The Complete Economic Impact of PRRS
Money in and out of your pocket
PRRS is an Economically Significant Disease

- PRRS slows the turnover of the farm
  - Reduces annual throughput (kg, head)
  - Reduces the total value of animals produced and sold
    - Increases lighter weight animals/culls
    - More animals sold are discounted by buyers

- PRRS causes unit costs and total costs to rise
  - Fixed costs are spread over fewer units of sales (cost/kg or cost/head)
  - Total costs also rise due to increased medication, veterinary cost, labor etc.

- Severity of economic impact varies
  - With seasonal/cyclical price and cost changes, severity of the out break and its duration, whether or not there are other health challenges present, ability of the farm to fund corrective action quickly
The Breeding Herd

- Increased reproductive failure (asset inefficiency)
  - Inability to conceive/nonproductive days rise
  - Increased late term abortions/premature farrowing
  - Fewer litters per female per year/Fewer and weaker pigs born and weaned

- Decreased weaned pig output (reduction in net profit margin)
  - Increase in mummies and stillborns/weak pigs born that die
  - Increased breeding herd mortality
  - Increased costs (veterinary etc.)
The Wean-to-Finish/Nursery-Finish Phase

- Slowed growth (asset inefficiency)
  - Fever and respiratory issues reduce feed intake and slow growth
  - Reduces building turns/year, All-in All-Out or “space turns” if continuous flow otherwise stocking density rises further depressing growth
  - Tempts manager to violate biosecurity to keep flow intact

- Increased costs (net profit margin)
  - Increased labor, veterinary assistance, medication
  - Total feed intake shifts toward maintenance as growth slows reducing kgs. produced per kg of feed intake (Feed conversion inefficiency)

- Reduced Sales (asset inefficiency and net profit margin)
  - Mortality increases wasting feed and reducing sales
  - Slow growing animals produce lights and culls that are discounted/kg and carry less total weight
  - Unfavorable total distribution of animals in buyer’s pricing matrix
Moving Beyond Partial Budgeting to Gain More Insights

• “Partial budget” estimates the net change in all variables impacted by a change

• Stochastic simulation and optimization allows a more comprehensive estimate of the “details” of a disease outbreak (“the devil is in the details”)

• Stochastic methods correct underestimation of costs and overestimation of sales common in partial budgeting
The breeding herd case / 650 BF
<table>
<thead>
<tr>
<th>Parity Structure</th>
<th>Parity Distribution</th>
<th>Mean TB</th>
<th>TB StDev</th>
<th>Mean NBA</th>
<th>BA StDev</th>
<th>Mean PWM%</th>
<th>PWM% StDev</th>
<th>Mean Pigs Weaned</th>
<th>Mean Pig Weight</th>
<th>Mean Weaned Pig StDev</th>
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</thead>
<tbody>
<tr>
<td>Gilts</td>
<td>17.0%</td>
<td>13.25</td>
<td>1.03</td>
<td>12.35</td>
<td>0.87</td>
<td>6.3%</td>
<td>3.2%</td>
<td>10.64</td>
<td>11.81</td>
<td>0.69</td>
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<tr>
<td>Parity 1 Breeding Females</td>
<td>16.0%</td>
<td>13.25</td>
<td>1.03</td>
<td>12.35</td>
<td>0.87</td>
<td>6.3%</td>
<td>3.2%</td>
<td>10.64</td>
<td>12.06</td>
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<td>Parity 2 Breeding Females</td>
<td>15.0%</td>
<td>14.01</td>
<td>1.04</td>
<td>12.13</td>
<td>0.89</td>
<td>9.9%</td>
<td>3.2%</td>
<td>10.93</td>
<td>12.67</td>
<td>0.63</td>
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<td>Parity 3 Breeding Females</td>
<td>14.0%</td>
<td>14.65</td>
<td>1.08</td>
<td>12.54</td>
<td>0.91</td>
<td>14.1%</td>
<td>4.1%</td>
<td>10.77</td>
<td>12.80</td>
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<td>Parity 4 Breeding Females</td>
<td>13.0%</td>
<td>14.80</td>
<td>1.11</td>
<td>12.50</td>
<td>0.92</td>
<td>15.0%</td>
<td>4.2%</td>
<td>10.62</td>
<td>12.83</td>
<td>2.00</td>
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<td>Parity 5 Breeding Females</td>
<td>11.0%</td>
<td>14.67</td>
<td>1.12</td>
<td>12.22</td>
<td>0.94</td>
<td>14.9%</td>
<td>5.5%</td>
<td>10.39</td>
<td>12.61</td>
<td>0.60</td>
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<td>Parity 6 Breeding Females</td>
<td>9.0%</td>
<td>14.33</td>
<td>1.12</td>
<td>11.80</td>
<td>0.93</td>
<td>13.6%</td>
<td>6.3%</td>
<td>10.20</td>
<td>12.39</td>
<td>0.63</td>
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<td>Parity 7 and Up Breeding Females</td>
<td>5.0%</td>
<td>13.22</td>
<td>1.08</td>
<td>10.62</td>
<td>0.88</td>
<td>8.8%</td>
<td>6.2%</td>
<td>9.69</td>
<td>12.63</td>
<td>0.68</td>
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</tbody>
</table>
2.35 litters/BF; 14.01 TB; 12.10 NBA; 10.89 Weaned/Litter; 25.6 Pigs/BF
## TABLE 2 – Outline of production and facility costs

**FARROW-TO-WEANED PIG COST-RETURN PROJECTIONS**

<table>
<thead>
<tr>
<th>Description</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>You Farm</th>
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<tbody>
<tr>
<td><strong>RETURNS PER PIG SOLD:</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1. Weaned pig</td>
<td>$44.75</td>
<td>$44.75</td>
<td>$44.75</td>
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<tr>
<td>2. Manner credit</td>
<td>1.30</td>
<td>1.36</td>
<td>1.64</td>
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<tr>
<td><strong>A. GROSS RETURNS PER PIG SOLD</strong></td>
<td>$46.05</td>
<td>$46.01</td>
<td>$46.39</td>
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<tr>
<td><strong>COSTS PER PIG SOLD:</strong></td>
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</tr>
<tr>
<td>3. Grain</td>
<td>$6.62</td>
<td>$5.92</td>
<td>$5.37</td>
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<tr>
<td>4. Distillers (EDGS)</td>
<td>1.54</td>
<td>1.55</td>
<td>1.51</td>
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<tr>
<td>5. Protein</td>
<td>3.41</td>
<td>3.39</td>
<td>2.86</td>
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<tr>
<td>6. Other ingredients</td>
<td>1.19</td>
<td>1.07</td>
<td>0.97</td>
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<tr>
<td>7. Complete feeds</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
<td>8. Feed processing</td>
<td>1.14</td>
<td>1.02</td>
<td>0.93</td>
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<tr>
<td>9. Labor</td>
<td>8.65</td>
<td>7.69</td>
<td>6.92</td>
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<tr>
<td>10. Veterinary, drugs, and supplies</td>
<td>1.93</td>
<td>1.75</td>
<td>1.58</td>
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<tr>
<td>11. Utilities, fuel, and oil</td>
<td>2.18</td>
<td>2.29</td>
<td>2.20</td>
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<tr>
<td>12. Transportation and marketing costs</td>
<td>2.97</td>
<td>2.87</td>
<td>2.86</td>
<td></td>
</tr>
<tr>
<td>13. Building and equipment repairs</td>
<td>1.86</td>
<td>1.65</td>
<td>1.49</td>
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<tr>
<td>14. Breeding/genetic charge</td>
<td>2.22</td>
<td>1.97</td>
<td>1.78</td>
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<tr>
<td>a. Depreciation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Sire</td>
<td>1.27</td>
<td>1.27</td>
<td>1.28</td>
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<tr>
<td>c. Interest</td>
<td>0.07</td>
<td>0.07</td>
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<td>d. Insurance</td>
<td>0.03</td>
<td>0.03</td>
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<tr>
<td>15. Professional fees (legal, accounting, etc.)</td>
<td>0.90</td>
<td>0.44</td>
<td>0.40</td>
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<tr>
<td>16. Depreciation on buildings and equipment</td>
<td>3.34</td>
<td>2.97</td>
<td>2.47</td>
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<tr>
<td>17. Interest on buildings and equipment</td>
<td>2.59</td>
<td>2.30</td>
<td>2.07</td>
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<tr>
<td>18. Insurance and taxes on buildings and equipment</td>
<td>0.98</td>
<td>0.87</td>
<td>0.78</td>
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<tr>
<td><strong>B. SUBTOTAL</strong></td>
<td>$44.86</td>
<td>$39.57</td>
<td>$35.02</td>
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<tr>
<td><strong>C. TOTAL COSTS PER PIG SOLD</strong></td>
<td>$46.42</td>
<td>$39.97</td>
<td>$35.72</td>
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<tr>
<td><strong>D. RETURNS OVER TOTAL COSTS (A-C)</strong></td>
<td>$1.53</td>
<td>$9.94</td>
<td>$5.00</td>
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</tr>
<tr>
<td><strong>E. BREAK~EVEN WEANED PIG PRICE, $/head</strong></td>
<td>$43.22</td>
<td>$38.81</td>
<td>$35.23</td>
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<tr>
<td><strong>F. TOTAL FEED COSTS (lines 3 – 8)</strong></td>
<td>$13.90</td>
<td>$12.48</td>
<td>$11.34</td>
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</tr>
<tr>
<td>21. Cert pork production</td>
<td>0.13</td>
<td>0.13</td>
<td>0.13</td>
<td></td>
</tr>
<tr>
<td>22. Feed cost/cost pork</td>
<td>$106.92</td>
<td>$95.97</td>
<td>$87.30</td>
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</tr>
<tr>
<td><strong>G. NET RETURN ON INVESTMENT</strong></td>
<td>$31.26</td>
<td>$37.39</td>
<td>$67.26</td>
<td></td>
</tr>
<tr>
<td><strong>H. NET RETURN ON INVESTMENT</strong></td>
<td>6.07%</td>
<td>11.79%</td>
<td>17.59%</td>
<td></td>
</tr>
</tbody>
</table>
Stochastic Simulation

- Costs from budget harmonized with EU database costs, source: Agriculture and Horticulture Development Board, www.pork.ahdb.org.uk (EU costs of production)
- Distribution of EU Weaned Pig Prices Aug2013-Aug2016
  - Mean €43.36 STDEV €5.97 Beta General Distribution
- Parity specific impacts obtained from:
  - Lewis, Torremorell, Bishop, Journal of Swine Health and Production, 2009
  - Preweaning mortality increases 34% from 10.8% to 14.5%
  - Breeding herd mortality increases 1-4%
  - Avg labor cost/breeding female increases 10%
- Correlated Corn and Soybean Meal Prices, EU Source, Aug2013-Aug2016 used for pricing gestation and lactation feed components
Total cost per weaned pig

- **€36.63/Weaned Pig**
  Without PRRS

- **€42.14/Weaned Pig**
  With PRRS Outbreak
Net income PRRS\textsuperscript{Neg}

Mean: €7.15/Weaned Pig
STDev: €6.31
90th P Range: -€2.93 to €16.74

Mean: -€4.36/Weaned Pig
STDev: €6.44
90th P Range: -€21.34 to €14.71
Breeding Herd Summary - Impact of PRRS

- Breeding herd turns reduced from 2.35 to 2.23
- Weaned per breeding female reduced from 25.60 to 20.31
- Total weaned pigs/year reduced from 16,630 to 13,498
- Avg profit/weaned pig reduced from €7.14 to -€4.36
- Avg profit difference/weaned pig is -€11.50
- Avg profit/breeding female reduced from €182.81 to -€88.56
- Avg profit difference/breeding female -€271.37
Financial Efficiency changes due to PRRS in breeding herd

€182.81 to -€88.56 Per Breeding Female

ROA PRRS Neg: 22.80%
ROA PRRS Pos: -3.96%

ROE PRRS Neg: 37.65%
ROE PRRS Pos: -16.38%

ROI PRRS Neg: 18.82%
ROI PRRS Pos: -8.19%
Bottom Line for Breeding Herd
For High Performing EU Breeding Herd

Without PRRS
Expect above breakeven net income 84% of the time

With Active PRRS
Expect above breakeven net income only 18% of the time
Bottom Line
The wean-to-finish case
The Issue of Subpopulations

- Subpopulations of differently affected groups in a single building creates special estimation problems when using averages.
- The essential issues are related to how finished pigs are priced in typical value matrixes, and how building turns and feed efficiencies are calculated.
- Averaging “lowers” the weight used in calculation for heavy weight subpopulations and “raises” the weight used for light weight and cull pig subpopulations BOTH may underestimate their discounts to the base price.
What Actually Happens

Sub Populations Emerge Of Differentially Affected Animals
Boehringer-Ingelheim Trial Data

- 10 pigs were randomly assigned to several groups at weaning.
- Weights were taken at Day 0 (weaning), Day 27 and Day 70.
- On Day 28 four different control groups were challenged with increasing amount of a PRRS virus (Groups: Log1-Log4).
- Each incremental challenge (e.g., from Log1 to Log2) received 10X the virus particles than the previous.
- Temperatures were measured daily from Day 27 to Day 42 and both coughing and behavioral changes were observed and noted from Day 27 through Day 70.
- One unchallenged group had been vaccinated (IngelVac).
“Heat Maps of Temperatures”
Simulating Subpopulations Through Harvest

- Separate left-skewed Weibull or Weibull-like distributions were fit to the weaning weight distributions and 300 random samples were made from each to create 1,500 pigs.
- Mean and STDev for Log1-Log4 at weaning were:
  - Log1: 5.60, 1.25
  - Log2: 5.39, 1.12
  - Log3: 5.55, 0.92
  - Log4: 5.65, 1.28
  - Unchallenged: 6.0, 0.99
- Polynomial growth functions were fit for each of the subpopulations based on their growth, weaning to Day 70.
- A feed intake function was estimated to match growth and daily consumption and was partitioned into maintenance and growth components using NRC2012.
- Digestible Energy based on Metabolic Body Weight estimated as BW0.60 and diet ME of 3,500 kcal.
Efficiencies Log1-Log4 and Unchallenged

- ADG for Log1-Log4 was 575g; wean to 105-108kg
- ADG for Unchallenged pigs was 718g; wean to 105-108kg
- **Average ADG Percent Reduction was 20%**
- FCR for Log1-Log4 was 2.00, 1.95, 2.03 and 1.95
- FCR for Unchallenged was 1.83 about an 8% improvement over the Log1-Log4 challenged subpopulations
Gross margin trajectory by subpopulation after day 133 (day the healthy example optimized)

Gross margin lines become flat when group gross margin is maximized (indicates day of sale)
Gross Margin Optimization

- All groups reached gross margin optimization in the 105-108kg live weight area
- An EU packing plant matrix was used to price pigs as a function of their weight and the distribution of EU SSP prices created from weekly market hog prices Aug 2013-Aug 2016.
Net income/head no challenge pigs

- €37.17
- 5.0%

- 90.0%

- €102.21
- 5.0%

No challenge pigs
Mean €22.17/head

Vs

Log1-Log4 Challenge pigs
Mean €10.20/head
Change in net income/head = -€11.97
Financial efficiency changes due to PRRS in Wean-Finish

ROI PRRS Neg: 8.36%  
ROI PRRS Pos: 1.30%  
ROA PRRS Neg: 11.72%  
ROA PRRS Pos: 2.83%  
ROE PRRS Neg: 9.36%  
ROE PRRS Pos: 2.61%
## Summary of All Results

Financial metrics based on phase of production and health status

<table>
<thead>
<tr>
<th>Phase</th>
<th>Status</th>
<th>Mean profit/pig</th>
<th>STDev profit/pig</th>
<th>90th percentile range</th>
<th>Pigs sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-W (650 sows)</td>
<td>NO PRRS</td>
<td>€ 7.14</td>
<td>€ 6.32</td>
<td>-€ 2.81 to €16.90</td>
<td>16,630</td>
</tr>
<tr>
<td>F-W (650 sows)</td>
<td>PRRS</td>
<td>-€ 4.28</td>
<td>€ 6.44</td>
<td>-€ 14.86 to €5.70</td>
<td>13,498</td>
</tr>
<tr>
<td>W-F (1,200 head)</td>
<td>NO PRRS</td>
<td>€ 22.17</td>
<td>€ 42.74</td>
<td>-€ 33.10 to €104.71</td>
<td>3,885</td>
</tr>
<tr>
<td>W-F (1,200 head)</td>
<td>PRRS</td>
<td>€ 10.20</td>
<td>€ 41.55</td>
<td>-€ 46.07 to €62.68</td>
<td>3,226</td>
</tr>
</tbody>
</table>
Summary

• PRRS has a substantial and variable economic impact to both the breeding herd and the wean-to-finish phase
• Substantial declines in Asset Turnover occur (slowing of production without the ability to pause resource use)
• Net Profit Margin impacts exceed Asset Turnover declines as Gross Sales falls dramatically while several variable input costs increase
• Subpopulations of differentially affected pigs suggest that widely used partial budgeting techniques are underestimating the costs and reduced returns from a PRRS outbreak
Thanks!