Pregnant Cow Nutrition:
Effect on progeny carcass and meat characteristics

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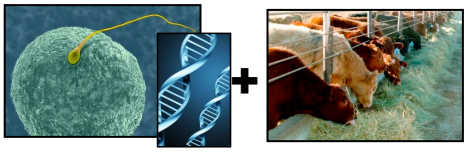
Beef Production

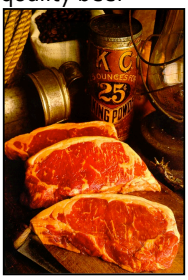
Genetics Environment



- Work to ensure "environment" maximizes "genetic potential"
  - Nutrition
  - Time on feed
  - Management practices
  - Technology

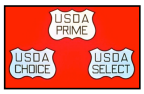
Beef Production Goals

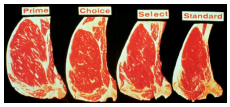
- Produce more pounds of high quality beef
  - Improve Yield Grade
  - Improve Quality Grade
  - Meets consumer acceptability
  - Economical



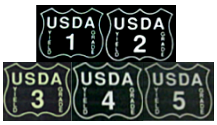
Beef Production Goals

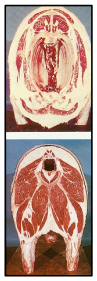
- Quality Grade
  - Maturity and Marbling
    - Measure of palatability





- Yield Grade
  - HCW, REA, FT, KPH
  - Percent of carcass that ends up as closely trimmed retail cuts

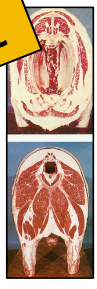




Beef Production Goals

- Quality Grade
  - Maturity and Marbling
    - Measure of palatability
- Yield Grade
  - HCW, REA

Muscle and Fat



Beef Production Goals

- Consumer acceptance of any muscle food is based on:
  - Appearance
    - Lean/Fat Color
    - Lean:Fat
    - Lean:Bone
  - Palatability
    - Tenderness
    - Juiciness
    - Flavor
  - Cost

Beef Production Goals

- Consumer acceptance of any muscl… based on:
  - Appearance
    - Lean/Fat Color
    - Lean:Fat
    - …ness
    - Flavor
  - Cost

Muscle and Fat

How to meet our production goals?

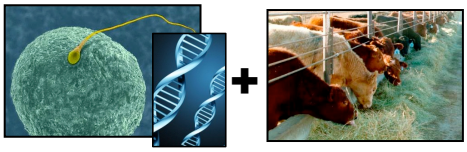
- Improvements in Yield Grade
  - Nutrition management strategies to maximize muscle growth potential
  - Genetic selection
  - Technology
    - Implant strategies
    - β-agonist???
- Improvements in Quality Grade/Consumer Acceptability
  - Extended feeding
  - Genetic selection
  - Management of technologies

How to meet our production goals?

- Often times are goals are antagonistic
  - Example → Quality vs. Cutability
  - Example → β-agonist vs. Tenderness

How to meet our production goals?

Genetics Environment



- Work to ensure "environment" maximizes "genetic" potential.
  - Nutrition
  - Time on feed
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Postnatal strategies

New Frontier

- Prenatal strategies?
  - Beginning to understand the importance of gestational environment in maximizing offspring potential
    - Health
    - Growth performance
    - Meat yield
    - Meat quality
- Emerging area of research
  - Fetal programming

What is Fetal Programming?

- Idea that the gestational environment exerts a permanent influence on postnatal metabolism and growth
- The offspring is being "programmed" to deal with the environment it will be born into
  - Thrifty phenotype
    - Dutch famine
    - Runt pig

Not a "new" concept…

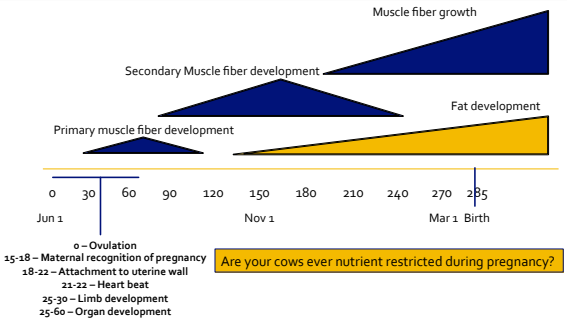
New Frontier

- Can we use this concept to manipulate the development of **muscle** and **fat**…and ultimately meat composition.

What's going on with the developing calf?

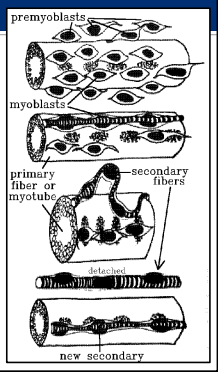
- When does muscle develop?
- When does fat develop?

Fetal timeline – beef cattle



Muscle development

- Primary muscle fibers act as a scaffolding for secondary fibers to form
- Secondary fibers composed the majority of mature muscle
- **Muscle fiber number is set at birth in cattle**
  - If muscle development is limited during gestation there is no way to recover
  - Could affect body composition



Fat development

- Fat cells can accumulate lipid to a set size
- Once full, new fat cells can be recruited
  - Influencing fat cell development during gestation could impact composition

Common practice…

- Fetus has limited nutrient requirements during early- to mid-gestation therefore cows can get by on lower quality feedstuffs during this stage
- Supplement cows late during gestation (third trimester)
  - Support fetal growth (~75% of growth occurs in the last 2 months of gestation)
  - Raise cow BCS
  - Prepare for lactation
  - Improve breed-back rate

Research Questions

- Does limited nutrition during early to mid pregnancy impact development, postnatal growth and carcass composition of the offspring?
- Can a better understanding of fetal programming be used to improve carcass characteristics?
  - Quality Grade
  - Yield Grade
  - Palatability traits

Research to date

- Conflicting results
- Small data sets
- Very new area of study
- Overview of fetal programming research at South Dakota State University

Fetal Programming Research at SDSU

- Preliminary data revealed differences in genes responsible for muscle and fat development due to maternal nutrition
  - Do alterations in genes responsible for muscle and fat development carry out to differences in carcass composition?
  - Follow-up study (USDA-AFRI/SDBIC)
    - Large group of young commercial cows
    - Restricted during mid-gestation
    - Follow calves out

Materials & Methods

151 beef cows were allotted into 2 groups during mid-gestation based on conception date, source, body weight, age, & BCS

Materials & Methods

151 beef cows were allotted into 2 groups during mid-gestation based on conception date, source, body weight, age, & BCS

Maintenance Group: Fed to maintain BCS of 5.0-5.5 (n=76)

Grazed dormant, native range & supplemented every other day (9.8% CP diet)

Materials & Methods

151 beef cows were allotted into 2 groups during mid-gestation based on conception date, source, body weight, age, & BCS

RESTRICTED GROUP: Fed to lose 1 BCS over the 98 d period (n=75)

Managed in 10 dry-lot pens, blocked by weight, fed a 9.7% CP diet consisting of 84.8% mature brome hay & 15.2% supplement

Materials & Methods

During mid-gestation, cows were evaluated for BCS, weight, & ultrasound REA & backfat

Measurements used to reclassify cows into groups based on energy status

POSITIVE ENERGY STATUS (n=79) | NEGATIVE ENERGY STATUS (n=70)

At weaning, calves were transported to the SDSU Feedlot and fed a common diet

Calves were harvested when they reached 0.4 in ribfat thickness: Carcass data, Warner-Bratzler shear force, objective color

Cow Performance

Trait[a]	Positive (n=79)	Negative (n=70)	SEM	P-value Status	P-value Block
Days of Gestation[b]	84	84	1.3	0.9730	0.0215
Initial BCS	4.78	4.94	0.051	0.1028	0.0076
Final BCS	4.92	4.29	0.046	0.0001	0.0128
Change in BCS	0.14	-0.65	0.050	<0.0001	0.4076
Initial BW, lb	1017	1017	5.2	0.9907	<0.0001
Final BW, lb	1126	967	6.7	<0.0001	<0.0001
Change in BW, lb	109	-50	5.6	<0.0001	0.3197
Initial REA, in^2	8.85	9.24	0.146	0.1035	0.0007
Final REA, in^2	9.38	8.25	0.155	0.0003	0.0004
Change in REA, in^2	0.53	-0.99	0.111	<0.0001	0.4460

[a]Measurements taken at the beginning and end of mid-gestation period, normalized by fill
[b]Days of gestation at beginning of mid-gestation treatment as estimated by pregnancy ultrasound

Cow Performance

Trait[a]	Positive (n=79)	Negative (n=70)	SEM	P-value Status	P-value Block
Initial 12th rib fat, in	0.15	0.16	0.005	0.7228	0.0081
Final 12th rib fat, in	0.16	0.14	0.004	0.0251	0.0418
Change in 12th rib fat, in	0.01	-0.02	0.004	0.0083	0.2907
Energy Status[a]	2.09	-2.32	0.146	<0.0001	0.9888

[a]Energy Status = $\left[\frac{(Obs\ BCS\ \Delta - BCS\ \Delta\ s)}{BCS\ \Delta\ S_d}\right] + \left[\frac{(Obs\ REA\ \Delta - REA\ \Delta\ s)}{REA\ \Delta\ S_d}\right] + \left[\frac{(Obs\ BW\ \Delta - BW\ \Delta\ s)}{BW\ \Delta\ S_d}\right]$

Offspring Carcass data

Trait	Positive (n=59)	Negative (n=48)	SEM	P-value
HCW, lb	728	714	8.9	0.2373
Dress, %[a]	63.12	62.97	0.194	0.5500
12th Rib Fat, in	**0.49**	**0.44**	**0.018**	**0.0585**
REA, in^2	13.00	13.10	0.172	0.6839
KPH, %	2.09	2.10	0.029	0.8722
Yield Grade	**2.86**	**2.64**	**0.084**	**0.0502**
Marbling[b]	430	440	8.6	0.3857
MRatio[c]	**-0.24**	**0.29**	**0.178**	**0.0275**
IM Fat, %	4.09	4.46	0.184	0.1332
IRatio[d]	**-0.32**	**0.33**	**0.167**	**0.0044**

[a]Calculated using final live body weight with 4% shrink
[b]300 = Slight50; 400 = Small00; 500 = Modest00
[c] Ratio of marbling to 12th rib fat thickness
[d] Ratio of % intramuscular fat to 12th rib fat thickness

Offspring – Meat Quality

Trait	Positive (n=57)	Negative (n=44)	SEM	P-value
L*[a]	42.02	42.11	0.345	0.8428
a*[a]	22.75	22.58	0.214	0.5369
b*[a]	8.07	8.00	0.170	0.7362
3-d WBSF, kg	4.17	4.18	0.188	0.9553
14-d WBSF, kg	3.14	3.08	0.103	0.6604
21-d WBSF, kg	3.16	3.10	0.116	0.6654

[a]L*: 0 = Black; 100 = White; a*: Positive values = red; Negative values = green; b*: Positive values = yellow; Negative values = blue

Conclusions to date

- The level of maternal energy restriction imposed in this study during the second trimester:
  - Had no impact on carcass tenderness, color or Quality Grade
  - Decreased Backfat
  - Improved Yield Grade
  - Increased the ratio of marbling to subcutaneous fat
    - Indicating maternal energy status could play an important role in augmenting composition of gain.

Industry Relevance

- Variable feed costs → Challenge for increased time on feed
- Future use of β-agonists?
- Changing market signals

- Manipulating maternal nutrition during gestation could be a powerful management tool to maximize offspring quality and yield grade potential
  - Still have a great deal to investigate

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USDA United States Department of Agriculture National Institute of Food and Agriculture

BEEF South Dakota Beef Industry Council

Thank You