Potential to Improve the Survivability of Low Birth Weight Pigs & Realize a Full Value Market Hog

A comprehensive approach by the K-State Swine Reproductive Physiology, Muscle Biology, and Swine Nutrition & Management labs

K-State Swine Day - November 20, 2014
Research Progression

Innovation

Refinement

Marketing
Collaboration at K-State

• Our goal is to further the development of management strategies and technologies to improve piglet survivability and ultimate value.
The most significant industry changes over the last 20 years

1. Genetics
2. Disease challenges
3. Export markets
4. Industry structure
5. Production facilities
6. Nutrition
7. Regulation
8. Consumer mind-set
9. Activist groups
10. New technology
Large litters

- Marked increase in litter size due to genetic selection
  - 28-30 PSY vs. 23 PSY just 10 years ago
- Continued selection for increased litter size to attain 40 PSY
Large litters...a problem?

- Genetic selection for increased litter size
- Larger litters = increased number of lighter birth weight pigs
  - Uterine capacity
  - Birth weight : muscle fiber number
Large litters...a problem?

- Low birth weight pigs = higher cost of production
  - Lower pre-weaning survivability
  - Slower growth rate (ADG)
  - Less feed efficient
  - Reduced percentage lean
Fetal Programming

• The uterine environment programs physiology and determines phenotypes throughout postnatal life.
Percentage of Total Time to Market Spent in Each Phase of Pork Production From Conception to Harvest

The Uterine Environment Programs the Fetus

- 39% finishing
- 39% pregnancy
- 15% nursery
- 7% lactation
The uterine environment programs the pig for:

- Feed Efficiency
- Carcass Composition
- Nutrient Partitioning
- Lean Muscle Accretion
- Disease Susceptibility
- Survivability
- Reproductive Performance
- Production Costs ($ vs. $$$$)
Placentas grow

**PREGNANCY in PIGS**

Fertilization in the oviducts

Embryos move to uterus and elongate

Increasing uterine blood flow

Day of Pregnancy

12 20 30 40
Elongation secures uterine space.

Uterine space is not allocated equally on d 12
Fetal weight and attachment length, d 60

Unpublished data
Brain and Liver weights as related to Fetal Weight on day 60 of pregnancy

- Brain, liver and other organs are competing for support
- But the brain has priority

**Brain wt vs fetal wt**

**Liver wt vs fetal wt**

Unpublished data
Brain wt as a % of Liver wt at d 60

- When nutrients are restricted, the brain has priority.
- The liver (and other organs) make do with less.

Unpublished data
**PREGNANCY in PIGS**

- Uterine Capacity is LIMITED
- In utero environment programs the fetus

418 pigs
Bergstrom et al., 2011

![Graph showing Bfat slaughter, mm vs Birth wt. category, kg for Gilts and Barrows](image)
Muscle Size
Fetal Muscle Development

• Muscle Mass Equation

Ultimate Muscle Mass = Muscle Cell Number + Cell Enlargement
Fetal Muscle Development

- Primary Myogenesis
- Secondary Myogenesis
- Adipogenesis
- Muscle Fiber Hypertrophy

Days

0 10 20 30 40 50 60 70 80 90 100 110 114

Conception

Embryonic Stage

Fetal Stage

Birth

K-State Research and Extension
Fetal Muscle Development

• What are the muscle differences between large and small?
Figure 1. Cross section of *Longissimus lumborum* muscle of a porcine fetus at 60-days of gestation. A) Hoechst 33342; nuclei, B) Dystrophin, C) BAD-5; myosin heavy chain - 1, D) merged image. Scale bar = 100 μm.
60-d Fetus Muscle Area

$P < 0.001$

Cross-sectional area (mm$^2$)

- Small
- Medium
- Large

Fetus Size

$P < 0.001$
Primary Fiber Number

Total number

Fetus Size

Small
Medium
Large

$P = 0.027$

a
b
b
Primary Fiber Area

Cross-sectional area ($\mu$m$^2$)

- Small
- Medium
- Large

$P = 0.108$
Secondary's per Primary

$P = 0.002$

Secondary:Primary

Fetus Size

Small  Medium  Large

1  2  3

a  a,b  b

K-State Research and Extension
Fetal Muscle Development

- Can we manipulate the small to develop like a medium or large?
Percentage of Time in Each Phase From Conception to Harvest

- Pregnancy: 39%
- Finishing: 39%
- Nursery: 15%
- Lactation: 7%
Possible Impact Areas

- Maternal Nutrition
  - Bump feeding gilt litters
  - Lysine
  - Energy
  - Vitamin D
- Farrowing crate design?
- Post-farrowing
  - 24-hour care
High Impact Areas

• Post-farrowing (24/7)
  – Decrease heat loss/hypothermia
    • Towel-drying
    • Micro zones: warm and draft-free
  – Colostrum
    • Split suckling
    • Preliminary cross-fostering for small pigs, large litters
    • Colostrum dosing
Summary

• Prenatal development appears to be the rate-limiting constraint to successfully managed 40 PSY in commercial production systems

• Innovative technology that increases placental efficiency, fetal size, and muscle fiber number is imperative to overcome the inherent limitations of larger litters