Title: Modeling Conductive Heat Transfer Through and Around Grow-Finish Pigs - **NPB # 16-056**

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Scientific Abstract

As we look to novel temperature control strategies in swine grow-finish facilities, we require updated data on heat loss data for modern genetic pigs. The project objectives were to: (1) Evaluate the postural (resting, standing) effects on heat flux and tissue thermal resistance; (2) Refine existing animal growth models to accommodate conductive heat transfer and activity, for modern pigs; and (3) Develop a monitoring methodology to measure the postural effects of floor tempering in group-housed animals. The long-term goal of this research is to understand the effect of floor temperature control on conductive heat transfer through the skin of the pig, swine performance, and management implications of utilizing this technology.

Heat flux (flow of heat energy per unit area and time) measurements were collected from twelve individually-housed active barrows in the average (±standard deviation) weight ranges of 95.6±15.5 kg and 111±13.9 kg, and referred to as Trials 1 and 2, respectively. Heat flux measurements were collected every minute from the right and left sides and rumps of the pigs over a six hour period during each trial. An overhead video camera system recorded pig behavior and positioning within a pen throughout the trials.

When standing, the average heat flux from the rear of the pigs (124 ± 67 W/m^2) was greater than the heat flux from the sides of the animal (117 ± 60 W/m^2) ($p<0.05$, n=24). A linear regression model (R^2 = 0.3154, n =24) with an intercept of 145 W/m^2, suggests the heat flux decreases 0.265 W/m^2 for each 1 kg increase in pig mass. Fat and thicker skin and muscle tissue provides more resistance to heat flow, thus decreasing the rate of heat flow for a given area. The heat flux measurements were collected from a shaved area, so the variable impact of the pig's coat was not considered.

Tissue resistance is related to both pig mass/size and ambient temperature conditions. An existing model of tissue resistance related tissue resistance to pig mass and ambient temperature, between a maximum at 0ºC and minimum beyond 39ºC. Based on the limited pig mass and ambient temperature conditions of this project between 20ºC and 25ºC, the suggested minimum and maximum tissue resistance values are 0.0015 and 0.014 ºC m^2/W, which are approximately 60% of the tissue resistance estimated from the 1990s. Repeating the

measurements in a broader set of ambient temperature conditions is necessary to further fine-tune tissue resistance models.

Behavior monitoring provides insight into how environment influences positioning and activity, which in turn affects feed conversion. Game cameras are a relatively inexpensive option for picture and/or video collection, for both short and long-term use. Using game cameras with movement detection, we monitored partial areas of group-housed animals over multiple days. Daily patterns in terms of feeder occupancy and number of pigs lying on the solid floor are suitable variables to measure with time lapse or motion detection with appropriate camera positioning.

As animal and environmental models progress, including conduction along with convection and evaporation (planned and unplanned) will add more complexity to heat production and transfer estimates, but will ultimately help us better evaluate an animal’s response to varying environments and management strategies to promote efficient production and animal welfare in all conditions.