

A Cost Effective Heating Method for Piglets in Swine Farrowing Barns

Eshetu Beshada, Research Associate

Department of Biosystems Engineering, University of Manitoba, Winnipeg, Manitoba

Quing Zhang, Professor

Department of Biosystems Engineering, University of Manitoba, Winnipeg, Manitoba

Ray Boris, Engineer

Manitoba Hydro, Winnipeg, Manitoba

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Abstract

An experimental study was conducted to compare two heating methods for piglets, namely heat mats and heat lamps, in a commercial swine farrowing facility. Two farrowing rooms each with 44 crates were instrumented to measure room environmental conditions (temperature and humidity), energy consumption, and piglet performance (mortality and weight gain). The study showed that there were no significant differences in piglet performance between heat mat and heat lamp heating methods. Using heat mats resulted in a monthly saving of up to 3.7 MWh of energy per room, or a daily saving of 2.8 kWh per crate.

Keywords: farrowing barn, temperature, local heating, energy consumption.

INTRODUCTION

At birth, newborn piglets leave their mother's womb that was at a temperature of about 39°C and a draft free environment. These piglets that weigh less than 1% of their mother, have poor hair cover and very limited fat layer, need warm environmental temperature to survive and grow. However, temperature in farrowing barns is typically maintained between 18 and 21°C for the comfort of sows. The different environmental requirements by newborn piglets and sows require a localized high temperature zone for the piglets in farrowing barns.

Localized heating may be attained by using heat mats (pads) or lamps. Heat lamps of 175 to 250 W are used in most swine operations. However, there has been an increased interest and installation of heat mats in preference to heat lamps. Xin and Zhang (1999) and Zhang and Xin (2000; 2001) have extensively investigated the advantage of heat mats over heat lamps and researched on the behaviors of pigs under both heating systems. They have found out that although the piglets spent more time under heat lamps during the first two days after birth, heat mats provided a more uniform heat over a wider area than the heat lamps, and energy saving of up to 60% could be achieved (Xin and Zhang, 1999; Zhang and Xin, 2001).

Although there are some clear advantages of using heat mats, it is also an important practice to test the practicality of the technology under a specific environmental condition and barn management. Hence this study was proposed with the objectives of investigating the effect of mat heating on the performance of the piglets (mortality and weight gain) and the total energy saving by heat mats in comparison with heat lamps.

MATERIALS AND METHODS

The experiment was carried out in the Inter lake Weanlings barn of Puratone Corporation, MB. Two farrowing rooms of 44 crates were selected for the comparative study. One of the rooms was equipped with 22 double-size (2 x 4 ft, or 600 by 1200 mm) heat mats each rated at a maximum power of 130 W (or 65 W per crate) (Hog Hearth, Alternative Heating Systems Inc., Winnipeg, MB), while the other room was equipped with 44 infrared lamps each rated at 175 W. Three heat mats were randomly chosen (locations 1, 2, and 3 in fig. 1) to test if there were any differences in the temperature profile between and within the mats. Mats 1 and 2 had built-in temperature sensors for controlling mat surface temperature (master mat), while mat 3 was a slave mat whose temperature was controlled by the sensor in its master mat. The surface temperature of each mat was measured at the centre and the periphery of the mat. The positions of the thermocouples were at 2.5 and 26 in (63 and 660 mm) diagonally from one corner of the heat mat. The T-Type (Copper-Constantan) thermocouples were used for temperature measurement. The thermocouples were connected to a data logger (Smart Reader Plus 6, ACR Systems Inc. Surrey, BC). The readings of the surface temperatures were recorded every 15 minutes.

The temperature and relative humidity of the rooms were measured using Onset HOBO sensor and data logger (Hoskin Scientific Ltd. Vancouver, BC). The sensors were placed in the center of the room (locations 4 and 5 in fig. 1). The loggers were sensing and storing the data every 10 minutes.

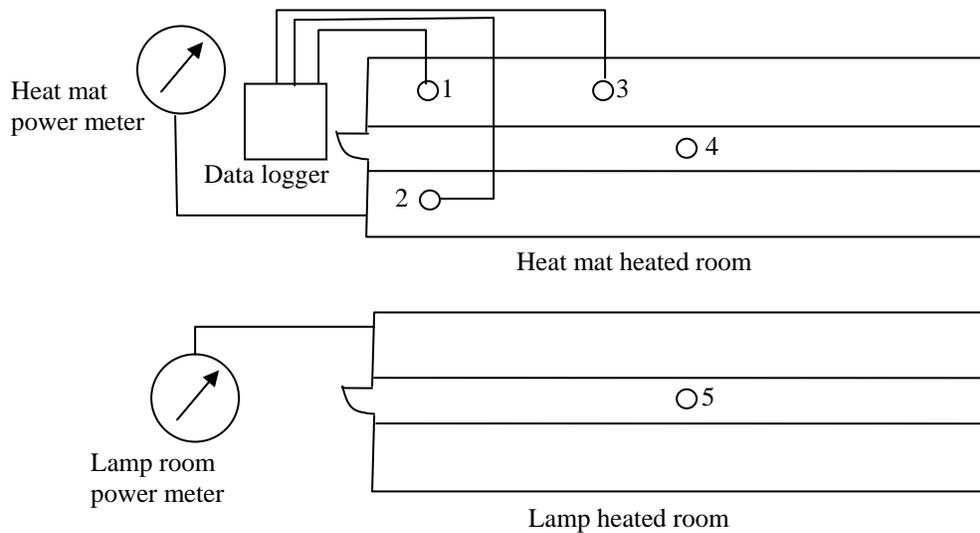


Figure 1. The positions of sensors used to measure temperature and relative humidity of the heat mat surface and the rooms condition in a farrowing barn.

A pulse meter (Schlumberger, Type Sentinel, Itron Canada Inc., Mississauga, ON) was installed in each room to record the total power consumption by mats or lamps. The energy consumption and power demand were recorded in KWh and kVA, respectively, every 15 minutes. Data from these meters were downloaded every three weeks and processed by using the Microsoft Excel.

The mortality was recorded by the barn operators. Numbers of piglets died after birth in both rooms were counted starting from the date of birth till they were weaned in three weeks. The weight gain was measured by weighing 10 litters selected randomly per room at birth and a day before weaning. The average weight increase of the litter was taken as average daily gain (ADG). The scale used was the Stock Market ST-10 Model No. GH24-5K (Rice Lake Weighing Systems, Rice Lake, WI).

RESULTS AND DISCUSSION

Room Conditions

The room temperature stayed between 20 and 22 °C in both rooms and the difference in room temperature was negligible between the two rooms during the entire test period from September, 2005 to March, 2006 (fig. 2). This period covered five farrowing-weaning cycles. The temperature dropped below 20°C between the cycles when the room was cleaned.

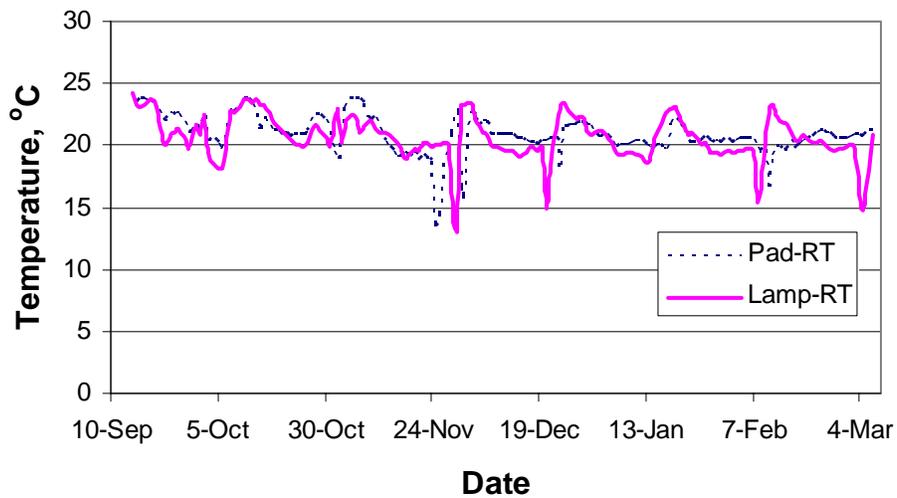


Figure 2. Daily average temperatures recorded in the heat mat and heat lamp rooms from September 15, 2005 to March 06, 2006.

The average relative humidity was about 70% and 50% in the heat mat and heat lamp rooms, respectively (fig. 3). Peaks at intervals were caused by room cleaning (washing) between cycles. Although, the humidity level in both rooms was within the acceptable range, the relative humidity in the heat mat room was on average 20% higher than that in the heat lamp room. The low relative humidity in the heat lamp room might be attributed to the higher heat supplied into the room, which in turn caused a higher ventilation rate in the room. Based on the power ratings of heat lamps (175 W/crate) and mats (65 W/crate), the lamp room received 4.84 kW more heat energy than did the mat room.

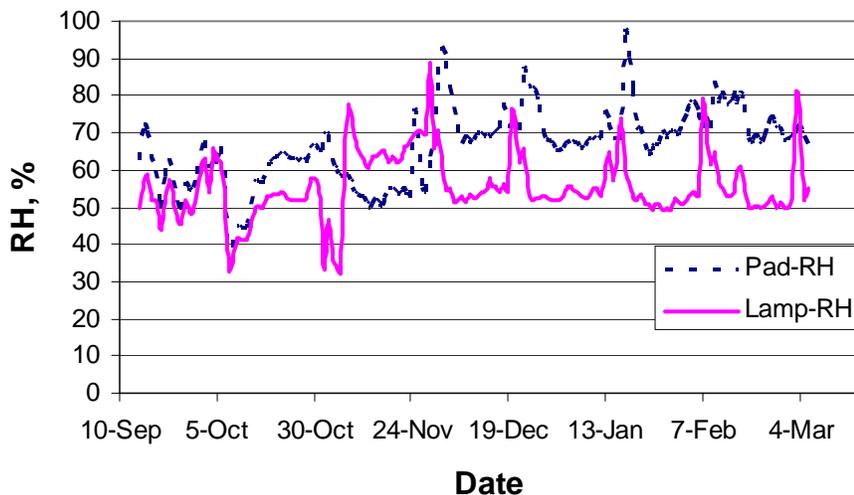


Figure 3. Daily average relative humidity recorded in both heat mat and heat lamp rooms from Sept 15, 2005 to March 06, 2006.

Heat Mat Surface Temperature

Figure 4 shows the comparison of the temperatures recorded at the centre and periphery of the heat mat. It can be seen from the graph that consistently there was a 3 to 5°C temperature difference between the centre and the periphery of the heat mat. This can be expected as the heating element at the periphery is surrounded by a colder outer edge of the mat compared to the central heating element which was surrounded by other heating elements.

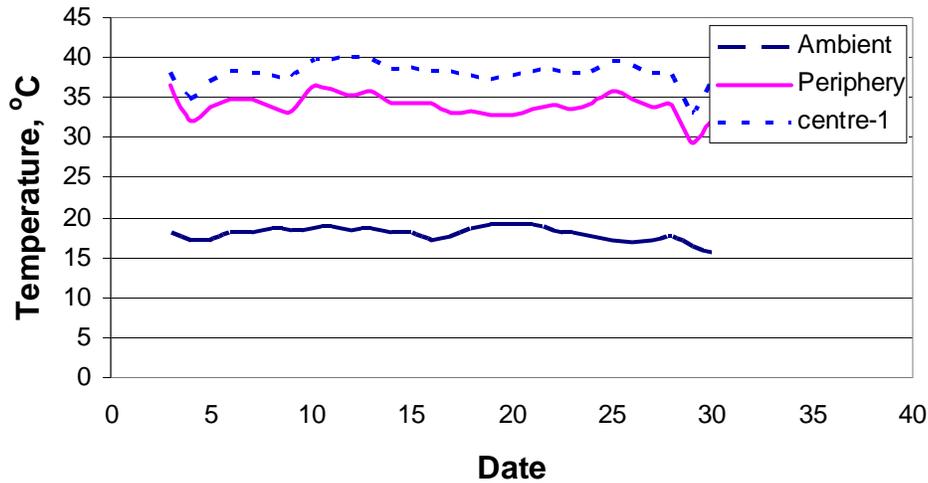


Figure 4. The surface temperatures near the periphery and at the centre of a heat mat.

Figure 5 compares the surface temperatures of two heat mats at their centre points. As one can see from the figure, the surface temperatures between the heat mats are not different. This has also been observed for the comparison at the periphery of the two heat mats. The statistical analysis further showed that the surface temperatures of two different heat mats were statistically not significantly different ($P < 0.05$).

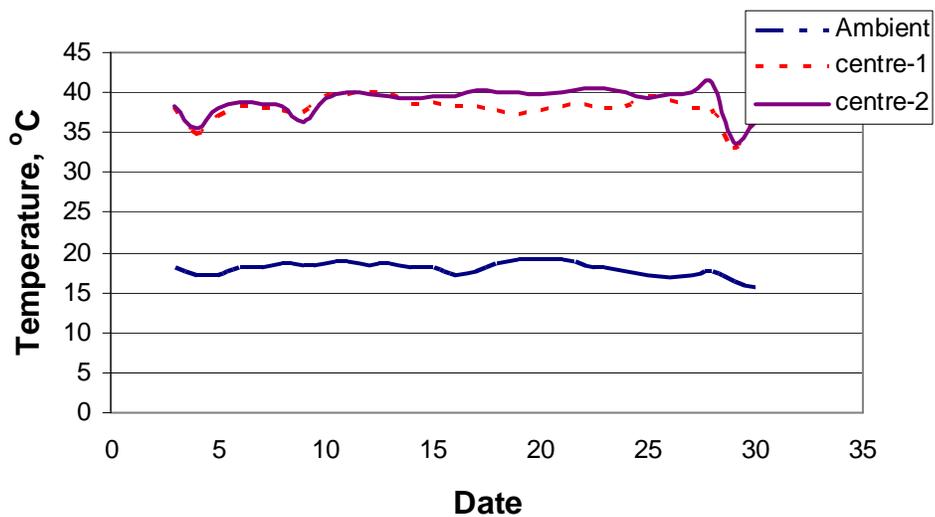


Figure 5. The central points surface temperatures for two different heat mats.

Energy Consumption

The average peak daily demand in the heat lamp room was about 5 kVA higher than that in the heat mat room (fig. 6), or about 113 W per crate. The difference between the two rooms was consistent through out the test period.

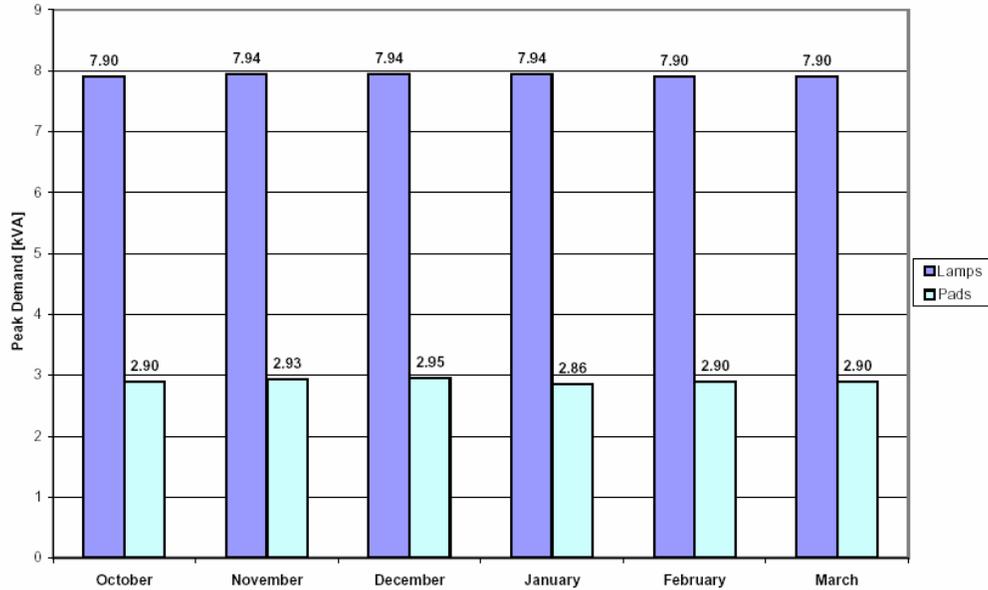


Figure 6. Peak load demand of the heat mat and lamp rooms.

The monthly energy consumption in the heat lamp room was 3.7 MWh higher than that in the heat mat room on average (fig. 7), or 22 MWh over the six month test period.

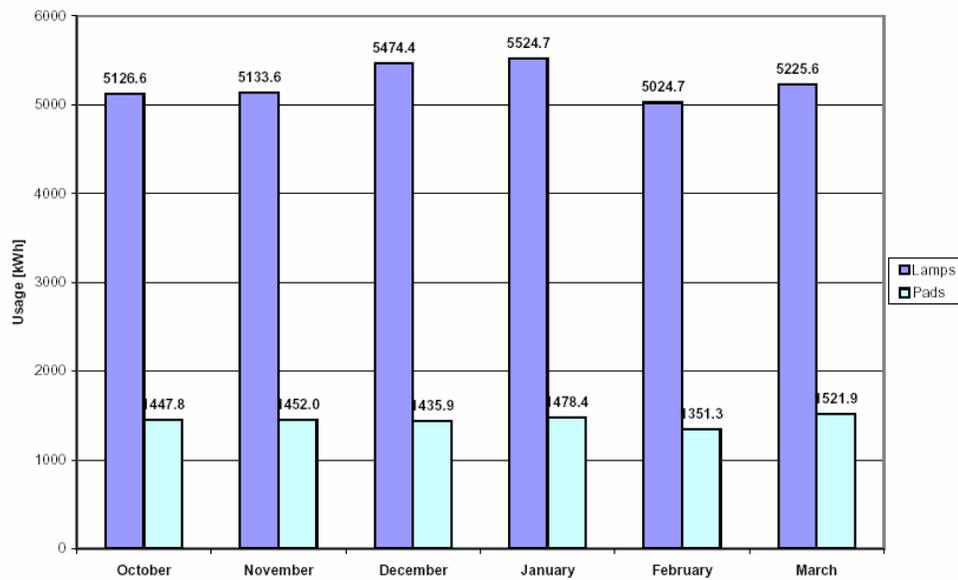


Figure 7. Normalized monthly energy consumption of the heat mat and lamp room.

Mortality and Average Daily Gain

The mortality in both mat and lamp rooms was within the range (10-15%) for typical swine operations (Table 1). The statistical analysis showed that the mortality between the two rooms was not significantly different ($P < 0.05$). In other words, the local heating method had insignificant effect on preweaning mortality.

Table 1. The percentage mortality recorded in the heat mat and lamp rooms

Test room	Test cycle					Average	Standard Deviation
	1	2	3	4	5		
Heat mat	10.5%	14.5%	8.8%	8.6%	11.7%	10.8%	2.4%
Heat lamp	11.0%	7.3%	10.8%	13.1%	13.3%	11.1%	2.4%

The average daily gain (ADG) in the mat room appeared slightly higher than that in the lamp room. However, the statistical analysis showed that the difference was statistically significant ($P < 0.05$).

Table 2. The average daily gain of the piglets in kg/day before weaning for both mat and lamp rooms (data were not available for cycle 5).

Test room	Test cycle				Average	Standard Deviation
	1	2	3	4		
Mat heating	0.268	0.239	0.256	0.221	0.246	0.0205
Lamp heating	0.236	0.223	0.231	0.229	0.230	0.0054

CONCLUSIONS

1. When heat mats were used to supply localized heating to newborn piglets in a swine farrowing room, the piglet performance (mortality and average daily gain) was not statistically different from that in a farrowing room equipped with traditionally used heat lamps.
2. The use of heat mats may significantly reduce energy consumption in swine farrowing operations.

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