Pelvic Organ Prolapse: An update & next steps from 104 farms collaborating on NPB project


August 28th, 2018
Timeline for Sow Prolapse Study

- Received the request for proposals
- Notification of funding
- Amanda Chipman start date—Project Leader
- Conference calls with collaborators to enlist sow farms
- ~50 farms committed to being on the project. Open forum at Iowa Pork Congress
- 104 Sow Farms enlisted on the project

**Sept 2017**
- Submitted proposal

**Oct 2017**
- Interviews for Extension Program Specialist

**Nov 2017**
- Visited first integrated production company to discuss project

**Dec 2017**
- On farm data collection begins

**Jan 2018**
- 62 on farm visits completed

**Feb 2018**
- March 2018
- April 2018
Problem solving cycle

1. Recognize the problem exists
2. Monitor the problem and accurately benchmark the occurrence
3. Identify the putative causes
4. Test hypothesis validating causes and risk factors
5. Develop and test mitigation strategies
6. Dissemination and implementation
Objectives of the Project

• Identification of risk factors associated with Pelvic Organ Prolapse in the US sow herd.
  1. Establish network of industry partners and Sow Farm Managers (target was 60-80 sow farms).
  2. Develop herd and individual sow survey tool and use it on farm.
  3. Establish communication and advisory network of producers, allied industry, university faculty and staff.
  4. Establish an accessible repository of data, samples and information.

• **This is a hypothesis generating project.**
  – It is expected to provide data used to justify pursuing future research studies that test specific hypotheses.
Examples of Data Collected

- **Herd factors:** Sow farm inventory, gestation and lactation diet parameters, distillers dry grain usage, feed type (i.e. pellet or mash), mycotoxin binder usage, bump feeding, prior mortality and prolapse incidence at the farm, disease history, gilt size at breeding.

- **Facility factors:** Water and feed delivery systems, sow housing type (i.e. pen or stall), gestation pen or stall hygiene, environmental conditions.

- **Management factors:** Artificial insemination hygiene/cleanliness, farrowing assistance strategies, sow feedback and vaccinations, protocols on gestation pen/stall management, culling criteria and strategies.

- **Animal based measures:** Data will be collected on sows that are at specific stages of production, assistance on previous farrowing, genetic background, lameness score, perineal region score, tail dock length, genital-anal distance, body condition score.

- **Records and data integrity:** Prior year sow production and mortality records will be extracted and communication on how records were created with farm staff to ensure causes of mortality are accurately defined.

- **Sample Banking:** We will collect representative fecal samples, feed samples, water samples, and swabs of gestation pens/stalls for future distribution and analysis if warranted.
## Mortality and Prolapse Record Sheet

**Scope of the project**
Weekly mortality and prolapse data submitted weekly by:

- 104 Farms
- 85 farms in 13 larger systems
- 19 independents
- Almost 400,000 sows
- 15 states

<table>
<thead>
<tr>
<th>Date of prolapse or mortality</th>
<th>Initials of person collecting data</th>
<th>Sow ID</th>
<th>Cause(s) of death (use code at bottom of sheet)</th>
<th>Prolapse (Y or N)</th>
<th>Type of prolapse (1=rectal, 2=vaginal, 3=length protruding)</th>
<th>Severity of prolapse (length protruding)</th>
<th>Timing of prolapse in relation to farrowing</th>
<th>1=Euthanize 2=Found dead 3=the prolapsed</th>
<th>Was she treated for lameness (Y or N)</th>
<th>Was she induced? (Y or N)</th>
<th>Date induced</th>
<th>Additional comments</th>
</tr>
</thead>
</table>
## Individual Animal Measurements

<table>
<thead>
<tr>
<th>Production System</th>
<th>Farm Name</th>
<th>POPID Number</th>
<th>Date</th>
<th>ISU collector initials</th>
<th>Days of gestation</th>
</tr>
</thead>
</table>

**Scope of the project**

On-site visits completed on:
- 62 of the 104 farms
- Over 5000 sows individually measured
- 11 of the 15 states
- 4 people collecting data on visits
Perineal Scoring: Score 1

A scoring system of the perineal region to identify sows with potential risk for POP

Score 1: Presumed “Little to no” risk of uterine prolapse
Has none of the following: protrusion, vulva swelling, and swelling of perineal region
Perineal Scoring: Score 2

Score 2: Presumed “Moderate” risk of uterine prolapse
Has evidence of some but not all of the following: protrusion, moderate vulva swelling, and swelling of perineal region
Perineal Scoring: Score 3

Score 3: Presumed “High” risk of uterine prolapse
Has all of the following: protrusion, moderate to severe vulva swelling, swelling of perineal region, and possible beginning of a prolapse
Currently in Progress

• Continuing to collect information for each farm (i.e. historical production data)
• K-means clustering to characterize patterns in POP incidence
• Laboratory analysis on a few biological samples
• Continued collection of weekly prolapse and morality data
• Continuous analysis as data is received and collected
• Actively sharing information with industry
Week 6-24 Trends:
Average POP Rate for 104 farms

Week 6-24 Cumulative Annualized Prolapse Rate

Farm ID

Annualized Mortality, %
0% 1% 2% 3% 4% 5% 6% 7% 8% 9% 10% 11% 12%

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Preliminary Analysis
Week 6-24 Trends:
Average Mortality for 104 farms

Week 6-24 Cumulative Annualized Mortality

Non POP mortality • POP Mortality

Annualized Mortality, %

Farm ID
Week 6 to 24 Trends:
Mortality Average of All Farms

Weeks 6-24 Total Mortality
Week 6 to 24 Trends: Prolapse Average of All Farms

Weeks 6-24 Prolapse Rate

Annualized Pelvic Organ Prolapse Rate (%)
Causes of Mortality

Breakdown of Week 6-24 Causes of Mortality

Causes of Mortality by Week

- Vaginal/Uterine Prolapse
- Rectal/Anal Prolapse
- Both Rectal and Vaginal/Uterine Prolapse
- Difficulty Farrowing/Retained Pig(s)
- Disease
- Intestinal (Ulcer) Complications
- Lame/Injured/Downer
- Unknown/Other

Week 6: 38%
Week 7: 16%
Week 8: 5%
Week 9: 2%
Week 10: 6%
Week 11: 2%
Week 12: 3%
Week 13: 28%
Week 14: 28%
Week 15: 20%
Week 16: 10%
Week 17: 20%
Week 18: 30%
Week 19: 40%
Week 20: 50%
Week 21: 60%
Week 22: 70%
Week 23: 80%
Week 24: 90%

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Preliminary Analysis
Significant Variation Across Farms Exists

Annualized Total Mortality

- Best 20%
- Average 60%
- Worst 20%

Preliminary Analysis
Significant Variation Across Farms Exists

There seems to be more seasonal variation in the high incidence farms.

Preliminary Analysis
K Means Clustering- Using the Weekly Incidence of POP/1,000 Sows

Farms distribution by cluster

<table>
<thead>
<tr>
<th>Cluster ID</th>
<th>Number of farms</th>
<th>Freq. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>49</td>
<td>52.1%</td>
</tr>
<tr>
<td>2</td>
<td>36</td>
<td>38.3%</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>9.6%</td>
</tr>
<tr>
<td>Total farms</td>
<td>94</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Clusters descriptive stats of the POP incidence by 1,000 sows

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Average</th>
<th>Sd</th>
<th>Min</th>
<th>Q1</th>
<th>median</th>
<th>Q3</th>
<th>max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.29</td>
<td>0.33</td>
<td>0</td>
<td>0</td>
<td>0.23</td>
<td>0.46</td>
<td>1.63</td>
</tr>
<tr>
<td>2</td>
<td>0.76</td>
<td>0.52</td>
<td>0</td>
<td>0.44</td>
<td>0.73</td>
<td>1.09</td>
<td>2.68</td>
</tr>
<tr>
<td>3</td>
<td>1.58</td>
<td>0.82</td>
<td>0</td>
<td>0.93</td>
<td>1.52</td>
<td>2.08</td>
<td>4.19</td>
</tr>
</tbody>
</table>

Farms divided into 3 clusters based on the trends of their weekly POP incidence
Low, Medium, and High Incidence Clusters for Weekly POP Incidence

Clusters for the weekly POP incidence by 1,000 sows
Relationship between POP and Mortality

**Total Mortality and Prolapse Incidence**

- \( R^2 = 0.40 \)
- \( P < 0.0001 \)

**Non-POP Mortality and Prolapse Incidence**

- \( R^2 = 0.03 \)
- \( P = 0.08 \)
Effect of Farm Size

Sow Farm Inventory

R² = 0.0007
P = 0.78
We still have questions about
• Stocking density
• Group size
• When are they moved into the pens
Relationship Between Farm Average of Tail Length and Rectum to Vulva Distance and POP

Whole Farm Average - Tail length

\[ R^2 = 0.0036 \]
\[ P = 0.64 \]

Whole Farm Average - Rectum to Vulva Distance

\[ R^2 = 0.0074 \]
\[ P = 0.51 \]
Farrowing Management Strategies - Induction of Parturition

Whole Farm Average - Inductions

R²=0.05
P = 0.12

n=50 farms
Farrowing Management Strategies-Assistance

Whole Farm Average - Never Sleeved

\[ R^2 = 0.004 \]
\[ P = 0.66 \]

Whole Farm Average - Multiple Sleeping

\[ R^2 = 0.001 \]
\[ P = 0.84 \]
Average Number of Animals Scoring a 3 Correlates to Higher Prolapse Incidence

Whole Farm Average - Perineal Score

\[ R^2 = 0.16 \]
\[ P = 0.001 \]
Perineal Score in Late Gestation as an Indicator of POP Risk

<table>
<thead>
<tr>
<th>Perineal Score</th>
<th>Total scored animals</th>
<th>Animals prolapsed</th>
<th>Percent prolapsed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score 1</td>
<td>1310</td>
<td>15</td>
<td>1.1%</td>
</tr>
<tr>
<td>Score 2</td>
<td>1361</td>
<td>12</td>
<td>0.9%</td>
</tr>
<tr>
<td>Score 3</td>
<td>235</td>
<td>17</td>
<td>7.2%</td>
</tr>
<tr>
<td>Total</td>
<td>2906</td>
<td>44</td>
<td>1.5%</td>
</tr>
</tbody>
</table>
Why Are Perineal Scores Important?

Perineal scores are an indicator of prolapse risk

Something biologically is happening and causing a score 3

Now we can design experiments before a prolapse happens to further understand what is going on and why it is happening.

Why is this happening?

Why are some farms more affected than others?

How is this happening?

When is it starting?
Initial Analysis of Pig Vaginal Microbiota

- Methods:
  - 88 samples sent for sequencing
  - 79 samples remained after quality control (discarded samples with low number of reads (<1000 reads per sample))
  - Clustered sequences into OTUs (Operational Taxonomic Units)

- Results
  - Vaginal microbiota is diverse
  - Distinct differences between the 2 farms
  - Significantly different OTUs for each farm comparing category 1 and 3 sample
    - Overall: 76 significantly different OTUs G1-G3 and 58 for (D1-D3)
    - Higher in 1: OTU3; OTU7; OTU26;
    - Higher in 3: OTU5; OTU23; OTU27
  - Whole community level: significant differences between:
    - Farm 1 Score 1 and Score 3: P = 0.05
    - Farm 2 Score 1 and Score 3: P = 0.02

- These preliminary data suggest that there may be a relationship between microbiota and perineal score
Body Condition Score in Late Gestation as an Indicator of POP Risk

<table>
<thead>
<tr>
<th>BCS</th>
<th>Total scored animals</th>
<th>Animals prolapsed</th>
<th>Percent prolapsed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>586</td>
<td>16</td>
<td>2.7%</td>
</tr>
<tr>
<td>2</td>
<td>2050</td>
<td>26</td>
<td>1.3%</td>
</tr>
<tr>
<td>3</td>
<td>215</td>
<td>2</td>
<td>0.9%</td>
</tr>
<tr>
<td>Total</td>
<td>2851</td>
<td>44</td>
<td>1.5%</td>
</tr>
</tbody>
</table>

Prolapses by BCS

Palpation of hip bones to determine body condition

<table>
<thead>
<tr>
<th>Heavy Sow</th>
<th>Ideal Sow</th>
<th>Thin Sow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can’t feel hip bones even with hand pressure</td>
<td>Can feel the hip bones with firm pressure</td>
<td>Can feel the hip bones without pressure</td>
</tr>
<tr>
<td>Reduce feed (1 lb)</td>
<td>Leave feed where it is</td>
<td>Add feed (0-2 lbs)</td>
</tr>
</tbody>
</table>

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BCS and Perineal Score as an Indicator of POP Risk

Perineal Score and Body Condition Scores

<table>
<thead>
<tr>
<th>Perineal Score</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCS</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Total animals</td>
<td>206</td>
<td>966</td>
<td>113</td>
</tr>
<tr>
<td>Prolapsed animals</td>
<td>5</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Percent prolapsed</td>
<td>2.4%</td>
<td>0.9%</td>
<td>0.9%</td>
</tr>
</tbody>
</table>

Preliminary Analysis
Bump Feeding Strategy

Effect of Bump Feeding on POP Incidence

\[ P = 0.002 \]

\[ P = 0.21 \]

A 0.1 change in POP/1000 sows/week is roughly 0.5% change in annualized mortality

<table>
<thead>
<tr>
<th>Strategy</th>
<th>POP/1000 sows/week</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>0.6</td>
<td>55</td>
</tr>
<tr>
<td>All Animals</td>
<td>0.4</td>
<td>13</td>
</tr>
<tr>
<td>Only Lower BCS</td>
<td>0.3</td>
<td>13</td>
</tr>
</tbody>
</table>
Bump Feeding Strategy

**Effect of Bump Feeding on POP Incidence**

- None: a
- All Animals: ab
- Only Lower BCS: b

**Effect of Bump Feeding on Total Mortality**

- None: a
- All Animals: b
- Only Lower BCS: b

<table>
<thead>
<tr>
<th>Strategy</th>
<th>POP Incidence</th>
<th>Total Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>0.6</td>
<td>3.0</td>
</tr>
<tr>
<td>All Animals</td>
<td>0.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Only Lower BCS</td>
<td>0.4</td>
<td>2.0</td>
</tr>
</tbody>
</table>

n=55, n=13, n=13
Bump Feeding Strategy

Effect of Bump Feeding on POP Incidence

- None: n=55
- All Animals: n=13
- Only Lower BCS: n=13

Effect of Bump Feeding on Non-Prolapse Mortality

- None: n=55
- All Animals: n=13
- Only Lower BCS: n=13
Farrowing Feeding Strategy

Effect of Pre Farrow Intake on POP Incidence

- Less than 5 Feed Allotment Pre-Farrow (lbs/d) with n=58
- 5 or More Feed Allotment Pre-Farrow (lbs/d) with n=42

Effect of Lactation Feed Day 0 on POP Incidence

- Limit Fed Lactation Feed Given on Day of Farrowing with n=36
- Ad lib Lactation Feed Given on Day of Farrowing with n=65
Why Are BCS and Feeding Strategy Important?

It seems like body condition or energy intake going into farrowing is important.

Something biologically happening related to POP risk.

Now we can design experiments to further understand what is going on and why is it happening.

Is she deficient in some nutrient?

Does she have inflammation or some sort of infection decreasing her appetite?

Why is this happening?

Are there some mitigation strategies we can test?
LPS Binding Protein in Late Gestation Across Perineal Scores

LPS Binding Protein (ng/mL) across perineal scores 0 to 12. The preliminary analysis shows a trend where the LPS binding protein levels increase with higher perineal scores.
Antibiotic usage influences POP mortality

Effect of Antibiotics in the Feed on POP Incidence

- Without Antibiotics
  - POP/1000 sows/week: 0.6
- With Antibiotics
  - POP/1000 sows/week: 0.5

Effect of Antibiotics in the Feed on POP Incidence

- Before Pulse
  - POP/1000 sows/week: 0.7
- During Pulse
  - POP/1000 sows/week: 0.4
- After Pulse
  - POP/1000 sows/week: 0.6

*p = 0.03

*p = 0.05

*p = 0.96

*p = 0.08
Effect of Feed Type on POP Rate

Effect of Feed Type on POP Incidence

P = 0.015

Feed Type

- Meal: n=75
- Pellets: n=28

POP/1000 sows/week
Effect of Particle Size

**Gestation Diet Particle Size**

![Gestation Diet Particle Size Graph]

*R² = 0.003  
P = 0.73*

**Lactation Diet Particle Size**

![Lactation Diet Particle Size Graph]

*R² = 0.10  
P = 0.53*
## Feed Sample Analysis and Correlation with POP

<table>
<thead>
<tr>
<th></th>
<th>Sulfur, %</th>
<th>Phosphorus, %</th>
<th>Potassium, %</th>
<th>Magnesium, %</th>
<th>Calcium, %</th>
<th>Sodium, %</th>
<th>Iron, ppm</th>
<th>Manganese, ppm</th>
<th>Copper, ppm</th>
<th>Zinc, ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gestation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>0.27</td>
<td>0.74</td>
<td>0.77</td>
<td>0.21</td>
<td>1.06</td>
<td>0.29</td>
<td>383</td>
<td>96</td>
<td>35</td>
<td>290</td>
</tr>
<tr>
<td>Median</td>
<td>0.26</td>
<td>0.74</td>
<td>0.75</td>
<td>0.21</td>
<td>1.06</td>
<td>0.27</td>
<td>366</td>
<td>91</td>
<td>31</td>
<td>265</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.16</td>
<td>0.52</td>
<td>0.55</td>
<td>0.15</td>
<td>0.66</td>
<td>0.17</td>
<td>171</td>
<td>50</td>
<td>16</td>
<td>129</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.53</td>
<td>1.01</td>
<td>1.07</td>
<td>0.37</td>
<td>1.63</td>
<td>0.56</td>
<td>709</td>
<td>151</td>
<td>73</td>
<td>1781</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.080</td>
<td>0.091</td>
<td>0.121</td>
<td>0.040</td>
<td>0.200</td>
<td>0.069</td>
<td>120.2</td>
<td>25.6</td>
<td>13.2</td>
<td>217.0</td>
</tr>
<tr>
<td>Nutritional Requirement</td>
<td>0.58</td>
<td>0.2</td>
<td>0.06</td>
<td>0.78</td>
<td>0.15</td>
<td>80</td>
<td>25</td>
<td>10</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.000</td>
<td><strong>0.010</strong></td>
<td><strong>0.001</strong></td>
<td><strong>0.082</strong></td>
<td><strong>0.000</strong></td>
<td>0.005</td>
<td>0.036</td>
<td>0.001</td>
<td>0.026</td>
<td>0.038</td>
</tr>
<tr>
<td>P-value</td>
<td>0.900</td>
<td>0.450</td>
<td>0.824</td>
<td>0.030</td>
<td>0.908</td>
<td>0.594</td>
<td>0.152</td>
<td>0.790</td>
<td>0.223</td>
<td>0.142</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Sulfur, %</th>
<th>Phosphorus, %</th>
<th>Potassium, %</th>
<th>Magnesium, %</th>
<th>Calcium, %</th>
<th>Sodium, %</th>
<th>Iron, ppm</th>
<th>Manganese, ppm</th>
<th>Copper, ppm</th>
<th>Zinc, ppm</th>
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<tbody>
<tr>
<td><strong>Lactation</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>0.33</td>
<td>0.74</td>
<td>1.09</td>
<td>0.26</td>
<td>1.10</td>
<td>0.29</td>
<td>394</td>
<td>101</td>
<td>38</td>
<td>306</td>
</tr>
<tr>
<td>Median</td>
<td>0.32</td>
<td>0.73</td>
<td>1.08</td>
<td>0.23</td>
<td>1.09</td>
<td>0.27</td>
<td>385</td>
<td>104</td>
<td>36</td>
<td>261</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.19</td>
<td>0.51</td>
<td>0.78</td>
<td>0.17</td>
<td>0.72</td>
<td>0.18</td>
<td>189</td>
<td>60</td>
<td>22</td>
<td>137</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.51</td>
<td>1.07</td>
<td>1.44</td>
<td>0.60</td>
<td>1.68</td>
<td>0.54</td>
<td>676</td>
<td>163</td>
<td>78</td>
<td>1974</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.070</td>
<td>0.094</td>
<td>0.139</td>
<td>0.100</td>
<td>0.201</td>
<td>0.071</td>
<td>102.7</td>
<td>21.5</td>
<td>11.7</td>
<td>259.2</td>
</tr>
<tr>
<td>Nutritional Requirement</td>
<td>0.61</td>
<td>0.2</td>
<td>0.06</td>
<td>0.7</td>
<td>0.2</td>
<td>80</td>
<td>25</td>
<td>20</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td><strong>0.133</strong></td>
<td><strong>0.013</strong></td>
<td><strong>0.152</strong></td>
<td><strong>0.004</strong></td>
<td><strong>0.001</strong></td>
<td><strong>0.006</strong></td>
<td>0.030</td>
<td>0.001</td>
<td>0.016</td>
<td>0.036</td>
</tr>
<tr>
<td>P-value</td>
<td><strong>0.005</strong></td>
<td><strong>0.401</strong></td>
<td><strong>0.003</strong></td>
<td><strong>0.632</strong></td>
<td><strong>0.822</strong></td>
<td><strong>0.557</strong></td>
<td>0.196</td>
<td>0.833</td>
<td>0.358</td>
<td>0.160</td>
</tr>
</tbody>
</table>
Effect of Added Dietary Fat in Lactation

The diagram shows the relationship between lactation added dietary fat and POP/1000 sows/week. The graph includes a regression line with the equation $R^2 = 0.08$ and $P = 0.008$. The data points are plotted along the x-axis representing pounds/ton of complete feed and the y-axis representing POP/1000 sows/week.
Dietary Sulfur

Gestation Dietary Sulfur

R² = 0.0003
P = 0.9

Lactation Dietary Sulfur

R² = 0.13
P = 0.005
Other Correlations with POP

**Gestation Dietary Magnesium**

- $R^2 = 0.08$
- $P = 0.03$

**Lactation Dietary Potassium**

- $R^2 = 0.15$
- $P = 0.003$
Dietary Phosphorus and Calcium

Gestation Dietary Phosphorus

\[ R^2 = 0.01 \]
\[ P = 0.45 \]

Gestation Dietary Calcium

\[ R^2 = 0.0002 \]
\[ P = 0.91 \]
**Water Source and Treatment**

Effect of Water Source and Treatment on POP Incidence

- **Untreated Well**: $p=0.006$, $n=57$
- **Rural**: $p=0.17$, $n=13$
- **Treated Well**: $p=0.02$, $n=13$
- **Treated Pond**: $p=0.17$, $n=6$
Weekly Effect of Water Treatment

**Annualize POP Rate**

- **Not Treated**
- **Treated**

**Annualize Total Mortality**

- **Not Treated**
- **Treated**
Effect of Water Treatment Strategy

Either treatment was effective

$$P = 0.0001$$

$$P < 0.01$$

$$P = 0.97$$
Effect of Treatment on Well Water

Water Treatment by Source of Water

- **Well**: 57 farms, 13 treated
- **Rural**: 13 farms, 6 treated
- **Pond**: 6 farms, 0 treated

Effect of Water Treatment on POP Incidence in Only Farms with Wells as Water Source

- **No Treatment**: 57 farms, 0.85 POP/1000 sows/week
- **Treatment**: 13 farms, 0.24 POP/1000 sows/week

*P = 0.008*
Discussion and Thoughts for the Future

- A lot has been done in 6 months and a lot more to do...
- Tremendous opportunities to build on:
  - Targeted studies for reduction of POP
  - Expand efforts in non-POP mortality
- Still doing some important analyses
- Ultimately to design and employ on farm mitigation studies.
- Working to “crack the code”