Optimizing temperature requirements of pigs to reduce energy use in swine production

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INSIGHT FOR PRODUCERS

By understanding the minimum temperature at which animal performance in unaffected, we can provide recommendations on barn temperatures. This will reduce barn heating costs.

SUMMARY

This project set out to investigate the optimum environmental temperature requirements of sows and grower-finisher pigs, reducing energy costs and greenhouse gas emissions while maintaining long-term overall productivity and performance.

The project consists of four phases: in Phase 1, group-housed gestating sows will be kept for 6 weeks either at 16.5 °C (current recommended set-point) or 8 °C (preferred temperature determined in a previous study); in Phase 2, the preferred environmental temperature of grower-finisher pigs will be determined, using the operant mechanism and experimental protocols developed in the previous sow study; in Phase 3, grow-finish pigs will be kept for 6 weeks at either the current recommended set-point temperature or the preferred temperature determined in phase 2 to assess growth performance; and in Phase 4, an assessment of the environmental (carbon) footprint will be completed, along with cost analysis and development of recommendations for practical application of the optimized temperature management in commercial barns. Preliminary results of Phase 1 show a reduction in energy consumption of >50% in group-housed gestation rooms with a setpoint of 8 °C vs. 16.5 °C.

INTRODUCTION

Utility costs typically rank third in total cost of production, ranking only behind feed and labour. Heating costs are a substantial part of the total energy costs, therefore reducing temperature set-points on farm will reduce how often the heater is running helping reduce energy costs. A previous research project indicates that group-housed sows could tolerate temperatures up to 8 °C lower than the typical set-point (16.5 °C) currently maintained in most gestation barns, without compromising the welfare and productivity of the animals. However, the impact of raising sows at this lower temperature, on their long-term reproductive performance, still needs to be evaluated to fully assess the economic benefits of adopting this technology across the industry. Presently, no study has been conducted regarding the feasibility of a similar temperature set-point reduction for grower-finisher pigs.

EXPERIMENTAL PROCEDURES

Phase 1

The goal of this phase was to implement the tolerable set-point temperature (determined from the previous study) in actual sow (group) gestation rooms and assess its impact on energy consumption and the long-term reproductive performance of the sows under commercial barn conditions. Two rooms were used with one room designated as Control and temperature maintained at 16.5 °C (which is the typical set-point currently applied in commercial sow gestation barns) while the other room designated as Treatment had temperature maintained at the sows' preferred temperature determined from the previous study (8 °C). A total of three sow trials were conducted, with each room housing up to 45 sows per trial. Each trial lasted for 6 weeks.

Phase 2

The aim of this phase was to determine the tolerable environmental temperature for grower-finisher pigs. To train grower-finisher pigs to control their own environmental temperature, a previously developed operant mechanism was installed in each environmental chamber. A total of 5 replicate trials were carried out in the environmental chambers during winter months, with each chamber housing 5 grower-finisher pigs.

Phase 3

After the tolerable environmental temperature of the grower-finisher pigs is established from the previous phase, it will be implemented in a commercial grow-finish rooms to assess the impact on energy consumption and the pigs' performance under commercial barn conditions. Two identical grow-finish

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rooms at PSC will be used, one room will be designated as "Pre-set" with temperature maintained at the typical set-point applied in grow-finish barns using a typical controller, while the other room designated as Treatment will have temperature maintained at the pigs' tolerable temperature determined from Phase 2. A total of 3 trials will be conducted, with each room housing 100 pigs per trial. Each trial will last for 6 weeks.

Phase 4

Following the in-barn experiments, an environmental footprint assessment will be performed using a sustainability assessment tool developed in a related study to determine the resulting carbon footprint from the application of the preferred temperature set-points in gestation and grow- finish barns. In addition, a feasibility analysis will be conducted to determine the costs and requirements for the proper implementation of the optimized temperature management approach in a commercial production facility. Data collected from this study, together with the information on all the expenditures and costs incurred during actual in- barn implementation including the purchase of materials and equipment, and labour and operating costs, will be used in the economic analysis. Recommendations for practical application of the optimized temperature management in commercial barns will also be developed.

RESULTS

Phase 1 trials are currently underway. Results from the first trial conducted from March 6 to April 17, 2024, are presented below.

Growth Performance

There was a slight difference in ADG between the Control room and the Treatment room (Table 1) during the first trial. In terms of ADFI, sows in the Treatment had slightly higher ADFI than those in the Control room (Table 1). This could be attributed to the difference in the initial body condition of some of the sows between the two rooms at the start of the trial; more sows in the Treatment room needed additional feed allowance to improve their initial body condition. Ultimately, G:F ratio was not significantly different between treatment groups (Table 1).

Table 1. Growth performance of sows in the Control and Treatment rooms during the first trial.

Growth performance	Control room	Treatment room
Average daily gain, ADG (kg/day)	0.43 ± 0.22	0.35 ± 0.16
Average daily feed intake, ADFI (kg/day)	2.54 ± 0.31	2.63 ± 0.41
Gain-to-feed ratio (G:F)	0.17	0.13

Note: ADG, ADFI, and G:F represent the average from 32-33 sows in each room.

Physiological responses

No substantial difference was observed in the measured rectal temperature of the sows in the two rooms. Sows in the Control room exhibited an average rectal temperature of 37.4 ± 0.4 °C, while those in the Treatment room had an average rectal temperature of 37.3 ± 0.5 °C, both measures below the expected average rectal temperature range of 38.3 – 38.8 °C. Slightly higher blood thyroxin levels were observed in the Treatment room (66.8 ± 12.1 nmol/L) compared to the Control room (63.6 ± 10.1 nmol/L). Thyroxin is a hormone produced by the thyroid gland which regulates the body's metabolic rate, with a higher concentration suggesting an increased metabolic rate (the body consumes more energy).

Room temperature

Figure 1 illustrates the average air temperature in various spatial locations within each room. In the Control room with set point maintained at 16.5 °C (which is typical for commercial gestation barns), the measured air temperature ranged between 15.8 and 17.2 °C throughout the trial. In comparison, the Treatment room (with temperature set-point maintained at 8 °C, which was determined as the sow's tolerable temperature based on previous study) exhibited air temperatures ranging from 8.3 to 11.0 °C.

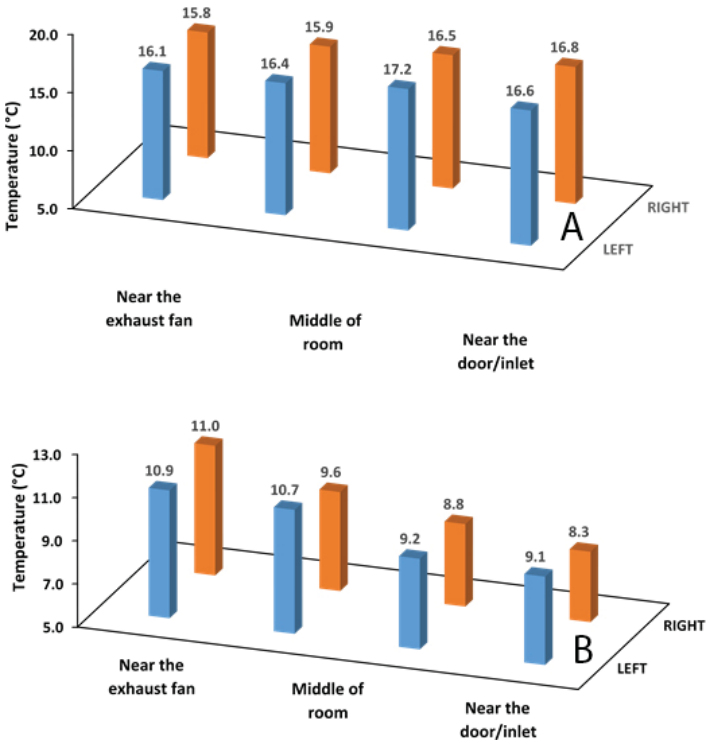

Figure 1. Average air temperature measured at various sampling locations in the Control (A) and Treatment (B) rooms

Figure 2 illustrates the temperature time series graph in each room. During the last two weeks of the trial, a temporal variation in temperature can be observed in the data. These fluctuations correlate with diurnal changes in ambient temperature, reaching a maximum of 18.8°C during the day and decreasing to as low as -4.6°C during the night (Environment Canada, 2024). The air temperatures in the rooms rely on the external ambient temperature.

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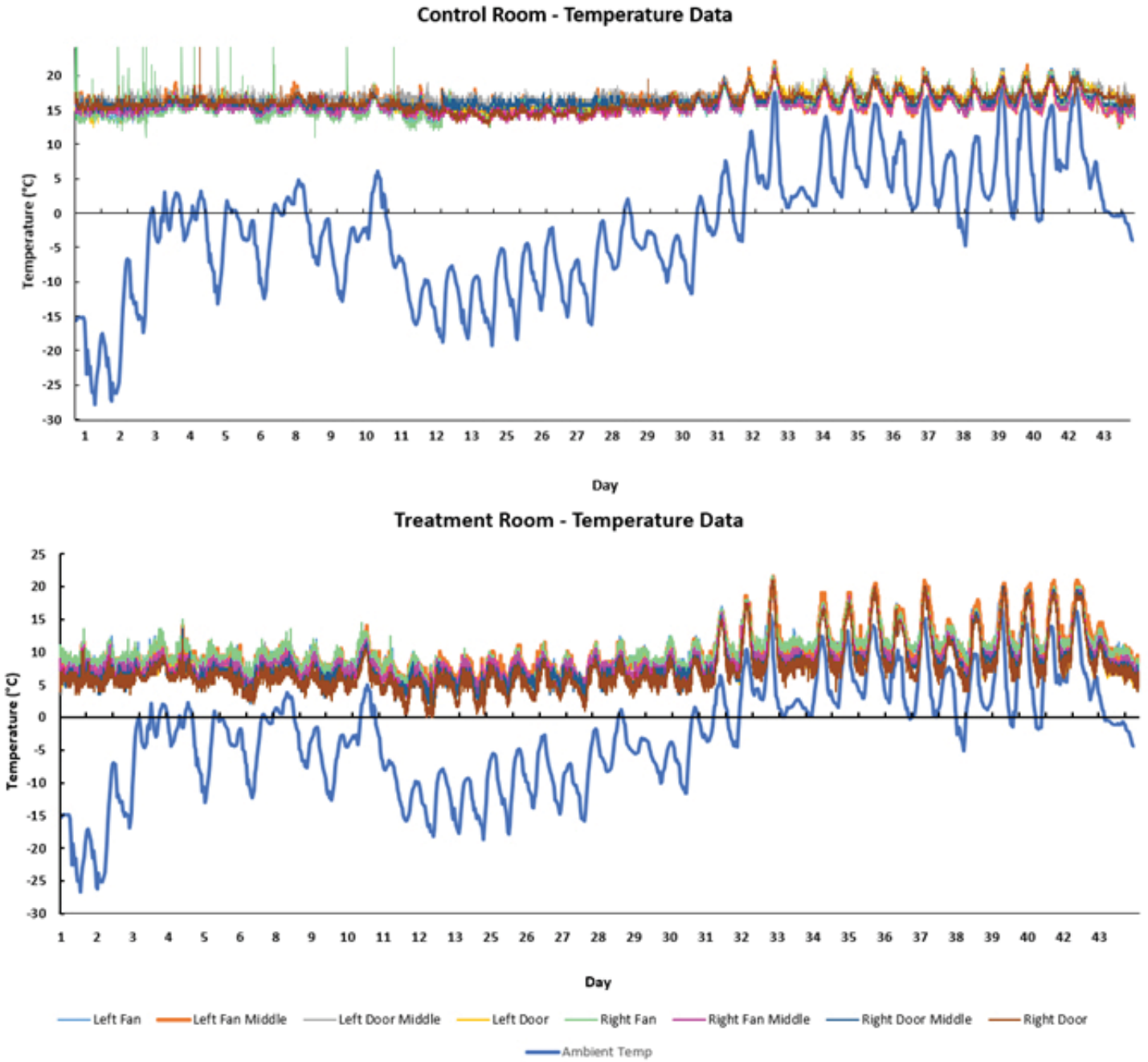

Figure 2. Air temperature profile at different sampling location in the Control (A) and Treatment (B) rooms.

Relative humidity

Figure 3 shows the average relative humidity (RH) in both rooms over the duration of the completed trial. The RH values in the Control room ranged between 57.0 to 60.7% and had an average of 58.6 ± 1.6%. On the other hand, the Treatment room had an average RH of 56.0 ± 0.3% and ranged from 55.7 to 56.4%. Both rooms showed RH levels within the recommended range for swine barns, which is between 50 to 65%.

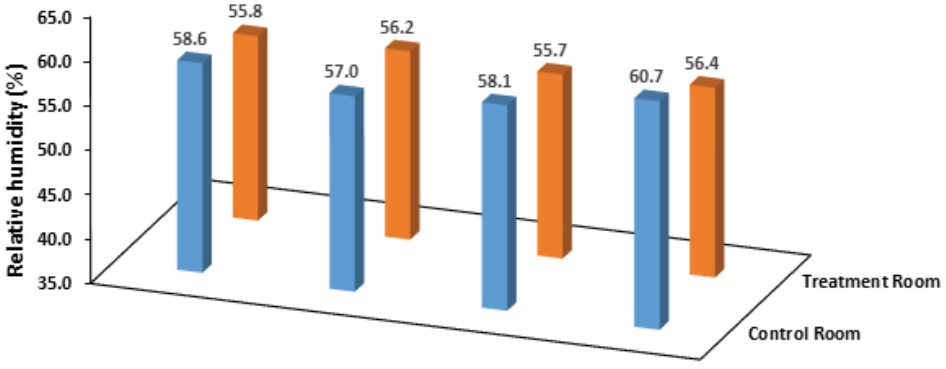

Figure 3. Average relative humidity measured in the Control and Treatment rooms over the duration of the trial.

Energy consumption (electricity and natural gas)
The electrical energy usage in each room included electricity consumption by the ventilation fans, furnace motor, and room lighting, while the natural gas utilized by the furnace for room heating during the experiment was also monitored (Table 2).

For the duration of the trial, the total electrical energy usage in the Control room was measured at 19.12 kWhr while the Treatment room recorded a total usage of 13.77 kWhr. For the total natural gas consumption, the Control room recorded usage of 3,214 BTU, which was more than double the gas consumption in the Treatment room, which totaled 1,355 BTU for the duration of the experiment.

Table 2. Total energy consumption measured from the Control and Treatment rooms during the first trial.

Energy consumption	Control room	Treatment room
Electricity, kW-hr	19.12	13.77
Natural gas, BTU	3,214	1,355

Gas concentrations (ammonia and carbon dioxide gas)
The average ammonia (NH3) level in the Control room was 15.8 ± 4.3 ppm while the Treatment room had an average NH3 level of 15.5 ± 4.2 ppm, which were below the 25 ppm level which may cause health problems for both pigs and barn staff (AASV, 2019). On the other hand, the average CO2 concentration in the Treatment room was about 987 ± 263 ppm, which was relatively lower than that in the Control room (1494 ± 387 ppm). Carbon dioxide levels are indicative of air quality, with lower concentrations indicating better quality. Barn personnel also reported perceiving more favorable air quality in the Treatment room than in the Control room.

IMPLICATIONS

This work has been conceptualized to validate and update the current industry recommendations on temperature set- points for gestating sows and to assess the impact on energy costs and overall pig production performance. The current results reflect that a lower temperature set-point reduces energy consumption and improves air quality. The impact on long-term reproductive performance is still being investigated. To date, these results imply that altering gestation room temperature is a valid approach to reducing energy use and associated costs.

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