Understanding Energy Conservation in Swine Production

Midwest Farm Energy Conference
June 14, 2017

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Why is Energy Important?

2013-16 median from: www.finbin.umn.edu

• Sow Farm
  – Fuel, Oil, Utilities $20.39 per liter produced
  – 5.1% of total expenses
  – 8.4% of non-feed expenses

• Wean-Finish Farm
  – Fuel, Oil, Utilities $1.98 per head
  – 1.7% of total expenses
  – 6.4% of non-feed expenses
Energy is a significant part of expenditures that you CAN do something about. Many energy savings can be implemented with very little expense and some with NO additional expense.
1st Rule of Energy Conservation

*If you don’t keep track of what you use, it’s hard to tell if you’re doing great or have a great opportunity to improve!*
Customize the spreadsheet to reflect your farming operation

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>Total</th>
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<tbody>
<tr>
<td><strong>Electricity</strong></td>
<td></td>
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</tr>
<tr>
<td>kWh</td>
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<td>4314</td>
<td>4980</td>
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<td>4865</td>
<td>4900</td>
<td>5020</td>
<td>6000</td>
<td>5600</td>
<td>4900</td>
<td>59409</td>
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<td>price per kWh</td>
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<td>$0.0948</td>
<td>$0.0900</td>
<td>$0.1046</td>
<td>$0.1064</td>
<td>$0.1087</td>
<td>$0.1069</td>
<td>$0.1082</td>
<td>$0.1195</td>
<td>$0.1000</td>
<td>$0.1250</td>
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<td>gallons</td>
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<td>price per gallon</td>
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<td>$2.44</td>
<td>$3.13</td>
<td>$2.89</td>
<td>$3.21</td>
<td>$2.97</td>
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<tr>
<td>Total diesel cost</td>
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<td>$2,200</td>
<td>$2,500</td>
<td>$2,600</td>
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<td>$2,200</td>
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<td>gallons</td>
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<tr>
<td>price per gallon</td>
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</tbody>
</table>
## Data Summary

*Based on small data set from cooperators.*

<table>
<thead>
<tr>
<th>Description</th>
<th>Electric/yr</th>
<th>Range</th>
<th>Propane/yr</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kWh/pig space</td>
<td></td>
<td>Gal/pig space</td>
<td></td>
</tr>
<tr>
<td><strong>Finishing</strong></td>
<td></td>
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<td></td>
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<tr>
<td>Curtain barn</td>
<td>22.6</td>
<td>19.0-26.8</td>
<td>&lt;0.67</td>
<td>0.5-1.0</td>
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<tr>
<td>Tunnel barn</td>
<td>25.9</td>
<td>20.5-30.7</td>
<td>&lt;0.67</td>
<td>0.5-1.3</td>
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<tr>
<td><strong>Wean-Finish</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tunnel barn</td>
<td>31.3</td>
<td>27.5-35.1</td>
<td>2.6</td>
<td>1.8-3.3</td>
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<tr>
<td><strong>Sow farms</strong></td>
<td>240</td>
<td>282-225</td>
<td>6.1</td>
<td>1.2-12.3</td>
</tr>
</tbody>
</table>

From: *Benchmarking energy usage for swine producers.* PM3063E. ISU Extension publication
Where do you start?

• Insulation?
• Lighting?
• Ventilation?
• Heating system?
Ventilation

• FAR and AWAY the biggest potential for wasted energy
• 80 to 90% of heating energy lost through ventilation when done properly
• Controller setting and fan selection have a big influence on energy
Proper Ventilation Rate?

• Sample: 1000 head barn, 41 x 200
  – Assume:
    • 50 lb pigs @ 3 cfm/head & 68 F setpoint
    • Mason City, IA
  – Questions:
    • How much does over-ventilating cost?
Annual LP Usage Estimate
Wean-to-Finish (annualized)

<table>
<thead>
<tr>
<th>Ventilation Rate</th>
<th>Gallons LP/1000 pig spaces per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proper</td>
<td>1-24” @ 51%</td>
</tr>
<tr>
<td>10% Over</td>
<td>1-24” @ 56%</td>
</tr>
<tr>
<td>20% Over</td>
<td>1-24” @ 61%</td>
</tr>
<tr>
<td>30% Over</td>
<td>1-24” @ 66%</td>
</tr>
<tr>
<td>40% Over</td>
<td>1-24” @ 71%</td>
</tr>
<tr>
<td>50% Over</td>
<td>1-24” @ 76%</td>
</tr>
<tr>
<td>59% Over</td>
<td>2-24” @ 40%</td>
</tr>
</tbody>
</table>

Gallons LP/1000 pig spaces per year
Why is Proper Rate so Difficult?

• Variable speed fans make delivering a prescribed minimum rate difficult.
  – Too much ventilation = excess LP
  – Too little ventilation = poor air quality

• Proper rate should be based on air quality & moisture, not “rule of thumb”
  – Example: 2 cfm
## Fan Selection – Example 24” Fan Data

<table>
<thead>
<tr>
<th>Static Pressure Inches of water</th>
<th>Speed RPM</th>
<th>Airflow cfm</th>
<th>Efficiency cfm/W</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>1101</td>
<td>6490</td>
<td>16.1</td>
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<tr>
<td>0.05</td>
<td>1094</td>
<td>6090</td>
<td>14.7</td>
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<td><strong>0.10</strong></td>
<td><strong>1089</strong></td>
<td><strong>5740</strong></td>
<td><strong>13.4</strong></td>
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<tr>
<td>0.15</td>
<td>1083</td>
<td>5250</td>
<td>12.2</td>
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<tr>
<td>0.20</td>
<td>1082</td>
<td>4760</td>
<td>10.8</td>
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<tr>
<td>0.25</td>
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<td>3950</td>
<td>9.0</td>
</tr>
<tr>
<td>0.30</td>
<td>1082</td>
<td>2330</td>
<td>5.6</td>
</tr>
</tbody>
</table>

Source: BESS (2009) – www.bess.illinois.edu
## How Efficient Should You Choose?

<table>
<thead>
<tr>
<th>Diameter of fan (in)</th>
<th>Efficiency Rating (cfm/W) @ 0.1 inches of water</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median Rating</td>
</tr>
<tr>
<td>&lt;16</td>
<td>7.9</td>
</tr>
<tr>
<td>16 to 20</td>
<td>10.3</td>
</tr>
<tr>
<td>22 to 35</td>
<td>13.0</td>
</tr>
<tr>
<td>36 to 46</td>
<td>15.9</td>
</tr>
<tr>
<td>48 to 56</td>
<td>18.9</td>
</tr>
<tr>
<td>&gt;56</td>
<td>20.1</td>
</tr>
</tbody>
</table>

Source: BESS (2009)

Look for rebates from your electricity provider
Fan Efficiency Comparison

1000 Head Tunnel B&G (250 cfm/head)
• 8 fans – 24” ~ 7000 cfm
• X fans – 50” or 51” – enough to reach 250 cfm/sow

Highest Efficiency
• Uses 33,400 kWh/yr
• ~ $3300 @ 10 cents/kWh

Lowest Efficiency
• Uses 60,000 kWh/yr
• ~ $6000 @ 10 cents/kWh

Savings of ~ $2700/yr (~44%)
Fan Selection

• Smallest fans may run all year (8760 hrs) so look for efficiency
• Largest fans are the most efficient, but do not run as many hours total (~ 1000 hrs?)
• Energy savings strategy
  – some controllers may be capable of turning off smallest fans during higher ventilation stages.
Heaters & Brooders
Fan Control

• Setpoint – Temperature that divides the heating and cooling phases

![Graph showing minimum ventilation rate and bandwidth]
Space Heater Control

Room temperature continues to increase after heater turns off.
Space Heater Control

Overshooting the setpoint causes fan to increase ventilation, exhausting heat that was just added.
Savings of 3.75 gallons of propane in one day
Heater Modulation

Heating is most effective and efficient running longer at lower settings.
Guidelines

• Initially set offset to 1.5 to 2 F below the setpoint.
• Offset needs to be larger in rooms where the furnace is large for the room size.
• Use modulation valves to turn the heater down when the full capacity is not needed. More constant operation keeps a more steady environment.
• LISTEN!
  – If the furnace runs, and then the minimum ventilation fans begin to increase speed after it has shut off, the offset needs to be larger!
Heater Control – Using Brooders

*Setpoint is set to slightly above the brooder temperature*

Heater Offset

Heater On

Heater Off

Setpoint

Temperature

70 F

72 F

86 F

14 F
Brooder Usage

- Keep room setpoint near the brooder temperature (~85)
- Set the heater offset so that the room space heaters come on at a lower temperature (~70 F)
- Keeps from exhausting extra heat when you still need it.
Dirty Fans and Shutters

- 1/8 inch of dirt/dust can cause up to a 40% reduction in fan and shutter air flow.
  - Triggers next ventilation stage sooner costing more energy.
How Does this Impact Performance?

Air is lazy and follows the easiest path... therefore air comes from here instead of the room.

Result is poorer air quality and possibly sicker pigs.
Loose fitting pit covers and fan shrouds allow short-circuiting and loss of ventilation.
Effect of Drive Belt Tension
48-inch Fan

Airflow (cfm)

Static Pressure (inches of water)

BESS lab
Airflow before belt adj.
Airflow after belt adj.
Linear (Airflow before belt adj.)
Linear (Airflow after belt adj.)
Sunken Belt 1/4” Due to Worn Pulley

Reduction in fan Speed
Preventing Belt and Pulley Wear

Figure 1. Fan pulley alignment.
Check Electrical Systems

• At the fan and in the electrical panel.
• Connections tend to loosen over time with heating and cooling.
Poorly Maintained Fans:

• Reduce air quality in winter
• Cause higher stages to run earlier and use more electricity
• Cause curtains to drop when it is colder outside
• Reduce the ability to cool animals in summer
Summary

• Begin by tracking your energy usage
• Ventilation Management is critical to energy management
• Controller Settings are an important part of efficient operation.
  – No investment in many cases .. Only management
What questions do you have?

ISU Extension Farm Energy Initiative
Farmenergy.exnet.iastate.edu