Fetal Programming in Beef Cattle
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What is fetal programming?
Fetal Programming

The idea that a fetus is developmentally plastic and can adapt to its predicted postnatal surroundings

- Occurs through epigenetic modifications
- Alters an animal’s performance in postnatal life

Causes:
- Nutrient restriction
- Twinning
- Heifer pregnancy
- Heat/Cold stress
- High altitude
In a nutrient restricted environment,

- The **fetus programs its metabolism** to partition more calories to the storage of fat than to lean muscle.
- Development of insulin producing cells in the pancreas is impaired.
  - Decreased insulin production.
Intrauterine growth restriction (IUGR)

- IUGR = Excessively low birth weights
- Significantly increases chance of sickness or death of calves
Matching and mismatching environments

- **Deprived**
  - Cues, e.g., undernutrition, adjust metabolic setpoints
  - Inherited genotype and epigenotype

- **Adequate**
  - Developmental environment

- **Matched (healthy)**
  - Mature environment richer than predicted

- **Mismatched**
  - Enhanced risk of metabolic disease

- **Matched (healthy)**
Forage based diet
Extensively managed
Variable management
Geographically variable

Grain based diet
Intensively managed
Uniform management
Regional location
Figure 1. Fetal weight, and protein, fat and ash content of the bovine fetus by day of gestation.
Organ Development

- Fetal organs develop early in gestation
  - Fetal calf heart beat: 21-22 days post-ovulation
  - 25 days post ovulation: Limbs, Pancreas, liver, adrenals, lungs, thyroid, spleen, brain, thymus, and kidneys start to develop
  - Reproductive organ development starts: 60 days post ovulation
    - Heifer calf’s future fertility and stayability can be affected
Muscle and Fat Development

Nutrient restriction reduces adipogenesis, decreasing marbling in offspring

Nutrient restriction reduces muscle fiber hypertrophy, decreasing birth weight

Nutrient restriction reduces myogenesis, decreasing muscle fiber number and muscle mass in offspring

Muscle fiber hypertrophy

Secondary myogenesis

Primary myogenesis

Adipogenesis

Conception

0 1 2 3 4 5 6 7 8 9 9.5 (Month) Birth

Embryonic stage

Fetal stage
Negative programming on growth

- Decreased weaning weight
- Decreased live weight at slaughter
- Decreased growth of the respiratory system
  - Cattle are more susceptible to respiratory illness
Negative programming on carcass traits

Nutrient restriction of cows can cause offspring to have:

- Reduced hot carcass weight (HCW)
- Reduced muscle tenderness
- Decreased 12th rib fat thickness
- Decreased carcass yield grade
- Increased size of fat cells
- Decreased marbling
- Reduced % grading choice
Negative impacts on replacement heifers

• Heifers born to nutrient restricted dams may have:
  • Later onset of puberty
  • Decreased Follicle stimulating hormone (FSH) production
    • Decreased follicular size
  • Delayed pregnancy achievement
Avoiding Negative Programming

- Keep Records
- Know your actual mature cow weight
  - Figure out her nutritional requirements
- Run suitable cattle to your environmental conditions/production goals
- Have a controlled breeding season (60-90 days)
- Have cows at a BCS 5-6 at calving
  - Allows for some loss due to lactation
- Don’t cut back heifer’s diets in late pregnancy
- Determine whether to keep replacements/retain ownership from a drought year
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