Fetal Programming

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Fetal Programming

1. Events prior to birth…imprint lifetime performance
   - In utero stress "under-nutrition"
   - In utero "optimum-nutrition"
2. Data in all species (*humans* and livestock)
3. Center for the Study of Fetal Programming, University of Wyoming

Historical Background

- World War II
  - Holocaust
  - Dutch Winter Hunger
- Children developed lifetime health problems that were:
  - Unique to their genetics
  - Passed on to their children

Epigenetics

- Is a term used to describe the idea that environmental factors can cause an organism's genes to behave (or "express themselves") differently, even though the genes themselves don't change.

Effects of the Holocaust on the Physical Health of the Offspring of Survivors

- The epigenetic changes brought about by fetal programming are not limited to the fetal period. There is ample proof that they are permanent, last throughout life, and can be <u>passed on to future generations</u>.

Hazani and ShaSha, Perspective, April 2008

Fetal Programming

- Refers to maternal events during development of the fetus…that have life-time effects on the calf after birth.
- Each trimester appears to be critical

Fetal Programming in cows

- The brood cow is the only "managed livestock species" where the industry plans on her to lose weight during gestation.
- Do cows receive consistent nutrition in early, mid and late gestation?
  - Green-up…condition loss
  - Drought…condition loss
  - Winter…condition loss
- "Maternal Hunger" is the norm.

Examples of Stress

- Nutritional deficiency
  - Protein, energy, vitamins and minerals
- Multiple pregnancies
- Environmental
  - Temperature extremes
    1. Heat
    2. Cold
    3. Wind chill
  - Prenatal steroid exposure
- Health

When is the critical stage?

- Last trimester
  - Over 75% of fetal growth
  - This has always been the focus
  - Birth weight can be effected
- First 2/3 of pregnancy
  - Overlooked because of supposed less demand for nutrients
  - Placenta develops
  - Organs differentiate (lung, liver, GI tract)
  - Organs grow

Fetal Programming Data

- Highlights from University of Nebraska
  - Google, Dr. Rick Funston on the internet
- Effects of supplementation during last 1/3 of gestation in beef cows
- Three year studies
- Looks at performance of the calf crop

Fetal Programming Data

- Following slides
  - Supplementation last trimester
  - Cow herd 5.0 to 5.5 body condition score
  - Only share the highlights

Effect of dam nutrition on weight of offspring

Item	Dam Nutrition No Supplement	Dam Nutrition + Supplement
Birth weight, lbs	79	81
Weaning weight, lbs	462[a]	476[b]

[a,b]Means with different superscripts differ (P<.05)

Stalker et al., 2006

Effect of dam nutrition on feedyard performance of offspring

Item	Dam Nutrition No Supplement	Dam Nutrition + Supplement
Avg. daily gain	3.48	3.43
Feed intake, dm	18.7	18.8
Feed conversion	5.4	5.5

Stalker et al., 2006

Effect of dam nutrition on carcass traits of offspring

Item	Dam Nutrition No Supplement	Dam Nutrition + Supplement
Carcass wt.	799	812
Dressing %	64.9	64.6
Yield Grade	2.99	2.96

Stalker et al., 2006

Effect of dam nutrition on marbling of offspring

Item	Dam Nutrition No Supplement	Dam Nutrition + Supplement
Marbling Score	467	479
Choice, %	85	96

Stalker et al., 2006

Cow Nutritional Status – Last Trimester

Item	Dam Nutrition No Supplement	Dam Nutrition + Supplement
Cow condition-December 1	5.3	5.2
Cow condition-February 28	4.5	5.1

Stalker et al., 2006

How do we characterize the nutritional program?

- Did supplementing the cowherd increase marbling & fertility of the next generation?

Or

- Was cowherd nutrition inadequate and therefore marbling & fertility was reduced?

Fertility of replacements

- A different set of data follows

Effect of nutrition the last trimester on cow body condition

Item	Dam Nutrition No Supplement	Dam Nutrition + Supplement
Body condition, initial	5.2	5.2
Body condition, final	4.6	5.2

Martin et al., 2007

Effect of dam nutrition on replacement heifer fertility

Item	Dam Nutrition No Supplement	Dam Nutrition + Supplement
Body wt lbs, weaning	455	466
Conception rate, %	80	93
Calved in the first 21 days, %	49[a]	77[b]

[a,b]Means with different superscripts differ (P<.05)

Martin et al., 2007

New set of Nebraska studies

- Forage Type
  - Winter Rangeland
  - Crop Residue
- Supplementation last trimester

Cow Nutritional Status – Winter Rangeland

Item	Dam Nutrition No Supplement	Dam Nutrition + Supplement
Cow condition @ Pre-calving	4.8	5.2
Cow condition- @ Weaning	5.1	5.2

Larson et al., 2009

Cow Nutritional Status – Crop Residue

Item	Dam Nutrition No Supplement	Dam Nutrition + Supplement
Cow condition @ Pre-calving	5.4	5.2
Cow condition- @ Weaning	5.2	5.1

Larson et al., 2009

Effect of "Winter Range" dam nutrition on weight of offspring

Item	Dam Nutrition No Supplement	Dam Nutrition + Supplement
Birth weight, lbs	81[c]	84[d]
Weaning weight, lbs	495[a]	543[b]

[a,b]Means with different superscripts differ (P<.05)

[c,d]Means with different superscripts differ (P<.10)

Larson et al., 2009

Effect of "Winter Range" dam nutrition on carcasses of offspring

Item	Dam Nutrition No Supplement	Dam Nutrition + Supplement
Carcass Wt	785[a]	827[b]
Choice, %	77[a]	85[b]
Premium Choice, %	27[a]	43[b]

[a,b]Means with different superscripts differ (P<.05)

Larson et al., 2009

Effect of "Crop Residue" dam nutrition on weight of offspring

Item	Dam Nutrition No Supplement	Dam Nutrition + Supplement
Birth weight, lbs	82[c]	86[d]
Weaning weight, lbs	539	517

[c,d]Means with different superscripts differ (P<.10)

Larson et al., 2009

Effect of "Crop Residue" dam nutrition on carcasses of offspring

Item	Dam Nutrition No Supplement	Dam Nutrition + Supplement
Carcass Wt.	816	810
Choice, %	65[a]	88[b]
Premium Choice, %	15[a]	35[b]

[a,b]Means with different superscripts differ (P<.05)

Larson et al., 2009

Health

- The number 1 cause of feedlot mortality and morbidity is respiratory disease

Effect of "Winter Range" dam nutrition on health of offspring

Item	Dam Nutrition No Supplement	Dam Nutrition + Supplement
Treated, % Birth to weaning	17	17
Treated, % Weaning to Finish	12[a]	0[b]

[a,b]Means with different superscripts differ (P<.05)

Larson et al., 2009

Effect of "Crop Residue" dam nutrition on health of offspring

Item	Dam Nutrition No Supplement	Dam Nutrition + Supplement
Treated, % Birth to weaning	19	20
Treated, % Weaning to Finish	11[a]	3[b]

[a,b]Means with different superscripts differ (P<.05)

Larson et al., 2009

It appears to be more than just maintaining body condition

- Winter Rangeland…Results of fetal programming were more dramatic when cows were in poorer condition before calving
- However, on Corn Residue…Even though cows were in similar body condition, providing supplement programmed the fetus for better health in the feedyard

How are cows in the U.S. fed?

- A beef cow is the most nutritionally challenged of livestock species
- We plan on gestating cows to lose weight during the winter
- What if we cared for the cowherd like we do pregnant women?

How Well Do We Care For Young Females?

- First calf heifer (pre-calving)
- Wet 2 year old
- Second calf cow
- Third calf cow

Priority for Nutrients-Wet 2 yr Old

- In alphabetical order
  1. Activity
  2. Basal metabolism
  3. Cycling & initiation of pregnancy
  4. Energy reserves, Basic
  5. Energy reserves, Additional
  6. Energy reserves, Excess
  7. Growth
  8. Lactation
  9. Maintenance of pregnancy

Priority for Nutrients-Wet 2 yr Old

- Ranked based on demand in the cow
  1. Basal metabolism
  2. Activity
  3. Growth
  4. Energy reserves, Basic
  5. Maintenance of pregnancy
  6. Lactation
  7. Energy reserves, Additional
  8. Cycling & initiation of pregnancy
  9. Energy reserves, Excess

Focus on Young Females

- How old are cows when they stop growing?
- Aren't 3-4 year old cows always thinner than mature cows?
  - Recall the "priority of nutrients"
  - They often wean lighter calves than mature cows do.
  - If you feed them, their calves can outweigh the calves from mature cows!

Year-round supplementation

- What is it?
- What have ranchers seen?

Fetal Programming Summary

In-utero nutrition effects subsequent generations:

1. Reproduction:
   - Conception rates
   - *First service conception rates
   - Calving difficulty
2. Growth traits:
   - Weaning weights
   - * Carcass weights
   - * Marbling
3. Health

Fetal Programming Conclusions

- The gestational nutrition of your herd this year, imprints the lifetime genetic potential and performance of subsequent generations.
- The performance of a calf is influenced not only by its nutrition before and after birth, but also by the prior fetal nutrition of both its dam and grand dam.

Implications of Fetal Programming

- If you buy and/or feed cattle…you need to know more than the pay weight
- Replacement heifers and young cows:
  - Know their history
  - Don't let them lose condition, it's an investment in the future
- The cow herd
  - This spring's calf crop was influenced by last year's climate and your nutritional decisions relative to forage resources.
  - You can positively influence the next calf crop(s) by focusing on consistent daily nutrition of your herd
- You cannot change the past, but you can positively influence future generations.