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Optimization of Pork Production Facilities

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Over the past 6-12 months there has being an increasing amount of media and industry discussion on the expansion of the pork industry in Canada. In the west the concern is expanding finishing capacity to optimize slaughter capacity. Other regions within Canada face other challenges such as environmental pressures and a shortage of slaughter space. If we take a whole system analysis or system optimization approach to pork production we have the opportunity to extract the greatest value from the products we produce in the most sustainable way possible.

Prairie Swine Centre (PSC) seeks your input in defining how best the experience and capabilities of PSC should be applied to this industry need. Given the Centre has expertise in several disciplines including engineering, nutrition, ethology, economics and communications with links to other expertise in Canada and around the world how can we harness this in preparation for the next evolution of the industry?

Maintenance:

A vast majority of hog barn construction occurred in a ten year period between 1995 and 2005, followed by ten years of tight margins. In order to maintain an efficient production system a certain number of facilities need to be replaced or receive

(Optomization of Pork Prod...Cont'd on pg. 3)

Research in pigs benefits human health

Dan Columbus,
Research Associate
– Nutrition

Lee Whittington,
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Awareness of the benefits of using large animal models in human nutrition and health related research has increased. In fact, it has been estimated that as little as 40% of research results obtained from rodent models result in successful human clinical trials; the species are just too different for example in physiology and structure. It is becoming increasingly important that health science researchers identify more appropriate animal models; the pig is one of those more appropriate models. Due to physiological, anatomical, and developmental similarities to humans, researchers have been increasingly identifying the pig as a model of choice for research designed to benefit humans. One of the main benefits of research in pigs is that, unlike with the more traditional rodent models, utilizing a species of agricultural importance has the potential to apply the knowledge gained from the research to both human health sciences and agricultural industry applications.

Those research initiatives that simultaneously advance both agricultural and medical science are referred to as agrimedical research. The dual application of research in humans and agricultural species is not a new concept and research in both fields has historically been advanced through discoveries made in the other. For example, human nutritionists have gained valuable information on nutrient interactions, bioavailability and requirements through work carried out in animals. Research in neonatal pigs has increased our knowledge of interaction between nutrients and muscle growth and development which could lead to nutritional interventions to improve growth and survival of both low-birth weight pigs and human infants.

Recent work performed at the Prairie Swine Centre in collaboration with researchers in the College of Kinesiology to examine the adequacy of dietary calcium recommendations in sows has furthered our understanding of bone development and remodeling which can be used to develop therapies to treat osteoporosis in humans. In the Colleges of Pharmacy and Nutrition, and Medicine, the piglet model has been used to examine the toxicity of intravenous solutions being provided to sick infants. Dr. Gordon Zello, Professor of Nutrition, points out that without animal model studies, advances in human health could not be achieved as there are additional ethical issues when conducting studies in vulnerable groups, such as the premature infant. These are just a few examples of how agrimedical research can have a direct benefit to both the pork industry and health sciences.

The Prairie Swine Centre currently works with 14 different groups utilizing the pig as a model from dentistry reconstruction to vaccine development, and toxicology to specialized suture validation. There is a further benefit beyond the intended outcomes of improvement of quality of life in humans, and improved productivity and cost in pork production. That benefit is the improved communication and exposure to diversity of ideas and concepts through collaboration between human and animal scientists. This may someday be seen as a renaissance of bringing diverse sciences back together which have grown apart through technical specialization; it reminds me of a quote "The Best way to predict the Future is to Design it" (source: Buckminster Fuller, architect, author, designer and inventor). The future will be brighter when diverse talents are brought together to solve problems.

By necessity, agrimedical research requires a multidisciplinary collaborative approach. In order to foster collaborations between researchers at Prairie Swine Centre and the University of Saskatchewan Health Sciences, we recently held a symposium on the use of agrimedical models in research. This symposium, organized in collaboration with the College of Pharmacy and Nutrition, included presentations from both animal and health science researchers to highlight the importance of pigs for human health research and the benefits of agrimedical models. In response to the symposium, Dr. Kishor Wasan, Professor and Dean of the College of Pharmacy and Nutrition, states "The Prairie Swine Centre provides expertise and relevant large animal models for our health science researchers and the ability to access unique facilities, expertise and of course the pigs. This collaboration helps our scientists move their research forward and makes it more cost competitive. In particular we see significant strength in collaborating with Prairie Swine Centre on disease and nutrition research."

Research is a significant investment for both industry and government; therefore, it is increasingly important that research demonstrate benefit to multiple clients, and through that way ensure funding agencies see benefit in continuing to grow their research commitment. Our Mission speaks to our ability to take this trust and support and create value for our stakeholders.

Our Mission:
We are a source of innovation - providing solutions through knowledge, helping to build a profitable and sustainable pork industry.

(Optomization of Pork Prod... Cont'd from pg. 1)

a significant update on an annual basis. For the most part, due to legislation, trade issues, and finances we have not seen significant construction in Canada for the past 10 years. Significant repairs and maintenance expenditures are now being made in an attempt to catch up, producers need to assess whether they are spending these dollars in the best manner possible.

Replacement:

The challenge is construction cost followed by design improvement. Not only has the cost of finishing barn construction in Canada doubled in the past 10-15 years, we are at a disadvantage when compared to U.S. producers. Industry figures have shown U.S. producers are able to build new finishing barns in the range of $300-$350 per pig place while similar facilities in Canada could be built in the $500-$600 range. Key stakeholders within the Canadian pork industry stress it's not about building sow barns or nurseries, it's about finishing barns. Currently there are over 3 million pigs that cross the U.S. border as iso-weans and feeder pigs, keeping these in Canada would increase the viability and sustainability of the Canadian pork producers and the packing industry. The Centre has been engaged in gathering and evaluating opinions and insights on the limitations of the key barn systems (ventilation, animal handling areas, equipment design, etc) to inform future research, this can also be used to assist in redesigning the next generation of production facility.

New Technologies:

Bigger units, fewer staff, continued economic pressure on efficiency – How can we address these challenges? Evaluation of new technologies and practices through near-market research has been the role of the Centre for 25 years. Electronic controls, wireless communication, automation and robotics have moved quickly in other industries. Digital technologies and big data will define the opportunities. The pork industry is only accessing a small fraction of what might be substantial labour and operating cost saving devices. For example, multiple diet delivery in gestation, lactation feeding optimization and precision grow-finish nutrition have all made substantial progress recently. How robust and reliable is this technology and what is its place in new barn design? Supplementing skilled stockpersons with equipment to monitor water and feed disappearance, key health criteria (such as movement, lying patterns and coughing) that identify and evaluate comfort and welfare is on the horizon.

Next Steps:

To remain competitive with the U.S., new alternative models and appropriate technologies need to be developed and considered. If finances and regulations were in place and we could build today - What type of production system do we build? What would it look like? Would it be based on design, layout, and structure of the barns built in the mid-1990's? What new technologies or innovations can be incorporated to optimize finishing facilities? How does the new Code of Practice for the Care and Handling of Pigs affect future barn design?

Finishing capacity is where the next Canadian industry investment will be made, based on personal conversations and media on the subject most producers are unprepared to gather and consider alternatives. To optimize finishing facilities over their lifetime we need to take into consideration: construction costs and alternative materials, pig performance, barn and group size, biosecurity, operating costs, especially utilities, environment, manure management, OH &S, animal welfare and transportation. Some alternative strategies and their economic impact is a good first step in identifying viable options.

Expansion of finishing capacity and optimization of finishing barns is an important and immediate issue that needs to be addressed by industry stakeholders to ensure the long term viability and sustainability of the Canadian pork industry. We want to determine your thoughts on the role Prairie Swine Centre should play in this process.

Questions/Comments

1. Are you satisfied with your present state of information and expertise to develop the layout, features or technology in new finishing systems?

2. Do you have access to an un-biased third party to assess new technologies or innovations?

3. What is the timeline for construction of new finishing facilities?

4. If you were to build a new finishing barn: What would it look like? What size would it be?

5. What about the overarching business model: Would you prefer to own pigs or contract finish pigs?

6. In what capacity should Prairie Swine Centre as a multi-disciplinary knowledge transfer and research organization be involved?

a. Enterprise design and ownership
b. Barn design
c. New building materials
d. Technology and innovation
e. Overall system optimization

Thank you for your input.

Lee Whittington
Ken Engele

Getting more piglets interested in creep feed

Yolande Seddon and Denise Beaulieu, University of Saskatchewan; and
Jennifer Brown, Prairie Swine Centre

Getting piglets to eat before weaning helps them to ease the weaning dip. Not even 50% of them, however, actually do eat prior to weaning.

Weaning results in numerous concurrent stressors for piglets: removal from the sow, mixing with unfamiliar conspecifics, movement to an unfamiliar environment, and the abrupt change from a liquid (milk) to a solid diet. Creep feed is an optional provision in the farrowing pen to familiarise piglets with solid food prior to weaning, helping to ease one aspect of the process. When consumed pre-weaning, creep feed has been shown to be beneficial, with previous research showing piglets that consumed creep significantly outperformed their littermates post-weaning.

> "When consumed pre-weaning, creep feed has been shown to be beneficial"

However, such studies have also shown that fewer than half the piglets actually consumed any creep feed.

A study conducted at Prairie Swine Centre tried tackling this problem with an ethological approach, investigating whether methods to stimulate and increase piglet exploration and social feeding could increase not only piglet interaction with the creep, but also the number of piglets in a litter consuming creep.

Percentage of litter swabbed as eaten/treatment (Pre-weaning) - every 48 hours

Figure 1

	Definate eaters		
	D14	D20	D25
SC	2.1	13.5	29.6
SE	2.1	10.4	22.9
TC	0.0	26.6	48.7
TE	4.0	23.7	34.7

Figure 2

	Definate eaters		
SEM	D14	D20	D25
SC	1.9	7.9	10.3
SE	1.9	7.9	10.3
TC	0.0	7.9	10.3
TE	1.9	7.9	10.3

Considering the challenges

In the wild, a piglet would learn to consume appropriate foodstuffs while foraging in social groups, imitating the behaviour of the dam and littermates. Domesticated piglets farrowed in outdoor production systems have been observed eating the sow's food and surrounding vegetation pre-weaning. In contrast, the modern intensive production environment is relatively barren and uniform, and the sow is commonly restricted in a crate. This limits the interaction between sow and piglet, and drastically reduces opportunities for meaningful learning and exploration by piglets.

There could be consequences of this rearing environment on creep consumption and the speed at which piglets adapt to weaning. The following study investigated whether providing environmental enrichment or an increased opportunity for social feeding, in the farrowing pen would affect:

1. Piglet interaction with the creep;
2. The percentage of piglets in the litter consuming creep; and
3. The growth performance pre- and post-weaning.

The environment and creep feed consumption

Will altering the environment stimulate pre-weaning creep consumption? That was the key question at this study. It compared four treatments (Figure 1), 16 litters, four per treatment:

1. Creep presented in a standard commercial creep feeder (SC);
2. Creep presented in a standard feeder, with additional pen enrichment provided (SE);
3. Creep presented in a tray feeder (TC);
4. Creep presented in a tray feeder, with additional pen enrichment provided (TE).

Treatment groups receiving environmental enrichment were given strips of cotton rope in the farrowing pen from five days post-farrowing. The enrichment was added to encourage exploratory behaviour in the piglets prior to the addition of creep feed. Creep feed was offered to all treatments at ten days of age. The tray feeder

allowed food to be provided over a wider area, in an attempt to encourage foraging and social (synchronised) feeding by piglets.

Food grade dye

To determine which piglets were eating creep, on days 12, 19 and 25, an indigestible, non-toxic, food grade dye (approved for use in swine feeds) was added to the creep feed. Anal swabs were taken from all piglets 48 hours following provision of dye to identify 'eaters' and 'non-eaters'. Eaters were identified as those piglets from which an anal swab revealed the colour of the feed dye provided to the litter. Creep feeders were cleaned of dye following swabs.

At weaning (28 days post-farrowing) litters were assigned to a pen and mixed with a litter of piglets not on trial. Litters that received enrichment in the farrowing pen were given rope enrichment in the nursery. On the day of weaning, a dye of different colour than that added to the creep feed was added to the nursery starter diet. 48 hours later, all trial piglets were swabbed to determine 'eaters' and 'non-eaters'.

Treatment 1
Creep presented in a standard commercial creep feeder (SC). On the right hand side a pen with material for exploration is presented. Photo Prairie Swine Centre

Treatment 3
Creep presented in a tray feeder (TC). Photo Prairie Swine Centre

Piglet weight was determined on day 5 of age, the day of weaning, on day two post weaning (to determine growth-check post weaning) and on day 14 post-weaning. In total, 50% of litters across all treatments were monitored for pig behaviour between the hours of 8 am-4 pm on days 12, 18 and 23 post-birth. Litters were observed by cameras taking photos above the pen at intervals of five minutes. Pictures were scanned to determine piglet interaction with enrichment and the number of piglets present at the feeder (head in feeder), from which the frequency of observations piglets were viewed at the feeder was calculated, as a measure of feeder use.

Results

Piglets provided with creep in the tray feeder were observed with their head in the feeder on a significantly greater frequency of observations than those provided with creep in the standard feeder (Figure 2). The frequency at which piglets were observed at the feeder increased as the age of piglets increased prior to weaning, with piglets consistently observed at a significantly higher frequency, at the tray feeder. Of litters provided with enrichment, piglets were observed to be interacting with the rope enrichment for an average of 5% of the total observations per day.

Eaters vs non-eaters

Swab results showed there was some evidence of creep feed consumption occurring in three of the four treatments by day 14, (four days after presentation of creep feed). The average percentage of piglets in a litter showing evidence of creep feed consumption increased over the pre-weaning period (Figure 3), with litters provided with a tray feeder and no enrichment numerically having the largest percentage of piglets showing evidence of creep consumption by day 25.

There was no significant effect of feeder type or enrichment provision on the ADG of piglets prior to weaning, immediately post weaning, nor in the post-weaning period.

What can be concluded?

The manner in which creep feed is presented to attract piglets could be improved, as demonstrated by the significantly higher frequency at which piglets were observed at the tray feeder compared to the standard feeder. In addition, this different presentation of creep appeared to numerically increase the percentage of piglets per litter showing evidence of creep consumption. In contrast to other work at PSCI, there was no positive influence of eater status on piglet ADG pre- or post-weaning.

Further research is needed in this area to optimise the pre- and post-weaning environment to better accommodate the learning and exploratory behaviour of the pig. This initial data suggests improvement in the management of the weaned pig could be made.

This project was supported by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward bi-lateral agreement. Programme funding for Prairie Swine Centre from Sask Pork, the Manitoba Pork Council, Alberta Pork and Ontario Pork is gratefully acknowledged.

The importance of nitrogen for growth

Dan Columbus,
Research Associate
– Nutrition

After energy, protein is the second most expensive nutrient in swine rations but utilization tends to be low. Retention of dietary nitrogen in pigs ranges from 30% to 60% of intake with much of this inefficiency the result of catabolism of excess amino acid/protein intake or unbalanced amino acid supply. This catabolism represents an energetic cost to the animal, reducing performance, and results in an increase in nitrogen excretion into the environment. Due in part to the contribution of dietary protein to total feed costs and the environmental impact of feeding excess protein, considerable research has been conducted to determine dietary requirements for essential amino acids.

While essential amino acid requirements are well-defined, there has been a general lack of research into requirements for non-essential amino acids and total dietary nitrogen. With the increased availability of affordable crystalline amino acids, it has become possible to feed reduced protein diets while maintaining essential amino acid content and growth performance. However, the endogenous production of non-essential amino acids requires a source of nitrogen, therefore, in situations where total dietary nitrogen is limited, as could be the case in reduced protein diets with supplemental crystalline amino acids, essential amino acids will be used to meet requirements for non-essential amino acid production.

A concept familiar to ruminant nutritionists is the provision of sources of non-protein nitrogen (i.e., urea and ammonia) and reliance on production of amino acids by rumen microbes. In addition to dietary supplementation with non-protein nitrogen, it has been well established in both non-ruminant and ruminant animals that a proportion of urea produced from amino acid catabolism enters the gastrointestinal tract where gut microbes are capable of utilizing the urea for amino acid production. This process, referred to as urea recycling, represents an important salvage mechanism to improve nitrogen retention during times of protein deficit, and presents an opportunity to both reduce feed costs and improve efficiency. However, the contribution of microbial amino acid production to meeting amino acid requirements in non-ruminants is not clear.

In order to more fully understand the utilization of nitrogen for lean gain in growing pigs, a series of studies were performed at the University of Guelph. These studies were designed to determine the ability of pigs to utilize sources of non-protein nitrogen under a variety of dietary conditions.

> "pigs are capable of utilizing non-protein nitrogen for body protein deposition and growth"

Study 1 – Utilization of non-protein nitrogen in pigs fed a diet limiting in an essential amino acid

A nitrogen-balance study was performed to determine the impact of infusion of urea or casein in the hindgut on whole-body nitrogen retention in growing pigs (n = 10; 22 ± 1.8 kg initial body weight) fed a valine-limiting diet (cornstarch-soybean meal based). Pigs were assigned to receive an infusion of saline (control), urea, or casein (40% of dietary protein intake) into the

cecum in a Latin square design. Fecal and urine output were measured daily and samples obtained for determination of nitrogen output and nitrogen retention. A continuous infusion of isotopically labelled urea (15N15N-urea) was given for determination of urea production, urea excretion, and urea recycling. It was hypothesized that nitrogen is absorbed from the hindgut as ammonia which may contribute to the amino acid supply of the pig through urea recycling and microbial amino acid production in the small intestine. The majority of the infused nitrogen was absorbed and protein deposition (114, 128, and 130 g/d; $P < 0.01$) was improved with infusion of both casein and urea, but did not differ between the two treatments. Urea flux and urinary nitrogen excretion increased similarly for both nitrogen infusions indicating that nitrogen absorbed from the hindgut is in the form of ammonia. The efficiency of utilizing nitrogen absorbed from the hindgut was approximately 18%. This indicates that while pigs can utilize non-protein nitrogen to correct an essential amino acid deficiency, this is likely not efficient enough to be a viable dietary alternative.

Study 2 – Utilization of non-protein nitrogen in pigs fed a nitrogen-limiting diet

A nitrogen-balance study was performed to determine the impact of infusion of urea or casein in the hindgut on whole-body nitrogen retention in growing pigs (n = 9; 17 ± 0.3 kg initial body weight) fed a cornstarch-soybean meal based diet formulated to be limiting in non-essential amino acids (high essential to total nitrogen ratio) but met requirements for essential amino acids. Pigs were assigned to receive an infusion of saline (control), or urea at 1.5 g/d or 3.0 g/d into the cecum in a Latin square design. Fecal and urine output were measured daily and samples obtained for determination of nitrogen output and nitrogen retention. A continuous infusion

of isotopically labelled urea (15N15N-urea) was given for determination of urea production, urea excretion, and urea recycling. It was hypothesized that nitrogen absorption from the hindgut can be used for endogenous non-essential amino acid production and increase body protein deposition in pigs fed a diet deficient in non-essential amino acids. Whole-body nitrogen retention (4.86, 6.40, and 7.75 g/d; $P < 0.01$) and average daily gain (267, 314, and 360 g/d; $P < 0.05$) were improved with increasing amounts of urea infused into the hindgut but there was no impact on urea kinetics. The efficiency of utilization of nitrogen in this study was nearly 100% for both amounts of urea infused indicating that non-protein nitrogen absorbed from the hindgut can be used efficiently for body protein deposition under conditions of dietary non-essential amino acid deficiency.

Study 3 – Dietary supplementation with ammonia and growth performance

A study was performed to determine the effect of addition of different sources of nitrogen to a diet limiting in non-essential amino acids on growth performance of growing pigs. A total of 36 growing pigs (15 ± 1.0 kg initial body weight) were fed a cornstarch-casein based diet deficient in non-essential amino acids (control) but met requirements for essential amino acids and supplemented with either urea, ammonium citrate, glutamate, or a mix of non-essential amino acids, each at two levels (1.37 or 2.75% additional dietary protein). Average daily gain (367, 399, 404, and 402 g/d; $P < 0.01$) and gain:feed (0.38, 0.42, 0.42, 0.42 kg/kg; $P < 0.01$) was lowest when supplemental urea was provided but was similar on all other sources of non-essential nitrogen and improved with increasing level of nitrogen provided (363, 387, 429 g/d ADG for 0, 1.37, and 2.75%, respectively; $P < 0.001$). These results indicate that pigs can utilize a source of non-protein nitrogen as efficiently as non-essential amino acids for growth when fed a diet deficient in total nitrogen.

Overall, these studies demonstrate that pigs are capable of utilizing non-protein nitrogen for body protein deposition and growth in diets limiting in either essential amino acids or total nitrogen. However, the results from these studies need to be interpreted with caution since conditions under which utilization were measured (for example, use of cornstarch based diets) do not replicate commercial practices. With increased use of alternative ingredients and co-products with potentially lower protein digestibility and continued use of crystalline amino acids in reduced-protein diets, it may become increasingly important to consider total dietary nitrogen supply and, therefore, further research into nitrogen utilization is required.

The research in this article was performed at the University of Guelph. Funding for this research was provided by Ontario Pork, Ontario Ministry of Agriculture, Food, and Rural Affairs (OMAFRA), the Natural Sciences and Engineering Research Council of Canada (NSERC), Swine Research and Development Cluster, Swine Innovation Porc, and Evonik Industries AG.

Further reading:

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Use of Novel Technologies to Optimize Pig Performance, Welfare and Carcass Value

Brian Sullivan, CEO and
Laurence Maignel, Geneticist,
Canadian Centre for Swine Improvement

Keeping on top of new technologies is critical for businesses to remain competitive and profitable. Technology for data recording is becoming increasingly important and more affordable in pork production whether you are a commercial hog producer, a swine genetics company or involved in the packing and processing of pork. It simply comes down the old adage that you can't improve what you don't measure. But of course, there is much more to it than simply adopting every technology that you hear or read about. There is a need to identify technologies that can truly help your business and be sure the technologies can work as promised. It can be challenging, if not impossible, for individual businesses to adequately assess and test many of the promising technologies that are out there. Collective efforts by the industry can address this challenge and with that in mind, the Canadian Centre for Swine Improvement (CCSI) is coordinating a large collaborative project on novel technologies. Some of the technologies tested can help monitoring pigs from nursery through to market weight. Others measure carcass and pork quality attributes. There are even technologies able to predict carcass and pork quality on the live animal.

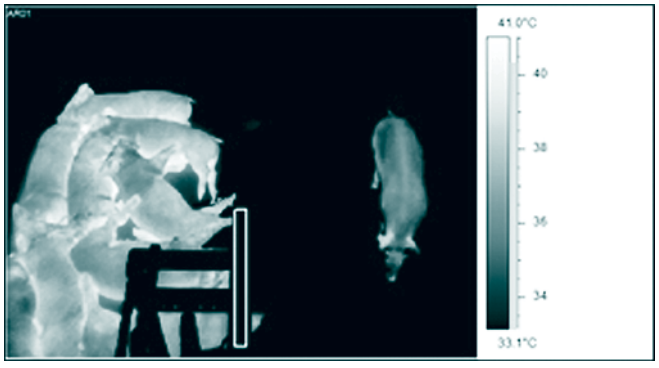

Figure 1. An infrared camera image of a pen of pigs at AAFC's Lacombe Research and Development Centre

Figure 2. Pens at CDPQ's Deschambault test station with feed and water intake recording as well as play objects fitted with accelerometers

The project includes the following pilot studies, three on live pigs and five on carcass and pork quality:

- Automated recording of feed/water intake and 3D vision systems to estimate weight/ conformation
- Infrared thermography diagnostic platform to monitor swine to health and predict feed efficiency
- Use of accelerometers to automatically assess pig behaviour and welfare
- Using 3D vision for rapid and objective hog carcass quality assessment
- Rapid in vivo prediction of pork composition and quality traits using near-infrared spectroscopy
- Determination of the age of bruises on pig carcasses at slaughter
- Application of rapid methods for non-invasive assessment of pork quality
- Quick, non-invasive technology for prediction of loin marbling in fresh loins on the cutting line

These pilot studies are underway in research facilities and will be completed during 2016. The results will help the industry to make informed decisions about these technologies. In each case we need to consider the value of what is being

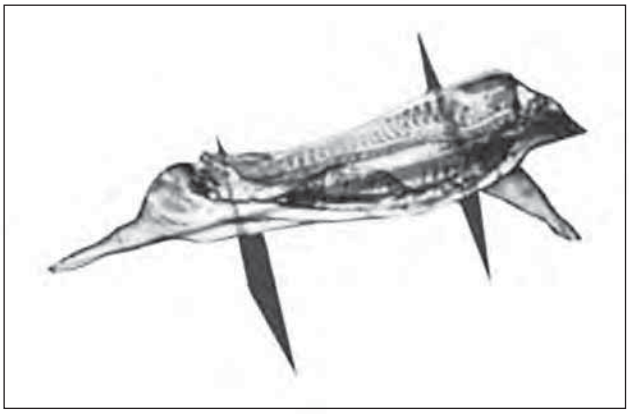

Figure 3. A 3-dimensional image captured on a half carcass at AAFC's Sherbrooke Research and Development Centre

measured as well as the accuracy, the cost and the practicality. Knowing which technologies are not ready yet is just as important as knowing which technologies are ready for commercial testing. From those that are deemed ready, the goal is to work with industry partners to test each selected technology on a total of at least 1000 pigs and carcasses.

One of the technologies that is now being considered for commercial tests is the automated recording of water intake. In the pilot study the water intake on individual pigs has been found to correlate highly with feed intake. As well, sudden changes in water intake can be indicators of individual pig health. The technology may also be helpful in assessing and reducing water wastage which was found to vary considerably amongst individual pigs. This could lead to a practical tool which can improve efficiency and pig health while also reducing environmental impact.

The overall project is assessing several novel technologies which can help producers to monitor health, welfare and feed efficiency while also offering tools to predict and enhance carcass value. There are also technologies for packers to better evaluate carcass and pork quality. This will allow them to get more value from each carcass and also to provide signals back to producers to motivate further improvement. The importance of attracting investment in new technologies is apparent as all industries are benefiting from greater data management and process control through electronically controlled devices. An added advantage of moving toward novel technologies and more electronically controlled devices is the attraction of new employees seeking to use their technical skills and interest as part of their career, thus a benefit in the pork industry to attract younger and well qualified personnel.

This project is funded by Swine Innovation Porc within the Swine Cluster 2: Driving Results Through Innovation research program. Funding is provided by Agriculture and Agri_Food Canada through the AgriInnovation Program, provincial producer organizations and industry partners.

About the Canadian Centre for Swine Improvement (CCSI)

CCSI is a non-profit organization created in 1994 to provide support to the Canadian pork industry by providing leadership, innovation and coordination in national genetic evaluations; database establishment and maintenance; program standards; and research and development. Members include Canadian Pork Council, Canadian Meat Council, Canadian Swine Breeders Association, regional swine improvement centres and users of the Canadian Swine Improvement Program.

PSC Scientist participates in world code for swine welfare

Dr. Jennifer Brown
Research Scientist- Ethology

Prairie Swine Centre In March, Dr. Jennifer Brown, PSC's Research Scientist in Ethology, travelled to Paris to participate in a meeting of the OIE (World Organisation for Animal Health). The purpose of the meeting was to draft international animal welfare guidelines for pigs, similar to our Canadian Codes of Practice, but in this case for the entire planet! The OIE is the organization responsible for improving animal health worldwide, and is recognized by the World Trade Organisation, with a total of 180 Member Countries. Its primary responsibility is related to animal health and the development of guidelines for disease detection, notification, prevention and control. More recently the OEI has developed welfare guidelines for animal transport, slaughter, care of lab animals and livestock. The OIE's Terrestial Animal Health Code already includes specifications for beef cattle, dairy cattle and broiler chickens, with pig and horse codes now under development. Dr Brown was the only North American participant; other committee members include vets and researchers representing Denmark, Spain, Brazil, China and Australia. The pig code will now be reviewed and ratified by all member countries, and will be completed in 2017.

Zinc Oxide and Antimicrobial Resistance in Pigs

M. J. Slifierz, R. M. Friendship, J. S. Weese

Summary

The objective of this research was to investigate whether therapeutic use of zinc oxide (ZnO) in swine production creates selective pressure for the emergence of methicillin-resistant Staphylococcus aureus (MRSA) due to co-location of the zinc-resistance gene (czrC) and methicillin-resistance gene (mecA) within the staphylococcal cassette chromosome mec (SCCmec). A randomized-controlled trial was completed using 110 pigs that were naturally colonized with czrC-positive MRSA. The prevalence of MRSA was significantly higher when pigs were fed a ration containing 3000 ppm of zinc oxide compared to the control group (100 ppm zinc). In an observational study of 26 farms, it was found that the use of therapeutic levels of zinc oxide (>2000 ppm) was associated with a higher likelihood of finding MRSA in nasal swabs of weanling pigs. The overall conclusion from these studies is that high levels of zinc oxide in starter rations are associated with a higher prevalence of pigs carrying MRSA.

Introduction

Zinc is an essential nutrient and needs to be provided in starter rations at around 100 ppm to

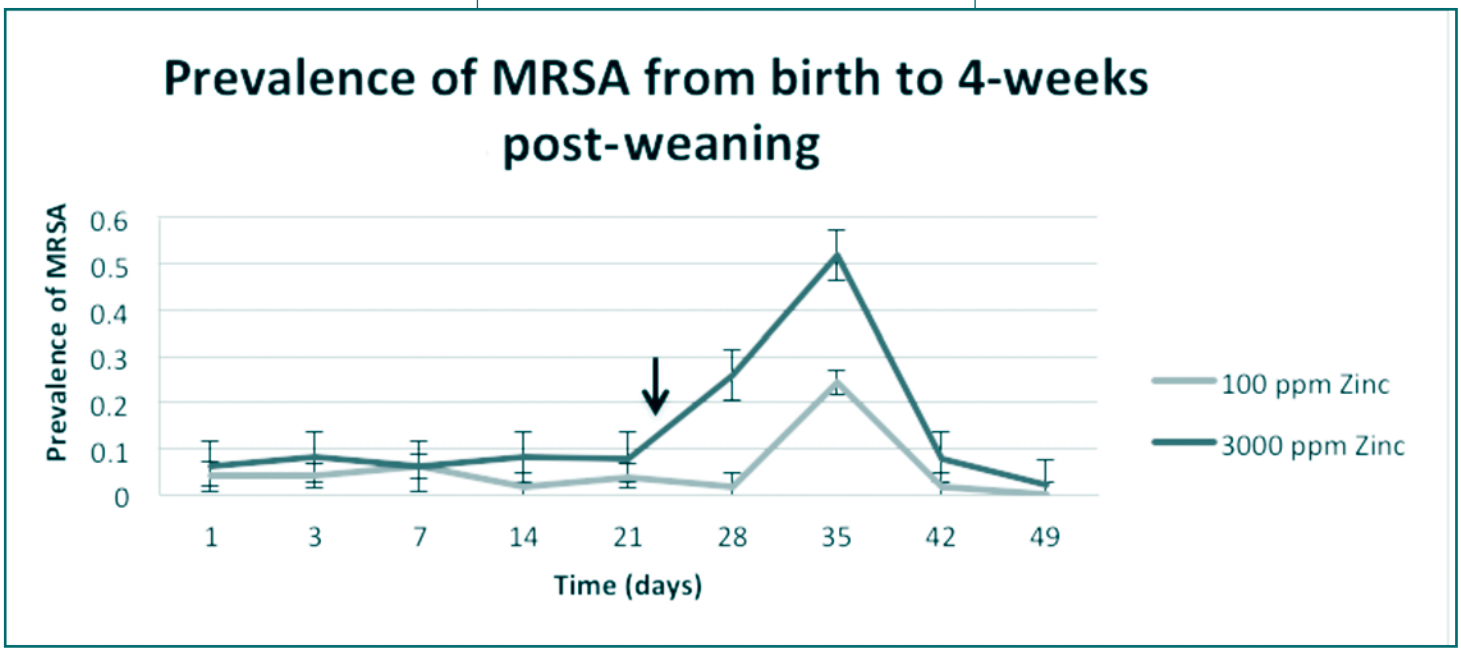

Figure 1. Nasal swabs of pigs tested for methicillin resistant Staphyloccus aureus at weekly intervals, during the suckling and nursery phases

Table 1. Factors associated with methicillin-resistant Staphylococcus aureus in nursery herds.

Parameters	MRSA positive cohorts (n=8)	MRSA negative cohorts (n=14)	P-value[a]
Herd size (sows, SD)	698.0 (433)	425.0 (427)	0.076
Continuous nursery flow (%)	25.0	57.1	0.204
Average weaning age (days, SD)	22.4 (2.6)	24.5 (4.8)	0.351
Nursery stocking density (pigs/m2, SD)	3.22 (1.23)	2.47 (1.17)	0.048
No outside breeding stock replacements (%)	62.5	71.4	0.999
Danish entry (%)	37.5	42.9	0.999
Shower-in/shower-out required (%)	62.5	28.6	0.187
Nursery pens disinfected for incoming pigs every time (%)	100.0	50.0	0.022
Corridors are disinfected on a weekly to monthly basis (%)	87.5	42.9	0.074
Cat(s) and/or Dog(s) on the property (%)	37.5	92.9	0.011
Live rodents observed in barn at sampling (%)	12.5	7.1	0.999
Wild birds observed in barn in past year (%)	12.5	42.9	0.193
Antibiotics administered by feed (%)	87.5	78.6	0.999
Antibiotics administered by water (%)	37.5	42.9	0.999
Antibiotics administered by injection (%)	87.5	71.4	0.613
Zinc therapyb (≥2,000 ppm in-feed) (%)	100.0	50.0	0.022

meet the pig's nutritional requirements. Levels of 2000 to 3000ppm of zinc oxide are often used in early starter rations as a therapeutic agent to control post-weaning E. coli diarrhea. Bacteria can carry resistance to heavy metals such as zinc and there is concern that the use of zinc oxide as a therapeutic agent might inadvertently co-select for antibiotic resistance. Of particular public health concern is methicillin resistant Staphylococcus aureus (MRSA), an organism commonly isolated from the nasal cavities of pigs and is often found on farms where antibiotics are not used. The objectives of this research was to determine whether the herd prevalence of MRSA among nursery pigs is affected by exposure to therapeutic levels of in-feed ZnO (3,000 mg/kg) when compared to the recommended dietary levels of in-feed ZnO (100 mg/kg), and to investigate risk factors for MRSA shedding in pigs in commercial nursery herds with a particular focus on antimicrobials, heavy metals, disinfectants, biosecurity, and management practices.

Results and Discussion

Trial 1

Fifty weaner pigs received feed containing therapeutic levels of ZnO (3,000 ppm) and 49 pigs received a control feed containing100 mg/kg of zinc. Pigs receiving therapeutic levels of ZnO were significantly more likely to carry MRSA on day 28 (OR=18.1, P=0.007) and day 35 (OR=3.01, P=0.015) when compared to the control pigs (see figure 1).

> "zinc oxide in starter rations are associated with a higher prevalence of pigs carrying MRSA."

Trial 2

Nasal cultures for MRSA were completed for 390 pigs from 26 farms at the end of the suckling phase and again at 3-weeks post-weaning. Herd-level information was collected and a random subset of MRSA isolates was screened for resistance to zinc. Multivariate analysis revealed that the concentration of in-feed zinc (P<0.001) and frequent disinfection of nursery pens (P<0.001) were associated with pigs carrying MRSA (see Table 1). Furthermore, 62.5% (25/40) of MRSA isolates carried the zinc-resistance gene czrC and were phenotypically resistant to zinc. The use of therapeutic levels of zinc oxide in starter feeds appeared to be an important risk factor in the persistence of MRSA in commercial swine herds.

Conclusion – Overall, exposure to therapeutic levels of in-feed ZnO is associated with an increase in the prevalence and persistence of MRSA among pigs, particularly during the early phase of the nursery.

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Personal Profiles

Ravneet Kaur

Ravneet is from Chandigarh,India. She has started her MSc at University of Saskatchewan in September 2015. She joined Prairie Swine Centre, Inc as a graduate student in Ethology under the supervision of Dr.Jennifer Brown.

She completed her bachelors in Veterinary Sciences and a masters in livestock Products Technology from Guru Angad Dev Veterinary and Animal Sciences Unversity, India.

Her study will focus on evaluation of optimal space allowance for nursery pigs. Significant research has been done in grow-finish pigs. However, not much research has been done pertaining to the effects of stocking density allowance to n nursery piglets. So she aims to look into the space allowance in nursery piglets to establish critical cut off points at which crowding occurs.

Victoria Kyeiwaa

Victoria Kyeiwaa is from Kumasi, a city in Ghana West Africa and has started her M.Sc. program at the University of Saskatchewan in September 2015. She joined Prairie Swine Centre Inc. as a graduate student in ethology under the supervision of Dr. Jennifer Brown. Her MSc project is part of a large collaborative study on sow management, directed by Dr Laurie Connor at the University of Manitoba, and funded by Agriculture and Agri-Food Canada.

Victoria earned her B.Sc. (honours) in Dairy and Meat Science and Technology from Kwame Nkrumah University of Science and Technology (KNUST), Kumasi-Ghana in June 2014. She served as a teaching/research assistant in the same university (KNUST) at the Department of Animal Science for one year. Shortly afterwards she moved to Canada and began her M.Sc. program. In the course of her M.Sc. project, she is investigating the behaviour and management implications of providing environmental enrichment for group housed gestating sows. She aims to develop effective environmental enrichment for sows in group housing systems.

Coming Events

World Pork Expo
June 8-10, 2016
Des Moines, Iowa

Alberta Pork Congress
June 15-16, 2016
The Westerner
Red Deer, Alberta

Ontario Pork Congress
June 22-23, 2016
Stratford, Ontario

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