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Design Criteria For Enhancing Cleanability and Welfare Characteristics of Pig Transport Trailers

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Transporting pigs from one farm to another location for various reasons has been associated with several disease outbreaks. Currently, regular and thorough cleaning and disinfection procedures are routinely implemented to maintain a clean and biosecure environment in the trailer. However, various aspects of trailer design and construction significantly impact the cleanability and welfare characteristics of the trailer, such as surface smoothness, exposed screws and weld joints, and presence of structures and hard-to-clean areas that may be prone to dirt accumulation. Animal transport trailers that are poorly designed in terms of cleanability are difficult to sanitize and cause significant downtime, increased costs and inconsistent cleaning results, thereby posing increased biosecurity risk.

Recent studies evaluating the effect of trailer design on production losses and welfare have found that stress responses and welfare are affected differently depending on the trailer compartment used. Correa et al. (2014) studied potbellied trailers which are commonly used in Canada and found that some compartments had negative impact on the health of pigs transported. Flat deck trailers with hydraulic lifts can reduce loading stress, as ramp angles above 20 degrees also cause handling problems in pigs during loading and unloading. More work needs to be done to improve the animal welfare characteristics of trailer designs.

(Design Criteria for Enhancing Cleanability ... cont'd on page 3)

Inside This Edition

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Feeding Canola Meal or Soy Expeller at Two Feed Energy Levels to Growout Hogs

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Previous research trials that we've conducted showed that we can feed reduced net energy (NE) diets (≤2.3 Mcal/kg) to growout hogs instead of traditional energy levels (≥2.4 Mcal NE/kg) as long as hogs can increase feed intake to compensate for reduced dietary energy level. Conventional (solvent-extracted) canola meal (CM) has low energy value due to relatively high dietary fibre content. Soy expeller (SE) is now locally produced in Canada (Ontario, Quebec, Maritimes, Manitoba, Saskatchewan, Alberta) and has greater energy value than imported soybean meal because of remaining oil. These feedstuffs therefore offer opportunities to reduce or increase dietary net energy level at low cost. Lowering feed cost is important, as feed is the largest cost of pig production and energy yielding feedstuffs account for 85 to 90% of feed cost. Therefore, nothing impacts the cost of pork production more than the dietary energy level of feed fed to growout pigs. We needed to confirm the response of pigs to reduced dietary net energy levels to endorse previous feeding recommendations and thought to utilize canola meal vs. soy expeller to achieve that. Therefore, the objective of our trial was to compare the growth performance, carcass characteristics, and economics of barrows and gilts fed low or conventional NE diets including either canola meal or soy expeller to market weight.

Trial setup

We conducted this commercial-scale pig trial at a contract grower barn set up as a test facility (Lougheed, AB). In total, 504 barrows and 504 gilts (~33 kg BW at the start of the trial) were housed in 48 pens by sex, 21 pigs per pen. Barrows and gilts were fed two NE levels: low (2.17 or 2.20 Mcal/kg for grower and finisher, respectively) or high (2.32-2.35 Mcal/kg). Within NE level, they were fed either canola meal (25% inclusion in grower and 20% in finisher) or soy expeller (15-12.5%) with 6 pens per NE level x protein source x sex, over 5 growth phases (Grower 1: d0-12, Grower 2: d13-33, Grower 3: d34-53, Finisher 1: d54-74, Finisher 2: d75-slaughter). For all 5 growth phases, diets were formulated to equal standardized ileal digestible (SID) lysine/Mcal NE. Low NE phase diets were based on barley grain, whereas high NE diets were based on wheat grain. Within NE level, the energy value of the canola meal diet was increased to match that of the soy expeller diet by including canola oil. Pig BW and feed disappearance (ADFI) were measured on day 0, 12, 33, 53, 74, every two weeks thereafter, and at slaughter weight (130 kg). Pigs were slaughtered at Maple Leaf (Brandon, MB). Individual warm carcasses were weighed and graded (Destron).

> "Research showed that feeding lower NE diets resulted in greater profit margin after subtracting feed cost."

What we found out

For the entire trial (d0-74), although hogs fed low NE diets consumed 72 g/d more feed than those fed high NE diets, NE intake was 350 calories/d less (Figure 1). Feed intake was lower for hogs fed canola meal vs. soy expeller in the first 12 days on test, but there was no difference in feed intake for the overall trial. Caloric intake was 209 calories/d greater for hogs fed soy expeller that grew 37 g/d faster than hogs fed canola meal. Weight gain per kilo of feed consumed (feed efficiency) was 14 g/kg lower (worse) for hogs fed low vs. high NE diets and 12 g/kg greater (better) for hogs fed soy expeller vs. canola meal (Figure 1).

Carcass dressing was 0.6%-points lower feeding low vs. high NE diets and feeding canola meal vs. soy expeller (Table 1). Lower dressing % is explained by more fibrous feed

(Feeding Canola Meal ... cont'd on page 4)

(Design Criteria for Enhancing Cleanability. ... cont'd from page 1)

An assessment tool (such as design criteria in a form of a checklist) has been used by various industries that have high regulatory requirements (e.g., aviation, healthcare, fleet transport, mining, and construction). They have reported significant benefits especially for routine and emergency procedures (Major et al., 2020; Myers, 2016; Ogden et al., 2016, Thongprayoon et al., 2016; Torous et al., 2020). In this project, a design criteria for cleanability and welfare characteristics of pig transport trailers was developed to provide the industry with an assessment tool for swine transport trailers to guide the design process in addressing inherent problems on trailer biosecurity and animal welfare.

What we did

The approach for this study involved a comprehensive literature review to gather available information on key design components for assessing cleanability, worker safety, and welfare that have been developed and/or evaluated in other industries. Results of the literature search were supplemented by surveys and interviews of various stakeholders such as truckers, wash bay operators, trailer manufacturers, veterinarians, pig producers, and other experts to develop a design criteria tailored for swine transport trailers. These components were used to develop the initial draft of the design criteria that covered the following aspects of the trailer: hygiene and cleanability, safety, and animal welfare. Each aspect included recommended guidelines, with a detailed description of each guideline presented as a glossary.

The developed design criteria was then field-tested and validated by applying the criteria on 10 different swine trailers in use in the Canadian swine industry, including potbelly, gooseneck straight deck, hydraulic lift, and straight deck trailers. The different components of the design criteria were re-assessed and refined throughout all trailer visits and inspections to ensure that the overall design criteria are appropriate and user-friendly. In addition, a rating scale was developed for cleanability, safety, and welfare characteristics to enhance its overall applicability in the industry.

What We Found

A comprehensive information search of more than 100 relevant literatures yielded 127 key design components. Following further assessment, 51 key components were selected based on their potential impact on ease of cleaning, worker safety, and level of comfort of the animals during transport. These 51 key components were presented to a variety of swine stakeholder groups through surveys and interviews to identify gaps and evaluate their applicability to livestock transport trailers.

For the hygiene and cleanability aspect, it was suggested that smooth flooring would undermine safety, so the addition of checkered grips on the floor is desirable. Surfaces such as walls and ceilings, however, should be smooth as much as possible. Animal-safe interior coatings for surfaces should also be considered to reduce the adhesion of soil and dirt. Difficult-to-reach areas, as well as open-ended panels or tubes should be capped or welded to ensure a continuous seal, avoiding dead spaces and allowing for thorough washing. A hollow floor approach is recommended for trailer interior design because it allows truck wash operators to remove the upper deck floors and gain a standing room, which increases the ease and efficiency of cleaning. In addition, a ceiling that can be opened would allow

the truck wash operator to stand on the upper decks to increase cleaning efficiency.

For the safety category, two main suggestions were proposed by the respondents - adjustable decks and perforated partitions. Adjustable decks are preferred over fixed decks to allow easier access and working posture for truck wash personnel. A slotted or perforated partition could further improve airflow circulation inside the trailer.

For the animal welfare aspect, it was suggested that ramps for loading and unloading should be avoided in future trailer designs. This point from the survey participants is consistent with literature findings that hydraulic lifts lessen the stress of loading for the animals (Correa et al., 2014). It was also noted that ventilation and insulation would be more efficient for climate management in the trailer. Another respondent also mentioned that the adjustability of the pen adds convenience in accommodating different animal herd sizes.

Trailer design criteria

Based on the information gathered from literature and survey, a draft of the design criteria was developed, which was then field-tested and validated by inspecting ten different trailers throughout Western Canada. The first draft of the design criteria for cleanability, safety and welfare went through seven iterations to remove extraneous components, improve friendliness of the user interface, and optimize the flow of inspections and presentation of each trailer design criterion or question. A significant gap in the structure or flow of the design criteria was identified during the trailer inspections. It was resolved by re-structuring the design criteria so that inspections are performed by compartments (i.e., front, middle, and back) and portions (i.e., exterior and interior) of the trailer, resulting in a smoother, more efficient, and user-friendly assessment tool. Another concern that arose during the trailer visits was the manner in which each criterion was presented. The first

(Design Criteria for Enhancing Cleanability ... cont'd on page 5)

(Feeding Canola Meal ... cont'd from page 2)

retained in the gut at slaughter feeding the low energy diets or the canola meal diets. As a result of lower dressing %, carcass weight was 0.8 kg lower for hogs fed low vs. high NE diets and 1.4 kg greater for hogs fed soy expeller vs. canola meal. Hogs fed soy expeller averaged 2.3 mm larger loin than those fed canola meal. Dietary energy level or protein source had no effect on backfat depth, pork yield or carcass index. Hogs fed canola meal stayed 2.6 d longer in the barn than those fed soy expeller (Table 1).

Dollars and cents

Diet cost averaged $28.38 per tonne less feeding low vs. high NE diet and $7.76 per tonne more feeding soy expeller vs. canola meal. Income margin after subtracting feed cost (ISFC) per hog shipped was $2.75 greater feeding low vs. high NE diet and only $0.32 greater feeding soy expeller vs. canola meal (Table 2). The lower dressing percentage observed feeding low NE diets would require an increase in live ship weight by 1 to 2 kg to achieve target carcass weights. This extra live weight would mean a few days extra in the barn. However, the lower feed cost per hog would make up for the extra cost of keeping hogs on farm for a few days more.

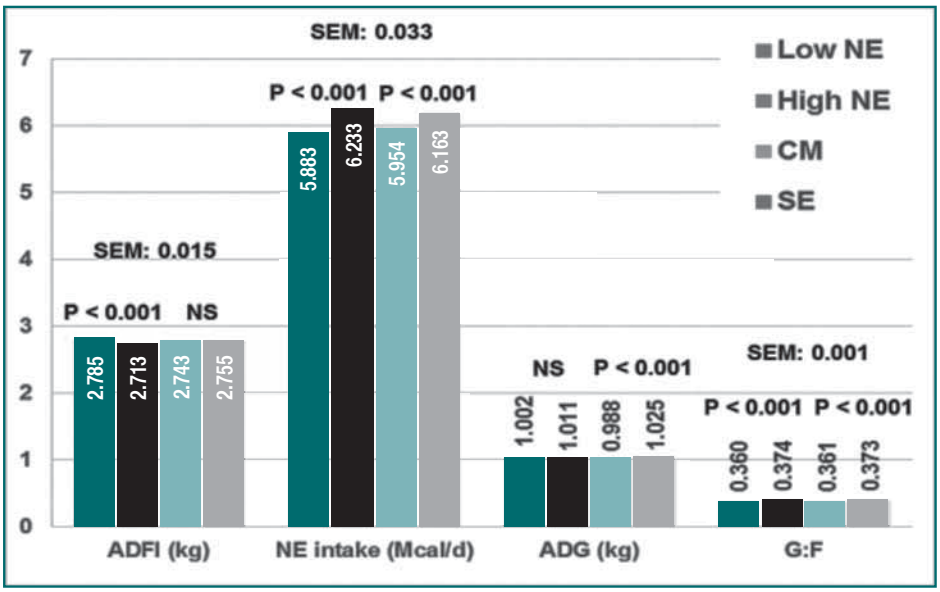

Figure 1. A snapshot of the refined design criteria for cleanability, safety, and animal welfare of pig transport trailers.

So what does this all mean?

From our results we concluded again that hogs can be fed diets with reduced feed energy (≤2.20 Mcal NE/kg) instead of traditionally fed energy levels (≥2.32 Mcal NE /kg) as long as pigs can sustain feed intake. Once again our research showed that feeding lower NE diets resulted in greater profit margin after subtracting feed cost than feeding conventional energy levels.

Abruptly introducing 25% canola meal in the grower phase diets was a challenge to hogs, either due to the fibre content and/or the taste. If hogs had been progressively introduced to canola meal, a drop in feed intake in the first 12 days would likely have been avoided. Pigs fed canola meal never caught up to those fed more palatable, lower fibre soy expeller, but this was in part because we slightly overestimated the NE and digestible amino acid content of canola meal resulting in a minor reduction in growth performance and loin depth. This experiment proved that both soy expeller and canola meal are good supplemental protein sources and can be fed to growout hogs without much problems.

Table 1. Effect of feed net energy (NE) level (low vs. high) and protein source (canola meal [CM] vs. soy expeller [SE]) on carcass traits (SEM=Standard Error of the Mean)

	NE level		Protein source		SEM	P value	
	Low	High	CM	SE		NE	Protein
Days to slaughter from d74 on test	23.20	23.40	24.60	22.00	0.50	0.779	<0.001
Ship weight, kg	130.10	130.20	129.70	130.60	0.30	0.925	0.081
% of pigs shipped	94.20	95.40	95.20	94.40	1.00	0.406	0.578
Carcass wt, kg	101.90	102.70	101.60	103.00	0.30	<0.050	<0.001
Dressing, %	78.30	78.90	78.30	78.90	0.10	<0.010	<0.010
Backfat, mm	18.40	19.00	18.50	18.90	0.20	0.064	0.172
Loin depth, mm	61.70	61.80	60.60	62.90	0.40	0.793	<0.001
Lean yield, %	60.80	60.50	60.70	60.60	0.10	0.061	0.755
Index	115.00	115.30	115.30	115.00	0.20	0.269	0.269
Carcass revenue, $	208.47	210.85	208.61	210.71	0.75	<0.050	0.052

Table 2. Effect of dietary net energy (NE) level (low vs. high) and protein source (canola meal [CM] vs. soy expeller [SE]) on feed cost and gross income margin subtracting feed cost (ISFC) in CA$ (Spring 2016; SEM=Standard Error of the Mean)

	NE level		Protein source		SEM	P value	
	Low	High	CM	SE		NE	Protein
Feed cost/tonne	265.86	294.24	276.17	283.93	0.07	<0.001	<0.001
Feed cost/kg BW gain	0.80	0.84	0.82	0.81	0.01	<0.001	0.070
Feed cost/shipped hog	78.54	82.87	79.96	81.46	0.75	<0.001	0.061
ISFC/shipped hog	68.84	66.09	67.46	67.78	0.68	<0.010	0.480

A cautionary tale

Our experiment was not conducted in the summer time, when feeding diets with greater energy may prevent reduced weight gain. Even in the Prairies, it can get so hot in July and August that hogs may reduce feed intake. During these hot days, only feeding denser energy diets may prevent both decreased weight and lean gain. Our experiment did not include diseased pigs and we did not look at crowding and feeder access, all of which may limit feed intake. We are currently running a trial looking at interactions between dietary NE level, stocking density and feeder space. We will share results of this trial in a future edition of Canadian Hog Journal and on our website. Our trial showed that the most economically optimal feed energy level was 2.2 Mcal NE/kg, which is lower than current existing feed energy suggestions for hogs (2.4 Mcal NE.kg). Keep in mind also that feed commodities and pork prices vary. Therefore, the profitability shown here is repeatable, but its consistency will vary.

Take home message

Feeding lower net energy diets to growout hogs increased profitability without resulting in major changes in growth performance. Abruptly introducing 25% canola meal in the grower phase diets was a challenge to pigs, either because of the fibre content or the taste. Pigs fed canola meal never caught up to those fed more palatable, lower fibre, soy expeller diets, partly because we overestimated the net energy value and digestible amino acid content of canola meal, resulting in a minor reduction in growth performance and loin depth.

Acknowledgements

We would like to thank the Drumloche team for caring for the animals and for their expertise in trial conduct. We acknowledge Lewisville Pork Farm for the use of animals, and Sunhaven Farms Milling for supplying the feed. Financial support from the Canola Council of Canada and Agriculture and Agri-Food Canada is acknowledged.

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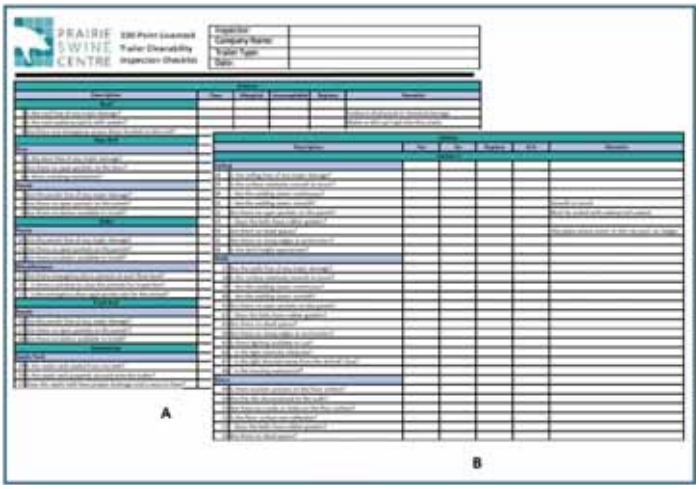

Figure 1. A snapshot of the refined design criteria for cleanability, safety and animal welfare of pig transport trailers.

version of the design criteria were mostly presented through the use of keywords, which may require the user to frequently review the supporting documents while on the field. As a result, each criterion was modified from keywords to questions to improve clarity and efficiency.

In addition, a rating scale for cleanability, safety, and welfare characteristics were established to enhance its overall applicability in the swine industry. Each component of the design criteria will be rated as Pass, Marginal, Unacceptable, or Replace, with an equivalent score of 1, 0.50, 0.25, and 0, respectively. A description of each rating scale was provided to maintain consistency of the rating scale throughout the number of checklist users. The overall score will be calculated at the end of the checklist so that each aspect of the trailer (i.e., cleanability, welfare, and safety) is evaluated from 0 to 10, with 10 being the highest score on the rating scale. In addition, an electronic version of the design criteria has been developed to provide end users with a more accessible interface (e.g., smartphones, tablets, laptops) when being used in the field. The electronic version can also provide a concise data report for easier review and interpretation, as well as facilitate compilation of the entire dataset. A snapshot of the final checklist is shown in Figure 1.

Acknowledgements

Financial support for this research project from Swine Innovation Porc and the participation of various respondents, trailer owners, trucking companies, and truck wash operators are gratefully acknowledged. The authors would also like to express appreciation for the strategic program funding provided by Sask Pork, Alberta Pork, Ontario Pork, the Manitoba Pork Council and the Saskatchewan Agriculture Development Fund.

Assessing Trailer Cleanliness

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Proper washing and disinfection of swine transport trailers is an important step in maintaining biosecurity. Research projects have shown visual inspection of trailers is not a reliable assessment1. While traditional microbiological culture method can be used, they involve the use of plated media which need to be incubated and analyzed to obtain the level of contamination on the sampled surfaces.

This approach can cause significant down-time for trailer operations and delays implementation of corrective actions while waiting for test results. A rapid, easy to use and reliable way of monitoring surface cleanliness of swine transport trailers is needed for practical industry applications. ATP bioluminescence has been demonstrated to be a good alternative tool for monitoring surface cleanliness in swine transport trailers, providing results within minutes as opposed to days for traditional microbiological testing.

In order to increase the speed of adoption of promising new technologies two demonstration sites were established (Quebec, Saskatchewan) to test the reliability and feasibility of ATP Bioluminescence in assessing trailer cleanliness.

The project was implemented in two different wash facilities where a minimum of 10 trailers were sampled on a weekly basis (over a 23 or 30 week period), representing 53% and 18% of the total number of trailers washed respectively, in Quebec and Saskatchewan. Both demonstration sites followed a similar protocol of cleaning, washing, disinfecting and drying, where drying included heated bays in the winter and trailers being placed outside during summer months (April-October). In addition, a minimum of two swabs were taken for each trailer ensuring an accurate representation of trailer cleanliness.

What Did We Find?

As with any new technology proper implementation and training is key to ensure proper validation of the technology. In reviewing the results of both demonstration sites there are specific outcomes that can be categorized into advantages and disadvantages when using ATP Bioluminescence.

Continued Use of ATP Bioluminescence?

The jury is still out on continued use of ATP Bioluminescence. One demonstration site has made the decision to stop using ATP Bioluminescence in the clean, wash, dry and disinfect (CWDD) procedure largely based on variances experienced in the meter readings related to (potential) environmental contamination.

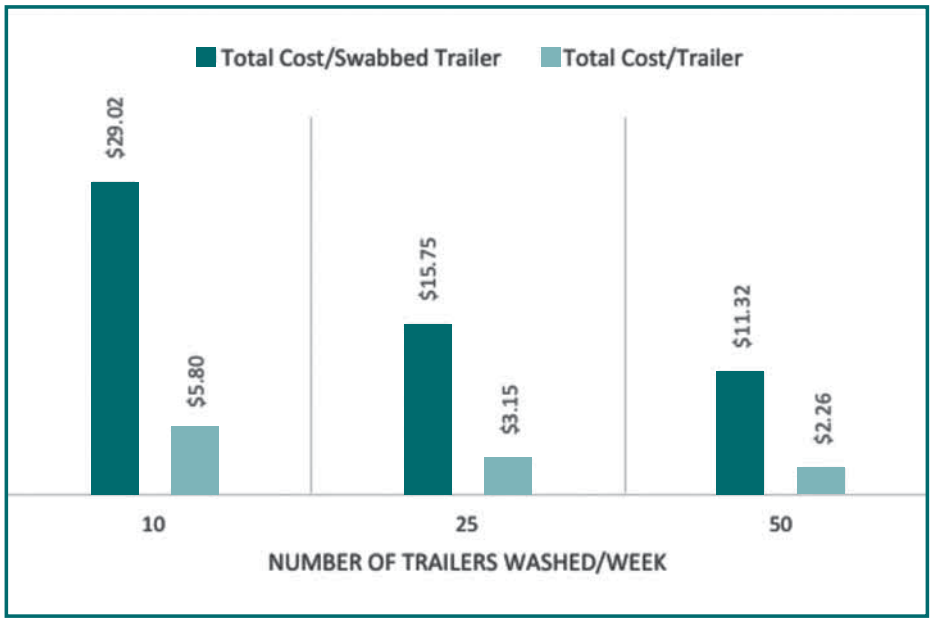

Figure 1. Economic analysis of incorporating ATP Bioluminescence in the trailer washing procedure.

*** Calculations are based on 20% of total washes are swabbed using ATP Bioluminescence*

Table 1. Advantages and disadvantages of using ATP Bioluminescence

Advantages	Disadvantages
• Easy to implement • Easy to train staff regarding use of the equipment • Employees more engaged in the cleaning process. Curious to know how well they were doing. • Removing some of the subjectivity from the cleaning process. Creates an objective measurement. • Rapid assessment of trailer cleanliness - no significant down time for trailer. • Trailers that required additional cleaning were identified prior to leaving the wash area. • Meter is multi-purpose – could be used to assess cleanliness in other areas of the operation. • Builds due diligence and a quality control component in the washing procedure • Fewer rejected trailers – arrival at production facilities	• One more step in the cleaning process/ procedure. Sometimes gets lost in the daily routine. • Swabs need to be stored and handled correctly in order to ensure accuracy of meter reading results. • Swabbing could require entering the trailer after disinfection. • Samples a small area, doesn't eliminate a visual inspection. • Variance in meter readings related to potential environmental contamination – readings were higher if measurements were taken outside the wash/dry bay.

Specifically it was difficult to establish whether the variation seen in meter readings related to an error in the CWDD procedure or to an external factor. This site will continue using third party visual inspection in combination with an annual training program with their employees to ensure quality control standards are met in the CWDD procedure.

The second demonstration site will continue to use ATP Bioluminescence perhaps even expanding its use within its internal truck wash facility. Both demonstration sites identified variances in meter readings related to (potential) environmental contamination, specifically when trailers were dried outside during summer months. They thought this could be addressed by adjusting the timing and increasing awareness related to sampling period and technique. They also felt it was an important step in the quality control process by removing some of the subjectivity in the CWDD procedure, in addition to creating more engaged employees. This site will continue to use ATP Bioluminescence combined with visual inspection as a method of maintaining quality control in the cleaning process.

Economics

The economics of using ATP Bioluminescence will be specific to each situation based on the total number of trailers swabbed as a percentage of total trailers washed. The following calculation is for illustration purposes only and may not reflect the two locations participating in the demonstration project. Figure 1 outlines the potential range in costs associated with ATP Bioluminescence. The use of ATP Bioluminescence may benefit all trailers in the fleet regardless if they were swabbed or not, as swabbed trailers should provide a reliable benchmark of balance of the fleet. This analysis used in Figure 1 also assumes the ATP meter is paid for in 1 year, extending the payback period for the ATP meter would reduce overall cost per trailer sampled.

Conclusion

Research indicated ATP bioluminescence method can be used as a supplementary tool for monitoring surface cleanliness of transport trailers in a rapid, simple, inexpensive and reliable way, to complement the CWDD procedures. However use of ATP Bioluminescence at demonstration sites indicates there are several distinct advantages and disadvantages to commercial implementation. Each company or individual looking to include ATP Bioluminescence in their CWDD procedure will need to accurately assess: Why are we implementing this technology? Where will it be implemented? Are we committed to it? What is the expected outcome and what will we do with it?

Table 2. Economics of ATP Bioluminescence Usage

ATP Bioluminescence meter	$2,300	
ATP testing swabs (100 swabs / box)	$345	
	Week	Year
Total number of trailers washed	25	1,300
Total Number of trailers tested (20%)	5	260
Total Number of swabs (2 per trailer tested)	10	520
Total swab cost	$34.50	$1,794
Total cost per swabbed trailer ($4,094 / 260 trailers)		$15.75
Total cost per trailer ($4,094 / 1,300 trailers)		$3.15

Pigs Consume More Water When Stressed

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Two novel technologies consisting of an individual water consumption system (IWCS) and infrared thermography system (ITHS) were installed in a finishing room. The individual water consumption system (installed in each pen) was composed of a nipple drinker attached to a water flow meter, and an RFID reader (and antenna) to capture individual pig data. The infrared thermography system was composed of two types of infrared cameras, one to capture images of individual pigs drinking, a second to capture an image of all the pigs in the pen. To assess whether the novel technologies were capable of detecting pigs that may be stressed due to routine practices, two stressors were introduced during the trial: (1) moving pigs to the barn hallway and handling them through a pre-defined route for 10 minutes, and (2) mixing unfamiliar groups of pigs.

As part of a larger Swine Innovation Porc project (#1237) entitled 'Use of novel technologies to optimize pig performance, welfare and carcass value', various technologies were developed and pilot- tested in different universities and research centers throughout Canada (under CCSI coordination). After pilot studies were completed by the original developers of the technologies, the next step was to conduct commercial trials where selected developed technologies were applied in a production environment and evaluated under typical commercial practices. Commercial trials were a critical step after the research and development phase, providing the opportunity to make adjustments to the technologies, facilitating their adoption in commercial barns.

Two novel technologies (IWCS and ITHS) were installed in a grow-finish room with six pens containing 14 pigs per pen (Figure 1). The IWCS was comprised of a nipple drinker attached to a water flow meter, and RFID reader and antenna together with electronic ear tag transponders. ITHS was composed of two types of infrared cameras: C3 camera (FLIR C3 Compact Thermal Imaging Camera) and A325 IRT camera (FLIR A325sc Infrared Camera). The A325 IRT cameras were used to capture the image of all the pigs in the pen while the C3 cameras were installed on top of the drinker to capture the image of an individual pig while drinking. Pigs were transferred into the room at 20-25 kg and remained in the room for 10 weeks until reaching 105-110 kg.

> "Water consumption increased as pigs grew regardless of stress induction"

RESULTS AND DISCUSSION

Water Consumption and Handling

Figure 2 shows the comparison of average water consumption before and after the moving activity. Regardless of stress induction, water consumption increased as the trial progressed. At the start of the trial, grower pigs had an average water consumption of about 4,014 mL/day; this increased to 5,876 mL/day towards the end of the trial when pigs were nearing market weight.

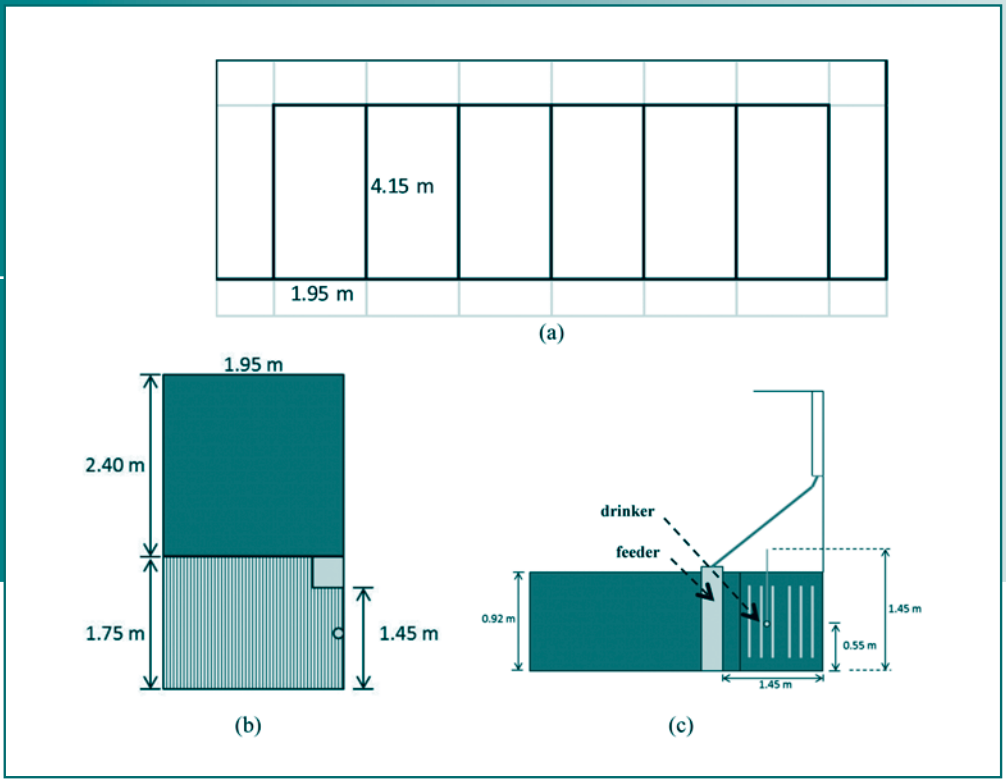

Figure 1: Floor layout (a) of the grow-finish room used in this study. Details of the pen showing the location of the feeder and drinker – top view (b) and side view (c).

At the start and middle of the trial, pigs tend to consume more water after the moving activity. On average, pigs consumed about 3,890 and 5,226 mL 24 hours before stress was induced at the start of the trial and middle of the trial respectively, increasing to 4,138 and 5,878 mL after the stress was induced. These results may imply that grower pigs consumed more water when stressed. No apparent trend was observed for water consumption towards the end of the trial.

Water Consumption and Mixing

A comparison of average water consumption of pigs 24 hours before and 24 hours after unfamiliar pigs were introduced into the pen is shown in Figure 3. In contrast to the moving activity, water consumption generally decreased 24 hours after mixing unfamiliar pigs into the pen. Pigs consumed an average of about 5,387 mL/day of water prior to the mixing activity; this decreased to 4,738 mL/day 24 hours after mixing occurred. The decrease in

(Pigs Consume More Water ... cont'd on page 11)

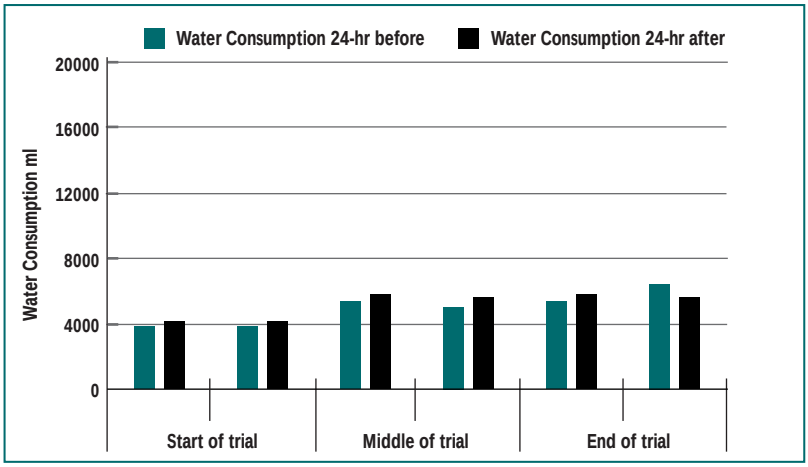

Figure 2. Average water consumption of pigs 24 hours before and 24 hours after the moving activity during the start (n=12), middle (n=12) and end (n=10) of the trial.

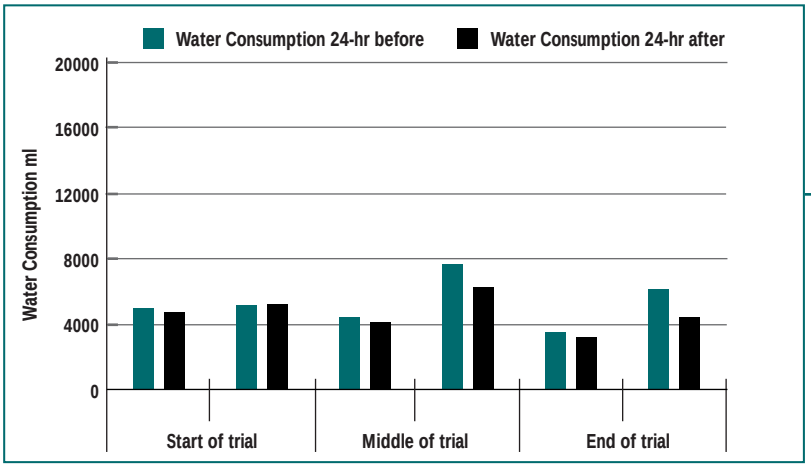

Figure 3. Average water consumption of pigs 24 hours before and 24 hours after unfamiliar pigs were introduced into the pen during the start (n=16), middle (n=16) and end (n=12) of the trial.

Effects of long distance transport on early-weaned pigs

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While transporting weaner pigs is a common practice in swine production, there is very little published research on how this process impacts piglet health and welfare. Transport of piglets to nursery or grower facilities benefits health by reducing disease transmission across age groups, however other aspects of transport (mixing, handling, temperature extremes, time off feed and water) can cause acute stress. The proximity of transport to another stressful event, weaning, is also likely to influence the overall impact of transport, but to date no studies have examined the timing of weaning relative to transport. Currently in Canada, federal transport regulations limit the maximum transport duration for all ages of swine to 28 hours. These regulations are based on studies conducted on market hogs and the published research on transport of weaner pigs is limited (Lewis, 2008; Rioja-Lang et al., 2019; Sutherland et al., 2014). However, the differences between market hogs and weaned piglets (e.g. body size, ideal temperature conditions, proximity to weaning) mean that weaned piglets are likely to have different responses to transport conditions.

To address this gap, Dr. Jennifer Brown and colleagues at the University of Guelph and University of Saskatchewan are conducting research on transport of weaner pigs under Canadian commercial conditions. Two commercial farms were selected based on transport distance between the sow and nursery barns. Nursery pigs were transported for short (SD: <3 h) and long (LD: >30 h) durations in summer 2019, with four trips studied for each duration. The LD piglets were transported in a 4-deck potbelly trailer in one of three compartments: the upper-back (C-UB), bottom-front (C-BF), or bottom-middle (belly) (C-B), which represent a range of different environmental conditions. SD piglets were transported on the main deck of a flat deck trailer, which was comparable in size and stocking density to the C-BF of the LD trailer.

Monitoring equipment on the interior and exterior of the LD and SD trailers recorded temperature (T, °C) and relative humidity (RH, %) at five-minute intervals throughout transport. Piglet data were collected at three time points: the morning before transport (T0), immediately after transport (T1) and approximately 3 days after arrival to the nursery barns (T2). Blood samples were collected at T0 and T1 to compare physiological measures of dehydration, stress and fatigue across treatments and time points. When piglets arrived at nursery barns, their behaviour was video recorded for 5 hours on arrival and three days later to identify differences feeding, drinking, and postures following transport.

The trailer conditions for SD groups were on average, slightly warmer and more humid than for LD groups. Average temperature during LD transport was 22.8°C while the average temperature in SD transport was 24.3°C. Temperatures were below the thermoneutral zone for this age group (24°C, National Farm Animal Care Council, 2014) for 47% of the time for LD transports, while the SD group experienced temperatures below 24°C for 36.0% of the time. The most extreme trailer temperatures (both cold and hot) were recorded in the upper back compartment of LD transports.

Piglets undergoing LD transport weighed significantly less than those in SD transport at T1 (immediately after transport) but no difference was found at T2, 72 h following arrival ((Table 1).

Table 1. LS Means comparing Long and Short Transport piglets on arrival and at 72 hours following transport (n = 440).

	Long transport (LD)		Short transport (SD)			
	Arrival (T1)	72 hrs (T2)	Arrival (T1)	72 hrs (T2)	SEM	P value
Body weight (kg)	5.7a	6.4 c	6.1 b	6.5 c	0.05	<0.001

Relative to their weights at T0, SD piglets gained 0.1% of their body weight between T0 and T1, while LD piglets lost 6.2%.

Of the total number of pigs loaded, no piglets died in SD transports (0/2,034) and 7 piglets died during LD transports (7/11,434 = 0.06%); due to the low frequency of mortality no significant difference was found between transport durations. In both transports, the ear location had the greatest increase in lesion severity, followed by skin lesions. Lesions on ears and skin appeared to be related to mixing aggression at weaning rather than due to transport alone. The incidence of lameness was low (1.84% of piglets scored) with all lameness cases identified as mild in severity.

Physiological parameters measured in blood were within normal reference ranges for piglets of this age group. Statistical analysis found significant differences between transport treatments, both before and after transport. Differences before transport were likely due to differences in the weaning timeline of piglets, as the LD piglets were weaned up to 6 days before transport while SD piglets were weaned immediately before. On arrival at nursery barns, indicators of physiological stress including cortisol and neutrophil: lymphocyte ratios were higher in SD piglets compared to LD piglets, reflecting acute stress. The SD piglets also showed greater levels of muscle injury compared to LD piglets (elevated aspartate aminotransferase and creatine kinase levels), while LD piglets had higher hematocrit levels indicating greater water loss.

Behaviour observations from video recording of piglets following arrival showed that all pigs spent most of their time lying after transport (77% of observations), followed by feeding (11%), drinking and sitting (both 9%). In the 5 hours following arrival, piglets from LD transports were observed to spend more time feeding, drinking and sitting than those from SD transports, suggesting greater hunger and thirst. However, differences in weaning timeline between treatments also likely influenced the behaviour results.

In conclusion, this study represents the first research in Canada on the effects of transport on weaner pig health and welfare. Differences between LD and SD transport were found, but neither treatment was identified as being better than the other. Based on physiological measures the SD piglets appeared to have a greater stress response compared to LD, likely related to SD piglets' exposure to multiple stressors (weaning, loading and transport) with limited time to recover. The LD piglets showed greater weight change and dehydration post-transport. The LD piglets were weaned days prior to transport and had more time to habituate to conditions during transport. This could not be controlled for due to the study being based on existing commercial practices, and as such, these results raise additional questions regarding the timing of weaning and transport. Is it better to complete weaning before pigs are transported? The answer may vary depending on the age of pigs, length of transport and trailer conditions. The study was completed in summer with minimal challenges to piglets thermal comfort. Information is needed on the effects of long duration transport of weaner pigs during winter, where thermal conditions are likely to pose a greater thermoregulatory challenge.

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(Pigs Consume More Water ... cont'd from page 9)

water consumption might be due to aggression that occurred after mixing, which subsequently prevented some of the pigs from drinking. This observation may have also caused the no apparent increase in water consumption from the start to the end of each trial.

Infrared Thermography - Handling

During the start and middle of the trial, no considerable change in body temperatures was observed. Towards the end of the trial when pigs were close to market weight, a slight increase in body temperature was observed after the moving activity. Pig average body temperature was 36.5°C before the moving exercise; this increased to 36.8°C after the mixing activity. This minimal change in body temperature could indicate that the moving activity was not strenuous enough to cause a marked change in body temperature of pigs

CONCLUSION

1. Using the individual water consumption system, it was observed that grower pigs tend to consume more water when stressed. The system also confirmed that water consumption increased as the pig grew regardless of stress induction.

2. As captured by the infrared thermography system, aggression as a result of mixing unfamiliar pigs to the pen caused an increase in the recorded body temperature of pigs. The system also showed that the pigs' body temperature was affected by changes in room temperatures.

3. In this study, installation of the individual water consumption system and infrared thermography system and inducing stress due to moving and mixing had no considerable negative impact on pig production performance.

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Personal Profile

Jessica Vehof
Ethology M.Sc. student

Jessica grew up on a hog farm in southwestern Ontario that has recently expanded to include farrowing. When she wasn't studying, she could be found in the new sow barn where she loves working with the sows and their piglets. After graduating from the University of Guelph with a B. Sc. in Agriculture (Major: Animal Science) in the spring of 2021, she wanted to contribute to research to help farmers with group housing management strategies. Therefore, she made her way over to the Prairie Swine Centre in Saskatchewan. Under the supervision of Dr. Jennifer Brown, her Master's project explores the effects of dynamic grouping and early mixing on gestating sows. After completing her degree, Jessica looks forward to moving back to Ontario to work on the home farm and apply the things she has learned in a practical setting.

Coming Events

Alberta Pork Congress
Red Deer, AB
June 15 -16

Alberta Livestock Expo
Lethbridge, AB.
October 5

Red Deer
Swine Technology Workshop
Red Deer, AB.
October 19

Saskatchewan Pork Symposium
Saskatoon, SK.
November 15 - 16

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