Electric and Thermal Energy Consumption in Commercial Swine Facilities

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WEST CENTRAL RESEARCH AND OUTREACH CENTER
University of MN’s Research and Outreach Centers

• University of Minnesota College of Food, Agriculture, and Natural Resource Sciences (CFANS)

• 10 ROCs in MN
  • Agronomy, animal science, climate, forestry, horticulture, invasive species, natural resources, plant health, renewable energy, soils, water

• RESEARCH for the public
West Central Research and Outreach Center (WCROC)

• Applied research in:
  • Agronomy
  • Animal science
  • Horticulture
  • Organics
  • Renewable energy
WCROC and Renewable Energy

- Consumers demanding products with less environmental impacts

- Increase utilization of renewable energy in production agriculture and support its further development

- Research/demonstration of large/small scale systems
  - Are these systems feasible, applicable, and economical for producers?

- Energy conservation, optimization
“Greening of Agriculture” Initiative

• Overall goal to reduce fossil-fuel consumption in ag production systems

• Research and results for producers to use as a guide

• Three focus areas:
  • Crops
  • Dairy
  • Swine
Meeting our goals

• Crops:
  • Cover crops
  • Organic
  • Livestock

• Dairy - net-zero goal:
  • Scroll compressor, plate cooler, VFD
  • Solar thermal
  • 50 kW PV
  • 2, 10 kW wind turbines (one with 4 kW PV)
  • 2 Polaris electric UTVs
  • Electric Chevy Bolt
  • Fast charger
  • More RE installations this summer
Greening of Ag - Swine

• At the WCROC:
  • Renewable energy generation
  • LED retrofit

• In the industry:
  • Commercial barn energy monitoring
Solar Cooling of Sows

• Heat stress on sows
• 20 kW array
  • Powers chiller in farrowing barn
• Cool water (70°F) circulated to Nooyen cooling pads
• Cool water (55°F) supplied for drinking
  • Evidence lower water temps can increase feed intake
• Preliminary data shows reduced body temperatures and lower breathing rate
Commercial swine barn energy monitoring

• How much electric and thermal energy goes into producing one pig?

• Where and how is energy being used within each phase of production?
  • Breed-to-wean, nursery, finishing

• Each phase has different environmental requirements
  • Electricity uses
  • Amounts of fuel

• First study to monitor specific electrical loads
Commercial swine barn energy monitoring

• Six barns within an hour of Morris, MN

• Production barns representative of Midwest pork production systems:
  • Two breed-to-wean barns (BWA and BWB)
  • Two nurseries (NBA and NBB)
  • Two finishers (FBA and FBB)

• Baseline data collection and analysis
  • Electricity
  • Fuel (propane)
  • Pig production
Data collection

• Electricity usage of specific loads
  • Ex. pit fans, heat lamps, pressure washers, lights, etc.
• HOBO Data loggers and sensors
• Propane tank fills collected from producer
Breed-to-Wean Results

• Breed-to-Wean Barn A
  • ~2,500 sows
  • Average 58,420 weaned pigs produced per year
  • South Gestation unit curtain-sided
  • North Gestation, farrowing rooms power-ventilated

• Electrical use (2015-2016)
  • Average use 62,000 kWh/month
  • Average of 11.36 kWh per weaned pig

• Breed-to-Wean Barn B
  • ~3,300 sows
  • Average 87,670 weaned pigs produced per year
  • Gestation unit cross-ventilated
  • Farrowing rooms power-ventilated

• Electrical use (2015-2016)
  • Average use 97,700 kWh/month
  • Average of 11.91 kWh per weaned pig
Breed-to-Wean Results

- **BWA**: 384,755 kWh/yr
  - Heat Lamps: 50%
  - Ventilation: 20%
  - Lights: 10%
  - Pressure Washers: 10%
  - Heater Fans: 5%
  - Feed System: 5%
  - Well: 2%
  - Manure System: 1%
  - Not Measured: 2%

- **BWB**: 637,002 kWh/yr
  - Heat Lamps: 60%
  - Ventilation: 20%
  - Lights: 10%
  - Pressure Washers: 5%
  - Heater Fans: 5%
  - Feed System: 2%
  - Well: 1%
  - Manure System: 1%
  - Not Measured: 1%
Breed-to-Wean Barn B Daily Electricity Use December 2014-December 2015
Nursery Results

• Nursery Barn A
  • ~3,000 head
  • Average 19,100 feeder pigs produced per year
  • Nursery rooms power-ventilated

• Electrical use (2015-2016)
  • Average use 3,900 kWh/month
  • Average of 2.38 kWh per feeder pig

• Nursery Barn B
  • ~12,000 head
  • Average 71,650 feeder pigs produced per year
  • Nursery rooms power-ventilated

• Electrical use (2015-2016)
  • Average use 12,650 kWh/month
  • Average of 2.10 kWh per feeder pig
Nursery Results

45,391 kWh/yr

150,598 kWh/yr

Percent of Total Electricity

- **NBA**
  - Ventilation: 50%
  - Not Measured: 30%
  - Heater Fans: 10%
  - Lights: 5%
  - Feed System: 5%
  - Well: 5%
  - Pressure Washer: 5%
  - Manure System: 5%

- **NBB**
  - Ventilation: 50%
  - Not Measured: 30%
  - Heater Fans: 10%
  - Lights: 5%
  - Feed System: 5%
  - Well: 5%
  - Pressure Washer: 5%
  - Manure System: 5%
Finishing Results

• Finishing Barn A
  • ~2,400 head
  • Average 6,300 market hogs produced per year
  • Rooms are tunnel-ventilated

• Electrical use (2015-2016)
  • Average use 7,300 kWh/month
  • Average of 14.40 kWh per finished pig

• Finishing Barn B
  • ~1,060 head
  • Average 2,800 market hogs produced per year
  • Rooms are curtain-sided

• Electrical use (2015-2016)
  • Average use 900 kWh/month
  • Average of 4.12 kWh per finished pig
Finishing Results

91,140 kWh/yr
11,591 kWh/yr

Percent of Total Electricity

- Ventilation
- Well
- Not Measured
- Feed System
- Lights
- Heater Fans
- Pressure Washer
- Curtain

FBA
FBB
Total annual electrical and thermal energy use

*Total MJ of energy used annually by each barn.
Conclusions

• Results comparable to other industry measures:
  • Unpublished data from a system with 70,000 sows:
    • Avg across all sows 9.7 kWh/weaned pig
    • Barns within system ranged from 5-12 kWh/pig
  • Nursery (Brumm, 2015):
    • ~1.8 kWh per feeder pig
    • ~0.31 gal lp per feeder pig
  • Unpublished data from a tunnel-ventilated finisher:
    • 11.2 kWh per market hog

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<tr>
<th>Barn</th>
<th>kWh/pig</th>
<th>Gal. lp/pig</th>
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<td>BWA</td>
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<tr>
<td>BWB</td>
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Summary

• Consumers and market chains will likely continue demanding:
  • Reduced carbon footprint
  • More environmental sustainability

• Approaches for producers to meet consumer demands

• Producers have the tools to reduce fossil fuel use on the farm:
  • More efficient piglet heating systems
  • Improved ventilation systems/ better maintenance!
  • Reduced nocturnal temperatures for nursery and finishing? (Johnston et al)
  • Higher efficiency lighting
  • Renewables on the farm
Acknowledgements

• Participating producers

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Questions?