Integrating Advances in Maternal Nutrition into a Practical System of Parity Segregation

R. Dean Boyd, Noel Williams and Gary L. Allee

The Hanor Company,
Pig Improvement Company and U. Missouri

13th Discover Conference on Food Animal Agriculture
Sow Productive Lifetime
Paper Describes the Rationale for Organizing Sow Farm Site:

- Into 2 Sub-Populations for Age-based Feeding.
- **Premise:**
  - Amount and Type of Nutrients differ so much for **Young** (1-2 Litters) compared to **Older** Females (>2 Litters)
- **Data** Shows how Pigs Born **and** per Sow Life-time improve

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*The Bottom Line!*
Approach to this Topic

Paper Integrates advances in Maternal Nutrition into a Practical Format. Two Sow sub-populations within a Farm are proposed in order to improve Life-time Pig Output. Cannot apply some advances unless the Sow Farm is Organized properly.

Publications:


Acknowledgments

Credit to Re-organize the Sow Farm to meet specific Nutrition and Management needs of the Young and Mature sow:

- Founding Team: M. Mortenson, J. Mencke, J. Keane, D. Wade
- Drs. Camille Moore, Tara Donovan
- Dr. G. Castro

Innovation
Example Benefits of Parity Segregation

- Nutrition **specific** to different needs of Young and Mature Sows
- Health Stabilization of Sow Herd
- Pathogen Control through **strategic** Litter Medication
- Life-time Pig Output (improved ROI)
- Medication Savings in Mature Progeny Flow
Parity Segregation – **1996 Template**

Separation of Sows into 3 Sub-populations within the Farm

- **First Litter**
  - Lactation, 1.40%
  - 2650

- **Litters 2-3**
  - 2650

- **Litters 3-10**
  - 2650

- **Breeding Prep Center**

- **Gilt Develop. Center**
  - Immunity
  - Skeleton
  - Nutrition
  - Space
  - Puberty

- **180 d Age**
  - Health Acclimatization
  - Physiological age
  - Body mass

- **0.56% Micro-Nutrients**
Hanmar Trails End I Sow Farm
Young and Mature Sow Groups are Segregated within the Farm
Segregation of Sows to Improve Herd Performance

Young and Mature Sows Sub-Populations

Lessons Learned from 1996 Format

Organizing the Sow Farm to Nutritionally manage the Two Extremes Improved litter-size in 2nd and Older Sows but

Template Simplified to 2 Sub-Populations:
(1) Maiden thru 2nd Litter
(2) Mature and Aging Sows
Young and Mature Sow Sub-Populations

Two Extremes in Life-cycle Nutrition – Same Farm

2006 Template
Huffman Sow Center

Gilt Develop

Young Sows
P 0 – P 2

Focus
- Large Litters 1-2 (PSY 28)
- Conserve Body Protein
- 1st Wean most vulnerable

Critical Nutrition is past when 1st Wean is 60 d bred w body Reserves reclaimed

Mature & Aging
P 3 – P 12

Focus
- Prevent Premature LS
- Manage Micro-Nutrients
- Growth Control

Nutritionally manage for 1.8 – 3.3 more wean pigs per Sow Lifetime
Young Sow Sub-Population

Nutrition Limits to Weaned Pig Potential for First 3 Litters?
The Young Sow Sub-Population

Body Protein Mass is **First** Nutrition Limit – Create *then* Preserve

- **Gilt Develop**
- **Young Sows**
- **Mature Sows**

**First Wean Sow is most Problem Sow in Herd**

- WEI
- Next LS

- **4 kg Protein ➞ 0.75 p/L**

This we Know to be True!

Boyd et al., 2000 Review
Prioritize the Attack:

(1) Achieve target body mass by farrow, (2) Lactation Intake then (3) Amino acid level
Impact of Body Protein Loss in First Litter Sows

12-14% Loss of Protein Mass is harmful to Next LS

% of Total Protein Mass Mobilized

16.6\% 14.4\% 12.1\%

Total Mass, kg

4.1 24.7 28.5 33.8

Protein Loss

Post-Farrow Body Weight by Parity, kg

P1 165  P1 195  P3 225

Target mass at 1st Breed: 135 kg

Net Maternal Gain to 1st Farrow: 30 kg

drawn from Boyd et al., 2000
Nutritional Burden of Nursing Large Litters

Lipid and Protein Mobilization in Restrict Fed (d 1-6) Litter 1 Sows

Boyd et al., 2000
Stimulating Feed Consumption (kg/d) through Plasma Mediated Immune Management

Trt effect: **P1, p < .0001**; **P2, p = 0.117; P3+, p = 0.0231**

Avg. lactation period, 18 d

Crenshaw et al., JAS in press
Impact of Immune Managed Intake in Lactation on % Sows in Estrus by Day 7

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>SDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>85</td>
<td>90</td>
</tr>
<tr>
<td>P2</td>
<td>70</td>
<td>75</td>
</tr>
<tr>
<td>P3+</td>
<td>65</td>
<td>70</td>
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</tbody>
</table>

Trt effect: P1, p < 0.0001; P2, p = 0.4662; P3+, p = 0.8077

Values are least square means of individual sows within parity group based upon Chi-square analysis.
Lysine Requirement of Lactating Sows in Relation to Litter Growth

Boyd et al., 2000 (updated Pettigrew 1993)

\[ \text{Lys (g/d)} = 0.0266 \times \text{LGR} - 7.549 \]

\[ R^2 = 0.63 \]

Red circle is P-1 estimate, G. Allee et al., 2007
Effect of Dietary Lysine Intake in First Litter Sows on Piglet ADG (g/d)

N=50/trt: Linear, P<0.001; SEM = 7.8

<table>
<thead>
<tr>
<th>Total Lysine, %</th>
<th>Piglet ADG, g/d</th>
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<tbody>
<tr>
<td>0.95</td>
<td>262</td>
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<tr>
<td>1.05</td>
<td>265</td>
</tr>
<tr>
<td>1.15</td>
<td>273</td>
</tr>
<tr>
<td>1.25</td>
<td>281</td>
</tr>
<tr>
<td>1.35</td>
<td>288</td>
</tr>
</tbody>
</table>

Return 10 d, %
89.9 90.1 90.1 92.0 96.3
**Dietary Lysine (total) by Parity and Phase**

<table>
<thead>
<tr>
<th>Item</th>
<th>Sow Age in Number Pregnancies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P-0</td>
</tr>
<tr>
<td>Gestation T Lysine, %</td>
<td>0.64</td>
</tr>
<tr>
<td>Lactation T Lysine, %</td>
<td>1.35</td>
</tr>
</tbody>
</table>

**Notes:**
- Lactation Calculated from Empirical data using 26 g Lysine/1 kg LGR:
  - P-1 Litter growth rate, Sow Feed Intake and P-2 LS
  - P-2 plus parities using LGR, SFI.
The Mature Sow Population
Consists of P-3 Mature thru Geriatric Sows

The Problem
Nutrition Limits Reproduction in Young and Older Sows but in different ways.

Objective to Avoid Premature decline in Pigs BA beginning ca Litters 5-6.

Nutrient adjustment Increase 1.8–3.3 Pigs per Sow Lifetime ➔

Extend Productive Life!

Unclear IF Viability can be Improved by Nutrient Level.
Is the Age-dependent Decline in Litter-size Premature?
Modulated by Lactation Length

Pigs Born Alive, p/L

Parity

- 25 d
- 15 d Wean

Smits, 2003
Nutrition Stress Impairs Reproduction in Older Sows has a Different Basis than Young Sows

- **Thesis:** Age-related LS Reduction has a **Nutritional** Basis

- **How** Pregnancy Feed Intake is held constant across ALL Parities as a means of Weight Control (2.3 kg/d) Despite Increasing Body Weight with Parity.

- Progressive Decline in Vitamins – T. Minerals / kg b.w. with Age

The **Older** (bigger) Sow is Increasingly at Nutritional Risk Reproductively and Immunologically
Progressive Decline in Micro-Nutrient Intake Occurs with Advancing Reproductive Age

Calculated from 2002 PIC USA ADFI assuming 0.149% Diet VTM

Boyd and Hedges, 2003
Test of Concept
Field Trial Involving Micro-Nutrient Equalization

- 2 Control Farms – 2650 Sows each
- 2 VTM Test Farms – 2650 Sows each
- 12 month Pre-test to verify EQ (TPB, PBA, PW, Sow Mortality) (2002)

- This Information is Circumstantial since inadequate EU / treatment

- Diet Equalization: Vitamins, Trace-minerals, Choline, Chromium
- Diets Equated to Parity 3 g VTM / kg b.w
- TM Forms from Inorganic Sources
- Cr-Picolinate not approved for Use above 200 ppb
- Gestation Intake: 2.2 kg avg   Lactation Intake: 5.7 kg avg
Response to Micro-Nutrient Equalization in the Mature and ‘Geriatric’ Sow Sub-Population

From Boyd, 2004
Litter-size Response to Corrected Micro-Nutrient Intake by the Older Sow Sub-Population

ca 50,000 Litters

Control
Geriatric

Total Born
Born Alive
Weaned

11.5
10.1
8.7

12.0
10.5
9.3

1.44 PSYW
**Matrix Used to Evaluate Nutrient Level and Form Needs**

- Reproductive Age and Physiological State

<table>
<thead>
<tr>
<th>Item</th>
<th>Sow Age in Number Pregnancies</th>
<th>P-0</th>
<th>P-1</th>
<th>P-2</th>
<th>P 3- 4</th>
<th>P- 5</th>
<th>P 6-12</th>
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<tbody>
<tr>
<td>Feed Cost, Gestation (% P-1)</td>
<td></td>
<td>93</td>
<td>100</td>
<td>97</td>
<td>96</td>
<td>96</td>
<td>96</td>
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<tr>
<td>Feed Cost, Lactation (% P-1)</td>
<td></td>
<td>- -</td>
<td>100</td>
<td>90</td>
<td>87</td>
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<td>Pre-breed Full Feed</td>
<td></td>
<td>x</td>
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<tr>
<td>Wean to Breed</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<td>x</td>
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<tr>
<td>Breed to 35 d, Immune Modulate</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>xx</td>
<td>xx</td>
<td>xx</td>
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<tr>
<td>Pregnant Growth</td>
<td></td>
<td>xx</td>
<td>x</td>
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<td>Pregnant Growth Restriction</td>
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<td>90 d Bred to Farrow, Immune Modulate</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>90 d Bred to Farrow, Stillbirth Modulate</td>
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<tr>
<td>Lactation Body Protein Conserve</td>
<td></td>
<td>xx</td>
<td>x</td>
<td></td>
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<tr>
<td>Micro-Nutrient Correction *</td>
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</tr>
</tbody>
</table>

* Immune and Absorption Capability declines in Senior dogs, cats

Boyd et al., 2006 AASV
Emerging Concepts

Immune Modulation
Lactation Intake
Embryo Viability
New Feed Phase Inserted into - Wean to 35 d Pregnant

Breed Row:
- P-0 Full Feed until mate
- P-1 Full Feed wean until mate
- Communal HOH ➔ NO!
- BC Reclaim begins ≥ 7 d bred

Breed – 35 d
- Immune Modulation may be Important to Embryo Viability in the First 35 d period
Functional Nutrients Important to Embryo Maintenance during Inflammatory Stressors?

Diets Specific to Feeding Phase beyond Scope of Paper.

NO BASIS yet for Δ GES Nutrient Level (Form) at Critical Periods: Built into Our GES Flow, in anticipation of Emerging Science.

Disease or Severe Heat Stress invoke Inflammatory Process, that in turn produce Cytokines, some of which disrupt Endocrine Function critical to Embryo Maintenance.

Increased Placental levels of TNF-a have been associated with Pregnancy Failure in humans and animals (Erlebacher et al., 2004).

Ex. Inflammatory Stressors:
- Disease (PRRS)
- Heat Stress
- Communal HOH (Bred – 30 d) ?

p.c. Dr. J. Crenshaw
Paper Described the Rationale for Organizing the Sow Farm into:

- 2 Sub-Populations to maximize Health and Performance
- Premise:
  Management specific to Gilts and Sows
  Nutrition . . .
  Pathogen Control Pre-wean and Post-wean
- Segregation of their Progeny unveiled differences in Immunity. Addressing these will increase Return over Investment!

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The Bottom Line!
Take Home Message

1. Parity Segregation can take 2 Formats:
   - P-1 vs Sows
   - P 1-2 vs Mature Sows
   Progeny for Separate Flow is obvious

2. Return per Sow Year
   - Pigs 4.0 PSLT (1.4 PSY) $ 42
   - Wean Pig NFdCost (-5.8%) $ 16
   - WEI P-1 (WEI Cost, PSY) $ 1
   - Gilt Cull reduction (or PG 600) $ nd

3. Investment per Sow Year
   - Δ Feed $ -3.5
   - Marginal Feed (1.4 PSY) $ 11

Net Return per Sow Year $ 51

‘One of the greatest failures of the North American Pork Industry . . has been an inability to capture the true Production potential of the excellent dam lines available.’

Dr. George Foxcroft
The End – Thanks for Coming!
First Litter Success Raises the 2\textsuperscript{nd} Litter Challenge
Oklahoma Farms – Second Litter-size needs Attention

Honor SDI Records, 2002-05
Dietary Lysine (total) by Parity and Phase

<table>
<thead>
<tr>
<th>Item</th>
<th>Sow Age in Number Pregnancies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Weight at mating, lbs</td>
<td>280</td>
</tr>
<tr>
<td>Net Maternal Weight, lbs</td>
<td>365</td>
</tr>
<tr>
<td>NS Lactation Intake, lbs/d</td>
<td>11.0</td>
</tr>
</tbody>
</table>

**Notes:**
Gestation computed using NRC 1998 Model with PIC 2000 Sow growth inputs
Lactation Calculated from empirical data assuming 26 g Lysine/kg LGR:
- P-1 Litter growth rate, Sow Feed Intake and P-2 LS
- P-2 plus parities using LGR, SFI.
Ovarian insufficiency and early pregnancy loss induced by activation of the innate immune system