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CENTRALIA SWINE RESEARCH UPDATE

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CENTRALIA SWINE RESEARCH UPDATE
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WRITTEN-ONLY TOPICS

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Ontario

Ontario Swine Health: What's Happening Out There?

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PRRS: The cost of PRRS in Canada is estimated at Can $120-$140 million/year. Outbreaks in Ontario continued late into the spring of 2012 and have resumed this fall. The 1-22-2 family of PRRSV continues to spread to additional herds. The good news is that 1-22-2 virus does not appear to be as virulent in the nursery as it was in 2010.

We have had a number of farrow to finish and farrow to feeder pig herds that have successfully completed a PRRSV elimination using a load, close, and homologize program with temporary growing pig depopulation. In addition there was at least one nursery to finish farm that successfully completed a partial depopulation with unidirectional flow and double blitz MLV vaccine. There are a growing number of tools in the PRRS tool box including the effectiveness of MLV vaccine in reducing the duration of shedding in populations of pigs that are infected with field strain.[5] Area Regional Control & Elimination (ARCE) activity is accelerating. Lots more rope testing is occurring and recent tests are increasing the confidence in oral fluid PRRS Elisa testing.

Swine Influenza: Swine Influenza Virus breaks are continuing to occur. There has been a renewed effort to pursue genetic typing on new isolates. Most diagnostic investigations in Ontario have gone no further than confirming Influenza Type A. In order to better understand the dynamics of SIV and develop better baselines of prevalence more definitive sequence testing is required. Rope testing is being used quite successfully for SIV diagnostics. Maternal antibody appears to be playing a role in "within population" spread of virus. Pig to human transmission has been in the press of late and it should be noted that personal protective equipment (PPE) may not be totally protective for contamination of clothing if the pigs are allowed to chew vigorously on the PPE.[1,3]

Porcine Circovirus type II: PCVD continues to be an expensive disease for producers given the almost mandatory use of vaccine. Some fractionated vaccine use continues to be promoted with variable results. There are sporadic cases of immediate post-weaning PCVD. More producers are testing out the reproductive benefits of sow herd PCV vaccination.[4]

Proliferative Enteritis: *Lawsonia intracellularis* can be a frustrating and recurring problem in a number of pig flows in Ontario. Antimicrobial resistance is an issue. There have been some sporadic outbreaks in breeding herds.

Mycoplasma hyosynoviae: While some pig flows have no issues with this disease, others are almost regularly seeing outbreaks in the finisher. Most discussion is pointing to management of this disease similar to the way we manage *Mycoplasma hyosynoviae*. There is a greater emphasis on getting gilts into the breeding herd several months prior to breeding so that they can be acclimatized. This increases passive immunity in piglets and reduces vertical transmission from gilts and young sows to piglets. The main focus in the finisher is preventive antimicrobial treatment several weeks prior to the most common time of onset of clinical signs.

Colibacillosis – Post-weaning: This issue has not disappeared for several producers. Antibiotic resistance is limiting the treatment options for this disease.

Swine Dysentery: *Brachyspira hyodysenteriae* has not been reported in Ontario but continues to spread in the province of Alberta. The industry is on a heightened alert and is closely monitoring for evidence that this disease has arrived in Ontario. This disease, if it does break in Ontario will be a production issue and control will fall to industry. There is evidence that strains that were not traditionally very virulent have developed increased ability to cause disease.[2]

Transmissible Gastroenteritis: One case reported. This is a highly contagious disease and has the potential to spread.

Umbilical Hernia: This problem can affect up to 4% of pigs marketed. Once the hernia exceeds the size of a couple inches it can prohibit normal transport and in many cases this has necessitated euthanizing these animals rather than transporting. Most focus is on umbilical cord hygiene at birth.

Hump Back / Vit D: There is growing evidence that Vitamin D in sow and growing pig feeds is implicated in the incidence of kyphosis or “Hump Back” in growing pigs. Affected pigs have an increased probability of morality or culling.[6]

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Utilization of Amino Acids by the Sow Mammary Gland During Lactation: Do Dietary Amino Acid Ratios Matter?

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Summary

Imbalances created by excesses or deficiencies of dietary amino acids (AA) reduce the global efficiency of dietary protein utilization by the animal by limiting milk protein synthesis and increasing N losses to the environment. Understanding the fate of AA is thus crucial for optimizing AA utilization for milk protein synthesis and reducing inefficiencies. Could we, in the near future, uncover pathways and molecular targets to improve the efficiency of AA utilization? In the presentation, the author highlights processes of utilization of AA by the mammary and litter growth in response to AA nutrition of the lactating sow, and proposes that knowledge of mechanisms that govern how AA are utilized offers impetus for refining the AA requirements for lactation.

Surprisingly, very few studies have addressed the impact of optimizing ratios between dietary lysine and other AA in lactating sow diets, including valine alone (Richert et al., 1996, 1997a), the branched-chain AA (Richert et al., 1997b; Moser et al., 2000), and threonine (Cooper et al, 2001) on litter growth. Furthermore, very little attention has been paid to the mechanisms linking dietary AA profiling to milk protein synthesis. Consequently, NRC (1998 and 2012) has relied on the AA profile in milk to estimate the AA requirement of the lactating sow; a dearth of knowledge however remains to uncover the partial efficiencies at which AA are used in order to correctly implement dietary AA ratios.

The author will discuss major pathways of AA utilization for mammary growth and milk protein synthesis and its relevance to the sow AA nutrition. It is well recognized that the sum of indispensable AA uptake by the lactating mammary glands exceeds that of in the secreted milk (Trottier et al., 1997; Guan et al., 2004). Of the total 188.5 g of essential AA taken up by the sow mammary gland daily, 49 g is retained, accounting for about 25% of the total uptake (Trottier et al. 1997). Consequently, there is a substantial use of essential AA in mammary metabolic pathways, including oxidation, synthesis of non essential AA, structural and functional proteins, and miscellaneous compounds, and tissue remodeling or repair. These pathways are unique to each AA both in terms of fate and rate of reactions and thus play important roles in dictating the partial efficiency of AA utilization into milk proteins. For instance, the udder of a lactating sow synthesizes daily 975 g of protein of which only 2.8% is used in mammary growth (assuming 9 kg milk production) but also breaks down 400 g of proteins (Guan et al., 2002), for a net protein balance estimated at 575 g, illustrating the extend of AA metabolism occurring within the tissue. The author will present a hypothetical model of dietary AA utilization across the mammary gland and a series of studies (Guan et al., 2002; Guan et al., 2004; Pérez Laspiur et al., 2009; Manjarín et al., 2012) conducted in the author's laboratory demonstrating that mammary AA extraction efficiency is improved with reduction in dietary CP intake and that possible interactions existing between AA in particular between the branched-chain and lysine.

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Broken hearted about in-transit losses? Your pigs may be.

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The specific cause of death for hogs that die in-transit to a packing plant has rarely been investigated. The increase in shipping mortalities during the summer months is often attributed to heat exhaustion or stress. However it is rarely questioned why so many hogs are able to tolerate the shipping conditions and why only a small percentage cannot. There have been suggestions in the past that heart failure may explain some shipping losses.

Heart lesions and heart failure in pigs

Generally heart lesions in pigs can be classified into two basic categories. The first is a heart defect due to an infection. In this case a pig contracts a bacterial infection such as *Streptococcus suis* which can result in bacteria entering the blood stream. After treatment with antibiotics the pig recovers but the bacteria have caused damage to parts of the heart, most commonly the heart valves or the heart sac. The resulting lesions are called valvular endocarditis and fibrinous pericarditis respectively. The scarred parts no longer allow the heart to work as efficiently as a normal heart. The affected heart must work harder or compensate to pump the required amount of blood to the body. The second cause of heart lesions is congenital or birth lesions. Just as with the infectious cause, a congenital defect causes the heart to work harder or compensate to perform normal functions.

Compared to all other species (including humans), a pig's heart is small in relation to its body size (1). This results in their heart working at close to its maximum ability for normal daily functioning, leaving less ability to compensate or work harder when physical demands increase. Therefore when the heart is abnormal, there is little to no reserve capacity to respond to challenges. When an abnormal heart is challenged with any type of stress (e.g. fighting, receiving an injection, or being loaded or unloaded onto a truck) that further increases the demands on the heart, the heart is often unable to compensate further and heart failure may occur.

The 2012 Ontario Pork In-transit Loss Project-Methods and Results

Two federally-inspected Ontario packing plants agreed to cooperate in this study. Slaughter plant A commenced participation in the study the last week of May, 2012 and Plant B during the first week in June, 2012. At the end of the receiving day at Plant A all dead on arrival hogs (DOA's) were transported to the Animal Health Laboratory and received post-mortem examinations from the on-duty pathologist. The hearts were removed and preserved in formalin for further examination. At Plant B, one of the authors (TVD) traveled to the plant two days a week (on rotating scheduled days) and performed post-mortem examinations of DOA hogs at the plant. Dr. van Dreumel also examined all the preserved hearts from the hogs shipped to the Animal Health Laboratory. Histology samples were collected on all DOA hogs at both plants and theses slides are being examined. A total of 62 DOA hogs have had a post mortem completed to determine their cause of death. It is clear that the majority of DOA hogs at these two slaughter establishments are not the result of uncomplicated hyperthermia or heat stress. To date only 21% of the market hogs that died in-transit had no underlying lesions affecting their risk of dying en route to the packing plant. Heart failure due to pre-existing heart lesions was the most consistent pathology found in the 62 hogs that died in-transit. The exact time of development for the heart lesions could not be determined but it was determined that the lesions were present for weeks to months prior to shipping. These data are summarized in Table 1.

A total of 50 hearts (27 from Plant A and 23 from Plant B were collected off the processing line to act as controls ("non-DOA hogs"). Each heart was examined blindly by the same veterinary pathologist who performed the post-mortems on the DOA hogs. No lesions were found in the gross examination of the control hearts. Microscopic examination of the heart muscle from the control hogs is ongoing. Hearts from those hogs with heart lesions appeared visibly larger than normal hog hearts. Heart weights (total heart weight and right ventricle and left ventricle plus septum separately) of the normal and abnormal hearts were compared. Hearts with lesions were found to be significantly heavier than normal hearts (those without any defect).

Table 1. Summary of the cause of death based on post mortem examinations of hogs from 2 federally-regulated slaughter plants in Ontario.

Cause of Death of 62 DOA hogs	**Plant A**	**Plant B**	**Total DOA Hogs**	**% DOA Hogs**
Other-fractures, enteritis, etc.	3	2	5	8%
Heat Stress -pulmonary congestion and edema are the only significant findings on PM with no other signs of disease	5	8	13	21%
Heat Stress -pulmonary congestion and edema are present on PM but a secondary disease is also present (e.g. pneumonia, kidney disease)	2	0	2	3%
Heart Failure (presence of one or more pre-existing heart lesions observed grossly)	34	8	42	68%
TOTAL post mortems completed	44	18	62	100%

Conclusions

- The overall low rates of in-transit losses at Ontario plants (the 2010 combined average for all 3 federally inspected plants was 0.07%) implies that the majority of hogs are able to physiologically respond to the stresses associated with the industry's current transport practices.
- A high prevalence of heart lesions (68%) was found in the DOA hearts examined in this study. These hogs died from heart failure. The defect was present for weeks or months prior to the hog being shipped. Heat may have exacerbated the heart condition, but these hogs died primarily from heart failure and not heat stress.
- This in-transit loss study investigated a convenience sample of DOAs this summer at 2 Ontario abattoirs. If heart lesions are responsible or the majority of DOA hogs in Ontario, then understanding the causes of these lesions (infectious or congenital) may be just as important to reducing DOA hogs as keeping hogs cool during transport.
- Veterinarians investigating above average sudden death or DOA rates on swine farms that complete a PM on farm should ensure they open and examine the heart or consider sending in the whole heart to the laboratory for gross and histological examination as some heart lesions are subtle.

The prevalence of hogs with heart lesions on farms in Ontario is unknown, as are the risk factors for why some hogs develop these lesions. Next steps for the study include farm visits with willing producers to attempt to determine if there are common factors associated with hogs developing these heart lesions. Visits are approximately 60 minutes long and involve a tour of the barn while answering questions regarding various aspects of production, management and health of the hogs on the farm. Producers with high DOA rates or high "sudden death" rates in their finishing barns who are interested in participating in the study can contact: Kathy Zurbrigg, 519-846-3418 or kathy.zurbrigg@ontario.ca

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Swine Influenza Update

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Summary

Influenza viruses circulate endemically in swine populations throughout the world. Clinical signs vary from subclinical infections to sudden outbreaks of respiratory disease characterized primarily by coughing, fever, inappetence in all age groups and additionally by abortions when pregnant animals are affected. Mortality is typically low, and production losses occur due to reduced growth, impaired flow due to reproduction problems, and the contribution of influenza virus to porcine respiratory disease complex (PRDC), a condition with a multifactorial etiology.

As a species, swine can be infected with different influenza virus subtypes, but only subtypes that contain H1, H3, N1, and N2 are well established. Most commonly, these include subtypes H1N1, H1N2, and H3N2 that widely circulate in swine populations of most swine-producing regions. Although identical at the subtype level, swine influenza viruses (SIV) in different geographical regions may further vary in their mechanisms of emergence, their abilities to establish in a population, and their molecular and antigenic properties. Swine may also be infected with viruses that are adapted to circulate in people and in different avian species. Similarly, influenza viruses of swine origin may infect humans.

Prevention and control of influenza in swine is based on several principles including: biosecurity, vaccination, and demographic measures including herd closure and flow management. Since 2005, incursions of different influenza variants occurred in pigs in Canada. This creates a challenge for animal health, for design of control programs including vaccination. An important prerequisite for successful vaccination programs is that influenza variants included in vaccines match those that currently circulate in the target population. This can only be addressed by appropriate virological studies. The objective of the current work was to assess which variants of influenza viruses commonly circulate in Ontario swine. Swine herds that experienced clinical signs suggestive of influenza virus or that had such history were visited during 2012. When possible, nasal swabs were taken from animals that showed clinical signs in order to maximize detection of influenza viruses. Nasal swabs were transported to a laboratory where each sample was processed for detection of influenza viruses. Following detection of a virus, one virus from a positive herd was sequenced for all genes. At this point, fourteen herds had at least one positive sample with varying level of within-herd positivity. Details of the sequence analysis will be discussed.

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P600 in Gilt Selection and the Subsequent Performance of P1 Sows Used as Nurse Sows

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Study 1- Is routine use of exogenous hormones to induce early puberty in gilts worthwhile?

Introduction

PG600®, a product containing a combination of equine chorionic gonadotropin and human chorionic gonadotropin, was licensed in Canada in the early 1980's for the induction of puberty in gilts. There is still much confusion about how it is to be used and controversy about its effectiveness. One particular concern is that if PG600® is used to induce gilts to come into their first heat instead of waiting for "natural" occurring puberty, then a herdsman might inadvertently select subfertile animals resulting in small subsequent litters and poor lifetime reproductive performance.

The objective of this study was to determine if there was a difference in performance between gilts selected on the basis of response to boar exposure versus gilts induced with PG600®.

Materials and Methods

This study was conducted on a 5,600 sow farrow-to-wean commercial facility. A total of 532 prepubertal replacement gilts were randomly assigned to 1 of 2 treatment groups at 153 days of age: Group 1 (n = 260) were injected IM with 5 mL of PG600® the day after selection and Group 2 (n = 272) were left untreated and selected on the basis of first to show heat. All gilts were housed in a gilt developer unit and subjected to boar exposure (30 min direct & 5 h indirect per day) for heat detection beginning at 155 days of age. Gilts were moved to the breeding barn after second estrus and artificially inseminated in a.m. and p.m., to a maximum of 3 inseminations, on their third or fourth heat depending on their weight and age.

Results

The age and weight at breeding for each group was similar (avg. 228d and 134kg). Slightly more than half of the PG600® -treated gilts showed pubertal heat within 9 days of beginning boar exposure whereas only 14% of Group 2 gilts responded as quickly to initial boar exposure. Farrowing rates were similar (92% and 94%, for Group 1 and 2, respectively). Litter size at parity 1 was greater for Group 1 (13±2.8) than for Group 2 (12.3±3) (P<.01). Subsequent weaning to breeding interval, farrowing rate, culling rate and litter size were similar between groups.

Discussion

In all likelihood most of the gilts given PG600® began to cycle whether or not the first heat was observed. A likely explanation for the larger litter size for the hormone treated group is that these gilts had been cycling longer than the control group. There was no evidence that using exogenous hormones to induce an early puberty led to the selection of subfertile animals and in this trial the increased litter size associated with early induction of puberty is advantageous.

Study 2- Is the use of parity-1 sows to nurse a second litter detrimental to their subsequent performance?

Introduction

Litter size is dramatically increasing. This is creating a problem of increasing pre-weaning mortality unless solutions can be found to feed all these extra piglets. A common and practical solution is to retain a sow that has just weaned her litter in the farrowing area, and assign her a second litter of surplus newborn piglets. Often the youngest sows are chosen as "nurse" sows because they more readily accept a foster litter. However, it is also noted that parity-1 sows are the sows most prone to metabolic problems because of weight loss and insufficient nutrient intake during lactation.

The objective of this study was to determine if the longer lactation length associated with nursing a second litter would result in a subsequent decrease in reproductive performance and a higher likelihood of culling.

Material and Methods

Parity-1 sows were randomly assigned to 1 of 2 treatment groups. Group 1 sows were held back in the farrowing area after weaning their original litter and a second litter of newborn piglets was placed with them. Group 2 sows were moved to the breeding area after weaning their original litter. After Group 1 sows weaned their foster litter they were moved to the breeding area. Weaning-to-breeding interval, culling rate, farrowing rate and subsequent litter size were recorded for both groups.

Results

Lactation length for sows nursing just one litter was 21.5±3.5 days (n=273sows), and for sows given a second litter, lactation length was 36.3±4.9days (n=199 sows). Only 66% of sows weaned after nursing one litter (Group 2) were observed in heat within 8 days of weaning compared to 75% of sows in Group 1. Subsequent litter size was affected by lactation length. Sows used as nurse sows had larger (P<0.001) parity-2 litter size of 13.8±3.6 total, with 13.2±3.6 piglets born alive compared to 12.1±3.5 total born and 11.6±3.5 born alive for non-nurse sows. Culling rate was similar between groups.

Discussion

Sows held back and assigned a second litter to nurse appeared to perform better subsequently than sows weaned at about 21 days lactation. It may be that in this herd the nutritional intake of parity-1 sows is insufficient at least in the first three weeks after farrowing to meet the needs of these lactating and growing animals. This appears to be resolved with a longer lactation period likely because milk yields are decreasing after 3 weeks while feed intakes are maintained, positively impacting sow metabolic status. Using these young animals as nurse sows does not appear to be detrimental to their subsequent performance.

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Factors Affecting Milk Production and Mammary Development

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Why is it important?

Sow milk yield is the main determinant of piglet growth rate as it is the only source of energy for suckling piglets. It is known that sows do not produce enough milk to sustain optimal growth of their litter and this problem was made worse with the current use of hyperprolific sow lines. Milk yield is influenced by numerous factors such as litter size, parity, nutrition, genetics, management, environment and endocrine status. Yet, one factor of importance which is often overlooked is mammary development. Indeed, sow milk yield is dependent on the number of milk-producing cells that are present in mammary glands at the onset of lactation. It was shown that there is a positive correlation between the number of mammary cells and piglet growth rate. Periods with relatively high mammary growth are of particular interest since it is during those periods that mammary growth may be susceptible to nutritional or hormonal manipulations.

Mammary development in swine: hormonal control

Mammary development in swine occurs at three developmental stages, namely, in prepubertal gilts as of 3 months of age, during the last third of pregnancy, and during lactation. It is controlled by a complex interaction of various hormones. During gestation, estrogens and prolactin are essential for mammary development and relaxin is also needed to stimulate total mammary gland growth. Very few studies have looked at the effect of providing hormones on mammary development. Gilts receiving injections of porcine prolactin for a period of 28 days, as of 75 kg BW, showed an increased mammary development (based on visual appraisal) and also had lacteal secretions already present. Interestingly, the degree of mammary gland development did not appear to be related to the dose of prolactin injected. A further study where gilts were slaughtered and mammary development actually measured, confirmed that injections of porcine prolactin to gilts for a period of 29 days, starting at 75 kg BW, stimulate mammary development at puberty. Yet, the impact of such a treatment on subsequent milk yield is not known.

Can prepubertal nutrition affect mammary development?

Nutrition does have an influence on mammary development in growing gilts, yet, data on the subject is sparse. Results showed that either a 20% or a 26% feed restriction from 90 days of age until puberty drastically reduces mammary tissue mass. On the other hand, earlier feed restriction, from 28 to 90 days of age, has no effect on mammary development at puberty. Furthermore, lowering protein intake (14.4 vs. 18.7% CP) during the period from 90 days of age until puberty does not hinder mammary development of gilts. Recent findings indicate that the composition of the diet fed to prepubertal gilts has an influence on their mammary development. Gilts fed 2.3 g/day of the phytoestrogen genistein from 3 months of age until puberty had an increased number of mammary cells at 183 days. On the other hand, dietary supplementation with flax as seed, meal, or oil during prepuberty brought about the expected changes in circulating fatty acids without any alteration in mammary development. Yet, when a 10% flaxseed supplementation was provided from day 63 of gestation until weaning, beneficial effects were noted in the mammary tissue of the female offspring of these sows at puberty. This was the first demonstration of such an in utero effect and it opens new avenues in terms of potential management schemes to stimulate mammary development of gilts.

Nutrition in late gestation and lactation: effects on mammary development

During gestation, feeding very high energy levels (44 vs. 24 MJ ME/day) may have detrimental effects on mammary development and subsequent milk production whereas increasing the amount of dietary protein (16 vs. 4 g lysine/day) has no effect on mammary development but may increase subsequent milk production. When manipulating body composition of gilts by changing their protein and energy intakes during pregnancy, it was found that overly fat gilts (36 mm backfat at the end of gestation) on a high energy-low protein diet had reduced mammary development and produced less milk than leaner gilts (25 mm backfat) at the same body weight. However, the backfat thicknesses of gilts in that study were much greater than what is normally seen and further investigation should be done to determine the ideal body condition required to ensure maximal mammary development in late gestation. Feeding in lactation also affects mammary development; an increase in weight of functional mammary glands is seen when sows are fed either more protein or more energy. It is therefore imperative to maximise sow feed intake during lactation.

Involution of mammary glands

Mammary involution at weaning is an essential process of the mammary gland and much remains to be learned about it in swine. It is associated with dramatic changes occurring rapidly in the 7 to 10 days following weaning, with a loss of more than two thirds of the weight of mammary glands being seen. Mammary gland involution also takes place in early lactation when a gland is not being suckled. It occurs rapidly during the first 7 to 10 days after farrowing and was shown to be an irreversible process after 3 days of non-suckling. On the other hand, involution is reversible after 24 h of non-suckling, but the “rescued” gland will never produce as much milk as if it had been used right from the onset of lactation.

Conclusion

A combination of factors are involved in the control of sow milk yield and with the current use of hyperprolific sow lines it has become imperative to provide the best-adapted management and feeding strategies to improve upon it. Special attention needs to be focussed on the nutrition of replacement gilts and of late-pregnant sows in order to ensure maximal mammary development and future milk yield potential. The use of bioactive feed ingredients, such as phytoestrogens, may prove to be useful tools in achieving this goal.

Effects of Vitamin D Supplementation at Weaning on an Ontario Swine Farm

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Introduction

Piglets may be born with low serum concentrations of the vitamin D which may result in a predisposition to vitamin D deficiency (Horst and Littledike, 1982). Indoor rearing of sows and their piglets, coupled with the fact that sow milk contains very low levels of vitamin D, makes it necessary to supply vitamin D via the diet (Littledike and Goff, 1987). Creep feed is a common way to supplement vitamin D to the nursing piglet. However, the timing and amount of feed ingested is highly variable among individual piglets resulting in variable vitamin D levels in weaned pigs (Witschi et al., 2011).

It has been anecdotally suggested that low levels of serum (blood) vitamin D may predispose piglets to suboptimal post-weaning performance such as a decreased average daily gain (ADG) and increased risk of morbidity (sickness). This has resulted in the adoption of routine supplementation of piglets with oral vitamin D at weaning. However, there is limited scientific evidence to support the practice of supplementing piglets with vitamin D to improve overall health and growth in the post-weaning period.

The purpose of this study was to explore the relationship between serum vitamin D concentrations, average daily gain (ADG), and morbidity in weaned piglets during the first 28 days post-weaning on an Ontario commercial swine farm.

Methodology

One hundred and eighteen piglets, from one week's weaning on a farm experiencing high levels of post weaning morbidity, were individually identified and randomly assigned at weaning (ranging from 21-24 days of age) to 1 of 2 groups (Day 1 of trial).

<u>Group #1</u> (60 piglets) was the control group and they were administered 1 ml strawberry syrup orally.

<u>Group #2</u> (58 piglets) was the treatment group and they were administered 1 ml (1.042 g/ml) of commercial vitamin D syrup orally.

Piglets were weighed, and blood samples were taken for vitamin D concentration analysis, on Day 1 and 28 of the trial. The piglets were observed daily for the 28 days after weaning and all piglet morbidity and treatments were recorded. The ADG of each piglet was calculated on day 28 of the trial. Investigators were blinded to the treatment groups.

Results

Group #2 had a higher average vitamin D serum level when compared to Group #1 at Day 28 (P<0.05). However, there was no significant difference (multilevel linear regression) in ADG in the first 28 days after weaning between the two groups. There was also no significant difference in piglet morbidity (multilevel logistic regression) between the two groups. All analyses used statistical techniques to account for repeated measures, sex, parity, and weaning weight.

Take home message

Supplementation of piglets with oral vitamin D at weaning resulted in higher average serum vitamin D concentrations when compared to non-supplemented piglets. However, the piglets with a higher serum level of vitamin D did not demonstrate any biological or performance advantage over the non-supplemented piglets in this study.

The results of this small study contribute to our present knowledge of the benefits of vitamin D supplementation in piglets. The results, however, do not support the management recommendation of routine supplementation of piglets with oral vitamin D at weaning in order to improve overall health or ADG in the first 28 days post weaning.

Continued research involving randomized and controlled clinical trials, utilizing large numbers of piglets, is needed in order to demonstrate consistency of these findings. Continued work in this area will further clarify any health and performance benefits associated with vitamin D supplementation at weaning.

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Canadian Global Food Animal Residue Avoidance Databank

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The Canadian Global Food Animal Residue Avoidance Databank (CgFARAD) is an important part of the Canadian agri-food industry, providing residue avoidance information to over 20 different commodity groups. The CgFARAD is operated and maintained by the Western College of Veterinary Medicine (University of Saskatchewan) and the Ontario Veterinary College (University of Guelph) by co-directors Dr. Trisha Dowling (DVM, MS, DACVIM, DACVCP) and Dr. Ron Johnson (DVM, PhD, DACVCP), respectively. Canadian veterinarians continue to utilize the expertise of the CgFARAD veterinary clinical pharmacologists in providing their clients with appropriate withdrawal times when extralabel drug use is required in food producing animals. Each time a veterinarian utilizes a drug extralabel in livestock animals, they should generate a CgFARAD request. In addition, the CgFARAD personnel work with veterinarians and their clients to protect the food supply when errors in drug administration or ingestion of harmful chemical intoxicants occur. In 2010, the CgFARAD responded to 1652 requests, an increase from 2009, when 1523 were received and almost double the number of requests received in 2003, the first full year of operation (854). The majority of requests came from the turkey, broiler chicken, and dairy commodity groups. Requests from swine veterinarians have typically been around 50 per year.

The distribution of swine requests by province does not closely match the distribution of producers based on numbers of farms located in provinces. Quebec (~2/3 of swine requests from ~1/3 of swine producers in Canada in 2010) then Ontario account for the vast majority of swine requests across Canada. Swine requests to CgFARAD comprise single drugs or combination drugs. Antimicrobials make up the majority of swine requests with penicillins continuing to lead followed by the tetracyclines; antiinflammatories and reproductive drugs, among others, are also queried.

For commodity groups including pork, export to Europe is an important component of their business. On a regular basis, the European Union audits countries that it imports from. These audits examine the strength of programs contributing to animal health and food safety. In 2010 an audit of the fresh meat sector measures for control was performed, including those aspects relating to the control of pharmaceutical use and prevention of the occurrence of residues. The CgFARAD is a recognized contributor to the food safety system through its provision of appropriate withdrawal times to veterinarians when extralabel drug use is required. The audit report identified no deficiencies in residue controls in pork.

The CgFARAD continues to provide support to livestock commodity groups primarily through response to extralabel drug use, but also through education of veterinarians on aspects of rational extralabel drug use in food producing animals, and the conduct of relevant clinical pharmacology research pertaining to drug use in livestock. The consistent increase in request numbers over the past several years has challenged the current model of service delivery and this is being factored into our revised CgFARAD service in order that we may provide the most timely and effective service possible to veterinarians and producers in Canada.

New Tools for Precision Feeding

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Introduction

Feed costs are by far the largest cost in commercial pork production (about 70%), and growing-finishing pigs account for about 80% of feed consumed. The extremely high feed costs in 2012 support the need for developing cost-effective feeding strategies for growing-finishing pigs. As such, the pig's growth potential and maximizing utilization of locally-available feedstuffs must be considered to match supply of dietary nutrient, especially expensive energy, with the pig's requirements to reduce feed cost per kg of carcass weight. In this short article pig performance potentials and approaches to formulating pig diets for energy content are addressed.

Maximizing performance potentials: genetics, health, gender

The ultimate determinant of on-farm pork production efficiency is the pig's genetically determined performance potential. Over the last few decades large improvements in pig genetics have been made. At the test station of CDPQ in Quebec terminal sires lines from a variety of breeders have been evaluated. A summary of these performance data (Table 1) suggest some differences between the various lines of pigs. These data also illustrate the high levels of performance that can be achieved under well managed environmental conditions.

Differences in pig performance levels across commercial units are largely attributed to pig management. Subclinical disease is probably still the single biggest factor that prevents pigs from expressing performance potentials and can depress pig growth performance by 20% or more. As a result, pigs of similar genetic background will express variable levels of performance, and performance levels (growth rates, carcass quality and feed intake) should be monitored on individual pig units for optimizing feeding programs.

Table 1. High and low mean values for performance traits for market pigs (30 to approximately 115 kg body weight) for 17 different sire lines and tested under identical conditions in the Centre de development du porc du Quebec (CDPQ) test station (values represent means of about 160 pigs per sire line; Fortin, 2013).

Trait	Most favourable	Least favourable	Difference
Age at 115 kg body weight, days	148.8	154.1	+5.3
Average body weight gain, g/d	1053	987	-66
Average feed intake, kg/d	2.42	2.64	+0.22
Feed : Gain	2.40	2.53	+0.13
Carcass dressing yield, %	81.3	79.9	-1.4
Lean yield, %	61.8	59.5	-2.3

During the grower-finisher phase feed efficiency in entire males is typically about 10% better and carcass lean yield about 2% higher than that in conventional physically castrated (PC) barrows (NRC, 2012). With the approval from the Canadian government and the availability of Improvest^{TM} there is the opportunity to capitalize on the use of entire males for pork production, overcoming the concern of boar tainted pork. The use of Improvest involves two injections to immunize pigs against Gonadotropin Releasing Factor (GnRF), which impacts metabolism of male steroids and thereby controlling boar taint. Growth performance of immunologically castrated (IC) barrows is identical to entire males up the 2nd dose of Improvest, which is given typically 4 to 6 weeks prior to slaughter. After the 2nd dose the IC barrow gradually changes to a castrated male, resulting in increases in both feed intake and body fat deposition, with only minor reductions in lean tissue growth.

Based on 6 growth performance studies conducted in the US towards registration of Improvest, IC reduces feed:gain by about 7% and improves growth rate by about 3% when compared to conventional PC barrows over the entire growing-finishing period (Table 2). Carcass yield will always be lower in the IC barrow than the conventional PC barrow because of extra weight at the slaughter house (testicles, gut fill, etc.). In order to achieve carcass weights that are similar to conventional PC barrows, IC barrows should be about 1.2% heavier at marketing. The implementation of IC will require adjustments in the packing plants (to remove testicles), a strict management protocol (to ensure all males are immunized properly), and adjustments in feeding programs.

Table 2. Performance of conventional physically castrated (PC) barrows and immunologically castrated (IC) barrows observed in 6 commercial US trials (Pfizer 2012).

Trait	PC Barrows	IC Barrows	Difference
Initial body weight, kg	21.15	21.15	
Final body weight, kg	125.0	127.7	+2.7
Average body weight gain, g/d	926	950	+24
Average feed intake, kg/d	2.41	2.33	-0.08
Feed : Gain	2.60	2.46	-0.14
Probe backfat, mm	19.5	17.9	-1.6

The rather dramatic increase in feed intake and body fat deposition after pigs are given the second dose of Improvest should be considered carefully for the development of effective feeding programs and optimizing carcass fatness (NRC, 2012).

Formulating diets for energy content: alternative feed ingredients, cost per unit of energy

The rapid increase in feed costs can be attributed largely to the high demand for energy. Based on least cost feed formulation, 85% of feed ingredient costs can be attributed to meeting the pigs' requirements for energy. This has four important implications. We need to: 1) accurately assess the available energy that is supplied from alternative feed ingredients, 2) understand how pigs respond to changes in dietary energy density, 3) manage pigs to maximize the efficiency of energy utilization, and 4) consider cost per unit of energy in the diet and energy costs per kg of carcass gain.

In July 2012 the 11th edition of the NRC publication “Nutrient Requirements of Swine” from the Academy of Sciences in the US was released, which is a revision of the 10th edition published in 1998. The 11th edition includes an extensive database about the nutritional value of feed ingredients and now allows us to evaluate North American feed ingredients based on net energy (NE) content, which better reflects the amount of energy available to pigs than DE or ME.

Based on US MidWest prices and NE content only - ignoring the value of other nutrients from feed ingredients - the cost of corn per unit of NE has increased more than 4 fold since 2007 (Table 3).

Moreover, per unit of NE DDGS has become more expensive than corn in 2012, while it was less expensive in 2007. The data in Table 3 illustrates the importance of regularly assessing feed energy costs and diet formulation. Failure to do this can have very substantial impacts on feed costs and profits. Dietary levels of other nutrients (amino acids, phosphorus, other minerals and vitamins) should be close to requirements and balanced against energy, to ensure that utilization of feed energy is optimized. NRC (2012) can be used as tool to estimate nutrient requirements for different groups of pigs under varying environmental conditions and at different levels of performance.

Table 3. Cost of selected swine feed ingredients (US MidWest prices; Patience, 2013).

Ingredient	**Energy Content**	**2005 Cost**		**2012 Cost**	
	Mcal NE/kg	$/tonne	¢/Mcal NE	$/tonne	¢/Mcal NE
Corn	**2.67**	**72**	**2.7**	**328**	**12.3**
Soybean meal	2.09	220	10.5	668	32.1
Corn DDGS	2.34	55	2.4	340	14.5
Wheat midds	2.12	66	3.1	316	14.9
Fat: AV blend	7.23	331	4.6	1,032	14.3

With the availability of alternative feed ingredients that differ substantially in energy content from corn, an important consideration is the impact of diet energy density on daily energy intake. In other words, how does the inclusion of extra fat, wheat shorts or distillers dried grains with solubles (DDGS) in the grower-finisher diet influence daily energy intake (and thus growth rate), feed efficiency, and carcass value? The growth response to varying diet energy density is rather variable across studies. For example, results of two studies from Kansas State University, using corn and soybean meal based diets, show very different results (Table 4). In the De la Llata et al. (2001) study a 11% increase in diet NE content results only in a 3% increase in daily NE content, while in the Barnes (2011) study a 9% increase resulted in a 8% increase in daily energy intake.

Table 4. Effect of diet energy density on daily energy intake and pig growth performance.

Trait	**Barnes et al. (2011)**[1]		**De la Llata et al. (2001)**[2]	
	LOW NE	HIGH NE	LOW NE	HIGH NE
Diet NE content, Mcal/kg	2.40	2.62 (+9%)	2.46	2.71 (+11%)
Feed intake, kg/d	2.92	2.88 (-1%)	1.97	1.83 (-7%)
NE intake, Mcal/d	7.01	7.56 (+8%)	4.84	4.97 (+3%)
Body weight gain, kg/d	0.963	1.014 (+5%)	0.754	0.782 (+4%)
Feed:gain	3.03	2.84 (-7%)	2.61	2.34 (-10%)
US Carcass dressing %, %	72.1	73.4 (+2%)	76.0	76.5 (+1%)
US probe backfat, mm	19.6	21.9 (+11%)	19.0	20.6 (+8%)
NE intake:body weight gain, Mcal/kg	7.28	7.45 (+2%)	6.42	6.35 (-1%)
NE intake:carcass weight gain, Mcal/kg	10.10	10.15 (+1%)	8.44	8.30 (-1%)

[1]the LOW NE diet contained 30% DDGS and 12.5% wheat shorts; the HIGH was based on Corn and SBM with about 2.5% added fat; 48 to 123 kg body weight.
[2]the LOW NE diet was based on Corn and SBM; the HIGH NE diet contained 6% added fat; 25 to 115 kg body weight.

These two studies, as well as others, show:

1. Increases in diet NE content result in proportional changes in feed efficiency, especially when feed efficiency is corrected for dressing percentage (i.e., by expressing it on a carcass weight basis).
2. Diet NE content is a good predictor of feed efficiency. Therefore calculating dietary energy costs ($/Mcal NE), and when all other nutrients are balanced against energy, is a very useful tool to optimize diets and feed costs.
3. Changes in diet NE content have varying effects on daily energy intake, and thus on daily gain and back fat thickness (carcass lean content). Factors such as pig density and health status will influences whether changes in diet energy density will result in changes in feed and daily energy intake.

Conclusions and take home messages

1. The current extremely high feed costs increase the need for developing cost-effective feeding strategies for growing-finishing pigs.
2. Improvements in growth performance can be achieved by improving health status and genetic potentials, as well as minimizing the pig's maintenance energy requirements.
3. Pay close attention to the cost of dietary energy, which is best expressed as $/Mcal net energy (NE).
4. In properly formulated diets, changes in diet NE content are proportional to changes in feed efficiency.
5. Failure to assess feed energy costs on a regular basis can have very substantial impacts on feed costs and profits.

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Does Teat Use In First Lactation Affect Its Milk Yield In Second Lactation?

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With today's hyperprolific sow lines, swine producers are currently faced with a problem in their farrowing rooms; namely, should they "load" the primiparous (first litter) sows with as many piglets as possible or should they leave some teats unused to give these sows a "respite". This is particularly important in first parity sows with poor body condition, in order to avoid the "lean sow syndrome" which potentially leads to reproductive problems.

New findings demonstrate for the first time that teats which are used in first lactation will produce more milk in the second lactation. Indeed, piglets suckling teats which were previously used weighed significantly more on day 56 than piglets suckling a previously unused teat. Furthermore, development of a teat which was previously used is improved in the second lactation and piglets suckling teats which were not used previously show a greater level of hunger in second lactation.

These results emanate from a project which was recently carried out at the Dairy and Swine Research and Development Centre in Sherbrooke, QC. Forty-seven first-parity sows were divided into 2 groups: 1) sows with the same teats being suckled in 2 subsequent lactations (SAME, n = 22); and 2) sows with different teats being suckled in 2 subsequent lactations (DIFFER, n = 25). In the first lactation, over half of the teats (teats 1, 2, 5, 6, and 7 from 1 side of the udder, and teats 3, 4, and 7 from the other side) were sealed with tape so that they were non-functional. During the following lactation, the SAME group had the same teats sealed as in the first lactation, so that in second lactation piglets were only suckling previously-used teats. In the DIFFER group, the opposite teats were sealed in first and second lactation, so that piglets in second lactation were only suckling teats which were not used previously. In both parities, litters were standardized to 7 piglets around birth and to 6 piglets at 48 hours postpartum so that there was 1 piglet per available functional teat. During the second lactation, piglets were weighed at birth and on days 2, 4, 7, 14, 21, 35, and 56 postpartum. Weaning was at 17 ± 1 days of age. Behavioural measures were obtained (using 24-hour video recording) on days 3 and 10 of lactation on 15 sows per treatment to evaluate hunger of piglets, using aggressiveness and nursing behaviour as indicators. At weaning after the second lactation, 16 sows per treatment were slaughtered and 4 functional mammary glands were collected for dissection and determination of composition.

In the second lactation, birth weights of piglets from SAME and DIFFER sows were similar, yet piglets from sows with the same teats used in both lactations weighed 1.12 kg more (22.72 vs. 21.60 kg) on day 56 than piglets from sows with different teats used in both lactations. A difference in piglet weight gain was observed as early as from days 2 to 4 of lactation (0.43 vs. 0.35 kg), which suggests that colostrum yield, and not only milk yield, might also differ between the two groups. Functional mammary glands from SAME sows contained more parenchymal tissue, which is the tissue where milk is secreted. This parenchymal tissue had more cells with a greater metabolic activity than similar tissue from DIFFER sows. Milk composition was not affected by treatment and blood samples obtained from sows in early and late lactation indicated that hormonal and metabolic status of the sows were similar in both groups. On the other hand, sows with the same teats used in both lactations consumed more feed during lactation in parity 2 than sows with different teats being used, which is in agreement with their greater milk yield. Behavioural measures also indicated a greater hunger level on day 3 for piglets using teats that were not previously suckled which corroborates the lower weight gain in these litters. More specifically, piglets from litters with different teats used in both lactations massaged the teat longer after milk ejection and had a greater incidence of fights so that they missed more nursings.

Such results led to the question: can piglets differentiate between a "good" teat that was suckled in the previous lactation and a teat which was not used previously. A project using 8 sows was carried out to answer that question. Teats were sealed in first lactation as described above, but in second lactation none of the teats were sealed and 8 piglets were left with the sow, so that 8 piglets were present with only 6 previously-used teats. Amazingly, piglets could tell the difference between previously-used and -unused teats. There was a greater incidence of fights which lasted longer at teats which were previously used. There was also a greater incidence of these teats being suckled by the piglets.

In conclusion, current findings clearly show that teats which were suckled in first lactation produce more milk and have a greater development in the second lactation than teats which were not suckled in first lactation. Furthermore, piglets seem to be able to differentiate between previously-used and -unused teats. Such knowledge is critical for producers to make the best decision in terms of management strategies for their first-parity sows.

Clostridium difficile in Pork Production and Processing

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Background
Clostridium difficile is one of the leading causes of hospital-associated infections accounting for 300,000 cases and over 20,000 deaths in North America each year. Those being administered antibiotic therapy to treat a primary infection are most susceptible to *C. difficile* infections (CDI) due to the disruption of the gastrointestinal tract microflora coupled to the multidrug resistance of the pathogen. Although commonly linked to hospital acquired infections there has been an increasing trend of community associated *C difficile* infection (CA-CDI). The case definition of CA-CDI is the acquisition of *C difficile* by persons with no recent history of being administered antibiotics or contact with health care environments. The source of exposure in CA-CDI remains unclear but pork has highlighted given that *C difficile* has been recovered from pigs and meat at retail.

MRSA (methicillin-resistant *Staphylococcus aureus*) is a further pathogen linked to hospital-acquired infections with those being administered antibiotics being most susceptible. Similar to *C. difficile*, there has been a recent increase in community-acquired infections that has been tentatively linked to carriage in pigs and presence on retail pork.

Given the link of *C difficile* and MRSA to pork our research has focused on assessing the carriage of both pathogens during the production phase, in addition to dissemination during processing.

Longitudinal study of *Clostridium difficile* and methicillin-resistant *Staphylococcus aureus* associated with pigs from weaning through to the end of processing
The carriage of MRSA and *C. difficile* on pigs raised within a commercial farm was monitored from birth through to the end of processing. *C. difficile* was isolated from 28/30 (93%) of pigs at 1 day of age, but prevalence declined sharply to 1/27 (3.8%) by market age (188 d). MRSA prevalence peaked at 74 days of age with 19/28 (68%) positive pigs, but declined to (3/27) 11% at 150 days of age with none being detected at market age. At the processing facility, *C. difficile* was isolated from the holding area with a single carcass testing positive for the pathogen at pre-evisceration. MRSA was primarily isolated from nasal swabs with 8 (31%) carcasses testing positive at post-bleed that increased to 14 positive (54%) at post-scald tanks. Only one carcass (sampled at post-bleed) tested positive for MRSA with no recovery of the pathogen from environmental samples taken. *C. difficile* ribotype 078 (commonly implicated in CA-CDI) predominated the longitudinal portion of the study accounting for all the 68 isolates recovered for pigs. Only three *C. difficile* isolates were recovered at slaughterhouse that were identified as ribotype 078. MRSA *spa* type 539 (t034) predominated in pigs on the farm and samples taken at the slaughterhouse accounting for 80% of all isolates recovered.

Carriage and Dissemination of *Clostridium difficile* and Methicillin Resistant *Staphylococcus aureus* in a High Capacity Pork Processing Line
The incidence and dissemination routes of *C difficile* and MRSA within a high capacity pork processing facility (6000 pigs per day) was studied. Sampling of carcasses and processing environment was performed over two visits to the facility. *C. difficile* was isolated 80% (16/20) of manure samples taken within the holding area, with 45% (9/20) of holding area floor and wall

samples testing positive for the pathogen. Three of the twenty carcasses (15%) sampled at post-bleed and a further 3 at post-evisceration also tested positive for *C difficile*. No *C. difficile* were recovered from scald water samples, polisher/scraper units or on carcasses in the cold room at the end of the line. Ribotype 078 was the predominant *C difficile* recovered with the remaining belonging to other ribotypes. MRSA was recovered from a single carcass at post-bleed and within the cold room, in addition to one sample taken from the holding area (overall prevalence of 2.7%). The MRSA isolates recovered from carcasses was spa t034 which is a commonly associated with pigs.

Conclusions

The overall conclusions from our studies to date is that both MRSA and *C difficile* are highly prevalent during the early-mid production phase although only low carriage was observed at market weight. Similar to enteric pathogens such as Salmonella, the holding area of slaughter lines represents a reservoir for *C difficile*. Yet, neither *C difficile* or MRSA appears to be disseminated amongst carcasses during processing indicating that pork represents an insignificant source of the pathogens.

Current studies are focused on assessing the prevalence of *C difficile* within the environment and performing trace back to different sources.

Publications

Philip Hawken, J. Scott Weese, Robert Friendship and Keith Warriner (2013). Carriage and Dissemination of *Clostridium difficile* and Methicillin Resistant *Staphylococcus aureus* in Pork Processing. Food Control (*In Press*).

Philip Hawken, J. Scott Weese, Robert Friendship and Keith Warriner (2013). Longitudinal study of *Clostridium difficile* and methicillin-resistant *Staphylococcus aureus* associated with pigs from weaning through to the end of processing. Journal of Food Protection (*In Press*).

Code of Practice for the Care and Handling of Pigs -: What Are the Problems?

Curtiss Littlejohn, Code Development Committee Member

Overview of Code Process

- Code Development Committee (CDC)
- Scientists' Committee (SC)

- Structure of the Code
- Code Process:
  - Code Development Committee (CDC) established
    - Drafting of code continues
  - Scientists' Committee (SC) established
    - Priority Welfare Issues (PWI) identified
    - First Draft of SC Report complete and presented to CDC (Nov/11)
    - SC Report peer reviewed
    - SC Report translated to French
    - SC Report released (September/12)
    - What's Next?
    - CDC continues drafting Code utilizing information provided in the SC Report
    - CDC consults with SC as needed
    - CDC consults with constituents as needed
    - Code available for comment for 60 day period (Mid 2013)
    - CDC reviews public comments; amends as required
    - Code Published (Late 2013)

Requirement

- Reflects regulatory requirement

  - OR

- Reflects an industry-imposed expectation which outlines acceptable and unacceptable practices

Recommended Practice

- Support the Code's Requirements
- Promotes producer education
- Encourages continuous improvement in animal welfare outcomes
- Generally enhance welfare outcomes, but failure to implement does not imply that acceptable standards of care are not met

Outcomes

- Need to balance on-farm management practices with animal welfare
- Need to consider international influences and potential impacts to trade
- General understanding that status-quo is no longer acceptable
- Buy-in of major stakeholders (e.g. – industry, retailers/food service and Canadian Federation of Humane Societies (CFHS)) is critical
-

Critical Issues Facing the Industry

- Gestation Sow Housing
- Pig Space Allowance
- Elective Husbandry Procedures
- Enrichment

Ontario Pork Research

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Research is important to the success of Ontario Pork producers. Ontario Pork commits 10¢ from the $1.00 service fee to support research that fosters a healthy business environment for industry development and innovation and will focus on production that is cost effective and viable to the producer. In 2012 Ontario Pork reviewed its research program and established the following research priorities:

- **Production**
  - Nutrition
  - Herd health
  - Reproduction
  - Environment

- **Economic**
  - Competitiveness
  - Economic and Business Sustainability

- **Social Trends and Perceptions**
  - Animal Welfare
  - Consumer Perceptions
  - Industry Trends

- **Innovation**
  - Production and Process Development
  - Health benefits and other attributes of pork

The resulting research will align with Ontario Pork's strategic direction and be driven by industry needs and accountability. It will be focused on maximizing the cost-benefit ratio and minimizing duplication and administration.

As part of its review process, Ontario Pork looked for ways to make research immediate and accessible. It has partnered with the Prairie Swine Centre to offer an online searchable database accessible from the Ontario Pork website (www.ontariopork.on.ca). This new web-based research tool will replace the print magazine, Pigs, Pork and Progress which has been discontinued for 2013. Ontario Pork, together with the Dairy Farmers of Ontario, the Ontario Cattlemens' Association and the Poultry Industry Council has created the Livestock Research Innovation Corporation (LRIC). The goal of LRIC is to deliver an innovative model for directing livestock and poultry research in Ontario, and will also drive the transfer of research to commercial interests – producers and other value chain partners. Ontario Pork has made a three year funding commitment, after which time the organization will be evaluated to insure value is being achieved for Ontario Pork and our producers. Approval has also been given by Ontario Pork's Board to fund research nationally through the Canadian Pork Council's corporation, Swine Innovation Porc (SIP). SIP is committed to facilitating research, technology transfer and commercialization initiatives designed to enhance the profitability and differentiation of the Canadian pork value chain. SIP was formed in 2010 and successfully secured federal funding of 9.3 million dollars. It embarked on a program comprising of 14 research projects focused on reducing the cost of production and product differentiation and three technology transfer initiatives. Details of the projects which conclude March 31, 2013 can be found at http://www.swineinnovationporc.ca/research-program.php.

SIP is currently in the process of applying to the Agri-Innovations program to secure funding from April 1, 2013 until March 31, 2018. For 2013, Ontario Pork has committed 2.5¢ of the 10¢ research fee to SIP.

In 2012 Ontario Pork committed funding to the following research projects:

Researcher Robert Friendship
Title Food Safety and Welfare Knowledge Translation and Transfer
Synopsis Welfare and food safety are two of the top public concerns related to food-producing animals in Canada and around the world. Thousands of research projects have been done on welfare and food safety in swine, yet there are significant gaps in transferring the results to producers. The objective of this project is to translate the research based knowledge of welfare, food safety and control measures into a practical language, and transfer it to pig producers and swine workers by means of electronic newsletter, pictorial bulletins, SMS, virtual groups, blog webinar and seminars.

Researcher Kathy Zurbrigg
Title Identifying the cause of death and factors associated with hogs that perish in transit:
Synopsis As shipping mortalities increase in the summer months, the in-transit deaths are generally attributed to heat exhaustion or stress. However it is rarely questioned why so many hogs are able to tolerate the conditions and why a small percentage cannot. Determining if there are underlying risk factors that predispose a hog to heat exhaustion or a stress-related death is necessary if total mortalities in transit are to be minimized. Identifying the cause of death in in-transit mortalities together with risk factors that cause stress to the hogs such as transport time, ease of loading and unloading and environmental temperatures is necessary to create effective protocols to further reduce shipping mortalities. In particular if a significant percentage of hogs are found to have a significant underlying pathology (e.g. respiratory disease) then the focus for improvement of in-transit losses should be on the respiratory health of the herd as much as the transport process. On the other hand, if the hogs are lesion free (with the exception of heat-stress lesions), then it re-emphasizes the fact that the shipping process is key.

Researcher Robert Friendship
Title Are Vitamin D concentrations in the sera of young pigs related to morbidity, mortality, or subclinical disease?
Synopsis A review of the limited studies on vitamin D in swine suggests that piglets are born in a vitamin D deficient state, similar to their deficiency in iron. The implication is that when sows farrowed outside, their piglets were exposed to soil and sunlight. As a result it was not necessary to provide newborn pigs with either iron or vitamin D. Modern rearing methods prevent these traditional exposures to iron and vitamin D. Currently all pigs are supplemented with iron at birth but not vitamin D. Recent studies in the Midwestern United States associate a mild vitamin D deficiency in suckling and early weaned pigs with increased morbidity, mortality, and microscopic bone

fractures. It is important to measure vitamin D levels in Ontario swine to determine if Ontario swine herds are experiencing similar problems related to vitamin D deficiency as reported in the United States. Increasing the vitamin D concentrations in the sera of Ontario swine could present a production opportunity for Ontario producers.

Researcher Lee Whittington
Title Air Filtration - A Technology Transfer Project to Speed Adaption in Canada
Synopsis The project will coordinate the delivery of a cohesive message on the ability of Air Filtration to provide a successful disease barrier to barns by linking various research projects with one technology transfer proposal. Using three media (print, electronic, and in-person) the project will create a significant awareness among veterinarians, agricultural engineers and pork producers on the effectiveness of the technology of barn air filtration. The projects include a variety of scenarios and provide advanced training for a group of lead users in all major pork producing provinces that can confidently advise and/or coordinate an installation and maintenance program on a commercial pork farm. The project will focus on the period between project start and March 2013, with the resources created being available indefinitely on the CSHB website for future use.

Researcher Julang Li
Title Recombinant production of antimicrobial peptides as alternative to antibiotics
Synopsis Antibiotic resistance in humans and animals is a growing concern for the public health in Ontario and worldwide. Searching for alternative effective means to overcome antibiotic resistance to treat emerging infectious diseases is a new challenge. Protegrins (PGs) are a family of antimicrobial peptides that are produced by the white blood cells in pigs. They have antimicrobial activity against gram-positive and -negative bacteria, mycobacteria, and enveloped viruses such as HIV (15), and therefore possess promising therapeutic potential for treatment of infections. However, chemically synthesized antimicrobial peptides are too expensive to be feasible for routine use in our pork industry. The objective of the project is to establish a cost-effective strategy to produce antimicrobial peptides using microorganisms as hosts. We plan to express a pig antimicrobial peptide, protegrin-1, in both yeast and Lactoccocus lactis (L. lactis) via recombinant DNA approach. The level of antimicrobial peptides produced and secreted by yeast, and L. lactis will be compared, and the most efficient system will be selected for subsequent investigation. The purified antimicrobial peptides will then be tested for bactericidal activity against both pig and human pathogens. We will also determine whether or not these purified antimicrobial peptides (PGs) can efficiently treat an infection in a bacteria-challenged animal model to assess any potential side effects of this clinical treatment.

Researcher C.F.M. de Lange
Title Impact of starter nutrition on pig robustness and compensatory growth
Synopsis Preliminary results from our lab show that feeding costs during the post-weaning period can be reduced without compromising pig growth performance and feed efficiency up to slaughter weight, while maintaining carcass and meat quality. However, before recommendations can be made to reduce feed costs of starter pigs, the impact of post-weaning nutrition on pig robustness needs to be assessed. Two studies are proposed to explore the impact of nutrition during the post-weaning period on (subsequent) growth performance and the response to an immune challenge. In the first study dietary treatments will be identical to these used in our previous large scale performance study on compensatory growth, and the pigs response to an immune challenge will be evaluated. In the second study newly weaned pigs will be fed diets varying in protein quality (to induce differences in post-weaning growth performance and subsequently compensatory growth),

with or without added fish oil (a dietary means to reduce the response to an immune challenge), and the pigs response to an immune challenge will again be evaluated.

Researcher Chandra Tayade
Title Enhancement of litter size in commercial swine using an immune stimulant
Synopsis The current application proposes evaluation of safety and toxicity of a livestock grade, low cost immune adjuvant formulation, MpRNC (Bioniche Life Sciences, Inc) that will be evaluated as a potential therapeutic for promotion of litter size in commercial swine. Aim1 of this proposal will explore whether MpRNC stimulates an immune response in treated sows and in piglets born to treated animals. Maternal and fetal tissue samples will also be screened for MpRNC traces. Independent toxicity screening of porcine maternal and fetal tissues will be conducted in collaboration with Bioniche Life Sciences, Inc. These studies will satisfy Canadian Food Inspection Agency that MpRNC is safe to use during pregnancy and it will advance the commercialization of this product for pork producers. Based on our previous observation that MpRNC stimulates uniform conceptus growth in utero and better postnatal life, Aim 2 will explore whether gilts born to MpRNC treated dams have better reproductive performance compared with control gilts. Aim3 of this proposal specifically addresses whether MpRNC and semen could be administered simultaneously rather than inseminating after 15 minutes of drug administration.

Benchmarking Ontario Farrow to Finish Farms – Productivity vs. Profitability

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Background

The Ontario Data Analysis Project (ODAP) has been conducted by University of Guelph, Ridgetown Campus since 1991. It is a benchmarking study based on financial and production data from land-based farrow to finish farms in Ontario. Participants that provide information receive a personalized farm analysis that compares their farm data to the group average. The farms that are involved have about 100 to 500 sows and it is believed that the results generated are fairly representative of a farm this size. The group of participants varies from year to year.

Results

The results are calculated on a "pigs produced"/sow basis. This reflects the number of market hog equivalents produced on the farm and it takes into account all production and inventory changes. Table 1 shows the group averages of some key productivity variables over the 12 year period from 2000 to 2011. The five year averages for the periods 2000-2004 and 2005-2009 are compared to the results from 2010 and 2011. The average number of sows during these periods ranged from 207 to 275 while the total acres worked varied from 256 to 444 depending on the year. The data indicates that productivity has increased over time with both born alive/litter and pigs weaned/litter increasing by about 0.9 pigs.

Pre-weaning mortality has been fairly consistent over time with the exception of 2010. Weaner and grow-finish mortality were higher during the 2005-2009 time period which was most likely due to disease challenges but improved in 2010 and 2011. Pigs produced/sow/year improved by 12% from the 2000-2004 period to 2011. Pork produced/sow/year increased 19% during the same period due to increased dress weights as well as more pigs produced/sow.

Table 1. Productivity over Time.

Group Average/yr	2000-2004	2005-2009	2010	2011
Number of sows	243	220	227	231
Total acres worked	316	426	430	414
Litters/sow/yr	2.30	2.28	2.24	2.18
Born alive/litter	10.7	11.0	11.5	11.6
Weaned/litter	9.3	9.6	9.9	10.2
Weaning age	21.7	23.2	23.2	23.9
Pre-wean mortality %	12.3	12.3	14.2	11.8
Weaner mortality %	2.4	3.6	2.6	2.4
Grow-finish mortality %	2.0	3.4	2.8	3.1
Pigs produced/sow/yr	17.7	18.3	19.7	19.9
Pork produced/sow/yr	1,589	1,690	1,841	1,892
Days to market	166.1	164.3	165.2	166.4

Table 2 shows some selected expenses/pig produced and financial ratios from 2000 to 2011. In 2011, feed expenses were approximately $40/pig produced higher than during the 2000-2004 period and were up $23 vs. 2010. Health expenses/pig produced has been relatively stable over time. The tough financial period from 2005-2009 that included high feed prices, low hog prices, COOL legislations and the strengthening Canadian dollar resulted in many producers having to assume more debt to finance their operations. This is reflected in an increase in interest expenses/pig produced and total debt/sow in the 2005-2009 period relative to 2000-2004. In 2011, total debt/sow was higher than the 2005-2009 period but increased land asset values have risen faster than debt levels allowing for the equity/sow ratio to increase also. The debt to asset ratio was a bit lower in 2011 relative to 2010 and 2005-2009 but was slightly higher than the period from 2000-2004.

Table 2. Expenses and Financial Ratios.

$/pig produced	2000-2004	2005-2009	2010	2011
Feed	$85.55	$93.24	$99.33	$121.05
Health	$4.98	$5.09	$4.95	$5.84
Interest	$7.09	$9.14	$6.94	$7.15
Total Expenses	$134.47	$145.14	$152.38	$175.30
Total debt/sow	$3,425	$4,224	$5,352	$4,757
Equity/sow	$7,355	$9,057	$10,137	$13,469
Debt/assets	0.33	0.37	0.41	0.35

The benchmark information above is helpful in getting a general sense of where things are at in the industry. However, from a competitiveness perspective it is also beneficial to compare to the top producers. Table 3 shows results for the average of all farms and the average for the top half of the producers for the five year time period from 2007 to 2011. Farms were sorted by net farm income per pig produced and included family labour expense. What is important to note is that productivity is very similar between the average of all farms and the average of the top half of farms. The top half of farms did have lower mortality at all stages of production. However, the biggest difference occurs in cost control. The top half of farms had $13.88 lower total expenses per pig produced with feed costs accounting for $7.28 of this difference.

Table 3 Difference Between Average of All Farms and Top Half of Farms 2007-11.

	Top ½ of Farms	Average of All Farms	Difference, Top - Average
Litters/sow/yr	2.26	2.25	+0.01
Born alive/litter	11.27	11.28	-0.01
Weaned/litter	9.90	9.87	+0.03
Pigs produced/sow/yr	19.30	19.39	-0.09
Pork produced/sow/yr	1,804	1,812	-8
Pre-wean mortality	12.0	12.4	-0.4
Weaner mortality	2.5	3.2	-0.7
Grow-finish mortality	2.5	2.8	-0.3
Expenses/pig produced			
Feed	97.08	104.36	-7.28
Health	4.21	5.15	-0.94
Interest	5.55	7.61	-2.06
Total expenses	140.60	154.48	-13.88
Debt/assets	0.35	0.39	-0.04

Key Points

It is important to have access to benchmark information to understand how competitive your farm is. It can highlight areas of your farm that are performing well and areas where improvements could be undertaken. Being able to compare your farm to a group or industry average is the first step but then trying to be as good as the top producers will further improve the chances of profitability and competitiveness. Productivity has been improving over time but controlling costs is a critical factor in farm profitability.

Acknowledgements

Thanks and appreciation is extended to Ontario Pork for their support and to the farm participants for sharing their time and information.

Benchmarking the Ontario Swine Industry

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Background

In Ontario the swine production industry has consolidated tremendously during the last few years. High feed costs, low market prices for pigs, and disease challenges that affected productivity were some of the factors that contributed to this. Benchmarking the Ontario Swine Industry was undertaken by University of Guelph, Ridgetown Campus during the winter of 2011/12. The goal of this study was to benchmark the industry at the time, to identify trends that are occurring and to compare results to similar studies that were undertaken in 1999 and 2006. This project involved surveying Ontario pig producers. Producers were contacted through mail and telephone to ensure participation from as many producers as possible.

Results

There were 1,928 people who were contacted and 77.1 per cent participated in the survey. Of this group 51.3 per cent indicated that they owned pigs at the time the survey was conducted. There were 44.8 per cent of participants that are over 50 years of age and family corporations were reported by 32.3 per cent of respondents, up from 23.1 per cent in 2006. Sole proprietorships decreased from 55.8 per cent in 1999 to 30.2 per cent in 2012. Farrow to finish is the main production type in Ontario with 59.5 per cent of respondents having this production. Finishing systems were the second highest reported system representing 18.5 per cent of respondents.

Over 2.3 million pigs were reported by participants. This represents 81.3 per cent of Statistics Canada estimates on January 1, 2012. Respondents planned to sell 6.74 million pigs in 2012 consisting of 1.96 million SEW pigs, 840,000 weaner pigs, 3.79 million market hogs and 150,000 other pigs. In 2012, very large farms with more than $1 million in sales represented 29.8 per cent of the farms and 80.3 per cent of the pig inventory. In 2006, this farm size represented 12.7 per cent of respondents and 63.4 per cent of inventory as shown in Table 1.

Table 1. Total Farm Sales and Pig Inventory.

Total Farm Sales	2012			2006		
	% of Resp	Inventory #	% Inventory	% of Resp	Inventory #	% Inventory
< $100,001	12.0%	9,045	0.4%	23.2%	52,354	1.9%
$100,001 - $250,000	18.3%	45,793	2.0%	25.8%	179,071	6.6%
$250,001 - $500,000	21.4%	128,193	5.7%	23.9%	327,403	12.0%
$500,001 - $1 million	18.5%	257,657	11.5%	14.3%	439,810	16.1%
> $1 million	29.8%	1,797,186	80.3%	12.7%	1,731,900	63.4%
Total		**2,237,874**			**2,730,538**	

Note: Pig inventory shown here is based on respondents who reported pig inventory and farm sales.

Nearly one-third of respondents reported having more than $3 million in total farm assets compared to 12.7 per cent of respondents in 2006 that had this amount. Appreciating farm land values are believed to be part of the reason for this. Farm debt levels are basically unchanged from previous studies with half of respondents reporting low debt (<33% debt), 37.6 per cent medium (33%-66% debt) and 12 percent reporting high debt (>66% debt).

Table 2 shows a summary of key variables by production type. With the exception of farrow to early wean systems greater than 40 per cent of producers are over the age of 50. More than one quarter of all production systems reported more than $1 million in sales annually while over half of wean to finish systems reported having this level of sales. A corporate business structure was the most common reported and more than 38 per cent of all production systems had this business organization. Farrow to finish and finishing systems, the two most common production systems in Ontario, reported the lowest percentage of respondents having high debt levels.

Table 2. Production System by Key Variables.

Production System	> 50 yrs old	> $1 mil sales	Fam/Bus Corp	High Debt
Farrow to finish	44.7%	27.8%	42.3%	10.5%
Farrow to early wean	29.7%	34.4%	50.0%	19.7%
Farrow to wean	53.5%	25.6%	38.6%	16.2%
Wean to finish	48.9%	52.3%	55.1%	20.9%
Finish	45.9%	27.1%	38.9%	10.2%

Note: Nursery production not included due to small sample size.

The results show that the "average" pig producer is about 48 years old and they own about 190 acres of land. The average producer operates a 293 sow farrow to finish farm and they plan to keep their farm the same size during the next 2 years. Farm sales are between $500,000 and $1 million annually, farm assets are valued at about $2 million and they have a low to medium level of debt.

Key Points

Ontario's swine production continues to consolidate but 90 per cent of the survey participants are still from family-operated farms. Older producers outnumber young producers however some young producers already operate very large swine farms and they intend to grow their farm businesses in the future. Nearly one-third of all producers own farm businesses that generate greater than $1 million in sales annually. In the last few years many producers have left the industry but those that remain are cautiously optimistic about the future.

Acknowledgements

Thanks and appreciation is extended to Ontario Pork for their support and to the farm participants for sharing their information.

Sensory Devices for Nursery and Grow-Finisher Pigs

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Study Objectives

Enrichment devices or "toys" for pigs such as chains, tires and plastic bottles have been used by Ontario farmers to provide stimulation for pigs and to reduce occasional inappropriate behaviours such as tail biting. Producers report that pigs quickly lose interest in such devices and that new designs able to stimulate lasting interactions with the pigs are needed. The development of innovative enrichment devices also demonstrates to consumers that Ontario swine producers are working to improve animal welfare on their farms . To address these needs for enrichment devices, this project involved the design, production and assessment of two novel pen enrichment devices on Ontario swine farms. The main study objective was to develop safe, inexpensive and durable pig enrichment devices that could be made easily accessible to Ontario farmers. A second goal of this project was to respond to consumer concerns regarding the lack of sensory enrichment for conventionally housed pigs by creating a pig toy device of lasting interest to the pigs.

Figure 1. An example of a lever device with wood toy attachments installed in a finisher barn

Methods

Two types of toys, a rooting device and a lever device, were designed, built and installed on Ontario swine operations. Both devices allowed for the fitting of a variety of toy attachments. For the prototype lever device, a design was created by Keith Robbins (Communications and Consumer Marketing, Ontario Pork) and Frank Kains (Agricultural Engineer, Ontario Pork) and built by a local fabrication company in Crosshill, Ontario. The lever device is similar to a teeter totter mounted on top of a pen wall with the chewing toys hanging down from each end into neighbouring pens (see Figure 1 where a block of wood was the toy being tested). The rooting device toy base is a white plastic half cylinder that is attached to the pen wall. This design comes from Finland and is used as a source of rooting enrichment. Once fixed to the pen wall, different articles can be placed into the cylinder to provide the pigs with various types of sensory enrichment (see Figure 2 with a piece of wood placed in the cylinder). Toy attachments were made from PVC pipe, softwood, hardwood and commercial dog toys.

Installation of toys and data collection

The lever prototype was installed on 10 farms and the rooting prototype was installed on 4 farms. Lever toys were installed in nursery pens and grower/finisher pens with different size toy attachments to reflect the differences in size and strengths between pigs at various stages of production. The rooting toys were installed

Figure 2. Example of rooting devices installed in nursery pens

in nursery pens where pigs were between 3 and 10 weeks of age. Following installation, producers were asked to record device usage twice daily and record their observations on toy durability, and on selected pig behaviours including tail biting, belly sucking and flank nosing if applicable.

Results

There was generally little interest in the rooting toys immediately after installation. Multiple variations of the devices were tried but none maintained the interest of the pigs. The rooting device was installed at the level of the pen floor and was often soiled with urine and feces shortly after installation. Because pigs prefer to play with clean objects, the soiling of the toys could explain the lack of sustained interest in rooting devices after installation.

Figure 3. Example of Kong® large sized dog toys that were attached to the lever toy devices. These toys were very popular and durable.

Similarly, a variety of toys were tried with the lever device including PVC pipe, soft wood, hard wood, rubber tire dog toys, and Kong® large and small size dog toys. The best appeared to be Kong® large size dog toys which resulted in more sustained interactions by the pigs (see Figure 3 for a photo of these toys). They were also the most durable of the commercial toys tested. Producers noted that pigs frequently bit the dog toys to make them squeak. This seemed to provide additional stimulus for pigs using the lever toy.

The records for pig usage of the lever devices supplied by the cooperating farms indicated that the devices were actively used for 2 to 4 weeks after installation by 3 to 10 pigs per pen at each observation period. After week four, there was decreased interest in the toys with 0 to 3 pigs playing with the toy per pen. If an adjustment was made to the toys attached to the lever, there was temporarily renewed interest in the device. Also it was noted that if new pigs were added to the pen there was increased activity around the device.

The addition of enrichment devices in swine pens has been anecdotally associated with reducing harmful behaviour like tail and flank biting. Several herds enrolled on the study reported sporadic tail biting, but neither control pens nor pens with toys experienced tail biting during the trial period. Therefore, we were not able to make conclusions about how the toys changed the pigs' behaviour with respect to vices such as tail biting. Producers reported that the toys did not negatively influence the behaviour of pigs.

There were nevertheless multiple benefits produced by the pig enrichment devices. The toys provided sensory enrichment to pigs for weeks after installation. On all 10 farms enrolled in the lever device study, the lever toys were actively used by the pigs throughout the growing period with some decrease in activity four weeks following placement if no adjustments were made to the devices. Working to enrich the environment of growing pigs demonstrates a real concern for animal well-being by Ontario swine producers beyond commonly cited production-based indicators of welfare.

Conclusions

This project produced a lever-style enrichment device that is safe, functional, inexpensive and more effective in engaging pigs than traditional toys such as hanging chains, tires and plastic bottles. This device is important for providing enrichment to growing pigs, and also serves to demonstrate the Ontario pork industry's commitment to excellence in animal welfare.

This project was funded in part through Growing Forward, a federal-provincial-territorial initiative. The Agricultural Adaptation Council (AAC) assists in the delivery of several Growing Forward programs in Ontario. The summary of the project presented here was adapted from the executive summary and online article submitted to AAC as part of a Farm Innovation Program (FIP) final report.

Does In-Feed Zinc Oxide Cross-Select for Multidrug Resistant Staphylococci?

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Background

Supplementing swine feed with high levels of zinc oxide (≥2500 ppm) to control post-weaning *E. coli* diarrhea is a common practice on swine farms in Southern Ontario (*1*). However, recent research has revealed that the bacterium known as methicillin-resistant *Staphylococcus aureus* (MRSA) has acquired a zinc-resistance gene (*czrC*) which functions by an unknown mechanism (*2*). MRSA is a multidrug resistant pathogen that is referred to as a "superbug" by the media. It is commonly isolated from domestic animals including pigs (*3*), and is generally not a clinical concern for pigs and healthy humans. A related bacterium that has more significance to the swine industry is *Staphylococcus hyicus*. This opportunistic bacterium causes mild to severe skin lesions in pigs, a disease commonly known as greasy pig disease or exudative epidermitis. For most swine production systems losses are small but outbreaks of the disease can result in significant morbidity and mortality (*4*). It is proposed that *S. hyicus* has also acquired the zinc-resistance gene similar to MRSA and that the use of high levels of high levels of in-feed zinc oxide may be contributing to the emergence and persistence of multidrug resistant staphylococci in swine production systems.

Objective

The objective of this study was to determine whether the zinc-resistance gene (*czrC*) is found within the genome of *S. hyicus* isolated from pigs with exudative epidermitis.

Methods

Staphylococcus hyicus isolates were collected in a previous study of 186 pigs that presented clinical signs of exudative epidermitis on 30 different farms in southern Ontario (*5*). This sampling provided 131 isolates of *S. hyicus*, of which 31 isolates were determined to be methicillin-resistant *S. hyicus* (MRSH). In the present investigation, all 31 isolates of MRSH were tested for the *czrC* gene using PCR amplification of genomic DNA. For each MRSH isolate, 2.0 µL of extracted DNA was used in combination with 12.5 µL of Taq Ready Mix KAPA 2G FHS (D-Mark Biosciences, Toronto, ON, Canada), 8.5 µL of DNase-free water, and 1.0 µL each of both the forward and reverse primers as previously designed by Cavaco ***et al***., 2010. The reaction temperatures for denaturation, annealing, and amplification were 94°C, 55°C, and 72°C, respectively. After 30 cycles of PCR amplification, gel electrophoresis was used to detect amplified DNA. A single 633 bp band on the gel indicated the presence of the *czrC* gene.

Results and Discussion

The 31 isolates of MRSH tested for zinc-resistance in this study represent 28 pigs divided across 15 different farms. The results from this study determined that 15 (48%) of the 31 MRSH isolates carried the zinc-resistance gene. In total, zinc-resistant MRSH was isolated from 50% (14/28) of the pigs and found on 53% (8/15) of the farms where MRSH was isolated. These results demonstrate the commonness of zinc-resistant MRSH in swine production.

In this study, methicillin-resistant *S. hyicus* (MRSH) was tested for zinc resistance (*czrC*) because these strains carry a mobile genetic element known as the Staphylococcus Cassette Chromosome *mec* (SCC*mec*). This genetic element is important because multiple antibiotic resistance genes tend to accumulate within this region and the mobility of the SCC*mec* allows for it to be shared between staphylococci bacteria through horizontal gene transfer. It has also been determined that the zinc-resistance gene (*czrC*) is found within this region (2). The association between *czrC* and SCC*mec* indicates that zinc exposure could maintain selection pressure for multidrug resistant staphylococci even in the absence of antibiotics.

These findings raise concern because supplementing swine feed with zinc oxide is often used as an alternative to antibiotics and it is becoming increasingly common as there is a movement towards decreasing antibiotic use in swine production. If zinc oxide is cross-selecting for these multidrug resistant bacteria then different alternatives need to be explored for replacing antibiotics in swine production. Further research is needed to determine how in-feed zinc oxide affects the emergence and persistence of multidrug resistant staphylococci bacteria in swine production systems.

Acknowledgements

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The Use of Crude Glycerol as a Novel Feed Ingredient for Market Pig Diets

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Background:
Ontario farmers are becoming more involved in bio-diesel production; crude glycerol (also known as glycerine) is a co-product of bio-diesel production and can be used as an energy source for animal feeding. To produce bio-diesel crude glycerol, oil extracted from oilseeds (example soybeans) is hydrolyzed to produce methyl esters (bio-diesel) and the co-product, crude glycerol. The production of one litre of biodiesel will yield approximately 80 grams of crude glycerol with the energy value of glycerol reported to be comparable to corn. Since the feeding of crude glycerol to pigs has not been approved for use in Canada, its use should be considered novel. Crude glycerol could be used as an alternate energy feed if our research work is successful and additional studies are undertaken to help meet CFIA approval requirements.

Objectives:
To determine the effects of crude glycerol feeding, designed to reduce dietary feed costs during the growing/finishing phase on growth performance, economic returns and carcass and meat quality.

Methodologies:
One hundred and twenty feeder pigs (38 kg body weight [BW]) began the feeding experiment on March 19th, 2012 at the Arkell Swine Research facility with 6 pigs per pen and 4 pens per dietary treatment. All diets were formulated to meet or exceeded National Research Council recommendations for growing and finishing pigs with crude glycerol (CG) provided at 0 (Control), 2.5 ($CG_{2.5}$), 5 (CG_5), 10 (CG_{10}) or 15 (CG_{15}) percent of the diet. Each pen of feeder pigs was introduced to their assigned diet over a two week period. The pigs were fed *ad libitum* with pen feed usage recorded weekly. Fat and lean depths were also measured on each pig using ultrasound at the start of the second feeding phase (50 kg BW) and finishing phase (80 kg BW).

After reaching the targeted 115 kg BW endpoint, pigs were transported to the University of Guelph Meat Science Laboratory and processed. Hot carcass weights were recorded prior to overnight chilling at ≤ 4°C. The left-hand side of each carcass was probed prior to chilling between the third and fourth last ribs, 7 cm off the mid-line using a Hennessy probe for the estimation of carcass lean content. Muscle pH and temperature were measured in a loin and ham from each carcass at 45 minutes and 24 hours after slaughter. After overnight chilling of the carcass, an experienced carcass evaluator assessed carcass measurements on the loin at the third and fourth last rib interface to determine backfat thickness, loin eye area, marbling, colour, and muscle firmness and wetness. Loin primals were then dissected to determine lean, fat and bone content. Belly flex measurements were also taken to determine estimates of belly firmness. Meat quality was evaluated via determination of drip and cooking losses to assess water holding capacity, and Warner Bratzler shear force to assess tenderness. A cost analysis was also completed to determine the economics of feeding crude glycerol.

Results to Date:

- Days to market and average daily gain (ADG) were similar ($P > 0.30$) for each crude glycerol (CG) feeding level [ADG (kg/d): 1.08 (Control), 1.11 ($CG_{2.5}$), 1.07 (CG_5), 1.07 (CG_{10}), 1.10 (CG_{15}); SE=0.03].

- Ø On a dry matter basis, daily feed intake (2.62 to 2.77 kg/day) or as a percentage of average body weight (3.39 to 3.56%) along with feed efficiency (2.40 to 2.53 feed DM/ BW gain) were not affected ($P > 0.18$) when comparing pigs fed the control diet (0% glycerol) versus pigs fed diets containing 2.5 to 15% glycerol. These findings indicate that glycerol palatability issues were not present for this novel feed ingredient.
- Ø Feed costs of gain were calculated using current commodity prices (Weekly Hog Facts – August 13th, 2012) for corn ($305.10/tonne) and soybean meal ($658.92/tonne), amino acids, glycerol ($205.80/tonne) and vitamin-mineral supplementation. Feed costs were unaffected by glycerol feeding level ($0.93 to1.00/kg BW gain).
- Ø Hennessy probe fat depth measurements on the hot carcass and ruler fat depth measurements on chilled carcasses were lower for carcasses from pigs fed $CG_{2.5}$ when compared to higher levels of glycerol feeding, while other comparisons (no crude glycerol vs. glycerol in diet, 5% vs. 10 & 15% glycerol feeding and 10% vs. 15% glycerol inclusion level) were similar.
- Ø Hot carcass weight, dressing percentage, lean depth, ruler loin width and length, loin eye area lean yield, and belly flex measurements were also not affected by glycerol feeding level.
- Ø An extensive meat quality evaluation was completed on all carcasses. Ham and loin pH measurements were taken at 1 and 24 hours after slaughter to assess the conversion of muscle to meat. Loin color was evaluated using the Japanese, NPPC and CIE, L^* a^* b^* scales. Drip and cooking losses were measured to determine if the feeding of crude glycerol can impact juiciness. Pork tenderness was evaluated using Warner-Bratzler shear force measurements on loin chops aged for 2 and 7 days. With one exception, all meat quality measurements analyzed were not affected by crude glycerol feeding level. There were differences in loin firmness with firmness values decreasing as the amount of CG fed to pigs increased from 5 to 15% of the diet.

Results and benefits to swine industry

Presently, crude glycerol (glycerine) is not an approved feed ingredient for market pigs in Canada. The trial was completed after a research exemption was approved by CFIA for experimental use. Therefore swine producers are not legally able to feed crude glycerol as an approved feed ingredient.

However, our preliminary cost analysis indicated that the use of crude glycerol is a viable feeding option presently. We also anticipate that the cost of crude glycerol will decrease in the future as glycerol supplies increase due to greater amounts of bio-diesel produced. Currently, methanol and other contaminants are produced along with crude glycerol in bio-diesel production which is hampering use of glycerol as a feed ingredient. More research/refining processes will be needed to deal with these contaminants to ensure that this energy source can be safely fed to pigs. However our trial results have demonstrated that future research is warranted and that pig performance and measurements of pork quality were not compromised when grower pigs were fed up to 15% glycerol inclusion levels on a 90% DM basis.

Acknowledgements:
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Methane Gas in Hog Barns

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Although fortunately rare, explosions and flash over fires from methane accumulation can and do occur in hog barns. The risk of methane fires and/or explosions in swine facilities is increased by various operational and design factors. The most important one is that the majority of swine facilities operated in Ontario produce and store liquid manure on a long-term basis within the facility and are often divided up into various rooms or sections. Often, these rooms or sections are emptied of all livestock but left idle with the accumulated manure until needed again.

Methane is produced by a family of bacteria called *Methanogens*. It is odourless, colorless and is non-toxic, though in concentrations greater than 50%, it will act as a simple asphyxiant. Methane is slightly soluble in liquid. We would generally assume that a low solubility in water means that manure can't store methane in the liquid phase, but a sufficient amount could be stored in form of small bubbles attached to manure particles. These methane bubbles are easily released when the manure is mixed and accumulate in the headspace and must be removed by the ventilation system before the flammable level is reached. It has a specific gravity of 0.5 compared to air or ½ the weight of air, so it rises and collects into unvented spaces. With liquid manure systems, always assume that methane gas is being produced. Research shows that even in cold weather, methane bacteria, though slower, will still produce methane; up to 16 litres per cubic meter of manure per day. In warm weather, the bacteria produce methane gas at a faster rate; up to 30 litres per cubic meter of manure per day. As the methane gas is lighter than air, it will always rise up. If there is an unvented area such as a closet, feed room, office or a hallway, combined with an ignition source such as a switch, motor, welder, grinder, pilot light; it will trigger a flash over or explosion and lead to a fire. All barns or rooms within barns with liquid manure storage or transfer pits should be ventilated at all times to minimize accumulation risks.

There are 4 main areas of concern in managing the risk of methane accumulation in swine facilities.

1. **Ventilation and flammable limits**

The first concern is unvented areas over or adjacent to liquid manure storages. Unvented rooms such as storage rooms, hallways, feed rooms or the entire room or section of barn combined with an improperly designed or operated ventilation system will accumulate methane if there is liquid manure being stored. Methane will collect on the ceiling of these areas and stratify into 3 flammable limits:

- An area above the flammable level at > 15% methane mixed with ambient air
- A middle zone that is at flammable level, between 5% to 15% methane mixed with ambient air;
- And a zone that is below the flammable level on the bottom of the flammability levels at a mixture of <5% methane mixed with air. Any source of ignition is a threat to each of these flammable levels, but the critical zone is the middle one. The most effective management practice is to provide continuous ventilation. Even if the barn is empty of animals, but still has liquid manure present, producers should provide at least 3 uniform air changes or more per day.

2. **Storage of manure**
The next area of concern is the methane gas being suddenly released and overwhelming the ventilation system of the barn due to how the manure is stored. Double pitted barns where the short term storage is located above the long term storage and manure is drained periodically via pull plugs to the lower storage. The risk is that if the lower storage is unvented to the exterior, the methane builds up in the headspace. When the upper short-term storage is drained, this methane is displaced by the incoming manure. Another risk occurs if the plugs are left out; all the methane will rise up into the room above and has the potential to cause a fire or explosion. The easiest solution for double pitted barns is to ensure the lower pit is ventilated to the exterior so all methane is removed as it is formed.

3. **Moving manure**
Some facilities move manure via a transfer pit under the hallway to an exterior pump out pit. On some barns, there is a solid baffle between the transfer pit and the pump out pit where in many situations the transfer pit is not vented to the exterior. Once the level of the manure reaches the bottom of the baffle the unvented transfer pit becomes hydraulically sealed. Any additional manure will cause a pressure build up in the headspace of the transfer pit. If there is a drain hole, cover plate or floor drain, the methane in the headspace will shoot out of the hole(s) under pressure into the hallway. If the ventilation system is inadequate to handle this sudden influx of gas, the flammable level is soon reached.

4. **Foaming manure**
The last area of concern is with the foaming manure, a combination of gas, methane bubbles, a surfactant, soap, and a stabilizer; filamentous *Methanogens* bacteria. Dr. Bo Hu from the University of Minnesota is part of a team that has worked on this issue for the last 2 years. It is suspected that soap is being formed from incompletely digested fats in the pig's diets. These fats can form long chain fatty acids, which are converted to surfactants and then soap by the action of the bacteria present in the manure. Though the use of Dried Distillers Grains with Solubles (DDGS) is suspected, a survey here in Ontario found that some barns have been experiencing foaming issues before the common use of DDGS. The methane portion of the foam makes up 50% to 70% of the total volume. The foam itself can be several feet thick. If the foam is rapidly broken up by aggressive agitation or pressure washing, it is suddenly released overwhelming the ventilation system. Many swine barn fires in the Mid West U.S.A. have been attributed to manure foam.

In conclusion always assume methane is being produced with liquid manure systems. Ensure that ventilation is being provided to all areas of the barn. All storage pits should be vented to the exterior so as to remove the methane as it is being produced and eliminate pressure build up in the headspace. Foaming manure is to be treated with extreme caution. Under no circumstances should the manure foam be aggressively knocked down.

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Lactobacillus Fermented Diets Reduced *Salmonella* Typhimurium Infection in Newly Weaned Pigs

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Salmonella Typhimurium is a food-borne pathogen often associated with swine. Recently, we identified *Lactobacillus* isolates that protected *Caenorhabditis elegans* from death due to *S.* Typhimurium infection[1]. Two of the isolates were evaluated in the present pig-challenge study. Three trials were conducted with 16 piglets (BW: 6.55±0.20 kg) for each trial. There were four dietary treatments (in a liquid form with a liquid/solid ratio of 2.2, four piglets per treatment): 1) basal diet (BD, control), 2) naturally-fermented basal diet (NF), 3) *Lactobacillus* LB1-fermented basal diet (LB1), and 4) *Lactobacillus* CL11-fermented basal diet (CL11). All pigs consumed the experimental diets for 3 d prior to *S.* Typhimurium DT104 challenge (approximately 10^6 CFU/pig) through gavage. The challenge was given twice (d4 and d5) in Trials 1 and 3, but once (d4) in Trial 2. Clinical signs (rectal temperature and diarrhea scores), and the level of haptoglobin in serum were examined. *Salmonella* counts of feces, and ileal and cecal digesta were quantified in Trials 2 and 3, while the presence of *Salmonella* in ileocecal lymph nodes (ILN) and spleen was determined only in Trial 3. Pigs from Trials 1 and 3 demonstrated clinical signs of infection, which were absent in Trial 2. Pigs receiving fermented diets had lower rectal temperature, diarrhea scores, and *Salmonella* counts in feces and digesta than the control group ($P \leq 0.01$); particularly, the diarrhea scores in NF and CL-11 treated-group was nearly 1 unit lower than that in BD treated-pig. *Salmonella* was detected in the ILN and spleen from all the pigs on BD, NF, or CL11, but only 50% in spleen from pigs on LB1. The haptoglobin concentration was lower in pigs on fermented diets ($P \leq 0.01$) with the lowest detected in LB1 treated pigs. In summary, these trials suggest that feeding a fermented diet, particularly one inoculated with LB1, can reduce *Salmonella* infection in pigs.

Main Results

Table 1 shows fermented feed significantly reduced the diarrhea scores ($P \leq 0.01$), particularly in NF and CL11 treated pigs. The effect was more obvious in Trials 2 and 3.

Table 2 shows nearly 1 log reduction of *Salmonella* Typhimurium DT 104 in the fecal samples from fermented feed treated pigs when compared with BD-fed pigs ($P < 0.01$), and the *Salmonella* level was increased when the time and dosage of challenge were increased.

Table 3 indicates a significant decrease of serum haptoglobin levels in the pigs on fermented feed with the lowest level detected in LB1-fed pigs ($P < 0.01$).

Figure 1 demonstrates that all the pigs fed BD, NF, or CL11 were infected by *Salmonella* in their ILN and spleen, but only 50% of the pigs on LB1 were positive in the spleen.

Table 1. Variation of diarrhea scores after pigs challenged by *Salmonella* Typhimurium DT104.

Treatment/Trial	Coefficient	Standard Error	95% Confidence Interval	P value
BD	Reference			
NF	-0.96	0.27	-1.50 ~ -0.43	< 0.01
LB1	-0.61	0.24	-1.08 ~ -0.15	0.01
CL11	-1.00	0.27	-1.53 ~ -0.47	< 0.01
Trail 1	Reference			
Trail 2	-0.48	0.23	-0.94 ~ -0.02	0.04
Trail 3	-0.49	0.24	-0.96 ~ -0.02	0.04

BD, basal diet (control)-fed group; NF, naturally-fermented basal diet-fed group, LB1, *Lactobacillus* LB1-fermented basal diet-fed group; CL11, *Lactobacillus* CL11-fermented basal diet-fed group. n = 4. The same was for remaining tables.

Table 2. Variation of fecal levels of *Salmonella* Typhimurium DT104 after challenge.

Treatment/Trial	Coefficient	Standard Error	95% Confidence Interval	P value
BD	Reference			
NF	-1.14	0.32	-1.76 ~ -0.51	< 0.01
LB1	-0.95	0.32	-1.57 ~ -0.32	< 0.01
CL11	-1.12	0.32	-1.74 ~ -0.49	< 0.01
Trail 2	Reference			
Trail 3	1.08	0.23	0.63 ~1.53	< 0.01

Table 3. Variation of serum concentration of haptoglobin after *Salmonella* Typhimurium DT104 challenge.

Treatment/Trial	Coefficient	Standard Error	95% Confidence Interval	P value
BD	Reference			
NF	-178.85	22.80	-223.55 ~ -134.15	< 0.01
LB1	-190.97	22.80	-235.67 ~ -146.28	< 0.01
CL11	-147.90	22.80	-192.60 ~ -103.20	< 0.01
Trail 1	Reference			
Trail 3	-95.13	016.50	-127.46 ~ -62.80	< 0.01

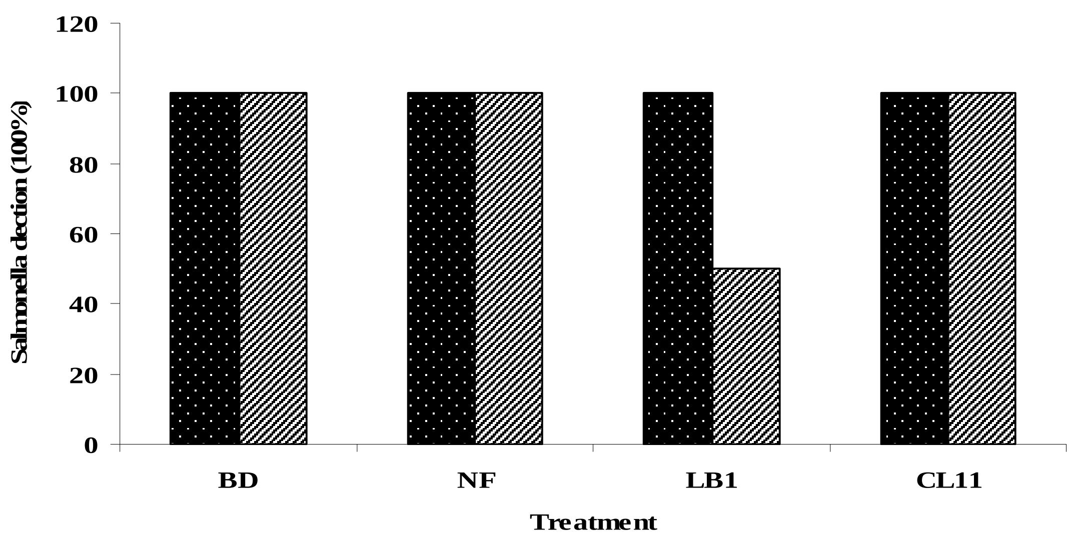

Figure 1. *Salmonella* appearance in spleen and ileocecal lymph nodes after challenged (▓), Ileocecal lymph nodes; (▒), Spleen. n = 4.

Reference

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Dietary Omega-6 to Omega-3 Fatty Acid Ratios Affect Body Fat Mobilization During Lactation in High Producing Sows

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SUMMARY
An experiment was conducted to determine the effects of altering the omega-6 (n6) to omega-3 (n3) fatty acid (FA) ratio in the diets of high producing sows on whole body metabolism. Results demonstrated that sows consuming diets with an n6:n3 ratio below 5:1 were more likely to be in a state of negative energy balance and body fat mobilization relative to sows with a greater n6:n3 ratio, with potentially negative consequences on reproductive performance and sow longevity.

INTRODUCTION
Improved genetics and management practices over several years have led to dramatically increased litter sizes. Pre-weaning mortality however, has increased at even greater rates, suggesting that sows may not be able to keep up with the increased energy demands of the litter. At farrowing, sows undergo many metabolic changes associated with milk production which can put them into a negative energy balance. Hypophagia at farrowing contributes to the sows' inability to meet the energy demands for milk production. Over subsequent parities, severe negative energy balance and the loss of body condition have negative impacts on subsequent rebreeding performance and may lead to early culling.

Altering the FA's in adipose tissue can affect lipolytic activity and the ability of the animal to mobilize body fat. Omega-3 FA's alter lipid metabolism, and may also affect feed intake. Moreover, it is possible that the ratio of n3 FA's in relation to n6 FA's will differentially affect body fat mobilization in the sow.

Our overall objective of a series of experiments is to improve the reproductive and productive functions of high producing sows. In this specific experiment, the objective was to determine how altering the n6:n3 FA profile of sow diets affects whole body metabolism and the ability to provide nutrients and energy to her offspring. Milk energy output, piglet growth rate, sow feed intake, plasma leptin and mobilization of fatty acids from sow adipose tissue in response to an epinephrine challenge were measured.

MATERIALS AND METHODS
The experiment used 5 dietary treatments, each divided into a gestation and lactation ration. Total fat concentration (5% crude fat) was the same among diets, but the ratio of n6 to n3 FA's varied. Treatment groups consisted of a control (tallow), 3 diets with plant oil based n6:n3 ratios (10:1, 5:1, and 1:1) and a 5:1 fish oil diet.

Sows (n=100) farrowing ≥ 11 piglets and nursing ≥ 10 piglets were assigned to 1 of the 5 diets. Piglet growth rate and sow feed intake was determined throughout lactation. Milk samples were collected on d 4 and 16, and the dry matter (DM), N and energy output of milk was estimated based on piglet growth. On d 5 of lactation, 8 sows from each of the 10:1 and 1:1 groups had jugular catheters inserted and were challenged with a single injection of epinephrine (epi) followed by serial blood collections to determine the effect of diet on maximal body fat mobilization. Blood was collected for leptin (a hormone which controls appetite and is negatively correlated with feed intake) analysis on day 5 and 15.

RESULTS AND DISCUSSION

There was no effect of treatment on the number of piglets born or weaned. Piglets raised by sows consuming the 5:1 plant diet had higher birth and weaning weights, while those nursing sows on the fish based diet had the lowest ($P < 0.05$). Control and 5:1 plant fed sows consumed the most feed, while the 1:1 and fish diet sows consumed the smallest amount ($P = 0.05$; Figure 1). Sow body weight was unaffected by dietary treatment; however, sows consuming the 1:1 diet had greater amounts of backfat when compared to the sows consuming the other diets ($P < 0.05$; Figure 2). Piglet growth rates were unaffected.

Altering the n6:n3 FA ratio in sow diets did not affect milk composition or output, suggesting that sows will compensate for changes in feed intake through body fat mobilization. Prior to any form of metabolic challenge, sows consuming the 1:1 ratio diet appeared to be in a state of body fat mobilization when compared to those consuming the 10:1 ratio (Table 1). Both NEFA and glycerol concentrations (indicators of body fat breakdown) were more than doubled in sows fed the 1:1 diet relative to those fed the 10:1 diet, however the variability associated with this determination was very high and thus significance was not reached. Leptin levels were also elevated in mid lactation in the 1:1 diet sows, which had reduced feed intakes relative to the 5:1 and control diet sows.

When sows were submitted to a metabolic challenge with exogenous epi, we found that the sows consuming a ratio of 10:1 had a greater response, indicated by a lower area under the response curve for glucose ($P < 0.05$) and tendencies for higher area under the curve responses for NEFA and glycerol concentrations. We hypothesize that since the 1:1 ratio sows were mobilizing more body fat prior to the challenge, they were less sensitive to a dose of exogenous epi. than the 10:1 ratio sows.

CONCLUSIONS

Reducing the n6:n3 FA ratio below 5:1 put sows into a state of increased body fat mobilization, which may have negative impacts on body condition and longevity. In order to ensure producers are not increasing their cull rates and cost of production due to body condition loss, diet formulations including n3 FA's should be formulated relative to n6 FA's. With the costs of raising replacements increasing, sow longevity is a key factor for producers to maximize profits. Producers can keep their most productive sows in the herd longer, and reduce the costs of raising replacements. When included correctly into diets, n3 FA's may help reduce the severity of the negative energy balance which occurs in early lactation.

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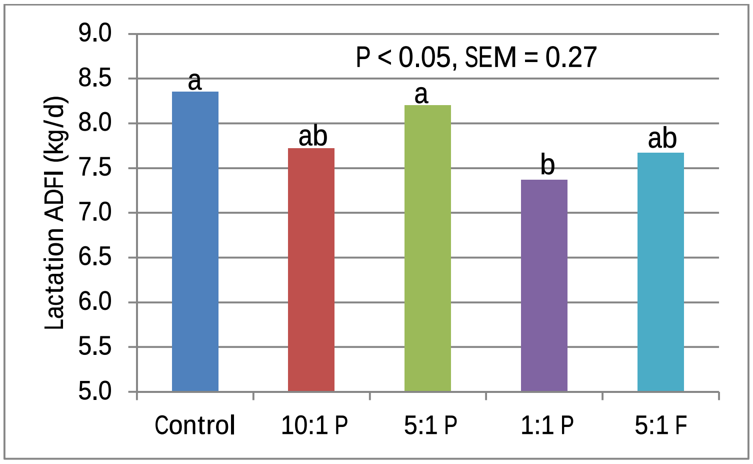

Figure 1: Average daily feed intake of sows consuming diets with varied omega-6 to omega-3 fatty acid ratios during lactation (kg/d).

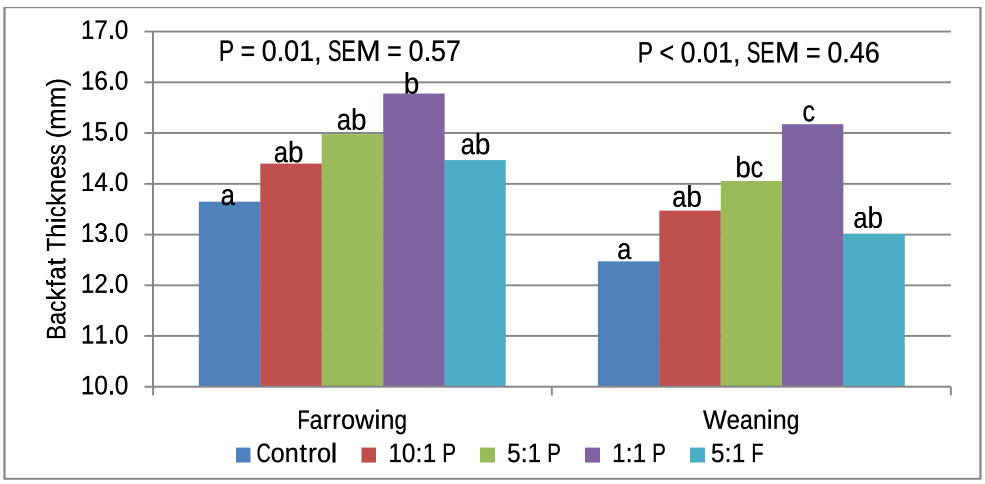

Figure 2: Backfat thickness (mm) of sows consuming diets with varied omega-6 to omega-3 fatty acid ratios at farrowing and weaning.

Table 1: Pre-challenge NEFA and glycerol concentrations in sow plasma in early lactation.

	Diet		Statistics	
	10:1 P	1:1 P	SEM	P Value
NEFA, uM	93.27	240.02	74.15	0.16
Glycerol, mg/dl	0.4	0.81	0.21	0.2

Reducing Water Consumption in Swine Barns: Alternatives for Animal Drinking and Barn Cleaning

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SUMMARY
Evaluation of selected water conservation measures involving drinkers and different cleaning procedures revealed that 60% reduction in water wastage was achieved with a drinking trough (with side panel and constant water level) to nipple drinkers. The use of conventional nozzle for pressure washing led to reduced time and water consumption during cleaning. Cost analysis of the different measures showed reduction in water wastage achieved by a drinking trough translated to about $4.76/pig savings or 29% reduction in total costs associated with water use when compared to a nipple drinker.

INTRODUCTION

More efficient water use in swine operations is essential both for economic and environmental considerations. Previous work demonstrated that there are various opportunities to improve water use in swine operations (PSC Annual Report 2010, pp. 24-25). Evaluation of conservation measures identified in the literature review and producer survey using an assessment criteria that considered effectiveness in reducing water use impact on manure production, and effect on pig performance and other operational aspects (i.e., air quality). Barn cleaning and animal drinking were identified as the areas in the barn where highest water savings can be potentially achieved, therefore these were further evaluated in commercial swine facilities.

METHODOLOGY

The overall approach of this study was to evaluate the effectiveness of selected water conservation measures pertaining to animal drinking and cleaning in reducing overall water use and to assess their economic impact in swine barn operations. Two different experiments were performed. The first experiment involved installing three different types of drinkers in a grow-finish room at PSCI barn facility. The drinkers used included 1) nipple drinker (Control), 2) nipple drinker with side panel, and 3) a trough with side panel and constant water level (Figure 1). Performance of these drinkers in terms of water disappearance (use), water wastage, water contamination level as well as effect on ADG and ADFI were assessed throughout one growth cycle. The second experiment involved water sprinkling and pressure washing during cleaning.

RESULTS

A. Animal drinking

Figure 3 shows the performance of the test drinkers in terms of water disappearance (water use), water intake, and water wastage. Results showed that 60% less water wastage was achieved when a trough with side panel and constant water level (1.27 L/day-pig) was used compared to the nipple drinker alone (3.77 L/day-pig) and the nipple with side panel (3.57 L/day-pig) (Figure 3). This observation led to lower total water disappearance (consumed + wastage) in trough with side panel and constant water level compared to nipple drinkers. Even with the substantial decrease in water disappearance, the net water intake of the pigs from the trough with side panel and constant water level (after subtracting the water wastage) was still within the recommended water intake requirements for grower-finisher pigs (4.5 – 10 L/day-pig).

Water in the trough had significantly higher microbial ATP (adenosine triphosphate) levels (indicating contamination with organic material) than the water drawn from nipple drinkers. However, this did not affect pig performance since the use of the trough with side panel and constant water level had no significant effect ($p>0.05$) on average daily gain and average daily feed intake of pigs. Further investigation is needed to find out the type of microorganisms present in the water in the trough and its potential effects on the pigs apart from ADG and ADFI.

B. Cleaning

As expected, water sprinkling (or soaking) in fully and partially slatted concrete flooring resulted in significantly higher ($p<0.05$) water consumption mainly due to the additional water used during the sprinkling phase. However, significantly more time ($p<0.05$) was needed when washing a partially slatted concrete flooring without sprinkling than with sprinkling. As shown in Figure 4, the use of the conventional nozzle led to the lowest water volume consumed and time spent in washing rooms with partially and fully slatted concrete flooring among all test nozzles. Also, the use of the conventional nozzle and the Y-nozzle achieved the highest significant reduction ($p<0.05$) in microbial ATPs on concrete and plastic surfaces (measured before and after washing), respectively.

C. Economic analysis

The economic analyses were based on the assumption that the treatment was applied to a 168-head grow-finish room with a floor area of 157.3 m^2 (14.3 m x 11 m) for one complete growth cycle of about 16 weeks. Table 1 shows the summary of the operational information and associated costs of installing each type of drinker (nipple, nipple with side panel or trough with side panel and constant water level) in the grow-finish room. Costs were calculated for each drinker type and included the cost of water of $8.01 per 1000 gallon for this particular barn as well as the costs associated with capital and installation, maintenance and operation, and manure slurry handling. The total cost of the use of the trough with side panel and constant water level was around $11.83/pig, which translated to about 29% reduction in cost when compared to the use of nipple drinkers. For cleaning, the total cost per pig for pre-soaking with water sprinkling and pressure washing a fully slatted flooring was about $0.54/pig, which is $0.01/pig higher than without sprinkling. However, for partially slatted flooring, the use of water sprinkling prior to washing was about $0.09/pig less than without sprinkling. Similarly, the use of the conventional nozzle for high-pressure washing resulted in a total cost of about $0.78/pig (fully slatted) and $0.80/pig (partially slatted), almost half the cost of the other test nozzles.

Based on the results of the producer survey on barn water use (PSC Annual Report 2010, pp. 24-25), the most common practices associated with water use in the participating barns were the use of nipple drinker, pre-soaking the room prior to cleaning, and high-pressure washing using the conventional nozzle. The total cost associated with these current production practices is about $17.13/pig for fully slatted flooring and $17.31/pig for partially slatted flooring (using the above assumptions for water and slurry handling costs). In comparison, using a trough with side panel and constant water level for animal drinking, pressure washing using conventional nozzle, and pre-soaking only in rooms with partially slatted flooring (not in fully slatted flooring), the total cost would be about $12.36/pig (fully slatted) and $12.55/pig (partially slatted). Using these alternative practices then could translate to savings of about $4.77 per pig or 28% reduction in costs associated with water use compared to the current conventional production practices in most barns.

CONCLUSIONS
The barn evaluation of selected water conservation measures indicated that relative to conventional nipple drinkers, the use of a drinking trough with side panel and constant water level saved significant amount of water mainly due to reduced water wastage without adversely affecting pig performance.

High pressure washing in fully slatted flooring can be done without prior water sprinkling (soaking). Compared to current conventional practices, the combination of using a drinking trough with side panel and constant water level for animal drinking, pre-soaking, and high-pressure washing with conventional nozzle for cleaning had the greatest potential for cost savings of up to $4.77 per pig arising from reduced overall water use and accumulated manure slurry.

ACKNOWLEDGEMENTS
Project funding provided by the Saskatchewan Agriculture Development Fund (ADF) is acknowledged. Strategic funding provided by the Saskatchewan Pork Development Board, Alberta Pork, Manitoba Pork Council, and Saskatchewan Ministry of Agriculture to the research programs at Prairie Swine Center is acknowledged.

Figure 2. Three types of animal drinkers used: nipple (D1), nipple with side panel (D2) and a trough with side panel and constant water level (D3).

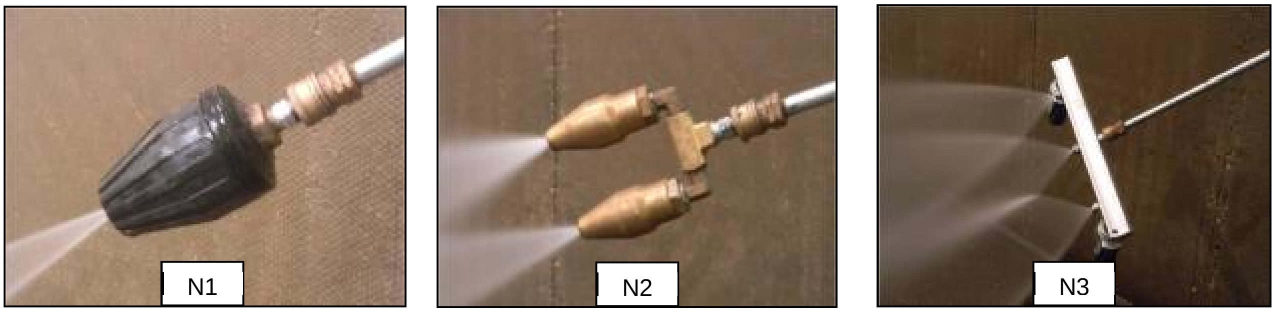
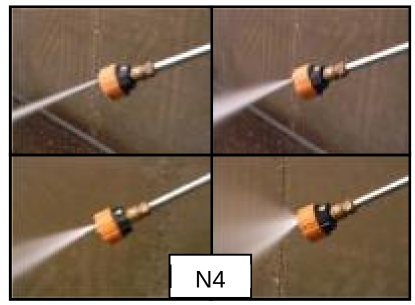


Figure 2. Four different types of pressure-washing nozzles used: conventional nozzle (N1), Y-nozzle (N2), water broom (N3), and 4-in-1 nozzle (N4).



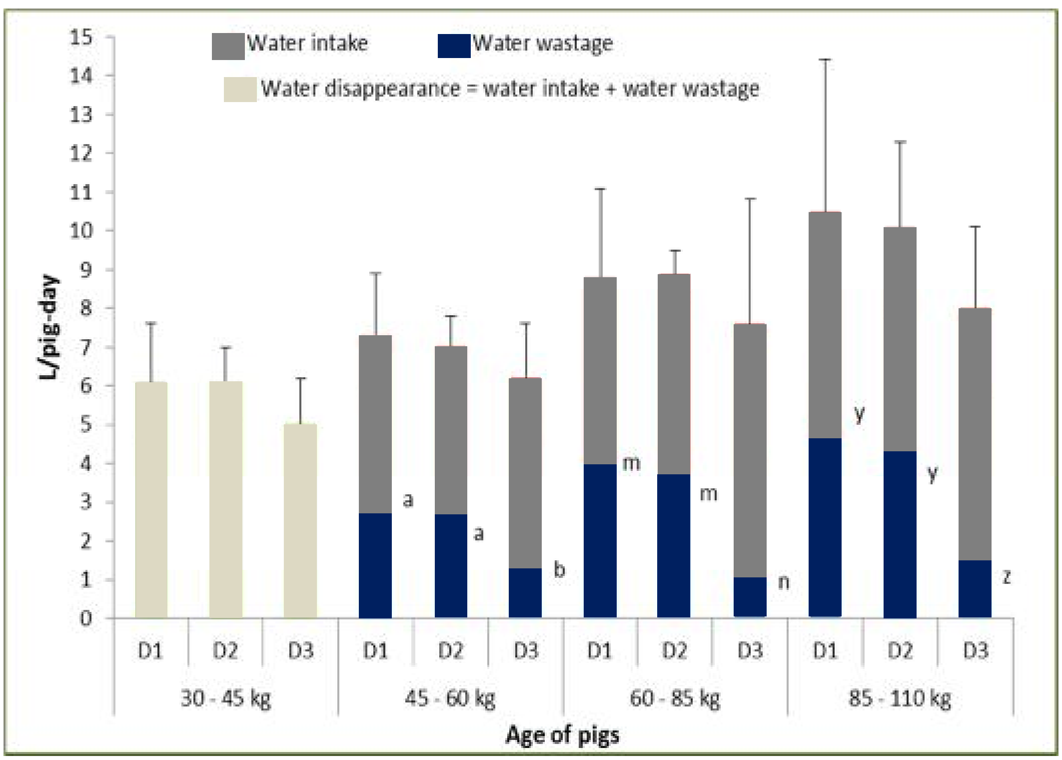


Figure 3. Effect of different types of drinkers on water disappearance and wastage, n=4. Means (water wastage) with the same letters are not significantly different ($p>0.05$) from each other. D1 – Nipple; D2 – Nipple with side panel; D3 – Trough with side panel and constant water level.

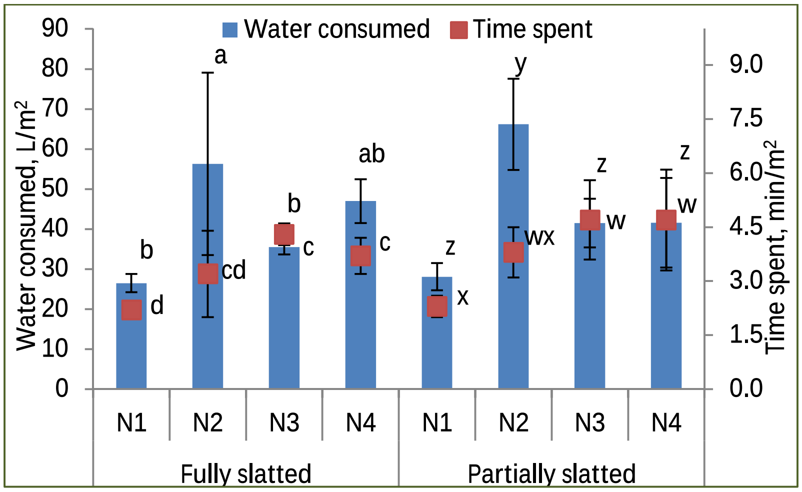


Figure 4. Effect of different types of nozzles on time and water consumption during high-pressure washing, n=5. Means with the same letters within the same type of flooring are not significantly different ($p>0.05$) from each other. N1 – Conventional nozzle; N2 – Y-nozzle; N3 – Water broom; N4 – 4-in-1 nozzle.

Table 1. Operational information and associated cost of using the different types of drinkers in a swine production room.

Operational information and associated cost	Nipple	Nipple with side panel	Trough with side panel and constant water level
Cost of required materials & equipment, $	546.0	826.0	1,185.0
Installation cost, $	104.0	156.0	156.0
Capital and installation cost (per pig basis), $/pig	0.26	0.39	0.53
Number of hours per cycle for drinker maintenance, hr	6	6	8
Labour cost for installation and maintenance (per pig basis), $/pig	0.93	0.93	1.24
Total water use (consumed + wastage) (per pig basis), L/day-pig	8.175	8.025	6.7
Total water consumption per year, gal/yr	397,281.2	389,991.7	325,600.5
Cost of water used (per pig basis), $/pig	6.30	6.19	5.16
Volume of additional water to the pit (due to wastage) (per pig basis), L/day-pig	3.77	3.57	1.27
Total manure produced (in storage tank) per year, gal/yr	262,804	253,084	141,311
Cost of handling the manure produced (per pig basis), $/pig	9.11	8.77	4.90
Total cost per pig, $/pig	**16.59**	**16.27**	**11.83**

All costs in CAD$
Wage rate = $13/hr; Cost of water = $8.01/1000 gal; Cost of manure handling = $0.0175/gal

Creep Feed Provision in the Farrowing Room Provides Benefits to Piglets Showing Evidence of Intake

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SUMMARY

The consumption of creep feed improved growth rates and nursery exit weights. However, only about 40% of the piglets offered the creep feed consumed it.

INTRODUCTION

Offering supplemental feed in farrowing (creep feeding) is thought to benefit piglets by 1) providing supplemental nutrition 2) aiding the adaptation of the gastrointestinal tract to nutrients not found in milk, including proteins and 3) introducing solid feed to the piglets. However, a study published in last year's annual report (Beaulieu et al. 2010. Annual Research Reports. *Weaning at 28 days. Is creep feeding beneficial?*) provided data showing that the provision of creep feed in the farrowing room for 7 days prior to weaning had no effect on weaning weights, suggesting offering creep didn't increase overall nutrient intake. Surprisingly, this conclusion was the same for the light and heavy pigs within a litter. Moreover, this data showed that piglets from litters offered creep in farrowing were less inclined to visit the feeder in the nursery immediately post-weaning. This implies that there were no behavioural benefits from the early introduction of solid feed.

This experiment however, was only able to describe the effects of offering creep feed to a litter on performance. We measured creep feed disappearance, but were unable to determine if consumption was equal among litter-mates. The objective of the current experiment, was to determine effects of creep feed provision in the farrowing room, specifically among those piglets who show evidence of consumption.

MATERIALS AND METHODS

One hundred sows were randomly assigned to one of 2 treatments, creep or no creep. The creep treatment piglets received creep feed (commercial) for one week prior to weaning. The creep feed was provided in multi-space creep feeders, added in 250 gram allotments as needed. The creep feed and the phase 1 nursery diets were marked with a non-toxic inert dye. Anal swabs taken from each piglet in the creep group 1 day prior to weaning and from all piglets on day 2 in the nursery allowed us to estimate performance responses to creep among those piglets who had actually consumed it and further if consuming creep in the nursery actually encourage intake of the phase 1 diet immediately post-weaning.

RESULTS AND DISCUSSION

Creep feed disappearance was approximately 240 grams per day per farrowing crate. Although birth weight was similar between groups regardless of subsequent creep feeding, weight at 21 days of age (when creep feeding actually began) was higher (Table 1). All litters had been treated exactly the same up to this point, thus, we can't attribute this difference to treatment. There was no difference in weaning weights and average daily gain (ADG) from day 21 (when creep was offered) to weaning was higher in those litters offered creep. Similar to what we had observed in previous experiments, providing creep in the farrowing room, had no impact on subsequent overall growth of those litters in the nursery (Table 1).

The data in Table 2 is only from those litters offered creep feed in the nursery. Approximately 37 % (175 out of 471) of piglets offered creep showed evidence of consumption after 5 days. Within the creep "eaters" 45 % had evidence of consuming the phase 1 diet when swabs were taken 48 hours after weaning. Within the creep "non-eaters" this figure was 55 %. This corroborates our previous experiment where video-tape observations showed that piglets from litters offered creep had fewer "feeder approaches" during the first 24 hours post-weaning. Growth rate during the first 3 days post-weaning, of piglets classified as "creep and nursery eaters" was improved relative to other groups (Table 2). Moreover, there is evidence that this improvement was maintained throughout the nursery period.

CONCLUSION

Creep feeding improves weaning and nursery exit weights, for those piglets who actually consume it. Further work is required to determine why not-all piglets consume the creep feed and if these piglets will show improvements in growth if they can be encouraged to consume the creep feed.

ACKNOWLEDGEMENTS

Strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development Fund. We appreciate the donation of the creep feed for this experiment from Masterfeeds.

Table 1. Weaning weights, and nursery growth rate in response to creep feed offered in the farrowing room for 7 days prior to weaning.

Variable	Creep	No creep	SEM	P value
N (litters/piglets at d 21)	55/578	52/538		
Farrowing room				
Wean age	26.20	26.05	0.265	
BW, birth, kg	1.48	1.47	0.022	
21 days of age, kg	5.82	6.05	0.078	0.01
Weaning, kg	7.61	7.76	0.100	
ADG, 21 doa to weaning, g/d	0.25	0.24	0.005	0.02
Nursery				
BW, d 3 (post-weaning), kg	8.03	8.18	0.101	ns
Nurs Exit, kg	20.46	20.35	0.339	
ADG, wean to d 3, g/d	0.14	0.14	0.019	
wean to d28, g/d	0.44	0.43	0.010	

Table 2. Growth of piglets offered creep in the nursery, separated by evidence of consumption of creep feed and the phase 1 nursery diet on day 1 post-weaning.

Farrowing	Eater			Non-eater		
Nursery	**Eater**	**Non-eater**		**Eater**	**Non-eater**	**Pooled SEM**
Wean Age	26.63[a]	26.00[bc]		26.26[ab]	25.93[c]	0.318
BW, birth, kg	1.50	1.46		1.47	1.48	0.039
d 21, kg	5.53[a]	5.70[ac]		5.99[bc]	6.03[b]	0.164
Weaning, kg	7.30[a]	7.51[ab]		7.68[b]	7.80[b]	0.196
ADG, d 21 to wean, g/d	0.25[ab]	0.26[a]		0.24[b]	0.25[a]	0.008
Nursery						
BW, d 3, kg	7.94	7.91		8.14	8.15	0.196
Nurs Exit (d 28), kg	21.10[a]	20.68[ab]		20.64[ab]	20.04[b]	0.484
ADG, Wean to d3, g/d	0.21[a]	0.13[bc]		0.15[b]	0.12[c]	0.025
d 4 to 7, g/d	0.16[a]	0.17[a]		0.13[b]	0.10[c]	0.019
Wean to d 28, d/g	0.48[a]	0.45[ab]		0.45[b]	0.42[c]	0.013

a,b,c,d. Numbers within a row with different superscripts, $P < 0.05$.

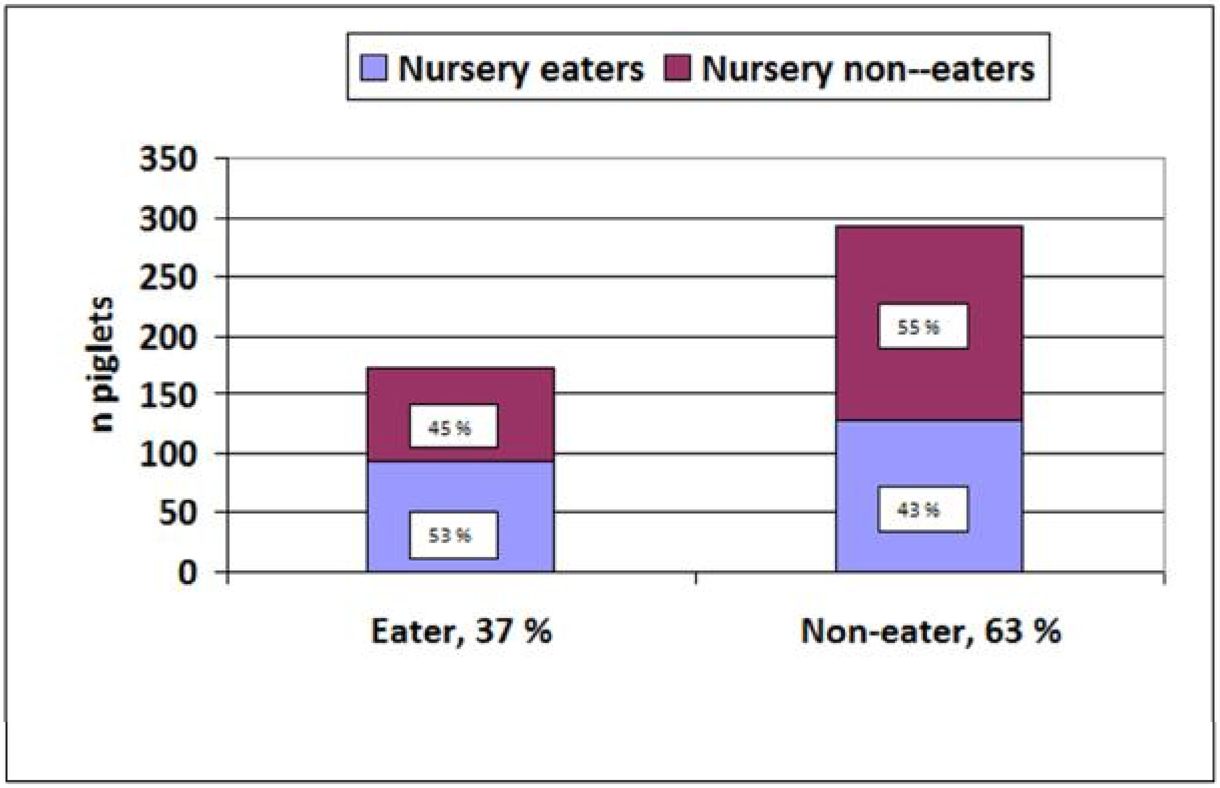

Figure 1. Proportions of piglets classified as creep eaters (n=175) versus non-eaters (n=296) in the farrowing room and nursery (first 24 hours post-weaning) eaters (n=221) and non-eaters(n=243).

Eaters and non-eaters in farrowing, of those offered creep feed

Acknowledgements.
Strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development Fund. We appreciate the donation of the creep feed for this experiment from Masterfeeds.

Loading Facilities for Market Hogs: Top 10

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SUMMARY

For many producers, loading pigs at marketing can be both stressful and time-consuming. Problems at loading also affect the welfare of animals, and can have a significant economic impact due to carcass damage, meat quality problems or increased death losses. The objective of this project was to identify components of swine loading facilities and handling at loading that have the greatest value for reducing pig stress and loading time. A total of 10 loadout facilities in Saskatchewan were visited in this study, and the facility design and handling methods at each was documented using photographs and video footage. Observations were compared against recommended practice to identify design features and practices that promote good handling in pigs. Suggestions to improve handling at loading include aspects of ramp design and lighting, as well as simple changes to management and handling technique.

INTRODUCTION

Loading pigs for transport to market can be stressful for pigs and their handlers. Poorly designed loading facilities increase the incidence of prod use and rough handling, and result in longer loading times. Stress associated with loading can increase the incidence of downer pigs and death losses, as well as having adverse effects on carcass and meat quality. Methods for reducing stress at loading have been identified, however few producers have adopted these changes as construction costs are high and the benefits are uncertain. This project documented loading facilities and handling methods in barns recognized for having good laodouts. The results provide clear suggestions for changes to facilities and management at loading, and will hopefully encourage the construction of better loadouts and adoption of practices at loading that can benefit pigs and producers.

The overall objective of the project was to document superior loading facilities and practices currently in used in the province of Saskatchewan. Specific objectives included; 1) the identification of 10 loading facilities that promote ease and speed of handling in market hogs; 2) evaluation of the design and management characteristics associated with each facility; and 3) preparation of a summary and educational materials for producers to aid them in improving the design and use of loading facilities.

EXPERIMENTAL PROCEDURES

Saskatchewan farms with good loading facilities were identified based on information supplied by pork producers and truckers. Once a farm was identified, the producer was contacted regarding participation in the study. Participating farms were selected from locations across the province in order to document a wide variety of loadout designs. Participating farms included corporations such as Fast Genetics and Big Sky Farms, as well as individual producers across the province. Each farm visit included a brief questionnaire on basic housing and management practices, measurements of the loading facility, and observation of the handling techniques used to move pigs at loading.

Loadout measurements included the width, length, and height of pens, alleys and doorways. Light intensity was measured in lux using a light metre placed at pig height at various locations throughout the loadout. Ramp angle was measured using a framing square and level, and calculating the inverse tangent of the rise over run. Any corners, flooring changes, or obstacles were documented using a digital camera.

Handling of pigs during loading was also recorded. For each farm visit, a video camera was either mounted in the loadout or hand operated by the producer to record handling techniques at loading. For each site, either live observations or video footage of pigs at loading were reviewed in order to assess handling technique and pig flow. Handling techniques used on farm were also evaluated on the basis of appropriate/inappropriate use of tools, handler vocalizations, handler body position, attitude, and factors affecting the flow of animals.

The results of this study were descriptive observations. By examining superior facilities and handling methods, and comparing them with codes of practice and recommended practice, we identified design and handling practices that were effective at reducing stress in pigs during loading.

RESULTS AND DISCUSSION

The ten farms studied included 6 farrow-to-finish operations, 3 finishing barns and one farrow-to-wean operation. On 8 farms, the pigs were housed in small to medium groups (12 to 50 pigs per pen), and on the 2 remaining farms, pigs were housed in large groups of 600-700 animals. Hogs marketed per week ranged from 160 to 1100 animals, with an average of 500 hogs shipped/ week. Loading time needed to fill a standard potbelly trailer (approx 230 pigs) ranged from 30 to 90 minutes (45 min average). Key facility and handling measures at each loadout were compared against recommended practice.

Loadout design

Recommended practice indicates that ramp angles should be less than 20°, that ramps should be fitted with cleats and have a non-slip surface. The ramps observed on all farms met these specifications, with ramp angles ranging from 0 to 11°. Figures 1 to 3 show examples of the ramps observed. The ramp designs varied considerably but all worked well. One farm had a covered adjustable hydraulic ramp with an attached man way, which was very efficient for moving groups onto the trailer (Fig. 1). As well, the adjustable ramp was used to load the top deck and reduced handling stress as it greatly reduced the angle pigs were required to climb compared to the internal truck ramp. Some farms had concrete step ramps with 30 cm treads, which the pigs readily negotiated (Fig. 2). Another farm fabricated a ramp extension which was used to reduce the slope of the internal truck ramp, making it easier to load pigs onto the top deck (see Fig. 3).

Lighting in the loadout area was also examined. It is recommended that loading facilities be well lit, with diffuse incandescent lighting preferred as it reduces contrast and shadows, which may cause animals to balk. Also, when moving into a new area such as the truck, lighting should ideally change from darker to lighter, as animals may balk if required to move into darkness. Lighting levels (recorded using a light meter) showed a large variation in lighting between farms, ranging from below 100 lux at some facilities to over 1000 lux at others. Lighting during loading was also affected by the time of loading and external weather conditions. Some facilities used an enclosed truck bay, which minimized the effects of time of day and weather conditions.

Other features of superior loading facilities were manways, dedicated loading pens near the loadout, and external truck sheds. Manways outside of the alley allow for more efficient handling, as the handlers can easily move around and past groups of pigs without affecting their movement. This improves not only pig flow, but also handler safety. Many barns had loading pens adjacent to the loadout that pigs were moved to up to a week before loading. This has the benefit of reducing mixing stress at transport and makes it much simpler to withdraw feed before transport, as well as making the loading process much faster, with reduced stress on pigs and handlers. Finally, some barns had truck sheds adjacent to the loadout. Sheds provide the advantage of having environmental conditions consistent between the barn and trailer, so pig movement onto the truck is not affected by wind, rain, cold temperatures or high contrast due to sunlight.

Handling practices

Recommended practices related to group size, distractions and handler technique and attitude were reviewed. In terms of group size, smaller groups (5-10 animals) have been shown to be easier to move. If larger groups are moved, considerations must be made regarding the animals (level of fear and willingness to move), facilities (minimal blockage or distractions), and the handlers abilities. Distractions are known to cause pigs to slow, balk or turn back, and farm managers must be observant to detect and minimize distractions in order to reduce stress and keep pigs moving. One common distraction is too many handlers, or handlers that get ahead of pigs and cause them to turn back. Several examples of this were found in the video footage and demonstrate how important it is to observe animals and minimize distractions during handling.

Handler technique and attitude are very difficult to define and measure, however some general recommendations include minimizing prod use, using behavioural principles such as the flight zone and herd behaviour, and maintaining a calm and consistent attitude. Prod use on the farms observed was very low. In fact, the farm with highest prod use actually had the longest loading time. This is because when the prod is used frequently, pigs become less capable of responding and attempt to turn back. Several examples of good handling were found. In one example, the handler stood well behind a group of about 20 pigs as they exited the home pen, providing 'release'. When pigs are moving well a good handler will step back and let the animals move on their own. If the handler steps in closer in an attempt to get them moving faster, the closest pigs will often turn back and escape past the handler. In another example, groups of 12 pigs were moved using handling boards and minimal prod use, and with minimal interference from handlers. The pigs exited a pre-loading pen, negotiated a turn and mounted the truck ramp calmly as there was plenty of space and the handlers provided an appropriate level of encouragement.

CONCLUSION

There is a large variation in facilities and handling skills across the swine industry, and often little opportunity for producers or barn employees to gain new knowledge.

Lighting, flooring, alley and ramp dimensions and animal handling techniques all have the potential to cause problems when moving pigs through a facility. The best loadouts in Saskatchewan are ones which have taken these factors into account. Our conclusions highlight the fact that handling of pigs at loading can be improved by a variety of measures. This may include extensive load-out renovations, but frequently simple changes in lighting or handling techniques can also be effective. Producers appreciate seeing designs from other facilities and discussing the practical ideas and options presented in this work.

ACKNOWLEDGEMENTS

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Figure 1. Covered hydraulic loading ramp with manway (looking down ramp from truck entry).

Figure 2. Well lit loadout with concrete steps (30 cm treads). Although this loadout involves some corners the transitions are smooth and well-lit and the alley is wide enough for multiple pigs to pass.

Figure 3. External loading ramp allows trucker to assist without entering barn. Note also the ramp extension (on the left) used to reduce the angle of internal truck ramp to the top deck.