



2950 Niles Road, St. Joseph, MI 49085-9659, USA
269.429.0300 fax 269.429.3852 hq@asabe.org www.asabe.org

An ASABE Meeting Presentation
DOI: <https://doi.org/10.13031/aim.202000142>
Paper Number: 2000142

Effective Environment Temperature comparison of two supplemental heat sources on a commercial sow farm

Benjamin C. Smith^a, Brett C. Ramirez^a, Steven J. Hoff^a, and Laura L. Greiner^b

^aDepartment of Agricultural and Biosystems Engineering, Iowa State University, Ames, IA, USA

^bDepartment of Animal Science, Iowa State University, Ames, IA, USA

**Written for presentation at the
2020 ASABE Annual International Meeting
Sponsored by ASABE
Omaha, Nebraska
July 12–15, 2020**

ABSTRACT. In the US swine industry, one of the largest economic and production losses is pre-weaning mortality (PWM). The vast differences in thermal needs of the sow and piglet create a complex environment that meets this requirement. The objectives of this study was to extend the Effective Environment Temperature (EET) calculation for newborn piglets to encompass the end of lactation at 21 days of age and compare the EET under a Semi-Enclosed Heated Microclimate (SEHM) and a Heat Lamp (HL). Twelve SEHMs were randomly placed in two farrowing rooms and data was collected over six turns from Thermal Environment Sensor Arrays (TESAs) installed under all SEHMs and selected HLs. Each SEHM had individualized heat output control via a dry-bulb temperature feedback and a commercial data acquisition and control (DAQC) system. Utilizing data from Midwest Plan Service on pig dimensions and maximum tissue resistance equations, the diameter and tissue resistance were estimated for piglets from 7 to 21 days of age. Data were analyzed for farrowing turns 2 through 6 as the SEHM was updated following the first turn. On average the SEHM averaged a higher EET compared to the HL (30.5°C and 27.0°C, respectively). The daily average comparison across an eighteen day lactation showed that the SEHM had a consistently higher EET and was closer to the ideal range of EET for piglets through day 7. Future development of the ideal EET range for piglets beyond day 7 of age is needed.

Keywords. *Pre-wean mortality, precision livestock farming, heat lamp*

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Introduction

Pre-weaning mortality (PWM) is one of the major economic and production losses in the swine industry. The drastic difference in the thermal environment between suckling pigs and the sow creates a complex farrowing room environment. A poor thermal environment for the suckling piglets has a direct impact on PWM as it drives the piglets to seek out warmth from the sow's body. Conventional practices to manage the piglet's thermal needs include a heat lamp with the height manually adjusted by farm staff and heat mats with one control unit in a room. These two options still leave the piglet exposed to drafts which are likely to occur in a commercial farrowing room environment. The magnitude of the drafts can have negative consequences to the piglet's thermal environment. The Effective Environment Temperature (EET) is a measure of the dominant modes of heat transfer for a pig at set weight. The objectives of this study were to expand the application range for piglets from day 7 of age to day 21, and compare the EET for SEHM units to HL over the course of a six month trial.

Methods

Site Description and Instrumentation

A 1,000 head commercial sow farm was utilized in this study. For specifics of the farrowing room layout and instrumentation refer to Smith et al. (2019). The Thermal Environment Sensor Array (TESA) utilized included a dry-bulb temperature, black globe temperature, and relative humidity sensor.

Effective Environment Temperature expansion and calculations

The Effective Environment Temperature (EET) was developed by Hoff et al. (1993) for newborn piglets through 7 days of age (Hoff et al., 1993) and accounts for the convective and radiative heat transfer modes of piglets. To calculate EET, the dry-bulb temperature, mean radiant temperature, airspeed, piglet skin and core body temperatures must be known. For simple application across multiple combinations of environmental conditions, piglet skin temperature was assumed constant, as was in the original development.

The expansion of EET to piglets between day 7 and 21 of age was accomplished by estimating the shape dimensions and tissue resistance during this growth phase. The diameter of the piglet was estimated using data from Midwest Plan Service (Midwest Plan Service, 1983). The weight of the piglet was estimated as 5.67 kg (12.5 lb) to determine the diameter as 0.11m (4.5 in.). The tissue resistance was determined using the maximum tissue resistance of a pig for 50 kg and assuming the age at 50 kg for PIC genetics (78 days, PIC, 2014; Usry et al., 1992). A linear regression of age (x-axis) and tissue resistance (y-axis) was used to determine the tissue resistance of the piglet between 7 and 21 days of age. This assumes that the piglet is of average weight and in good health.

The expanded EET was applied to a sub-sample of the SEHM from turns 2 through 6 that had both litters farrow on the same date. The first turn data was not used as the SEHM was updated following that turn. A heat lamp that farrowed on the same date in each room was used for comparison. Data was collected at 1-minute intervals and then a daily average was calculated. An overall average across lactation (18 to 21 days) was calculated for each unit. An SEHM and HL from the same turn was randomly selected for a by day comparison.

Results and Discussion

Overall Averages

The SEHM had a higher average EET (30.5°C) compared to HL (27.0°C) across the five turns of data analyzed (figure 1).

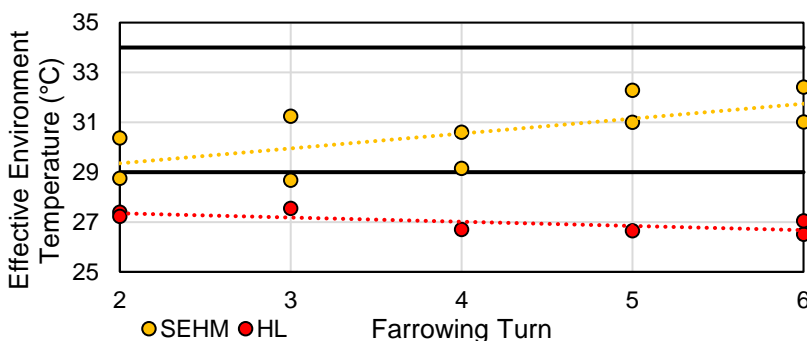


Figure 1. Lactation average EET for both SEHM (orange) and HL (red). The solid black lines represent the ideal EET range for newborn piglets up to 7 days of age.

The daily comparison of an SEHM and HL across the 18 day lactation (figure 2) indicated that the SEHM was able to consistently maintain a higher EET compared to the HL. During this specific lactation turn the SEHM was able to maintain the EET in the ideal range during the first 7 days of lactation.

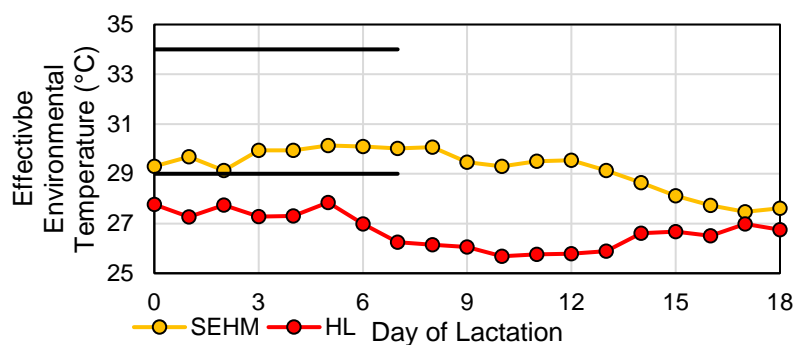


Figure 2 Daily average EET comparison for a SEHM (orange) and a HL (red). The black bars represent the ideal EET for newborn piglets up to 7 days of age.

The limitation of EET in this application is that it was assumed that the HL litters were in still air 0.12 m s^{-1} . Due to the harsh environment adding an airspeed sensor to the TESAs deployed on farm was not possible. If the piglet’s environment was not in still air the EET would be significantly lower as the convective heat loss would then dominate the piglet’s heat loss. The expansion of the EET would be improved with accurate dimension and tissue resistance data for today’s wean pig.

Conclusions

The EET developed by Hoff and et al. (1993) was expanded to account for piglets from 7 to 21 days of age. The expansion would benefit from accurate dimension and tissue resistance data for piglets ranging from 7 to 21 days of age. The application of the EET to quantify the piglet’s environment from a field study indicated that the Semi Enclosed Heated Microclimate (SEHM) was superior at maintaining a higher EET compared to an industry standard heat lamp (HL) treatment.

Acknowledgements

This research was funded by the Center for Industrial Research and Service (CIRAS) and FarrPro, Inc. through the CIRAS Technology Assistance Program (TAP). The authors would like to thank those at Highway Farms including Craig and Cory Christensen (owners) and the farm staff; Scott Dorr (manager), Alex Schmidt (department manager), and Juan Partida (department manager) for their generous and much appreciated assistance. In addition, the authors thank the numerous graduate and undergraduate students that aided with this study and finally Dr. Adina Howe for technical assistance with the data processing.

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