Energy Efficiency in Barns PART I

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PRAIRIE SWINE CENTRE INC.

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Fluorescent Tube Lighting

Compact Fluorescent Lighting

Lighting up the Barn

The main lights used in barns are: incandescent, compact fluorescent and fluorescent. Regular incandescent are only 10% efficient at converting energy to light; the rest is wasted as heat. Long life' incandescent are poorer still at about 7-8% efficiency. Compact fluorescent (CF) provide good energy efficiency and are easily retrofitted into incandescent fixtures. However, CF lamps have shorter equipment life and higher cost of replacement compared to T-8 (standard 4') fluorescent tube systems. The new standard (for barns where ceiling height is less than 12') is the T-8 fluorescent fixture with electro-magnetic ballast (Note: electronic ballasts are less reliable on farms), mounted in a weatherproof fibreglass or plastic housing with gasketed diffuser. These units are more than four times as efficient as regular incandescent and the lamps last at least 24 times longer.

The main light sources in swine production are fluorescent and incandescent. There are large variations in these two lighting systems:

- fluorescent lighting takes less energy to provide the desired light compared to incandescent
- incandescent lamps are closer to sunlight (similar spectrum of light) than typical "cool white" fluorescent
- conversion from incandescent to fluorescent will reduce energy usage by up to 75%
- incandescent lamps cost about $1.00 each and last 1000 hours (120 V regular life) to 5000 hours (130 V long life). However, the long life lamp provides about 25% less light than the regular lamp for the same amount of energy
- fluorescent lamps last 24,000 hours and cost about $2.00 each
- conversion to fluorescent from incandescent typically has a payback of less than 4 months

Other considerations for energy efficient light systems includes the use of timers, programmed to turn lights on/off to meet daily swine needs (see Table 1) or motion sensors in personnel areas.

A lighting retrofit from incandescent to vapour proof fluorescent (and some compact fluorescent) fixtures on a 240 sow farrow-to-finish facility realized annual savings of over $5000. The cost of electricity was about $0.07/KWh and the payback was less than two years.

Where barn ceiling height exceeds 12', the more efficient high intensity discharge (HID) fixtures (including metal halide and high pressure sodium) should be considered. They are easier to install, maintain and require fewer fixtures to provide the same level of light.

Table 1: Recommended Light Levels and Photoperiods for Swine Hous-

Type of Housing	Light Levels	Photoperiod	Comments
Breeding/Gilts	>10 f.c.	14-16 h/d	-necessary for estrus cycling
Gestation	>5 f.c.	14-16 h/d	-to assist missed cycles, bring estrus on again
Farrowing	5-10 f.c.	8 h/d	-if no heat lamps, some light in room 24 h/d
Nursery	5 f.c.	8 h/d	-some light in room 24 h/d
Grower-Finisher	5 fc	8 h/d	-minimum 6h/d unbroken light recommended

What's it Cost?

Let's consider a 200 head grow/finish room, with dimensions 40' x 40' x 10', eight pens and a centre alleyway. Assume energy costs of $0.06/KWh and demand charges of $4.50/ KW.

Placing one, 150 watt, regular life incandescent lamp per pen in the centre would provide close to four foot-candles (43 lux). This system would cost about $100 to install and $279.70 annually to operate.

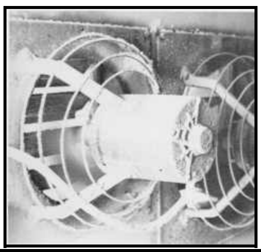
Replacing this with four, 4' twin tube, waterproof fluorescent fixtures, with one fixture per pair of pens, would provide the same 4 foot-candles. This T-8 system would cost $400 to install and $81.00 per year to operate, with a simple payback of 1.5 years.

The Bottom Line

A properly designed, energy efficient light system will enhance productivity and save maintenance and electrical operating costs.

Take Time to do Maintenance

Fans, Motors and Shutters. Cleaning and adjustment of ventilation equipment is important for energy efficiency. Fans won't deliver the rated capacity of air if there is dirt on the shrouds, blades or shutters. Studies have shown that dirty fan blades can reduce output by 10% and if not cleaned, lead to imbalance and vibration reducing the life of the motor. Blades can be cleaned with manual scrubbing or compressed air. Fans should be positioned correctly with respect to the orifice and in corrosive environments, open bearings replaced with sealed. Shutters and louvers should be inspected periodically to see if they are warped, rotted or stuck. Dirt on louvers or shutters become heavy and the hinges sticky. Dirty shutters have been shown to affect fan performance by reducing airflow up to 20%. Shutters and louvers should be power washed or wire brushed regularly.



Fans must be periodically cleaned to prevent buildup of dirt

Thermostats and Controllers. Large temperature fluctuations often point to dirty or worn-out controllers. Thermostats need to be cleaned and calibrated a minimum of two times a year. Controllers will not perform effectively if dust accumulates on the sending elements. This dust acts as an insulator and delays response. Compressed air or a cloth can be used to clean thermostats and controllers.

Air Inlets. Often inlet adjustment and maintenance can accommodate changes or fluctuations in barn temperature. Instead of checking inlets, a common mistake is to increase ventilation rate to lower barn temperature and thus increase energy consumption. Screens are crucial to keep birds out but must be serviced as they can become clogged with dirt in summer and the soffit inlets plugged with frost in winter.

Waterers and Pens. After cleaning pens, be sure to scrape up as much excess water as possible. Maintain leaking waterers by cleaning or replacing valves, nozzles, jets, etc. A wet environment is detrimental to animal health and barn structure. Ventilation rate will have to be increased to satisfy the moisture balance but also a large heating bill will be introduced to compensate for the heat that is blown out by the increased ventilation. Energy to evaporate the water will be robbed from heat that otherwise would be used to keep the air space warm.

What's it Cost?

Let's consider a variable speed 12'' (300mm) fan operating at minimum ventilation rate in a 200 head grow-finish room. The fan has an airflow rate of 402L/s and requires 0.105 KW input power. Assume a minimum ventilation rate over a three-month period of 1.5L/sec/pig and an electricity cost of $0.0585/KWh. This fan runs 24 hours per day.

-- The fan will cost $9.90 to operate for the three-month period.

If the fan blade and shutters are dirty, airflow can be restricted 30% (10%+20%) as stated above.

-- The fan will now cost $14.14 to operate for the three-month period.

This represents an approximate 42% increase in electricity costs over the three-month period.

Remember that this example utilizes minimum ventilation rates. As ventilation requirements increase, the cost associated will also increase dramatically due to the effect of restrictions or drag on the exhaust fan.

The Bottom Line

Maintenance in the barn is often overlooked as a way to decrease energy costs and increase efficiency. Fans and associated equipment should be cleaned at least four times a year. Thermostats and controllers two times a year. Remember to keep water spillage and washing water in the pens to a minimum.

Know the Temperature Requirements of Your Animals

Studies have shown that a pig may spend over 50% of its lifetime out of its thermal comfort zone. The producer must identify this zone as it has implications regarding animal health and energy efficiency.

In a building that is too warm:

- energy is wasted
- costs are greater than a room at optimal temperature
- pigs will separate from one another and seek out wet parts of the pen
- animals will suffer from slow weight gain and are susceptible to disease

In a building that is too cool:

- cold pigs will huddle and lie with minimal body contact to the floor and piglets will shiver
- animals will suffer from slow weight gain and are susceptible to disease
- feed consumption will increase but not rate of weight gain

For groups of uniform size, producers should aim for the optimal temperature settings outlined in the table below. Values stated in the chart are temperatures producers should strive for; however, a variation from these temperatures of +/- 3^{o}C is still within the acceptable range of animal well being and productivity. Remember that feeding level is relevant, as full fed animals are able to withstand colder temperatures. Producers can decide to increase or decrease feed or fuel to maximize net returns.

Recommended Setpoint Temperatures[1] for Various Ages of Pigs (Heating Season)

Room and Body Mass (kg)	Solid Floor	Slatted Floor	Solid Floor with Straw
Dry Sows	17	19	15
Farrowing	16	18	14
Weanling			
7kg	26	28	25
20kg	23	24	22
Grower/Finish (continuous)			
25-60kg	18	21	16
60-100kg	14	15	12

[1] Increase in setpoint temperature when outside temperature increases must be accompanied by minimum ventilation adjustments whenever such an adjustment is allowed. Refer to minimum ventilation recommendations (Adapted from Pork Production Guide PSC, 2000)

What's it Cost?

In our 200 head grower-finish room, winter temperature recommendations are 21^{o}C for 25kg pigs reduced to 15 ^{o}C for 75kg pigs. Let's consider 3 temperature scenarios within this room and the impact that it has on energy costs.

Scenario 1 — 21^{o}-15 ^{o}C = represents the correct temperature recommendations

Scenario 2 — 21^{o}-18 ^{o}C = temperature is maintained at 21^{o}C until pigs are 50kg and reduced to 18^{o}C for 75kg pigs and stays constant until animals reach their market weight

Scenario 3 — 21^{o}C = maintains pigs at 21^{o}C throughout the full production cycle

Saskatoon and Winnipeg are the two locations that have been chosen for this example. Calculations are based on monthly average temperatures over a 30 year period with a prairie energy cost of $0.023/KWh. Winnipeg had lower average temperatures than did Saskatoon. The following values look only at the heating costs to maintain the desired temperatures and do not consider the energy costs of ventilation.

The results are as follows:

Saskatoon – The cost to maintain the recommended temperature (21^o-15^o) would be \$120.20/yr. Moving to the 21^o-18^o and 21^o temperature scenarios represents an additional \$67.07/yr and \$168/ yr increase in heating costs respectively.

Winnipeg – It would cost \$132.88/yr in heating to maintain the recommended setpoint temperature of 21^o-15^o. Moving to the 21^o-18^o and 21^o temperature scenarios again would represent a large increase in the heating bill: an additional \$65.77/yr for the 21^o-18^o scenario and \$164.88/yr for the 21^o scenario.

The Bottom Line

Temperature within the barn is crucial for animal health and productivity but also affects energy efficiency (over heating, over cooling). Know your animals' target temperatures. Barn design and full vs. limit fed have implications in cold animal housing.

Water Wastage

Pigs consume 1/4 to 1/3 gallons of water per pound of dry feed or a ratio by weight of approximately 3:1. Temperature has an impact on water consumption as a 1^oC rise above 20^oC results in a sow drinking 0.2L more water per day. Severely restricting water to swine results in concentrated urine, urinary tract infections and even death. The implication is that limiting water cannot be used to reduce energy costs but decreasing water wastage can.

Danish Drik-O-Matic watering bowl reduces water wastage up to 20% compared to conventional nipples

In regards to water wastage, producers should consider the following:

- wet/dry feeders address the water wastage concern by incorporating a nipple drinker in the feed bowl as the only water source, reducing water use by 30% and slurry volume by 20-40%. This has an implication on quantity of slurry within the barn
- it is recommended that 1 nipple drinker be provided for every 15 pigs
- in a period of one minute drinkers should deliver 1 litre for breeding stock, 650-700ml for growers and 475ml for weaners
- grower – finisher pigs may waste up to 60% of the water from a nipple drinker
- cup or bowl waterers are returning in popularity primarily because they waste less water, reducing spillage 10-15%
- hauling manure a mile away costs at least a penny a gallon with a custom hauler. Therefore, cup waterers or bowl drinkers will save you money for manure removal and reduce the water bill.

What's it Cost?

Let's return to our model example of 200 head in a grower-finish room. Assuming a total weight gain of 8.2kg and feed conversion 2.9kg of feed/kg of gain, each pig will drink 595L water/production cycle. If we use a 40% water wastage value at the drinker, 396L will be wasted/pig/cycle. There are approximately 2.8 cycles over the year and each pig produces 7.5L of manure/day.

-- Total water wastage (L/year) = 221,760
-- Total manure produced (L/year) = 547,500
-- Water wastage/manure production (%) = 41%

If waste is pumped from the transfer pit to the outdoor storage facility, this would represent the first energy component. Manure pumps have an energy cost of \$0.01/m^3 of product. Outside the barn, we need to consider 3 processes: agitation, loading and transportation. This energy cost works out to \$0.04/m^3. Adding the two totals results in a cost of \$0.05 to move $1m^3$ of product. Therefore, the cost to move the wasted water in our example barn would be \$11.09/yr.

In addition to moving the waste water, field application should be considered. Using typical custom application rates (assume \$1.55/m^3 which includes labour, equipment use and energy costs) the cost could be estimated at \$0.61/pig. Therefore, the cost to spread just this waste water would be \$343.73/yr. The final yearly total (cost of moving and land application) is \$354.82.

The Bottom Line

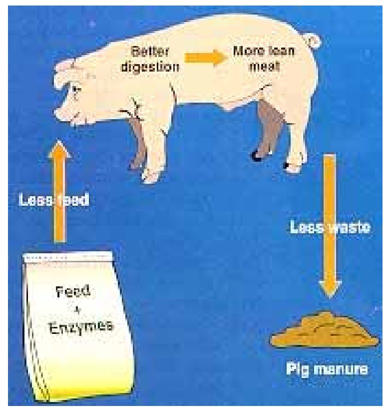
Slurry can include approximately 40% clean water wasted from drinkers. Producers can limit this by reducing water wastage within the barn. Wet/dry feeders, for example, can help to reduce water spillage. Try to incorporate cup or bowl drinkers, as they are more efficient at conserving water than nipple drinkers.

Cut Back on Manure Volume

Feed has been an area of interest regarding manure volume reduction. This is important for the producer as it impacts the amount of manure to be removed from the barn and the energy required to do this.

The issue of manure volume can be simplified into the following three points:

- feed enzymes can shift the digestive process in the pig allowing for more efficient growth, being brought to slaughter on a lower feed intake and consequently, less manure being produced. A 7% improvement in feed utilization efficiency will translate into a 5% reduction in the weight or volume of manure excreted
- reducing crude protein in swine diets results in as much as a 28% decrease in slurry volume. This is due to the pig consuming less water in an effort to eliminate reduced amounts of nitrogen in the body
- feeding pellets rather than meal can increase digestibility and decrease excretion due to efficiencies of digestion resulting from grinding to a smaller particle size. The feed processing aspect however is an energy consumer and producers should be aware of this. More information regarding feed processing will be available in Part II of this factsheet.



What's it Cost?

Considering our grower-finish operation example of 200 head, total manure production can be approximated to 7.5L/pig/day. Taking into account total energy requirements (transfer from barn to storage, agitation and emptying) it would cost $27.38/yr to move this slurry. If the producer were to incorporate two manure volume reduction methods: feed enzymes and diet protein, slurry removal would now cost $18.34/yr.

Similar to the example in the water wastage section, field application should be considered. Recall our estimated cost of $1.55/m^3$ or $0.61/pig. Without a manure reduction method, the cost for field application would be $848.63/yr or a total yearly cost of $876.01 for slurry removal. With the two combined manure reduction methods (feed enzymes and diet protein) the total yearly cost is reduced to $586.92/yr, a savings of $261.71/yr.

The Bottom Line

Manure requires energy to remove it from the barn. Although it is a large energy sink, producers do have options to reduce this expense. Feed enzymes, protein levels and particle size can be manipulated for this benefit.

Conclusion

Energy conservation and efficiency can be achieved through improved management, minor structural changes and new technologies. The remaining 5 of the Top 10 ways to reduce energy costs in the barn can be found in **Energy Efficiency in Barns Part II**. Of equal importance will be an information database set up on the Prairie Swine Centre website for producers, professionals, scientists, etc. to access more detailed information regarding energy efficiency. This database will be functional in May 2001.

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Coming Soon

Energy Efficiency in Barns Part II

AND

The PSC Wesite Energy Database