USPCE and NPB Swine Research Experience & Educations (SREE) FINAL RESEARCH GRANT REPORT

Project Title

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Keywords: farrowing, isolation stress, light cycle, photoperiod, sow
Scientific Abstract: The purpose of this study was to investigate the effects of light on farrowing performance in sows. Thirty sows were moved to the farrowing unit at d 110 of gestation and were assigned one of two treatments: 12 h light/dark cycle (Dark) or 24 h light (Light). Treatments were initiated upon entry into the farrowing unit until completion of farrowing was confirmed. For Dark sows, the farrowing crates were structured with light blocking tarps that were lowered at 1900 hr and raised at 0700 hr daily. Video recording devices were installed above all sows and continuous video was recorded from initiation of the treatments until farrowing was complete. Data collected included duration of farrowing, birthing interval, number of stillborn piglets as an indirect measure of dystocia, total born, and liveborn piglets. All statistical analyses were performed using the mixed procedure of SAS, where the experimental unit was individual sow. Funding for this project was provided by the National Pork Checkoff and the U.S. Pork Center of Excellence. Dark sows were more likely to give birth closer to their due date compared to Light sows (1.34 vs. 2.16 ± 0.24 days relative to a 115-day due date, respectively; P = 0.02). Total duration of parturition did not differ between treatments (P = 0.56). Number of liveborn piglets between treatments did not differ (P = 0.68), however the number of stillborn piglets between treatments was different (P = 0.02), where Dark sows had a higher incidence of stillborn piglets compared to Light sows (1.52 vs. 0.65 ± 0.25 stillborn piglets/litter, respectively). The interval between piglets did not differ between treatments (P = 0.93). It is hypothesized that the effects on due date and increased incidence of stillborn piglets was caused by increased stress due to visual isolation in the Dark sows.

Introduction: Producers provide some form of a light source for sows in the farrowing unit in the form of heat lamps and/or overhead lighting. The length of time of light for farrowing sows varies by operation. The light cycle for an animal has been shown to have an impact on preferred time for parturition, as well as wean to estrus interval in various species (Campitelli et al., 1982; Prunier et al., 1994). Today, producers face farrowing complications, many of which can be attributed to farrowing duration (Mainau et al., 2010).

Studies have found light regiments may impact parturition in horses, rats, and swine. These studies found horses prefer to give birth during hours of darkness as opposed to hours of daylight, rats, a nocturnal species, initiate parturition preferentially during times of light, and shortened light regiment resulted in a reduced wean to estrus interval for sows compared to those exposed to a long light regiment (Campitelli et al., 1982; Rowland and Schoot, 1995; Prunier et al., 1994). A study by Mainau et al. (2010) correlated parturition duration with the incidence of stillborn piglets and increased mortality. While light cycles are up to preference of the operation, the potential effects of a consistent day/night cycle may reduce farrowing complications. Though research has been conducted on the effect of photoperiods on the time of day of parturition, little research has been done to show the effects of photoperiods on duration of farrowing and complications involved in farrowing. The purpose of this study was to compare the duration of farrowing, birthing interval, posture and consummatory behaviors, and total born and liveborn piglets of sows exposed to 24 h of light per day with sows exposed to 12 h of light per day. The hypothesis of the present study was that sows exposed to 12 h of light would have a reduced farrowing duration and fewer stillborn piglets.

Objectives: Determine the effects of visual isolation and darkness on farrowing performance in sows.

Materials & Methods: All experimental procedures were approved by the Institutional Animal Care and Use Committee at Illinois State University (#2019-1131).

Experimental Design and Animals

This study was conducted at the Illinois State University farm and consisted of 30 pregnant, crossbred (Yorkshire x Chester White) sows. Sows were randomly allocated to one of two light regiment treatments at d 110 of gestation. Light regiments included 12 h of light/dark per day (Dark) or 24 h of light per day (Light). Sows were equally allotted to light treatment based on sow parity (2.14 ± 0.53 and 2.00 ± 0.65 for Dark and Light, respectively). Sow parity in the present study ranged from 1 to 3 prior to farrowing, where all sows had previously had at least 1 litter prior to the present study. The present study was conducted in two replicates with an equal number of sows per treatment represented in each replicate. Manipulation of light for sows in the Dark treatment was achieved by use of light deprivation tarps that were suspended from the ceiling to the top of the farrowing crate dividers. To ensure for proper ventilation, commercial 10.16 cm drainage tile was placed between the farrowing crate dividers and the light deprivation tarps. Staggering 2.54 cm diameter holes were drilled on either side of the drainage tile for ventilation of the farrowing crate in the Dark sows. For Dark sows, light deprivation tarps were lowered from the ceiling at 1900 hr daily from day 110 of gestation until completion of farrowing. At 0700 hr, the light deprivation tarps were lifted and resuspended from the ceiling. Prior to initiation of the present study, illuminance was measured in a pilot study to determine the effectiveness of light deprivation from the tarps. For this, a digital illuminance meter (AOPUTTRIVER AP-881E) was utilized to measure the amount of light in the center of the sow stall approximately 30.5 cm from the front end of the crate at three heights 30.5, 61.0, and 91.4 cm from the flooring. Illuminance data are summarized in Table 1.

Video cameras (LBV2531 cameras with D841A63B DVR, Lorex Technology, Markham, ON, CA) were installed above each farrowing crate and continuously recorded video from day 110 of gestation until completion of farrowing. Behavior observations were performed as scan samples from video every 5 min by a single, trained observer. Behaviors included posture (standing, sitting, lying, and rolling over), consummatory (eating and drinking), bar chewing, and pawing while standing. All sows received the same light treatment following the completion of parturition. Additionally, video footage was used to measure duration of farrowing, birthing interval, and total born and liveborn piglets was recorded for each sow.

Statistical Analysis

Two repetitions of this study were conducted with a total of 15 sows per treatment represented. However, due to a technical issue, data is missing from one sow in the Dark treatment, thus statistical analysis was performed on 14 Dark treatment sows and 15 Light treatment sows. All variables were analyzed using the Mixed procedure of SAS (v9.4; SAS Inst. Inc., Cary, NC). The main effect in the model included light treatment. Covariates used in the model included parity, replicate, and average litter size prior to this trial, when appropriate. Statistical significance was defined as $P \leq 0.05$.

Results: Farrowing performance results are summarized in Table 2. Parturition day relative to due date was different between treatments (P = 0.020), where Dark treatment sows were more likely to give birth closer to their due date (1.3 ± 0.2 d) when compared to Light treatment sows (2.2 ± 0.2 d). Total duration of parturition and the interval between piglets did not differ between treatments (P ≥ 0.353). Number of liveborn piglets between treatments did not differ (P = 0.681), however the number of stillborn piglets between treatments were different (P = 0.018). Dark treatment sows had an increased incidence of stillborn piglets (1.5 ± 0.2) compared to Light treatment sows (0.7 ± 0.2). Observed behaviors did not differ by light treatment (P ≥ 0.360).

Discussion: The present study reported that sows exposed to 12 hrs of light and darkness per day gave birth closer to their due date than sows exposed to 24 hrs of light. It is predicted this is due to the increased amount of stress the Dark treatment sows experienced. Janssens et al. (1994) reported the restriction of social contact and visual stimulation causes increased levels of cortisol, thus an increased level of stress for sows. A study by Nagel et al. (2019) showed that increased stress levels can cause premature parturition in some livestock species. We hypothesize that the visual isolation association with the dark cycle in Dark sows caused elevated stress resulting in early parturition. Due date in the present study was based on a 115-d gestation length from the time of first insemination. The data from the present study suggests that this herd has an actual gestation length closer to 117 days, which was reduced to 116 days in the Dark sows.

The present study reported that the total duration of parturition and the interval between piglets did not differ between treatments. A study conducted by Oliviero et al. (2008) found that environmental factors such as the type of farrowing enclosure affects the duration of parturition and interval between piglets. Though light manipulation did not occur in that study, the authors reported that the duration of farrowing was longer for sows that gave birth

in crates compared to pens. Additionally, the authors reported that sows that gave birth in crates had an increased interval between piglet births. The authors from that study reported that oxytocin levels were reduced in sows housed in crates compared to pens and suggested that it was caused by increased opioid release due to confinement stress and inactivity. While the present study did not evaluate oxytocin or stress hormones, it is likely that the stress of visual isolation may have interfered with the physiology of oxytocin release during parturition. Our original hypothesis was that Dark treatment sows would have a reduced duration of farrowing and interval between piglets based on the prediction that darkness would have a calming effect due to reduced visual distractions allowing sows to complete farrowing rapidly. However, this was not observed in the present study. This result may be explained by the relatively small number of sows utilized and the high amount of variation in duration of parturition. Conversely, the results of the present study may be a result of the study design that could have unintentionally induced visual isolation stress.

While the number of liveborn piglets between treatments did not differ in the present study, the number of stillborn piglets between treatments were different. Visual isolation has been reported to causes increased levels of cortisol in sows indicating elevated stress (Janssens et al., 1994). Increased stress during parturition increases chances for dystocia (Jacobson et al., 2020). As such, the presumed increased stress levels for the Dark treatment in the present study may explain the increased stillborn piglets, suggesting increased dystocia. Mota-Rojas et al. (2014) reported early parturition results in a higher incidence of stillborn piglets, which is in agreement with the results of the present study.

The present study reported that the duration spent standing, laying down, sitting, eating, and drinking were not affected by light treatment. However, a study by Ruis et al. (2001) disagreed with these findings, where it was reported that social isolation resulted in an increase of these behaviors. Additionally, in the study by Ruis et al. (2001) it was reported that gilts had increased stress levels when introduced to darkness, as well as increased movement. However, the gilts in that study were young, immature females as compared to the mature sows of the present study and were not confined in stalls. These factors may explain why the studies reported dissimilar results. While the results of these studies in regard to behavior differed, both suggest that visual isolation and/or darkness increases stress levels in pigs.

The present study was intended to investigate the effect of lighting on parturition in sows. However, the methods utilized to do so may have unintentionally stimulated a stress response due to visual isolation. Future studies are warranted to investigate both visual isolation and the effect of light duration on farrowing performance in sows.

Student Statement: Throughout my study, I not only learned about photoperiods and farrowing, but also how to design and conduct a research project, as well as write a manuscript for the results. I was able to design my own study from scratch and determine how I wanted to collect data. I then got the chance to learn how to collect the data needed as well as help analyze it. The process of writing a manuscript was also very educational, as I learned about finding other research that proved and/or disproved my findings, and how to take all the information I had and combine it into one cohesive manuscript. This following March, I intend to present my results at the American Society of Animal Sciences Midwest section meeting. This research opportunity will help me exponentially when I am applying to grad school within the next year. Upon the completion of my degree, I intend to go on to get a master's degree, so already having experience designing and conducting research, as well as writing up my results will greatly help me with the completion of my future degree. I also currently hope to earn a doctorate following my master's, so again, this experience will help me with all my future endeavors in research.

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Table 1 Illuminance in farrowing crates with and without light deprivation tarps

	Height from flooring[2]			
Light Treatment[1]	30.48 cm	60.96 cm	91.44 cm	SD
Tarp Up, lux	48.14	58.02	74.32	14.45
Tarp Down, lux	58.31	66.16	89.82	9.89
Dark Treatment[1]				
Tarp Up, lux	31.93	45.99	51.87	7.31
Tarp Down, lux	0.12	0.13	0.22	0.06

[1] Light treatments included 24 h of light per day (Light) and 12 h light/dark per day (Dark)

[2] Illuminance was measured approximately 30.38 cm from the front of the crate in the center of the sow stall at three heights from the flooring (30.48, 60.96, and 91.44 cm). Illuminance was measured in 8 farrowing crates per treatment and data are presented as means.

Table 2 Effect of light treatment on farrowing performance

	Treatments[1]			
Measurement	Light	Dark	SE	P value
Parturition relative to due date[2], d	2.2	1.3	0.2	0.020
Farrowing Start Time, hr:min	13:22	13:40	1:49	0.906
Duration of Farrowing, min	312.7	251.9	46.5	0.353
Birthing interval between piglets	24.3	21.1	3.9	0.557
Total born, n	12.7	13.3	0.5	0.459
Liveborn, n	11.7	11.4	0.6	0.681
Stillborn, n	0.7	1.5	0.2	0.018
Mummified Piglets, n	0.3	0.4	0.2	0.932

[1] Light treatments included 24 h of light per day (Light) and 12 h light/dark per day (Dark)

[2]Sow due date was based on a 115-day gestation length from the date of first insemination and parturition day relative to due date was the deviation from the expected due date.