# Responses of Piglets to Variable and Constant Wattage Heat Lamps with Clear or Red-Color Radiant Rays

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### Summary and Implication

Piglets from birth to weaning were subjected to heat lamps with a constant output of 175W or a variable output from 175W at birth to 100W by weaning. Each output-type heat lamp had either clear or red-color radiant rays. The effects of the lamp output and color on piglet behavior and performance were evaluated at two air temperatures of 65 (±2)°F and 80 (±2)°F, respectively. The results indicate that the variable-output lamp is more suitable for swine farrowing operation. Compared with the constant-output lamp, the variable-output lamp would yield an annual energy savings of $29 (@$0.10/kWh and 88% of usage) while maintaining the same or somewhat improved piglet performance. The red-color rays showed no advantages over the clear rays with regards to piglet behavior and performance. Air temperature significantly affects heat lamp usage of the piglets. Development and application of an intelligent device to operate heat lamps based on the piglet's need is warranted.

### Introduction

Approximately 35% of the energy in swine farrow-to-finish operations for the North American climates is used in supplemental heat by heat lamps during the period of farrow to weaning (Barber et al., 1989). This percentage translates to an annual energy cost of $99.3 million with heat lamps for the 94 million hogs marketed in the United States.

Infrared heat lamps of 250W had been used as a primary localized heat source to piglets. Our recent study comparing the conventional 250W heat lamps with energy-efficient 175W heat lamp revealed that the lower-wattage lamp not only saves energy (by 30%) but also reduces pre-weaning mortality from 6.2% to 5.0% ($P<0.05$) (Xin et al., 1997). The previous study further revealed that the heat provided by the higher-wattage lamp tended to be excessive, causing uneven distribution of piglets resting under the heat lamps. Although there is no supporting experimental data, it was speculated that the excessive heat could have driven the piglets away from the intended heat source, thereby increasing the likelihood of the piglets being crushed by the sow. According to a recent survey by the U.S. National Animal Health Monitoring system (Tubbs, 1996), a major profit loss for swine production is the pre-weaning piglet mortality (averaging 12 to 15% for the nation) that amounts to about 16 million pigs or $197.3 million per year in potential profits. Of the pre-weaning mortality 48% was from crushing. Thus, an improved microenvironment for piglets that leads to reduced crushing would be desirable.

Although replacing the 250W heat lamp with the 175W heat lamp improves energy efficiency and piglet performance, potential seemed to exist that more energy savings could be achieved by using certain variable heat lamp output. Such a proposal was based on the outcome of gradually decreased heat lamp usage as piglets grow. Furthermore, if a certain color radiant ray is more attractive to the piglets than another, then the use of such color lamp may have a positive effect in reducing crushing-related death losses. However a search of literature found little information on the responses of piglets to light intensity (Rohde Parfet and Gonyou, 1991) or to color rays.

The objectives of this study were to (1) compare the responses of piglets to the constant 175W heat lamp with a heat lamp whose output gradually decreased with piglet age, and (2) compare responses of the piglets to radiant rays of clear or red color that applied to both the constant or variable heat lamps. It was hypothesized that the variable-output heat lamp would be more conducive to swine farrowing operation from the stand points of piglet performance and energy efficiency. Red-color rays were hypothesized to be more attractive to piglets than clear rays. The effects of lamp output and radiant color on piglets were evaluated two ambient temperatures of 65°F and 80°F, respectively.

### Materials and Methods

An environmentally controlled room at the ISU Swine Nutrition and Management Research Center near Ames was equipped with four farrowing crates and measurement instruments (Fig. 1). Each crate received one treatment from a 2x2 factorial design that was formed by the heat lamp output of constant 175W vs. variable from 175 to 100W and the lamp color of clear vs. Red. The farrowing room was maintained at either 65±2°F or 80±2°F with a relative humidity of 50 to 65%.

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**Figure 1. A top view of the experiment farrowing unit.**

The floors of each farrowing crate were made of woven wire, plastic slat, and woven wire covered by black rubber mat, respectively, for the sow (Yorkshire x Landrace), creep and the front end of the crate, i.e., heat lamp area. Two heat lamps were used per crate, suspended 18 in. (45 cm) above the floor. They were turned on one day before the expected farrowing. The heat lamps were initially located in the back of the crates, and relocated to the front of the crates when the piglets reached 2 days of age. The total wattage output per crate was equally divided between the two heat lamps. The variable heat lamp wattage was regulated with a heat lamp rheostat controller (Model F911, Osborne Industries, Osborne, KS), with the starting wattage of 175W and lowered 12.5W every 3 days during the 21-day lactation period.

Heat lamp usage (HLU), defined as the percentage of litter mates using the heat lamp at the time of sampling, was continuously measured with a low-profile, platform loadcell scale (Model 642-A5-50kg-3MP2, Revere Transducers, Cerritos, CA) situated underneath the heated floor in the front of the crate. The emf output of the scale (10 mV/kg/V) was sampled every 10 seconds with a PC-based data logging system (CR10 module, Campbell Scientific, Inc., Logan, UT) and stored as 10-minute averages. The average number of pigs using the heat lamps was determined by dividing the projected piglet body weight into the total weight as recorded by the data-logging system. Each crate also was equipped with a high-speed aperture lens video camera (Panasonic, WV-CP410) used in conjunction with a time-lapse video recorder (Panasonic, AG-6730) to continuously record the locomotive behavior of the piglets.

Four replicates were conducted for each of the heat lamp output, color, and air temperature combinations. The effect of the treatments on the piglet behavior and performance was analyzed by General Linear Model procedure and Duncan's multiple mean comparison using a complete randomized block design (SAS, 1994).

## Results and Discussion

The average HLU, daily gain, pre-weaning mortality, lamp failure rate, and electricity use for the experimental treatments are presented in Table 1. The daily HLU patterns of the piglets from 3 to 20 days of age at 65°F and 80°F room temperatures are shown in Figure 2 for the constant-output heat lamps and in Figure 3 for the variable-output heat lamps. Because heat lamps were located in the back of the farrowing crates during the first 2 days, HLU during this period was not measured by the electronic method.

As can be noted from Table 1, there was no significant difference in HLU between the clear and red heat lamps regardless of the output type or the ambient temperature levels tested. This outcome was in contrast to the original hypothesis that the red-color heat lamps might be more attractive than the clear color to piglets. Hence, it is not advisable to spend extra money on the red-color heat lamps for swine farrowing units.

Because HLU was independent of the lamp colors, pooled averages from both colors were used to determine the daily mean HLU at each room temperature. As shown in Figures 2 and 3, HLU tended to be fairly constant during the first 6 days, especially at the lower room temperature. It then gradually declined with age.

The effects of ambient temperature on HLU were obvious, averaging 52 to 58% for the cool temperature (65°F) and 7 to 10% for the warm temperature (80°F). The outcome of this study parallels that as observed by Xin et al. (1996) for piglets during different production seasons of the year. The results suggest that a device that controls the operation of the heat lamps based on the dynamic need of the piglets, e.g., day vs. night where a substantial change in room temperature exists, would be beneficial from both the energy efficiency and the animal comfort points of view. Also shown in Table 1, the higher room temperature has some suppressing effects on the average daily gain (ADG) of the piglets ($P<0.05$). Moreover, HLU tended to decline more quickly for the constant output than for the variable output (Figures 2 and 3), indicating a better suitability of the variable output for the piglets. Furthermore, piglets subjected to the variable heat lamp had somewhat improved ADG (254 g/day) and lower mortality rate (7.0%) than piglets subjected to the constant heat lamp (247 g/day; 8.4%). However, no statistical significance was detected ($P>0.05$) due to the large variability within the treatments. The relatively high mortality rates in this study were due to the small number of the experimental units (two litters per replicate and a total of eight litters per treatment).

Perhaps the most attractive aspect of using the variable-output heat lamp would be the energy savings of 21% or 0.9 kWh/crate/day compared with its constant-output counterpart. Assuming an annual farrowing operation of 320 days and an electric cost of $0.10/kWh, the annual energy savings would be $29 per crate. At the retail price of roughly $30 per rheostat that can control two crates, the controller can be paid off in 6 months. The variable-output heat lamps also tend to last longer than the constant-output heat lamps, a possible result of less heat load on the filament.

**Acknowledgments**

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Table 1. Average heat lamp use (HLU), daily gain, mortality rate of piglets, lamp failure rate, and electricity use for heat lamps with different output types and radiant colors under warm and cool ambient temperatures. Mean (standard error).

| Heat Lamp Output | Room Temperature | Lamp Color | HLU (%) | ADG (g/day) | Death (%) | Tot. Lamp Failure | Electricity Use (kWh/crt/day) |
|---|---|---|---|---|---|---|---|
| 175~100W | 80±2°F | Red | 10(2) [1] | 229(4) [1] | 10.9(2.0) [1] | 1 | 3.3 |
| | | Clear | 10(2) [1] | 238(12) [1] | 4.5(2.5) [1] | 0 | 3.3 |
| | | Avg./Tot. | 10(1) [b] | 234(6) [b] | 7.7(1.9) [a] | 1 | 3.3 |
| | 65±2°F | Red | 58(4) [1] | 255(16) [1] | 2.5(2.5) [1] | 0 | 3.3 |
| | | Clear | 57(2) [1] | 294(20) [1] | 10.3(4.0) [1] | 0 | 3.3 |
| | | Avg./Tot. | 57(2) [a] | 274(14) [a] | 6.4(2.5) [a] | 0 | 3.3 |
| | Overall | | 34(6) [x] | 254(8) [x] | 7.0(1.6) [x] | 1 | 3.3 [y] |
| 175W | 80±2°F | Red | 6(2) [1] | 232(22) [1] | 6.1(2.0) [1] | 1 | 4.2 |
| | | Clear | 8(3) [1] | 225(20) [1] | 4.5(2.5) [1] | 1 | 4.2 |
| | | Avg./Tot. | 7(2) [b] | 228(14) [b] | 5.2(1.5) [b] | 2 | 4.2 |
| | 65±2°F | Red | 52(4) [1] | 266(9) [1] | 10.5(6.0) [1] | 0 | 4.2 |
| | | Clear | 52(4) [1] | 265(13) [1] | 12.6(5.0) [1] | 0 | 4.2 |
| | | Avg./Tot. | 52(3) [a] | 266(7) [a] | 11.5(3.7) [a] | 0 | 4.2 |
| | Overall | | 30(6) [y] | 247(9) [x] | 8.4(2.2) [x] | 2 | 4.2 [x] |

Column means followed by different superscript numbers within each room temperature or heat lamp output type differ significantly (P<0.05) between the clear and red colors.
Column means with different superscript letters of "a" and "b" within each heat lamp output type differ significantly (P<0.05) between the cool and warm room temperatures.
Column means with different superscript letters of "x" and "y" differ significantly (P<0.05) between the variable output and the constant output.

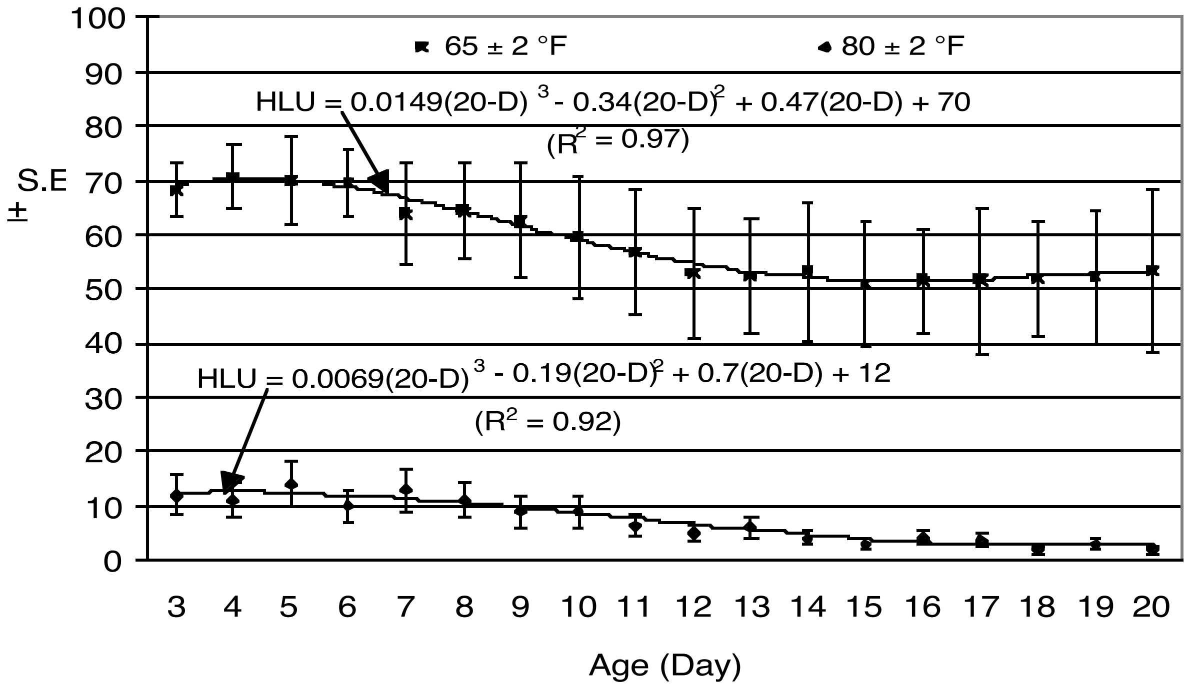


**Figure 2. Daily heat lamp usage of piglets subjected to constant-wattage heat lamp of 175W at 65°F or 80°F air temperature.**

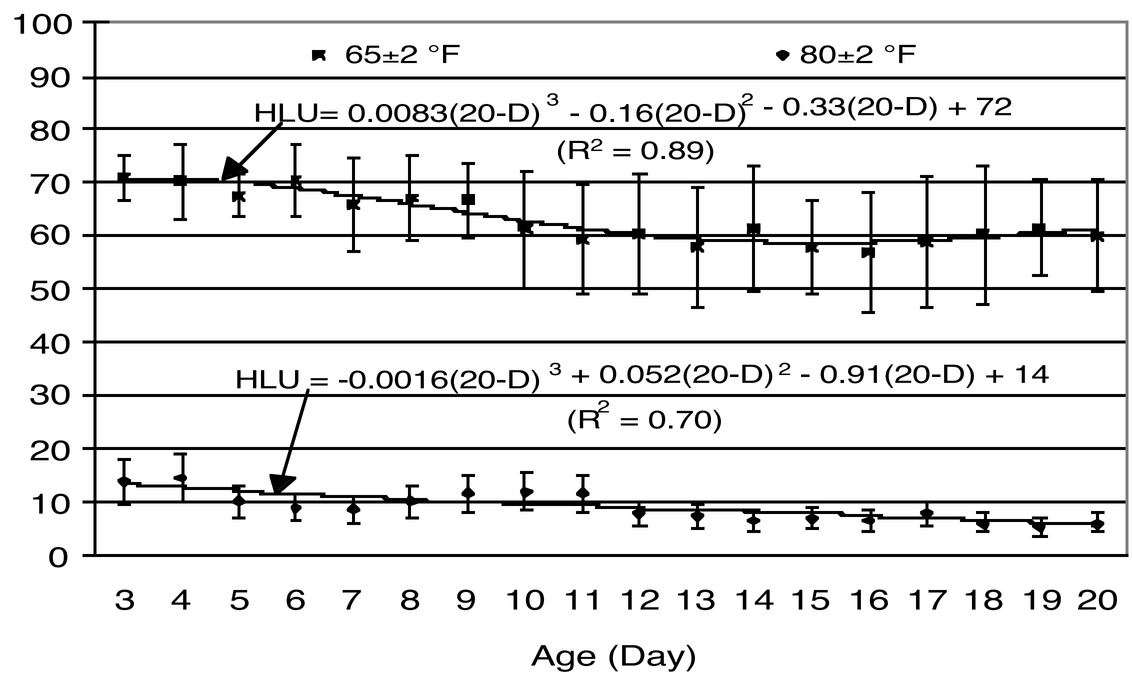


**Figure 3. Daily heat lamp usage of piglets subjected to variable-wattage heat lamp of 175W to 100W (decreasing at 12.5W per 3 days) at 65°F or 80°F air temperature.**