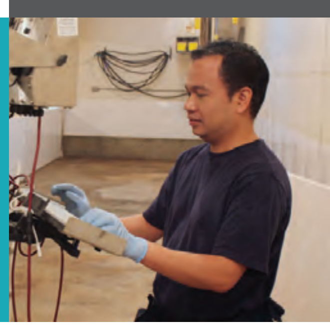
PRAIRIE SWINE CENTRE | 25 YEARS

ANNUAL RESEARCH REPORT 2015-2016



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MISSION STATEMENT

"We provide solutions through knowledge, helping to build a profitable and sustainable pork industry"

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2015-2016 Report Highlights

Chairman's Report

Creative Times

JAMES RESSOR - Chairman of the Board

It has been an honour and privilege to serve the Board of the Prairie Swine Centre (PSC) as Chair this past year. I wish to especially thank Rick Prejet, the previous Chair, for his diligent, dedicated and professional leadership. As well, the dedication of numerous past Board members are key factors enabling the PSC to become highly regarded within Canada and around the world.

One may always consider our swine industry to be in "Creative Times". Let me suggest some thoughts on what this means for 2016. Our industry faces the need to integrate numerous disciplines. They include: traditional "on-farm" production measure research; environmental sustainability research that considers the wider "foot print" our industry leaves, including opportunities for integrating with crop production and livestock systems; food quality and safety research; and, social expectations regarding animal care and well-being. Overlapping all these areas are the need for designing and implementing economic systems that integrate these disciplines, enabling our industry to compete around the world. The PSC Board and senior staff have been very engaged and helpful in strategic discussions regarding these issues. The dedication, ability and willingness of the Board and PSC staff will continue enabling the Centre to deliver world class swine research and leadership.

During the coming year, the Board and senior staff will continue reviewing how to focus and integrate the valuable research the PSC conducting. This will include continuing to cooperate with other swine research centres in Canada and around the world. As well, PSC wants to reinforce the valuable relationship with the University of Saskatchewan and continue helping the University achieve its own research and teaching objectives.

PSC is privileged to receive very strong support from the Alberta, Saskatchewan, Manitoba, Ontario and Quebec pork producer associations and is dedicated to continue earning this support and delivering valuable research and information back to the Canadian swine industry. As well, the PSC Board wishes to sincerely thank the dedicated efforts of the research farm production staff – while conducting world class research they are also are achieving world class sow, nursery and finisher production numbers, a difficult task for all research farms.

On behalf of the Board, I want to congratulate Lee Whittington and his highly skilled team on another successful swine research year. As this Annual Research report is reviewed, their passion and dedication becomes evident. The PSC Board looks forward to working with Lee and all the PSC staff during the coming year.

James Reesor

President's Report

Strategic Vision - What Does It Take to Be World Class?

LEE WHITTINGTON, B.Sc. (Agr.) - MBA - CEO/President

World-class research organizations don't just happen, they are the culmination of seeking out research scientists that have a passion for progress and share a vision of how science can make a contribution to the organization's mandate. Although strong science is at the centre of a research institute it is just the beginning. The full team of staff must be pulling in the same direction, which can be a challenge because science by its nature is based in discovery and the outcome isn't known. So research centres have that juxtaposition within their DNA. That is: 1) to perform as an innovative knowledge developer; while 2) managing production systems and a workplace expectation that seeks stability and regularity.

Dr. Jim Brandle, CEO of Vineland Research and Innovation Centre summed it up succinctly in their Centre's 2014 Innovation Report: ***World-class research organizations don't just happen. They're the result of great science, innovative thinking, strong local and global partnerships and sheer tenacity. – J. Brandle***

Our vision which started 25 years ago was to differentiate Prairie Swine Centre's approach to science from other institutions. Our commitment is to turn science into knowledge that the industry can readily access, interpret and apply. These must be results that are useful to the barn manager, to the transporter, the packer and the suppliers of feed, equipment, and health supplies.

To deliver on this vision we need to do two things. First we seek the best people in the world to employ and partner with people that share our passion for applied research and want to measure their success by creating real change on the farm. Secondly, we don't leave science communications to chance. Commercialization and implementation of new science needs regular and ongoing support to overcome the inertia that exists in every business. It was estimated by Dr. Dave Downey (Agricultural Marketing Professor, Purdue University) many years ago that it takes at least seven exposures to the same information to change our behavior.

Differentiating our offering in the marketplace, regularly communicating value to the customer, and commercializing new scientific discoveries, are all key parts of the sustainability vision for the Centre. This year, we are pleased to have made progress in all our strategic areas. I will highlight a few here that you can read more about within this Annual Research Report.

- In pork production operations we exceeded that elusive target of 30+ pigs/sow/yr. Our production team under the supervision of Brian Andries took on the task of reducing pre-weaning mortality. Technical staff were on board to work with production staff to ensure litters on trial were receiving the same extra care.
- We have successfully completed over two years managing our production system without in-feed antibiotics.
- We have over 125 partners from around the world including research scientists and collaborating industry partners that help us make advances.
- We significantly improved our interaction with the University of Saskatchewan when two Prairie Swine Centre employees were selected from world-wide searches to fill new positions; one in nutrition at the College of Agriculture and Bioresources, and the other in animal welfare at the Western College of Veterinary Medicine.
- We have entered into agreements with international partners in Spain to access new technology for Canadian pork producers, and will be announcing innovations in biosecurity through a partnership with a new Canadian firm.
- The ultimate measurable for this past year: "How well did we do in bringing new science and innovation to the industry?" This year you will find 17 articles in this publication that include sow housing adaptations on farm, the use of nano-particles, and reducing cost of production through advanced feeding programs.

As we enter our 25th year of operation, Prairie Swine Centre has developed a reputation for reliable science that works in the field. Each year we take our results and using economic enterprise modeling, we estimate what economic benefit this work will have on the Canadian pork industry. Over the past decade, Prairie Swine Centre research has and continues to contribute an extra $4.00 per pig in improved net income, each and every year from new knowledge created through research. As always I welcome your input on our programs and invite you to contact me directly at 306-667-7447, or lee.whittington@usask.ca.

Operation's Report

Enhancing efficient and sustainable production

BRIAN ANDRIES, B.Sc. - Manager, Operations

This last fiscal year was a good one for production, even though animal sales for the first nine weeks of the fiscal year were down about 130 animals. Lower farrowing rates from 2014-2015 resulted in lost sales going into July and August of 2015. The target for 2015-2016 was to sell 148 animals a week and as of May 27, 2016 we have sold 7,944. This is 804 animals above target and by fiscal year end we will have sold a minimum of 8,600 animals. This has been the highest number of animals sold in the history of the Centre, falling on a yearly average between 7,200 to 7,700 animals, since 2005. These sales are composed of finished market hogs (approx. 5,200) and weanlings of various sizes sold to commercial pork producers and researchers at the University of Saskatchewan.

"Over the past year the production unit has sold the highest number of pigs in the Centre's 25 years."

We are very pleased to report that all production targets were surpassed this year except post-wean mortality that was set at 1.5%, and is currently sitting at 1.8%.

Production staff were challenged to decrease pre-wean mortality beginning in October 2015. We wanted to reduce farrowing room mortality to 10% if possible, and as staff are off work at 3:00 p.m. daily, a portion of attaining this target is left to fate.

We examined where most of our losses were when it came to pre-wean mortality and over 60% of the losses could be attributed to either being laid on or non-viable. This has been very constant over the last number of years and so it was these losses that were examined, to reduce mortalities. The following were the main focus in reducing mortality:

- At the time of farrowing, staff check sows on a continual basis throughout the day, drying off piglets at birth, and clipping needle teeth. Piglets are marked to differentiate the first, middle and later born animals to determine order of birth and in turn colostrum consumption. This will determine which animals are cross fostered, with later born piglets fostered last. Piglets are towel dried at birth and corn starch is put down as a drying agent.
- Every week, when sows are farrowing, colostrum is collected and either used as fresh or frozen for later use. Production staff decide which piglets need extra support after farrowing and depending on the size of the piglets, 6-15 ml's of colostrum are syringe fed, preferably with colostrum from its own mother. These piglets are fed 2-3 times the day of birth and 1-2 times the following day.
- We utilize split suckling when sows have large litters and later born or smaller piglets require nursing time.
- Nurse sows from the previous week are held back when the number of piglets born is greater than cross fostering can accommodate.

Table 1. Production Parameters

	2013	2014	2015	2016*
Sows farrowed, #	714	701	739	326
Conception rate, %	90.5	87.4	92.8	95.7
Farrowing rate, %	92.8	86.8	93.1	90.1
Avg. born alive/litter	13.9	13.6	14.0	14.6
Farrowing Index	2.46	2.47	2.46	2.47
Number weaned/sow	12.6	12.6	12.8	13.2
Pre-wean mortality, %:	13.2	11.0	11.4	10.3
Pigs weaned /Sow/Year	28.4	28.5	28.7	30.3

*last 16 weeks, ending June 30, 2016

- Due to averaging 14.5 pigs born alive we are doing a fair amount of either cross fostering or utilizing nurse sows to handle extra piglets. We make sure that when cross fostering, only piglets that have been born first and have had sufficient colostrum are moved to other sows. We foster according to piglet size and as well give consideration to the teat size of the sow, putting smaller weight piglets on animals with a smaller teat size. We work on getting litters as uniform as possible in relation to piglet size. The litters with smaller piglets on the sow are then given special attention, like feeding colostrum, or an oral energy supplement.

As we raise our own gilts and have an abundance of space in gilt development to house gilts, we wanted to be sure that we were successfully managing our gilt pool. We do have this luxury of housing more gilts than we actually need as replacements for our 325 inventoried sow herd. For calendar years 2012 and 2013, gilt replacement rates averaged 52% but jumped to 65% for both 2014 and 2015. When looking at why replacement rates had increased substantially over the last two years it became obvious that research protocols did play a major role in the increase. It became apparent that we do require extra gilts on the farm that would allow us to easily incorporate new females into the herd when research takes sows out of the regular rotation.

Moving from four to three week weaning for nursery research protocols is one factor that dictates requiring extra gilts to fill the gap when moving back to four week weaning. At this time we need 15 gilts on farm at the appropriate age and stage of ovulation to fit them into that particular breeding week. Notice of these trials might sometimes be only 1-2 months prior to the actual start of the trial. We have also sold pregnant females to VIDO for research purposes. For the last two years we have sold an average of 40 pregnant sows per year. We would be in trouble if we didn't have these "extra" gilts to fit these gaps.

Data suggests that 85% of gilts should be in heat by 170-200 days of age. This means that gilts have to be exposed to boars early and properly. I looked at individual data on the last 290 gilts that we exposed and found that 93% came into heat on an average of 13.5 days after exposure. The 21 animals that did not cycle from this group were sold as markets. All of our gilts are bred after they reach 135 kg. and have cycled at least twice. Our gilts are fed a gilt developer diet from 50 kg. body weight and after first heat moved into individual stalls and full fed until bred.

Table 2. Gilt Performance at Prairie Swine Centre

	Gilts		1st Parity	
	2014	2015	2014	2015
Farrowing rate, %	86.3	94.9	96.6	93.8
Avg. born alive/litter	13.4	13.6	13.5	13.8
Farrowing Index	11.8	11.3	12.5	12.9
Pigs weaned /Sow/Year	30.5	27	30.5	34.8

To manage the fact that we are producing over 8,500 animals per year and only have room to market 5,500, (resulting in approximately 60 extra animals on farm per week), we have to be cognisant of the way we fill grow-finish rooms to make sure pigs are at appropriate density levels for their size and age. We have been selling a weekly supply of three different size animals (27kg, 40kg and 55kg) totalling about 40-45 animals, to an abattoir in the Osler area. Production rooms are filled to accommodate these sales and by the time pigs reach 55kg (approximately 15 weeks of age), the room is at the proper density. This still leaves animals for additional sales to University of Saskatchewan researchers.

We continue to be plagued by some tail and side biting in grow-finish, so I decided that before refilling rooms they would be fitted with some type of enrichment to help alleviate the problem. We have hung chain from the ceiling, one or two per pen depending on stocking density, with three foot 2x4's on the ends that hangs down to the floor. It appears to be working quite well but we will see late fall and next spring when these type of problems are more prevalent.

I had a summer student start this May that filled in when production staff took their holidays during the summer months. He also leads a small research project looking at the influence of three types of lactation feeding systems and how they affect sow and piglet performance. We evaluate our current electronic feed system that has the advantage of supplying fresh feed, and reduces labor, a modified system consisting of a feed drop tube that sows manipulate to access small quantities of feed, and the traditional hand feed system. Detailed records were kept. Sow weights and back fat were monitored pre and post farrowing as well as litter birth weights, day seven and day 21 piglet weights.

The National Body of the Canadian Council of Animal Care was out for their three year visit on May 10, 2016. They did not appear to have any concerns and all requests for modifications from their last visit had been addressed. We started 6,012 animals on test in 2015 that included 21 experiments and have so far this year registered 16 new trials.

Production staff was very busy training volunteers that are trying to enter the College of Veterinary Medicine. The volunteers are required to give the Centre 20 full days of volunteering. This ensures the appropriate amount of time is taken to properly train volunteers on all aspects of commercial swine production.

Technology Transfer Report

Engaging the Industry

KEN ENGELE, BSA. - Manager, Information Services

2016 represents the 25th anniversary of Prairie Swine Centre being formed as a non-profit organization. A great deal of credit goes to the original advisory committee in realizing the importance of Technology Transfer in delivering a successful research program that continues to deliver practical, relevant, and timely information. As one of the original pillars of the Centre, the Technology Transfer program has seen many changes over these 25 years. While the three core areas of communication (personal, electronic, and print) remain the same, the level of importance dedicated to each method has changed significantly over time.

As the pork industry has changed so to has the Technology Transfer program adapted to the needs and economic pressures of the hog industry. Today approximately 40% of Canada's hog production is classified as vertically integrated; colonies still represent 30% of production with the balance of production being held in various sized operations. How we communicate with the industry is, and needs to be, different than the way we communicated with the industry in the past.

A 2014 Ipsos-Reid survey of agricultural producers provides some valuable insight on the type of information and how its collected by producers for their operation. The two most common sources of information were print (72%) and websites (50%), while social media ranked very low comparatively (2%). Do these numbers speak to an aging producer demographic? Or are tools like Twitter and Facebook seen more a personal network rather somewhere people look for credible information?

The survey also indicates the type of information producers are looking for is information on new technologies and products. On the surface this makes sense as we are in the commodity production business. By being one of the first adopters of a new technology we inherently maintain or increase our competitive advantage against our nearest competitor.

Where and how do producers gather information? A vast majority of producers (58%) get their information from aggregate news sites like Farms.com, ThePigSite, SwineWeb, MeatFYI or PorkInsight. According to the stats, they access this information from desktops (70%), laptops (49%), and mobile devices (43%).

As we continue to assess how to best communicate with the pork industry we need to ensure there is a specific communication plan for each one of our target markets. The ultimate goal of Technology Transfer, is Technology Adoption. Thus ensuring the pork producers are implementing recommendations produced by the research programs at Prairie Swine Centre, those projects that improve profitability & competitiveness or address sustainability (welfare & environmental). The real trick becomes how do we measure implementation of recommendations, technologies, and products.

We are continually assessing the most effective way in driving research results out to the industry. We always welcome feedback from the industry at any time. Over the course of the next 18 months you will see several new initiatives rolled out to engage the industry on a different level.

Corporate Objectives

Objective #1
To be a profitable organization operating in a marketplace that offers growth opportunities.

Objective #2
To meet the technology needs of the pork value chain better than any competitor. Using an industry-oriented and multidisciplinary approach that ensures timely adoption of knowledge by the stakeholder*.

Objective #3
To provide scientific leadership in our areas of expertise to industry, university and government.

Objective #4
To empower our people – that they should feel Valued, Challenged and Engaged in a safe work environment. Assisting them to find the breakthroughs to take us to the next level.

Objective #5
To enhance the Centre's effectiveness and sustainability, through successful collaborations, co-operative action and strategic alliances in our research, education and technology transfer roles.

* We define stakeholder as all beneficiaries in the pork value chain from cereal development to consumer acceptance of pork.

Research Objectives

Objective #1
To increase net income for pork producers by $1/ pig/year through improved nutrition.

a) This includes the development of feeding programs which emphasize economic efficiency, meat quality, and market value.

b) Understanding feed and fibre sources and the modifications of these to meet the needs of the pig, and changing economic conditions.

Objective #2
To improve animal wellbeing by developing and modifying housing systems, animal management practices, and improving health of the pig.

Objective #3
To improve barn environment through the development of economical and practical techniques ensuring the health and safety of barn workers and animals.

Objective #4
To reduce the operating costs by $0.50/pig/year and reduce the environmental footprint of pork production through breakthroughs in the science of odour and gas emissions, nutrient and water management, utility and resource efficiency.

Objective #5
To address the needs of society by leveraging our knowledge of the pig. This includes for example, using the pig as a model for human health and nutrition.

OUR COMMITMENT

To meet or exceed the research data and scientific analysis expected by our clients, and demanded by regulatory guidelines.

Prairie Swine Centre - 25 Years

Original - Practical - Results

Prairie Swine Centre Advisory Board, 1991

Prairie Swine Centre Aerial View, 1992

PRAIRIE SWINE CENTRE 25 YEARS

Lee Whittington, MBA.
President/CEO
2008 - Present

Manager, Information Services
1992-2008

John Patience, Ph.D.
President/CEO
1992-2008

Brian Andries, B.Sc.
Manager, Operations
1992 - Present

Bernardo Predicala, Ph.D.
Research Scientist, Engineering
2005 - Present

Stephane Lemay, Ph.D.
Research Scientist, Engineering
1996 - 2005

Yuanhui Zhan, Ph.D.
Research Scientist, Engineering
1992 - 1996

Executive Management Team, 1992

Dan Columbus, Ph.D.
Research Scientist,
Nutrition
2015 - Present

Pascal Leterme, Ph.D.
Research Scientist,
Nutrition
2002 - 2006

Ruurd Zijlstra, Ph.D.
Research Scientist,
Nutrition
1995 - 2002

Kees de Lange, Ph.D.
Research Scientist,
Nutrition
1992 - 1994

Ken Engele, BSA>
Manager, information Services
2011 - Present
Assistant Manager,
Information Services
1999 - 2008

Jennifer Brown, Ph.D.
Research Scientist,
Ethology
2010 - Present

Harold Gonyou, Ph.D.
Research Scientist,
Ethology
1992 - 2015

Prairie Swine Centre Aerial View, 2004

Denise Beaulieu, Ph.D.
Adjunct Research Scientist,
Nutrition
2016 - Present

Research Scientist
Nutrition
2005 - 2016

Yolande Seddon, Ph.D.
Adjunct Research Scientist,
Ethology
2016 - Present

Post Doctoral Fellow,
Ethology
2012 - 2016

Prairie Swine Centre Aerial View, 2011

ATP Bioluminescence a Means for Assessing Trailer Cleanliness

B.Z. Predicala, A.C. Alvarado, and J. Cabahug

Bernardo Predicala

Alvin Alvarado

SUMMARY

Proper washing and disinfection of swine transport trailers is an important step in maintaining biosecurity. This study examined the feasibility of using adenosine triphosphate (ATP) bioluminescence as a rapid and effective swine trailer cleanliness assessment tool. Samples were taken from newly-cleaned, dry trailers using an ATP swab by swabbing an area of 10 cm x 10 cm and were tested for microbial contamination level using an ATP bioluminescence meter.

The results obtained from ATP testing were compared to the co-located samples taken using standard microbiological techniques with MacConkey and R2A agar contact plates (diameter Ø = 60 mm). From a total of more than 500 samples collected from 16 commercial swine transport trailers across Saskatchewan, a significant correlation ($r = 0.206$; $p=0.001$) was found between ATP bioluminescence method and standard microbiological technique using R2A agar plates. Lower correlation ($r = 0.154$; $p=0.002$) was observed between ATP method and MacConkey agar plate counts. Unlike R2A that detects a wider group of bacteria, MacConkey agar supports only the growth of selected gram-negative bacteria while ATP bioluminescence detects ATP from both microbial and organic sources.

"Visual inspection of newly-cleaned transport trailers is not sufficient in assessing trailer cleanliness."

Assessing the effectiveness of swine transport trailer cleaning protocol using ATP bioluminescence method threshold values were established with readings of less than 430 RLU per 100 cm^2 as 'Pass' while higher than 850 RLU per 100 cm^2 as 'Fail' or has high risk of disease propagation. With these assessment criteria, 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 procedures specified in CSHB (2011) guidelines.

INTRODUCTION

Animal transportation is widely recognized as a significant risk for transmission of swine diseases. With the recent outbreaks of Porcine Epidemic Diarrhea (PEDv), rigorous effort has been exerted to ensure that transport trailers are properly washed, disinfected and inspected for organic debris and microbial contamination prior to use. However, confirmation of the cleanliness of trailers after washing/disinfection/drying procedures is presently carried out mainly by visual inspection, with occasional microbiological testing using culture method (CSHB, 2011).

Visual inspection is not a reliable assessment, while traditional microbiological culture method involves the use of plated media which need to be incubated and analyzed to obtain an indication of the contamination of 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.

Over the last decade, adenosine triphosphate (ATP) bioluminescence method has been used in other industries (i.e., food, hospitals, cattle) for monitoring surface cleanliness and microbial contamination. This method uses bioluminescence as an indicator of the level of residual ATP present on swabbed surfaces. Once the surface is swabbed, the sample is exposed to an ATP-releasing agent (lysis buffer) and an ATP-activated light-producing substrate and enzyme (luciferin and luciferase). The amount of ATP present on the tested surfaces can then be quantified by the amount of light emitted during the enzymatic reaction (in terms of relative luminescence units, RLU) (Green et al., 1999). The intensity of light is proportional to the amount of ATP and therefore the degree of contamination (Davidson et al., 1999). The ability to provide results within minutes, as opposed to days for traditional microbiological testing, makes ATP bioluminescence a good alternative tool for monitoring surface cleanliness of swine transport trailers. If proven effective, rapid monitoring of surface cleanliness of swine transport trailers can be done on the large number of trailers being used across the industry at a relatively low cost, thus enhancing the effectiveness of biosecurity measures.

MATERIALS AND METHODS

A total of sixteen (16) commercial swine transport trailers were assessed for surface cleanliness after washing and disinfection using two methods: microbiological control method using two formulations of contact agar plates, and using the ATP bioluminescence meter. Sampling was done on dry trailers after undergoing washing and disinfection procedures in their respective truck washes.

Six sampling locations were identified for each trailer: lower deck floor and wall, upper deck floor and wall, loading ramp and partition panels, and trailer exterior. At each sampling location, five pairs/sets of co-located samples, one for each method, were gathered. Overall, 536 swab samples for ATP bioluminescence and 626 microbiological samples (389 using MacConkey Agar and 237 using R2A agar), were collected.

RESULTS AND DISCUSSIONS

Based on the criteria for assessing whether a newly-washed trailer can be categorized as 'Pass', 'Critical/Caution', or 'Fail' using microbiological testing with MCA plates as specified in the "Quality Control of Wash/Disinfect/Dry Protocols for Live-Hog Transport Vehicles" document from the Canadian Swine Health Board (CSHB, 2011), the equivalent threshold limits for ATP and R2A readings were derived using the relationships established from the paired data collected using both methods. The data values which were normalized to cfu/cm^2 and RLU/cm^2 during statistical analysis, were converted to their original units of RLU per 10 cm x 10 cm for ATP bioluminescence and cfu/per contact plate (A = 28.3 cm^2) for both MCA and R2A, to make them directly comparable with the CSHB guidelines shown in Table 1. Expressed in these units, the original data set for ATP bioluminescence ranged from 0 to 3500 RLU per 10cm x 10cm sampling area.

Table 1. Threshold values in assessing effectiveness of swine transport trailer washing/disinfection/drying protocol using MCA, ATP bioluminescence and R2A

Assessment criteria from CSHB, 2011		Threshold Values		
Category	**Remarks**	**MacConkey agar[a]**	**ATP bioluminescence[b]**	**R2A agar[c]**
Pass	Maintain wash, disinfection and drying protocols.	0 – 10	0 – 430	0 – 140
Critical	Risk of disease propagation, improve protocols. Room for improvement.	11 – 50	431 – 850	141 – 625
Fail	High risk of disease propagation. Identify problem and correct the wash, disinfect and drying protocol and its observance.	>50	>850	>625

a Values are in colony forming units (cfu) per agar contact plate (Ø = 60 mm). Source: CSHB Quality Control document 2011.
b Relative light unit (RLU) per 10 cm x 10 cm sampling area. Range of values obtained from regression equation derived from the paired data set.
c Values are in colony forming units (cfu) per agar contact plate (Ø = 60 mm).

Sampling location

To identify the critical areas for cleaning (i.e., 'hot spots') the trailers, five co-located samples using the ATP bioluminescence meter and either or both MCA or R2A were randomly gathered per sampling area. Figure 1 shows the mean value of RLU per cm^2 and CFU per cm^2 for each sampling location for all 16 trailers. Using the ATP bioluminescence meter, no clear 'hot spots' were identified since the RLU levels were comparable among the different sampling locations for all trailers sampled. However, significant difference ($p<0.05$) in microbial contamination levels was observed among the different sampling locations when tested using R2A and MCA plates. Specifically, microbial contamination for all trailers was significantly high on floors. Aside from corrugations on floors which make cleaning relatively challenging, accumulation of water on floor surfaces before complete drying may have contributed to this observation.

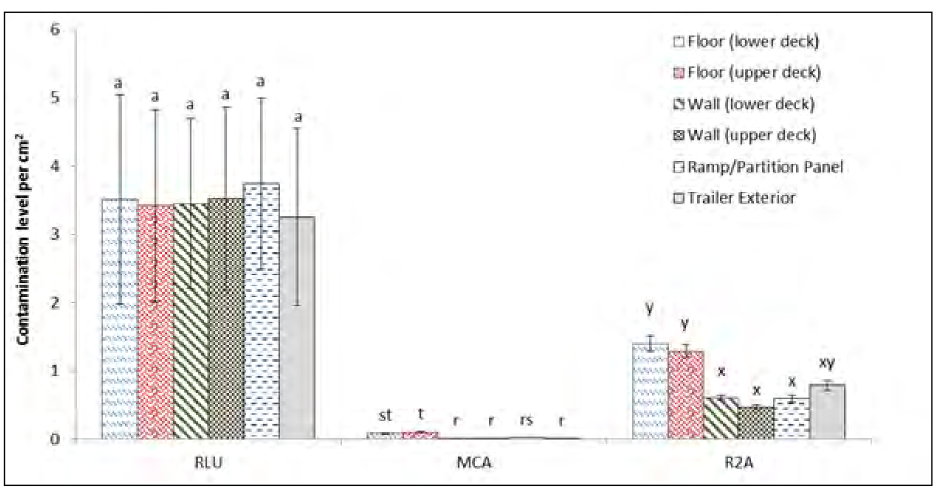


Figure 1. Mean (±SE) contamination levels (n = 16) of different sampling locations in the trailers as detected by the ATP bioluminescence meter (in RLU per cm^2), and MCA and R2A agar plates (in CFU per cm^2). Means with the same letters are not significantly different ($p>0.05$).

Figure 2 shows the plot of contamination levels in different locations in trailers washed from three different truck wash facilities (A, B, and C). Trailer floors from truck wash A had significantly higher RLU values compared to other sampling locations, while truck wash B needs to pay special attention to the walls during washing of trailers. However, microbial contamination was found concentrated on floors which may suggest careful cleaning and extra disinfection need to be applied on floors.

Trailers washed in truck wash C had mean RLU values below the suggested pass threshold level for RLU readings, indicating that the cleaning and disinfecting procedures in this facility was adequate.

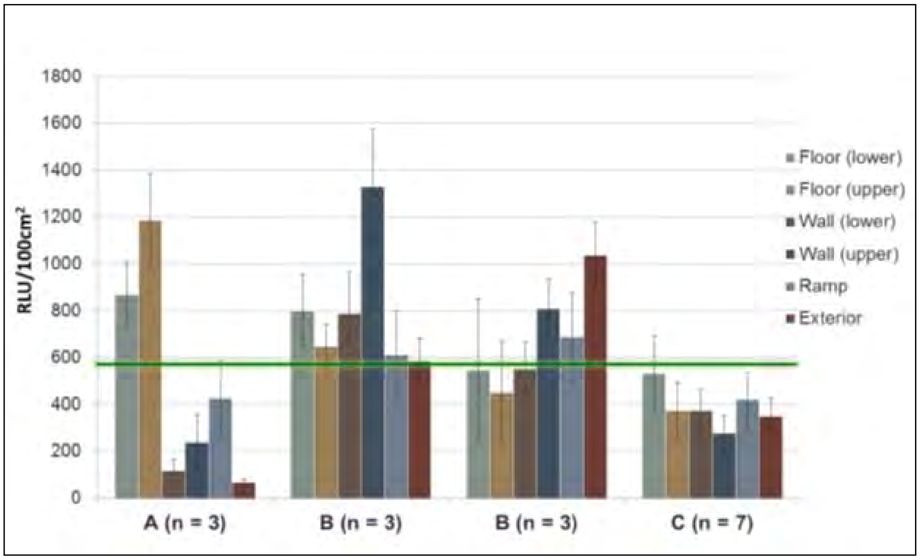


Figure 2. Mean (±SE) RLU readings from trailers washed at different truck wash facilities. Horizontal green line represents suggested RLU pass threshold.

CONCLUSIONS

- ATP bioluminescence method can be used as a tool for rapid assessment of surface cleanliness of swine transport trailers, complementing the procedures specified in CSHB (2011). Dirty areas in trailers can be rapidly identified using ATP method hence, corrective actions on the current washing/disinfection protocol can be made.
- ATP method had moderate correlation with the standard microbiological method using R2A agar plates; no readily apparent relationship was observed between ATP method and MacConkey agar (MCA) plate counts.
- Results from this study have confirmed that visual inspection of newly-cleaned transport trailers is not sufficient in assessing its surface cleanliness because significant levels of ATP and microbial loads were detected on trailer surfaces after cleaning.
- Regardless of the method of assessment used, trailer floors posed the highest risk of microbial contamination among all the six critical areas tested.

ACKNOWLEDGEMENTS

We would like to acknowledge the financial support for this project provided by the ADOPT Program by the Saskatchewan Ministry of Agriculture. The authors would also like to acknowledge the strategic program funding provided by Sask Pork, Alberta Pork, Ontario Pork, the Manitoba Pork Council and the Saskatchewan Agriculture Development Fund.

Reducing Energy Use in Group Sow Housing Systems

B. Predicala, A. Alvarado, L. Moreno, R. Baah, D. Beaulieu, J. Brown

Bernardo Predicala Alvin Alvarado

SUMMARY

Conversion of gestation sow housing from stalls to group systems has been mandated in the recently revised Canadian Code of Practice for the Care and Handling of Pigs, with all sow farms expected to adopt this practice by July 2024 (NFACC, 2014). As such, this study aimed to investigate management options that will take advantage of potential merits of group sow housing. One such advantage may be that sows housed in groups can interact with one another and exhibit thermoregulatory behavior (e.g., huddling), thereby potentially tolerating temperatures below the lower critical temperature (LCT). This could result in reduced energy costs for heating and ventilation. Housing sows in groups can also lead to aggression among gestating sows and is aggravated by feed restriction during gestation. High fiber (high heat-increment) diets have been reported to increase satiety and reduce aggression among sows in addition to increasing heat production of sows. The addition of fiber to the diet could be a means of addressing behavioral issues associated with grouped-sows as well as contributing to the energy balance of sows under reduced barn temperature.

"Preliminary results have shown that sows could tolerate temperature as low as 9 °C."

In this study, an operant mechanism was designed and developed to allow sows to control their own environmental temperature. Two barn rooms were configured for group housing, with each room containing 28 gestating sows. One room was operated at a typical set-point temperature (16.5°C) while an operant mechanism was installed in the other room, allowing the sows to control the temperature in addition to high heat-increment diets fed to the sows. The trials were carried out during the winter season and results have shown that sows could tolerate temperature lower than the current set-point maintained in most gestation barns. Lower temperature set-points could result to considerable reduction in energy consumption for heating and ventilation.

INTRODUCTION

Barn temperatures currently maintained in barns with sows housed in individual stalls are based on the reported lower critical temperature (LCT) (Geuyen et al., 1984). Allowing the temperature to drop below this LCT will require additional feed to maintain the sow body condition and weight gain over the gestation period. It has been estimated that sows housed in groups may have LCT values significantly lower than 15°C when given the ability to utilize thermoregulatory behaviour. Thus, if group-housed sows can maintain body condition and weight gain at temperatures lower than currently maintained in sow barns without the need for additional feed, the potential exists to significantly reduce energy costs for heating and ventilation.

Some issues anticipated with group-housed sows include the potential for higher activity levels and aggression among sows. These problems are exacerbated when sows are put on a restricted feeding regime, which is a common practice for gestating sows to maintain optimal body condition. The sensation of feeling "full" is improved with high-fiber (high heat-increment) diets; these diets are also known to reduce the urge to feed continuously, overall activity, and repetitive behaviour in sows. Moreover, dietary fiber increases heat production in sows without increasing digestible energy. As such, adding fiber to the diet can be a means of reducing activity and limiting aggression in sows under reduced barn temperature.

MATERIALS AND METHODS

Phase 1 – Controlled environmental chamber tests

Two fully instrumented and controlled-environment chambers at Prairie Swine Centre (PSC) were used in developing the operant mechanism that allows the sows to control their own environmental temperature. The operant mechanism consisted of a manual control switch installed in the chamber along the penning at a location which the sows can access and manipulate, and a radiant heater. When a sow activates the switch, it operates the existing supplementary heating system for the entire room for a specified period, and the radiant heater placed above the area of the switch as 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) was also installed close to the real switch to distinguish between deliberate behaviour by the sows to control the room temperature and random interaction with the mechanism. In addition two experimental diets were used, with sows in one chamber fed with the control diet (standard gestation diet) while sows in the other chamber were fed with the treatment diet (high heat-increment diet).

Phase 2 – Group-housed Sow Gestation Rooms

For the Phase 2 of the study, two rooms were used with one room was designated as "pre-set" with temperature maintained at 16.5°C (which is the typical set-point applied in sow barns) while the other room as "sow-controlled" with sows allowed to control their own environmental temperature using the operant mechanism developed in Phase 1.

With the exception of temperature, management of the two rooms was identical as much as possible. In the pre-set room, air temperature was set to 16.5⁰C while the temperature in the sow-controlled room was set at a lower temperature of 8°C to prompt the sows to activate the heat control switch for supplemental heating. At 1 degree below the setpoint (i.e., 7°C), the supplemental room heater was set to run automatically without the need of switch press from the sows. This was done to protect the animals in the room from potentially being exposed to very cold temperatures. In addition a high-heat increment diet (treatment diet in Phase 1 trials) was fed to sows in both rooms at 2.3 kg per day per sow.

RESULTS AND DISCUSSIONS

Phase 1 - Controlled environmental chamber tests

One major component needed to carry out the experiments in this research project was the design and assembly of the operant mechanism. The operant mechanism was configured to control the heating system of the chamber as well as a small radiant heater provided as an immediate feedback reward. When a sow activates the switch, it operates the existing supplementary heating system for the entire room for a specified duration as well as the small radiant heater above the location of the switch. One of the installed timers was configured to prevent sows from successively activating the heaters by deactivating the switch for a period of five minutes after its previous activation, i.e., any switch presses during this five-minute period will not operate the heaters. In order to encourage the sows to use the operant mechanism, the chambers were run at a set-point temperature of 8°C. To be able to do this, cold ambient air from outside the barn was directly drawn and streamed into the chambers.

Actual room temperature at the time when sows activated the operant mechanism was recorded and shown in Figure 1. Most of the time, sows fed with high heat-increment diet activated the operant mechanism at a relatively lower pig level temperature than sows fed with standard gestation diet. Over 3 trials, the average temperature when the operant mechanism was activated by sows fed with high heat-increment diet was 12.5 °C while that in the control chamber was higher at 13.4 °C. This suggests that sows fed with high heat-increment diet could tolerate lower temperature before calling for supplemental heat than sows fed with standard gestation diet.

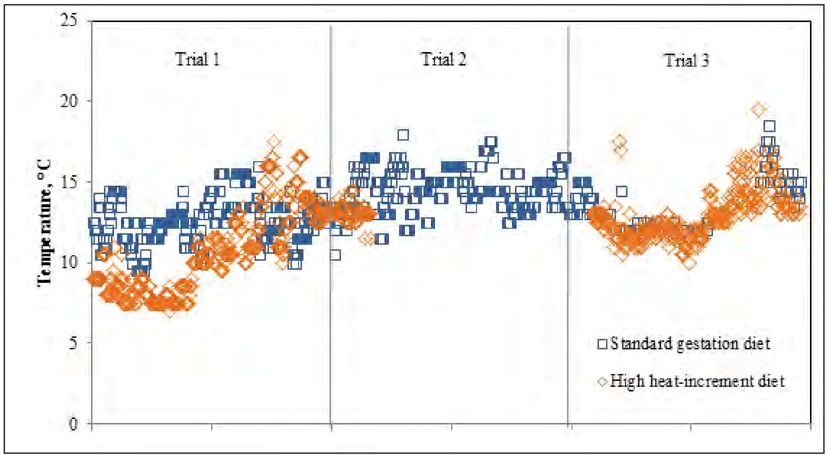


Figure 1. Pig level temperature at the time the operant mechanism was activated by the sows in the two chambers.

Phase 2 – Group-housed Sow Gestation Rooms

Figure 2 shows the average air temperature readings at 9 different locations in each room over the 6-week duration of the completed trial. Air temperature in the Pre-set (control) room was uniformly distributed which ranged from 16.4 to 17.0 °C on average (Figure 2A). Set-point temperature in this room was at 16.5 °C, which is the typical set-point for gestation rooms during heating (winter) season. Unlike in the Pre-set room, temperature in the Sow-controlled (treatment) room was relatively variable which ranged from 10.7 to 12.3 °C (Figure 2B). On average, temperature in the Sow-controlled room was about 5 °C colder than the Pre-set room.

The actual temperatures at the instant when sows activated the operant mechanism were also recorded. Throughout the trial, majority of the temperature recorded was between 9 and 12 °C. Moreover, most switch presses were made during daytime and the corresponding average temperature recorded was 9.9 and 9.7 °C during the first and second weeks, respectively. In the succeeding weeks, switch presses occurred when the average temperature at the pig level was about 10.5 to 12 °C. This initial result suggests that the preferred environmental temperature of sows is between 9 and 12 °C, although this has to be confirmed in subsequent trials.

Natural gas and electricity consumption

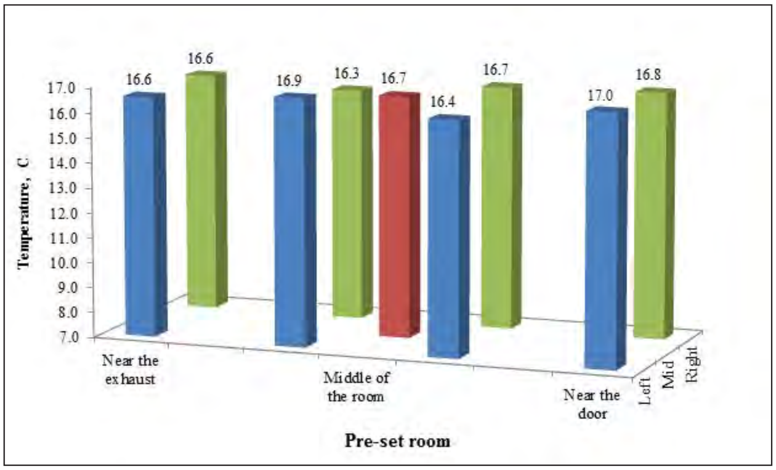
The natural gas consumed for heating and the electricity consumed by the fans, room heater, and lights comprised the energy consumption of the room. Over six weeks, the Pre-set room consumed a total of 4,622.6 m^3 of natural gas for heating; this was about 78% higher than the Sow-controlled room which had a total of 1,011.1 m^3 natural gas consumed. Similarly, the total electricity consumption in the Pre-set room during this 6-week period was about 324.55 kWh while the Sow-controlled room used about 289.81 kWh of electricity to heat and ventilate the room during this period. The considerable difference in the total energy consumption (natural gas and electricity) between the two rooms was mainly due to the difference in temperatures maintained in the rooms during the trial.

CONCLUSIONS

In Phase 1 of this project, results obtained from the controlled-environment chambers have shown that sows fed with high heat-increment diet tended to maintain relatively lower temperatures (12.5 °C on average) in the chamber than those fed with standard gestation diet (13.4 °C). Moreover, the exposure of sows fed with high heat-increment diet to relatively colder temperatures had no considerable effect on their performance and physiological response; results from subsequent trials will be analyzed to confirm the overall effect of this temperature management strategy on sow physiology and overall performance.

In gestation room trials (Phase 2), preliminary results have shown that sows could tolerate temperature as low as 9 °C, which is significantly lower than the set-point typically maintained in gestation barns (i.e., 16.5 °C). Furthermore, it was confirmed that maintaining gestation rooms at lower environmental temperature could result in considerable reduction in energy consumption (as much as 78%) for heating and ventilation. However, the overall effect of this treatment approach on sow behaviour, physiology and overall performance is still to be assessed from the data collected in the subsequent trials done in this study.

A. Pre-set Room



B. Sow Controlled Room

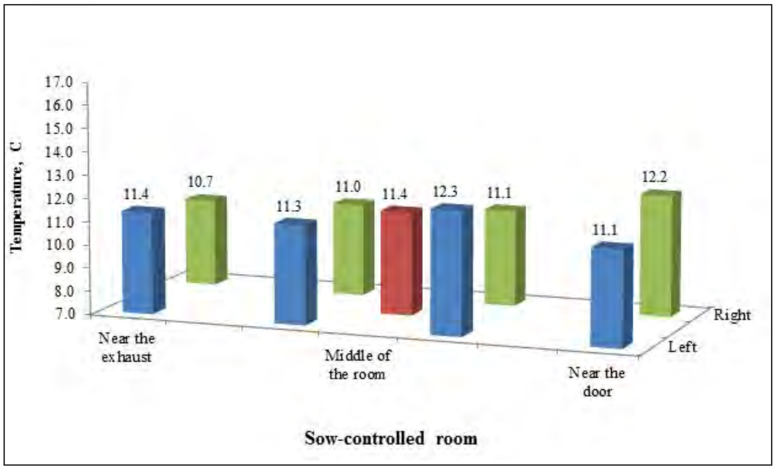


Figure 2. Average air temperature measured at various locations in the Pre-set room (A) and the Sow-controlled room (B) over 6 weeks of continuous monitoring.

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We would like to acknowledge the financial support for this research project from the Saskatchewan Agriculture Development Fund and the Saskatchewan Pork Development Board. The authors would also like to acknowledge the strategic program funding provided by Sask Pork, Alberta Pork, Ontario Pork, the Manitoba Pork Council and the Saskatchewan Agriculture Development Fund. In addition, we also wish to acknowledge the support of the production and research technicians at Prairie Swine Centre that made it possible to conduct this research.

Ventilation System Requirements for Converted Gestation Barns

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SUMMARY

Computer simulation was utilized to assess the performance of different ventilation system configurations needed for a sow gestation barn newly-converted to group housing. Various configurations of the ventilation system involving varying capacities and locations of exhaust fans as well as size, design and location of air inlets, were examined based on indoor air quality (i.e., air temperature, humidity, and air speed at the animal level) and ventilation effectiveness (i.e., air distribution and airflow pattern, inlet air velocity, and room static pressure). Based on the computer simulation results, horizontal flow ventilation system with air inlets on one side and exhaust fans on the opposite side showed the best simulated performance among all ventilation design configurations tested. The horizontal flow ventilation configuration was then selected for further evaluation in an actual group sow housing facility, where energy use, temperature and air quality, and sow welfare and performance were assessed.

"Among all the design configurations tested, horizontal flow ventilation system was the most effective in removing heat from the animal occupied zone."

INTRODUCTION

Ventilation affects many aspects of the animal environment as well as barn operating costs, specifically energy costs. Retaining the existing ventilation system in a converted group-housed sow barn leads to over-ventilation during winter because the existing minimum ventilation fans are designed for higher animal density, thereby using extra heating fuel, and most likely causing chilling of the animals and affecting its performance. According to Harmon et al. (2010), if ventilation is continued at the pre-remodeling level (prior to conversion to group housing), the building would be over-ventilated by about 33% higher than required.

An estimate of energy use for an over-ventilated facility indicated that over-ventilating by 30% can raise heating energy consumption by 75%. During summer, the impacts are less pronounced but over-ventilation will use extra electricity which translates to higher electricity cost (Harmon, 2013). In addition, the transitioning of the ventilation system design from stalls to group housing is not simply reducing the ventilation rate but requires careful reconfiguration to ensure proper air distribution throughout the room to eliminate dead spots (unventilated areas) and unwanted drafts.

Air exchange is critical to providing a healthy environment that fosters efficient pig growth by reducing humidity and noxious gases like ammonia and carbon dioxide. Since under-ventilation creates an unhealthy environment and over-ventilation wastes valuable heating and electrical energy, finding the right balance is the key to a healthy environment for both animals and workers as well as to energy savings and efficiency (Harmon et al., 2010). This balance can only be achieved by careful re-design of the existing ventilation system of a converted gestation barn.

MATERIALS AND METHODS

Assessment of ventilation system designs using computer simulation

In this project, numerical computer simulation technique which utilized computational fluid dynamics (CFD) principles to numerically simulate fluid flow, heat and mass transfer, and mechanical movement, was used as a tool to examine various design configurations and determine the most effective design of the ventilation system for a converted group sow housing facility.

The ventilation system design parameters investigated include: (1). capacity and location of exhaust fans, and (2). size and location of air inlets. These two parameters were configured in such a way that the resulting ventilation system design followed the principles of either an upward airflow, downward airflow, or horizontal flow ventilation.

Computer simulation was carried out using ANSYS Fluent 15.0 (ANSYS Inc., Canonsburg, PA, USA). The setting-up of models and mesh as well as the evaluation of results were done through the application of DesignModeler, Meshing and CFD-Post in the ANSYS Academic Research CFD Package (ANSYS Inc., Canonsburg, PA, USA). A standard κ-ε model with scalable wall functions was used. A pressure-based solver with SIMPLE algorithm was employed for the calculations

Barn implementation of the most effective ventilation system design

Two group-housed gestation rooms were used: one room designated as the Treatment room was modified to incorporate the horizontal flow configuration identified from the simulation work, while the second room's ventilation system was similar to those in pre-converted (stall) gestation barns (Control room).

A

B

Figure 1. Photos of the control room with the existing (unmodified) ventilation system (A) and the treatment room with the air inlets on the opposite side (B) following the principle of a horizontal flow ventilation system. B – inset: wall air inlets installed in the treatment room.

Figure 1 shows the ventilation design configuration of the two experimental rooms. In the Treatment room, air inlets are located on one side of the room and exhaust fans are on the opposite side allowing air to flow horizontally through the entire length of the room (Figure 1b). In the Control room, inlets are located on the ceiling while the fans are on one of the external walls; this configuration represents a downward air flow direction which is typical in commercial sow barns (Figure 1a). Each room has inside dimension of 23.1 ft (w) x 65 ft (l), two electronic sow feeders, four nipple drinkers, and housed 40 sows, on average, throughout the study.

With the exception of the ventilation system design, the management of the two rooms was as identical as possible throughout the test. Prior to the start of the trial sow feeder, sensors and monitoring equipment were all calibrated, and all sows were trained to use the sow feeders. Feed consumption of sows in the rooms were monitored in addition to daily health checks and all sows were weighed at the start and end of the trial.

RESULTS AND DISCUSSIONS

Computer models of the sow gestation rooms with different geometries were generated in the simulation work. The developed models were used in simulations under winter and summer conditions. In general, with the group housing layout and new ventilation design, heat removal effectiveness (HRE) values increased particularly when the air inlets were located on the opposite side of the exhaust fans following the principle of a horizontal flow ventilation system (HFVS). HFVS had an average HRE value of 1.32 ± 0.32, which was the highest among all the design configurations investigated. Also, for this configuration, all nine monitoring points in the animal-occupied zone (AOZ) had HRE values greater than 1 (lowest HRE was 1.08) which indicate that the air was homogeneously mixed.

During winter period, all HRE values decreased which could be attributed mainly to the lower ventilation rates maintained in the rooms during the cold season. However, HFVS still had HRE values greater than 1 in all 9 monitoring points. On average, HFVS had an HRE value of 1.11 ± 0.12, which was the highest among all the designs tested for winter. Therefore, this ventilation system configuration (horizontal flow ventilation system) was selected for the subsequent in-barn evaluation.

Temperature

Average air temperatures in both the control and treatment rooms were uniformly distributed ranging from 19.9-20.7°C and 19.3-20.8°C, respectively (Table 1). Set-point temperature in these rooms was set at 16.5°C which is the typical set-point temperature in actual gestation barns. On average, there was not much difference with the inlet air temperature for control (16.0°C) and treatment (16.1°C) rooms. However, significant difference was observed at the exhaust with the average air temperature of 19.9°C and 20.4°C for the control and treatment rooms, respectively. This may imply that the ventilation system in the treatment room is effective in removing heat from the room as compared to the control room.

The control room had an average HRE value of 0.92 ± 0.05 which generally implies that part of the fresh air coming from the inlets was directly removed from the room without mixing and without causing air displacement in the AOZ. This may result in accumulation of high contaminant levels at the AOZ because stale air is not being efficiently removed by the ventilation system. Only one point (at the center of the control room) had a HRE value of 1.0. Conversely, the treatment room had an average HRE value of 1.12 ± 0.15 indicating effective air displacement in the AOZ. Almost all the monitoring points in the treatment room had HRE values greater than one indicating that the fresh inlet air mixed well with the room air first before heading out through the exhaust.

Air quality

The treatment room had an average CO_2 concentration of 1343 ppm and ranged from 1238 to 1385 ppm. These levels were significantly lower ($p<0.05$) than the CO_2 levels in the control room which had an average of 1594 ppm and ranged from 1521 to 1654 ppm. Furthermore, the treatment room had an average CO2 concentration of 1359 ppm at the exhaust and 379 ppm at the inlet. The control room, however, had 1471 ppm at the exhaust and 538 ppm at the inlet. This implies that CO_2 was efficiently removed from the treatment room as compared to the control room, which is consistent with the HRE values calculated in both rooms.

Energy Consumption

Natural gas consumed for heating and the electricity consumed by the fans, room heater and lights comprised the energy consumption of the room. During winter, the treatment room with the horizontal flow ventilation consumed, on average, 608.7 m^3 of natural gas over four weeks for heating; this was about 21% lower than the control room which averaged 767.2 m^3. Similarly, average electrical consumption in the treatment room over four trials was, on average, 250 kWh while the control room averaged 250 kWh over the same period. The considerable difference in total energy consumption (natural gas and electricity) between the two rooms during the winter season was mainly due to frequency of heater operation; heater ran more often in the control room compared to the treatment room. During the summer months the difference in electrical consumption can be attributed to the operation of fans which is dependant on te temperature maintained in the rooms throughout the trial. It was observed the temperature in the treatment room was lower, but still within the recommended ramge, than the control room.

Location		Control		Treatment	
		°C	HRE	°C	HRE
Near door	1	20.1	0.93	19.3	1.10
	8	20.2	0.95	19.3	1.34
Middle of room	2	20.0	0.83	19.5	1.13
	7	20.7	0.91	19.9	1.26
	9	19.9	1.00	20.3	1.02
	3	20.3	0.91	20.0	1.26
	6	20.3	0.97	19.5	1.10
Near exhaust	4	20.5	0.93	20.8	0.93
	5	20.2	0.87	20.7	0.91

Table 1. Average air temperature and ventilation effectiveness at nine locations control and treatment rooms.

Sow performance and condition

Monitoring of the performance of sows in terms of rectal temperature, average daily gain (ADG), backfat depth, condition score and dirtiness over four trials showed that the average rectal temperature of sows in the control and treatment rooms was the same (36.7 °C). Moreover, no considerable difference was observed in ADG of sows in the control and treatment rooms which translated to similar condition score. Sow condition score was assessed using a 1 to 5 condition score with 1 – emaciated; 2 – thin; 3 – ideal; 4 – fat; and 5 – overly fat. Both rooms had an average sow condition score of 3 which is the ideal condition for gestating sows. On the other hand, it was observed that backfat depth of sows in both rooms decreased as each trial progressed; this cannot be attributed to the modifications done in the ventilation system in the treatment room as both rooms showed the same trend.

Room cleanliness

Sow dirtiness was assessed weekly during each trial by following a 0 to 4 dirtiness score: 0 – completely clean; 1 – mostly clean; 2 – some dirt; 3 – dirty; and 4 – very dirty. Over four trials, it was observed that sows in the treatment room were relatively 'cleaner' than sows in the control room. Sows in the treatment room had an average dirtiness score of 2 which indicates that only their hooves and 20 % of their legs and body were soiled. On the other hand, sows in the control room had an average dirtiness score of 3 which implies that their hooves and 50 % of their legs and body were soiled. Similar result was observed after assessment of pen dirtiness. Consistently, the treatment room had 25 to 50 % of its floor covered with manure while the control room had about 50 to 75 % of its floor covered with faeces and urine. Dirtiness of sows as well as pens is a good measure of an effective ventilation system, which in this case, implies that the horizontal air flow ventilation system in the treatment room was relatively more effective than that in the control room.

CONCLUSIONS

Results from the computer simulation work have confirmed the need to re-design the ventilation system of a newly-converted group sow housing facility. Among all the design configurations tested, horizontal flow ventilation system was the most effective in removing heat from the animal occupied zone (AOZ) in the room during both summer and winter seasons.

In-barn evaluation of the selected ventilation system design showed about 21% reduction in natural gas consumption during heating season and 14% reduction in electricity consumption in the room with the horizontal flow ventilation system relative to the control room with the unmodified ventilation system.

The new ventilation system design for group sow housing has provided better air quality and cleaner floors than the unmodified ventilation design. Also, the room with the new ventilation design had relatively cleaner floors than the room with the unmodified ventilation design.

Animal performance and productivity were not adversely nor beneficially impacted by having a horizontal flow ventilation system in a gestation room.

ACKNOWLEDGEMENTS

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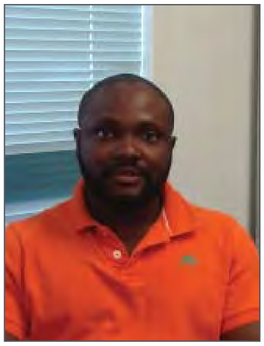
Mitigating DON Through Optimal Use of Blood Plasma in Nursery Diets

A.K. Agyekum, D.A. Columbus, S.N. Barnsley and A.D. Beaulieu



Atta Agyekum

Dan Columbus

SUMMARY

Previous research showed that nursery pigs fed deoxynivalenol (DON) contaminated diets supplemented with spray-dried porcine plasma (SDPP) had similar growth rate and feed intake as those consuming non-contaminated diets. In this study, two blocks of 100 weanling pigs were used to determine the optimal inclusion level of spray-dried bovine plasma(SDBP) required in nursery diets contaminated with DON to maintain growth performance. Growth performance was not statistically different for pigs fed the diets with DON contaminated diets and the diet without DON. Also, adding SDBP to the DON-contaminated diets had no effect on nursery pig growth performance. Therefore, we were not able to determine the optimal inclusion level of SDBP in the DON-contaminated nursery diet.

INTRODUCTION

Mycotoxins have become an important issue to local crop and livestock producers in Saskatchewan in recent years. Deoxynivalenol (DON; vomitoxin), a mycotoxin produced by various Fusarium species, contaminates grains such as wheat, barley, and corn. When cereal grains are contaminated with DON, they are downgraded and typically used for livestock feed rather than using such grains for human consumption. Among the livestock species, pigs are the most sensitive to DON and dietary exposure to levels above 1 ppm of complete diet has been reported to depress pig growth rate and feed intake and negatively impact pig health.

The most ideal solution is to replace DON contaminated grains partially or completely with clean grains for pig feed. However, this approach may not be a viable option in times when mycotoxin contamination of grains is rather high or widespread. Therefore, if pigs are to be fed cereal grains contaminated with DON, there is a need to develop cost effective strategies that will help to ameliorate the negative effects associated with dietary exposure to DON.

Spray-dried animal plasma (SDAP) has been reported in several experiments to promote feed intake and growth performance of nursery pigs and to confer health benefits when included in nursery diets. It follows that SDAP could be used as a dietary strategy to mitigate the negative effects of DON-contaminated feeds on nursery pig performance. Indeed, a previous study at Prairie Swine Centre showed that nursery pigs fed a DON-contaminated diet supplemented with spray-dried porcine plasma (SDPP) had similar growth rate and feed intake as those fed the diet without DON. However, because SDAP is expensive an optimal inclusion level that can mitigate the adverse effects associated with DON-contaminated nursery diets needs to be determined. Moreover, many producers have removed SDPP from their diets because of a reported association with the PEDv. Therefore, the objective of this study was to determine the most cost effective inclusion level of SDAP into DON-contaminated nursery diets that will maintain growth performance. Secondly, we wanted to see if spray-dried bovine plasma (SDBP) would have similar benefits to those previously observed with SDPP.

"Dietary exposure to DON levels above 1 ppm of complete diet has been reported to depress pig growth rate and feed intake and negatively impact pig health."

MATERIALS AND METHODS

Two blocks of 100 newly weaned pigs (26 ± 2 days of age) each were used for this 4-week growth trial. Piglets were housed in groups of 5 pigs/pen and pens were randomly assigned to 5 dietary treatments to obtain 8 pens per dietary treatment (40 pigs per diet). Pigs were allowed to acclimatize to their new environment and fed on a standard starter diet for 3 days post-weaning before introducing them to experimental diets (Table 1). Diets consisted of a negative control (NC; no DON, no SDAP), a positive control (PC; DON, no SDAP), and 3 PC diets supplemented with 2%, 4% or 8% SDBP The DON diets were produced by adjusting the inclusion of DON-contaminated wheat to obtain a final dietary DON concentration of 4 ppm. Diets were formulated to meet or exceed nutrient requirements for nursery pigs. Body weight and feed intake were recorded on days 0, 3, 11, 21, and 25 of the trial to calculate ADG, ADFI, and G:F. Diets were assayed for DON by liquid chromatography/mass spectrometry (Prairie Diagnostic Services, Saskatoon, SK).

RESULTS AND DISCUSSION

Diets

The NC, PC, 2% SDAP, 4% SDAP and 8% SDAP diets contained 0.3, 4.7, 4.6, 5.1, and 3.4 ppm of DON, respectively, representing 117%, 115%, 128% and 85%, of the target of 4 ppm DON. Sampling problems and uneven distribution of DON in the contaminated wheat is a potential cause of variability among the diets. The values reported are a composite of samples taken at each feeding.

Pig growth performance

Pigs showed no signs of diarrhea or vomiting throughout the trial. The NC and PC diet were not statistically different ($P > 0.10$) in any of the performance parameters measured. The final body weight, overall ADG, ADFI, and G:F were also not different ($P > 0.10$) between the NC and PC diets. The current findings contradict results of previous research showing that ingestion of diets contaminated with DON reduced growth rate and feed intake. For example, Beaulieu et al. (2007) reported that ADG and ADFI decreased by

5.6% and 4.9%, respectively, in nursery pigs exposed to 1.57 ppm of diet compared with a control diet. Analysis indicated that the NC diet used in the present study contained 0.3 ppm of DON, a level considered not harmful for pigs. However, this might have resulted in the inability to detect an effect due to DON in the current trial.

Addition of SDAP to the PC diet did not (P > 0.10) increase BW, ADG, ADFI compared with the PC diet. The varying levels of DON in the SDAP-supplemented diets make it difficult to determine the effect of SDAP on growth and intake responses of the pigs fed those diets. Therefore, we could not determine the optimal dietary inclusion rate of SDAP in DON-contaminated diets in the present study.

CONCLUSIONS

DON did not cause the expected detrimental effects on nursery pig growth performance in this study. Further, inclusion of SDBP in the DON-contaminated diet did not improve feed intake and growth rate relative to the positive DON control diet. Therefore, we could not confirm our hypothesis nor determine the optimal inclusion level because SDAP was not effective in this study. Research is ongoing to determine the mechanism of action of SDAP in DON-contaminated diets to explain the varying results.

Table 1. Composition of nursery pig diets for Experiment 1 (as-fed basis)1

Ingredient, %	Dietary Treatment				
			SDAP		
	NC	PC	2%	4%	8%
Wheat (clean)	50.93	11.05	10.80	10.54	10.03
Wheat (DON)[2]	-	39.88	39.88	39.88	39.88
Barley	4.90	4.90	5.13	5.35	5.80
Soybean meal	19.00	19.00	18.78	18.55	18.10
Whey powder	11.70	11.70	11.63	11.56	11.43
SDAP	-	-	2.00	4.00	8.00
Fish meal	9.00	9.00	6.75	4.50	-
Canola oil	2.30	2.30	2.33	2.35	2.40
Amino acids[4]	0.497	0.497	0.470	0.444	0.39
Limestone	0.05	0.05	0.375	0.70	1.35
Monocalcium phosphate	0.60	0.60	0.85	1.10	1.60
Premix[5]	1.02	1.02	1.02	1.02	1.02

[1] NC, negative control; PC, positive control; SDAP, spray-dried animal plasma
[2] DON contaminated wheat was obtained from Southern Saskatchewan in 2015 and contained 10.9 ppm DON, upon analysis.
[3] American Protein Corporation (APC 920)
[4] Amino acids (using synthetic lysine, threonine, methionine and tryptophan) were added to meet amino acid requirements.
[5] Diets contained equal amounts of vitamin and mineral premixes, salt, choline chloride and CuSO4-5 H2O.

ACKNOWLEDGEMENTS

We would like to acknowledge strategic program funding provided by Saskatchewan Pork Development Board, Alberta Pork, Manitoba Port Council, and Ontario Pork, and project funding provided by Saskatchewan Agriculture Development Fund. In addition, we wish to acknowledge the support of the production and research technicians at Prairie Swine Centre that made it possible to conduct this research.

Table 2. Growth performance of nursery pigs fed diets without or with DON and supplemented with SDAP [1,2]

	Dietary Treatment					SEM
			SDAP			
	NC	PC	2%	4%	8%	
Body weight, kg						
Day 0	8.09	8.12	8.04	8.19	8.13	0.064
Day 3	8.41	8.40	8.30	8.49	8.54	0.086
Day 11	10.55	10.38	10.03	10.48	10.65	0.209
Day 21	15.89	15.45	14.85	15.38	15.98	0.278
Day 25	18.56	18.22	17.45	17.93	18.56	0.317
P-value, diet 0.14						
ADG, kg/day						
Day 0-3	0.14	0.11	0.10	0.12	0.16	0.022
Day 4-11	0.30	0.26	0.24	0.27	0.29	0.023
Day 12-21	0.56	0.53	0.51	0.51	0.54	0.020
Day 22-25	0.70	0.71	0.67	0.66	0.67	0.033
P-value, diet <0.10						
ADFI, kg/day						
Day 0-3	0.69	0.62	0.61	0.64	0.72	0.088
Day 4-11	1.46	1.34	1.24	1.38	1.52	0.108
Day 12-21	3.29	3.01	2.80	2.99	3.10	0.145
Day 22-25	4.51	4.39	4.21	4.36	4.20	0.169
P-value, diet 0.38						
G:F, kg/kg						
Day 0-3	0.12	0.15	0.14	0.16	0.19	0.033
Day 4-11	0.19	0.18	0.18	0.19	0.18	0.007
Day 12-21	0.17	0.17	0.18	0.17	0.17	0.006
Day 22-25	0.15	0.16	0.16	0.15	0.16	0.008
P-value, diet 0.79						

NC, negative control; PC, positive control; SDAP, spray-dried animal plasma
[1] Data was analyzed as repeated measures and the p-values represent the overall time points. Pooled SEM.
[2] The experiment was conducted for 28 days. Day 0 and 25 represent day 4 and 28 post-weaning, respectively.

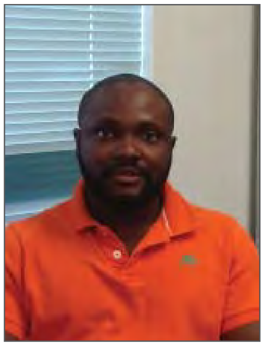
Table 3. Average daily gain, average daily feed intake and gain:feed of nursery pigs over the entire experimental period

	Dietary Treatment					SEM	P-value
			SDAP				
	NC	PC	2%	4%	8%		
ADG (kg/d)	0.42	0.40	0.38	0.39	0.42	0.01	0.11
ADFI (kg/d)	2.52	2.37	2.22	2.37	2.44	0.12	0.28
G:F (kg/kg)	0.17	0.17	0.17	0.17	0.17	0.01	0.95

NC, negative control; PC, positive control; SDAP, spray-dried animal plasma.
ADG, average daily gain; ADFI, average daily feed intake; G:F, gain:feed.

Developing Spray-Dried Animal Plasma Programs for DON Contaminated Diets

A.K. Agyekum, D.A. Columbus, and A.D. Beaulieu



Atta Agyekum

Dan Columbus

SUMMARY

This study was designed to determine if feeding high quality diets supplemented with spray-dried animal plasma (SDAP) during the early post-weaning period, will provide benefits if deoxynivalenol (DON)contaminated diets are fed in subsequent phases. Two blocks of newly weaned pigs were fed according to a 3-phase feeding program such that phase I, II and III diets were fed for 1, 2, and 1 week, respectively. Neither DON nor SDAP inclusion had an effect on nursery pig growth performance. We suspect the low and variable levels of DON in the diets (1.8 to 2.8 ppm), compared with the target (4 ppm) dietary DON contributed to the lack effect of SDAP on performance in this study.

INTRODUCTION

Deoxynivalenol (DON), also known as vomitoxin, is a mycotoxin of great concern in the grain and livestock industry. When cereal grains are contaminated with DON, they are downgraded and typically used for livestock feed rather than for human consumption. Pigs are more sensitive to DON than other livestock species, with dietary levels above 1 ppm resulting in reduced feed intake, growth depression, redu, and health-related issues. Iingestion of DON contaminated diets has been reported to cause gut lesions, and alter immune response of animals. Therefore, strategies need to be developed to mitigate the adverse effects of DON in case DON-contaminated grains are used for pig feed.

Several strategies have been used to reduce the negative effects of feeding grains contaminated with mycotoxins to swine. For instance, clay binders have been used to reduce the adverse effects of aflatoxins. However, these agents are less effective for DON contaminated diets. Recent research (Eastwood et al., 2013) at the Prairie Swine Centre showed that spray-dried porcine plasma (SDPP) was more effective in reducing the negative effects of DON in nursery pig diets than activated clay... The previous research used 8 % SDPP which would add considerably to diet cost, therefore, there is the need to determine how long it can be fed during the post-weaning period and still ameliorate negative effects of DON contamination. Moreover some producers have removed SDPP from their diets due to concerns related to transfer of PEDv. Thus, the objective of this study was to determine if SDAP, produced from bovine plasma (SDBP), fed for the first week post-weaning could confer performance benefits to piglets when fed DON-contaminated diets in subsequent diet phases in the nursery.

MATERIAL AND METHODS

Two blocks of 120 newly weaned pigs (26 ± 2 days of age) were used for this 28-day growth trial. Piglets were housed in groups of 5 pigs/pen and pens were randomly assigned to 6 dietary treatments (Table 1 and 2) to obtain 8 pens per dietary treatment. Diets were formulated to meet or exceed nutrient requirements for nursery pigs. The DON contaminated diets were produced by adjusting the inclusion of wheat naturally contaminated with DON to obtain a final dietary DON concentration of 4 ppm. Pigs were fed according to a 3-phase feeding program with Phase I, II and III fed for 1, 2 and 1 week, respectively. Body weight and feed intake were recorded weekly to calculate ADG, ADFI, and G:F. Diets were assayed for DON by liquid chromatography/mass spectrometry at the Prairie Diagnostics Lab (Saskatoon, SK).

"Neither DON nor SDAP inclusion had an effect on nursery pig growth performance."

RESULTS AND DISCUSSION

Diets

The control diet had 0.2 ppm DON, whereas DON concentration in the DON contaminated diets ranged from 1.8 to 2.8 ppm. Thus, the analyzed DON levels in the contaminated diets were below the target level (4 ppm). The reason for the low and varying DON levels in the contaminated diets is not clear although we suspect uneven distribution of DON in the contaminated wheat and the complete feed.

Growth performance

Addition of SDBP to the diets reduced ($P < 0.05$) ADFI and tended ($P = 0.07$) to reduce ADG from day 8 to 21, and overall ADFI tended to be reduced ($P = 0.05$). Nursery pigs fed diets contaminated with DON had greater ($P < 0.05$) G:F from day 8 to 21 compared with those fed the non-contaminated diet. However, there was no effect of diet ($P > 0.10$) on final body weight,

Table 1. The 6 different treatments were designed to determine the optimum feeding strategy of SDAP if DON contaminated wheat is included in phase II or III.

	Phase I		Phase II		Phase III	
TRT	DON	SDAP	DON	SDAP	DON	SDAP
1	No	No	No	No	No	No
2	No	8%	No	4%	No	No
3	No	8%	Yes	4%	No	No
4	No	No	Yes	No	No	No
5	No	8%	No	4%	Yes	No
6	No	No	No	No	Yes	No

overall ADG, ADFI, and G:F, suggesting that neither DON nor SDBP inclusion influenced performance parameters in the present study. The DON level in the DON contaminated diet may have not been high enough to elicit the same detrimental effects on piglet performance observed previously (Eastwood et al. 2013)). Besides, the control diet contained 0.2 ppm and thus could have masked the adverse effect of DON on growth performance. Further, whereas recent research (Eastwood et al., 2013) at Prairie Swine Centre suggested that SDPP may be effective in DON-contaminated diets for nursery pigs, this was not observed in the current study. We speculate the ineffectiveness of SDBP to be due to the observed lack of effect of DON contamination on growth performance.

CONCLUSION

We cannot make concrete conclusions regarding DON or SDBP effects in nursey pigs because of the difficulties encountered in this study. Thus, we were not able to achieve the target 4 ppm of DON in the contaminated diets, whereas the DON levels in the contaminated diets varied greatly. Nonetheless, research is ongoing to clarify the discrepancies in results observed in this study and previous studies.

ACKNOWLEDGEMENTS

We would like to acknowledge the strategic program funding provided by Saskatchewan Pork Development Board, Alberta Pork, Manitoba Port Council, and Ontario Pork, and project funding provided by Saskatchewan Agriculture Development Fund. In addition, we wish to acknowledge the support of the production and research technicians at Prairie Swine Centre that made it possible to conduct this research.

Table 2. Composition of nursery pig diets (as-fed basis)[1]

	Phase I		Phase II				Phase III	
DON	No	No	No	No	Yes	Yes	No	Yes
SDAP	No	8%	No	4%	4%	No	No	No
Wheat (clean)	57.7	54.9	42.1	45.6	16.6	13.1	44.2	15.2
Wheat (DON)[2]	-	-	-	-	29.0	29.0	.	29.0
Soybean meal	22.0	17.0	21.0	16.9	16.9	21.0	18.6	18.6
Barley	-	2.7	27.9	28.0	28.0	27.9	31.9	31.9
Whey powder	11.4	11.4	-	-	-	-	-	-
SDAP[3]	-	8.0	-	4.0	4.0	-	-	-
Fish meal	3.9	-	3.2	-	-	3.2	-	-
Canola oil	1.9	2.5	2.4	1.9	1.9	2.4	2.0	2.0
Salt	0.40	0.20	0.57	0.34	0.34	0.57	0.45	0.45
Amino acids[4]	0.902	0.566	0.804	0.905	0.905	2.104	0.571	0.571
Monocalcium phosphate	-	0.20	-	-	-	-	-	-
Limestone	1.05	1.80	1.30	1.65	1.65	1.30	1.55	1.55
Premix[5]	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72

[1] SDAP, spray-dried animal plasma
[2] DON contaminated wheat was obtained from Southern Saskatchewan in 2015 and contained 10.9 ppm DON, upon analysis.
[3] American Protein Corporation (APC 920).
[4] Amino acids (using synthetic lysine, threonine, methionine and tryptophan) were added to meet amino acid requirements.
[5] Diets contained equal amounts of vitamin and mineral premixes, choline chloride and CuSO4-5H2O.

Table 3. Growth performance of piglets fed DON- and SDAP-containing diets

	Treatment						SEM	Contrasts[1]				
	1	2	3	4	5	6		1 vs. 2	1-2 vs. 4-6	3 vs. 4	5 vs. 6	2 vs. 4+6
Body weight (kg)												
d 0	8.39	8.40	8.31	8.36	8.36	8.36	0.07	NS	NS	NS	NS	NS
d 7	8.99	8.99	8.85	8.65	8.95	9.03	0.15	NS	NS	NS	NS	NS
d 21	13.1	12.5	13.1	12.9	12.9	13.2	0.32	NS	NS	NS	NS	NS
d 28	17.4	16.6	17.6	17.2	16.8	17.1	0.43	NS	NS	NS	NS	NS
Average daily gain (kg/d)												
d 0-7	0.086	0.086	0.076	0.041	0.084	0.096	0.015	NS	NS	0.09	NS	NS
d 8–21	0.295	0.249	0.302	0.303	0.281	0.298	0.017	0.07	NS	NS	NS	0.02
d 22–28	0.616	0.581	0.644	0.610	0.566	0.560	0.029	NS	NS	NS	NS	NS
d 0-28	0.323	0.291	0.331	0.314	0.303	0.313	0.014	NS	NS	NS	NS	NS
Average daily feed intake (kg/d)												
d 0-7	0.132	0.127	0.127	0.088	0.141	0.134	0.010	NS	NS	<0.01	NS	NS
d 8-21	0.441	0.392	0.429	0396	0.416	0.407	0.016	0.04	NS	NS	NS	NS
d 22–28	0.864	0.810	0.883	0.824	0.831	0.846	0.026	NS	NS	NS	NS	NS
d 0-28	0.469	0.430	0.467	0.426	0.451	0.448	0.014	0.05	NS	0.04	NS	NS
Feed conversion (kg gain/kg feed)												
d 0-7	0.60	0.66	0.50	0.49	0.59	0.69	0.10	NS	NS	NS	NS	NS
d 8–21	0.67	0.64	0.70	0.77	0.67	0.73	0.04	NS	0.03	NS	NS	0.01
d 22–28	0.71	0.72	0.73	0.74	0.68	0.66	0.03	NS	NS	NS	NS	NS
d 0-28	0.69	0.68	0.71	0.74	0.67	0.70	0.02	NS	NS	NS	NS	NS

1Contrast statements were designed to answer the following questions (refer to Table 1 for treatment descriptions): 1 vs. 2 = effect of SDAP inclusion; 1 and 2 vs. 4 to 6 = effect of DON contamination; 3 vs. 4 = effect of DON and SDAP inclusion in Phase II; 5 vs. 6 = effect of SDAP inclusion in Phase II followed by DON inclusion in Phase III; 2 vs. 4 and 6 = comparing the effect of SDAP vs. DON inclusion.

Fermented Soybean Meal for Weaned Piglets

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Denise Beaulieu

Andrew Van Kessel

SUMMARY

Soybean meal contains a variety of anti-nutritional factors which limit its inclusion into the diets of young piglets. It has been shown that fermentation of soybean meal (fSBM) effectively removes trypsin inhibitors, oligosaccharides and phytic acid and improves digestibility of nutrients, including amino acids.

These improvements however, are not consistently observed (Song et al. 2010), and work is required which determines reasons for the variability among fSBM produced from different plants. Preliminary results from this research project indicate pigs receiving approximately 17% HP5010 fSBM in their diets had reduced body weight relative to the pigs receiving a comparable amount of a commercial SBM product, Hamlet 300.

INTRODUCTION

There is some evidence in the literature of improvements in feed efficiency when fSBM replaced SBM in the diet of nursery pigs. However, in many of these experiments the fSBM is used as only a partial replacement of the SBM, being used as an additive to a typical post-weaning diet. For example, Jones et al. (2010) and Gebru (2010) observed an improvement in feed efficiency when either 3.75 or 7.5% fSBM (Jones et al. 2010) or 5% fSBM (Gebru 2010) was included in the diet of post-weaning piglets. Other work has indicated that while the inclusion of fSBM in the diet of post-weaning piglets is "better" (based on performance and health indicators) than a diet with a high inclusion of SBM, piglets still do better when receiving a diet with reduced levels of soy proteins (Song et al. 2010). This suggests that optimization of the fermentation procedure is required. The objective of this project was to determine if there are differences in palatability and nutrient content of fSBM from different sources and if these differences can be attributed to specific processing methods.

"There was no evidence that the fSBM used in this experiment was superior to a standard SBM in improving growth or feed intake of the newly weaned pig."

MATERIALS AND METHODS

This study was designed to examine eight different treatments including five different fermented soybean meals (fSBM), obtained from China, standard 46% soybean meal (SBM), or the commercial products, Pepsoygen and Hamlet protein. Each week, 100 or 120 piglets, (~50% barrows, 50% gilts) were weaned at 3 weeks of age, (approximately 6 kg BW) being selected from the 130 to 160 piglets produced on a weekly basis. Piglets were assigned to treatment, ensuring equal numbers of males and females and average weight per treatment. They were then assigned at 4 or 5 pigs per pen, depending on selection pool size with either 3/2 barrows/gilts or 2/3 barrows/gilts or 2/2 barrows/gilts per pen.

Piglets were fed diets in 3 phases. Phases were 3, 18 and 14 days for phase 1, 2, 3 respectively and diets were formulated to meet all requirements of pigs of each weight range. The control diet contained the standard SBM and was formulated to contain 22% SBM in the finished diet. Individual fSBM's were substituted so that CP, NE and the lysine/NE ratio was comparable in all diets, and we assumed the AA/CP ratio was constant in all the SBM ingredients.

Diet palatability

Because diet palatability was estimated in the initial 24 hours post weaning, the time between the process of weaning and introduction to the phase 1 diet had to be consistent among pigs and rooms.

Therefore all piglets were removed from the sows at the same time (time recorded) weighed, randomized and placed into experimental pens with diets weighed into the feeders (time recorded).

RESULTS AND DISCUSSIONS

On day 14 and 21, pigs receiving approximately 17% HP5010 fSBM in their diets had reduced body weight relative to the pigs receiving a comparable amount of a commercial SBM product, Hamlet 300. Average daily gain was consistently highest on the soybean meal diet (treatment 1), this achieved significance, relative to the HP5010 on days 10 to 14 ($P < 0.05$). Differences in feed intake followed a similar pattern. A significant treatment effect was only observed during the d 15 to 21 period when a difference between the soybean meal and HP5010 diet was observed. Piglets receiving the control diet had higher feed intake relative to those receiving the HP5010 fSBM in their diet ($P < 0.05$). Although only speculative, since there were no significant treatment effects, some of these results may indicate reduced palatability with the fSBM product. The number of piglets with evidence of diet consumption during the initial 48 hours post-weaning was numerically increased on the soybean meal diet, relative to the fSBM supplemented diet.

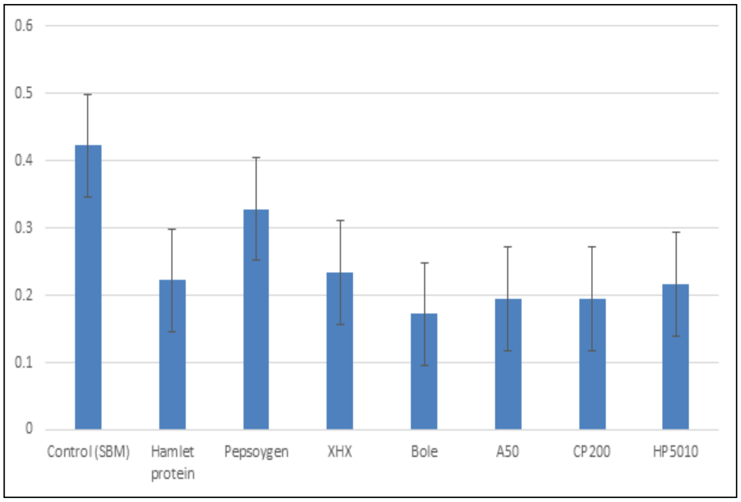

Figure 1. The proportion of piglets (mean ± SEM) exhibiting evidence of feed intake in the initial 46 hours post-weaning. Effect of treatment , P = 0.29.

CONCLUSIONS

There was no evidence in this experiment that fSBM was superior to a standard SBM in improving growth or feed intake of the newly weaned pig. Further work is required to determine potential reasons for the lack of response in this experiment.

ACKNOWLEDGEMENTS

We would like to acknowledge the financial support for this project provided by Bunge Global Innovation, LLC. The authors would also like to acknowledge the strategic program funding provided by Sask Pork, Alberta Pork, Ontario Pork, the Manitoba Pork Council and the Saskatchewan Agriculture Development Fund.

Table 1. Performance of post-weaning piglets receiving diets containing diets with fSBM replacing a standard SBM

		Experimental fSBM								
	SBM control	Hamlet	Pep	XHX	Bole	A50	CP200	HP5010	SEM	P-value
Body weight, kg										
d 0	6.37	6.45	6.45	6.38	6.39	6.42	6.5	6.46	0.05	0.39
d 3	6.15	6.27	6.20	6.25	6.07	6.11	6.23	6.13	0.07	0.27
d 9	6.56	6.79	6.64	6.69	6.51	6.53	6.64	6.51	0.10	0.33
d 14	7.70ab	8.17a	7.54ab	7.78ab	7.58ab	7.56ab	7.56ab	7.18b	0.21	0.07
d 21	10.20ab	10.60a	9.75ab	10.20ab	9.79ab	9.69ab	9.59ab	9.05b	0.29	0.02
d 28	13.40	13.6	13.10	13.40	12.70	12.80	12.40	12.10	0.43	0.12
d 35	17.90	18.30	18.00	18.20	17.30	17.20	17.30	16.50	0.61	0.42
Average daily gain, g/d										
d 0-3	-73.7	-57.6	-82.8	-42.8	-107.8	-104.1	-93.0	-111.8	19.30	0.098
d 4-21	232.2a	227.8a	202.7ab	218.1ab	203.3ab	192.3ab	186.0ab	168.1b	14.2	0.02
d 22-35	551.8	549.6	589.1	570.9	535.3	534.7	547.7	535.2	29.8	0.85
Average daily feed intake, g/d										
d 0-3	50.8	46.7	39.9	55.6	37.8	40.7	42.6	46.8	7.8	0.70
d 4-21	287.0	290.2	266.7	283.1	284.8	255.9	261.1	236.1	12.8	0.06
d 22-35	809.7	833.4	845.0	869.2	819.9	812.1	85.8	749.1	50.8	0.80
Feed conversion										
d 0-3	-2.46	-1.91	-0.62	-18.95	-5.31	51.6	4.69	-1.15	22.3	0.46
d 4-21	0.81a	0.78ab	0.76ab	0.77ab	0.71b	0.75ab	0.71b	0.71ab	0.02	0.02
d 22-35	0.69	0.67	0.70	0.66	0.66	0.68	0.70	0.74	0.03	0.41

Does the Inclusion of Lyso-Lecithin (Lecired) Improve the Growth of Newly Weaned Pigs?

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Denise Beaulieu

Pascal Leterme

SUMMARY

The inclusion of lyso-lecithin (10% of dietary fat) into high or low energy diets fed to newly weaned pigs had no effect on growth or feed conversion regardless of whether the diets contained 2, 4 or 6 % tallow.

INTRODUCTION

The newly weaned piglet is abruptly transferred from a liquid milk diet, containing about 8% fat to a dry diet with approximately 5% fat. Moreover, fat digestibility of milk fat by the suckling pig approaches 95% while the digestion of dietary fat by the piglet shortly after weaning is only about 75% (cited by Price et al. 2013). Thus, supplementing dietary fat to the diet of the newly weaned piglet does not alleviate the deficit in energy intake experienced at this time.

Price et al. (2013) showed that the addition of lecithin to the diet of newly weaned piglets improved digestibility of long-chain fatty acids. However, similar to the results of others, this did not result in an improved growth rate. Lecithin, which is primarily phosphatidylcholine, is commonly added to food, because it is an emulsifier. It is listed in CFIA, Schedule IV. We hypothesized that Lyso-lecithin will improve digestibility of tallow, resulting in a performance response when the pigs are limiting in energy.

MATERIALS AND METHODS

The experiment used 12 treatments, 10 pens of 4 pigs (weaned at 26 days of age, n = 480) per pen per treatment. Each room (considered a block) contains 24 pens, thus the experiment required 5 nursery rooms, started 1 room per week. Pigs were assigned to pen based on body weight. Gender was not considered a blocking factor.

Piglets received a commercial phase 1 diet for 7 days before switching to the phase 2 diet for the remaining 21 days. Diets were formulated to be a minimum of 5% different in NE content (approximately 120 calories) within 2 phases (average BW of weight group, 5 to 12 kg BW, and 12 to 25 kg BW). Except energy, all other nutrients met requirements for piglets of this age. In order to minimize variation among the diets, 4 batches (diets 1 to 6, 7 to 12, 13 to 18 and 19 to 24) were prepared. These were then divided into smaller batches and appropriate amounts of corn starch, cellulose and tallow added. Piglets and feeders were weighed on day 0, 3, 7, and weekly until day 42 (nursery exit). This allowed the determination of growth rate, feed intake and feed efficiency.

"Inclusion of lyso-lecithin (10% of dietary fat) into high or low energy diets fed to newly weaned pigs had no effect on growth or feed conversion."

RESULTS AND DISCUSSIONS

Overall, there were minimal effects of treatment on performance of the piglets in this experiment. Because there were very few significant interactions of lecithin with either dietary tallow or energy, only the main effects of the lecithin are shown. Adding lecithin at 10% of dietary fat to the diet did improve growth and feed intake in the first 3 days of the experiment (Table 1. $P < 0.05$, d 7 to 10 post weaning). However, despite a significant effect of the lecithin, there were no interactions with either dietary energy or tallow during this time period. We had hypothesized that lecithin would improve digestibility of the tallow, and effects would be more apparent in a low energy diet. However, as can be seen in Figure 1, the effect of lecithin was greater in the high energy diet ($P < 0.05$).

Table 1. Treatment designation.

Treatment #	1	2	3	4	5	6	7	8	9	10	11	12
Tallow, %	2	2	4	4	6	6	2	2	4	4	6	6
Lecithin	0	10%	0	10%	0	10%	0	10%	0	10%	0	10%
NE, kcal/kg	2400	2400	2400	2400	2400	2400	2280	2280	2280	2280	2280	2280
Actual lecithin inclusion, %												
Lyso lecithin (Lecired)	0	0.2 (0.4)	0	0.4 (0.8)	0	0.6 (1.2)	0	0.2 (0.4)	0	0.4 (0.8)	0	0.6 (1.2)

NOTE: Lecired is 48% lecithin.

This experiment was designed to examine the effect of lecithin in the diet, because there is evidence that fat digestibility in the newly weaned pig is impaired because of a lack of lipase enzyme, and the observation that fat emulsification would improve fat digestibility and thus energy available to the piglet. For example, the addition of 0.02% lysolecithin improved growth performance and tended to improve fat digestibility when added to the diet of weanling pig (Jin et al. 1998). However, others (ie. Price et al. 1988) saw no effect of fat emulsification on the performance of newly weaned pigs. It was suggested that dietary energy was not limiting growth in these piglets. We included the energy treatment in our experiment to test this hypothesis. Tallow was used as a fat source in our experiment because it has been shown that the digestibility of tallow a saturated fat) was improved more by the addition of dietary lysolecithin to the diet than when an unsaturated fat was used (Jin et al. 1988).

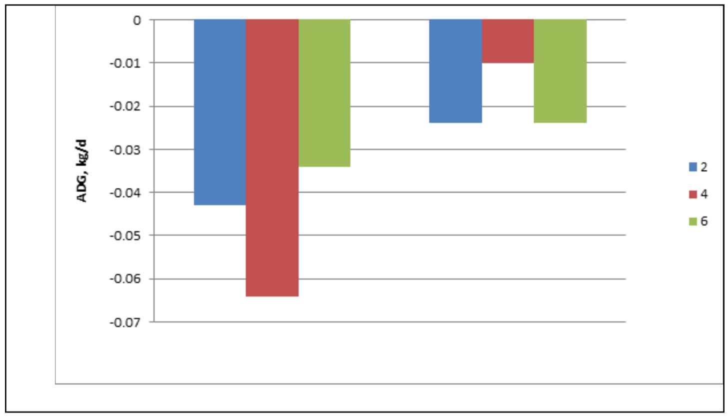

Figure 1. The interaction of lecithin (0 or 10 % of dietary fat) and tallow (P < 0.05) in the diet on the growth of weanling pigs, experimental d0 to 3 (d0 is d7 post-weaning)

CONCLUSIONS

In conclusion, the addition of 10% (of dietary fat) lyso-lecithin to high or low energy diets of weanling pigs had only modest effects on the performance of these piglets, regardless of the inclusion of tallow in the diet. Future experiments need to clarify if fat emulsification is limiting fat digestibility in piglets of this age.

ACKNOWLEDGEMENTS

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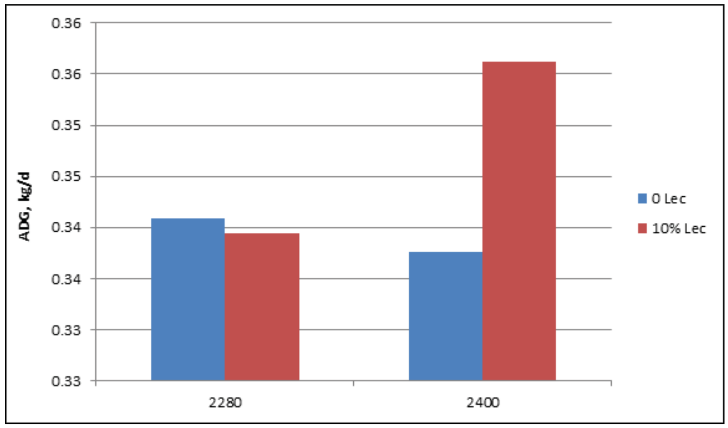

Figure 2. The interaction of lecithin (0 or 10 % of dietary fat) and dietary energy content (P < 0.05) on the growth of weanling pigs, experimental d0 to 28 (d0 is d7 post- weaning)

Table 2. Ingredient composition of phase 1 diets (5 to 12 kg BW)1

	Treatment					
	1,2	3,4	5,6	7,8	9,10	11,12
NE, kcal/kg	2400	2400	2400	2280	2280	2280
Tallow, %	2	4	6	2	4	6
Lecired*, %	0, 0.4	0, 0.8	0, 0.12	0, 0.4	0, 0.8	0, 0.12
Ingredients, % as fed						
Wheat	38.52	38.52	38.52	38.65	38.65	38.65
Barley	5.70	5.70	5.70	……..		……..
Soybean meal	23.00	23.00	23.00	23.70	23.70	23.70
SD whey	10.71	10.71	10.71	10.71	10.71	10.71
Canola meal	8.00	8.00	8.00	8.00	8.00	8.00
Lysine HCl	0.480	0.480	0.480	0.455	0.455	0.455
DL methionine	0.145	0.145	0.145	0.130	0.130	0.130
L-threonine	0.035	0.035	0.035	0.045	0.045	0.045
Corn starch	8.01	4.01	0.00	8.00	4.00	0.00
Cellulose (solka Floc)	……..	2.00	4.00	5.00	7.00	9.00
Tallow	2.00	4.00	6.00	2.00	4.00	6.00

[1] Diets also contained minerals and vitamins in amounts sufficient to meet requirements for pigs of this age.

Stimulating Exploratory Behavior in Piglets: Effects on Pre-Weaning Creep Consumption

Y.M. Seddon, M.M. Bouvier, and J.A. Brown

Yolande Seddon

Jennifer Brown

SUMMARY

This study investigated whether pre-weaning creep consumption can be increased through stimulating exploratory behaviour in piglets, and whether this is best achieved through provision of enrichment (E) or through presentation of creep in a large shallow feeder. In order to examine differences between farms , studies were conducted at Prairie Swine Centre (PSC) as well as two commercial farms.

The enrichment treatment (E) consisted of cotton ropes hung in the farrowing pens, and was compared to pens with no enrichment. Each pen was also given one of two types of feeders; a standard feeder or a large tray feeder, giving four different treatment combinations. Results indicate that piglets provided with E interacted with it in 5% of observations. Overall, the tray feeder resulted in a greater frequency of piglet visits to the creep feeder compared to a standard round feeder, but there was no effect of enrichment. Fecal swabs indicated that over 50% of animals with access to a tray feeder were eaters prior to weaning.

The provision of a large tray feeder that encourages social feeding, appears to have a greater influence than rope enrichment on attracting piglets to creep feed. While the increased creep disappearance found with the tray feeder indicates that more piglets were interacting with the creep, no benefits to growth rate were found.

INTRODUCTION

Weaning is a stressful experience for piglets due to several factors, including an abrupt change from a liquid (milk) diet to a solid diet, removal from the sow, change of pen environment, and mixing with other litters. The cumulative result is that piglets will often fail to consume feed in the first days after weaning, and a reduction in growth is commonly seen. In some situations this can also result in reduced immunity and impaired gut function.

Creep feeding in the farrowing pen is done to familiarize piglets with solid food prior to weaning. Trials conducted at Prairie Swine Centre Inc. have previously demonstrated the importance of creep feed intake in the nursing period on growth of the weaned pig. Piglets that consumed creep feed while nursing, or that consumed feed immediately after weaning significantly outperformed their litter-mates. However, studies have shown that fewer than half of the piglets in a litter actually consume creep feed (Beaulieu et al., 2011). In the wild, piglets learn to consume appropriate foodstuffs while foraging in social groups, imitating the behaviour of the dam and littermates (Stolba and Wood-Gush, 1989). In contrast, standard farrowing crates are relatively barren and uniform, and combined with restriction of the sow in a crate, provides little opportunity for interaction or exploration by piglets.
A recent study at Prairie Swine Centre Inc. showed that providing creep feed to piglets in a large tray feeder, as opposed to a conventional round feeder, resulted in a number of improvements. Benefits of the tray feeder included: more frequent feeder visits, more piglets at the feeder per visit, greater creep feed disappearance, and importantly, no weight loss during the first days post weaning.

"Feeder type resulted in a greater frequency of piglet visits to the creep feeder, but there was no effect of enrichment."

Observation of feeding behaviour indicated that the large tray feeder encouraged social feeding more effectively than the standard round feeder. This is accomplished by facilitating exploratory behaviour and synchronized feeding as compared to when creep was presented in a standard round feeder. However, it is still unknown whether the tray feeder increases the number of piglets consuming creep per litter, or whether it increases the amount eaten by those pigs that consume creep. Therefore, the following study was conducted to investigate whether the results of previous studies could be replicated when repeated at multiple farm sites, and to assess individual piglets response in terms of the number of pigs affected per litter.

MATERIALS AND METHODS

Forty-eight litters were studied on three farms across Saskatchewan farms (16 litters per farm). On each farm, four litters were assigned to each of four treatments.

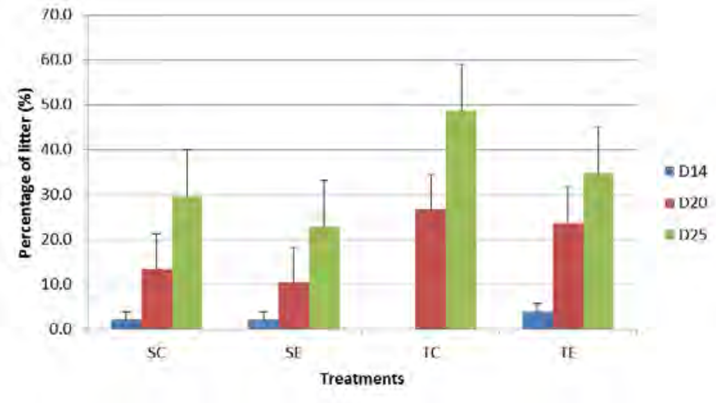

Figure 1: Percentage of piglets per litter showing evidence of creep consumption in farrowing. Results of swabbing on days 14, 20 and 25 of age (pre-weaning) across four treatments, standard creep feeder control (SC), standard creep feeder with rope enrichment in the pen (SE), creep provided in a tray feeder (TC) and creep provided in a tray feeder with rope enrichment provided in the pen (TE). (PSCI herd; n = 16, four litters per treatment).

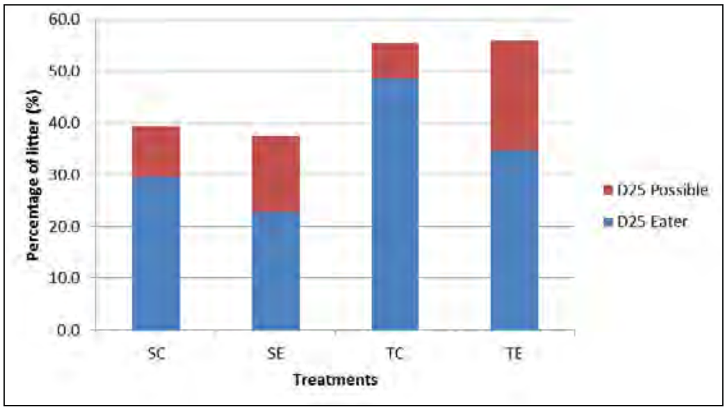

Figure 2: Percentage of piglets per litter considered eaters and possible eaters on day 25 of age (pre-weaning). Four treatments studied: standard creep feeder control (SC), standard creep feeder with rope enrichment in the pen (SE), creep provided in a tray feeder (TC) and creep provided in a tray feeder with rope enrichment provided in the pen (TE). (PSCI herd, n = 16, four litters per treatment).

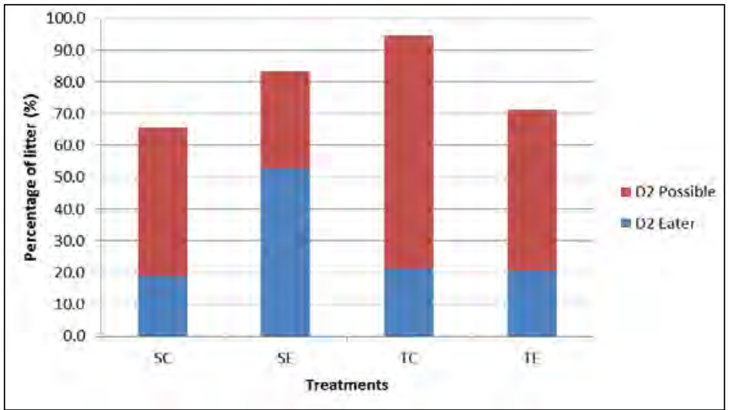

Figure 3: Percentage of piglets per litter considered eaters and possible eaters at day 2 after weaning. Four treatments studied: standard creep feeder control (SC), standard creep feeder with rope enrichment in the pen (SE), creep provided in a tray feeder (TC) and creep provided in a tray feeder with rope enrichment provided in the pen (TE). (PSCI herd, n = 16, four litters per treatment).

Treatments consisted of:
T1. Provision of creep in a standard feeder (SC),
T2. Provision of creep in a standard feeder with addition of environmental enrichment (SE),
T3. Provision of creep in a large tray feeder (TC),
T4. Provision of creep in a large tray feeder with the addition of environmental enrichment (TE)

In order to encourage exploratory behavior, a cotton rope was provided to treatment groups to encourage exploratory behavior prior to the addition of creep feed. Creep feed was offered to all litters from 10 days of age until weaning. For all farms, on days 12, 19 and 25, an indigestible, non-toxic, food grade dye was added to the piglet creep feed as required. Anal swabs were taken from piglets 48 hours following provision of dye into the creep feed to identify 'eaters' and 'non-eaters'. Eaters were identified as those piglets for which an anal swab revealed the colour of the feed dye.

Prairie Swine Centre

- For the PSC herd, the quantity of feed provided to each litter was recorded, and feed returns were measured at weaning, in addition, anal swabs were taken from every piglet per litter on trial.
- Piglets were weighed on four occasions: day five of age, the day of weaning, day two post-weaning (to determine growth-check post weaning) and day 14 post weaning.
- 50% of litters across all treatments were monitored for behavior using digital cameras, with photos taken at five minute intervals.
- Photos were used to document the number of interactions with the enrichment and the number of piglets present at the feeder per visit.

Commercial Herds

- For the two commercial herds, swabs were taken from six piglets per litter, with piglets identified using ear tags.
- Individual pig weights were taken from the six identified piglets at days five and 19 of age (pre-weaning), and days 22 and 34 of age (post-weaning).

At weaning, litters from the same treatment were mixed together to form pen groups in the nursery. Litters that received enrichment in the farrowing pen were also provided rope enrichment in the nursery. On the day of weaning, a different coloured dye was added to the phase 1 starter diet, and pigs were determined as 'eaters' and 'non-eaters" 48-hours later using anal swabs.

RESULTS AND DISCUSSION

Prairie Swine Centre

In three of four treatments, piglets showed evidence of creep feed consumption starting on day 14 (4 days after presentation of creep feed), and the percentage of piglets feeding increased over the pre-weaning period (Figure 1). Litters given the tray feeder and no enrichment had the largest percentage of piglets showing evidence of creep consumption on day 25, but this difference was not significant.

Table 2: Effect of feeder type or enrichment provision on percentage of piglets showing evidence of eating creep before and after weaning

	Before weaning (%)			After weaning (%)		
Treatments	Eater	Non-eater	P	Eater	Non-eater	P
Standard (n = 143)	52	48	0.0002	70	30	NS
Tray (n = 147)	73	27		66	34	
Enrichment (n = 145)	58	42	NS	66	34	NS
No enrichment (n = 137)	67	33		70	30	

N.B. Data from the SK 2 site were not included in this analysis.

When including piglets that were considered 'possible eaters' (swab was not bright blue, but darker than normal, indicating probable passage of blue dye) the results indicate more than 50% of piglets were utilizing tray feeders, compared to less than 40% with the standard feeder (Figure 2). When sampled on day two after weaning, litters given the tray feeder showed that, on average, 20% of the litter were definite eaters, with over 90% of the litter being eaters and possible eaters (Figure 3).

Commercial Herds

For the two commercial herds, six pigs per litter were swabbed rather than the whole litter. For one of the herds the percentage of piglets identified as eaters was very low when compared to the other two sites. This most likely indicates there was a problem with either the correct timing and delivery of dye into the creep, or the criteria used to identify "eaters" at that site.

Comparing individual effects of feeder type (standard creep or tray feeder) and presence or absence of enrichment on the percentage of eaters and non-eaters from two sites indicates more "eaters" with the tray feeder prior to weaning (Table 1). Data from one barn site were excluded from this analysis due to the low numbers of eaters before and after weaning.

Growth Rate

Based on the results of this experiment there was no significant effect of feeder type or enrichment provision on the ADG of piglets (prior to weaning, immediately post weaning, or in the post-weaning period). This remained true with data analyzed separately for each site (data not shown).

From data at PSC, pigs identified as possible eaters had a significantly lower ADG in the pre-weaning period (Mean, ADG(kg): Eater: 0.28; Non-eater: 0.30, pooled SEM: 0.01, P<0.01), with no significant effects of 'eater' status on the ADG in the post-weaning period. Examining differences in body weight between eaters and noN eaters, piglets identified as possible eaters had a lighter body weight at day 20 of age (Eater: 6.64 ± 0.14; Non-eater: 6.95 ± 0.17; P<0.01), and on the day of weaning (Eater: 8.27 ± 0.21; Non-eater: 8.62 ± 0.24; P<0.05) compared to piglets that were identified as non-eaters.

It was useful to analyze individual piglet weights on whole litter data from PSC. Lower average weights in piglets that were eaters supports earlier research indicating that smaller pigs within a litter generally obtain poorer teats on the sow, receive less milk, and are therefore more likely to consume and benefit from creep feed

CONCLUSIONS

The manner in which creep feed is presented to piglets can be improved, as demonstrated by the significant increase in frequency of visits to the tray feeder as compared to the standard feeder. In addition, the different presentation of creep appeared to increase the number of piglets consuming creep feed. The small number of pigs and litters used in this study made it difficult to find significant differences.

A large tray feeder that encourages social feeding and foraging appears to be more effective at attracting piglets to creep than a standard feeder, or the provision of rope enrichment. While a previous study showed that providing the tray feeder before weaning had a positive effect on piglet growth after weaning, a similar result was not found in the current study. Further research is needed in this area to optimize the pre and post weaning environment to better accommodate the learning and exploratory behaviour of the pig.

ACKNOWLEDGEMENTS

We would like to acknowledge the financial support for this project provided by the Canadian Agricultural Adaptation Program. The authors would also like to acknowledge the strategic program funding provided by Sask Pork, Alberta Pork, Ontario Pork, the Manitoba Pork Council and the Saskatchewan Agriculture Development Fund.

Determining Effective Enrichments for Group Housed Sows

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SUMMARY

Effective enrichments have been shown to reduce aggression and injuries, and can be an effective tool to improve the management of group-housed sows. This project set out to identify the most effective forms of enrichment based on attractiveness, durability, and sustainability of a range of enrichment objects. The objects identified as most effective within this study will be used in a future enrichment study.

Groups of 28 multiparous sows and gilts were housed in walk in/lock in stalls with a partially slatted loafing area. Five treatments were examined over five days, including: 1) a horizontal piece of wood (4"x4"), suspended on chains between two posts; 2) a block of wood (18"x 2"x 4"), attached to a chain allowing the block to rest at a 45^0 angle; 3) three items (rope, chain, and wood block) hung together on a chain; 4) straw provided in two metal racks; and 5) straw placed on the solid floor at 300g/day/sow.

When looking at the overall interaction, the percentage of sows interacting with enrichment items on day 1 far exceeded those on days 3 and 5. This habituation response was expected. There was an increase in sows lying down throughout the five day treatment with the swing, straw on the floor, and straw in a rack treatment groups. Ranking the enrichment treatments according to durability, safety, and sow attractiveness resulted in the following ratings (first to last): straw on the floor, straw in a rack, three-item enrichment, and the block of wood. Based on these results, the straw, cotton rope and the wooden block treatments will be further examined in the next phase of the study.

INTRODUCTION

The provision of enrichment is recognized as an important environmental modification to improve the biological functioning and well-being of animals (Newberry, 1995). It is also a requirement for pigs reared in Canada as defined within the revised Canadian Code of Practice for Pigs. For pigs, enrichment provides an outlet for their highly motivated exploratory behavior, and promotes positive social interactions. Failure to provide enrichment has been linked to the development of adverse behaviours, most notably tail-biting in grow-finish pigs; and in sows, increased aggression and stereotypic behaviours (Van de Weerd, 2006; Wittaker et al., 1999). Studies have shown that sows value access to enrichment in their home pen (Elmore et al., 2011), and its use in group housing systems has the potential to improve welfare by reducing aggression, stimulating exercise and increasing measures of positive affect (Dudnik et al., 2006).

"Viable enrichments were durable, with little to no maintenance required after 1 week of use. "

Development of environmental enrichments that can be effectively used in group sow housing systems (on slatted or partially slatted floors) will provide important management tools to help producers manage sows in groups. Specifically, effective enrichment will help to reduce aggression and injuries, and promote sow well-being through expression of rooting and exploratory behaviours. Sows may also be more fit at farrowing, giving potential for shorter birthing intervals, and fewer laid-on piglets. Addressing the challenge of suitable and effective environmental enrichment for slatted-floor systems

Figure 1. Sows at the Prairie Swine Centre interacting with the block of wood enrichment.

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will provide producers with useful tools to meet or exceed future codes, and achieve the intended social and physical benefits of enrichment, such as improved fitness and reduced culling due to aggression and injuries.

MATERIALS AND METHODS

Three groups of 28 multiparous sows and gilts were housed in walk in/lock in stalls with fully slatted group housing. In each group, five treatments were examined over five days, including: 1) Swing: a horizontal piece of wood (4'x 2"), suspended on chains between two posts; 2) Block of wood (18"x 2"x 4"): softwood attached to a chain allowing the block to rest at a 450 angle on the floor; 3) Three items (rope, chain, and wood block): hung together on a chain; 4) Straw provided in two metal racks; and 5) Straw on the floor at 300g/day/ sow delivered an hour after feeding.

Initial sow enrichment interactions were observed at two minute intervals for one hour by live observation while sows were locked out of the stalls. Enrichment interaction and activity were recorded using time lapse photos at 10 minute intervals for 8hrs/day on days 1, 3 and 5. Based on results from the first replicate, the swing device was removed from the study at one week as it was deemed a hazard and unsafe for the sows.

Based on the results of this initial enrichment assessment, a full study will be carried out on approximately 224 sows (28 sows x 8 reps) at PSC, and 120 sows (22 sows x 5 reps) at the University of Manitoba. Each group of sows will be exposed to a series of treatments of 12 days each. These trials are currently on-going at Prairie Swine Centre Inc. and the University of Manitoba.

RESULTS AND DISCUSSIONS

Enrichment interactions on days 1, 3, and 5 are shown in Figure 2. Straw on the floor was the most popular, followed by straw in a rack, the 3-piece item, the swing, and the wooden block. The percentage of sows interacting with enrichment items on day 1 far exceeded those on days 3 and 5. This can be attributed to the 'novelty' of the enrichment items, and the reduced interaction with objects on subsequent days is known as habituation. Interactions with the swing device decreased significantly over the five day study, and sows were notably apprehensive of it. The percentage of interacting sows also decreased for the 3-piece item, straw on the floor, and straw in a rack. Average use of the wooden block increased slightly from day 3 to day 5.

Figure 3 shows percentage of sows that were present in the solid area of the T pen, which is an indication of the overall attractiveness of the enrichment. Day 1 had the highest percentage of sows in the solid area for each treatment. The percentage of sows present increased from day 3 to day 5 in every treatment except for the 3-piece item.

Sow postures in the solid group space were also examined as an estimate of enrichment attractiveness. Observations focused on the average percentage of sows lying down (Figure 4), as lying behaviour can be interpreted as an indicator of satiety and comfort. It is important to note that sows were categorized as either interacting with the enrichment or lying down, which explains why there was the lowest percentage of sows lying down on day 1. There was an increase of sows lying down throughout the five day treatment with the swing, straw on the floor, and straw in a rack treatment groups. Straw is known to be a valuable enrichment item, so the increase in sows out of their crates and lying down in the straw treatments was an expected result. The percentage of sows lying down when given the swing increased dramatically over day 1, 3, and 5. This was likely due to negative feedback from the device as the enrichment swung in an erratic manner and was observed to swing against their legs. This would explain the decline in interactions over time, shown in Figure 2.

CONCLUSIONS

It was concluded that ranking of enrichment treatments in terms of durability, safety, and sow attractiveness were as follows: 1) Straw on the floor, 2) Straw in a rack, 3) Three item enrichment, and 4) the Block of wood. The swing (horizontal wood) treatment was removed from the study due to it being a safety hazard to sows. No sows were injured, but the necessary precaution was taken. Each of the viable enrichments was durable, with little to no maintenance required after 1 week of use.

ACKNOWLEDGEMENTS

Strategic funding provided by Sask Pork, Alberta Pork Council and Saskatchewan Agriculture and Development Fund. Specific project funding is provided by Swine Innovation Porc within the Swine Cluster 2: Driving Results Through Innovation research program. Funding is provided by Agriculture and Agri-Food Canada through the AgriInnovation Program, provincial producer organizations and industry partners.

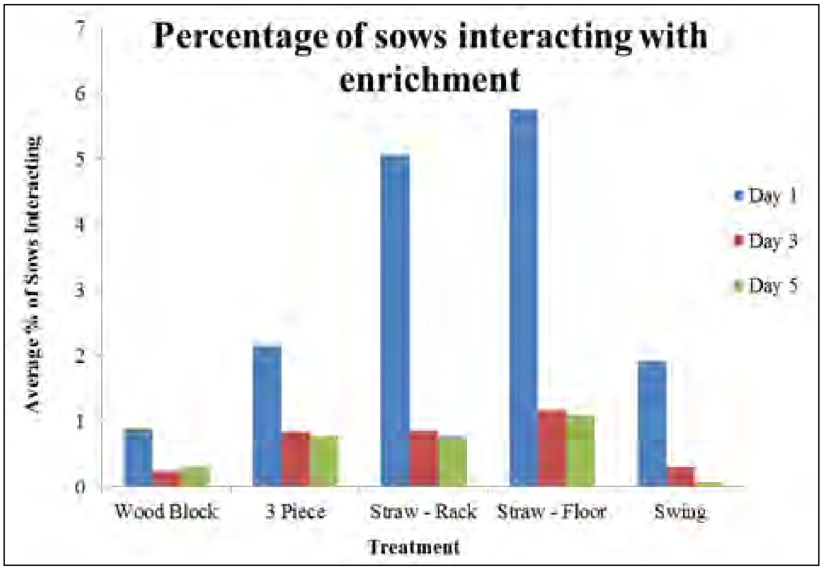

Figure 2. The percentage of sows interacting with enrichment over an 8 hr period, on days 1, 3, and 5

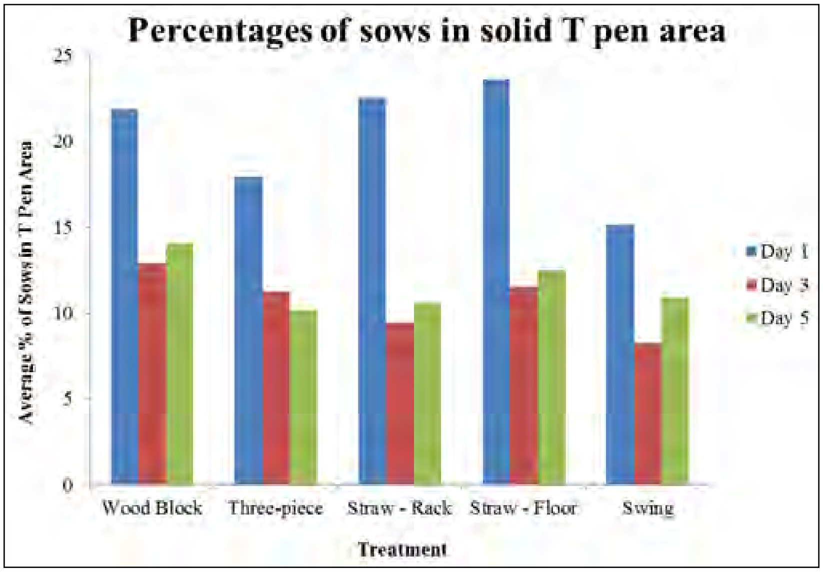

Figure 3. The percentage of total sows in the solid T pen area on days 1, 3, and 5

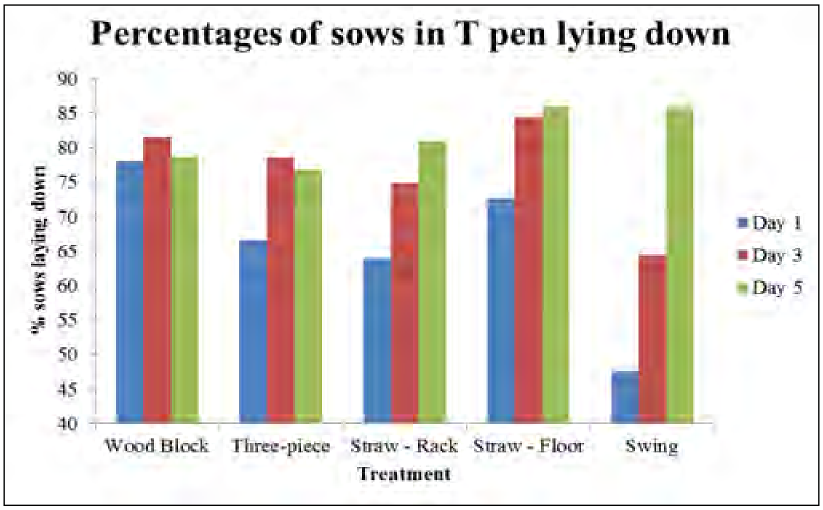

Figure 4. The percentage of sows in the solid T pen area lying down on days 1, 3, and 5

Determining the Optimum Stocking Density in Nursery Pigs

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SUMMARY

Floor space allowance is a complex issue in swine production, and one that is critical for both economic and welfare reasons. The quantity of space provided substantially affects pig welfare by influencing behaviour, stress and social interactions, and has significant economic impacts on productivity and the total pig throughput possible on a farm. It's important that recommendations for the minimum floor space allowance for groups of pigs are not arbitrary, but based on sound biological and economic research. The current space allowance requirements specified in the Canadian Code of Practice for the Care and Handling of Pigs are largely based on research performed on grower-finisher pigs. However, comparatively little is known on the effects of space allowance on nursery pigs, and current space allowance requirements may overestimate the requirements for nursery pigs due to their increased willingness to overlie one another. The objective of this project is to determine a precise value for the minimum space allowance for nursery pigs which provides an optimal and scientifically defensible balance between profitability and animal welfare.

INTRODUCTION

Floor space allowance is a complex issue and one that is critical for both economic and welfare reasons. The most widely accepted method in defining floor space allowance (A) is to relate it to the size of pig by converting body weight (BW) through the expression of $A = k * BW^{0.667}$. The critical k value established by Gonyou et al. (2006) was used to calculate the minimum required space allowance for nursery pigs in the Canadian Code of Practice for the Care and Handling of Pigs (NFACC, 2014). However, relative little is known concerning effects of stocking density allowance on nursery pigs (EFSA, 2005; Gonyou et al., 2006), and tit is hypothesized that the k value which is designed for finishing pigs may overestimate the requirements of nursery pigs, as nursery pigs have a greater willingness to overlie one another.

Although individual pig growth declines at higher densities, it has been reported farm profitability can increase as we increase pig density, as fixed costs are spread across a greater number pigs (Kornegay and Knotter, 1984). Therefore the economic optimum for space may be lower than that for achieving maximum growth rate. However, stocking at higher densities can also negatively affect the welfare of the pig, with risk of immune suppression and increased disease susceptibility (Turner et al., 2000) and restriction of pigs' ability to express normal behaviors.

It has been recommended that evaluations of space requirements for pigs should include changes in the behaviour of pigs, and establish the welfare relevance of such changes, to support calculation of space allowances based on what space an animal needs rather than solely on the basis of production performance (Ekkel et al., 2003). Group size and seasonal differences should also be evaluated or controlled for as these factors may also influence growth and behavior (Hyunh et al., 2005, Spoolder et al., 2012),. It has been suggested that larger groups of pigs may require less space, due to the sharing of free space (McGlone and Newby, 1994). However, this has also been disputed (Street and Gonyou, 2008).

This study will examine measures of productivity and welfare in nursery pigs, and will include an economic analysis comparing space allowance treatments above and below the Code requirement of k= 0.0335.

"Preliminary results suggest that housing pigs at a lower space allowance did not negatively affect the growth of animals."

MATERIALS AND METHODS

Phase 1

Animals: Density studies at PSCI were conducted using 1,200 newly-weaned pigs that were housed in the nursery for 5 weeks. Piglets were housed at one of six different densities (k= 0.023, 0.0265, 0.0300, 0.0335, 0.0370, and 0.0390) in pens of either 10 or 40 pigs/group. Four four replicate trials were completed over a one year period, with one replicate per season. Pigs were weighed weekly and pen size was adjusted weekly to the prescribed density based on the predicted average body weight. Two temperature and humidity monitors (iButtons) were placed in each pen, suspended approximately 15cm above pig height to monitor conditions at pig level. An additional iButton was suspended in the center of the room to monitor room temperature and humidity throughout the trial.

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Data collection: Video cameras were placed above each pen to record pig behaviour for a 24 hour period once per week. An infra-red setting was used during the hours of darkness. Scan sampling at 15 minute intervals was used to identify laying postures and overlying behavior. Standard nursery diets were provided ad libitum, and feed weigh backs were recorded weekly. Total feed consumption and animal weights were recorded on a weekly basis.

Lesion scores were assessed weekly as pigs were weighed, and used as an estimate of aggression (Table 1). Saliva samples were collected weekly from four focal pigs for determination of cortisol as an indicator of stress. The immune response was tested in six pigs per pen, with pigs receiving vaccines for Mycoplasma hyopneumonie. Serum samples were collected at three time points to determine M.hyo specific IgG as a measure of immune competence.

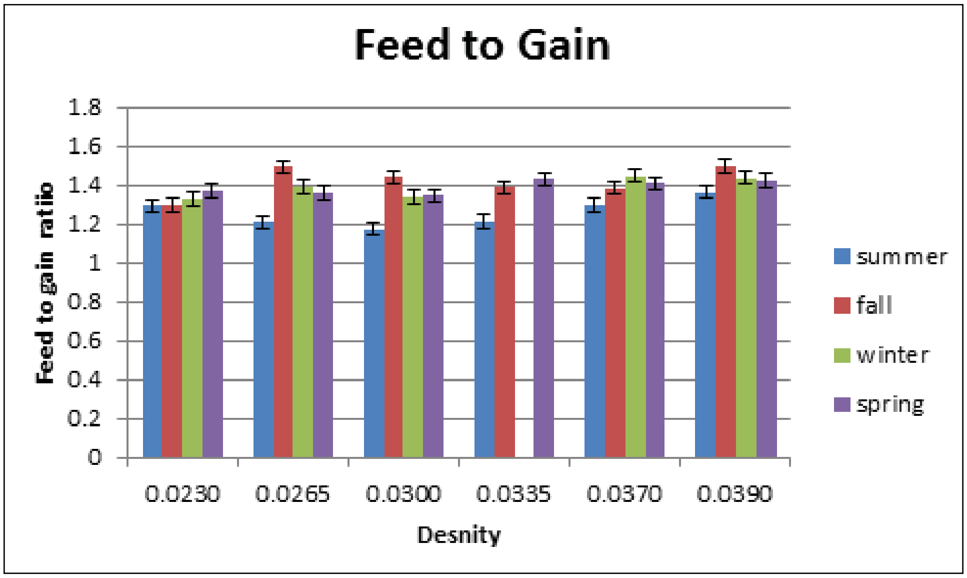

Figure 1. Feed to gain ratio in Phase one trials

RESULTS AND DISCUSSIONS

Growth

Pigs on trial gained an average of 0.3924 Kg per day, with the best growth occurring during the summer months at densities 0.0265 and 0.0390. There were no noticeable differences in ADG between densities; pigs given less space at a k value of 0.0230 did just as well on average as pigs given the most space (k = 0.0390), however there were some seasonal interactions with density. As shown in Figure 4 the feed to gain ratios observed were fairly consistent across seasons and densities, with the summer months being the best for all densities.

Immune Response

A seasonal effect on immune titers was seen with the highest titer values in summer. As only a minor immune challenge (inactivated m. hyopneumoniae vaccine) was present, it is plausible that increased titer and growth rates result from improved ventilation in summer months. Low titer levels and poor growth response during the cooler months may indicate that animals are facing other immune challenges at this time. There were no apparent effects of density treatment, indicating that the tighter densities did not affect immunity.

CONCLUSIONS

Based on Phase 1 of the study conducted at Prairie Swine Centre, preliminary results suggest that housing pigs at a lower space allowance did not negatively affect the growth of animals. However, final conclusions are not available as analysis of piglet behavior and stress response has not been completed, and the commercial trials are ongoing.

ACKNOWLEDGEMENTS

Strategic funding provided by Sask Pork, Alberta Pork Council and Saskatchewan Agriculture and Development Fund. Specific project funding is provided by Swine Innovation Porc within the Swine Cluster 2: Driving Results Through Innovation research program. Funding is provided by Agriculture and Agri-Food Canada through the AgriInnovation Program, provincial producer organizations and industry partners.

National Sow Housing Conversion Project

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SUMMARY

The National Sow Housing Conversion Project (NSHCP) is a descriptive project intended to facilitate the successful conversion of Canada's sow barns to group gestation housing. The project brings together industry and scientific expertise to produce a comprehensive national strategy involving demonstration farms and technology transfer to support Canadian pork producers. The full project will track four barns across Canada as they convert to group housing, and will collect less detailed information from a further ten barns where group housing has already been implemented. The information collected is in the form of questionnaires, interviews, photos, videos, barn layouts and production and economic data. The results are being made available to producers through producer meetings and presentations, newsletters, and a comprehensive website: www.groupsowhousing.com.

The main goal of this project is to provide assistance to producers to guide them through the process of converting existing barn systems, or design of a new site. With a large range of housing options available, producers will benefit from having high quality information and support in this area. By providing in-depth design, management and costing information, the project will facilitate the adoption of effective and proven technologies for sow housing.

INTRODUCTION

In 2007 the largest pork producers in the USA and Canada pledged to transition their sow housing to group systems over the next 10 years. The EU has already made a full transition to groups, following a ban on sow gestation stalls as of January 1, 2013. In recent years, increasing numbers of food retailers have also pledged to source pork from producers who have plans for conversion to group housing, and the revised Canadian Code of Practice for Pigs stipulates that, as of July 2014, all barns newly built or renovated must accommodate group housing in gestation. Consequently, the Canadian pork industry is under great pressure to convert existing gestation stall housing for its approximately 1.3 million sows to group systems. With over 60% of Canadian pork going to export markets, the future strength of the industry depends on maintaining and increasing access to global markets.

However, there are major concerns surrounding the conversion from stalls to group housing. The process requires a large capital investment with little room for error, and selecting the 'right' system can be a daunting task. Within the Canadian industry there is relatively little knowledge or experience on the management of sows in group systems. A variety of group housing systems are available, most of which require more space, different management skills and labour inputs compared to stall housing. Without proper support and advice, there is the potential for substantial losses in herd productivity, a decline in sow welfare and an overall reduction in the Canadian herd size as producers struggle to implement this change. The National Sow Housing Conversion Project (NSHCP) has brought together industry and scientific expertise to produce a comprehensive national strategy, involving demonstration farms and technology transfer to support Canadian pork producers in this conversion.

"Results from the NSHCP will help producers transition to a group sow system in the most cost effective and manner possible."

MATERIALS AND METHODS

Primary barn sites

Four barn sites have been identified across Canada to document the conversion to group housing. Once a barn site is confirmed, the conversion process is documented through questionnaires, interviews, farm visits, photos, and videos taken before, during, and after the transition. As well, producers are asked to provide production data and economic data. Videos

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4 Manitoba Pork Council, 28 Terracon Place, Winnipeg, MB, R2J 4G7.
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6 FGC Construction, 4892 Line 42 Perth County, Sebringville, ON, N0K 1X0.

and the project website will be used to give other producers a 'virtual tour' of each facility. The owners of participating primary site barns will be assisted during and after the conversion process by the provision of barn layouts using a software tool, the SHCDU, a barn evaluation by an experienced engineer, and support from the NSHCP working group.

Secondary barn sites

In addition to the four primary barns, up to ten other barns that have already implemented group housing will be identified across Canada. Less intensive data will be collected from these sites, which will include questionnaires, interviews, photos, videos, and barn visits. These additional sites will be used to show producers a wider variety of feeding systems design choices, and to highlight the necessity of developing a system that will work with the individual barn design, budget, and management style. Newly built barns will be included as well as renovations.

Table 1: Existing group housing sites documented as part of the National Sow Housing Conversion Project

Barn location	Size (sow herd)	Barn Description	Group Housing System
New Brunswick	1,600	New build (2004), farrow-to-wean	ESF feeders (Schauer); one feeder per pen, 16 static pen groups of 60 sows
Quebec	850	Renovation (2012), farrow-to-wean	ESF feeders (Schauer); two feeders per pen, 4 static groups of 160 sows.
Ontario	1400	New build (2012), farrow-to-wean	Competitive feeding in trough; 48 static groups of 18 sows/pen
Ontario	650	Barn addition (2013), farrow–to-wean	ESF feeders (WEDA); five feeders in one dynamic pen of 260 sows
Saskatchewan	600	New build (2015), farrow to wean	ESF feeders (Nedap); four feeders per pen, two dynamic pens of 180 sows
Alberta	275	Renovation (2014), farrow-to- finish	ESF feeders (Nedap); three feeders in one dynamic pen of 168 sows

All barns are documented on the project website at www.groupsowhousing.com

Communications

Communicating the results to other producers interested in converting to group housing is one of the main goals of the NSHCP. Results are being presented through workshops and producer meetings, a bi-annual newsletter, and the development of the project website containing documentation of the four primary site conversions, information from secondary sites, and general information on group housing options and management. A working group consisting of provincial pork organization representatives from across the country will conduct yearly meetings throughout the project to ensure that producers across the country are aware of the project. The working group also provides updates to the project on what is happening in each region and facilitates communication of the project through producer meetings.

RESULTS AND DISCUSSIONS

Two primary sites have been identified in Ontario, one in Quebec and one in Manitoba. The remaining primary site will be determined in 2016. The first documented site is Hog-Tied Farms, Ltd, a 250 sow farrow to finish operation owned by John and Joan van Engelen and located in Thedford, Ontario. Father and son, John and Mitch van Engelen, operate the herd in a well-kept barn that includes multiple innovations including a state-of-the-art ventilation system, hydraulic sow platforms in farrowing, a precision feeding area, and autosort feeders in grow-finish. The barn was originally built in 1983, and renovations for group-housing began in 2013. Doing most of the construction work themselves, the existing breeding and gestation room was converted from stalls in a three stage process. All sows were kept on-site, and while some minor reductions in herd size took place during the transition, the same numbers can be housed in the renovated barn as in the previous stall design. Sows in the group pens have roughly 20 sqft/sow due to the efficient use of alley space around stalls and the use of a large group dynamic ESF system with Nedap feeders. Doing the work in stages allowed the barn to remain in full operation, with little impact on the number of hogs shipped during the transition.

The second producer on the project is Adam Schlegel of Schlegelhome Farms, near Shakespeare, Ontario. The Schlegel sow barn accommodates 2000 sows, farrow to wean. The barn conversion involved building on a new farrowing room addition in 2014, and then gutting the existing farrowing area and converting it to two large dynamic group pens for 500 sows. The new farrowing wing includes side-loading farrowing crates, in-floor heating and a robotic power washer. The new gestation area was completed in the spring of 2015. Sows in gestation are fed using four ESF feeders per pen, with a sorting alley. The ESF feeders are Sow Choice feeders, made by Ontario firm CanArm Ltd.

The documentation of these primary barn sites can be viewed at www. groupsowhousing.com.

The Quebec site is a 600 sow herd in Ste. Marie owned and operated by Luc Veilleux. The transition to groups at Ferme Porcine LV Inc. is ongoing in 2016 with the installation of Gestal free-access ESF feeders, produced in Quebec. The Manitoba site is a 3,000 sow herd located near La Broquerie and owned by HyLife. The site will undergo conversion in the fall of 2016.

Secondary barn sites

There are currently six existing barns with group sow housing that have been identified across the country, with site locations from the east coast (New Brunswick) to Alberta (Table 1). The herd examples range in size from 275 to 1600 sows, and include a variety of new builds, renovations and barn additions. In terms of renovation costs, smaller herds that have completed owner-built conversions have reported material costs as low as $300 per sow for basic conversion including existing manure pits and some floor improvements (new slats and/or solid bedroom areas).

CONCLUSIONS

The NSHCP is designed to help Canada's swine production sector respond to the emerging issue of group sow housing. By compiling the best information available on group housing and working with producers on demonstration projects, the project will aid producers in meeting this challenge in an efficient manner. This four year project is being run in collaboration with the University of Manitoba and producer groups in Quebec and Manitoba. The information produced will include barn and pen designs, and detailed costing and management strategies. The results will be conveyed through demonstrations, factsheets, presentations at producer meetings, newsletters and the project website.

The purpose of the NSHCP is thus to increase producer confidence surrounding this transition and to provide up to date scientific information on sow feeding systems and the management of sows in groups. The project will assist producers by providing the support needed to implement new housing technologies effectively. This will help producers to maintain productivity during the transition, and will place the Canadian pork industry in a strong position to maintain and expand global markets.

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National Sow Housing Conversion Newsletter

October 2014 Vol. 1, Issue 1

NSHCP

SIP Swine Cluster 2 Funding Announcement

Final contracts for Swine Innovation Porc's Swine Cluster 2 program were signed in June, providing support for a four year project documenting barn conversions to group housing. The National Sow Housing Conversion Project (NSHCP) is directed by Dr. Jennifer Brown, a Research Scientist in Ethology at Prairie Swine Centre, and includes research partners from the University of Manitoba, Manitoba Pork and CDPQ. The goal of the project is to document barn conversions at four sites across Canada, including planning, construction, management decisions, staff training, changes to the sow herd and production levels both before and after.

"Barn conversions and new builds for group housing represent a huge cost to the pig industry", says Dr. Brown. "Our goal is to put together the best possible information, in terms of barn layout, sow management, and cost of construction, to help Canadian producers who are considering this investment." While countries in the EU have banned stall use except during breeding and early pregnancy (embryo implantation) as of January 2013, the new Canadian Code of Practice encourages the use of group housing systems, but does not totally ban stall use. The EU deadline resulted in reports of poor implementation in some countries, with last minute renovations resulting in lost production and poorer welfare in sows. By not having a deadline, Canadian producers can properly consider their options, and choose the right time for them depending on their situation and financial capability.

The project participants include leading researchers in the science of sow management, and will draw from barn design and management concepts developed in European countries over the past 20 years. "Due to poor market conditions, very little barn construction work has been done in North America over the last 10 years", says project participant and CEO of the Prairie Swine Centre, Lee Whittington. "By documenting top-notch barn conversions here in Canada, we will develop new expertise and can provide builders and producers with the information they need for successful conversion to group housing."

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In addition to funding from AAFC, the project is supported by provincial pork organizations, Alberta Pork, Sask Pork, Manitoba Pork and Ontario Pork. By taking a consistent and science-based approach on this issue, the Canadian pork industry demonstrates a pro-active approach to sow management that will have long-term benefits to sow welfare and production, while strengthening domestic and export markets.

CDPQ Centre de développement du porc du Québec inc.

University of Manitoba

Prairie Swine Centre

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In addition to the many industry and government funding agencies, the University of Saskatchewan uses the facilities and services at Prairie Swine Centre for research and teaching.

The following organizations have provided funding or donations and in-kind to support public research at the Centre throughout the 2015-2016 fiscal year.

PROGRAM SPONSORS

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