Energy intake and feedlot cattle performance

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Observed vs Expected

- Every purposeful observation has:
  - rational expectations
  - rational limits
- What we "see" or "perceive" is nested in
  - Concepts (notions of how things are)
  - experience
    - experimental abstractions

How much will an observation deviate from expected before we experience

- Surprise
- Concern
- Alarm!

Example: medium-frame English-cross calves, late finishing phase (last 112 days)

	"Observed"	Expected ?
Initial weight, lbs	880	
Final weight, lbs	1201	
ADG, lbs	2.93	
DMI, lbs/d	13.3	
DMI/ADG	4.45	

Diet NEm, 2.15 Mcal/kg

Example: medium-frame calves, late finishing phase (last 112 days)

	Observed 1st look	Observed 2nd look
Initial weight, lbs	880	880
Final weight, lbs	1201	1201
ADG, lbs	2.93	2.93
DMI, lbs/d	13.3	16.6
DMI/ADG	4.45	5.68

Example: medium-frame calves, late finishing phase (last 112 days)

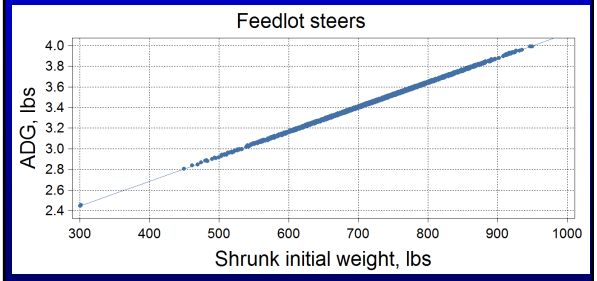
	Observed 1st look	Observed 2nd look	Expected
Initial weight, lbs	880	880	880
Final weight, lbs	1201	1201	1201
ADG, lbs	2.93	2.93	2.99
DMI, lbs/d	13.3	16.6	16.7
Exp/Obs DMI	1.26	0.985	1.00
DMI/ADG	4.45	5.68	5.59

Confidence in expectations

- **Sense of certainty is dependent on:**
  - **Repeatability/ supported by experience**
  - **Risk**
    - **Inversely proportional to confidence**
    - **> sense of risk = closer focus/ attention**

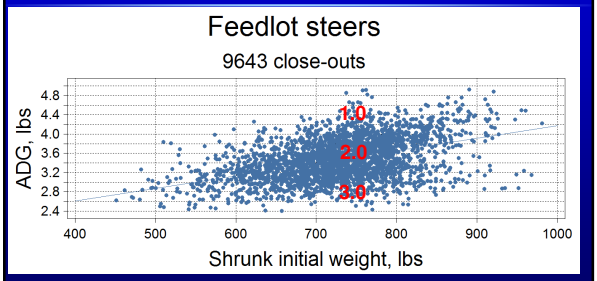
ADG is also a predictable function of initial weight

Average daily gain predicted from initial shrunk weight of steers (ADG = 0.72 + 0.0029 SIW − 0.00000142 SIW^2; r^2 = 0.25; $S_{y.x}$ = 0.147; P < 0.001) and heifers (ADG = 0.5015 + 0.004027 SIW − 0.00000397 SIW^2; r^2 = 0.22; $S_{y.x}$ = 0.127; P < 0.001) at commercial feedlots (the "•" symbol identifies the gender mean).



Zinn et al.,2008

Variation in feedlot cattle ADG



Sources of apparent performance variation

- **Inaccurate assessment of initial weight condition (shrunk, full, etc)**
- **Error in classification of gender and quality (Frame)**
- **Improper or poor weighing conditions**
- **Recording errors**
- **Cattle transferences/mixing**
- **Environmental stressors**

Sources of intrinsic variation in ADG

- **Genetics**
- **Background**
  - **body condition**
  - **Prior nutrition (range vs pre-fed)**
- **Shrink**
  - **Accounting for fill**
  - **Relationship between empty vs live weight**
- **Environment**
  - **Weather (month out)**
  - **Pen location**
- **Space allowances**
  - **pen**
  - **manger**
  - **drinker**
  - **shade**
- **Feed additives**
- **Implant failure/ calendaring**
- **Diet acceptability/palatability**
  - **forage quality**
  - **fat**
  - **excess ionophore**
- **Nutritional deficiency/ excess**
  - **metabolizable amino acids**
  - **excess sulfur**
- **Inadequate feed mixing**
- **Health**
  - **chronics**
  - **bulling**
- **Digestives**
  - **acidosis**
  - **bloat**
- **Delay start-up/ restricted energy intake**
- **Etc.**

Variation in DMI major determinant of variation in ADG

✓Coefficient of variation in ADG >10%

✓Taking into consideration DMI:
Coefficient of variation in ADG <5%
(In controlled research trials, CV <2%)

Expected vs observed feedlot performance

Actual pen close-out summary: 579 steer, 305 heifer

1.35	2.26	757	1272	3.41	1208	154	3.37	19.4	0.99
0.35	0.17	0.13	0.06	0.08	0.07	0.16	0.12	0.09	0.10
		HEIFER Frame	2.2		STEER Frame	2.25			

GENDER	FRAME	IW	FW	prdADG	FSBW	DOF	ADG	DMI	ADG Ratio
1	2.31	782	1309	3.54	1252	153	3.48	19.8	0.98
2	2.18	711	1197	3.15	1123	155	3.17	18.6	1.00

0.105	0.61	0.98	19.7	1.02	82.00	17.32	1.22	5.80
0.07	0.10	0.00	0.09	0.05	0.00	0.95	0.95	0.09

cof	cog	NM	EXPDMI	DMI RATIO	PDM	PMORB	DEATH	FG
0.105	0.60	0.98	20.1	1.02	82.00	17.85	1.19	5.67
0.105	0.62	0.98	19.0	1.02	82.00	17.95	1.27	5.73

6-month summary, 884 close-outs (Engish units)

The coefficients of variation is lower for measures of "variance ratio"

Single feedlot, (6-month data summary) 884 close-outs

Item	CV, %
ADG	12.0
Feed/gain	9.0
Variance ratio	
Expected/Observed DMI	4.9

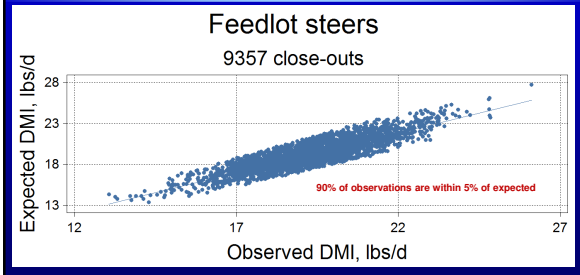
Performance evaluation

- **Feed efficiency and ADG**
  - Most commonly evaluated performance factors
  - Confound by:
    - Initial weight (purchase weight)
    - Frame/mature weight
    - Harvest weight:mature weight ratio
    - Dietary energy density
  - **Can be very misleading in terms of management controls**

Relationships between energy intake and growth-performance……..perhaps the **most reliable of nutritional concepts**

The objective this presentation is to briefly focus on this important nutritional principle related to feedlot production

ADG and DMI are predictable functions



ADG and DMI of feedlot cattle are predictable functions of:

- **Gender**
- **Frame size/ quality score (measured in a range of 1 = large 2 = medium 3=small)**
  - **Most feedlot cattle fall between 1.75 and 2.25 in frame/quality score**
- **Purchase weight**
- **Average live weight for period of interest**
- **Diet energy density (NEm and NEg)**

Standards/ "expectation" references

(Zinn et al., 2008)

- MFW_{steer}, kg = 509.6 + 0.4697 SIW – 46.54 Frame
- MFW_{heifer}, kg = 551.5 - 0.2482 SIW + 0.00119 SIW^2 – 39.84 Frame
  - Where Frame is a value between 1 and 3 (average Frame = 2)

ADG based on initial weight

- ADG_{steer}, kg = 1.628 + 0.00287 SIW - 0.00000107 SIW^2 – 0.461 Frame
- ADG_{heifer}, kg = 1.265 + 0.00432 SIW - 0.00000425 SIW^2 – 0.410 Frame
  - ADG predictions assume cattle are harvested at expected mature final weight

ADG based on DMI

- ADG_{steer}, kg = (((DMI - ((0.077*($AW^{0.75}$))/NEm))*NEg)/ (0.0606 * ((AW * 478/MFW)$^{0.75}$)))$^{1.105}$
- ADG_{heifer}, kg = (((DMI - ((0.077*($AW^{0.75}$))/NEm))*NEg)/ (0.0618 * ((AW * 478/MFW)$^{0.75}$)))$^{1.105}$

What can we expect of a 803 lb yearling steer, where Frame = 2.0 and diet NEm = 0.98 Mcal/lb?

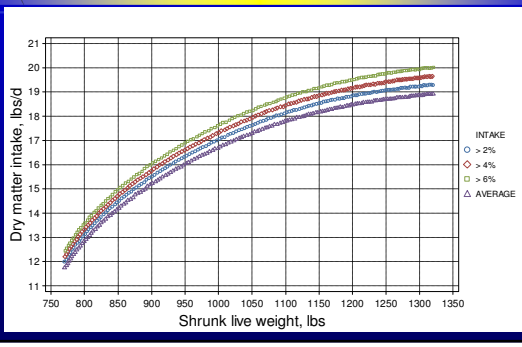
Frame	2	Lbs
SIW, kg	365	(803)
SFW, kg	634	(1395)
MFW, kg	634	(1395)
NEm, Mcal/kg	2.15	(0.98)
DMI, kg/d	9.35	(20.6)
ADG_{SIW}, kg	1.61	(3.54)
ADG_{DMI}, kg	1.61	(3.54)

Relationship between feed intake and performance

Influence of energy intake on growth performance

Live weight vs cumulative DMI

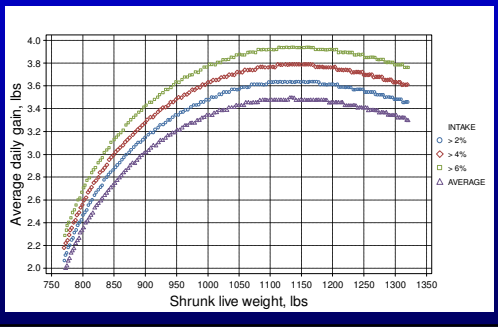
803 lb medium frame yearling steer



Influence of energy intake on growth performance

Live weight vs cumulative ADG

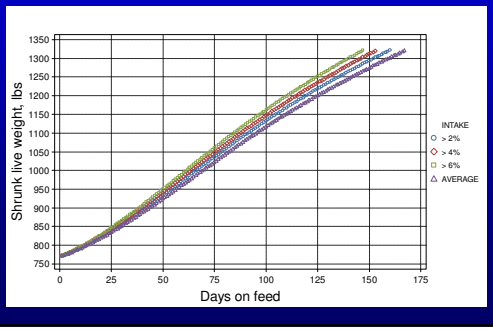
803 lb medium frame yearling steer



Influence of energy intake on growth performance

Live weight vs days on feed

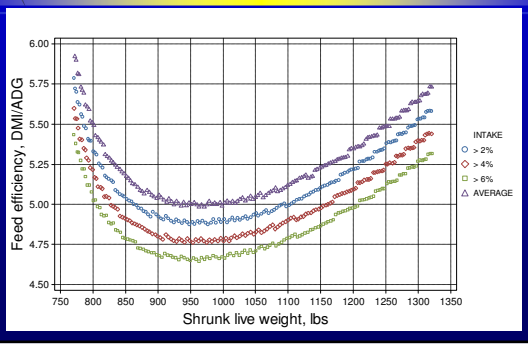
803 lb medium frame yearling steer



Influence of energy intake on growth performance

Live weight vs feed efficiency

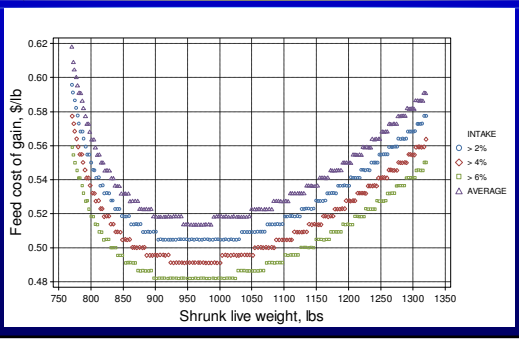
803 lb medium frame yearling steer



Influence of energy intake on growth performance

Live weight vs cost of gain

803 lb medium frame yearling steer



Influence of energy intake on growth performance

Summary

803 lb medium frame yearling steer

	Feed intake			
	Average	> 2%	> 4%	> 6%
Shrunk Weight, lbs				
Initial	771	771	771	771
Final	1320	1320	1320	1320
Days on feed	167	160	153	147
ADG, lbs	3.30	3.45	3.61	3.76
DMI, lbs/day	18.9	19.3	19.6	20.0
DMI/ADG	5.73	5.58	5.44	5.32
COG, $/lb	0.595	0.577	0.564	0.550
Breakeven, $/cwt	114.94	114.28	113.66	113.00
Net return, $	53.59	62.44	70.49	79.20
Δ profit, $		8.85	16.90	25.61

Purchase weight, 803 lbs
Purchase price, $147/cwt
Market price, $119/cwt
Feed cost, $169/T (82% DM)
Medicine, $35/h
Death loss, 1.5%
Interest rate, 5% (Prime + 1%)

Feed intake and performance of calf-fed Holsteins

(Salinas et al., 2017)

Item	Control	Prebiotic	Δ
Days on test	336	336	
Live weight (lb) [a]			
Initial	2930	292.2	
Final	1293	1355	+62.4 lbs
ADG (lb)			
1 to 112 d	2.62	2.77	+5.9%
112 to 224 d	3.23	3.41	+5.4%
224 to 336 d	3.06	3.32	+8.6%
1 to 336 d	2.97	3.17	+6.7%
DMI (lb/d)			
1 to 112 d	11.7	12.3	+5.2%
112 to 224 d	17.6	19.0	+7.8%
224 to 336 d	22.1	24.0	+8.9%
1 to 336 d	17.19	18.5	+7.7%
Diet NEm, Mcal/lb	0.96	0.96	ND

[a] Initial weight is the shrunk off truck arrival weight. Interim and final weights were reduced 4% to account for digestive tract fill.

Energy intake and performance of calf-fed Holsteins (Ramirez et al., 1998)

Item	Control	Laidlomycin	Δ
Days on test	262	262	
Live weight (lb)[a]			
Initial	332	332	
Final	1043	1107	+29 kg
ADG (lb)	2.71	2.95	+8.9%
DMI (lb/d)	14.9	15.2	+2.2%
DMI/ADG	5.50	5.16	-6.1%
Diet NEm, Mcal/lb	0.95	0.99	+3.3%

[a] Initial and final weights were reduced 4% to account for digestive tract fill.

40% of variation in ADG due to increase in DMI

60% of variation in ADG due to enhanced efficiency of energy utilization

39% of variation in DMI/ADG due to increased ADG

61% of variation in DMI/ADG due to enhanced efficiency of energy utilization

Conclusions:

- **Reliable standards exist**
  - **Weight gain is a highly predictable function of energy intake**
  - **Energy intake is a function of:**
    - **DMI**
    - **Diet energy density (NEm, NEg)**
    - **Nutritional/management effects on efficiency of NE utilization**
  - **DMI is an important benchmark for:**
    - **Recognition of performance variance**
    - **Directing management focus**
    - **Useful filter for detecting data entry errors**

Factors that may enhance energy intake

- **Optimal use of growth implants**
- **Feed additives**
- **Proper feeding management**
- **Adequate dietary effective fiber**
- **Diet acceptability/ palatability**
- **Nutritional balance and water quality**
- **Adequate pen and drinker space**
- **Environment** (shade/ shelter/ flooring)