995 BIF**
  - **The Search for the Elusive Optimum Beef Cow**
    "I have searched for her for more than 20 years, and have come up empty handed. But I believe I'm getting close."

Beef Cow Efficiency

- **Why worry about cow efficiency?**
  - **~70% of feed resources for cowherd**
  - **~70% of feed for maintenance**
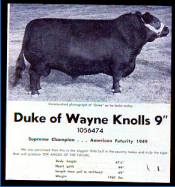 - **50% OF ALL FEED TO MAINTAIN COWHERD**

Maintenance Energy

High Maintenance Cow
- High milk production
- High visceral organ weight
- High body lean mass
- Low body fat mass
- High output and high input

Low Maintenance Cow
- Low milk production
- Low visceral organ weight
- Low body lean mass
- High body fat mass
- Low output and low input

Ritchie, 1995

Maintenance Energy

High Maintenance

Low Maintenance

Duke of Wayne Knolls 9"

Which one is more efficient?

Environment

Restricted feed resources
- Favors more moderate size, moderate milk production
- "Low maintenance" breeds are most efficient
  – Angus, Red Poll
- High maintenance breeds are least efficient
  – Simmental, Charolais, Limousin, Gelbvieh

Abundant feed resources
- Favors larger, heavier milking biological types
- "High maintenance" breeds are most efficient
  – Simmental, Charolais, Limousin, Gelbvieh
- Low maintenance breeds are least efficient
  – Hereford, Red Poll, Angus**

Jenkins and Ferrell, 1994

Variation in cow efficiency

	"Small" Cow	"Big" Cow	"Moderate" Cow	"Moderate" Cow
BW, lbs	1186	1453	1306	1308
Milk Production, lbs	15.8	23.0	17.8	20.4
Hip Height, in.	52	53.0	53.0	53.5
BCS	5.5	6.0	6.0	5.5
DMI, lbs	56.6	45.4	54.4	35.8

Adcock et al., 2010

Objective

- **To estimate the relationship between measures of growth, feed intake, feed efficiency, in developing heifers and their subsequent performance as cows**

Materials and Methods

- **Postweaning intake and performance**
  – **5 year study**
    - Angus and Simmental x Angus (n=511)
  – **70% corn silage, 25% distillers grains, 5% supplement**
  – **Minimum of 70 d evaluation each year**
    - Years 1, 2, 3
      – Cattle weighed beginning and end (2 d weights)
    - Years 4 and 5
      – Cattle weighed every 2 weeks
        » ADG calculated by regression
    – 12th rib backfat determined via ultrasound

Materials and Methods

- Heifer RFI calculation
  - DMI regressed on ADG and midpoint metabolic weight (MWW)
  - Contemporary groups to account for breed and origin
  - Backfat included in years 4 and 5
- Heifer RG calculation
  - ADG regressed on DMI and MWW
  - Contemporary groups to account for breed and origin
  - Backfat included in years 4 and 5

Materials and Methods

- RFI, RG, and Intake classification groups
  - Heifers more than 0.5 SD below the mean = LOW
  - Heifers ± 0.5 SD of the mean = MED
  - Heifers more than 0.5 SD above the mean = HIGH

Materials and Methods

- 366 identified as potential replacements
  - Synchronized and AI
  - Exposed to clean-up bulls for 60 d
- Pregnant heifers retained and calved out
  - First service AI and overall pregnancy
  - Cow age at first calving
  - Calf birth weight

Materials and Methods

- 2-year-old cow evaluation
  - Cows brought back into GrowSafe barns
    - 60 d postpartum (lactating)
    - 240 d postpartum (dry cow; calves weaned at 180-200d)
  - Forage diet (ground hay / haylage; ~60% TDN)
  - 7 d adaptation to diet and GrowSafe
  - 14 d intake evaluation period
  - At conclusion of intake evaluation
    - Weigh-suckle-weigh for milk production (only at 60 d)
    - 2 d BW
    - Hip height
    - BCS
    - 12th rib backfat via ultrasound

Materials and Methods

- Cow RFI (lactating cow)
  - Assumed to represent the residuals from a multiple regression model regressing DMI on metabolic weight, BF and 24-hr milk production
- Statistics
  - MIXED procedure of SAS for continuous variables
    - Fixed effect of RFI, RG, or Intake classification group
  - GLIMMIX procedure of SAS for binomial data
    - Fixed effect of RFI, RG, or Intake classification group

Effects of heifer RFI on heifer performance and reproductive traits

Item	Heifer RFI Category			SEM	P-value
	Low	Med	High		
Performance traits					
DMI, lb	19.2[a]	21.5[b]	24.3[c]	0.3	<0.01
ADG, lb	2.93	2.88	2.96	0.04	0.40
RFI, lb	-2.35[a]	0.04[b]	2.33[c]	0.09	<0.01
RG, lb	0.06	0	-0.06	0.04	0.12
Reproductive traits					
Retained as replacement, %	69	76	71	-	0.36
First AI conception rate, %	45	50	42	-	0.50
Overall pregnancy rate, %	86	83	85	-	0.80
Cow age at first calf, d	736	734	741	3	0.16

[a,b] Row means that do not have a common superscript differ, P < 0.05

Effects of heifer RFI on cow and calf performance traits

| | Heifer RFI Category | | | | |
Item	Low	Med	High	SEM	P-value
Calf performance[1]					
Calf birth weight, lb	73	73	75	1	0.51
Calf weaning weight, lb	598	586	618	12	0.12
2-year-old cows (lactating)[2]					
Cow BW, lb	1270	1257	1272	14	0.68
Cow hip height, in	52.6	52.8	52.9	0.2	0.54
Cow BCS	5.7[xy]	5.6[x]	5.7[y]	0.1	0.08
Cow BF, in	0.25	0.24	0.25	0.01	0.91
24 h milk production, lb	18	17	18	1	0.70
Cow DMI, lb	32.4[a]	35.9[b]	36.9[b]	1.1	<0.01
Cow RFI, lb	-1.67[a]	0.56[b]	1.09[b]	0.65	<0.01

[a,b] Row means that do not have a common superscript differ, P < 0.05
[x,y] Row means that do not have a common superscript tend to differ, P > 0.05 and < 0.10
[1] Progeny of 2-year-old cows
[2] 2-year-old cow traits measured at 60 d postpartum

Effects of heifer RFI on cow performance and reproduction

| | Heifer RFI Category | | | | |
Item	Low	Med	High	SEM	P-value
2-year-old cows (dry)[1]					
Cow BW, lb	1378	1368	1384	14	0.67
Cow hip Height, in	53.5	53.5	53.5	0.2	0.99
Cow BCS	5.8	5.8	5.9	0.1	0.81
Cow BF, in	0.27	0.27	0.28	0.01	0.55
Cow DMI, lb	29.0[x]	30.9[xy]	33.4[y]	1.3	0.06
2-year-old cows rebreed					
First AI conception rate, %	49	51	52	-	0.90
Overall pregnancy rate, %	83	91	83	-	0.20

[x,y] Row means that do not have a common superscript tend to differ, P > 0.05 and < 0.10
[1] 2-year-old cow traits measured at 240 d postpartum

Effects of heifer RG on heifer performance and reproductive traits

| | Heifer RG Category | | | | |
Item	Low	Med	High	SEM	P-value
Performance traits					
DMI, lb	21.4	22.2	21.3	0.3	0.07
ADG, lb	2.59[a]	2.92[b]	3.22[c]	0.03	<0.01
RFI, lb	0.15[a]	0.27[a]	-.43[b]	0.17	<0.01
RG, lb	-0.46[a]	0.01[b]	0.41[c]	0.03	<0.01
Reproductive traits					
Retained as replacement, %	71	71	74	-	0.80
First AI conception rate, %	46	44	47	-	0.91
Overall pregnancy rate, %	86	83	85	-	0.72
Cow age at first calf, d	739	737	735	3	0.47

[a,b] Row means that do not have a common superscript differ, P < 0.05
[x,y] Row means that do not have a common superscript tend to differ, P > 0.05 and < 0.10

Effects of heifer RG on cow and calf performance traits

| | Heifer RG Category | | | | |
Item	Low	Med	High	SEM	P-value
Calf performance[1]					
Calf birth weight, lb	73	74	74	1	0.84
Calf weaning weight, lb	596	600	601	12	0.94
2-year-old cows (lactating)[2]					
Cow BW, lb	1261	1256	1280	14	0.42
Cow hip height, in	52.5[x]	52.7[xy]	53.0[y]	0.2	0.06
Cow BCS	5.7	5.6	5.6	0.1	0.91
Cow BF, in	0.26	0.24	0.24	0.01	0.45
24 h milk production, lb	18	17	18	1	0.47
Cow DMI, lb	35.1	35.0	35.2	1.1	0.99
Cow RFI, lb	0.92	-0.30	-0.54	0.63	0.21

[x,y] Row means that do not have a common superscript tend to differ, P > 0.05 and < 0.10
[1] Progeny of 2-year-old cows
[2] 2-year-old cow traits measured at 60 d postpartum

Effects of heifer RG on cow performance and reproduction

| | Heifer RG Category | | | | |
Item	Low	Med	High	SEM	P-value
2-year-old cows (dry)[1]					
Cow BW, lb	1372	1359	1398	14	0.12
Cow hip Height, in	53.3	53.4	53.7	0.2	0.14
Cow BCS	5.9	5.8	5.8	0.1	0.83
Cow BF, in	0.28	0.27	0.27	0.01	0.67
Cow DMI, lb	29.6	31.7	31.9	1.3	0.36
2-year-old cows rebreed					
First AI conception rate, %	54	51	48	-	0.65
Overall pregnancy rate, %	83	91	84	-	0.20

[1] 2-year -old cow traits measured at 240 d postpartum

Effects of heifer intake on heifer performance and reproductive traits

| | Heifer Intake Category | | | | |
Item	Low	Med	High	SEM	P-value
Performance traits					
DMI, lb	18.4[a]	21.3[b]	25.1[c]	0.2	<0.01
ADG, lb	2.76[a]	2.89[b]	3.10[c]	0.04	<0.01
RFI, lb	-1.88[a]	0.00[b]	1.81[c]	0.13	<0.01
RG, lb	0.03	-0.02	0	0.04	0.60
Reproductive traits					
Retained as replacement, %	57[a]	80[b]	76[b]	-	<0.01
First AI conception rate, %	51	44	45	-	0.62
Overall pregnancy rate, %	84	84	86	-	0.87
Cow age at first calf, d	731[a]	738[ab]	741[b]	3	0.04

[a,b] Row means that do not have a common superscript differ, P < 0.05

Effects of heifer intake on cow and calf performance traits

Item	Heifer Intake Category			SEM	P-value
	Low	Med	High		
Calf performance[1]					
Calf birth weight, lb	71[a]	73[a]	77[b]	1	<0.01
Calf weaning weight, lb	605	590	607	14	0.47
2-year-old cows (lactating)[2]					
Cow BW, lb	1225[a]	1273[b]	1285[b]	16	0.02
Cow hip height, in	52.1[a]	52.8[b]	53.2[c]	0.2	<0.01
Cow BCS	5.6	5.7	5.7	0.1	0.75
Cow BF, in	0.24	0.26	0.24	0.01	0.25
24 h milk production, lb	18	18	17	1	0.73
Cow DMI, lb	30.2[a]	35.4[b]	38.4[c]	1.2	<0.01
Cow RFI, lb	-1.24[a]	-0.20[ab]	1.19[b]	0.74	0.04

[a,b] Row means that do not have a common superscript differ, P < 0.05
[1] Progeny of 2-year-old cows
[2] 2-year-old cow traits measured at 60 d postpartum

Effects of heifer intake on cow performance and reproduction

Item	Heifer Intake Category			SEM	P-value
	Low	Med	High		
2-year-old cows (dry)[1]					
Cow BW, lb	1305[a]	1377[b]	1409[b]	19	<0.01
Cow hip Height, in	52.9[a]	53.5[b]	53.9[c]	0.2	<0.01
Cow BCS	5.7	5.8	5.9	0.1	0.24
Cow BF, in	0.27	0.27	0.29	0.01	0.44
Cow DMI, lb	27.3[a]	30.7[ab]	33.1[b]	1.5	0.02
2-year-old cows rebreed					
First AI conception rate, %	58	46	50	-	0.27
Overall pregnancy rate, %	88	84	86	-	0.72

[a,b] Row means that do not have a common superscript differ, P < 0.05
[1] 2-year -old cow traits measured at 240 d postpartum

Summary

- RFI
  - Heifers with "good" or Low RFI ate less as cows and had better cow RFI than heifers with High RFI
- RG
  - Differences in heifer RG did not affect cow traits
- Intake
  - Heifers with Low Intake were less likely to be kept as replacements, were younger when they had their first calf, had lower birth weight calves, weighed less as 2-year-olds, ate less as 2-year-olds, and had better cow RFI than heifers with High Intake

Conclusions

- Relationship of heifer intake and cow intake is encouraging
  - Measuring intake on replacement heifers is much more feasible than on cows
- Very minimal antagonistic relationships identified thus far
- Ultimate goal should be to include intake in selection indexes

Acknowledgements

- Angus Foundation
- Joe Cassady, South Dakota State University
- Chris Cassady, University of Illinois
- Justin Adcock, Agridyne
- Keela Retallick, California Polytechnic State University