

Optimizing temperature requirements of pigs to reduce energy use in swine production

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SUMMARY

The overarching goal of this research project is to investigate the optimum environmental temperature requirements of sows and grower-finisher pigs to reduce energy costs and greenhouse gases while maintaining their long-term overall productivity and performance. The project consists of four phases; 1) group-housed gestating sows will be kept for 6 weeks either at 16.5°C

(current recommended set-point) or 8°C (preferred temperature determined in a previous study);

- 2) determine the preferred environmental temperature of grower-finisher pigs, using the operant mechanism and experimental protocols developed in the previous sow study;
- 3) grow-finish pigs will be kept for 6 weeks at either the

current recommended set-point temperature, or the preferred temperature determined in phase 2;
4) assessment of environmental (carbon) footprint, cost analysis and development of recommendations for practical application of the optimized temperature management in commercial barns.

INTRODUCTION

Rising cost of energy has caused financial hardship for many producers, with energy costs for a typical 500 sow farrow to finish pig production unit in Saskatchewan estimated to be ~\$6.70 per pig sold. Heating costs are a substantial part of the total energy costs, so reducing temperature set-points in the barn to reduce how often the heater is running would help reduce energy costs.

A previous research project showed that group-housed sows could tolerate temperatures up to 8°C lower than the typical set-point (16.5°C) currently maintained in most gestation barns,

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without compromising the welfare and productivity of the animals. However, the impact of raising sows at this lower temperature on their long-term reproductive performance still needs to be evaluated in order to fully assess the economic benefits of adopting this technology across the industry. Presently, no study has been conducted yet on the feasibility of a similar temperature set-point reduction for grower-finisher pigs. Thus, this project has been conceptualized to fill this gap by conducting a series of experiments to validate and update the current industry recommendations on temperature set-points for grower-finisher pigs and to assess the impact on energy costs and overall pig production performance.

EXPERIMENTAL PROCEDURES

Phase 1: Building upon the findings from the previous project, the goal of this phase is to implement the preferred temperature set-point determined from the previous study in actual sow gestation rooms to assess the impact on energy consumption and the long-term reproductive performance of the sows under conditions that represent actual commercial sow barns. Two identical sow rooms at the PSC pig production barn configured for group housing system will be used. One room will be designated as Control with temperature maintained at 16.5 °C (which is the typical set-point currently applied in commercial sow gestation barns) while the other room designated as Treatment will have temperature maintained at the sows' preferred temperature determined from the previous study (8 °C). A total of 3 sow trials will be conducted, with each room housing 45 sows per trial. Each trial will last for 6 weeks.

Phase 2: The aim of this phase is to determine the preferred environmental temperature of grower-finisher pigs, using the operant mechanism and experimental protocols developed in the previous ADF study. Two fully instrumented, controlled-environment chambers at the Prairie Swine Centre (PSC) barn facility will be used. To train the grower-finisher pigs to control their own environmental temperature, the developed operant mechanism will be installed in each chamber. The mechanism is configured to allow the pigs access to a switch that controls the heating system of the chamber as well as a small radiant heater which provided 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) will also be installed close to the real switch to distinguish between deliberate behavior by the pigs to control the room temperature and random interaction with the mechanism. As proven in the previous ADF study, this set-up will allow the pigs to demonstrate their preferred environmental temperature by enabling them to control the operation of the heating and ventilation equipment installed in the room. A total of 5 replicate trials will be carried out in the environmental chambers during winter months, with each chamber housing 5 grower-finisher pigs. The duration of each replicate trial is 3 weeks with the first week dedicated to allowing pigs to acclimatize to the chamber and to learn to use the operant mechanism, while the remaining 2 weeks is designated for data collection.

Phase 3: After the preferred environmental temperature of the grower-finisher pigs is established from the previous phase, the goal of this phase is to implement the preferred environmental temperature in actual grow-finish rooms to assess the impact on energy consumption and the pigs' performance under actual

commercial barn conditions. Two identical grow-finish rooms at the PSC barn will be used, one room will be designated as "Pre-set" with temperature maintained at the typical set-point applied in grow-finish barns using a typical controller, while the other room designated as Treatment will have temperature maintained at the pigs' preferred temperature determined from phase 2. A total of 3 trials will be conducted, with each room housing 100 pigs per trial. Each trial will last for 6 weeks.

Phase 4: Following the actual in-barn experiments, an environmental footprint assessment will be performed using a sustainability assessment tool developed in a related study to determine the resulting carbon footprint from the application of the preferred temperature set-points in gestation and grow-finish barns. In addition, a feasibility analysis will be conducted to determine the costs and requirements for the proper implementation of the optimized temperature management approach in a typical commercial swine production facility. The data collected from this study, together with the information on all the expenditures and costs incurred during actual in-barn implementation including the purchase of materials and equipment, and labour and operating costs, will be used in the economic analysis. Recommendations for practical application of the optimized temperature management in commercial barns will also be developed.

RESULTS

Phase 1 result: 2nd sow trial

Phase 1 trials are currently underway. Some of the measured parameters from the first trial conducted from January 21 to March 3, 2025, are presented below.

A. Room temperature

Figure 1 illustrates the average air temperature across various spatial locations within each room. In the Control room with set point maintained at 16.5 °C (which is typical for commercial

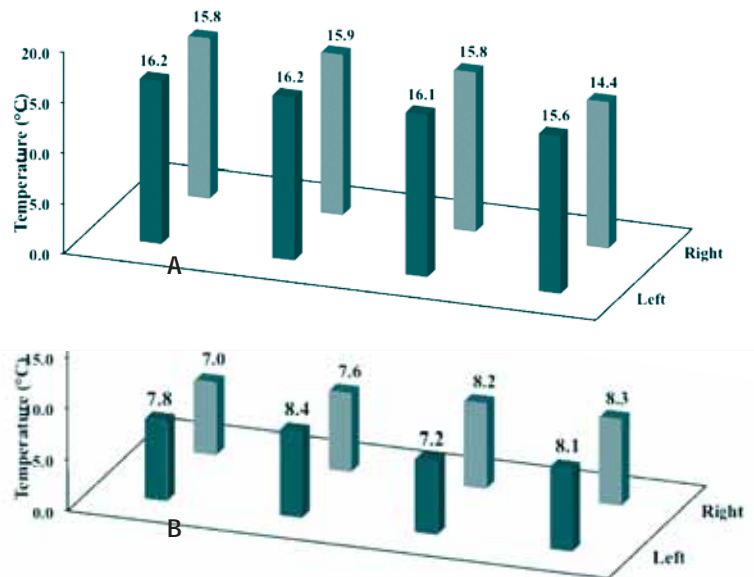


Figure 1. Average air temperature measured at various sampling locations in the Control (A) and Treatment (B) rooms (n = 5,387 to 5,590 temperature readings).

gestation barns), the measured air temperature ranged between 14.4 and 16.2 °C over the duration of the trial. In comparison, the Treatment room (with temperature set-point maintained at 8 °C, which was determined as the sow's preferred temperature based on previous study) exhibited air temperatures ranging from 7.0 to 8.4 °C.

B. Relative humidity

Figure 2 shows the average relative humidity (RH) in both rooms over the duration of the completed trial. The RH values in the Control room ranged between 55.3 to 56.9% and had an average of 55.4 ± 1.4%. On the other hand, the Treatment room had an average RH of 59.5 ± 1.5% and ranged from 57.8 to 61.3%. Both rooms showed RH levels within the recommended range for swine barns, which is between 50 to 65%.

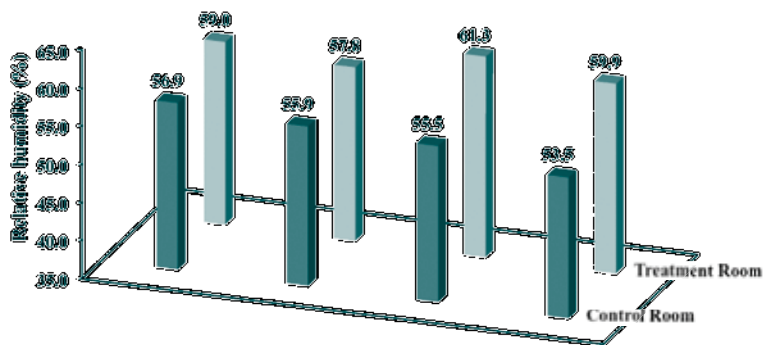


Figure 2. Average relative humidity measured at the occupied space of the sows in the control and treatments rooms over the duration of the trial (n = 5,207 to 5,208 RH readings)

C. Energy consumption (electricity and natural gas)

The electrical energy usage in each room included electricity consumption by the ventilation fans, furnace motor, and room lighting, while the natural gas utilized by the furnace for room heating during the experiment was also monitored (Table 2). The overall electrical energy reading for the Control room was measured at 95.5 kWhr while the Treatment room recorded a total reading of 56.08 kWhr. The total gas energy consumption, with the Treatment room recording 11,078 kJ of gas, while the Control room has a total gas consumption of 23,000 kJ. This is equivalent to an almost 52% reduction in energy consumption. The variance in energy usage (electricity and natural gas) was primarily due to the temperature difference between the two rooms. The Control room needed more energy to keep the room at 16.5 °C throughout the trial while the Treatment room was maintained at 8 °C.

Table 1. Total energy consumption measured from the Control and Treatment rooms during the first trial.

Electricity consumption, kWhr		Natural gas consumption, kJ	
Control room	Treatment room	Control room	Treatment room
95.5	56.08	23,000	11,078

D. Growth performance

Table 2 shows the average daily gain (ADG) of sows. No difference was observed in the ADG of sows in the Control (0.27 ± 0.22 kg/day) and Treatment (0.10 ± 0.20 kg/day) rooms during the first trial indicating that sows were able to sustain their weight gain even at relatively lower temperatures without requiring additional feed.

Table 2. Average daily gain of sows in the Control and Treatment room

Sow performance parameter	Control room	Treatment room
Average daily gain*, kg/day	0.27 ± 0.22	0.10 ± 0.20

*ADG represents average from 32 – 34 sows per room

E. Physiology

Table 3 shows that sows in the Control room exhibited an average rectal temperature of 37.3 ± 0.6 °C, while those in the Treatment room had an average rectal temperature of 37.2 ± 0.5 °C. This suggests that despite the colder environment, the sows in the treatment room maintained body temperature similarly to those in the control. On the other hand, slightly lower blood thyroxine levels were observed in the Treatment room (64.9 ± 8.1 nmol/L) compared to the Control room (69.4 ± 10.4 nmol/L).

Table 3. Average rectal temperature and blood thyroxine levels of sows in the Control and Treatment rooms

Sow physiological parameters*	Control room	Treatment room
Rectal temperature, °C	37.3 ± 0.6	37.2 ± 0.5
Blood thyroxine level, nmol/L	69.4 ± 10.4	64.9 ± 8.1

*Rectal temperature and blood thyroxine level represents average from 12 focal sows per room

Phase 2 results: Grower-finisher pigs' trial (1st and 2nd replicate)

Phase 2 trials are currently underway. Some of the measured parameters from the first and second replicate conducted from February 7 to 28, 2025, are presented below.

A. Chamber temperature and activations of operant mechanism

The temperature at the pig level, along with the corresponding switch activations by sows and the operation of both the radiant and room supplementary heaters in both chambers, was continuously monitored throughout the trial. Profile temperature and switch and heater activations during the 1st and 2nd replicates is presented in Figure 4. During the 1st replicate, the chamber recorded an average room air temperature of 11.8 ± 1.3 °C while 2nd replicate had an average of 10.2 ± 2.0 °C.

As shown in Figure 4, the pigs demonstrated considerable engagement with the operant mechanism, as indicated by the high frequency of activations. Notably, a substantial number of activations were also recorded from the dummy switches, suggesting exploratory behavior or curiosity in addition to intentional use.

(Optimizing temperature...cont'd on page 7)



Promoting play behaviour in grow-finish pigs

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APPLICATION FOR PRODUCERS

Consider providing a variety of novel enrichments intermittently to growing pigs to provide opportunities for pigs to play. This play behaviour is a rewarding experience for pigs that can enhance their quality of life through improved welfare.

commercial setting. The secondary aim was to determine whether play was positive which was explored through linking play opportunities with behavioural indicators. The effect of play on physiological and production (growth) measures was also explored.

SUMMARY

Play behaviour has been associated with excitement and fun, suggesting that playing animals experience pleasurable states. To determine if the provision of play opportunities could enhance the quality of life of pigs, this study investigated if play can be promoted and sustained in pigs beyond the natural period of expression (2-6 weeks of age) in a commercial setting. Growing pigs (n = 288, 10 weeks of age), housed in standard partly slatted pens, were assigned to either a Control treatment with no play interventions (CON, 1 m²/pig); or to a Novelty (NOV) or Play pen (PLP) treatments, with play promotion between 10 and 21 weeks delivered through play sessions 3x/week. Play treatments received the intermittent provision of destructible novel objects provided either in the home pen (NOV, 1 m²/pig), or in an enclosed 'play pen' area providing extra space (PLP, 2.9 m²/pig). The results showed that play was successfully promoted and sustained until the finishing period and equally expressed regardless of extra space. Pigs with play opportunities expressed indicators that play is a rewarding and motivating behaviour and could enhance the quality of life of farmed pigs when supported.

INTRODUCTION

To improve the quality of life of farmed pigs, negative welfare states should be replaced or balanced with joyful activity, for example opportunities for play, which may provide positive affective engagement for animals and support positive welfare states. In pigs, play is naturally expressed between 2 and 6 weeks of age and declines with age.

The main objective was to investigate whether play can be promoted and sustained beyond the natural window of expression, in grow-finish pigs (10–21 weeks of age) in a

“Pigs in play pen treatment and novelty treatment played more frequently and for a longer duration of time across weeks compared to control.”

A total of 288 growing pigs (~35 kg) were housed in standard partly slatted pens (8 pigs/pen, 1 m²/pig) with point-source enrichment consisting of an untreated spruce lumber piece with a rope attached to a single chain. Pigs were assigned to one of three treatments from 10 to 21 weeks of age: i) Control (CON), ii) Novelty (NOV), and iii) Play pen (PLP). The Control treatment did not receive play interventions. Play was promoted in NOV and PLP treatments, collectively called play treatments, during intermittent play sessions that consisted of novel objects given in the home pen (NOV) or within a specific play pen (PLP, 2.9 m²/pig, solid concrete floor). Treatment pens (NOV and PLP) received a total of six, 30-minute play sessions, provided three days/week (Monday, Wednesday, Friday), two times/day (10 am/1 pm). Novel objects were rotated on a weekly schedule to reduce habituation and consisted of six items (cardboard, straw, plain popcorn, cotton rope, lumber, burlap) provided in different combinations. For each play session, the experimenter first distributed novel objects in the play pen, then entered the room and gave the novel objects to NOV treatment pens and then released PLP treatment pigs into the play pens, one group at a time. PLP pigs could not re-enter the room and their home pen during the play session. After 30 min, PLP treatment pigs were

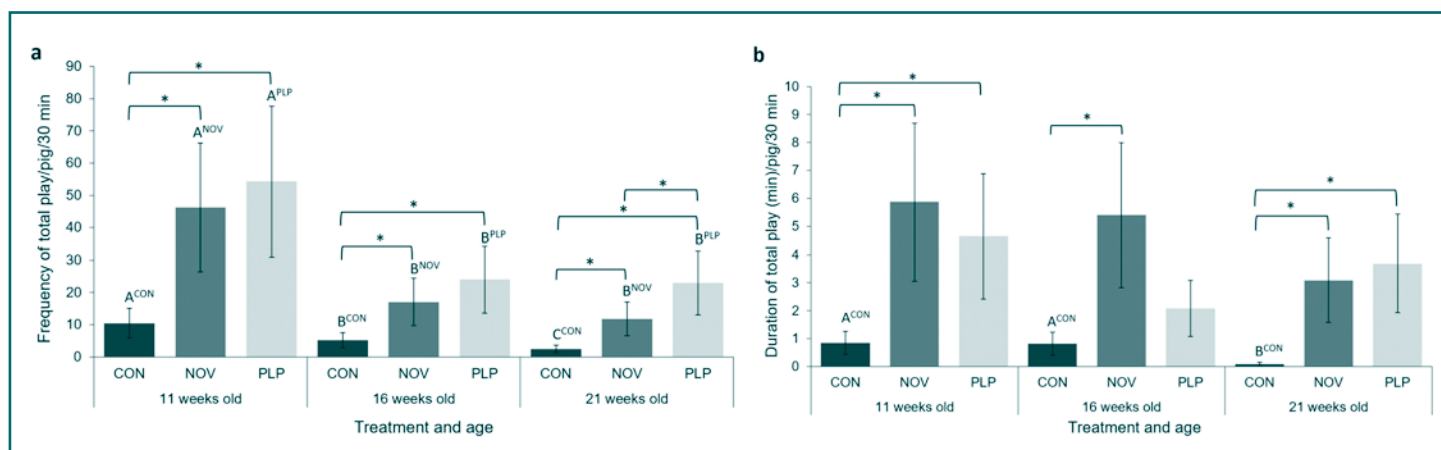


Figure 1. Frequency (a) and duration (min, b) of total play behaviour (locomotor, social, and object play) per pig ($n = 159$) in Control (CON), Novelty (NOV), and Play pen (PLP) treatments (12 pens/treatment) in the active phase (30-min play session) at the age of 11, 16 and 21 weeks. Predicted means and lower and upper 95% confidence intervals (CIs) are presented. * The asterisks (*) above the bars denote significant differences between treatments within week and the letters above the bars (A, B, C) denote significant differences within treatment across weeks. For clarity, where group letter above the bar was omitted,

there was no significant difference. The threshold of significance for multiple comparisons (Bonferroni correction) for differences between treatments within week and within treatment across weeks (18 comparisons) was $p \leq 0.003$. Figure published in Steinerová, K., Parker, S. E., Brown, J. A., & Seddon, Y. M. (2024). The promotion of play behaviour in grow-finish pigs: The relationship between behaviours indicating positive experience and physiological measures. *Applied Animal Behaviour Science*, 275, 106263. <https://doi.org/10.1016/j.applanim.2024.106263>.

returned to their home pen, one group at a time, and the remains of the novel objects were cleared from the home pens of NOV treatment. The play pens were only cleaned after the PM play session of the day.

Two gilts and two barrows were randomly selected from each pen (144 pigs) for behavioural observations at 4 phases: 1) a pre-play phase (PRE) recorded on a day without play sessions; 2) an anticipatory phase (ANT) of two minutes recorded before an AM play session, where anticipatory behaviour was stimulated with an experimenter walking back and forth in the room (conditioned stimulus) before the play session (unconditioned stimulus) commenced; 3) an active phase (ACT) capturing the AM play session; 4) a post-play phase (POST) starting one hour after completion of the PM play session lasting for 30 min. Saliva was sampled from the same pigs to determine the physiological response to play, with cortisol and alpha-amylase. The body weight of all pigs was measured at the start and end of the trial to calculate average daily gain (ADG).

Table 1. Frequency of ear and tail postures per pig ($n = 159$) in Control (CON), Novelty (NOV) and Play pen (PLP) treatments (12 pens/treatment) in the active phase (30-min play session) across weeks. Predicted means and lower and upper 95% confidence intervals (CIs) are presented.

Posture	CON		NOV		PLP	
	Mean	95% CIs	Mean	95% CIs	Mean	95% CIs
Ears relaxed						
Week 11	0.27a	0.04–0.50	3.52b	1.49–5.54	2.82b	1.20–4.43
Week 16	0.54	0.22–0.86	1.94	0.93–2.96	2.22	1.09–3.34
Week 21	0.58a	0.24–0.92	1.70ab	0.80–2.60	2.96b	1.48–4.44
Ears forward						
	2.43a	2.07–2.80	3.01ab	2.57–3.46	3.28b	2.81–3.75
Ears backward						
Barrows	2.33a	1.66–2.99	1.29a	0.86–1.72	0.29b	0.14–0.45
Gilts	2.49a	1.75–3.23	1.53ab	1.02–2.04	0.74b	0.44–1.03
Ears mixed						
	0.17	0.08–0.25	0.19	0.09–0.30	0.13	0.05–0.21
Tail wagging						
Week 11	0.44	-0.09–0.99	1.33	-0.15–2.82	0.87	-0.08–1.81
Week 16	0.07	-0.02–0.16	0.56	0.13–0.99	1.22	0.34–2.10
Week 21	0.09	0.02–0.20	0.35	0.05–0.65	0.67	0.16–1.17
Tail motionless						
	4.62a	4.18–5.06	5.75b	5.22–6.27	4.26ac	2.83–4.68

*Different superscript letters denote significant differences between treatments within week or sex (a, b, c; bolded). No significant differences within treatment across weeks or sexes found. The threshold of significance for multiple comparisons (Bonferroni correction) for difference between treatments (ears forward/mixed, tail motionless; 3 comparisons) was $p \leq 0.02$, between treatments within week and within treatment across weeks (ears relaxed, tail wagging; 18 comparisons) was $p \leq 0.003$, between treatments within sex and within treatment across sexes (ears backward, 9 comparisons) was $p \leq 0.006$.

(Promoting play behaviour...cont'd on page 6)

RESULTS AND DISCUSSION

Promotion and sustainability of play behaviour (Figure 1): Pigs in PLP and NOV played more frequently ($p = 0.002$) and for a longer duration of time ($p < 0.001$) across weeks compared to CON. NOV and PLP did not differ in play frequency and duration, except for week 21 when PLP played more frequently. In all treatments, the greatest frequency of total play occurred at 11 weeks, decreasing in weeks 16 and 21 in CON, while NOV and PLP sustained the level of play between weeks 16 and 21. Object play was more frequent in pigs with play opportunities than CON pigs across all weeks. Compared to CON, NOV played for a greater duration of time in all weeks while PLP played longer in weeks 11 and 21, but not 16.

Behaviours indicating positive experience (Table 1): Play treatments expressed more anticipatory behaviour and behavioural indicators associated with a positive experience (ears relaxed and forward, tail wagging, barks) compared to CON.

Agonistic behaviours (Figure 2): In the ACT phase, PLP pigs performed the least agonistic behaviour, while NOV was intermediate, and CON had the highest frequency. In CON, agonistic behaviour increased in the ACT compared to the PRE phase, while in PLP aggression decreased in the ACT phase compared to the PRE and POST phases. Agonistic behaviour in NOV did not differ across phases (Figure 2a). Play treatments interacted with objects for a greater amount of time during the

ACT phase compared to other phases, while CON did not differ across any phase (Figure 2b).

Physiological response to play – measures of cortisol, alpha-amylase, and ADG: Cortisol was elevated only in NOV compared to CON after the play session, but alpha-amylase and growth rate did not differ among treatments.

IMPLICATIONS

The present study demonstrated that play behaviour can be promoted and sustained in grow-finish pigs in a commercial setting, regardless of whether extra space is available, as long as pigs are intermittently provided with novel enrichment. The fact that play was increased in the standard production pen with 1 m²/124 kg pig, similar space allowance to the minimal space allowance of 0.95 m²/100 kg pig in the Pig Code of Practice, indicates that promotion of play is a promising proof of concept to improve welfare of farmed pigs. The findings indicate that play is a highly positive behaviour for pigs, fostering positive welfare states. Incorporating this concept into husbandry routines and utilizing lower cost materials for novel objects like cardboard can minimize extra labor and costs, as would automating the delivery of materials, supporting its application on commercial farms. These findings hold significant implications for supporting the development of animal-friendly husbandry systems and for improving the quality of life of intensively farmed pigs.

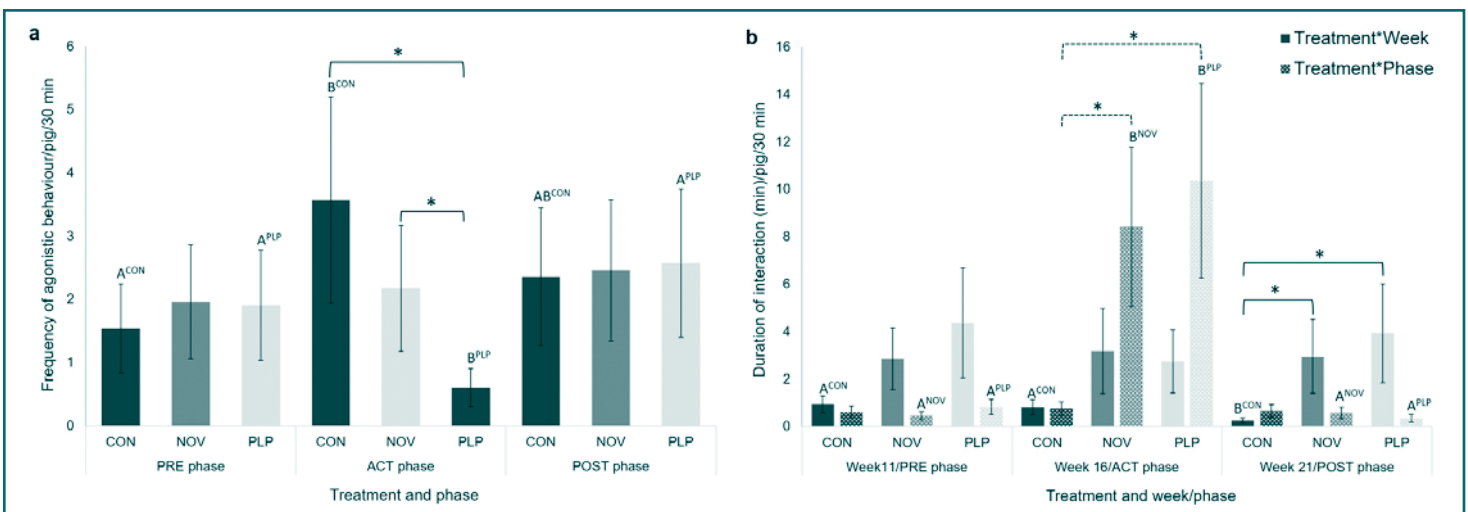


Figure 2. Frequency of agonistic behaviour across phases (PRE-play 30-min, ACT: active 30-min play session, POST-play 30-min, a), and duration (min) of interaction behaviour across phases and weeks 11, 16 and 21 (b) per pig ($n = 159$) in Control (CON), Novelty (NOV) and Play pen (PLP) treatments (12 pens/treatment). Predicted means and lower and upper 95% confidence intervals (CIs) are presented. * The asterisks (*) above the bars denote significant differences between treatments within phase or week and the letters above the bars (A, B, C) denote significant differences within treatment across phases or weeks. For clarity, where group letter above the bar was

omitted, there was no significant difference. The threshold of significance for multiple comparisons (Bonferroni correction) for differences between treatments within phase or week and within treatment across phases or weeks (18 comparisons) was $p \leq 0.003$. Figure published in Steinerová, K., Parker, S. E., Brown, J. A., & Seddon, Y. M. (2024). The promotion of play behaviour in grow-finish pigs: The relationship between behaviours indicating positive experience and physiological measures. *Applied Animal Behaviour Science*, 275, 106263. <https://doi.org/10.1016/j.applanim.2024.106263>.



Table 4. Average daily gain (ADG) of the grower-finisher pigs during the two-replicate trial

Pigs' performance parameter*	1st replicate	2nd replicate
Average daily gain*, kg/day	1.19 ± 0.11	1.18 ± 0.06

*ADG represents average from 5 grower-finisher pigs at each replicate

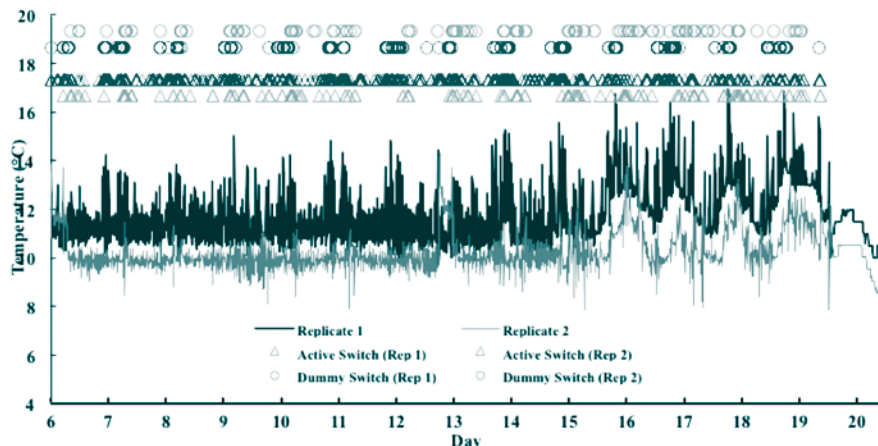


Figure 4. Pig level temperature and switch activation throughout the 1st and 2nd replicate trial in the controlled environment chambers

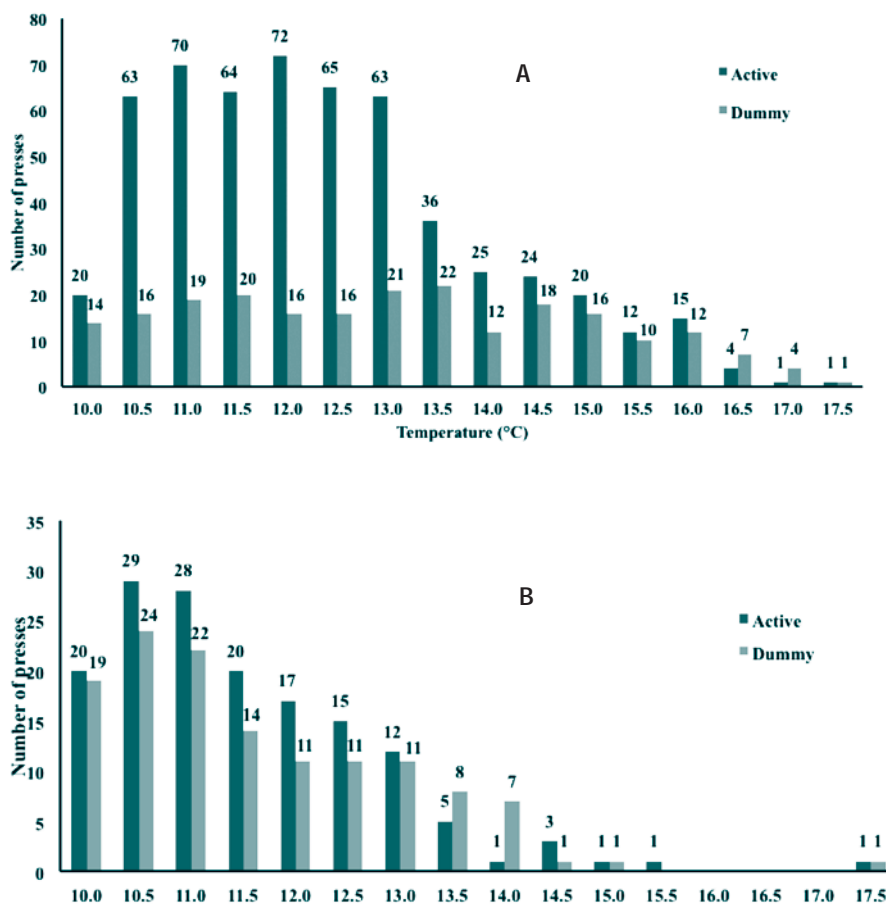


Figure 5 presents the actual room temperature at the times when pigs activated the operant mechanism. In the 1st replicate, a total of 555 activations were recorded for the active switch, while the dummy switch was pressed 224 times. In the 2nd replicate, although the total number of activations was lower, pigs still engaged more with the active switch (153 presses) compared to the dummy switch (130 presses). This pattern suggests a clear preference for the operant switch over the dummy switch. Furthermore, the data indicates that pigs were most engaged with the operant system when the room temperature ranged between 10°C and 13.5°C.

B. Grower-finisher pigs' performance and physiological response

Table 4 presents the performance and physiological responses of grower-finisher pigs across both replicates. Performance was evaluated using average daily gain (ADG), while physiological responses were assessed through blood thyroxine levels and rectal temperature measurements. These indicators provide valuable insights into the pigs' ability to adapt to environmental conditions, highlighting potential physiological adjustments in response to temperature variations. Throughout the trial, the average daily gain (ADG) of the pigs was recorded at 1.19 ± 0.11 kg/day in the first replicate and 1.18 ± 0.06 kg/day in the second replicate. These values fall within the expected ADG range for a 25 kg grower-finisher pig, indicating that the pigs maintained normal growth rates despite the environmental conditions. This suggests that the lower temperature conditions did not negatively impact their growth performance.

Meanwhile, the physiological responses were assessed through the measurement of the rectal temperature and blood thyroxine levels of the pigs as shown in Table 5. The average rectal temperature of the pigs at the start (37.8 ± 0.3°C) and end (38.1 ± 0.4°C) of the first replicate was closely comparable to the temperatures recorded at the start (37.5 ± 0.5°C) and end (38.5 ± 0.5°C) of the second replicate. This consistency suggests that the pigs maintained stable body temperatures throughout the trial, regardless of the lower temperature conditions. The average thyroxine levels of the pigs increased from 73.5 ± 13.9 nmol/L at the start of the first replicate to 86.7 ± 18.4 nmol/L by the end, indicating a rise in thyroid activity. A similar trend was observed during the second replicate, with thyroxine levels increasing from 73.3 ± 17.8 nmol/L at the start to 87.3 ± 12.4 nmol/L at the end, further indicating a consistent rise in thyroid activity throughout the trial. The increase in thyroid activity suggests that pigs' metabolism adapted to prolonged exposure to cold temperatures.

Figure 5. Number of switch activation of "Active" and "Dummy" switches at specific pig level temperature during the 1st (A) and 2nd (B) replicate

The effect of standard and large pellet creep feed on the performance and blood parameters of weanling pigs

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Take-home messages

- Piglets show equal preference for a large pellet creep (4cm pellet) and crumble starter diet.
- An off-the-shelf high-fibre pellet feed (E17 horse feed) did not improve piglet growth or blood measures.
- Large piglets showed signs of anaemia at weaning compared to smaller littermates.

The benefits of creep feeding have often been debated, with some studies finding benefits in terms of weight gain before weaning or in the nursery while others do not. A recent meta-analysis has settled the debate by synthesizing outcomes from 20 studies and confirming that creep feeding is beneficial in terms of improved growth and also improved gut development (Muro et al, 2023). The review also found that the benefits of creep feeding are increased when it is provided at least 14 days before weaning. Now that the benefits of creep feeding are confirmed, questions remain on what and how best to provide creep, and what effects we can expect.

Key factors influencing creep intake include creep feed type, timing (duration), feeder location and feeder design. Current creep diets are expensive and contain high levels of starch, sugar (to promote digestibility and palatability) and lysine. However, a recent review indicates that these high glycaemic diets cause a surge in insulin, leading to fluid retention and oedema, which can inflate body weight measurement (Van Kempen et al, 2023). This also causes an increase in haematocrit levels after weaning and masks the anaemic condition of fast-growing, newly weaned pigs. It is recommended that diets designed for young pigs should include less carbohydrates and lysine and more fibre to minimise insulin spikes. High fibre ingredients typically contain higher iron levels compared to more protein-concentrated feeds, directly benefiting anaemic piglets (Huang et al., 2017).

In terms of the feed format, studies show that young pigs prefer a large pellet over more finely textured feed (Van den Brand et al, 2014). Hence in this study, off-the-shelf and affordable large pellet diets (high in fibre) were tested and compared to a standard creep diet (Phase 1 nursery diet) to determine which diet piglets prefer. A mixture of standard creep and large pellets was also provided to determine if providing a more varied diet can improve creep consumption. The main objective was to determine if large pellet feed would increase creep consumption and improve piglets' weight gain and blood iron status at weaning.

WHAT WE DID

Pilot study

We first conducted a pilot study to assess piglets' preference for different types of creep. Twelve litters at 2-4 weeks of age were presented two choices of creep feed 3 times a week forming 4 comparison groups (Table 1). Creep was provided in a 33 cm x 22.5 cm steel pan attached to a 70 cm x 44 cm rubber mat to facilitate group feeding and reduce waste (Figure 1). The feeder's location was also balanced with half of the litters having the feeder towards the front of the pen and half towards the back of the pen to determine the optimal location.

Table 1. Pilot study: four comparison groups with 2 diets in each group provided to 2-4 week old pigs to test their preference.

Creep Diet Options		
Comparison	Choice 1	Choice 2
1	Standard creep (meal starter diet based on wheat, soybean meal, whey permeates, corn, and barley)	HHC: Hoffman's Horse Crunchies (medium pellet approximately 1.5cm cubic based on soybean hulls, peas, rice bran, wheat mill run, canola meal, malt sprouts, oat hulls)
2	Standard creep	E17: quest 17% Crunchies (large pellet approximately 4 x 1.5 cm cube based on dehydrated alfalfa, oats, and peas)
3	Standard creep	50% HHC + 50% Standard creep
4	Standard creep	50% E17 + 50% Standard creep

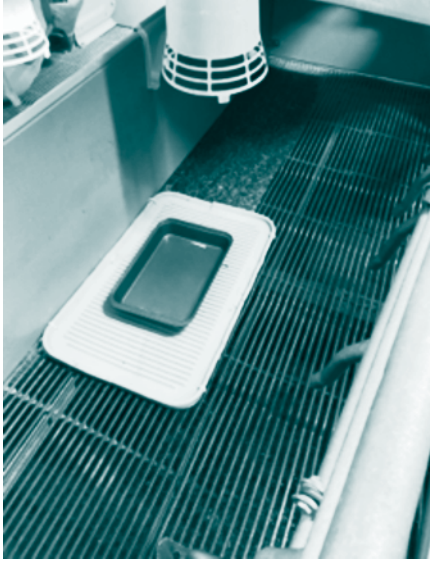


Figure 1. Creep feeder used was a 33 cm x 22.5 cm steel pan attached to a 70 cm x 44 cm rubber mat to facilitate group feeding and reduce waste.

We recorded piglets' latency to interact with creep when it was first delivered and subsequent interactions at 1, 2, 3, 30, 60, 90 and 120 minutes post-delivery. Results from the pilot study showed that E17 pellet and standard creep maintained greater interest than HHC pellets. Therefore, in the main study, these two creep feeds were further investigated (Figure 2). To prevent soiling but still attract the piglets' interaction, the location of the feeder in the main study was placed under the heat lamp in the middle of the pen.

Table 2. Common blood parameters that can indicate signs of anaemia.

Blood parameter (unit)	Defonition	Anaemia indication
RBC (x10 ¹² /L) ³	Red blood cells: Number of RBCs per unit of blood volume	↓
HGB (g/L) ³	Haemoglobin: Concentration of oxygen-carrying protein in RBC	↓
HCT (L/L) ³	Haematocrit: Percentage of blood volume occupied by RBCs	↓
MCV (fL) ³	Mean corpuscular volume: Average size of individual RBCs	↓
RDW (%) ³	Red cell distribution width: Variation in RBC size	↑
Iron (umol/L)	The amount of iron circulating in blood	↓
TIBC (umol/L) ³	Total iron binding capacity: How much iron can potentially bind to transferrin (iron-transport protein)	↑

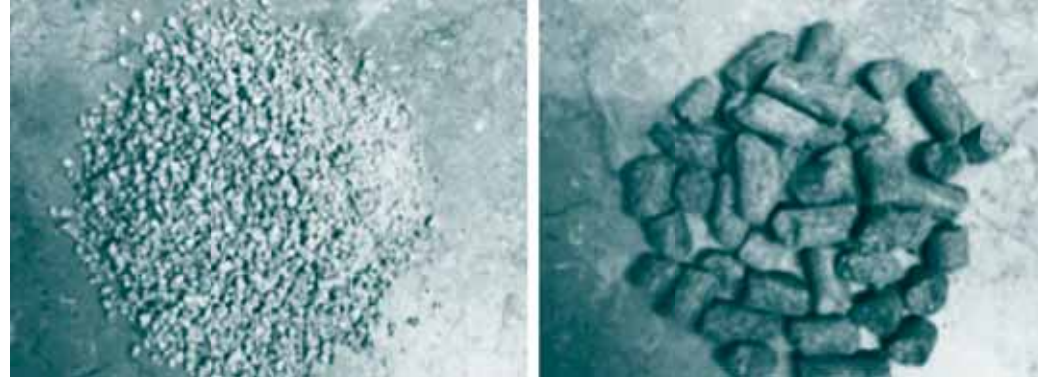


Figure 2. Standard creep (left) and pellet creep E17 (right).

Main study

We used a total of 283 piglets from 21 litters randomly assigned to one of four diets: 1. Standard creep (SC), 2. Pellet creep (PC, E17), 3. A mix of SC and PC (MC), and 4. No creep (Control: NC). Starting at 10d of age, litters were provided with 1400g of their respective diet daily until weaning (D24). At creep introduction on D10 of age, piglets' body weight was equal across treatment groups (SC 2.7±0.5/PC 3.2±0.5/MC 3.2±0.5/NC 3.1±0.7 kg). Each pig was weighed at D10 (creep introduction), D24 (weaning), D28, and D52 (nursery exit). The same behavioural observation as in the pilot study took place at 1, 2, 3, 30 and 60 minutes post-delivery 3 times per week from D13-24. We also recorded how much creep was left before creep was refilled daily and the amount of waste on the feeder mat. At D23, blood samples were collected from one small and large male piglet/litter (n=42) to compare their blood profiles (Table 2).

What we found

Effect of creep feed treatment

No difference in weaning weight or average daily gain was found across the different creep treatments, before or after weaning. Further analysis will be done to compare growth of large vs small piglets as blood results and previous studies indicate that creep consumption varies depending on piglet size. Creep treatment also did not have an effect on piglets' latency to contact, interaction with the creep at any time point or how much creep was left. There was a slightly higher likelihood that the MC piglets had no creep waste.

Piglets receiving pellet diet had higher RDW compared to all other groups (PC: 20.31±0.85 vs NC:17.08±0.85, MC: 19.15±0.85, SC: 17.37±0.85, P=0.02). Significant interactions were also found between creep treatment and piglet size for HGB, HCT and RDW (p<0.05), with iron levels also tending to differ (P=0.08, Table 3). Overall, large pigs on the pellet diet showed the worst blood parameters (low HGB and HCT, high RDW).

Effect of piglet size on blood profiles

Piglet size had a significant effect on all blood measures except RBC count, with large pigs showing signs of anaemia compared to small (p<0.001). Large pigs had iron levels less than half that of small pigs (Table 4). This result confirms previous work indicating that larger pigs are more likely to present with anaemia due to a combination of faster growth, accessing a better producing teat, and potentially eating less creep than smaller pigs.

(The effect of standard... cont'd on page 11)

Table 3. Blood parameters of large (L) and small (S) piglets receiving four different creep feed treatments. Table 2 lists the definitions of all parameters. Treatment: NC = no creep, PC = pelleted creep, MC = mix of pelleted and standard creep, SC = standard creep. Treatment means within a row with a different letter are significantly different. SEM is the standard error of the mean.

	Treatment								Trt x Size P-Value	SEM
	NC		PC		MC		SC			
	L	S	L	S	L	S	L	S		
n										
HGB (g/L)	108ab	122a	92b	124a	114ab	118a	114ab	121a	0.037	6.24
HCT (L/L)	0.35ab	0.39a	0.31b	0.40a	0.37ab	0.38a	0.37ab	0.39a	0.024	0.02
MCV (fL)	58.53	62.8	53.86	63.60	57.78	59.66	59.92	62.37	0.111	1.73
RBC (x1012/L)	5.99	6.17	5.67	6.30	6.44	6.36	6.14	6.18	0.253	0.25
RDW (%)	18.53b	15.75b	24.89a	16.54b	18.82b	19.48ab	18.55b	16.26b	0.009	1.13
Platelets	5.88	5.87	5.95	5.72	5.82	5.90	5.85	5.52	0.574	0.40
Iron (umol/L)	7.40	19.20	6.20	26.60	11.40	15.20	14.00	26.67	0.082	3.40
TIBC (umol/L)	73.12	52.12	103.92	62.32	87.52	78.32	79.17	51.00	0.253	9.36
WBC	2.43	2.60	2.56	2.67	2.41	2.32	2.55	2.50	0.452	0.16

Effect of day of creep provision and time of observation

Piglets took the longest time to approach the creep on D13 compared to D17 to D24. Also, on D20 piglets interacted with the creep more than D13 and D15 (P<0.01, Figure 3). Consequently, we observed that there was less creep left in the feeder on D22 compared to D13 & D15 (P=0.01). These results show that creep feed became more attractive as the pigs grew and became more familiar with creep. Within each day, time of observation also had an effect on interaction with creep feed. There was more interaction with creep in the first two minutes after feed was added, then it dropped off over time (P < 0.001, Figure 4).

What it means

It is important to alleviate weaning stress for piglets, especially for fast-growing piglets who may show signs of anaemia. Providing creep diets to suckling piglets is a practice that can reduce weaning stress and improve piglet health.

As an alternative to standard creep, we provided a large

Table 4. Blood parameters of large and small piglets at 23 days of age. Table 2 lists the definitions of all parameters. SEM is the standard error of the mean.

	Large	Small	SEM	P-Value
RBC (x1012/L) ²	6.06	6.25	0.19	0.15
HGB (g/L) ²	107	121	4.55	<0.001
HCT (L/L) ²	0.35	0.39	0.01	<0.001
MCV (fL) ²	57.52	62.11	0.87	<0.001
RDW (%) ²	21.33	18.09	0.68	<0.001
Iron (umol/L)	9.75	21.92	1.70	<0.001
TIBC (umol/L) ²	85.93	60.94	4.95	<0.001

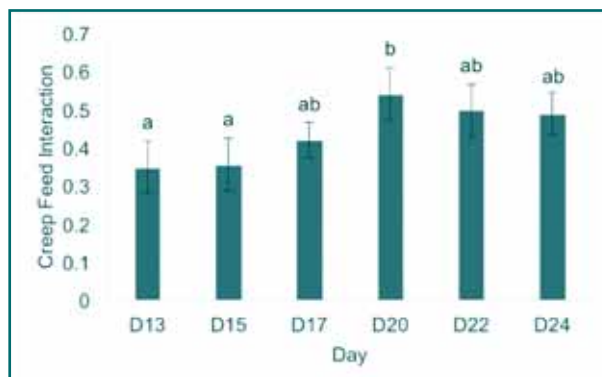


Figure 3. Relationship between creep feed interaction and day. Creep feed interaction was calculated by dividing the total number of piglets interacting with the creep, feeder, or rubber mat by the total number of active piglets. Day with different letters (a and b) are different (P<0.05).

pellet diet high in iron and fibre, which is readily available and affordable, and hypothesised that pigs would be attracted by the pellet format and show reduced signs of anaemia at weaning. Contrary to this hypothesis, the large pellet creep feed did not result in greater creep interaction or improve weaning pigs' blood parameters in relation to anaemia. The interaction between piglet size and creep diets indicates that larger pigs receiving the large pellet creep had worse blood values, and more evidence of anaemia at weaning. Previous studies by PSC indicate that larger pigs within a litter are less likely to consume creep due to better access to teats. Therefore, provision of creep does not explain their worse performance, as smaller pigs given the same creep feed or no creep performed similarly well.

The open creep feeder allowed more piglets to feed together to encourage social feeding, but the drawback is that it is easier for the pigs to push the feed out. In general, we observed that

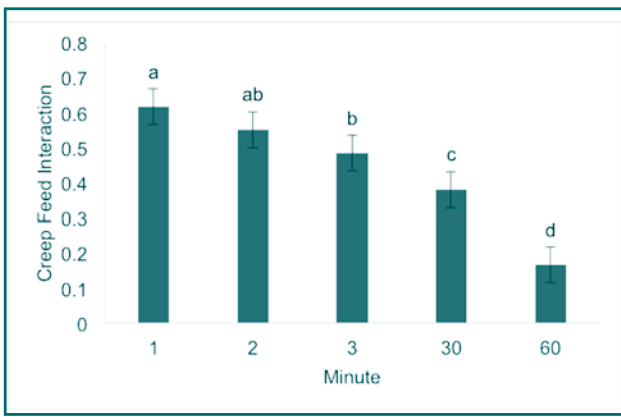


Figure 4. Relationship between creep feed interaction and time of observation. Creep feed interaction was measured at 1, 2, 3, 30, 60 minutes after creep provision and was calculated by dividing the total number of piglets interacting with the creep, feeder, or rubber mat by the total number of active piglets. Minute with different letters (a, b, c, and d) are different ($P < 0.05$).



the feeder was usually empty with some wastage on the mat, which suggests that piglets might be playing with them instead of ingesting them. As the contemporary farrowing pens are usually barren, large pellet creep can be a form of enrichment to stimulate interests in solid food in the early developmental stage. Past studies have also shown that a creep feeder decorated with manipulable materials attracted more creep interactions from piglets (Middelkoop et al., 2020).

No measures of creep consumption were collected for this study, only feed disappearance and waste were estimated. Identifying 'eaters' versus 'non-eaters' would have required addition of edible feed markers to the diets and would be useful in further

studies. The next step is to understand the impact of anaemia on post-weaning health and performance, and how we can counter this deficiency using dietary formulation of creep feed or supplementation that balance for better digestibility and palatability, and adequate fibre and iron level to help with gut health and iron deficiency at weaning.

Acknowledgement

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(Optimizing temperature...cont'd from page 7)

Table 5. Physiological responses of the pigs during the 1st and 2nd replicates

Physiological parameter*	Replicate 1		Replicate 2	
	Start of trial	End of trial	Start of trial	End of trial
Average rectal temperature, °C	37.8 ± 0.3	38.1 ± 0.4	37.5 ± 0.5	38.5 ± 0.5
Average thyroxin level, nmol/L	73.5 ± 13.9	86.7 ± 18.4	73.3 ± 17.8	87.3 ± 12.4

*Physiological parameters represent average from 5 grower-finisher pigs at each replicate

IMPLICATIONS

This work has been conceptualized to validate and update the current industry recommendations on temperature set-points for gestating sows and grower-finisher pigs and to assess the impact on energy costs and overall pig production performance. The expected deliverables from this project are: 1. optimized temperature requirements for sows and grower-finisher pigs that reduce barn energy use while maintaining productivity and performance, and 2. economic feasibility of implementing updated temperature management in gestation and grow-finish barns.

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Abigail Tillotson

Abigail originally grew up in a small town on Vancouver Island, BC. After years of 4-H and developing a passion for animal welfare, she moved to Saskatoon in 2016 to complete a Bachelor of Science in Animal Bioscience. She then completed her Master of Science in Animal Science in 2024, where her studies focused on the effects of periodic enrichment provided at different life stages on the welfare and production of growing pigs. Abigail has worked at the Swine Centre as an undergraduate summer student, a graduate student, and is now currently working as a research assistant under the supervision of Dr. Jen-Yun Chou.



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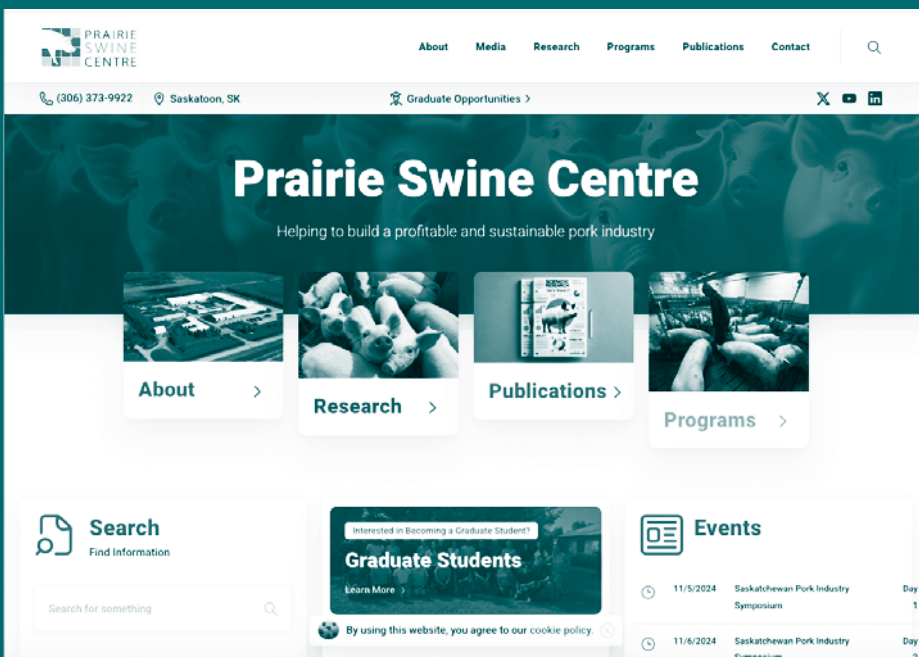
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