PRAIRIE SWINE CENTRE

MISSION STATEMENT

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

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Chairman's Report

Let the Good Times Roll

RICK PREJET - Chairman of the Board

It has been an honour and a pleasure to serve the Board of the Prairie Swine Centre as chairman over the past year. There are many people I would like to thank including our previous chair Mary Buhr and other board members, past and present, who I have had the privilege of working with over the past six years. Their insight, knowledge and passion for the Centre have played a significant role in the success of the Centre and where it is today.

I have as a title "Let The Good Times Roll". This of course is in reference to the excellent returns we are experiencing in the hog industry as I write this report. PSC is a not for profit business that depends heavily on revenues from pig sales. Market prices along with excellent production in the barn play a huge role in the survival of the Centre. On that note I must recognize Brian Andries and his team for achieving world class production under the challenges of research restrictions. This is nothing short of amazing.

The fact that the PSC has survived and grown over the past years is a testament to its leadership. Mr Lee Whittington had big shoes to fill when he was chosen to manage the Centre after the retirement of Dr John Patience. Not only has Lee filled those shoes but with his strategic plan and ability to look to the future Lee has moved the Centre forward by bringing in other critical parts of the value chain to sit on the board. The plan has also led the Centre to a more national approach as well as a more collaborative approach with other research institutions.

As we, pork producers, move forward and enjoy the profitability of the hog industry we must also be reminded that we need to continue to invest and re invest in our industry. With more free trade agreements in place and a changing customer base it will be important for us to stay ahead of the game to ensure we meet the needs and demands of our customers worldwide. My guarantee to you is I will continue to push for what is best for the pork value chain so that the industry can rebuild where it needs to and that future generations can prosper as a result of decisions we make today.

On a final note, PSCI is taking a lead role on one of the hottest topics the last few years. Animal welfare is in the spotlight and we have the opportunity to further our knowledge on this topic by having the Chair in animal welfare located at the Centre. Dr Sandra Edwards, an expert in this field, will become the lead researcher when funds are raised to make this a reality. I encourage support from the whole pork value chain in achieving this critical goal.

In closing, the board of directors is proud of what the centre and its world class researchers and staff have accomplished. Our goal is to continue to be the best. Your continued support will ensure that the good times keep on rolling.

All the best, Rick

Board of Directors

Back Row L-R: Matt Schoonderwoerd, Walter Heuser, Neil Ketilson, Mark Debusschere, James Ressor, Jim Bassinger, Wayne Thompson, Brad Marceniuk

Front Row L-R: Mary Buhr, Lee Whittington, Rick Prejet (Chair)

President's Report

What is Long Term Sustainable Growth?

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

Guarded optimism has returned to the industry in North America. This has been building for the past six months along with pork prices, and benefiting from stabilized grain prices. During this period our personnel have had first-hand opportunity to discuss the future of the pork industry at pork congresses in Des Moines, Red Deer, Alberta and Stratford, Ontario. Additionally, a series of meetings across western Canada co-sponsored by PSC and Elanco realized excellent turnouts as pork producers came to talk about the hot topics of changes to the Code of Practice and Welfare of Pigs and what to do about biosecurity and PEDv. In eastern Canada there is some finisher barn building in Ontario and a few replacement sow barns which have been based on strong balance sheets buoyed by rising land values since 2010. In western Canada most pig places have been pressed into service, with a few sow projects planned primarily to convert or build new sow group gestation facilities to replace existing barns. In the US, although vendors were not reporting orders for equipment, barn plans were being discussed and equipment enquiries were strong. New products are being launched in gestation sow feeding (at least 3 new manufacturers entering the market), and some innovative technology was being showcased in beta stage which PSC will be testing.

This optimism is welcomed but is generally recognized in Canada as a mixed blessing. If US producers take the current margins (perhaps $60/hog) as a signal to expand, the tradition of a hog cycle, although not as predictable as 30 years ago, will result in prices trending downwards again. Farrowing intentions will rise in fall 2014 given normalized corn crop yields and prediction of sustained pork prices for the next year. To protect the industry's investment in research PSC is taking a cautious approach by dealing with needed facility repairs, making some capability improvements that expands our base of clientele and focuses on providing the one thing that never goes out of style and that is knowledge to lower production costs.

Prairie Swine Centre continues to stay focused on its near market generation of applied science for the pork value chain, and expanding the supporter's base with processors and retailers on production issues we have in common. Such is the role to be played by the National Chair in Swine Welfare.

"Production at Prairie Swine Centre broke the 30 pigs/sow/year barrier in 2014"

Production stats are excellent with our first production achievement over 30 pigs weaned per sow per year, in spite of a pen breeding experiment for the past year, and significant lactation sow research. Congratulations to the production staff under Brian Andries leadership working with both the herdspeople and cooperatively with research personnel to achieve such success.

Biosecurity has been enhanced at PSC by limiting access for non-essential personnel including temporarily stopping student tours. We have redesigned the front entrance and truck arrival protocols to further reduce risk of manure and persons as sources of infection.

So what about sustainable growth rate? In business you are taught that there is a solution to this question. A financial sustainable growth rate considers target profit margins, dividends paid, debt:equity ratio and assets:sales ratio. The number of 4% is often cited as a long-term sustainable growth expectation for a country's economy. But when dealing with commodities these prediction tools are lacking due to the cyclical nature of commodity prices. Long-term sustainable growth in the commodity pork business is built on an approach to be constantly looking for opportunities to lower costs while increasing productivity (p/s/y, or ADG for example). To that end our Annual Report addresses topics in nutrition, engineering, behaviour, health, management and economics which can be applied to your pig farming enterprise – right now!

Operation's Report

Achieving Record Production in a Research Environment

BRIAN ANDRIES, BSA. - Manager, Operations

I would like to acknowledge my production staff for reaching 30.8 pigs weaned per sow per year over the last 16 weeks of production for 2014. Production has improved steadily year by year since we populated the new barn and in spite of reducing production staff numbers by 2. The efficiencies found in breeding and gestation through feed automation and closely monitoring sow condition right through breeding and gestation has greatly influenced performance in farrowing and the ability to rebreed post weaning. I also believe that the free access stalls in gestation have also played a part in the success we are currently achieving.

Our breeding and gilt selection programs are also contributing to the overall success in production. Gilts are bred at an average of 233 days of age. They are all on full feed before breeding and are only bred if they weigh over 135 kg. For 2013-14, gilts and first parity animals performed as follows:

Table 1. 2013-14 Sow Herd Performance

Category	Gilts	1st Parity
Farrowing Rate %:	91.0	96.6
Average born alive/litter:	13.5	13.5
Number weaned/sow:	12.2	12.5
Pigs Weaned/sow/Year:	28.3	30.5

I think it is also important to note how production and research technicians are maintaining a barn environment that is conducive to optimizing performance by reducing bacterial and viral loads through proper sanitation and ensuring proper monitoring of feed, water and ventilation. The Centre's combined nursery and grow-finish mortality has dropped from 4.2% in 2012 to 2.6% last year. Taking into consideration that our pigs are not vaccinated for circovirus and that they have access to antibiotics only for the first 6-7 days post weaning, the herd's health status is quite remarkable. This is important in reducing variability and stabilizing the herd which assists in the overall running of research trials along with producing a consistent product on a weekly basis.

Table 2. Production Parameters

	2010-11	2011-12	2012-13	2013-14*
Sows farrowed, #	686	780	714	216
Conception Rate, %	92.7	93.4	90.5	91.1
Farrowing Rate, %	92.7	93.0	92.8	90.0
Avg. Born Alive/Litter	12.7	13.0	13.9	13.6
Farrowing Index	2.48	2.48	2.46	2.48
Number Weaned/Sow	11.7	11.9	12.6	12.8
Pre-wean Mortality, %:	12.7	10.7	13.2	13.6
Pigs weaned /Sow/Year	26.5	26.8	28.4	30.8
Sow Non-Prod. Days/Sow/Yr	27.2	24.3	28.0	27.5

*last 16 weeks, ending June 30, 2014

This fiscal year will sell 8,492 animals from our target of breeding 14 sows per week. We saw almost identical number in sales from fiscal year 2012-13 but marketing's for that fiscal year were the result of targeting 16 sows bred per week from breeding's during the last half of 2011-12 and the first half of 2012-13.

We started 33 new experiments in 2013 and put a total of 9,717 animals on trial. The total number of animals on trial includes animals used for research at the Centre by our or other researchers, as well as all animals that have been purchased for trials on campus. This fall we sent a total of 50, 8-week old nursery pigs by semi to Laval Quebec to be used on a research project. This number does not include the number of animals used in commercial barns around North America.

"Over the past year there were 33 new experiements started utilizing more than 9,700 animals"

We have been feeding whey via the water system in grow finish animals for a number of months now. This has allowed us to feed less expensive diets. We are also capable of feeding whey in nurseries but as yet have not as they have been busy with research trials. A small trial was done comparing 2 rooms of 240 animals that were on water and regular diet as opposed to two rooms of 240 animals on whey and the whey diet. It was found that both ADG and ADFI were higher for pigs fed without whey, however feed conversion was more efficient in pigs fed whey.

Technology Transfer Report

Ever Changing Communications for a Ever Changing Industry

KEN ENGELE, BSA. - Manager, Information Services

As the Canadian pork industry turns a page we find ourselves starting a new chapter, one that speaks to perseverance, re-investment and optimism. Over the past 20 years, in particular since 2008 we have seen a major shift in the size, structure and scope of the pork industry. While the core group of our stakeholders have not changed, (pork producers, funding agencies, research institutions) how we communicate the value of Prairie Swine Centre needs to be specifically tailored to bring the greatest value to these stakeholders.

Core communication still takes the form of personal contact, publications and electronic communication. While the core areas have not changed over the past 20 years emphasis and funding dedicated to each area have dramatically shifted over the same period. It all started in 1999 with the Environmental Issues Resource Centre (EIRC) – an on-line database focused on providing an expanding hog sector information dedicated to manure management, soil and water quality, human health, odour and gas emissions and deadstock management. Over the past 15 years this database has been transformed to include subject matter in the areas of welfare, production, energy utilization, economics and environment, with each one of these sections being added to address a industry need. The past 15 years have also seen rebranding of the database to what started as the EIRC we know today as PorkInsight, what started with 500 articles on the environment is now home to more than 5,000 articles in 12 different sections. Over this same period we have seen traffic to the website more than triple starting at 1,500 unique visitors/month to an average of 4,500 unique visitors today.

It's always interesting to take a retrospective look on how we got to where we are today. In 1999 print and personal contact were the two most importance streams in how we communicated with the industry. It was the goal of the Technology Transfer program to put a copy of Centred on Swine, Annual Research Report and fact sheets in the hands of every pork producer in western Canada, printing 4,500 copies of each issue to accomplish this. During the same period a great deal of emphasis was focused on personal contact which include meeting one-on-one with large producers, hosting nutrition, ethology, and engineering workshops at PSC, delivering the Focus on the Future conference, in addition to attending numerous conferences, symposia and trade shows throughout the year.

Then along came 2007 - 2011 which accelerated the restructuring the pork industry. Prairie Swine Centre was equally hard hit throughout this period, subsequently needing to make tough decisions on what projects remain funded and what projects get cut. Centred on Swine went from 4 issues per year to one, we discontinued printing of the Annual Report making it available in electronic form, fact sheets were made electronic, reduced attendance at trade shows and producer meetings were discontinued in 2009 and 2010, as PSC along with the entire pork industry focused on tightening our belts. Throughout this period communication largely focused on electronic communication a cost-effective means of communicating with the industry.

The past three years have seen a re-investment of resources to the Technology Transfer program at Prairie Swine Centre, and an increased communication with the pork industry. We have seen the incorporation of spring producer meetings across western Canada and including Ontario, increased frequency of Centred on Swine up to 2 issues and starting with three issues in the summer of 2014, limited printing of the Annual Research Report , and continued meeting with producers. In conjunction with the 2014 Banff Pork Seminar PSC hosted a strategic planning session with the a cross section of pork producers from across Canada. I asked the simple question. What's the best way to communicate with producers? The answer was quite simple "call me".

The Technology Transfer program will continue to adapt to changes within the industry finding the best combination of results to effectively communicate with our stakeholders.

Prairie Swine Centre in 2013-2014

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 - defined as all stakeholders in the pork value chain from cereal development to consumer acceptance of pork. Using an industry-oriented and multidisciplinary approach that ensures timely adoption of knowledge.

Objective #3

To leverage our strengths and capabilities as a 'knowledge-based' company.

Objective #4

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

Objective #5

To define 'Best in Class' and benchmark against critical efficiency, innovation and accountability metrics (in operations, human resource, financial, and scientific output).

Objective #6

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 #7

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. This objective applies equally to initiatives within Prairie Swine Centre as well as relationships with external institutions/agencies.

Research Objectives

Serviving the Needs of the Centre's Stakeholders

Objective #1

To increase net income for pork producers through improved nutrition.This includes the development of feeding programs which emphasize economic efficiency, meat quality, and market value. Also understanding feed and fibre sources and the modifications of these to meet the needs of the pig, changing economics and opportunities to favourably impact meat quality.

Objective #2

Improve animal wellbeing by developing and modifying housing systems, animal management practices, and 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 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.

Quantifying the Prevalence of Lameness and Hoof Lesions in Canadian Nucleus Herds

Y.M. Seddon and J.A. Brown

Yolande Seddon

Jennifer Brown

SUMMARY

The aim of this survey was to collect information on the prevelance of lameness and hoof lesions on genetic nucleus herds, to help provide baseline information on the prevelance of lameness and hoof lesions in Canadian sows. Six genetic herds were visted, located in AB, SK, MB, ON and QC. Results found a wide variation in lameness across the herds, ranging from 8 – 46%. Combining data from all herds (1,139 sows in total), 20% of sows showed signs of lameness. although much of this was mild, with only 5% showing signs of more severe lameness. In all barns surveyed, a high percentage of sows were observed with hoof lesions, with 74 – 97% of animals affected. Heel erosion was the most common hoof lesion observed, being present in > 50% of sows in four barns. These results suggest that leg and hoof health problems exist, and could be added to sow evaluation or selection criteria. The fact that some barns had much lower levels of lameness suggests that some herds may carry beneficial genetic traits that help reduce lameness. The baseline information gathered from this survey presents useful information for industry and researchers alike, and demonstrates that greater emphasis may be needed on sow robustness, especially as group housing for sows becomes more common. Further work to determine characteristics of sows with good leg health and hooves, along with genetic links related to leg and hoof health is of interest, and would help improve the welfare and longevity of sows, and aid in the development of more robust sows for use in group housing.

Table 1. Housing characteristics, percentage of surveyed animals sound and lame, and percentage showing lameness scores of greater severity (scores 2 & 3) on surveyed herds.

Herd ID	Floor type	Housing type	Animals sound (%)	Animals lame (% gait score 1-3)	Animals lame (% gait score 2-3)
1	Fully slatted/Part slatted	Stalls	67.1	32.9	9.8
2	Part slatted	Stalls	92.0	8.0	3.8
3	Part slatted	Stalls & groups	92.2	7.8	0
4	Part slatted	Stalls & groups	54.1	45.9	6.6
5	Part slatted	Groups	90.3	9.7	2.3
6	Part slatted	Stalls	73.2	25.3	1.0

INTRODUCTION

Sow efficiency and longevity is of paramount importance to the profitability of swine operations. Genetic advances have come far, with modern sows able to produce large litter sizes and maintain a high level of production. However, lameness is a common problem among sows and a major reason for premature culling. Lameness is a painful condition and as such can influence the fertility, mobility, feed intake and longevity of sows in the herd.

"Results showed a large variation in lameness across herds, ranging from 8 to 46%."

Recent studies suggest that lameness in sows may be a larger problem than originally thought. The first quarterly report from the Canadian Swine Intelligence Health Network reports lameness as the second most frequent clinical diagnosis on pig farms (C. Byra personnal communication, 5th May 2014). A lameness survey conducted by the Prairie Swine Centre on a 6,000 sow herd found that 54% of sows showed signs of lameness, and of the sows identified as lame, 23% were gilts and young sows (parities 0-3). Furthermore, 94% of sows had hoof lesions, which are known to be detrimental to sow comfort and a route for infection entry. It is widely understood that lameness and hoof problems are multi-factorial, being influenced by factors in the environment, genetics, nutrition and management of the sow.

The current study surveyed six genetic nucleus herds to assess the prevelence of sow lamness and hoof condition within the Canadian breeding pyramid. Assessing the sow breeding pyramid is a valuable approach, as these animals are the source of commercial stock and their selection ultimately impacts productivity, sow health and well-being on all commercial farms. With the potential change from stall to group housing, now is a critical time carry out this quantative survey. The survey results provide a benchmark and assessment training that will aid genetics companies in selecting animals suited to group housing systems, to ensure a 'fit for purpose' sow.

The objectives of this research were to survey herds within the Canadian swine genetic pyramid to:

i. Quantify the prevalence of lameness and hoof lesions in sows.

ii. Transfer practical knowledge to barn staff on the techniques for assessing lameness and hoof lesions.

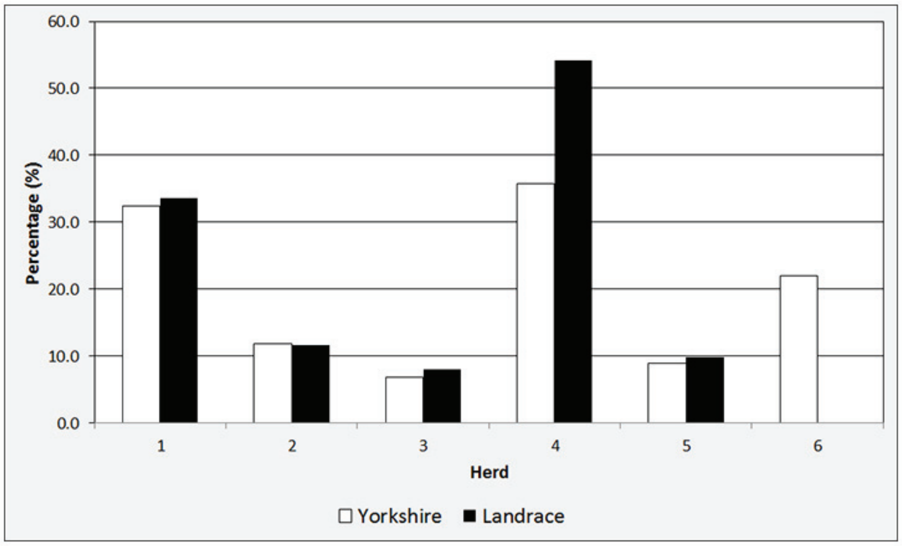

Figure 1. Percentage of lame sows in Yorkshire and Landrace breeds surveyed over 6 farms. Note: Farm #6 held only one breed.

To the authors' knowledge, this is the first study to gather lameness and hoof lesion data from multiple genetic nucleus herds. The level of lameness present is higher than may be considered acceptable, and across all herds suggests a 20% level may exist within Canadian genetic herds. While the prevalence of more severe lameness was lower, ranging from 0 to 10%, this and the high prevalence of hoof lesions indicates a need for better understanding of the problem and indicates room for improvement. In particular, more research is needed on the genetic links between lameness and hoof lesions and their interaction with diet and flooring type.

This project also gathered information on the floor type and nutritional composition of feed provided to the animals. More in-depth analysis is needed before any interpretation can be given on how these factors are related to lameness or hoof lesions. However, the results so far suggest that even in nucleus herds, improvements can be made to reduce lameness and develop stock with greater robustness. If lameness is prevalent within genetic stock, managed with a high rate of sow turnover, it is likely to be found at equal or greater levels under commercial production conditions.

RESULTS AND DISCUSSION

Lameness

A representative sample was achieved at all sites, with data collected on 1,139 sows in total. Combing data from all herds, 20% of sows surveyed were scored as lame (score 1-3). Across farms, there was a large variation in levels of lameness observed, ranging from 7.8% to 45.9% (Table 1). Potential sources of variation include differences in environment (floor type, slat width and placement), nutrition or genetics. Individual variation among observers scoring on each farm also contributed to variation in the results. In particular, the assessment of lameness score 1 (indicating mild lameness) is open to subjective interpretation. Agreement on gait scores of 2 and 3 is typically much greater, as animals with pronounced lameness are much easier to identify. Therefore, the percentage of sows with gait scores of 2 and 3 is also included in Table 2, and still shows fairly high levels of lameness, with 9.8% in herd 1 and 6.6% in herd 4. More objective measures of lameness are needed and will increase the reliability of results in future research.

Table 2. Total percentage of surveyed animals identified with hoof lesions, and the percentage of animals identified with each type of hoof lesion per herd.

Herd	Animals with hoof lesions (%)	Toe length	Dew claw	Heel erosion and sole cracks	White line disease	Wall cracks
1	83.2	27.3	25.6	77.3	51.4	33.1
2	74.6	50.8	31.5	60.5	17.1	47.4
3	89.8	53.1	43.8	80.5	55.5	60.9
4	96.7	90.6	80.3	81.8	75	54.2
5	80.3	33.5	75.0	.	.	11.4
6	97.2	25.3	16.4	75	56.6	25.4

* Herd 5 was not able to score for two types of lesions (heel erosion and white line disease), herds 1-5 did not score for heel sole cracks. Percentages derived from the number of animals successfully scored for each hoof lesion per herd.

Of the two maternal breed lines studied per farm, it was found that lameness was similar between breeds on all farms, with the exception of farm four where a higher percentage was found in Landrace sows (Figure 1).

Hoof Lesions

Hoof lesions were present in a high percentage of sows surveyed on all farms (Table 2). This result is similar to what has been reported in other studies. The prevalence of different types of lesions differed between barns, although some lesion types were prevalent throughout. Heel erosion was observed in a high percentage of sows in all barns, and white line disease affected over 50% of surveyed sows in four barns. Mechanical factors such as the way the sow is standing, and the effects of flooring, in combination with inferior hoof horn growth is believed to contribute to both of these conditions. The severity of lesions was mild to moderate, with similar severity on the front and hind feet.

CONCLUSION

The results of this survey indicate that moderate levels of lameness exist within genetic nucleus herds, and suggests that selection could be done to improve the leg and hoof health of breeding stock. The information gathered from this survey provides an initial baseline that can increase our understanding of genetic factors related to lameness and hoof lesions. The gait and hoof lesion scoring protocols used in this project can be incorporated into selection criteria, allowing continued monitoring and promoting the development of sows with more desirable leg and hoof characteristics. In turn, this may produce a more robust sow that is better suited for group housing.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge specific project funding for this study provided by the Canadian Agricultural Adaptation Program (CAAP). Strategic program funding to the Prairie Swine Centre was provided by Sask Pork, Alberta Pork, Manitoba Pork Council, Ontario Pork, and the Saskatchewan Agricultural Development Fund.

Increasing Creep Feed Intake by Stimulating Exploratory Behaviour using Enrichment

Y.M. Seddon and J.A. Brown

Yolande Seddon

Jennifer Brown

SUMMARY

This project examined whether increasing exploratory behaviour in piglets by providing enrichment in the farrowing pen can stimulate creep intake in piglets. If successful, this concept would be a simple way to reduce stress at weaning and increase growth rates. Four treatments were tested in a 2 x 2 factorial design comparing presentation of creep in a standard feeder (SF) or a large tray feeder (TF), to encourage social interaction around the creep, combined either with enrichment (E) or without enrichment (C). Enrichment consisted of cotton ropes hung in the farrowing pen. Results found that feeder type rather than enrichment increased the frequency of piglet visits to the feeder, with a greater frequency of visits to the TF on days 12 and 26 of age. Litters supplied with the TF also had a greater daily creep disappearance. However, litters supplied with the SF had a greater birth to wean ADG (kg). After weaning, piglets with the SF and enrichment had a significantly greater growth check within the first 24 hours of moving into the nursery, while the ADG of piglets in all other treatments did not differ. At weaning, groups that received a TF did not show a negative ADG in the first 24 hours post-weaning, while groups with the SF had negative ADG values for this period. There were no treatment differences in ADG values for any other time period. The increased creep disappearance found with the TF suggests piglets were interacting with the creep. However, birth to wean growth rates did not reflect any benefits of increased creep consumption suggesting, that feed wastage may have been greater with the TF. We conclude that providing pigs with a larger feeder that encourages social feeding and rooting had a greater influence than rope enrichment at attracting them to creep feed. Effects of the TF on feeding behavior needs to be studied further to understand how exposure to the TF in farrowing prevented weight loss on day 1 post weaning as was found in groups provided the SF.

INTRODUCTION

Weaning is a highly stressful time for piglets, with multiple significant changes occurring simultaneously (change in diet, environment, mixing with unfamiliar piglets). Weight loss and increased cortisol levels have been observed for the first few days after weaning, indicating this is a stressful event for piglets. Inadequate food intake in the first two days after weaning, in combination with the stress of weaning, decreases piglet performance, resulting in increased disease susceptibility and mortality through changes in metabolic and immune function. Promoting solid feed intake before weaning by provision of creep feed familiarizes the piglets with solid food. Piglets that consume creep show better feed intake and improved growth rate in the critical weaning and post-weaning period. However, previous work conducted at the Prairie Swine Centre shows that the amount of creep feed consumed is often very low, and a high number of piglets fail to eat creep.

"At weaning, piglets that received the tray feeder performed better, showing no growth check."

It is important to identify convenient and effective ways of increasing the volume and consistency of creep feed consumption by piglets. Previous research by others has determined that the amount of creep consumed by piglets can be increased by provision of a specially designed feeder that encourages exploratory interaction around the feeder. It is known that piglets raised outdoors are quick to consume starter feed and will often ingest soil and plant material while exploring their environment. However, piglets reared indoors do not have the same opportunity for exploration. This study builds upon current knowledge to investigate the effects of provision of environmental enrichment within the farrowing pen and nursery on exploratory behaviour, frequency of visits to the creep feeder, creep consumption and piglet growth rate. If simple enrichment can increase creep feed consumption in piglets this could result in reduced stress at weaning and better growth in the post-weaning period.

This work 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) to increase pen exploration, or by presenting creep in a large shallow feeder to facilitate synchronized feeding among littermates. Piglets were observed and weighed for two weeks after weaning to determine the impact on weaning stress and growth rate. Specific objectives of the project were to determine:

1) If providing enrichment, and/or a large shallow tray feeder in the farrowing pen results in increased exploration of creep feeders and increased creep consumption or improvement in pre-weaning growth rate.

2) If the continued provision of enrichment in the nursery and/or having had a larger tray feeder in farrowing results in increased feed consumption or improvement in piglet growth during the first 2 weeks in nursery.

EXPERIMENTAL PROCEDURE

Four treatments, (n=7 litters/treatment) were studied: T1: Creep provided in a standard feeder (SF); T2: Creep provided in SF, with enrichment (E); T3: Creep provided in a large tray feeder (TF); T4: Creep provided in TF with E. Creep feed was offered to all litters from 10 days after birth until weaning (28 days). For enrichment, strips of cotton rope were hung in farrowing pens from 5 days after birth until weaning. Piglet weights and creep consumption/pen were recorded weekly. Behaviour was recorded on four litters per treatment for 8 hours (8am to 4pm), on days 12, 19, and 26, and again on days 1, 5 and 10 post-weaning. Behaviour of the whole pen was recorded, as well as the individual behaviour of four marked focal pigs.

Video footage was scanned at five minute intervals and the number of piglets interacting with the feeders (head in feeder) recorded, and for E treatments, the number of piglets interacting with E (snout touching, or chewing E). Pen ADG and creep consumption were calculated. Data were analysed to determine the individual and interactive effects of feeder type and provision of enrichment.

Table 1. Average total frequency of visits per litter made to the creep over 8 hours (8am – 4pm) when presented in a SF or TF.

	Feeder type			
Day	SF	TF	PooledSEM	P
12	1.3	6.0	1.2	<0.05
19	3.8	15.0	3.6	0.052
26	5.3	16.4	4.1	0.086

Table 2. Average total number of piglets observed visiting the feeder at once

	Feeder type			
Day	SF	TF	Pooled SEM	P
12	0.6	1.1	0.2	0.060
19	1.1	1.2	0.1	NS
26	1.2	1.2	0.1	NS

RESULTS AND DISCUSSION

Piglet behaviour

Within the farrowing pen, piglets provided with rope enrichment were found to make on average 11 visits to the enrichment per day. However, provision of a tray feeder, rather than enrichment resulted in a greater frequency of piglet visits to the creep (Table 1) on day 12, with a tendency for a greater number of visits to the feeder on days 19 and 26. There was a tendency for a greater number of piglets per visit at the tray feeder on day 12 before weaning, but no differences thereafter between the treatments (Table 2). Typically, only one piglet was seen at the feeder at a time.

> *"Litters supplied with the large feeding tray had greater daily creep disappearance. However, litters supplied with the standard feeding tray had a greater birth to wean ADG (kg)"*

Creep intake and growth rate

The addition of rope enrichment had no effect on the creep disappearance or average daily gain in the pre-weaning period. Litters supplied with the tray feeder had a greater daily creep disappearance (SF: 86g, TF: 163g: SEM 20, $P<0.05$), than those given the standard feeder. However, litters provided with the standard feeder had a greater piglet birth to wean average daily gain in the pre-weaning period (SF: 0.25kg, TF: 0.22kg, SEM 0.01, $P<0.05$).

On day 1 after weaning, piglets with the standard feeder and enrichment had a significantly greater growth check within the first 24 hours of moving into the nursery, while the ADG of piglets in other treatments did not differ. Groups that received a tray feeder did not show a negative ADG in the first 24 hours after weaning, while those with standard feeders had negative ADG values for this period. There were no differences in treatment between the ADG values for any other time period (Table 3). Further analysis will be done on behavioural data in the nursery to examine relationships between behaviour and growth.

The provision of rope enrichment in the farrowing pen did increase the exploratory behaviour of piglets. However, provision of a larger feeder that could encourage social feeding and rooting, appeared to have a greater influence on attracting piglets to creep feed. This was demonstrated by the increased frequency of visits to the feeder when litters were provided with tray feeders. This feeder differed from conventional round creep feeders, as it was long and shallow (22cm x 33cm), allowing several piglets to investigate the feeder simultaneously. In comparison, the standard creep feeder is smaller, and round (24cm in diameter), with divisions to discourage rooting and reduce wastage. Pigs are social feeders, and tend to synchronize feeding behaviour. The accessibility of the tray feeder may help to facilitate synchronized feeding. However, our results found no difference in the average total number of piglets at the feeder per visit, suggesting the tray feeder did not increase synchronization of feeding. Instead, the tray feeder may simply facilitate investigation of the feeder, being shallow and large, piglets can actively root in the creep. The increased creep disappearance found with tray feeders suggests piglets were interacting with the creep. However, birth to weaning growth rates did not reflect any benefits due

Table 3. Growth rate (ADG in kg) per pig across treatments

	Treatment					
	T1:	T2	T3			
Growth period	C	ESC	TC	T4:TEC	Pooled SEM	P
Birth to Wean	0.26	0.23	0.21	0.22	0.014	NS
Wean to D14 nursery	0.22	0.16	0.24	0.25	0.03	NS
Growth D1 after weaning	-0.04[ac]	-0.22[c]	0.16[ab]	0.18[ab]	0.11	0.05
ADG day 7 nursery	0.22	0.23	0.16	0.16	0.02	NS
ADG day 14 nursery	0.35	0.34	0.34	0.38	0.02	NS

to increased creep consumption, suggesting that the tray feeder may have resulted in greater wastage. In contrast, piglets provided with creep in the standard feeder had the greatest ADG in farrowing.

In the period immediately after weaning (day 1), piglets that received the tray feeder performed better, showing no negative growth check, and maintaining a positive ADG compared to piglets that had been given standard feeders, and lost weight. There was no effect of enrichment on the piglet performance post weaning. In fact the piglets that received the standard feeder and the rope enrichment had a significantly greater growth check at day 1 post-weaning than did the piglets provided with the tray feeder, with or without enrichment.

Further work will be conducted to complete analysis of the data. In particular, analysis of piglet behaviour post-weaning will be done to determine if feeding behvaiour can help to explain the reduced growth check that was seen in groups provided with the tray feeder. We speculate that providing creep in the tray feeder encouraged rooting and exploration within the farrowing pen, and this may have transferred to an increased exploration and consumption of feed in the nursery.

CONCLUSION

Providing piglets with rope enrichment, and/or presenting creep feed in a large, shallow tray feeder did not increase creep consumption or growth rate before or after weaning. However, litters given a tray feeder showed a higher frequency of visits to the feeder than those provided with the standard feeder, and did not have a negative growth check post-weaning. This lack of post-weaning growth check observed in piglets given a tray feeder pre-weaning is an area to explore further. Further work should be done to explore other avenues to stimulate feeding behavior, increase creep consumption and reduce weaning stress in piglets.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge specific project funding for this study provided by the Canadian Agricultural Adaptation Program (CAAP). Strategic program funding to the Prairie Swine Centre was provided by Sask Pork, Alberta Pork, Manitoba Pork Council, Ontario Pork, and the Saskatchewan Agricultural Development Fund.

Impact of Various Parity Groupings on Welfare and Productivity in ESF Housing

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SUMMARY

Electronic sow feeders (ESF) provide an automated system for controlling the individual feed intake of group-housed sows. However, this system can prompt increased aggression, especially in the initial period following mixing, as sows compete for access to the ESF. The primary objective of this research was to compare different methods for grouping sows and their effects on feeding behaviour, sow injury and production. Sows were housed in groups of mixed parity (control), or uniform groups of low (parities 1-2), medium (parities 3-4), and high parity (≥ parity 5). Of specific interest was whether low parity sows experience less aggression and injury during gestation when managed in uniform groups than in mixed groups, and what effects these treatments may have on production measures.

Preliminary results indicate there are some benefits to housing sows in uniform groups, especially for younger sows. Sows in uniform groups had reduced lameness, and younger sows were able to increase backfat over gestation, as opposed to losing it. Younger sows in mixed groups lost backfat, suggesting feeder competition was more of a challenge for these sows in the mixed parity group. No production differences were found among the different grouping methods. Managing gilts as a separate group is already a common practice, and the results from this study suggest that parity 1 and 2 sows can also benefit from this practice. Maintaining uniform groups also reduced mixing injuries, in uniform medium and high parity groups with injuries sustained following mixing being equal to or lower than in mixed parity groups. However, the low parity uniform group had higher injury scores. Greater injuries in younger sows is more likely related to the social ability of these animals, and management of gilts to improve sociability is a further management consideration that could be implemented.

INTRODUCTION

The management of sows in groups generally requires greater input from stockpersons than management of sows in stalls. While group-housed sows may benefit from increased freedom of movement, these systems can also result in increased aggression and decreased welfare, particularly in lower-ranking animals.

> *"Primary objective of this research was to compare different methods for grouping sows in static ESF systems"*

Electronic sow feeders (ESF) are a method for managing sows in group housing, providing an automated system for delivering and controlling individual feed portions to sows. Aggression often occurs when sows are initially mixed and establishing their dominance hierarchy, but can also be ongoing throughout gestation due to competition for feed and lying areas. If managed correctly, ESF systems can significantly reduce ongoing competition for feed. However, if not managed correctly, sows in ESF systems can experience prolonged daily competition for access to the feeder throughout gestation.

Low-ranking sows tend to have a disadvantage in ESF systems because they receive more aggression and injuries, have reduced production, gain access to the ESF later in the feeding cycle, and are displaced from feeding more often. In static groups, high-ranking sows eat earlier in the feeding cycle and for longer. Because the use of ESF systems is becoming more common in North America, information on how to manage low-ranking sows in these systems is needed, and will benefit sow welfare and productivity.

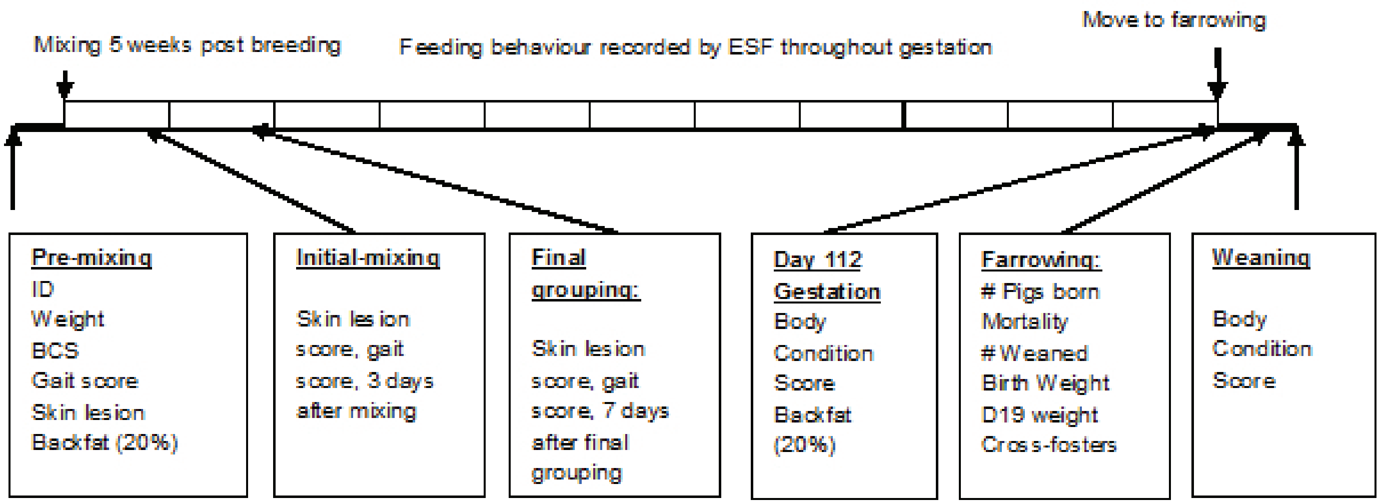

Figure 1. Timeline of experimental procedures.

The current study examined the effect of different grouping strategies (mixed parity groups and uniform parity groups) on the welfare and productivity of group housed sows in ESF, and to determine their effects on the feeding behaviour, and injury scores. The objectives of the study were to:

1. Determine whether low parity sows (parities 1 and 2) experience less aggression and injury during gestation when managed in uniform groups than in mixed groups, and what effects this may have on measures of production.
2. Determine any effect of mixed and uniform grouping treatments on variation in sow ESF entry time (feeding time of day), both within individual sows and among sows within a treatment, and whether this influences productivity.

EXPERIMENTAL PROCEDURE

This trial was conducted over six replicates with 240 sows per replicate, and 1,440 sows trialed in total. For each replicate, four groups, each of 60 sows were formed, comprising of low (parity 2), medium (parities 3 - 4) and high parity sows (parity ≥5), and one mixed parity group (Control, parities 2 - 8). Sows groups were first formed in a mixing pen, where sows were kept for one week. After one week, sows were moved to their final gestation pen where they remained up until farrowing. All mixing and gestation pens contained one ESF feeder (Nedap, Groenlo, Netherlands) with software to record feeding time (time of feeder entry) and feed consumption for individual sows.

Feeding behaviour was recorded throughout gestation, up to the time that sows were moved to farrowing (approx. day 112). Body condition score (BCS) was determined for each sow before being mixed at 5 weeks gestation, at day 112 of gestation, and at weaning. The BCS was determined using a scale of 1 (very thin) to 5 (obese), (Young et al., 2004). Sow weight was recorded at five weeks gestation. Sow backfat thickness was measured on a sub-sample of 20% of sows, equally distributed across parity and treatment. Standard production measures at farrowing were collected, as were piglet weights from a sub-sample (27%) of litters.

Sows were scored for skin lesions and gait prior to being mixed at 5 weeks gestation, at 3 days after initial mixing (gait and lesions), and at 7 days after final grouping in the gestation pen. Lesion scores ranged from 0 (no injury) to 3 (severe injury) and were evaluated for eleven body regions, and gait was assessed using a standardised scale from 0 to 4. Sows with lameness score ≥2 were removed from the study and placed in relief pens and provided care based on the farm's procedures. All sow removals due to lameness or other health considerations were recorded.

RESULTS AND DISCUSSION

Feeding duration

Within all of the treatments, average meal length ranged from 15 – 20 minutes, with the longest daily feeding duration found in the uniform low parity group. There was no significant difference in average feeding duration among the treatments. The longest feeding duration recorded was performed by low parity sow groups in the first two weeks of gestation, taking 20 minutes to feed. By the end of gestation, feeding duration for low parity sows was significantly reduced, with average meal duration of 17 minutes (Table 1). The longer feeding times for young sows may reflect their lack of familiarity with the system, or greater time spent exploring the feeder.

Feeder entry order

A significant positive correlation was found between the average daily sow feeder entry order and sow bodyweight, (r = 0.13, P<0.01), and also between sow parity and average daily sow feeder entry order (r = 0.07, P<0.01). This suggests that smaller sows were eating earlier in the feeding cycle. However, previous studies have found younger sows eat significantly later in the feeding cycle than old or intermediate sows.

Effect of grouping on sow production performance

Between treatments, there were no differences in the total number of piglets born, the total number born alive, or mummified piglets born, but differences were found in the number of stillborn piglets, pre-weaning mortality up to 5 days of age and the number of piglets weaned (P<0.05).

Uniform grouped high parity sows had fewer total piglets born, higher piglet mortality and fewer piglets weaned. This is likely due to differences in productivity due to sow age, rather than a result of the treatment. Ongoing analysis will examine differences in the number of sows removed per treatment over the course of gestation due to low BCS, injury and lameness.

Table 1. Mean daily feeding duration (hours: minutes: seconds) during gestation periods for mixed parity and uniform (low, medium and high) parity groups.

Treatment	Gestation period* (Early)	(Mid)	(Late)	SEM	P**
Mixed parity	0:17:22	0:15:51	0:17:43	0:08:13	NS
Low parity	0:20:01a	0:16:32b	0:17:20b	0:10:17	<0.01
Medium parity	0:16:02	0:15:37	0:18:21	0:07:03	NS
High parity	0:19:10	0:16:10	0:17:00	0:08:28	NS

* Gestation period: Early: weeks 1 and 2, Mid: weeks 5 and 6, Late: weeks 9 and 10 following mixing.

**Within a row where superscripts differ, P<0.05.

Backfat

There were significant interactions between treatment and parity score on the change in backfat from 5 to 15 weeks gestation. High parity sows were the only ones to gain back fat in the mixed group, while other sows in this treatment lost backfat over the course of gestation. Young sows (parity 2) lost 4.12 mm of backfat on average when in mixed groups, while in the uniform treatment these sows had an average gain of 0.22 mm. Although parity 3 and 4 sows did not fare significantly better in uniform groups, these sows did show positive gains instead of loss when in uniform groups. This indicates high parity sows could be dominating access to the ESF system, and reducing the ability of younger parity sows to feed at regular intervals, or preferred times of day in mixed groups.

Effect of group type (mixed vs uniform) on sow welfare

Sow lameness

Sows in the mixed parity group had a significantly greater increase in lameness between the pre-mixing assessment and day 3 after mixing (P<0.01), and also during the period from premixing to seven days after final grouping (P<0.05), compared to the uniform treatment groups. This indicates that there was a greater risk of lameness following mixing when sows were housed in mixed parity groups, and that housing sows in uniform groups helped to reduce the severity of lameness that developed as a result of mixing.

Lesion scores

Across all treatments, the total average body lesion score increased in severity from premixing to five days post mixing. After this time a reduction in lesions was observed, indicating that the greatest amount of aggression occurs in the period immediately following mixing, and reduces thereafter. This data also suggests that there was little ongoing aggression or injury due to competition for ESF entry once the group hierarchy was established.

The lesion score data suggest that injuries from aggression were largely related to sow age, with the uniform low parity group having the highest injury scores. Medium and mixed parity groups had intermediate lesion scores, and groups of uniform high parity sows had the lowest level of injuries at day 5 following mixing (P<0.001).

CONCLUSION

The preliminary results from this study suggest that housing sows in uniform groups in ESF systems may be a positive strategy for the management of group housed sows. ESF is a feeding system of choice for managing large sow herds in groups. The large herd (≥ 6,000 sows) sizes found in North America will make it possible to consider grouping sows by parity in these systems. In this study, housing sows in uniform groups helped to reduce the severity of lameness developing as a result of mixing. The increases in backfat over gestation also suggest that the well-being of younger sows may be better in uniform groups, and that competition may be less in uniform groups. The practice of managing gilts separately is already a common practice, and the results of this study indicate that parity 1 and 2 sows may also benefit from this practice. While the productivity of sows in uniform groups was equivalent to that of mixed groups, the study followed sows through one gestation, and so there may be longer term effects on sow longevity. Maintaining uniform groups may help reduce mixing injury, with injuries sustained following mixing being equal to or lower in uniform groups than in mixed parity groups, with only the low parity uniform group having higher injury scores. The injuries found in low parity sows appear to be related to the social ability of younger pigs, rather than grouping, and thus management practices that improve sociability of gilts (e.g. increased socialisation by repeated mixing before breeding) may be a further area of research to be examined.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge specific project funding for this study provided by the National Pork Board. Strategic program funding to the Prairie Swine Centre was provided by Sask Pork, Alberta Pork, Manitoba Pork Council, Ontario Pork, and the Saskatchewan Agricultural Development Fund.

National Sow Housing Conversion Project: Initiation and Pilot Demonstrations

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SUMMARY

Increasing numbers of food retailers and supermarket chains have announced plans to develop a 'stall-free' pork supply chain. Consequently, the Canadian pork industry is under pressure to convert existing gestation stall housing of its approximately 1.3 million sows to group systems. However, there are major concerns within the industry around the conversion from stall to group housing. The process requires a large capital investment, and selecting the 'right' system can be a daunting task.

Within the Canadian industry there is relatively little knowledge and experience on the management of sows in group systems. The National Sow Housing Conversion Project (NSHCP) is intended to facilitate the successful conversion of Canada's sow barns to group 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. This report describes the initial phase of this initiative. Building on the outcomes of a University of Manitoba project on group housing, it involved the establishment of a national working group, preparation of educational materials for producers, and the initiation of two barn conversions along with detailed costing information. Selected barns in Saskatchewan and Manitoba were used as pilot sites to develop a strategy for barn conversion and technology transfer activities. This information will aid producers in making effective decisions that will sustain and enhance Canada's access to domestic and export markets.

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 banned sow gestation stalls in all member countries as of January 1st 2013. More recently, increasing numbers of food retailers, including Tim Hortons, Burger King and McDonalds, have pledged to source pork from producers who have plans for conversion to group housing, and the supermarket chains Safeway and Costco recently announced plans to develop a stall-free pork supply chain. 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 within the industry 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 require more 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 make 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.

EXPERIMENTAL PROCEDURE

The NSHCP pilot project was a collaborative project between the Prairie Swine Centre, the University of Manitoba, the Manitoba Pork Council and engineering consultant, Murray Elliott. The NSHCP is a descriptive project with the practical aim of generating information that will increase producer's confidence in adopting group housing. This was achieved through five key activities:

Development of information resources for producers on group sow housing

Three factsheets and seven articles were developed that describe the pros and cons of different group housing systems and principles that promote ease-of-management, sow productivity and welfare. All materials have been made available at PSC's website.

Development of barn conversion plans two farms in Saskatchewan and Manitoba

A number of barns interested in conversion from stall to group housing were identified with the assistance of Sask Pork and the Manitoba Pork Council. Each farm was asked to complete a Survey Monkey questionnaire describing their herd size and building characteristics. Based on the information provided, two barns were selected for the pilot project, one in Saskatchewan and one in Manitoba.

Barn selection was followed by three site visits. The first visit was designed to provide information to farms about the project and to gather detailed information on barn layout. Based on this information, detailed barn layouts were prepared for a variety of group housing options, including electronic sow feeder (ESF), free-access, and shoulder stall options. Barn plans were developed with the assistance of a computer program developed by the University of Manitoba, the Swine Housing Conversion Design Utility (SHCDU), which is capable of producing floor plans and also provides detailed cost estimates for each option.

The goal of the second farm visit was to narrow down the barn renovation options based on input from farm management. Final meetings were held in late fall during which an agricultural engineer inspected each barn site to determine if the buildings were structurally sound and would warrant the significant investment needed for conversion. Finally, rough blueprints were prepared for each site, detailing the design of the selected group housing option, and including a detailed costs analysis for the barn conversion.

Technology transfer: disseminating barn conversion information to pork producers

The three factsheets on group housing options were created and made available on PSC's website. Video interviews were carried out with staff at each farm site to document the initial views and concerns of barn management regarding the move to group housing. Additional footage will be collected as part of the full NSHCP as barn renovations proceed in order to document the full conversion process. Presentations were also made at producer meetings, including PSC's 2013 spring producer meetings and the 2014 Banff Pork Seminar, describing the project and its objectives.

Refining the University of Manitoba barn conversion computer model

The two pilot barn sites were used as case studies for testing the Swine Housing Conversion Design Utility (SHCDU). Over the course of the project, numerous improvements were made to the SHCDU based on limitations that were identified through the use of these case studies.

Development of a national working group

The National Sow Housing Working Group (NSHWG) was formed, consisting of producer groups, industry representatives and scientists across the country. The goal of the NSHWG will be to advise and coordinate the long term NSHCP. Having a national working group to coordinate future projects will ensure that producers across the country have access to similar information and the best possible advice regarding barn conversions. The group met twice to discuss the project goals and plans for securing funding for the full NSHCP.

RESULTS AND DISCUSSION

Three factsheets were prepared discussing the pros and cons of different group housing options.

The factsheets are available on the internet at: http://www.prairieswine.com/national-sow-housing-conversion-project-2/ and are titled:

a. Competitive feeding Systems
b. Free Access Stalls
c. Electronic Sow Feeders

Seven articles were also compiled which review scientific information on group sow housing and management. The articles make up PSC's 'Science of Ethology' series, and can be found by searching 'Science of Ethology' using PSC's Pork Insight search engine, located at: http://www.prairieswine.com/pork-insight/

Sample barn layouts produced by the SHDCU for the Saskatchewan barn site are shown in Figures 1 through 4. The information presented here describes one room, with the barn containing two similarly designed rooms for breeding and gestation. The draft layout for Dynamic ESF housing with 22 sq ft/sow is shown in Figure 1. The Electronic Sow Feeder (ESF) option is presented with three groups of roughly 250 sows, and 4 to 5 ESF feeders per pen. Each gestation pen would hold 2 week's breeding. Hospital pens are provided as well as boar places and 520 breeding stalls to facilitate the flow of the herd.

Each group housing system presented has different strengths and weaknesses, which were discussed with farm management. In terms of maintaining existing herd numbers, the ESF options were the most successful, requiring no additional floor space or reductions to the sow herd.

Total cost estimates for barn renovations range from 1.2 to 1.4 million (Table 1), with investment in flooring and penning being the most costly items. Renovation costs per sow in breeding and gestation range from $900-1400, and depend largely on the number of sows that can be accommodated with each option. On a cost per square foot basis, Short Stall housing (Figure 4) is the least expensive at $37.21/sq ft. This is due to the ability to re-use existing feed lines and stall fronts. However, the longer term costs such as increased management inputs and potential for production losses due to competitive feeding should also be considered. Transition costs, such as transfer of sows to another site during the renovation period, were not included in this estimate and have been estimated at an additional $75-100/sow.

Table 1. Cost comparison between the four group housing conversion options for the Saskatchewan sow barn.

	Dynamic ESF	Static ESF	Static Free Access	Short Stalls with Static Groups
	(22 ft^2/sow)	(22 ft^2/sow)	(22 ft^2/sow)	(22 ft^2/sow)
Total cost	$1,020,242	$1,169,021	$1,061,223	$935,963
Cost per Sow	$699.75	$904.12	$1024.35	$744.60
Cost per Sq. Ft.	$33.80	$38.73	$35.16	$31.01
# of Sows	1,458	1,293	1,036	1,257
Sq. Ft.	30,186.48	30,186.48	30,186.48	30,186.48

Some areas for improvement and cost saving were suggested with each option. Changes to flooring/concrete work are especially cost intensive, and the current estimates assume that barn flooring and pits will require a full renovation. Cost savings were calculated assuming that 45% of flooring could be kept 'as is'. These calculations for the Dynamic ESF option resulted in a final cost of $2,058,370, with an overall savings of 16% compared to full replacement.

Improvements made to the SHCDU over the course of the project included the development of a new method for construction of barn rooms which allows for multiple rooms to be assembled and named. This allows the model to simulate complex barn layouts. Adjustments were also made to how leftover space is handled by the program. The program has been changed to optimise the use of leftover space for comfort pens, which increases the estimated barn capacity.

CONCLUSION

The NSHCP is designed to help Canada's swine production sector respond to the emerging issue of sow housing. By compiling the best information available on group sow housing and working with producers on demonstration projects, the project will aid producers in meeting this challenge in an efficient manner. The information produced will include barn and pen design, detailed costing and management strategies, and will be conveyed through demonstrations, factsheets and presentations. The NSHCP will thus increase producer confidence surrounding this transition and provide clear guidance for producers wanting to convert from stall to group housing. The transition process will therefore be accelerated, and producers will have the support needed to implement new housing technologies effectively. This will help producers to maintain productivity during the transition, and place the Canadian pork industry in a strong position within global markets.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge specific project funding for this study provided by the Canadian Agricultural Adaption Programme (CAAP) of Alberta. Strategic program funding to the Prairie Swine Centre was provided by Sask Pork, Alberta Pork, Manitoba Pork Council, Ontario Pork, and the Saskatchewan Agricultural Development Fund.

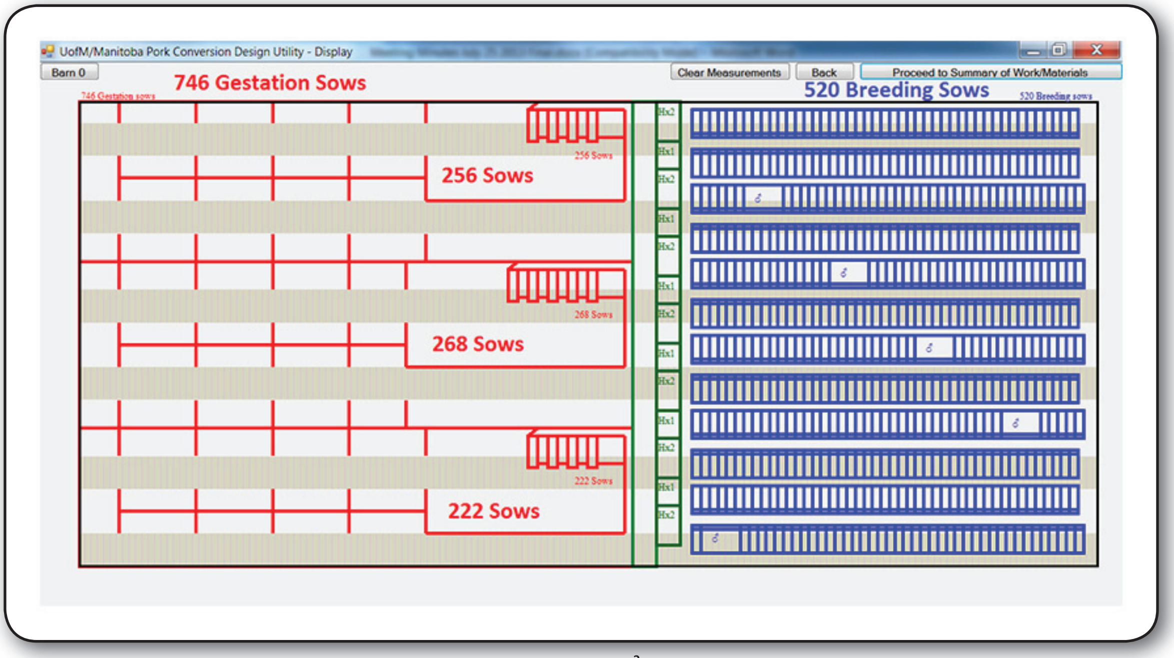


Figure 1. Draft barn layout showing the Dynamic ESF housing option at 22 ft²/sow. This design would contain 520 breeding stalls and 746 gestation places.

Figure 2 shows the draft layout for Static ESF housing at 22 ft²/sow. The ESF option is presented with 4 groups of 124 sows utilizing two feeders per pen. Unlike the Dynamic ESF option, the smaller group size and pen layout is designed for static gestation groups, with all-in all-out management and one pen filled per week. Unfortunately the model was not able to optimise floor space usage for this design, as can be seen by the open areas of flooring in Figure 2. To improve floor space use, additional drawings were prepared using Microsoft PowerPoint showing alternative floor plans for static ESF housing.

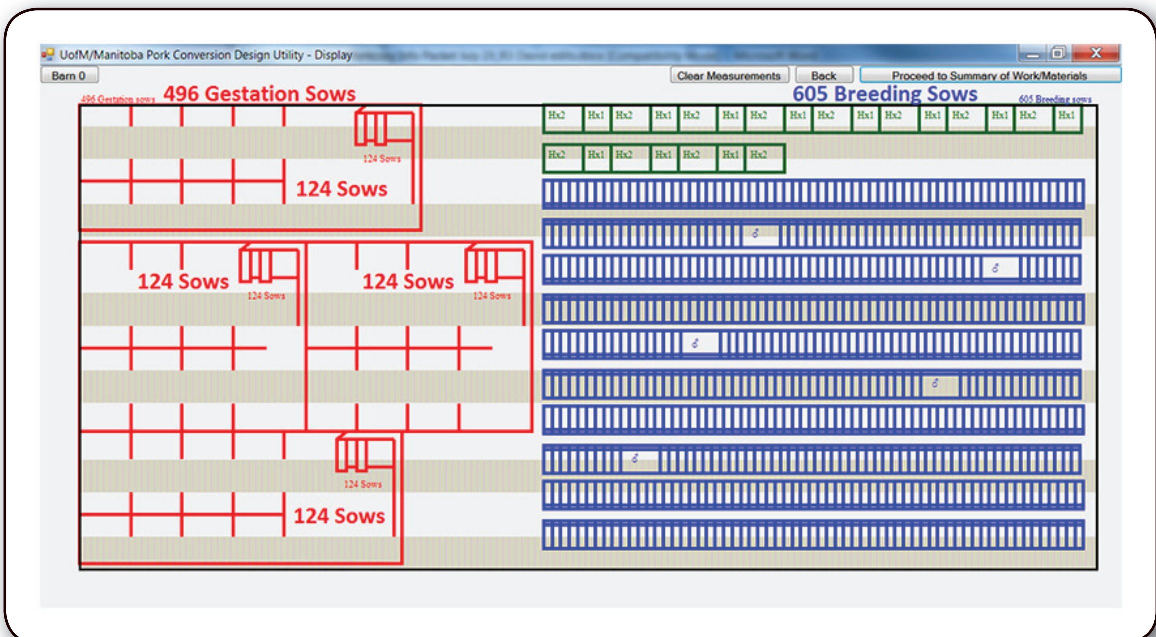


Figure 2. Draft barn layout showing the Static ESF at 22 ft²/sow housing option. This design would contain 605 breeding stalls and 496 gestation places.

Figure 3 shows the draft layout for static free access housing. The free access group housing option is presented with eight groups of 62 sows in a "T" loafing area layout and two groups of 31 sows in a "L" loafing area layout utilitizing an equal number of feeders as sows per pen. Hospital pens are provided as well as boar places and 286 breeding stalls in each barn to facilitate the flow of the herd.

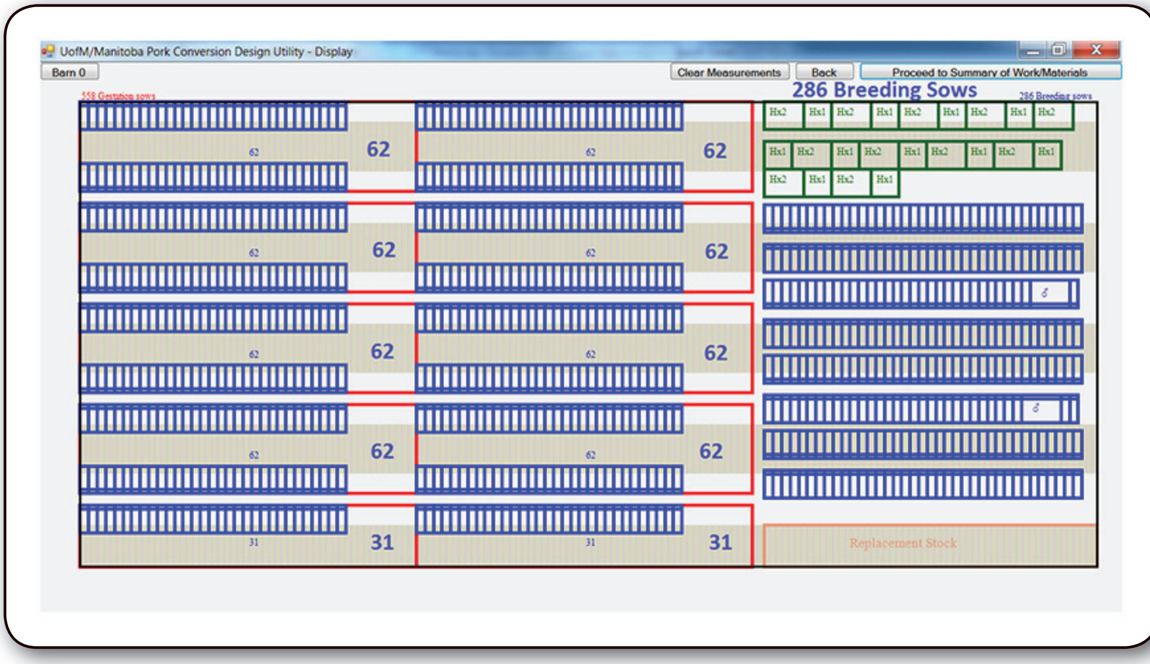


Figure 3. Draft barn layout showing the Free Access at 22 ft^2/sow group housing option. This design would contain 286 breeding stalls and 558 gestation places.

The draft layout for Short Stalls with static groups is shown in Figure 4. The Short Stalls group housing option is presented with 24 groups of 20 sows and six groups of nine sows utilizing an equal number of feeders as sows per pen in an "L" loafing area layout. Hospital pens are provided as well as boar places and 531 breeding stalls in each barn to facilitate the flow of the herd.

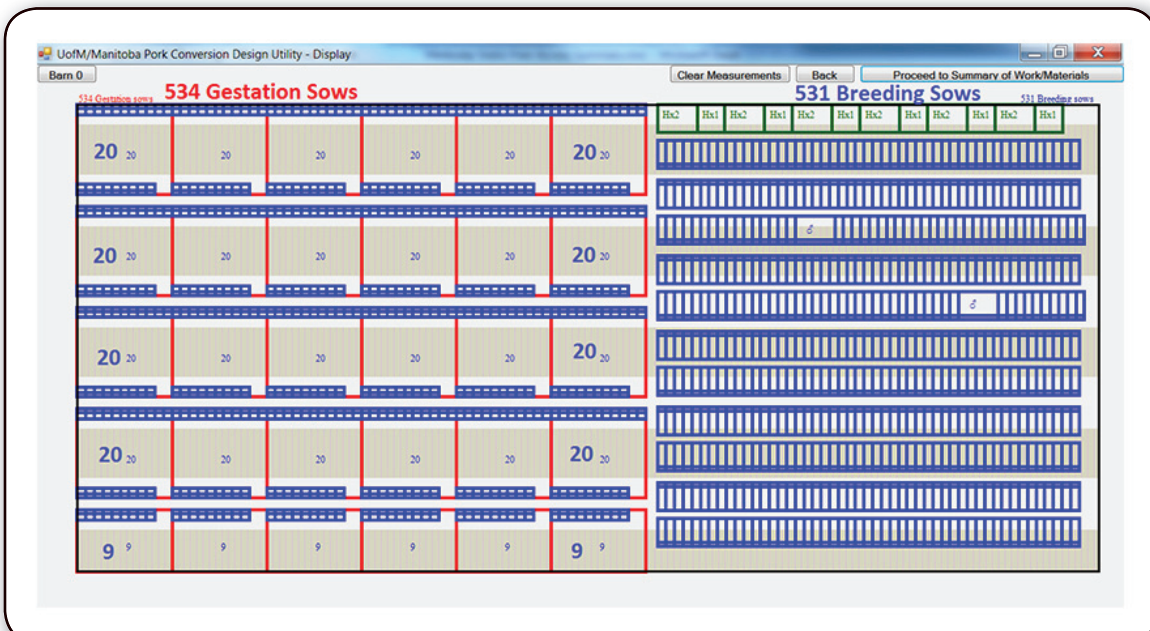


Figure 4. Draft barn layout showing the Short Stalls with Static Groups at 22 ft^2/sow housing option. This design would contain 531 breeding stalls and 534 gestation places.

Can Group-Housed Sows be Raised at Lower Temperatures to Reduce Barn Heating Costs?

B. Predicala, A. Alvarado, D. Beaulieu and J. Brown

Bernardo Predicala

Alvin Alvarado

SUMMARY

In this project, an operant mechanism that will allow sows housed in a group system to control their own environmental temperature was developed. The mechanism was configured with a manual control switch that the sows can access and operate, which in turn activated the supplementary room heating system, as well as a localized radiant heater above the location of the switch as an immediate reward. Testing of a prototype system installed in a controlled-environment chamber with two sows showed that the mechanism functioned satisfactorily to allow the sows to control their environmental temperature. Preparations for subsequent tests in group-housed sow gestation rooms to assess overall heating cost savings, associated sow behavior, and optimal dietary requirements when raised at lower temperatures are underway.

INTRODUCTION

It was hypothesized that sows housed in groups can be maintained at lower environmental temperature because the sows have the opportunity to exhibit thermoregulatory behavior such as huddling when the barn temperature is lowered, thereby saving on energy to heat the barn. As such, the objective of this project was to develop a mechanism that will allow group-housed sows to operate the heating system in their airspace and maintain the environment at their preferred temperature.

An operant mechanism comprised of a manual control switch that operated the existing supplementary heating system for the sow room as well as a small radiant heater placed above the area of the switch as an immediate feedback reward was developed. The underlying principle for this operant mechanism has been successfully implemented in a study to assess the temperature preference of nursery pigs (Bench and Gonyou 2007).

EXPERIMENTAL PROCEDURE

The initial design of the operant mechanism shown in Figure 1 was composed of three timers and an isolation relay. Timer 1 was used to supply power to and activate the isolation relay while timers 2 and 3 were used to activate the heat lamp and the room heater, respectively, over the time period set for the timer. Also, timer 1 was used to deactivate the push button over the time period set for the timer, to prevent extended operation of the system in case the button was activated in close succession.

"Operant mechanisms allow sows housed in group systems to control their own environmental temperatures, allowing for lower barn temperatures."

A prototype module was assembled and installed in a controlled-environment chamber at the PSC barn. Over a 2-week period, the environmental temperature in the chamber was monitored continuously using data loggers, and the sows were observed by video camera for 24 hours to assess the learning process of the sows to operate the mechanism over time, the average temperature selected by the sows, as well as operational parameters to optimize the settings of the operant mechanism.

Data gathered over the 2-week testing period of the operant mechanism and the associated controls, switches and heaters showed the temperature in the room and in the inlet zone as well as the

Figure 1. Experimental set-up for testing of the prototype operant module (inset) in a controlled-environment chamber.

instances that the button was pressed to activate the room heating system over this 48-hr period (see Figure 2). The air coming into the chamber through the inlet had an average temperature of 8.1 °C and ranged from 6.5 °C to 9.2 °C over this period. On the other hand, the temperature inside the room was about 13.1 °C on average and ranged from 11.5 °C to 16.0 °C. The difference in temperature between the inlet and the room can be attributed mostly to the heat generated by the sows and the supplemental heat from the heaters when in operation. Validated data showed that the room temperature selected by sows ranged from 13 °C to 14 °C, with most hits on the switch occurring when room temperature was about 13.5 °C. This temperature occurred during daytime when sows were mostly awake and active. At night, sows seemed to tolerate room temperatures as low as 11.5 °C while asleep. In addition, there were instances that the temperature in the room was below 13 °C during the day and sows did not even bother to press the heat control switch.

CONCLUSION

From this work, it was shown that an operant mechanism with an accessible control switch and associated functions to allow sows to control their environmental temperature can be successfully developed. Subsequent barn-scale studies utilizing the developed operant mechanism to determine energy savings from allowing group-housed sows to control their own environmental temperature, impacts on general activity, body condition, and weight gain of sows, and addition of high-fibre in sow diets to supplement sow metabolic heat generation, will be among the next steps.

ACKNOWLEDGEMENTS

Funding for this project has been provided by Agriculture and Agri-Food Canada through the Canadian Agricultural Adaptation Program (CAAP). In Saskatchewan, this program was delivered by the Agriculture Council of Saskatchewan. Strategic funding provided by the Saskatchewan Pork Development Board, Alberta Pork, Manitoba Pork Council, Ontario Pork, and the Saskatchewan Ministry of Agriculture is also acknowledged.

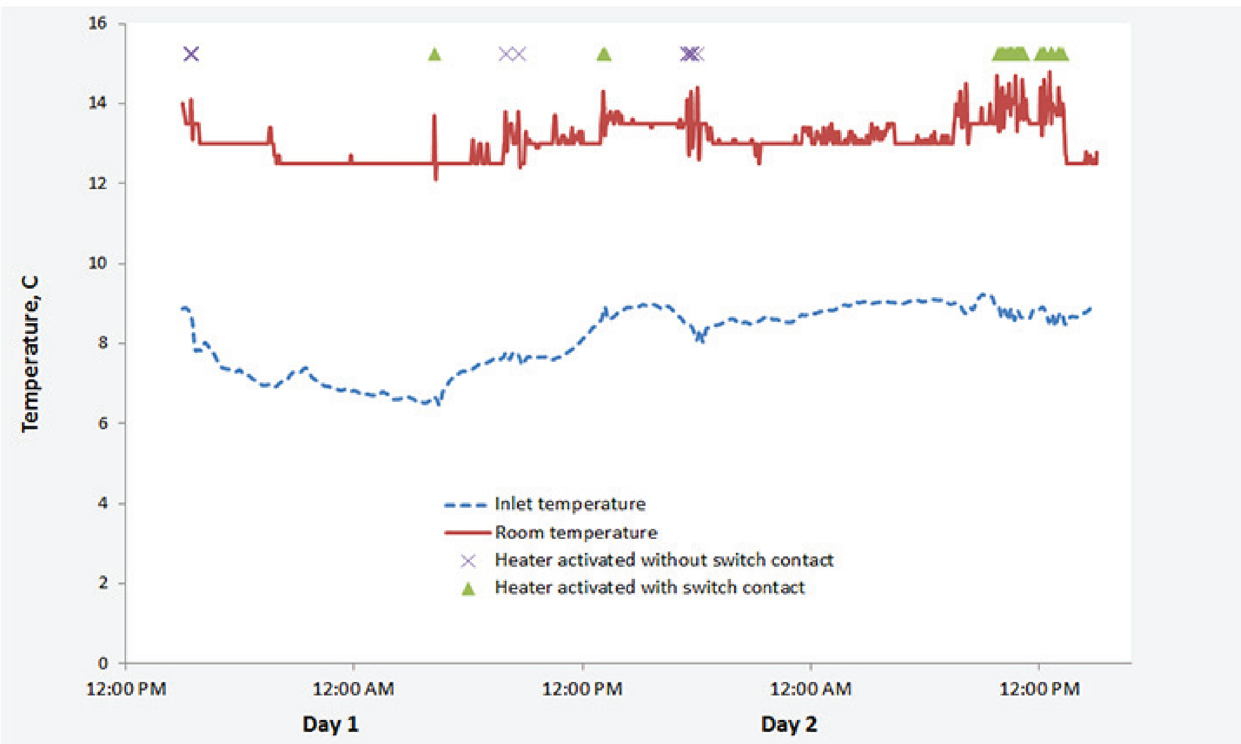


Figure 2. Measured temperature in the animal-occupied zone in the controlled-environment chamber and in the inlet zone as well as the occurrences of activation of the heating system in the room over a 48-hr period.

Field Testing of an Air Filtration System for a Pig Transport Trailer

B. Predicala, A. Alvarado and S. Ekanayake

Bernardo Predicala

Alvin Alvarado

SUMMARY

The spread of airborne transmissible disease such as PRRS continues to be a serious threat to the Canadian swine industry as this disease causes significant economic losses to infected herds. This project aimed to develop an additional line of defense against infection of airborne diseases by designing an air filtration system for a swine transport trailer to maintain a pathogen-free environment inside the trailer during transport. Testing and evaluation of the prototype air filtration system showed that the use of antimicrobial filters (i.e., MERV 16 and fabric bag filters) can effectively capture bioaerosols in the air and prevent their entry into the animal compartment of the trailer.

INTRODUCTION

The growth and success of the Canadian pork industry over the past decades depended significantly on access to highly improved genetics. High-value breeding stock produced from nucleus and multiplier farms inevitably would need to be transported to the commercial producers, thus putting these valuable genetic stock at risk of exposure to pathogens circulating in the transit areas. While individual farms have biosecurity procedures to ensure that the delivered animals are not introduced to the herd if infection was detected, the risk of infection of the breeding stock during transport can be significant, particularly during passage through pig dense areas of Quebec, Ontario and Manitoba, where disease outbreaks can still happen despite current biosecurity protocols in place. Thus, it is imperative that measures be developed to protect breeding stock during transport, thereby avoiding infection of these high-value animals and the consequent significant economic loss.

"Air filtration system showed that the use of antimicrobial filters can effectively capture bioaerosols in the air preventing entry into the trailer"

This project's overall goal was to design, develop, and evaluate an air filtration system that can be fitted to a transport vehicle to prevent infection of the high-value breeding stock during transport. The specific objectives were to fabricate and install a prototype system in an actual transport trailer, and evaluate the performance of the filtered trailer system.

EXPERIMENTAL PROCEDURE

An initial design which included an axial fan, air filtration system (pre-filter combined with high-efficiency filter), air inlets, and air exhaust vents with shutter was formulated based on literature review and information gathered from previous and existing filtered trailers. The components were installed on a commercial swine transport trailer (goose-neck trailer with 16' body length, 6'6" width and 6'height). The air filtration components were fitted in the goose-neck area and was operated using a forced-ventilation system (Figures 1 and 2).

The retrofitted trailer was tested for effectiveness in maintaining a pathogen-free environment inside the trailer during operation of the filtration system. A bacteriophage φX174 (ATCC 13706-B1) which is a benign model used as surrogate for pathogenic microorganisms in filtration studies, was used in this test.

During the actual testing and evaluation, the bacteriophage solution was aerosolized in the goose-neck area of the trailer using a fogging equipment. Air samples were collected upstream (inlet side) and downstream the filtration system (inside the trailer) using a 3-piece sampling cassette with mixed cellulose filter (MF-Millipore), and a vacuum pump operated at 2.5 Lpm flow rate. Bacteriophage concentrations collected on the sample filters were determined based on amplification of a specific deoxyribonucleic acid (DNA) sequence in the target organism using quantitative polymerase chain reaction (qPCR).

Two types of air treatment filters were tested: MERV 16 with a pre-filter and antimicrobial fabric bag-type filters. Both types of filters are used in air filtered commercial barn installations.

The concentration of bacteriophage φX174 at the inlet area (upstream side) was reduced significantly ($p=0.002$, $n=9$) after passing through the MERV 16 filter. The average reduction relative to the upstream concentration was about 89.3%; during the tests, a few instances showed that the MERV 16 achieved a 100% reduction in bacteriophage concentration.

The effectiveness of the fabric bag filter in removing bacteriophage in the air is shown in Figure 3. Similar to MERV 16 filter, the fabric bag filters achieved significant reduction ($p=0.02$, $n=3$) in bacteriophage φX174 concentration. Relative to the upstream concentration, the fabric bag filters had an average reduction of about 99.8%.

Figure 1. Commercial swine transport trailer with installed air inlets (inset) for the air filtration system.

Figure 2. Ventilation fan and air filter holder were installed in gooseneck area which was partitioned from the animal compartment of the trailer. Exhaust vents (inset) were installed on both sides of the trailer.

Comparing the percent reduction achieved by the two filter types, MERV 16 filters were not significantly different (p=0.695) from the fabric bag filters.

Based on the information gathered from conducting the tests, a number of recommendations were identified to improve the operation and effectiveness of the system. These included creating more openings in the inlet as well as in the exhaust area to reduce the fan static pressure, installation of an environmental controller for better regulation of the temperature inside the trailer, and installation of a temperature monitoring system and carbon dioxide detection system with alarm function that can be detected in the truck driver cab.

CONCLUSION

Based on the work completed for this project, the following conclusions can be made:

1. Using information available from literature and other resources, various design components can be identified and assembled to develop an air filtration system for an existing commercial swine transport trailer to maintain a pathogen-free environment inside the trailer during transport of animals.
2. Testing and evaluation of the prototype air filtration system showed that the use of antimicrobial filters (i.e., MERV 16 and fabric bag filters) can effectively capture bioaerosols in the air and prevent entry into the animal compartment of the trailer, thereby protecting the animals from potential infection by airborne transmissible diseases during transport.

ACKNOWLEDGEMENTS

Funding for this project has been provided in part through Industry Councils from Saskatchewan, Alberta, Manitoba and Ontario which deliver the Canadian Agricultural Adaptation Program (CAAP) on behalf of Agriculture and Agri-Food Canada. Strategic funding provided by the Saskatchewan Pork Development Board, Alberta Pork, Manitoba Pork Council, Ontario Pork and the Saskatchewan Ministry of Agriculture.

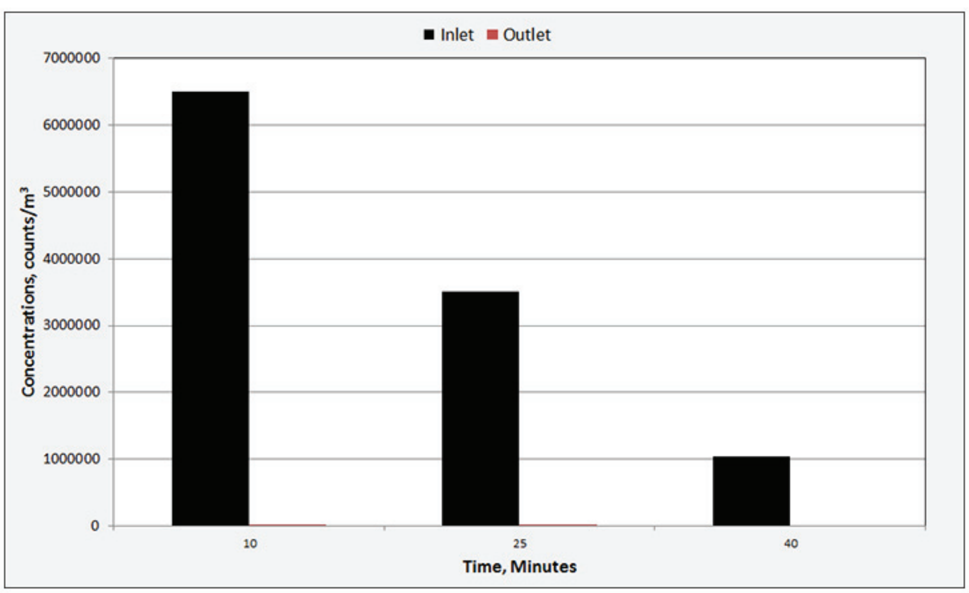


Figure 3. Concentrations of bacteriophage at the upstream and downstream side of the fabric bag filter.

Will Hogs Provided with Whey Compensate in Their Feed and Water Intake?

M. Deibert, D. Wightman and A.D. Beaulieu

Denise Beaulieu

SUMMARY

Minimizing feed cost is always important for improving profits in swine production and can sometimes be accomplished by utilizing by-products from other agricultural industries. Whey, a product of the dairy processing industry, has well-known beneficial properties as a feed additive and is typically fed to newly weaned pigs in dry form. The drying process however, increases the cost. Swine producers in close proximity to dairy processing plants may have access to liquid whey products.

There has been very little research conducted to determine how inclusion of liquid whey would affect nutrient intake in nursery pigs, which became the objective of this experiment. Overall, when liquid whey was fed to nursery pigs (via their water supply), they decreased feed intake to voluntarily control for total energy intake. Throughout the trial pigs remained in good health and no adverse effects were seen from feeding the whey. This decrease in dry feed intake means lower total feed costs depending on price and availability of the liquid whey.

INTRODUCTION

Whey, a highly digestible lactose product, is the liquid remaining after acidification of milk during the production of cheese and other dairy products. It can be fed to nursery pigs immediately post-weaning, often in a deproteinized, dried form. These processing steps require energy and increase the cost of the whey product and therefore, for producers close to dairy processing plants, liquid whey could be a more viable alternative.

Theoretically, including the whey in the water supply of the pigs should reduce feed costs while maintaining growth. The net benefit will depend on the cost of whey and transportation. This may not be feasible for all producers, but may be an option for some. This project was designed to provide information to producers considering liquid whey as an alternative feed ingredient.

Our overall objective was to determine if the pig maintains a consistent dry matter intake when additional nutrients are supplied in the water.

The specific objectives included: 1) measuring the liquid and dry feed intake of piglets supplied varying whey/water concentrations, 2) determine if pigs maintain caloric intake when receiving whey in the drinking water, and 3) determine the potential feed cost savings associated with feeding liquid whey.

EXPERIMENTAL PROCEDURE

Seventy two newly weaned piglets (26 ± 2 days of age), housed one barrow and one gilt per pen, were allocated to receive either 0%, 8% or 16% whey (vol/vol) in their drinking water. The experiment was completed in 2 cycles each consisting of a 7 day acclimation period followed by a 14 day experimental period for a total of 8 weeks. Piglets were housed in pairs to minimize boredom, which may cause excessive drinking or water wastage. Enrichment was also provided and changed daily in an effort to mitigate boredom (Figure 1).

The water system was adapted using suspended buckets above each metabolism crate to dispense the whey and water mix and allow accurate intake measurements (Figure 2). Pigs began to receive the selected treatment of whey on the third day of acclimation. Each pen also had trays suspended under the water/feeder to collect and measure waste. Liquid waste was weighed and then placed under heat lamps and reweighed to estimate dry matter. Feed and whey-water were monitored to ensure it was available ad libitum and daily health checks were performed. Fecal scores were assessed and recorded also.

During the acclimation period pigs were fed a commercial starter diet that was switched to a pre-grower diet during the 14 day experimental period. No antibiotics were included in the feed but copper sulfate was included at a rate of 0.04%. In the last week on trial, TiO^2 was added to the feed as a non-digestible marker to determine overall diet digestibility.

> *"Growing pigs provided liquid whey in their drinking water deecreased intake of dry feed, and thus overall nutrient intake was unchanged"*

RESULTS AND DISCUSSION

Water and feed intakes were calculated weekly taking into account the waste of each, which was measured daily. The pigs were weighed weekly to monitor growth and performance and during the last week on trial, feed and fecal samples were obtained on a per pen basis to assess for digestibility.. A numerical decline in feed intake and calories from feed was observed; however, there was large variability associated with this measurement and it was not significant (P = 0.18; Table 1, Figure 3). Overall liquid intake increased with increasing whey incorporation in the drinking water, and thus intake of dry matter and calories from whey increased (P < 0.01; Table 1). Despite the increasing energy intake from the whey, total caloric intake remained relatively constant, indicating that pigs compensated for the increasing proportion of caloric intake from whey by decreasing intake of dry feed.

There was no effect of treatment on average daily gain (P = 0.57); however, the combination of a numerical tendency for increased energy intake and decreased growth with increased whey in the drinking water resulted in a reduction in energetic efficiency (DE/gain, P = 0.03; Table 1). This calculation was based on a reported DE content for the whey, a value which may vary depending on the individual processing plant and whey composition. As shown in Table 1, consistency of nutrient intake was well maintained between the 0 and 8% inclusion levels, while liquid (and thus whey intake) increased dramatically between the 8 and 16 % inclusion levels. This requires further investigation.

CONCLUSIONS

Nursery piglets receiving 8 or 16 % whey in their drinking water decreased feed intake in proportion to the nutrients in whey while maintaining growth. Assuming a cost of $100 per tonne of whey DM this would result in cost savings of approximately $2.00 per pig in the nursery (2013 summer feed prices). Actual savings would be farm specific and depend on cost of whey and transportation as well as feed costs.

ACKNOWLEDGEMENTS

Funding for this project has been provided in part through Industry Councils from Saskatchewan, Alberta, Manitoba and Ontario which deliver the Canadian Agricultural Adaptation Program (CAAP) on behalf of Agriculture and Agri-Food Canada. Strategic funding provided by the Saskatchewan Pork Development Board, Alberta Pork, Manitoba Pork Council, Ontario Pork and the Saskatchewan Ministry of Agriculture.

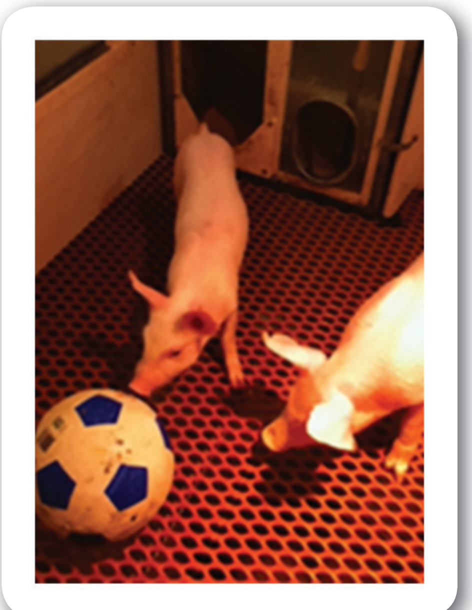


Figure 1. Two pigs per pen playing with the toys used as enrichment to prevent boredom and water waste

Figure 2. Modification with whey feeding buckets above the metabolism crates

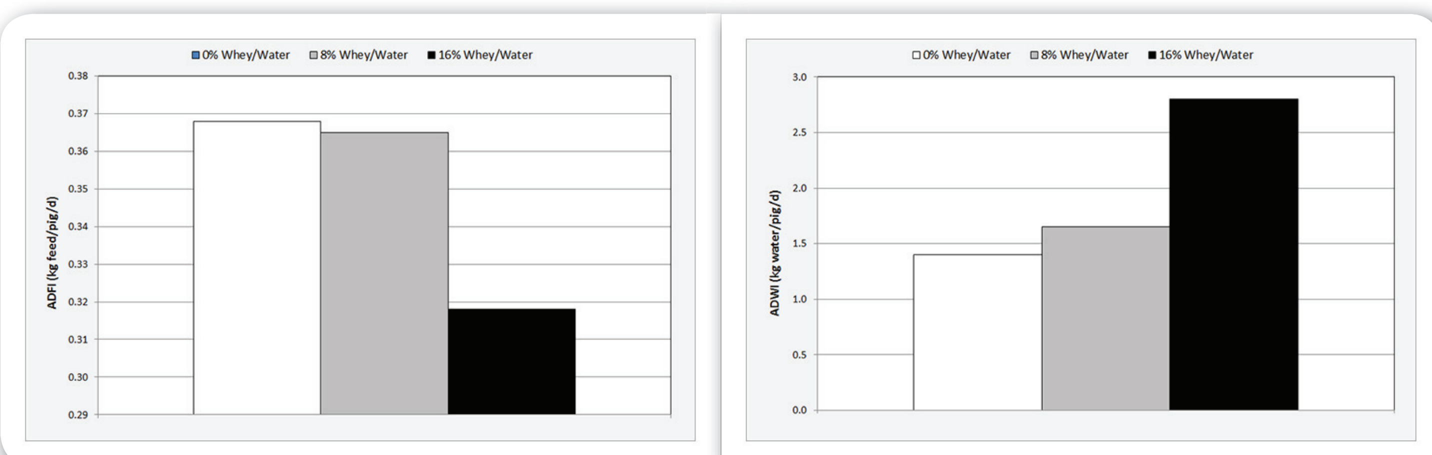


Figure 3. Comparison of whey treatment to the average daily intake of feed and water per pig

Table 1. Feed and whey-water intake[a]

	% whey (by volume)			SEM	P < (linear)
	0	8	16		
Intake					
Feed, kg	10.33	10.25	8.91	0.88	0.18
Feed, Mcal	35.72	35.45	30.82	3.04	0.18
Liquid, kg	39.01	49.59	80.01	7.09	<0.01
Whey DM, kg	0.00	0.61	1.96	0.13	<0.01
Whey, Mcal DEb	0.00	2.10	6.78	0.46	<0.01
Mcal DE, Total	35.72	37.55	37.60	3.34	0.57
Calories from whey, %	0	6	18		
Mcal DE/day	2.55	2.68	2.69	0.24	0.57
Body weight and growth, pen averages (per pig)					
Initial BW, kg	5.99	5.96	6.27	0.43	0.40
Final BW, kg	10.61	10.77	10.23	0.54	0.57
ADG, kg/pig day^{-1}	0.33	0.34	0.28	0.04	0.25
Energetic efficiency (Mcal/gain)					
Mcal DE intake/kg gain	3.92	3.98	5.06	0.49	0.03

[a] Except where indicated data is per pen (2 pigs) for the 14 day experiment.

Are My Pigs Eating?

R. Gauvreau and A.D. Beaulieu

Denise Beaulieu

SUMMARY

The objective of this project was to demonstrate to swine producers the proportion of piglets who actually consume some feed during a 48 hour period. We focused on piglets in the farrowing crate offered creep feed (supplemental feed to milk during lactation) or on piglets early post-weaning.

INTRODUCTION

Recent trials conducted at the Prairie Swine Centre, Inc. have confirmed the importance of feed intake by the piglet immediately post-weaning and/or consumption of creep feed in the farrowing room. We have also demonstrated that more than half of the piglets may not consume either creep feed, or the starter diet immediately post-weaning. However, in commercial barns, where producers typically measure feed disappearance, piglets are maintained in groups, which makes it difficult to determine which piglets are actually consuming feed. In order to estimate which piglets consume some of the food offered during a specified time period, we have developed a technique where we incorporate non-toxic, food grade dye into the ration. We then used this technique on commercial farms, to demonstrate to participating swine producers, and swine producers in general, that a proportion of pigs in a pen may not be accessing feed during a 24 to 48 hour period. Producers may adopt and use this method periodically on farm to determine if management changes affect the proportion of piglets accessing the feed.

EXPERIMENTAL PROCEDURE

Dyed pellets were created using a basic dog biscuit recipe (flour, eggs, milk, sugar) with added "Brilliant Blue" (FD & C Blue #1) at 10% mass ratio. Brilliant Blue is non-toxic, and is not completely absorbed in the gastrointestinal tract, and thus can be visualized in the feces. Pellets were broken up to be a similar size to a crumble diet, so they could be easily mixed into a given ration. All dyed pellets were prepared in a cleaned and disinfected lab in Prairie Swine Centre, and then transported to participating farms in new pails.

Hog producers were contacted via email or phone and, if interested in the project, filled out a questionnaire about creep feeding and weaning details. Producers contacted included commercial barns, multiplier facilities, genetics facilities, and private colonies/producers. Producers were added to the project on a first response first serve basis.

Participating producers mixed the dye pellets into the creep feed or starter diets, depending on which was being assessed for consumption. A detailed instruction list was provided when the pellets were delivered. The pellets were mixed into the feed at a 5% by mass ratio, meaning the brilliant blue would be present in a 0.05% by mass ratio (0.5 g Brilliant Blue would be present in 1kg of mixed creep or starter diet). Previous work in our barn showed that this concentration allowed for an accurate assessment of which pigs were consuming feed due to the visible change in feces colour.

"Dyed diets were available for the pigs to consume for a total of 48 hours."

The dyed diets were typically available for the pigs to consume for a total of 48 hours. When creep consumption was being examined, the dyed pellets were added to the farrowing rooms in the last week with the sow. Twenty-four hours later, an anal swab was performed by gently inserting a cotton swab into the anus of individual pigs to determine if that piglet could be classified as an "eater" or "non-eater". An "eater" would show evidence of blue or green feces, while "non-eaters" would have the yellow or brown coloured feces. Approximately 200 pigs were evaluated at each production facility.

RESULTS AND DISCUSSION

Farrowing Rooms

The relative number of "eaters" vs "non-eaters" for evidence of creep-feed consumption is shown in Figure 1, compared to similar data collected at PSC for pigs just prior to weaning, at day 21 or day 28. The PSC data is based on over 2000 piglets, while about 220 piglets were swabbed at each producer facility. Piglets on the producer farms were weaned at about 21 days of age. As shown, only 20 to 40 % of piglets had evidence of creep feed consumption. Although difficult to extrapolate data among farms, our experience at PSC shows that creep feed is more likely to be consumed in piglets weaned at a later age.

Nursery

Figure 2 shows the proportions of piglets showing evidence of consumption of the phase 1 diet immediately post-weaning. The data for PSC represents 24 hours post-weaning, while at the producer farms the dye was in the phase 1 diet for about 48 hours post-weaning. It is possible that this is why there is a difference between PSC data and commercial facilities, as piglets on commercial farms were given a longer opportunity to adapt and consume the feed.

CONCLUSION

Typically 40 to 50% of piglets do not consume creep feed in the farrowing room and about 20% do not consume phase 1 diet within 48 hours post-weaning. Producers should observe piglets to identify potential problems (crowding, feeder access) which might alleviate the problem. If feed or management changes occur, producers can repeat the assessment to determine if the change has been positive or negative relative to the number of “eaters” previously determined. It is important that producers conduct this test at their own facility and use it to set a “benchmark”.

ACKNOWLEDGEMENTS

This project was supported by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward bi-lateral agreement. We thank the participating producers who allowed us into their facilities to perform the assessment. Program funding for Prairie Swine Centre, Inc. from Sask Pork, the Manitoba Pork Council, Alberta Pork, and Ontario Pork is gratefully acknowledged.

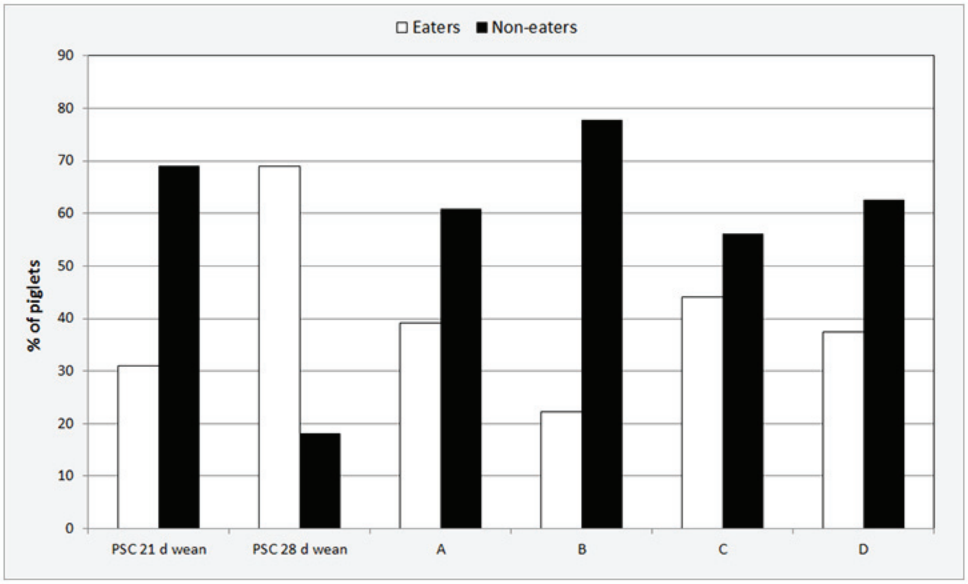


Figure 1: Evidence of creep feed consumption in the 24 hour period pre-weaning at Prairie Swine Centre (weaned at 21 or 28 days of age) and on 4 producer facilities(weaned at 21 days of age).

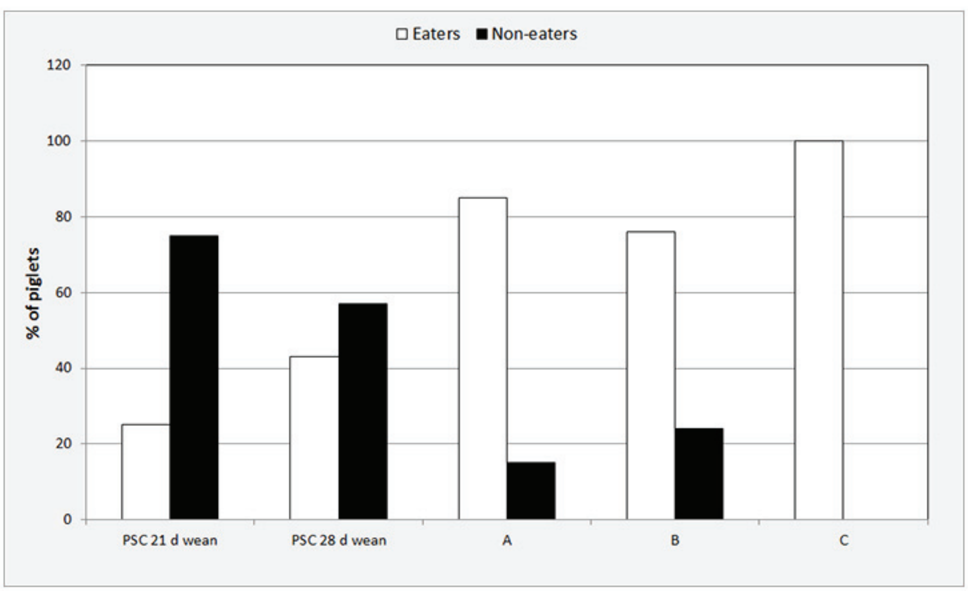


Figure 2: Evidence of phase-1 diet consumption post-weaning at Prairie Swine Centre (weaned at 21 or 28 days of age) and on 3 producer facilities (weaned at 21 days of age). In barn C, all piglets (n = 22) had evidence of consumption.

Bovine Colostrum for Piglets: Can it Mitigate the Post-Weaning Growth Lag?

J. Wu, J. DeNure, D.A. Gillis and A.D. Beaulieu

Denise Beaulieu

SUMMARY

Bovine colostrum is a good source of nutrients and growth factors, and is very palatable. It was added to the creep feed of piglets in the farrowing room and to the phase one diets immediately post-weaning to determine if it would increase feed intake, and help reduce the impacts of the post-weaning growth lag. Overall, the bovine colostrum had no beneficial effects on growth or feed intake of the piglets. However, it did increase the number of piglets that consumed the creep feed or phase one diet immediately after weaning.

INTRODUCTION

Weaning is a stressful time for a piglet, and as a result piglets may undergo a "post-weaning growth lag," characterized by failure to consume solid feed in the hours or days immediately post-weaning. This can be especially detrimental for piglets already compromised because of very low birth weights, which can be a consequence of larger litters.

Increased litter size reduces the overall cost of pork production by spreading out the over-head cost of sow maintenance with increased piglet numbers, and thus increased kilograms of pork produced per sow. However, as the litter size increases, average piglet birth-weight decreases, and pre-and post-weaning mortality increase.

We hypothesized that supplementing bovine colostrum in the creep feed during lactation would benefit piglets that are not receiving sufficient nutrition from the sow, and if continued as a supplement immediately post-weaning, will aid the transition to solid diets in the nursery. The objective of this experiment was to determine if powdered bovine colostrum added to the creep feed or the feed supplied immediately post-weaning would improve feed intake, leading to improved growth.

EXPERIMENTAL PROCEDURE

A total of 20 sows (10/week) and their litters were used for this experiment. All litters were supplied with creep feed from day 19 post-farrowing to weaning (26 ± 2 days of age). Half of the litters had supplemented bovine colostrum with their creep feed (6% of offered feed). At weaning, piglets were moved to the nursery and randomly assigned into nursery pens, based on treatment (± colostrum) and body weight. Pigs were housed 4/pen, and there were 6 pens/treatment/room (2 rooms). The treatments were arranged as a 2 x 2 factorial (plus or minus colostrum in creep x plus or minus colostrum in phase one nursery diet). Piglet body weights were recorded one week prior to weaning, at weaning, and on days 9, 16 and 30 in the nursery. Creep feed consumption was determined daily in farrowing rooms. Feed intake was recorded in the nursery. Creep feeding began one week prior to weaning. Creep feed was spiked with 0.5% brilliant blue for three days to detect eating behavior; which was determined by anal swabbing 48 hours after the blue dye was removed. Half of the phase one diets contained colostrum and all of them were spiked with ferric oxide (red dye colour) for 24 hours post-weaning. Anal swabbing was used to determine the "eaters" of the phase one diet 36 hours post-weaning.

"The objective was to determine if bovine colostrum added to the creep feed or the feed supplied post-weaning would improve feed intake"

RESULTS AND DISCUSSION

Overall, top-dressing the creep feed or the nursery phase 1 diet with bovine colostrum had no effect on growth of the piglets in the farrowing room during the week prior to weaning, nor did it affect growth or feed intake in the nursery (Table 1). Subsets of piglets, the smallest third or the largest third based on day 19 weight, were examined and the same conclusion was drawn. Therefore, it can be concluded that colostrum did not benefit growth of these piglets, nor was there a differential response depending on the body weight of the piglets.

Addition of the colostrum did increase the percentage of piglets identified as "eaters" in the farrowing room and the nursery (Figure 1, $P < 0.05$). When looking specifically at the percentage of piglets identified as "eaters" of the phase one nursery diet it was observed that colostrum added to the creep feed is more influential than added to the nursery diet.

CONCLUSION

Colostrum, whether provided as a top dress to creep feed or added to the phase one diet, did not improve the growth of these piglets. The observation that colostrum did increase the proportion of piglets identified as "eaters" is important however, and more research is required to determine how we can take advantage of this to improve the growth and health of these piglets.

ACKNOWLEDGEMENTS

Funding for this project has been provided by Agriculture and Agri-Food Canada through the Canadian Agricultural Adaptation Program (CAAP). In Saskatchewan, this program is delivered by the Agriculture Council of Saskatchewan. We also acknowledge and appreciate funding from the Saskatoon Colostrum Company, Ltd. Program funding to Prairie Swine Centre Inc. is provided by the Saskatchewan Pork Development Board, Alberta Pork, Manitoba Pork Council, Ontario Pork and Saskatchewan Agriculture and Food Development Fund.

Table 1. The response of piglets receiving colostrum with their creep feed from day 19 to 26 (weaning) post farrowing and their Nursery phase 1 diet.

	Treatment					P Values		
Farrowing	Yes	Yes	No	No			Col. vs. No Col.	
Nursery	Yes	No	Yes	No	SEM	Trt	Farrowing	Nursery
Farrowing room								
BW, d 19	6.05	5.99	5.539	5.60	0.32	0.53	0.52	0.82
BW, d 26	8.10	8.01	7.54	7.63	0.37	0.64	0.73	0.80
ADG, d 19 to 26	0.29	0.29	0.29	0.29	0.11	0.97	0.81	0.79
Nursery room								
BW, d 35	9.48	9.43	9.00	8.86	0.01	0.54	0.69	0.50
BW, d 42	12.02	11.88	11.14	11.27	0.47	0.45	0.63	0.90
Feed intake, g/d	0.75	0.72	0.73	0.70	0.45	0.65	0.42	0.45
Gain, g/d	0.25	0.24	0.23	0.23	0.05	0.43	0.74	0.71
Gain:feed	0.33	0.34	0.32	0.323	0.02	0.28	0.34	0.28

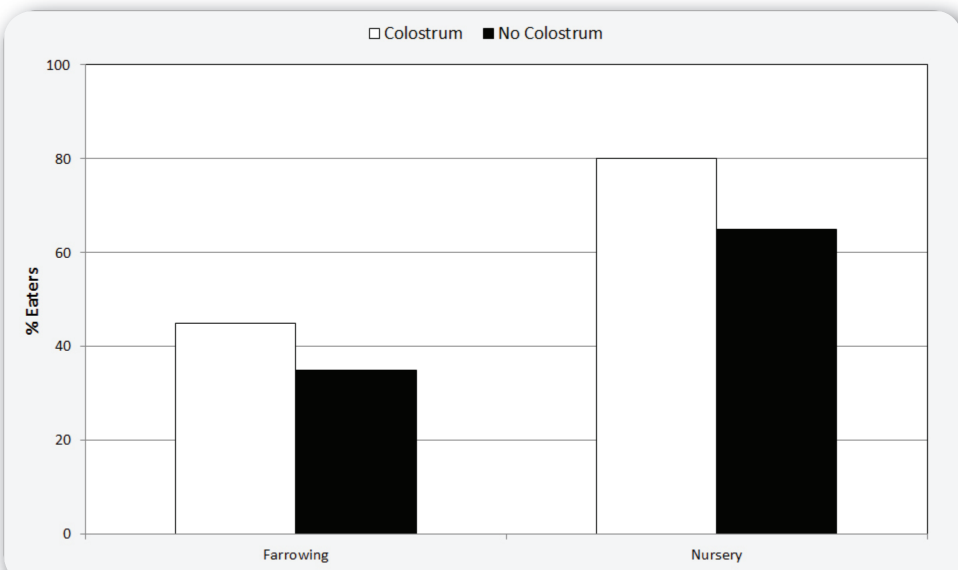
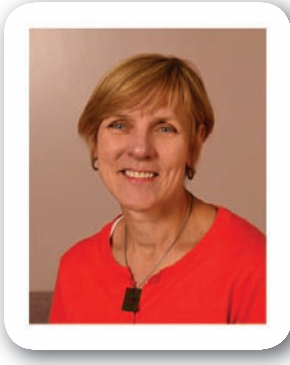


Figure 1. The percent of piglets in the farrowing room or nursery identified as eaters of the creep or phase one diet, respectively. Within a room, ($P < 0.05$).

Dietary ω-6 to ω-3 Ratio Impacts Nursery Pigs More than ω-3 Intake Alone

L. Eastwood and A.D. Beaulieu

Laura Eastwood



Denise Beaulieu

SUMMARY

Results from these experiments indicate that altering the omega(ω)-6 to ω-3 fatty acid (FA) ratio can improve nursery pig performance, and protein deposition, potentially by diverting nutrients away from an unnecessary inflammatory response. Additionally, we found no effects on piglet performance or health by altering the amount without changing the FA ratio. Results from this project indicate that in order to observe benefits of feeding ω-3 FA's to nursery pigs, it is more important to ensure the ratio of ω-3's relative to ω-6's are altered as opposed to simply increasing the amount without changing the ratio.

INTRODUCTION

Weaning is a stressful time in a piglet's life. They undergo social, environmental and nutritional stressors at a time when their immune system is not fully developed. This can precipitate the 'post-weaning growth lag', which is characterized by animals going off feed, reduced or negative growth rates and increased susceptibility to pathogens. These stresses can trigger an inflammatory reaction in some piglets. Although a certain degree of an inflammatory response is beneficial, an over-production of inflammatory cells may become detrimental to the animals, leading to reduced muscle synthesis or even muscle degradation, characteristic of the post-weaning growth lag.

Over the years, there has been a high degree of interest in nutritional modulation aimed at helping piglets cope during this time period. Omega 3 fatty acids have many potential health benefits, including anti-inflammatory properties. Previous research however, has shown conflicting data in terms of inflammatory responses and animal performance when ω-3's are fed. We hypothesize that different concentrations of ω-6 fatty acids in the diet among the different studies may explain some of these contradictions. In fact, it has been suggested that it may be more beneficial to reduce the dietary ω-6 to ω-3 FA ratio when feeding pigs than to simply increase the ω-3 amount, in order to see benefits.

This project was designed to determine if whether altering the dietary ω-3 to ω-6 ratio or changing the absolute intake amount of ω-3 FA's was more important for impacting nursery pig health and performance. To achieve this, we conducted 2 experiments. First, our aim was to characterize how the FA ratio and intake would affect the growth and performance of nursery pigs, including whole body FA and protein deposition. Secondly, we wanted to look specifically at how the ω-3 ratio and intake amounts affect the piglets' ability to mount an acute inflammatory response post-weaning.

"Altering the ω-6 to ω-3 ratio, not the absolute intake amount, improves nursery pig performance and protein deposition."

EXPERIMENTAL PROCEDURE

A total of 5 dietary treatments were used for each trial. Diets consisted of a control (Con; 10:1 ω-6:ω-3 , 3.5% total fat, tallow based), 3 diets with 3.5% fat (plant based) and ω-6:ω-3 ratios of 10:1, 5:1 or 1:1 (3.5/10, 3.5/5 and 3.5/1 respectively), and a 10:1 ratio diet with 5% total fat (5/10). This design allowed the comparison of increasing ω-3 intake at a constant ratio (10:1 ratio, 3.5% vs 5% fat) and decreasing ratio at a constant ω-3 intake (3.5% fat, 10:1, 5:1 and 1:1 ratios).

Experiment 1: Nursery Pig Performance

Newly weaned pigs (n = 300; 26 ± 2 days of age) were housed in groups of 5/pen. Pens were assigned to one of the 5 diets described above. Pigs and feeders were weighed weekly for 4 weeks. Additionally, 6 pigs were slaughtered on d 0 (initial slaughter group, ISG) and 6 pigs/diet were slaughtered on d 28, allowing the calculation of whole body protein, fat and water deposition rates throughout the course of the 4 week trial.

Experiment 2: Inflammatory Challenge

Individually housed, newly weaned pigs (26 ± 2 days of age; n = 100) were assigned to one of the five diets and one of two inflammatory challenge groups arranged as a 5 x 2 factorial with repeated measures. Challenge groups consisted of a saline or LPS (15 μg/kg BW E. Coli lipopolysaccharide) injection. Pigs were fed their assigned diets for 22 d prior to the 24 h inflammatory challenge on d 23. Rectal temperatures were measured hourly for the first 6 h, then at 12 and 24 h post-injection. Blood samples were collected at 0, 2, 6 and 12 h post-injection for analysis of certain inflammatory proteins (interleukin (IL)-1β, IL-6, IL-8 and tumor necrosis factor (TNF)-α) as well as blood urea nitrogen (BUN) as an indicator of muscle catabolism.

RESULTS AND DISCUSSION

During the nursery performance study (Table 1), increasing ω-3 amount (constant 10:1 ratio), did not affect average daily feed intake (ADFI) or average daily gain (ADG); but when the ω-6:ω-3 ratio decreased (constant total fat) from 10:1 to 1:1, ADFI improved (0.93 vs 1.13 g/d, $P = 0.02$) during d 21 to 28 post-weaning. Pigs consuming the 3.5/5 diet tended to have increased protein (82.5 vs 71.1 vs 74.2 g/d, $P = 0.07$) and water (342.1 vs 301.0 vs 313.0 g/d, $P = 0.06$) deposition rates relative to those consuming the 3.5/10 or 3.5/1 diets. Lipid deposition was unaffected by treatment ($P > 0.10$). These results indicate that altering the ω-6:ω-3 ratio is more beneficial than altering the intake amount of ω-3's in terms of eliciting positive responses such as increased feed intake and protein deposition in nursery pigs when using plant based ω-3 FA's.

In the inflammatory challenge experiment, ADG and ADFI from d 0 to 22 or just during the challenge period were unaffected by diet ($P > 0.05$). During the challenge, LPS pigs had lower ($P < 0.01$) ADFI (0.93 vs 0.40 kg, saline vs LPS) and ADG (+0.44 kg vs -0.52 kg, saline vs LPS). Rectal temp, BUN, IL-1β, IL-6 and TNFα were unaffected by diet ($P > 0.05$), but were increased by LPS ($P < 0.01$). Serum IL-8 concentration was reduced with decreasing ω-6:ω-3 ratio (16.79 vs 11.14 pg/ml; 10:1 vs 1:1; $P = 0.03$) but was unaffected by dietary ω-3 amount at a constant ratio ($P > 0.05$). Pigs consuming the 3.5/1 diet had lower IL-8 responses relative to those consuming the 3.5/10 and 3.5/5 diets (diet × challenge $P = 0.03$). Additionally, the IL-8 response of pigs fed the 1:1 diet and challenged with LPS was similar to the saline injected pigs fed the 10:1, 5:1 or 1:1 diets ($P = 0.09$, Figure 1), indicating that reducing the dietary ω-6:ω-3 ratio impacts a piglets inflammatory response post-weaning.

CONCLUSION

During the inflammatory challenge, we observed a significant reduction in interleukin (IL)-8 (an inflammatory cytokine) as the dietary ω-6:ω-3 ratio decreased, but there was no effect on IL-8 when just the ω-3 amount was altered. In addition to this, during the challenge, pigs consuming the 1:1 diet had an IL-8 response level similar to the non-challenged pigs on any diet. During the performance study, increasing the amount of dietary ω-3 fatty acids while keeping the ω-6:ω-3 ratio constant did not affect piglet growth, feed intake or carcass composition; however, when total fat was held constant, a 5:1 ratio led to improved feed intake in older nursery pigs, as well as increased protein deposition without altering lipid deposition. It is possible that this reduction in inflammatory response at weaning may help explain why pigs consuming the lower ratio diets had increased feed intakes and improved protein deposition rates, as they did not require as much protein to mount an inflammatory response.

ACKNOWLEDGEMENTS

The authors acknowledge with gratitude the financial support provided by the Canadian Agricultural Adaptation Program (CAAP) administered by Agriculture & Food Council of Alberta, in conjunction with Agriculture Adaptation Council, Quebec Agriculture Development Council and Agriculture Council of Saskatchewan. We also wish to acknowledge program funding to PSCI from Saskatchewan Pork, Manitoba Pork Council, Alberta Pork, Ontario Pork and the Saskatchewan Agriculture Development Fund.

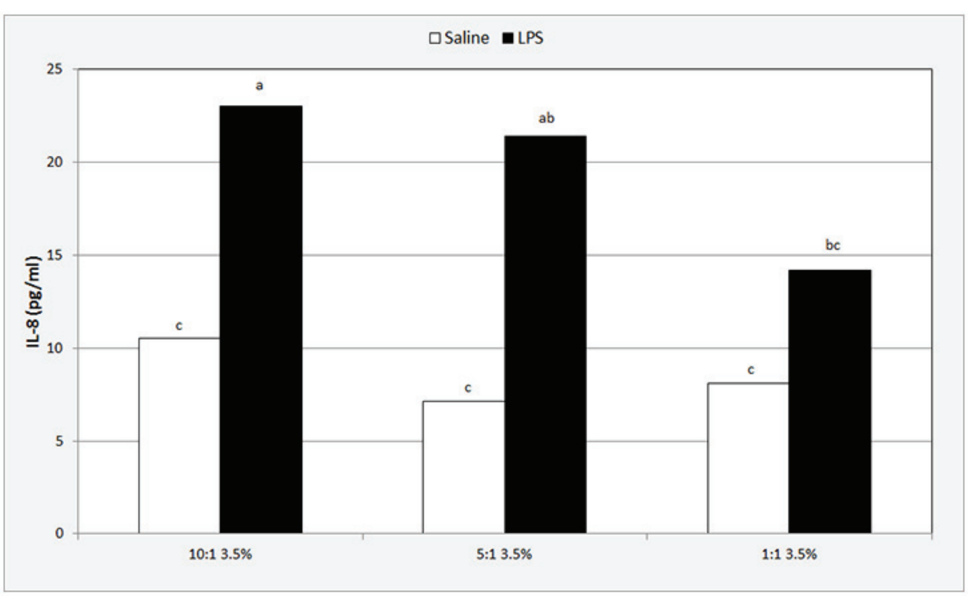


Figure 1. Diet by challenge interaction for pigs fed decreasing ω-6 to ω-3 fatty acid ratios during an inflammatory challenge (SEM = 2.02, P = 0.09)

Table 1. Effects of altering the dietary omega-3 fatty acid amount or ratio on nursery pig performance and carcass composition

	Dietary Treatment[1]					Effect of Ratio[2] (Diet B vs. D vs. E)	
	A	B	C	D	E		
n6:n3 Ratio	10:1s	10:1	10:1	5:1	1:1		
% Fat	3.5%	3.5%	5%	3.5%	3.5%	SEM	P Value
ADFI (kg/d)							
d 21-28	0.97[a]	0.95[a]	0.93[a]	0.97[a]	1.13[b]	0.042	0.02
d 7- 28	0.68	0.67	0.66	0.69	0.78	0.031	0.08
d 0-28	0.56	0.55	0.54	0.56	0.63	0.025	0.11
ADG (kg/d)							
d 21-28	0.97	0.97	0.95	0.94	1.01	0.031	0.59
d 7- 28	0.48	0.49	0.48	0.49	0.51	0.016	0.65
d 0-28	0.39	0.40	0.39	0.40	0.42	0.015	0.58
G:F							
d 21-28	1.00	1.02	1.03	0.98	0.92	0.032	0.18
d 7- 28	0.71	0.73	0.75	0.72	0.68	0.023	0.38
d 0-28	0.70	0.73	0.74	0.71	0.69	0.024	0.64
Deposition Rate (g/d)							
Protein	78.45[ab]	71.07[bc]	69.27c	82.45[a]	74.24[abc]	3.241	0.07
Lipid	35.62	31.88	34.03	31.37	30.29	2.800	0.92
Water	328.72[ab]	300.95[bc]	298.61c	342.05[a]	313.01[bc]	11.520	0.06

[1] 10:1s diet contains a saturated fat source whereas all other diets contain unsaturated fat sources

[2] Effect of altering the ω-3 amount (diet B vs. C) was non-significant for all parameters

Dietary ω-6 to ω-3 Fatty Acid Ratios Affect Protein Deposition in Nursery Pigs

L. Eastwood and A.D. Beaulieu

Laura Eastwood

Denise Beaulieu

SUMMARY
An experiment was conducted to determine if decreasing the dietary omega-6 (ω-6) to omega-3 (ω-3) fatty acid (FA) ratio would affect protein deposition in nursery pigs during a prolonged E. coli lipopolysaccharide (LPS) inflammatory challenge. Following a one week long challenge, six week old piglets fed a lower ω-6: ω-3 ratio had increased protein deposition rates, increased liver protein synthesis rates and increased average daily weight gains relative to those pigs consuming a diet with a higher ω-6: ω-3 FA ratio when feed intakes were similar. Protein synthesis was unaffected by the presence of an LPS induced inflammatory challenge. Overall, reducing the ω-6:ω-3 FA ratio improves the efficiency by which piglets can utilize nutrients for growth, regardless of the presence of an inflammatory challenge.

INTRODUCTION
In the swine industry, weaning is a critical time in a pig's life. They are exposed to a series of stressors (social, environmental, nutritional), which can impact animal health and performance. These stressors can lead to the 'post-weaning growth lag' characterized by decreased growth performance, reduced feed intakes, and an inflammatory response. Although a certain degree of inflammatory response is beneficial during this time, an over-production of immune cells can be detrimental, leading to increased muscle degradation and reduced protein synthesis.

"Overall, reducing the ω-6:ω-3 FA ratio improves the efficiency by which piglets can utilize nutrients for growth"

Throughout the years there have been many nutritional strategies implemented with the aim of alleviating the stress response of piglets during this time period. Omega-3 FA's are anti-inflammatory, and are pre-cursors for eicosanoid synthesis, and can also alter the production of pro-inflammatory cytokines (proteins secreted by immune cells in response to stimuli) which assist in regulating the inflammatory response. Omega-6 FA's are pro-inflammatory, and thus the ratio between the ω-6 and ω-3 FA's may be important to establish a well-balanced immune system in these animals.

The objective of this experiment was to determine if decreasing the dietary ω-6:ω-3 FA ratio would affect protein deposition in nursery pigs during a prolonged E. coli lipopolysaccharide inflammatory challenge, used to model a stress response.

EXPERIMENTAL PROCEDURE
Twenty-four individually housed barrows (21 days of age) were acclimated to one of 2 dietary treatments for a period of 14 days. Diets were wheat and barley based, and formulated to meet nutritional requirements according to NRC 2012. Total fat was constant across diets; however, the specific FA profile of the diets changed (10:1 ω-6:ω-3 vs. 5:1 ω-6:ω-3). These changes were accomplished by adjusting the amount of corn oil (high in ω-6) and flax oil (high in ω-3).

On d 15, within diet, pigs were randomized to an LPS (challenge) or saline (control) injection group. Pigs received either 15 µg/kg BW LPS or saline. Repeat injections were given on d 18 and 21. Throughout the challenge period, saline injected pigs were pair fed to the consumption level of LPS injected pigs.

On d 21, pigs were given a flooding dose of deuterium (^2H_2O; 4 ml/kg body water using an estimate of 72% body water) 1.5 h post-feeding in order to determine the fractional rate of protein synthesis (FSR). The LPS or saline injections were then given 2.5 h post feeding, followed by euthanasia and sample collection (liver, semi-tendinosus muscle and blood) at 5.5 h post-feeding. Carcasses were then ground and protein and water deposition were determined for the 21 day period relative to an initial slaughter group (ISG) of 6 pigs. Liver, muscle and blood samples were used to determine the FSR.

RESULTS AND DISCUSSION

During the acclimation phase (d 0-15), dietary treatment had no effect on feed intake (P > 0.10); however, piglet ADG tended to be impacted by dietary treatment, with pigs fed the 10:1 diet gaining 25.0 g/d and those consuming the 5:1 diet gaining 28.8 g/d (SEM = 1.4 g/d, P = 0.06).

Throughout the challenge phase (d 15-18), pigs were pair fed (saline injected pigs were restricted fed to the level of LPS injected pig intakes), and thus ADG and ADFI were similar for all pigs (P > 0.10) regardless of diet or challenge group.

Table 1 shows the effects of diet and inflammatory challenge on carcass composition, carcass protein deposition rates and specific protein synthesis rates in pigs with similar feed intakes. For the whole 3 week period (d 0-21), pigs consuming the 5:1 diet, regardless of challenge group, had higher whole body protein deposition rates relative to pigs consuming the 10:1 diet (87.8 g/d vs. 61.3 g/d; P = 0.04). Similarly, 5:1 fed pigs tended to have increased FSR in the liver on the final day of the challenge relative to those consuming the 10:1 diet (8.55 % synthesized/h vs 6.16 %/h; P = 0.08). There was no effect of LPS challenge on carcass composition, protein deposition rate or on liver or muscle FSR measured using $^{2}H_2O$ enrichment (P > 0.05). Protein deposition measured over time and on the final challenge day (FSR) was also unaffected by LPS challenge (P > 0.10).

CONCLUSION

This experiment shows that reducing the n-6:n-3 FA ratio in nursery pig diets improves the efficiency by which the animal utilizes nutrients for growth, as evidenced by similar feed intakes but improved ADG and protein deposition rates.

ACKNOWLEDGEMENTS

Strategic program funding was provided by Saskatchewan Pork Development Board, Alberta Pork, Manitoba Pork Council, Ontario Pork and Saskatchewan Agriculture and Food Development Fund. Specific funding for this project was provided by Alberta Livestock and Meat Agency (ALMA) and Vandeputte s.a. (Mouscron, Belgium).

Table 1. Effects of diet and inflammatory challenge on the carcass composition, carcass protein deposition rates and specific protein synthesis rates in pigs with similar feed intake levels

Diet *(ω3-ω6)*		10:1	10:1	5:1	5:1			P Values	
Challenge	**ISG[1]**	**LPS**	**Saline**	**LPS**	**Saline**	**SEM**	**Diet**	**Challenge**	**D x C[7]**
n	6	6	6	6	6				
Slaughter BW, kg	9.72	12.45	12.03	12.24	12.17				
Carcass Composition, g/kg[2]									
Protein	157.42	164.19	168.13	169.31	168.21	2.215	0.25	0.53	0.27
Water	741.69	739.49	730.86	727.17	724.59	3.685	0.02	0.14	0.42
Deposition Rate, g/d[2]									
Protein	-	67.20	55.46	97.45	78.08	12.193	0.04[4]	0.22	0.76
Water	-	260.58	168.65	338.54	256.04	47.306	0.10	0.08	0.92
Deposition Rate, g/kg BW gain[2]									
Protein	-	137.91	173.93	199.10	245.44	27.720	0.03[5]	0.15	0.85
Water	-	536.27	536.03	678.57	802.69	103.620	0.06	0.56	0.56
Nutrition Deposition Ratio[2]									
WDR:PDR	-	5.26	3.05	3.31	3.25	0.836	0.31	0.19	0.21
Protein Synthesis Rate, % newly made/hr[3]									
Semitendinosus	-	3.83	3.26	3.19	3.13	0.272	0.17	0.27	0.36
Liver	-	5.45	6.87	9.70	7.39	1.306	0.08[6]	0.73	0.17

[1] ISG's are not included in statistical analysis; values are presented for information only

[2] Carcass composition, deposition rates and deposition ratios were determined for d 0-21 relative to ISG pigs

[3] Protein synthesis rates determined using $^{2}H_20$ enrichment of the carcass on experimental d 21

[4] 10:1 diet PDR (g/d) = 61.33, 5:1 diet PDR (g/d) = 87.76

[5] 10:1 diet PDR (g/kg BW gain) = 155.92, 5:1 diet PDR (g/kg BW gain) = 222.27

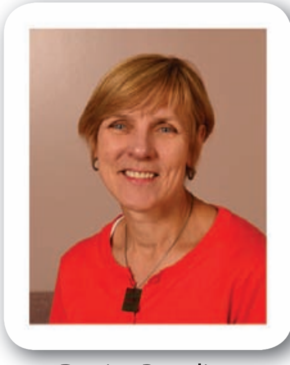
[6] 10:1 diet liver synthesis = 6.16 %/hr, 5:1 diet liver synthesis = 8.55 %/hr

[7] No diet x challenge interactions were present

Neither Photoperiod in the Farrowing Room nor Time of Weaning Affect Nursery Performance

J. Shea, L. Eastwood and A.D. Beaulieu


Laura Eastwood


Denise Beaulieu

SUMMARY
Weaning, which requires adapting to a new feed source and environment, may result in anorexia and reduced growth in the initial 24 to 48 hours in the nursery. This study was designed to determine if altering the photoperiod in the farrowing room and/or if weaning at the end of the light or the dark cycle would affect performance in the nursery. Pigs were given either a 16 h light:8 h dark (16L:8D) or a 8L:16D photoperiod while in the farrowing room, and weaned either at the end of the dark or the light cycle.

Neither photoperiod in the farrowing room, nor time of weaning affected growth rate in the nursery and nursery exit weights were similar among treatments.

Pigs weaned at the end of the light period had more feeder visits in the first 24 hours post-weaning, however this did not result in higher feed intake post-weaning. Neither photoperiod nor time of weaning had an effect on the percentage of pigs (34) identified as "eaters" during the initial 24 hour in the nursery. Overall, photoperiod manipulation in the farrowing room did not benefit post-weaning growth rates

Interestingly, pigs exhibiting evidence of phase 1 consumption immediately post-weaning were the lighter pigs and they had higher ADG immediately post-weaning than those identified as non-eaters.

INTRODUCTION
Successful pork production is highly dependent on sow productivity. The number of pigs born alive per sow per year is the parameter commonly cited, however improvements are not realized if pre-weaning mortality increases or growth rate is not maintained post-weaning. A piglet experiences social, nutritional and immunological stressors at weaning. They are separated from the sow, moved to a new environment, mixed with non-littermates and expected to begin consumption of a novel diet.

Hours of light, or photoperiod, can affect performance through behavioural or endocrine (melatonin) mechanisms. The following study focused on the behavioural aspects of the photoperiod. In a previous experiment at PSCI we observed a marked diurnal pattern in nursery feeding behaviour post-weaning. Despite continuous lighting, feeder approaches declined markedly 8 hours post weaning, remained low for 8 hours, then increased again to the previous level. Thus, there was an 8 hour period when the feeder was under utilized. We hypothesized that the time of weaning and the photoperiod would alter this behavior, and all pigs would take advantage of the availability of feed duirng the first 24 hours post-weaning.

The objective of this experiment was to determine if weaning at the end of a dark or light cycle would affect subsequent performance in the nursery and if this effect depended on photoperiod in the farrowing room.

"Neither photoperiod in the farrowing room, nor time of weaning affected growth rate in the nursery."

MATERIALS AND METHODS
Treatments consisted of 2 photoperiods in the farrowing room (16L:8D or 8L:16D) and time of weaning (end of the light or dark cycle) arranged as a 2 x 2 factorial. Each farrowing room was one photoperiod/time of weaning treatment. The experiment used 12 farrowing rooms, for a total of 157 sows and their litters (~1755 piglets).

Lighting, including that coming from heat lamps was standardized across farrowing rooms. Windows were covered to block external light. Light emissions were quantified at sow level, and averaged approximately 12 lux with the lights off and 43 lux with lights on. Sows were weighed on day 1 following farrowing and at weaning. Pigs were weighed at 3 days of age, one week prior to weaning and at weaning (day 26 ± 2). All pigs were weaned into nurseries maintained on a 16L:8D lighting regime at the beginning of a dark cycle.

At weaning, pigs were divided among treatments and sorted so that all pens within a treatment had equal body weight in the nursery. For the first 24 hours, the phase 1 diet was spiked with pellets containing ferric oxide (red dye which can be visualized in the feces). Anal swabs were taken 48 hours into the nursery period to see which pigs ate in the first 24 hours. Pigs and feeders were weighed on day 0, 7, 14 and nursery exit (8 weeks of age). Four pens were selected and still photos were taken every 5 minutes for the first 24 hours to monitor behaviour and feeder visits (Figure 1).

RESULTS AND DISCUSSION

Growth rate in the nursery, and nursery exit weights were unaffected by treatment (Table 1). During the first week in the nursery, we observed a photoperiod by time of weaning interaction for feed intake (Figure 2). The lowest feed intakes were seen with pigs who were on the 16L:8D photoperiod and weaned at the end of the dark cycle. This effect, however, was not extended beyond the first week in the nursery.

Pigs weaned at the end of the light cycle averaged more feeder approaches in the first 24 hours post-weaning than those weaned at the end of a dark cycle, regardless of photoperiod. This however, did not affect feed intake. There was no evidence that treatment affected aggression.

The lighter weight piglets at weaning were more inclined to eat during the initial 24 to 36 hours in the nursery, had increased growth rates during week one in the nursery and nursery exit weights were similar (Table 2).

CONCLUSION

Photoperiod manipulation in the farrowing room did not benefit post-weaning growth rates. Piglets weaned at the end of the light period had more feeder visits in the first 24 hours post-weaning. This however, did not translate into greater feed intake post-weaning.

ACKNOWLEDGEMENTS

We are grateful for support for this project from the Saskatchewan Agriculture Development Fund. Program funding for Prairie Swine Centre, Inc. from Sask Pork, the Manitoba Pork Council, Alberta Pork, and Ontario Pork is gratefully acknowledged.

Figure 1. Still photos used to monitor piglet behaviour during a light or dark period.

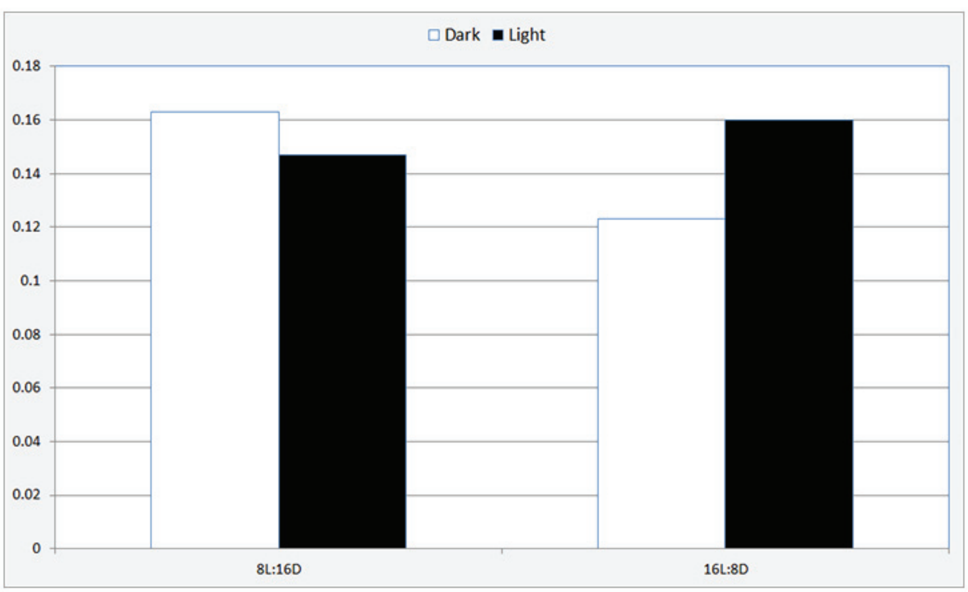


Figure 2. The interaction of photoperiod in the farrowing room and time of weaning (end of dark or light cycle) on ADFI from weaning to day 7 (SEM=0.001, P =0.06).

Table 1. Effects of photoperiod in the farrowing room, and the timing of weaning relative to photoperiod on the post-weaning growth performance of piglets weaned at 26 days of age

Item	Farrowing photoperiod (P)		Time of weaning (T)		SEM	P value
	8L/16D	16L/8D	End of dark phase	End of light phase		
n, piglets	887	868	837	918		
Age at weaning, d	24.9	25.6	25.6	24.9		
Age at nursery exit, d	54.2	54.9	54.4	54.7		
Piglet body-weight, kg						
Weaning,	7.42	7.65	7.36	7.71	0.056	NS
Nursery, d7	8.58	8.67	8.46	8.78	0.063	PxT
Nursery, d14	10.96	10.85	10.78	11.04	0.136	NS
Nursery exit, d56	22.04	19.79	19.31	22.53	1.734	NS
Average daily gain in the nursery, kg						
Weaning to d7	0.17	0.15	0.16	0.16	0.004	NS
Day 7 to 14	0.34	0.31	0.33	0.32	0.016	NS
Day 14 to 56 (exit)	0.74	0.59	0.57	0.77	0.116	NS
Weaning to exit	0.50	0.41	0.41	0.50	0.060	NS
Average daily feed intake in the nursery, kg						
Weaning to d7	0.16	0.14	0.15	0.14	0.001	P, T, PxT[1]
Day 7 to 14	0.35	0.37	0.34	0.37	0.002	NS
Day 14 to 56 (exit)	0.71	0.77	0.72	0.76	0.010	NS
Weaning to exit	0.51	0.54	0.52	0.53	0.015	NS

[1]PxT, P = 0.06.

Table 2. Performance of piglets categorized as eaters or non-eaters[1]

	Post-weaning		SEM	P value
	Eater	Non-eater		
Body weight, kg				
Birth	1.52	1.53	0.015	0.92
Weaning	7.28	7.62	0.070	<0.01
Day 7, post-weaning	8.58	8.62	0.070	0.69
Nursery exit, d56 post-weaning	19.64	21.02	1.950	0.56
Average daily gain, kg				
Weaning to d7	0.187	0.141	0.004	<0.01
Weaning to nursery exit	0.419	0.456	0.067	0.67
Average daily feed intake, kg				
Weaning to d7	0.154	0.149	0.001	<0.01
Weaning to nursery exit	0.502	0.519	0.002	<0.01

[1]Phase 1 diet contained ferric oxide pellets for 24 h post-weaning. Piglets categorized as an eater or non-eater based on anal swabs taken at 48h post-weaning.

The Interaction Between Pig Density and Dietary Energy on Performance and Returns

G. Rozeboom, D.A. Gillis, M. Young and A.D. Beaulieu

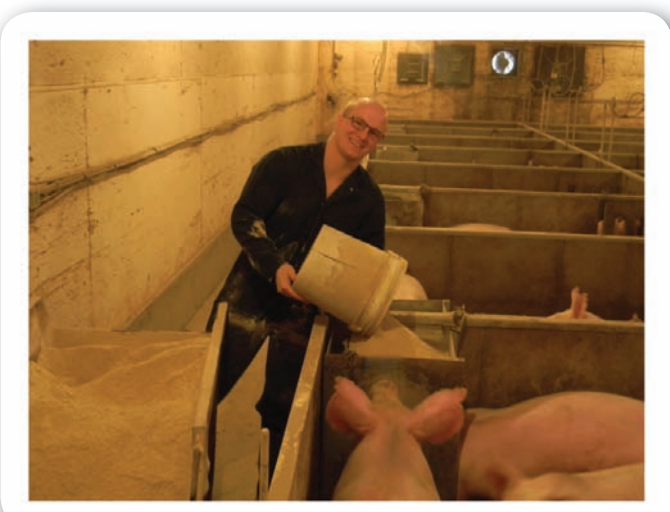
Denise Beaulieu

SUMMARY

Dietary net energy and stocking density independently affect performance, feed utilization and profits in the finisher barn. The objective of this experiment was to assess the interactions of stocking density and dietary energy, and determine how these interactions affect net income. When stocking density was increased, the performance of finishing pigs was reduced; however the income over feed cost (IOFC) was maximized when pigs were stocked at higher densities. Furthermore, finishing pigs responded to increasing dietary energy by decreasing feed intake and improving growth rate, feed efficiency, caloric intake, caloric efficiency, and IOFC. However, the dietary energy which maximized performance and economics did not vary with stocking density. Thus producers should optimize both of these factors separately when determining optimal production.

INTRODUCTION

Stocking density and dietary net energy concentration independently affect performance and feed utilization of growing finishing pigs. There is limited information however, on whether the interaction of these two factors is important for optimizing performance and income. This information is vital to producers facing new requirements for the Canadian Code of Practice on stocking density.



Garrett Rozeboom

Reduced space allowance has negative effects on growth, and is usually a consequence of reduced nutrient intake. We hypothesized that the negative effects of crowding can be reduced by increasing dietary energy concentration, and that the optimal dietary energy concentration which maximizes net income will depend on stocking density. Pork producers will be able to improve their return on investment by better understanding the relationship between dietary energy and stocking density.

EXPERIMENTAL PROCEDURE

There was a total of 18 treatments arranged as a 2 x 3 x 3 factorial, which included gender (barrows and gilts), dietary energy (2.15, 2.3 and 2.45 Mcal NE/kg) and stocking density (14, 17 or 20 pigs/pen providing 0.92, 0.76 and 0.65 m^2 per pig, respectively). Each of the 18 treatments had three replications, using a total of 918 pigs (Camborough Plus dam x line 337 sire PIC Canada Ltd.; Winnipeg, MB).

Rooms were fully slatted, and consisted of 10 rectangular (4.8 x 2.7m) pens. Each pen contained two single space wet-dry feeders providing 0.22 m^2 of feeder space per pen, and the feeders were the only source of water.

"Overall there were no interactions between dietary energy concentration and stocking density."

Pigs were selected to ensure typical barn variation and were started on test at an average of 75 kg BW (range of 60 to 90 kg BW). They were marketed weekly when they reached a BW of 115 kg.

The diets used for this experiment are presented in Table 1. Four sets of diets, with three dietary energy levels within each diet, were used. Diet sets 1 through 3 were fed as the three phases for gilt and diets 2 through 4 were used as the 3 phases for barrows. All diets were formulated to meet or exceed nutrient requirements (NRC, 2012). Feed was available *ad libitum* but weighed daily when added to the feeder.

Space allowance was calculated by using an allometric equation k = A ÷BW^$^{.667}$, where "A" represents area (m^2), k is a space allowance coefficient, and $BW^{.667}$ is the metabolic body weight. The k-value of 0.0336 was used to define crowding (Table 2) which occurred at about 85 and 108 kg BW with 20 and 17 pigs per pen respectively.

Table 1. Ingredient and nutrient composition of the diets formulated to contain 2.15 and 2.45 Mcal of NE/kg fed to both genders in this experiment. The 2.30 concentration was the intermediate (as-fed basis)[1,2]

Diet Phase	1		2		3		4	
Gilts	75-90 kg		90-105 kg		90-105 kg			
Barrows			75-90 kg		105-118 kg		105-118 kg	
	Dietary Net Energy (Mcal/kg)							
Item	2.15	2.45	2.15	2.45	2.15	2.45	2.15	2.45
Barley	48.83	5.79	54.84	30.36	66.55	50.27	68.8	61.81
Wheat	-	50.06	-	28.66	-	18.64	2.94	15.00
Millrun wheat	20.00	20.00	20.00	20.00	14.41	15.00	5.00	10.00
Peas	18.97	18.66	14.47	15.00	7.70	10.0	6.65	7.33
Oat hulls	7.37	-	7.89	-	8.53	-	13.08	-
Canola meal	2.00	-	-	-	-	-	-	-
Limestone	0.91	1.08	0.86	0.99	0.83	0.95	0.70	0.88
Tallow	0.50	2.80	0.50	3.41	0.50	3.57	1.37	3.45
L-Tryptophan 98%	0.01	-	-	-	-	-	-	-
Lysine HCL 78%	0.19	0.32	0.21	0.30	0.26	0.31	0.25	0.30
L-Threonine 98%	0.08	0.12	0.09	0.12	0.10	0.12	0.10	0.11
DL-Methionine 98%	0.03	0.05	0.02	0.04	0.01	0.03	-	0.01
Calculated composition								
ME, Mcal/kg	2.95	3.24	2.93	3.24	2.91	3.22	2.90	3.21
SID lysine g/Mcal of NE	3.23	3.23	2.97	2.97	2.73	2.73	2.52	2.52
Ca, %	0.60	0.60	0.56	0.56	0.53	0.53	0.50	0.50
P, %	0.25	0.25	0.24	0.24	0.23	0.23	0.23	0.23

[1] All diets were formulated to meet requirements for pigs of each phase (NRC 2012)

[2] Contain the same amount of vitamin, mineral, choline, salt, and ronozyme (phytase)

RESULTS AND DISCUSSION

As dietary energy increased feed intake was reduced, caloric intake increased, growth rate was increased, and feed efficiency improved (Table 3). Stocking 14 pigs per pen did not improve pig performance when compared to the pen of 17, presumably due to minimal crowding in the pen of 17 (Table 3). However, feed intake and ADG were reduced when stocking density was increased to 20 pigs per pen.

Feeding the high energy diet reduced days to market (75 to 118 kg BW), and increased barn throughput by 1.6% (Table 4). Despite the improvement in feed efficiency, feed costs were 11% higher with the high energy diet. There was no effect of dietary energy on carcass margin per pig. The improvement in barn throughput resulted in a tendency for increased income over feed cost (IOFC) with the high energy diets.

On a per pig basis, the pen of 20 had the lowest feed cost per day, but required 1.6 more days to reach market weight (118 kg BW) and there was no difference in total feed cost to reach market weight. Barn throughput increased by 40% when stocking density increased from 14 to 20 pigs per pen. There was no effect of stocking density on carcass value. The increase in barn throughput and no difference in feed cost to reach market weight, resulted in stocking density being the most important factor in determining IOFC. As stocking density increased there was a linear improvement in IOFC (Table 4). There was no statistically significant interaction effect on IOFC because the response to dietary energy was similar across all stocking densities. However, there were numerical differences in the IOFC within stocking densities.

Table 2. Space allowance and k-value for each stocking density at various weights throughout the finishing period (75-118 kg BW, crowding defined as a k-value≤0.0336)

	Stocking Density		
	14	17	20
Area/pig (m^2)	0.93	0.76	0.65
BW (kg)		k-value	
75	0.0520	0.0428	0.0364
85	0.0478	0.0394	0.0335
108	0.0405	0.0334	0.0284
118	0.0384	0.0316	0.0269

Figure 1 shows the interaction effects on IOFC. Stocking density of 20 pigs per pen and feeding the 2.30 NE, Mcal/kg resulted in the highest IOFC. However, this increase in IOFC was only $70 (CDN) higher per pen than the pigs fed the high energy diet. Pigs housed 20 per pen and fed the low energy diet had an IOFC that was $700.00 lower per pen than the pigs fed the high energy diet. In the pens that housed 17 pigs, IOFC of the high energy diet was $472.00 and $319.00 more than the pens fed the low and medium energy diets, respectively. Increasing dietary energy for pigs housed 14 per pen resulted in no IOFC improvement; all pens had an IOFC within $40.00 of each other.

CONCLUSION

As space allowance decreased, a linear reduction in caloric intake and growth was observed. The restriction in nutrient intake resulted in the growth reduction, suggesting that if pigs were able to maintain a comparable caloric intake at higher stocking densities effects on growth would be reduced. Overall there were no interactions between dietary energy concentration and stocking density. A similar response to dietary energy at all stocking densities was observed. The negative effects of a high stocking density on performance were not mitigated by dietary energy. Increasing the stocking density linearly increased the IOFC per pen but there was not an interaction between dietary energy and stocking density. Therefore the dietary energy which maximized the IOFC did not differ with stocking density.

ACKNOWLEDGEMENTS

Funding for this project was provided by Gowans Feed Consulting and Agriculture and Agri-Food Canada through the Canadian Agriculture Adaptation Program administered by the Agriculture and Food Council of Alberta. Program funding provided by Saskatchewan Pork, Saskatchewan Ministry of Agriculture, Manitoba Pork Council, Alberta Pork, and Ontario Pork.

Table 3. Main effects of stocking density and dietary energy concentration on ADG, ADFI, G:F, caloric intake, and caloric efficiency from 75-118 kg BW [1,2,3]

	Stocking density Pigs per pen (NP)			Diet regimes Dietary NE (Mcal/Kg)				P-value[4]	
Item	14	17	20	Low	Medium	High	SEM	Stocking	NE
ADFI, kg[5]	4.00[a]	3.97[a]	3.82[b]	4.09[a]	3.92[b]	3.77[c]	0.08	<0.001	<0.001
ADG, kg[6]	1.21[a]	1.21[a]	1.17[b]	1.17[a]	1.21[b]	1.23[b]	0.03	0.05	0.005
G:F[7]	0.30	0.31	0.31	0.29[a]	0.31[b]	0.33[c]	0.004	0.61	<0.001
Caloric intake, Mcal/d[5]	9.19[a]	9.12[a]	8.12[b]	8.81[a]	9.02[b]	9.29[c]	0.17	<0.001	<0.001
Caloric efficiency, Mcal:Gain	7.59	7.52	7.52	7.54	7.49	7.59	0.09	0.69	0.63

[abc] Within a row and treatment, means without a common superscript differ (P<0.05)

[1] Data presented on an as fed basis

[2] Quadratic contrasts were not significant

[3] Dietary energy x stocking density (P > 0.10)

[4] P-values: stocking= stocking density, NE= dietary net energy

[5] Gender x stocking density (P < 0.10)

[6] Gender x dietary energy (P< 0.05)

[7] Gender x dietary energy (P< 0.10)

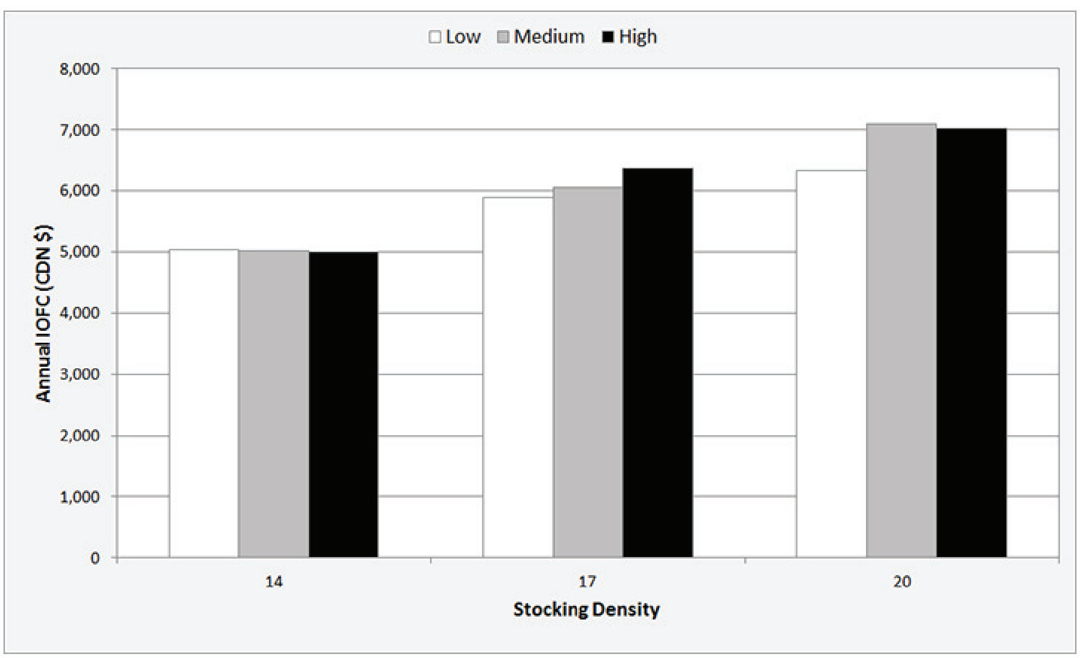


Figure 1. The interaction effect of dietary energy and stocking density effects on IOFC (CDN $) in pigs weighing 75 to 118 kg BW[1]
[1] Interaction was not significant (P>0.10)

Table 4. Main effects dietary energy concentration and pen density on barn throughput, carcass revenue, feed cost, and IOFC [1,2,3]

	Stocking density			Diet regimes				P-value[3]	
	Pigs per pen (NP)			Dietary NE (Mcal/Kg)					
Item	14	17	20	Low	Medium	High	SEM	Stocking	NE
Days to market[4]	35.4[a]	36.0[ab]	37.0[b]	36.9[a]	36.0[ab]	35.5[b]	1.3	0.03	0.06
Finisher rotations[5]	3.47[a]	3.45[ab]	3.41[b]	3.42[a]	3.45[ab]	3.47[b]	0.41	0.03	0.05
Barn throughput[6,7]	48.5[a]	58.6[b]	68.3[c]	58.0[a]	58.5[ab]	58.9[b]	0.7	<0.001	0.02
Carcass revenue/pig[8]	134.33	135.36	133.08	133.08[a]	134.35[ab]	136.10[b]	1.39	0.50	0.08
Feed cost/pig, CDN $[7]	30.66	30.91	30.71	29.85[a]	30.57[a]	31.86[b]	1.04	0.86	<0.001
Feed cost per kg gained, CDN $ [9,12]	0.73	0.72	0.72	0.70[a]	0.72[a]	0.75[b]	0.01	0.82	<0.001
Feed cost pig/d, CDN $[10,13]	0.87[a]	0.86[a]	0.83[b]	0.81[a]	0.85[b]	0.90[c]	0.02	0.002	<0.001
Feed cost/pen, CDN $[4]	429.48[a]	525.49[b]	614.14[b]	508.70[a]	520.31[a]	540.11[b]	16.76	<0.001	<0.001
Carcass margin/pig CDN $	103.40	104.19	102.89	102.98	103.50	104.01	1.58	0.67	0.78
IOFC CDN $[11,12]	5,012.50[a]	6,102.50[b]	7,015.90[c]	5,950.83	6,052.26	6,127.81	141.37	<0.001	0.22

[abc] Within a row and treatment, means without a common superscript differ (p<0.05)

[1] Dietary energy x stocking density (P > 0.10)

[2] Feed prices based on Saskatoon, SK 5 year average grain prices (2009-2013)

[3] P-values stocking= stocking density, NE= dietary net energy

[4] Days to market from 75-118 kg BW

[5] Finisher rotations= 365/(days to market +(70 day constant for all treatments 20-75 kg BW))

[6] Barn throughput= finisher rotations x pigs per/pen

[7] Value calculated from 75- market wt.

[8] Carcass revenue based on a 5 year average Saskatchewan carcass price (2009-2013)

[9] Feed cost per/kg gained = F:G x cost per tonne

[10] Feed cost per pig/d = ADFI x cost per tonne

[11] IOFC= annual income over feed cost based on carcass value and barn throughput (75-118 kg BW)

[12] Gender x Energy (P < 0.10)

[13] Gender x Energy (P < 0.05)

The Effects of Water Availability and Space Allowance on Productivity and Profitability

J. Landero, A.D. Beaulieu, and M. Young

Denise Beaulieu

SUMMARY

Reduced floor space allowance for pigs may negatively affect growth performance as a result of competition for feed and water access, especially at later stages of the grower-finisher period. However, kilograms of pork produced per unit of floor space may increase with more pigs per pen, improving overall profitability for pork producers. The effect of space allowance was tested by altering the numbers of pigs per pen to provide 8.2, 7.4 or 6.8 ft^2 space allowance/pig. The effect of water availability was tested by adding one extra bowl drinker to create non-restricted water availability, or leaving as is to create restricted water availability. 1008 pigs (initial body weight 32.1 kg) were used to evaluate the effects on profitability, carcass traits and growth performance during the grower-finisher period. Despite an overall growth performance reduction observed with increased pigs per pen, results from this trial clearly indicate that producer's profitability per square foot is increased. The findings of this trial also indicated that access to an extra water source in high stocking densities will improve profitability of the swine unit.

INTRODUCTION

Space allowance, or stocking density, is expressed in terms of pigs per floor area. Space allowance requirements are based on the body weight of the pig, which is proportional to surface area of the pig. The optimal space allowance is the minimum area per pig for maximal individual weight gain. Many experiments have arrived at the same conclusion: "a decrease in space allowance per pig reduces growth performance" because reduced floor-space allowance increases competition for water and feed, reducing feed intake and consequently body weight gain. However, from an economic perspective it is clear that fewer pigs per pen means less kilograms of pork will be produced per pen, despite the improvement in individual weight gain.

Under conventional management in the grower-finisher period, pigs remain in the same pen for several weeks until they reach market weight. The maximum space requirement has to be calculated based on the day that the first pig is sent to market. Considering a target market weight of 125 kg, the first pigs would be typically sent to market when the average weight of pigs in the pen is around 105 to 110 kg. According to the Canadian Code of Practice for the Care and Handling of Pigs (2014) the minimum space allowance per pig under these circumstances will be 0.75 to 0.77 m^2 or 8.04 to 8.29 ft^2. According to the same publication, a decrease of up to 15% is allowed in the grower-finisher period if the higher stocking density doesn't compromise the welfare of animals.

The following experiment was designed to evaluate the effects of increasing water availability and stocking density on profitability, carcass traits and growth performance during the grower-finisher period.

"Increasing the number of pigs per pen and, consequently, reducing available floor space reduced ADG and ADFI in grower-finisher pigs."

EXPERIMENTAL PROCEDURE

The trial was conducted at the grow-finish Drumloche Research Barn (Lougheed, AB, Canada) using 1008 pigs. Space allowance and water availability provided 6 treatments, with 8 pens per treatment. Pens had 19, 21, or 23 pigs, and altering the number of pigs per pen gave a floor space allowance of 8.2, 7.4 and 6.8 ft^2 (0.76, 0.69 and 0.63 m^2) space allowance/pig respectively. Pigs were either water restricted, or non-restricted by the addition of one extra bowl drinker. Each pen had two feeder spaces at a wet/dry feeder, and was fed a 4 phase diet based on average pen weight from start of the trial to market weight.

Pigs were weighed every feed phase change to calculate average daily gain for each feed phase and for the overall period. The amount of feed delivered by the feed system, FeedLogic, was recorded daily, and the feed remaining at the end of each phase was measured to calculate average daily feed intake. Weight gain and feed usage was used to calculate feed conversion (feed:gain) per phase of feeding and for the overall period. Pigs reaching market weight (123 kg) were slaughtered and carcass characteristic data collected (carcass weight, dressing percentage, backfat, loin depth, and index).

RESULTS AND DISCUSSION

Performance results are shown in Table 1. A decrease in space allowance reduced overall ADG, and tended to reduce overall ADFI, but did not affect overall F:G which agrees with previous studies. As expected, the reduction in growth performance attributed to the reduced space allowance was more evident with the increased weight and size of the pigs. For example, ADG was not affected during Grower 1 (32-56 kg) feeding phase, but stocking density started to reduce ADG by approximately 50 g/day during the Grower 2 (56-76 kg) feeding phase. This pattern continued through to the pre-marketing finisher period, but as soon as the first pigs were removed ADG was improved.

Water availability did not affect ADG during Grower 1 to 3, but tended to increase ADG during the Finisher feeding phase when an extra-drinker was available for pigs. Provision of an additional drinker did reduce dry matter intake in pigs, and thus improved F:G during the Grower 3 and Finisher phases (Table 1).

Carcass characteristics were not affected by either stocking density or water availability. Results from this experiment, however, clearly show that producer's profitability per square foot increases as both water availability and stocking density increased. The greatest reduction in feed cost per pig due to increased water availability was $2.30, and was found in the 23 pig stocking density with an extra drinker. The increase in number of pigs per pen increased the IOFC (income over feed costs) per square foot by $1.78 for water restricted pigs when numbers went from 19 to 23, and increased $2.08 for non-water restricted pigs. The extra drinker increased IOFC by $0.67 for 19 pigs/pen, and by $0.97 for 23 pigs/pen (Figure 1). Carcass weight and revenue was also increased by increasing both stocking density and water availability. Total carcass revenue per square foot was increased in $4.61 by increasing pens from 19 to 23 pigs in water restricted pens, and $4.23 for the same pig number increase when water was not restricted (Figure 2).

CONCLUSION

Increasing the number of pigs per pen and, consequently, reducing available floor space reduced ADG and ADFI in grower-finisher pigs. The addition of one extra drinker resulted in a significant improvement in ADG and F:G, and reduced ADFI. Despite the overall growth performance reduction with the increased pigs per pen, producer's profitability per square foot increased. Producer's profitability was also improved by providing an additional drinker in the pen.

ACKNOWLEDGEMENTS

Appreciation is expressed to Drumloche Research Barn management team for their expertise and smooth running of the trial. Thanks also to Lewisville Pork Farm for the use of their animals and Sunhaven Farms Milling for supplying the feed. We would like to thank Agriculture and Agri-Food Canada through the Canadian Agricultural Adaptation Program for financial support for this trial.

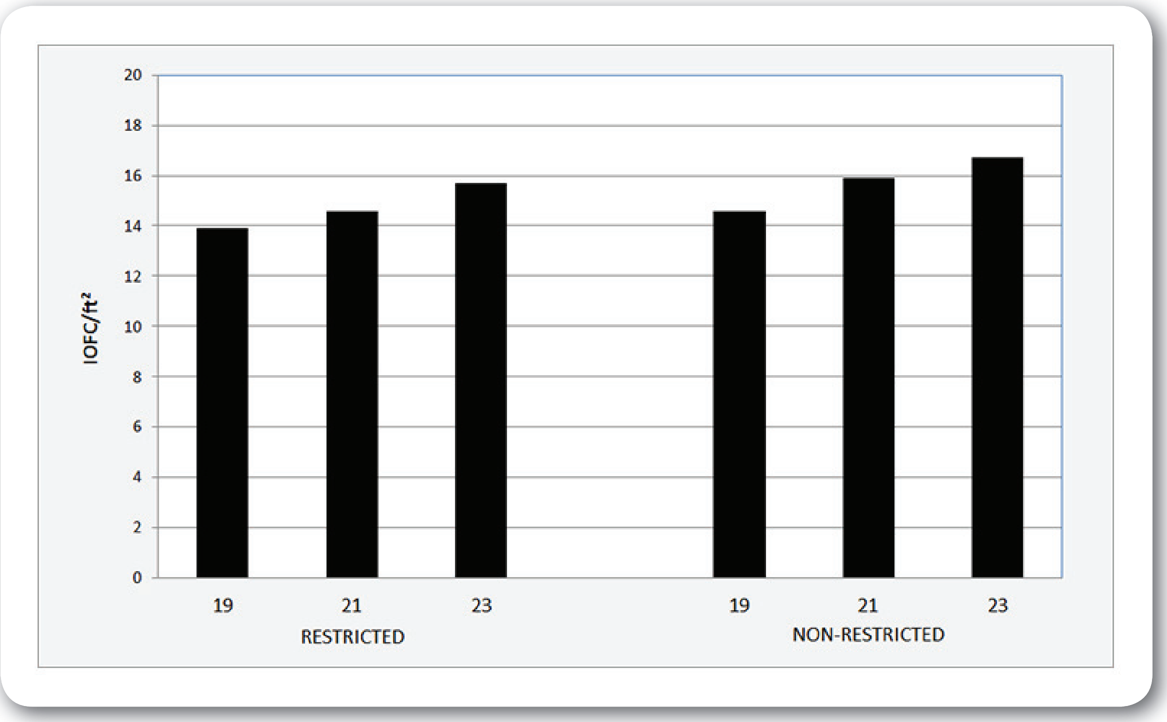


Figure 1: Effect of stocking density and water availability on income over feed cost (IOFC) per square foot of grower-finisher pigs

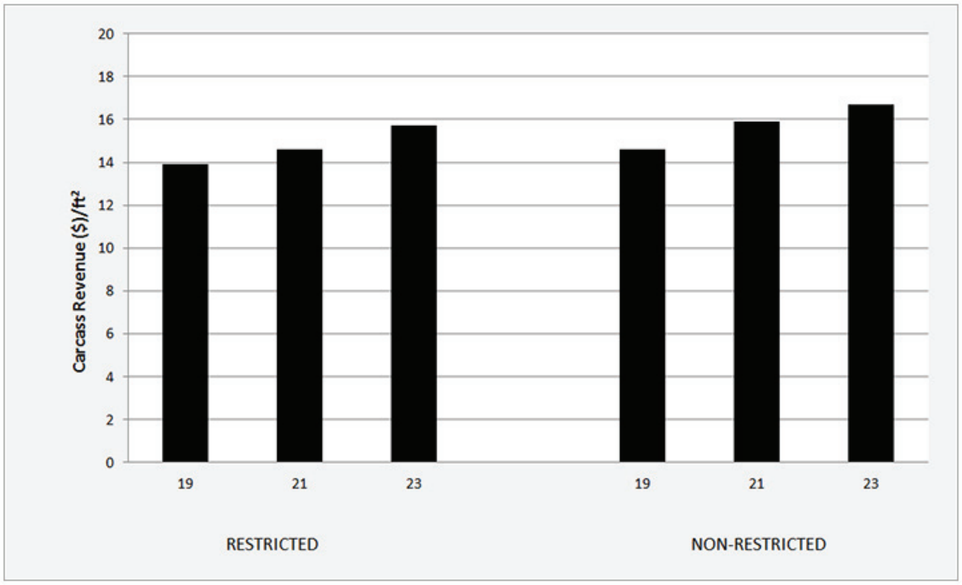


Figure 2. Effect of stocking density and water availability on total carcass revenue ($) per square foot of grower-finisher pigs

Table 1. Effect of group size of pigs (stocking density) and water availability on growth performance of grower-finisher pigs[1]

Water availability[2]	Restricted			Non-restricted				P-value		
Density (#pigs/pen)	19	21	23	19	21	23	SEM	Density	Water	Density × Water
Grower 1 (32-56 kg)										
ADG, g/d	1011	1017	1025	1020	1002	1021	11	0.234	0.593	0.343
ADFI, kg/d	2.26	2.24	2.23	2.27	2.24	2.21	0.04	0.088	0.849	0.772
Feed:Gain	2.24	2.21	2.18	2.23	2.23	2.16	0.03	0.010	0.838	0.562
Grower 2 (56-76 kg)										
ADG, g/d	1042	1021	997	1046	1037	998	19	<0.001	0.427	0.774
ADFI, kg/d	2.69	2.71	2.62	2.67	2.65	2.65	0.07	0.206	0.392	0.361
Feed:Gain	2.58	2.66	2.63	2.55	2.56	2.65	0.04	0.022	0.083	0.059
Grower 3 (76-99 kg)										
ADG, g/d	1001	969	903	993	1002	953	20	0.002	0.127	0.311
ADFI, kg/d	3.09	3.05	3.02	2.98	3.01	2.90	0.08	0.084	0.005	0.588
Feed:Gain	3.09	3.15	3.39	3.01	3.00	3.06	0.11	0.057	0.005	0.240
Overall Finisher (99-122 kg)										
ADG, g/d	832	808	824	829	852	849	16	0.896	0.089	0.338
ADFI, kg/d	3.15	3.13	3.13	3.02	3.19	3.03	0.07	0.189	0.124	0.105
Feed:Gain	3.79	3.89	3.81	3.65	3.74	3.57	0.10	0.132	<0.001	0.675
Overall (32-122 kg)										
ADG, g/d	962	942	926	961	963	947	8	0.004	0.021	0.218
ADFI, kg/d	2.83	2.82	2.79	2.76	2.81	2.72	0.06	0.056	0.025	0.384
Feed:Gain	2.94	2.99	3.01	2.88	2.91	2.87	0.05	0.260	<0.001	0.365

[1] Least square means based on 8 pen-observations per diet.

[2] Pigs non-restricted and restricted did have access or not to 1 extra drinker in the pen

Publications List

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Financial Support

Prairie Swine Centre wants to recognize the individuals and agencies that supported the Research and Technology Trasnfer program this year. The support is essential to the ongoing developments that keep Canadian pork producers at the fore front of applied technology.

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 2013-2014 fiscal year.

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