Reducing Energy Use in Group Sow Housing Systems

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SUMMARY

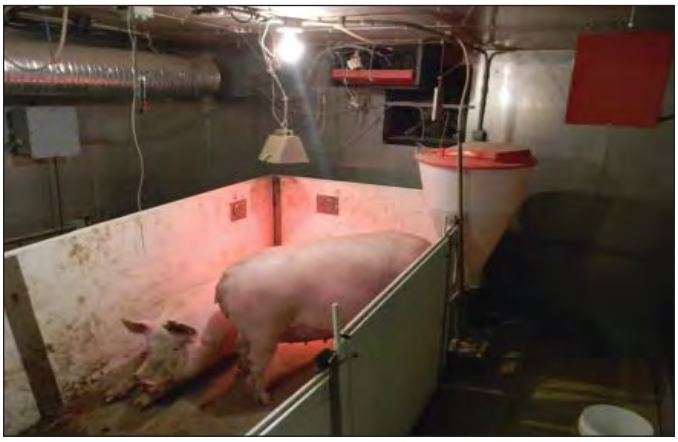
Conversion of gestation sow housing from stalls to group systems has been mandated in the recently revised Canadian Code of Practice for the Care and Handling of Pigs, with all sow farms expected to adopt this practice by July 2024 (NFACC, 2014). As such, this study aimed to investigate management options that will take advantage of potential merits of group sow housing. One such advantage may be that sows housed in groups can interact with one another and exhibit thermoregulatory behavior (e.g., huddling), thereby potentially tolerating temperatures below the lower critical temperature (LCT). This could result in reduced energy costs for heating and ventilation. Housing sows in groups can also lead to aggression among gestating sows and is aggravated by feed restriction during gestation. High fiber (high heat-increment) diets have been reported to increase satiety and reduce aggression among sows in addition to increasing heat production of sows. The addition of fiber to the diet could be a means of addressing behavioral issues associated with grouped-sows as well as contributing to the energy balance of sows under reduced barn temperature.

"Preliminary results have shown that sows could tolerate temperature as low as 9 °C."

In this study, an operant mechanism was designed and developed to allow sows to control their own environmental temperature. Two barn rooms were configured for group housing, with each room containing 28 gestating sows. One room was operated at a typical set-point temperature (16.5°C) while an operant mechanism was installed in the other room, allowing the sows to control the temperature in addition to high heat-increment diets fed to the sows. The trials were carried out during the winter season and results have shown that sows could tolerate temperature lower than the current set-point maintained in most gestation barns. Lower temperature set-points could result to considerable reduction in energy consumption for heating and ventilation.

INTRODUCTION

Barn temperatures currently maintained in barns with sows housed in individual stalls are based on the reported lower critical temperature (LCT) (Geuyen et al., 1984). Allowing the temperature to drop below this LCT will require additional feed to maintain the sow body condition and weight gain over the gestation period. It has been estimated that sows housed in groups may have LCT values significantly lower than 15°C when given the ability to utilize thermoregulatory behaviour. Thus, if group-housed sows can maintain body condition and weight gain at temperatures lower than currently maintained in sow barns without the need for additional feed, the potential exists to significantly reduce energy costs for heating and ventilation.



Some issues anticipated with group-housed sows include the potential for higher activity levels and aggression among sows. These problems are exacerbated when sows are put on a restricted feeding regime, which is a common practice for gestating sows to maintain optimal body condition. The sensation of feeling "full" is improved with high-fiber (high heat-increment) diets; these diets are also known to reduce the urge to feed continuously, overall activity, and repetitive behaviour in sows. Moreover, dietary fiber increases heat production in sows without increasing digestible energy. As such, adding fiber to the diet can be a means of reducing activity and limiting aggression in sows under reduced barn temperature.

MATERIALS AND METHODS

Phase 1 – Controlled environmental chamber tests

Two fully instrumented and controlled-environment chambers at Prairie Swine Centre (PSC) were used in developing the operant mechanism that allows the sows to control their own environmental temperature. The operant mechanism consisted of a manual control switch installed in the chamber along the penning at a location which the sows can access and manipulate, and a radiant heater. When a sow activates the switch, it operates the existing supplementary heating system for the entire room for a specified period, and the radiant heater placed above the area of the switch as an immediate feedback reward. In addition to the functioning

heat control switch, a 'dummy' switch that does not operate the radiant heater (i.e., unrewarded activity) was also installed close to the real switch to distinguish between deliberate behaviour by the sows to control the room temperature and random interaction with the mechanism. In addition two experimental diets were used, with sows in one chamber fed with the control diet (standard gestation diet) while sows in the other chamber were fed with the treatment diet (high heat-increment diet).

Phase 2 – Group-housed Sow Gestation Rooms

For the Phase 2 of the study, two rooms were used with one room was designated as "pre-set" with temperature maintained at 16.5°C (which is the typical set-point applied in sow barns) while the other room as "sow-controlled" with sows allowed to control their own environmental temperature using the operant mechanism developed in Phase 1.

With the exception of temperature, management of the two rooms was identical as much as possible. In the pre-set room, air temperature was set to 16.5°C while the temperature in the sow-controlled room was set at a lower temperature of 8°C to prompt the sows to activate the heat control switch for supplemental heating. At 1 degree below the setpoint (i.e., 7°C), the supplemental room heater was set to run automatically without the need of switch press from the sows. This was done to protect the animals in the room from potentially being exposed to very cold temperatures. In addition a high-heat increment diet (treatment diet in Phase 1 trials) was fed to sows in both rooms at 2.3 kg per day per sow.

RESULTS AND DISCUSSIONS

Phase 1 - Controlled environmental chamber tests

One major component needed to carry out the experiments in this research project was the design and assembly of the operant mechanism. The operant mechanism was configured to control the heating system of the chamber as well as a small radiant heater provided as an immediate feedback reward. When a sow activates the switch, it operates the existing supplementary heating system for the entire room for a specified duration as well as the small radiant heater above the location of the switch. One of the installed timers was configured to prevent sows from successively activating the heaters by deactivating the switch for a period of five minutes after its previous activation, i.e., any switch presses during this five-minute period will not operate the heaters. In order to encourage the sows to use the operant mechanism, the chambers were run at a set-point temperature of 8°C. To be able to do this, cold ambient air from outside the barn was directly drawn and streamed into the chambers.

Actual room temperature at the time when sows activated the operant mechanism was recorded and shown in Figure 1. Most of the time, sows fed with high heat-increment diet activated the operant mechanism at a relatively lower pig level temperature than sows fed with standard gestation diet. Over 3 trials, the average temperature when the operant mechanism was activated by sows fed with high heat-increment diet was 12.5 °C while that in the control chamber was higher at 13.4 °C. This suggests that sows fed with high heat-increment diet could tolerate lower temperature before calling for supplemental heat than sows fed with standard gestation diet.

Phase 2 – Group-housed Sow Gestation Rooms

Figure 2 shows the average air temperature readings at 9 different locations in each room over the 6-week duration of the completed trial. Air temperature in the Pre-set (control) room was uniformly distributed which ranged from 16.4 to 17.0 °C on average (Figure 2A). Set-point temperature in this room was at 16.5 °C, which is the typical set-point for gestation rooms during heating (winter) season. Unlike in the Pre-set room, temperature in the Sow-controlled (treatment) room was relatively variable which ranged from 10.7 to 12.3 °C (Figure 2B). On average, temperature in the Sow-controlled room was about 5 °C colder than the Pre-set room.

The actual temperatures at the instant when sows activated the operant mechanism were also recorded. Throughout the trial, majority of the temperature recorded was between 9 and 12 °C. Moreover, most switch presses were made during daytime and the corresponding average temperature recorded was 9.9 and 9.7 °C during the first and second weeks, respectively. In the succeeding weeks, switch presses occurred when the average temperature at the pig level was about 10.5 to 12 °C. This initial result suggests that the preferred environmental temperature of sows is between 9 and 12 °C, although this has to be confirmed in subsequent trials.

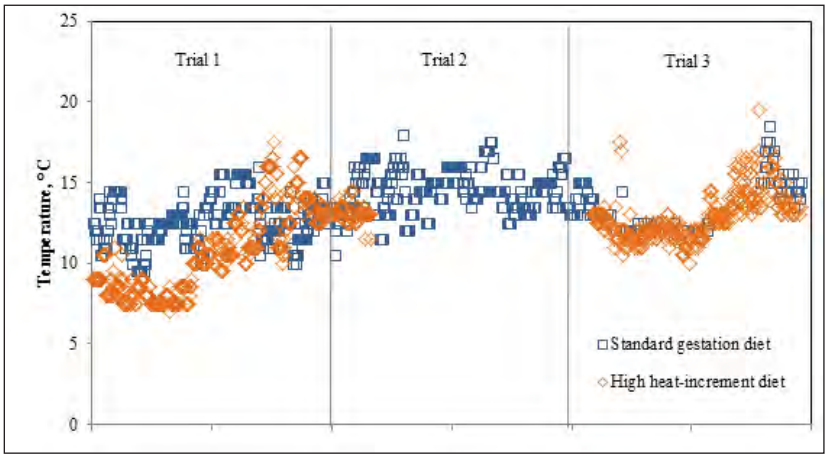


Figure 1. Pig level temperature at the time the operant mechanism was activated by the sows in the two chambers.

Natural gas and electricity consumption

The natural gas consumed for heating and the electricity consumed by the fans, room heater, and lights comprised the energy consumption of the room. Over six weeks, the Pre-set room consumed a total of 4,622.6 m^3 of natural gas for heating; this was about 78% higher than the Sow-controlled room which had a total of 1,011.1 m^3 natural gas consumed. Similarly, the total electricity consumption in the Pre-set room during this 6-week period was about 324.55 kWh while the Sow-controlled room used about 289.81 kWh of electricity to heat and ventilate the room during this period. The considerable difference in the total energy consumption (natural gas and electricity) between the two rooms was mainly due to the difference in temperatures maintained in the rooms during the trial.

CONCLUSIONS

In Phase 1 of this project, results obtained from the controlled-environment chambers have shown that sows fed with high heat-increment diet tended to maintain relatively lower temperatures (12.5 °C on average) in the chamber than those fed with standard gestation diet (13.4 °C). Moreover, the exposure of sows fed with high heat-increment diet to relatively colder temperatures had no considerable effect on their performance and physiological response; results from subsequent trials will be analyzed to confirm the overall effect of this temperature management strategy on sow physiology and overall performance.

In gestation room trials (Phase 2), preliminary results have shown that sows could tolerate temperature as low as 9 °C, which is significantly lower than the set-point typically maintained in gestation barns (i.e., 16.5 °C). Furthermore, it was confirmed that maintaining gestation rooms at lower environmental temperature could result in considerable reduction in energy consumption (as much as 78%) for heating and ventilation. However, the overall effect of this treatment approach on sow behaviour, physiology and overall performance is still to be assessed from the data collected in the subsequent trials done in this study.

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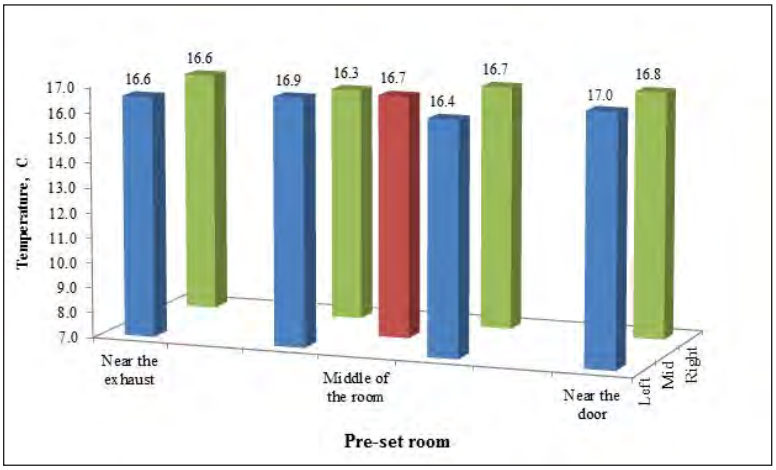
A. Pre-set Room



B. Sow Controlled Room

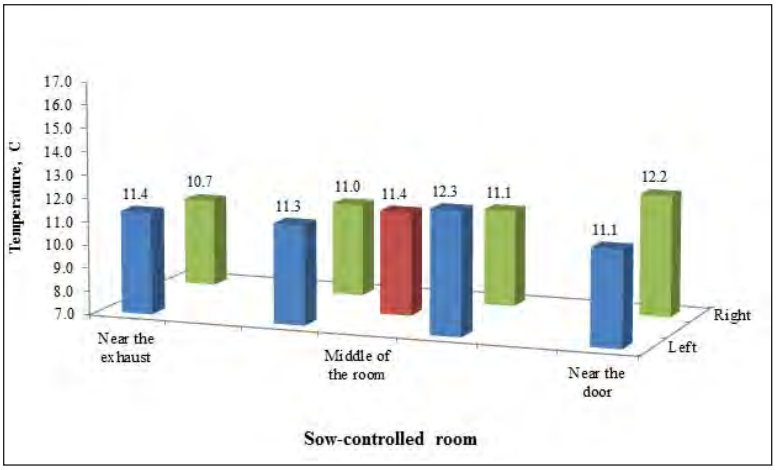


Figure 2. Average air temperature measured at various locations in the Pre-set room (A) and the Sow-controlled room (B) over 6 weeks of continuous monitoring.