Reducing Energy Costs in Swine Barns

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Presentation Outline

• Background
• Project Objectives
• Methodology
• Results
• Preliminary Conclusions
• Future Work
• Take Home Message
Background

- Steady global escalation in energy prices
- Utilities cost (gas, electricity) creeping up
- Current estimate: $6 to $10 per pig sold
- 3rd largest variable cost component (after feed and labour)
- Reducing utilities cost – can be significant competitive advantage

Project objectives

- Conduct comparative evaluation of energy use
- Quantify impact of energy-conservation strategies using simulation
- Demonstrate selected measures in actual barn
- Develop decision-support software tool
Methodology - 4 phases

- Phase 1: Benchmarking
- Phase 2: Evaluation of energy-conservation measures
- Phase 3: Demonstration in actual barn
- Phase 4: Development of decision-support tool

- Phases 1 & 2 – currently funded by ACAAFS
- Phases 3 & 4 – additional funding sought

Phase 1: Benchmarking

- Survey of 25 to 30 swine operations
  - Different types – Farrow-to-Finish, Farrowing, Nursery, Finishing, Grow-Finish, etc.
  - Determine energy cost ($) per pig
- Energy audits in selected barns
  - Identify energy-intensive tasks
  - Measure actual energy usage – summer, winter
  - Monitoring of parameters related to energy use
Phase 2: Evaluating conservation measures

- Use computer simulation - simulate a typical barn, apply various conservation measures
  - lighting: energy-efficient lamps, lighting schedule, cleaning
  - heating: energy-efficient heaters and lamps, reduced nocturnal temperature settings, heat recovery systems, alternative fuels
  - ventilation: energy-efficient fans, improved controls and ventilation efficiency, alternative cooling systems
  - materials handling: feed handling, manure removal, reduced contaminant generation
  - management: peak demand load shifting, equipment and building envelope maintenance

Phase 3: Actual demonstration

- Most promising measures will be selected based on simulation results
- Retrofitted into actual rooms at PSC Elstow barn
- Impact on energy use, animal productivity, room environment will be monitored; compared with conventional rooms
- Results displayed at the Pork Interpretive Gallery
Phase 4: Decision-tool development

- Software tool has 2 main functions:
  - Allow monitoring of monthly energy consumption & cost patterns, specific to the facility
  - Provide projected cost savings if various energy-conservation options available in the software are implemented; estimate pay-back for investment
- Facilitate management decisions on adopting available measures
- Distributed in CDs, or from website

Methodology - Phases 1 & 2

**Phase 1 - Benchmarking**

- Survey
- Barn Monitoring

**Phase 2**

- Computer Simulation

- Target respondents: At least 25 swine producers
- Expected Output:
  - Utility cost per animal marketed ($ per 100-kg pig sold)
  - Selection of 2 highest and 2 lowest energy users
**Methodology**

**Phase 1 - Benchmarking**

- Survey

**Barn Monitoring**

**Phase 2**

- Computer Simulation

- 4 Swine facilities – selected from survey
- Barn Monitoring Procedure
  - Energy Use Assessment
    - Inventory of equipment
    - Determine operating hours
    - Building envelope
    - Management practices
  - Energy and Environmental Parameters Measurement (Summer and Winter)
    - Sensors and dataloggers

**Expected Output:**
- Energy consumption
  - per stage of production
  - per type of equipment
- Identify energy intensive tasks
- Impact of energy input on IAQ parameters
Methodology

**Phase 1 - Benchmarking**

- **Survey**
- **Barn Monitoring**

**Phase 2**

- **Computer Simulation**

- Use energy simulation program - apply energy conservation strategies
  - Lighting
  - Heating
  - Ventilation
  - Manure handling
  - Feed handling
  - Management practices

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**Results of Benchmark Survey**

- **28 swine facilities** participated in survey
  - 16 Farrow-to-Finish barns
  - 2 Nursery barns
  - 6 Grow-Finish barns
  - 4 Farrow-to-Wean barns
## Results of Benchmark Survey

- **Utility cost per 100 kg pig and animal marketed for different types of barn**

<table>
<thead>
<tr>
<th>Type of barns</th>
<th>Size range</th>
<th>S/100-kg pig sold</th>
<th>S/animal marketed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Range</td>
<td>Avg</td>
</tr>
<tr>
<td>Farrow-Finish</td>
<td>300 to 1,500 sow</td>
<td>3.5 – 12.0</td>
<td>6.3</td>
</tr>
<tr>
<td>Farrow-Finish excluding feedmill</td>
<td>300 to 2,000 sow</td>
<td>6.0 – 11.5</td>
<td>6.3</td>
</tr>
<tr>
<td>Grow-Finish</td>
<td>10,000 to 40,000 feeders/ weanlings</td>
<td>1.2 – 2.6</td>
<td>1.7</td>
</tr>
<tr>
<td>Nursery</td>
<td>130,000 to 140,000 feeders/ weanlings</td>
<td>1.7 – 2.2</td>
<td>2.0</td>
</tr>
<tr>
<td>Farrow-wean</td>
<td>150 to 1,200 sow</td>
<td>8.2 – 17.8</td>
<td>12.2</td>
</tr>
</tbody>
</table>

## Results of Benchmark Survey

- **Highest and lowest energy users within each barn category**

<table>
<thead>
<tr>
<th>Type of barns</th>
<th>Lowest energy user</th>
<th>Highest energy user</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Size</td>
<td>$/100kg</td>
</tr>
<tr>
<td>Farrow-Finish</td>
<td>1,500</td>
<td>3.5</td>
</tr>
<tr>
<td>Farrow-Finish excluding feedmill</td>
<td>700</td>
<td>6.0</td>
</tr>
<tr>
<td>Grow-Finish</td>
<td>30,000</td>
<td>1.2</td>
</tr>
<tr>
<td>Nursery</td>
<td>140,000</td>
<td>1.7</td>
</tr>
<tr>
<td>Farrow-wean</td>
<td>1,000</td>
<td>8.2</td>
</tr>
</tbody>
</table>
Energy Audit – summer and winter

- Barns selected from the survey:
  - Highest Energy-User Barns
    - Barn A – Farrow-to-Finish
    - Barn B – Farrow-to-Wean
  - Lowest Energy-User Barns
    - Barn C – Grow-Finish
    - Barn D – Farrow-to-Finish

### Barn A - Farrowing room

**Electrical Energy Consumption**

<table>
<thead>
<tr>
<th>Day</th>
<th>Hours</th>
<th>Heat lamps</th>
<th>Heat Pad</th>
<th>Stage 1&amp;2 fans</th>
<th>Distribution fans</th>
<th>Lights</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12</td>
<td>38.0</td>
<td>7.3</td>
<td>14.7</td>
<td>1.0</td>
<td>2.1</td>
<td>63.1</td>
</tr>
<tr>
<td>2</td>
<td>24</td>
<td>34.7</td>
<td>9.0</td>
<td>29.2</td>
<td>1.9</td>
<td>4.4</td>
<td>79.1</td>
</tr>
<tr>
<td>3</td>
<td>24</td>
<td>20.1</td>
<td>20.6</td>
<td>30.3</td>
<td>1.9</td>
<td>4.4</td>
<td>77.2</td>
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<tr>
<td>4</td>
<td>24</td>
<td>16.4</td>
<td>16.6</td>
<td>30.2</td>
<td>1.9</td>
<td>4.4</td>
<td>69.5</td>
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<tr>
<td>5</td>
<td>24</td>
<td>0.0</td>
<td>14.6</td>
<td>27.7</td>
<td>1.9</td>
<td>4.4</td>
<td>48.6</td>
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<tr>
<td>6</td>
<td>24</td>
<td>0.0</td>
<td>10.7</td>
<td>26.8</td>
<td>1.9</td>
<td>4.4</td>
<td>43.8</td>
</tr>
<tr>
<td>7</td>
<td>24</td>
<td>0.0</td>
<td>8.8</td>
<td>26.1</td>
<td>1.9</td>
<td>4.4</td>
<td>41.1</td>
</tr>
<tr>
<td>8</td>
<td>13</td>
<td>0.0</td>
<td>9.3</td>
<td>12.7</td>
<td>0.9</td>
<td>2.5</td>
<td>25.3</td>
</tr>
</tbody>
</table>
Barn A - Farrowing room

- Total Energy Consumption

- Barn A - Nursery room

- Total Energy Consumption
Barn A - Grow-finish room

- Total Energy Consumption

Barn A - Gestation room

- Total Energy Consumption
Barn B - Farrow-to-Wean Barn

- Total Energy Consumption – Farrowing room

Barn B - Gestation room

- Total Energy Consumption
Barn C - Grow-finish room

• H₂S, NH₃ and CO₂ concentrations

Peak concentrations of NH₃ (80ppm) and H₂S (25ppm) due to pit pulling.

Barn C - Grow-finish barn

• All measured parameters
Summary

• Farrowing Rooms

Barn A

- 37% Recirculation Fan
- 9% Fans
- 18% Heat lamps
- 36% Heat pads
- 6% Light

Barn B

- 78% Heat lamps
- 17% Feed motor
- 4% Stage 1 & 2 Fans
- 9% Lights

Summary

• Farrowing Rooms

- Barn A used heat lamps for 1-2 days only (36% of the total energy consumption); then used heat pads for other days (18% of the total energy consumption)

- Barn B used heat lamps only (78% of the total energy consumption)

- Barn A used Fluorescent lamp while Barn B used T-8 energy efficient lamp

- Barn A lights - 10 hours (6% of total energy consumed), while Barn B lights - 8 hours (4% of total energy consumed)

- Barn A – fans used more energy (40%); Barn B – fans 17%
Summary

• Nursery Room

Barn A

- Recirculation Fans
- Stage 3 & 4 Fans
- Stage 1 & 2 Fans

- Feed Motor
- Lights

Summary

• Grow-Finish Room

Barn A

- Recirculation Fans
- Stage 3 & 4 Fans
- Stage 1 & 2 Fans

- Feed Motor
- Lights

Barn C

- Stage 3 fans
- Stage 0 & 1 fans
- Stage 2 fans
Summary

- **Gestation Room**

  **Barn A**

  - Recirculation Fan: 2%
  - Lights: 53%
  - Stage 3 & 4 Fans: 26%
  - Stage 1 & 2 Fans: 18%
  - Feed Motor: 1%

  **Barn B**

  - Recirculation Fan: 17%
  - Stage 5 & 6 Fans: 19%
  - Stage 1 & 2 Fans: 23%
  - Stage 3 & 4 Fans: 25%
  - Feed Motor: 1%
  - Lights: 10%

**Preliminary Conclusions**

- Fans are most intensive energy users – i.e., summer conditions
- Potential energy savers:
  - Lights
    - Duration can be reduced to recommended levels (i.e., 14 hours for gestation and 8 hours for the rest)
    - Use of energy efficient lamps
  - Recirculation fan
    - Use can be reduced without compromising air quality
  - Use of heat lamps vs. heat pads
**Additional tasks**

- Currently monitoring Barn D
- Installation of gas meters in the barns
- Winter monitoring
  - Temperature and relative humidity
  - Indoor air quality parameters
  - Energy (electricity and gas) consumption
- Computer simulation
- Secure funding for Phases 3 & 4

**Take-home messages**

- Global energy indicators point to continuing escalation of energy costs in the future
- Current swine production operations need to be optimized for improved energy use
- Range of energy cost values indicates a wide range of opportunities to reduce energy cost in swine barns
- An Energy Audit program will help producers assess their current energy usage and decide on appropriate energy conservation measures.
Acknowledgement

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- Collaborating pork producers
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