27th Annual

CENTRALIA SWINE RESEARCH UPDATE

January 30th, 2008

CentraliaSwineResearch.ca

CENTRALIA SWINE RESEARCH UPDATE
Kirkton-Woodham Community Centre
January 30, 2008

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[2]Population Medicine, University of Guelph
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Wed. January 27, 2010

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Centralia Swine Research Website Update

J.H. Smith
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The annual Centralia Swine Research Update has been a key event for the presentation of research and innovation for the Ontario pork industry for 27 years. The Proceedings from the event are an industry resource. They include a range of written updates in addition to summaries of the speakers' talks.

In October 2006 I created a website, www.CentraliaSwineResearch.ca, to promote the 2007 meeting. The website hosts the program, registration information, directions to Kirkton, sponsorship acknowledgements, and past proceedings (back to 2002). This seemed a good way to increase the distribution of the information available in the Proceedings, and make it available to people in Ontario's pork production industry who cannot attend the meeting. (Proceedings for the current meeting are posted a couple of months after the event.) We did not anticipate the activity the website would experience.

The website increases the speed and scope of getting information out to Ontario and, in fact, to the world. Table 1 summarises some usage statistics gathered since the site was created. "Hits" represents different pages visited on the site. "Visits" are really sessions, in that one visitor viewing several pages during a session is only counted once. A visitor who returns on another day will be counted again. The nearly 7,000 visits since inception and the volume of downloads is impressive for a local, commodity-specific event. While most visitors are from Ontario, many are from elsewhere in Canada, from the US, and in fact from all around the world. The downloading of the proceedings has exceeded all expectations. I estimate that the nearly 3 million kilobytes of downloads over the past 15 months represents the equivalent of about 2,500 full copies of the proceedings, roughly equivalent to the number of paper copies distributed by the usual means over the last 10 years.

The site is indexed by Google. Anyone in the world searching for a topic we've covered will find it on our website. Most of the visits, however, are through direct address requests (80-90%), which demonstrates that the existence of the event is widely known and that the new website is now used as a resource for information. The next most common route is through links from other websites, such as OMAFRA, Ontario Pork, or OVC at the University of Guelph.

A good proportion of visitors view the sponsorship acknowledgement page. In fact, the success of the website reflects the ongoing success of the planning committee, the sponsors, and the registrants in collectively producing a useful and highly regarded event.

We have archived Proceedings going back to the first Update, and a possible future project is to post past programs and selected papers as a resource and as a picture of the topics of interest to the pork industry over the last 27 years.

Table 1. Usage statistics, summarised by month, for the Centralia Swine Research Update website.

	Visits	Hits	Kilobytes downloaded
Jan-08[1]	517	3137	176390
Dec-07	538	3888	273982
Nov-07	496	3488	272395
Oct-07	500	3642	273398
Sep-07	537	3407	178286
Aug-07	601	4041	314227
Jul-07	693	4115	265993
Jun-07	815	4994	293709
May-07	352	2553	175627
Apr-07	458	4342	290404
Mar-07	282	2166	129455
Feb-07	262	2349	114631
Jan-07	575	4161	88946
Dec-06	219	1296	29024
Nov-06	89	995	9184
Totals	**6,934**	**48,574**	**2,885,651**

1. To January 20th.

DDGS in Swine Rations

Phil McEwen, University of Guelph – Ridgetown Campus, and
Ron Lackey, OMAFRA, Feed Ingredients & Byproducts Feeding Specialist
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Background:
An increased output of Dried Distillers Grains with Solubles (DDGS) is expected for North American livestock production. However, very little research has been completed in Ontario using product manufactured by GreenField Ethanol from their Chatham plant.

Objective:
The project evaluated the effects of feeding Chatham DDGS (10 and 20 percent of diet) on pig growth rate, feed intake, economic returns and carcass quality.

Experimental Procedures:
After a three week adjustment period, ninety-six pigs (48.8 ± 5.2 kg) began the trial on February 14th, 2005. Each pen (3 barrows and 3 gilts) was randomly assigned to one of the four grower diets until they were 70 kilograms body weight (BW). They were then fed an assigned finisher diet until they were marketed (≥ 110 kg BW) by pen. The following dietary treatments were formulated and fed:

1. Grain corn, SBM (control diets) and premix. A grower diet [17% CP (0.8% lysine)] was fed until the pigs were 70 kg followed by a finisher diet [14% CP (0.6% lysine)] until they were marketed.

2. Similar diets and feeding strategy to control group. However a 10 percent inclusion of DDGS + crystalline lysine was added to produce diets with similar lysine content.

3. Similar diets and feeding strategy to control group. However a 20 percent inclusion of DDGS + lysine was added to produce diets with similar lysine content.

4. Similar crude protein levels to control diets. However a 10% inclusion rate of DDGS was added with no additional lysine supplementation to produce diets with reduced lysine content [0.7% (grower diet) & 0.5% (finisher diet)].

Results and benefits to swine industry:

- When diets were balanced to a constant lysine level (growing and finishing phase) – similar growth rate (Table 1), feed intake and efficiency estimates were obtain when diets containing 0, 10 or 20 percent dried distillers grains and solubles (DDGS).

- Feed intakes were similar for each dietary treatment indicating that DDGS was highly palatable for the pigs during the growing and finishing phase (35 to 110 kg body weight).

- Carcass measurements were similar for each dietary treatment with comparable dressing percentage, lean yield index, loin depth and backfat thickness observed.

- Gain costs were similar for each DDGS inclusion rate. However due to similar feed efficiencies, gain costs were strongly related to ingredient costs. Therefore producers are advised to incorporate DDGS when this co-product is favorably priced relative to corn and soybean meal.

- Experimental findings were similar to results obtain in the United States from "New Generation" ethanol production facilities. Therefore DDGS, manufactured by GreenField Ethanol (Chatham plant), should be considered equivalent to other DDGS sources (new generation plants) in the United States.

Acknowledgments:
The authors would like to thank the Innovation and Risk Management Branch (OMAFRA), GreenField Ethanol, and OMAFRA for their financial and technical assistance. Support and technical input from each research team member was also greatly appreciated.

Table1. Effects of dietary treatment on pig growth rate, feed intake and carcass quality.

	Control Diet	**10% DDGS + Lysine**	**20% DDGS + Lysine**	**10% DDGS no Lysine**
Growth Performance				
Number of pigs	24	21	23	16
Days to Market (by pen)	56.6	56.7	55.2	56.6
Average Daily Gain (kg)	1.13	1.12	1.14	1.09
Feed Intake Measurements				
Total Feed Intake (kg)	174.7	170.6	171.3	170.9
Average feed intake (kg/d)	3.1	3.0	3.1	3.0
Feed efficiency (F/G)	2.8	2.7	2.7	2.6
Cost of gain ($/kg) - 2005	0.50	0.47	0.46	0.45
Carcass Measurements				
Dressing Percentage	79.6	79.8	79.4	79.5
Yield Index (%)	61.3	61.1	60.5	60.8
Grade Fat (mm)	17.1[a]	17.8[ab]	19.3[b]	18.5[ab]
Meat depth (mm)	62.0	62.6	61.3	64.0

[a] and [b] LS means within row that do not share a common superscript differ significantly (P<0.05).

Methicillin-resistant *Staphylococcus aureus* (MRSA) and *Clostridium difficile* in pigs

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Methicillin-resistant *Staphylococcus aureus* (MRSA)

Methicillin-resistant *Staphylococcus aureus* is a multidrug resistant bacterium that is a tremendous problem in people and an emerging concern in a variety of animal species. In people, MRSA was originally a concern mainly in hospitalized individuals but there has been a dramatic increase in community-associated disease over the past 10 years. MRSA is now a leading cause of skin and soft tissue infections in people in the general population and can also cause severe diseases such as necrotizing fasciitis ('flesh-eating disease') and severe pneumonia.

MRSA has also been identified in pigs. The first reports were from Europe and involved investigation of pigs following diagnosis of MRSA infections in pig farmers and their families. These studies identified contact with pigs as a very significant risk factor for MRSA colonization (carrying MRSA in the nose without signs of disease) and infection. In some countries, pig farmers are automatically isolated when they go to a hospital because they are assumed to be carrying MRSA. The strain of MRSA that was found in pig-associated infections was a new strain that had not been seen in people previously. However, there has been a dramatic increase in infections by this strain in some European countries, including infections in people that do not have contact with pigs. It is suspected that this strain originated in pigs, then spread to pig farmers and pig veterinarians and their families, who gradually spread to the general population. Recently, MRSA was found in pigs and pig farmers in Ontario. This study, the only study to date to look for MRSA in pigs in North America, identified MRSA in pigs from 9/20 (45%) of farms in Ontario. Overall, 25% of pigs were carrying MRSA (mainly in their nose) and 100% of tested pigs were positive on some farms. None of the pigs had MRSA infections; all were carrying MRSA without any outward signs. Similarly, MRSA was also isolated from the nasal passages of 20% of pig farmers, and in all situations where MRSA was found in a farmer, the same strain was found in pigs on the farm. The most common strain was the same MRSA strain that is of concern in Europe. Interestingly, the second most common strain was a type of MRSA that is currently the most common strain in people in Canada, and infection of pigs with this strain probably originated from people. Results from this study suggest that MRSA can pass between people and pigs, in both directions.

There is obviously concern about the potential for MRSA contamination of pork. MRSA can cause food-poisoning, just like other *S. aureus* strains, but this is extremely uncommon. Perhaps a greater concern is the potential for people to become colonized with MRSA after handling contaminated meat. The potential for this is completely unclear at this time. A recent study from the Netherlands reported MRSA contamination of 2.5% of retail meat samples; all positive samples were pork. Similar studies are underway in Canada.

The true risk of MRSA in pigs is unclear. While there have been reports of MRSA infections in pigs, the vast majority of pigs do not develop disease from MRSA. Public health risks are of greater concern and are most relevant for people that have regular contact with pigs. Risks to the general public are probably minimal but further studies are underway to clarify this. Pig farmers should be aware of their occupational risk of MRSA and ensure that their physician is also aware of this should they develop infections that could be caused by MRSA, particularly skin and soft tissue infections (ie. abscesses, boils, infected cuts). Close attention to infection control and hygiene are likely important factors for preventing MRSA infection of pig farmers. Further study is required to identify optimal practices. Ongoing surveillance is also needed to determine whether this 'pig MRSA' strain will spread to the general population, as is occurring in Europe.

Clostridium difficile

Clostridium difficile is a bacterium that is an important cause of disease in various species, including people and animals. In people, it is the most commonly diagnosed cause of diarrhea in people in hospitals and those treated with antibiotics. Recently, large outbreaks of *C. difficile* associated diarrhea have been reported internationally. More severe disease is also been reported, with higher mortality rates, more complications and severe disease in people traditionally considered to be at low risk.

Clostridium difficile is clearly a cause of disease in pigs, particularly 1-7 day old piglets. Disease can range from diarrhea to sudden death. Outbreaks can occur. The incidence of disease seems to vary geographically and the role of *C. difficile* in disease in pigs in Ontario is unclear. Risk factors for *C. difficile* in pigs are unclear. There is concern that the use of antibiotics, particularly ceftiofur, may be associated with *C. difficile* in pigs.

Contamination of retail meat with *C. difficile* has recently been reported. Reported prevalences range from 20-60%, with higher prevalences reported in the United States. It is currently unclear whether there are any true risks of foodborne disease. One area of concern is the ability of *C. difficile* spores to survive normal cooking temperature, unlike other bacteria such as *Salmonella* and *E. coli*. It is possible that low-level exposure to *C. difficile* in food is a common event and very low risk. Considering the high prevalence of retail meat contamination, it is clear that exposure to *C. difficile* in food does not necessarily result in disease. Concerns about *C. difficile* in meat have recently been heightened because of increased suspicion that *C. difficile* is an under-recognized cause of diarrhea of people in the community. Further, the strains of *C. difficile* that tend to predominate in food animals are also the ones that are more common in community-onset *C. difficile* infections. This has led to suggestion that meat may be one factor involved in community-onset *C. difficile* disease. This is currently unproven.

Because *C. difficile* can be found in a large percentage of older pigs and because *C. difficile* spores are highly resistant in the environment, eradication of *C. difficile* on farms will be difficult to impossible. Therefore, measures to reduce the incidence of disease and meat contamination are probably more valuable. A recent study demonstrated that feeding piglets spores of strains of *C. difficile* that are non-toxigenic (and can't produce disease) protected piglets from developing *C. difficile* diarrhea when inoculated with disease-causing strains. Vaccination may be another option in the future.

Can Canada Compete?

Kevin Grier
George Morris Centre, Guelph, Ontario

The Canadian hog industry is undergoing a period of uncertainty due to the rapid escalation of feed grain prices, the appreciated Canadian dollar and packer consolidation. The pending US Country of Origin Labeling legislation is also threatening the industry's access to the US. Throughout 2007, producers have seen either negative margins or margins that are weaker than their US counterparts. For these and other reasons, producer attrition is accelerating and producers are assessing their futures in the industry.

In this environment, producers are asking themselves whether their businesses can be competitive or not.
This paper looks at the current challenges and assesses prospects for the future in the Ontario hog industry.

Before dealing with problems, it is important to assess the Canadian industry's strengths. A number of factors converged in the mid-1990's to generate and sustain the Canadian and in particular, the prairie industry's growth. The following are key points:

§ The 1995 repeal of the Western Grain Transportation Act (WGTA), in particular, created an incentive to produce livestock in the Western provinces, a region historically dedicated to grain production.
§ The move from single desk selling to open marketing accelerated change on the Prairies. Essentially, the fact that producers were responsible for their own marketing decisions resulted in a more efficient and competitive industry, based a more knowledgeable producer base.
§ The Governments on the Prairies also played a role through overt support for the hog industry. The governments of the day provided the vision, the direction and the reassurance that growing the hog industry was the right thing to do. This was very significant because it provided the simple message to the public that the hog industry is competitive and sustainable.
§ Related to the above concepts was the fact that there was regional acceptance of livestock growth. This acceptance was due to the lack of alternatives or, conversely, the positive spin-offs of hog production.
§ During the period of depreciation of the Canadian dollar in the late 1990's and early 2000's, a lower dollar meant higher hog prices. Not only that, but other costs such as labour could be much higher in Canadian dollars while still remaining competitive in US dollars. A cheap dollar was especially good for weaner pig shippers to the US. Given that feed grains were not a large part of their business, compared to finishers, the depreciating dollar simply translated into higher prices and higher profits. The net result was that the cheaper dollar resulted in higher profits or lower losses than would have otherwise been the case. This encouraged expansion, especially of the weaner trade.
§ Canada signed trade agreements with the US in 1989 through CUSTA, with Mexico in 1993 through NAFTA, and with the WTO in 1994 which had the effect of increasing market access for Canadian products. In addition, the countervailing duty that had been levied by the US on Canadian hog exports expired fully in 1997. The effect was greater access to export markets for meat and livestock, along with other products. This was significant for Western Canada because the local population of consumers is quite small compared to its productive capacity for livestock and meat; the presence of a more readily accessible export market provided a demand-based rationale for livestock development.

§ The Canadian industry also had an advantage over the US in terms of swine diseases, available land and a supportive climate for production. This is partially manifested in the fact that Canada has much higher sow productivity than the US.

Industry Issues and Challenges

Canadian hog producers face a number of competitive challenges relative to their counterparts in the US Midwest. The most important challenge relates to feed grain costs, but labour is also a significant variable. Based on George Morris Centre analysis, as of late 2006 or early 2007, an efficient operation on the Prairies and Ontario may be at a cost disadvantage, compared to the US Midwest, by approximately $5-8/head. This differential between Canada and the US helps to explain why, over the past three years, US producers have enjoyed an extended period of profitability while prairie producers have seen variable returns at best, or losses at worst.

The Canadian pork packing industries appear to be at a competitive disadvantage across a range of critical success "drivers." The most important of these drivers is economies of scale and its impact on plant efficiency. There is little doubt that there are real, measurable weaknesses facing Canadian packers for each of these competitive drivers. For the industry as a whole, a conservative estimate of the disadvantage would also be $5-8/hog in Prairie plants.

Lastly, the pending 2008 US legislation regarding Country of Origin Labeling has the potential to exert a negative impact on the Canadian livestock industry. It might result in lower prices in Canada and will accelerate producer attrition and the decline in herd sizes for both cattle and hogs.

Prospects for the Future

There is a moderately positive outlook for Canadian hog production competitiveness in the future, compared with recent history. The policy factors working against feed grain production and pricing are now widely known and producers are working to deal with them. The major factor that could act against this would be major ethanol developments in Canada that cause corn, barley and feed wheat prices to increase proportionally or more against US corn. The driver for this would be a policy decision by the government to increasingly subsidize ethanol production, given that it is not economical without subsidies.

The prospects for the packing industry range from optimistic to pessimistic, from a producer perspective. The pending sale or closure of the Maple Leaf Burlington plant is of course the most difficult challenge facing Ontario producers.

Hog density per square kilometer of arable farmland has been cited as a measure of industry potential when compared to the swine industry in other regions and countries. In Canada, Saskatchewan is at 7 hogs produced per square kilometer, Alberta at 17, Manitoba at 76, Ontario at 126, and Quebec at 208.
Compared to the United States and other major pork producing countries, hog production densities are not remotely an overriding issue for the prairie industry. Internationally, by comparison, densities in Canada are low compared to Iowa at 212, North Carolina at 484 and the Netherlands at 1,350 pigs per square kilometer of arable farmland.

In addition, Canada has the second highest quantity of arable land per person in the world, after Australia. Canada's arable land per person is nearly double that of competing nations such as Argentina, Brazil and the United States. In general, according to the Canadian Agri-Food Marketing

Council, Canada has greater availability of fertile arable land relative to human and animal requirements than most, if not all, major pork producing countries.

Summary and Conclusions

The Canadian hog and pork industry is an agricultural success from any economic perspective including growth, jobs, incomes and trade. The entire industry in Canada has undergone a period of three years in which it has suffered disproportionate losses relative to US competitors. As a result, the industry now finds itself in a period of rationalization of packing plants and more rapid attrition in producer numbers. The summer 2007 announcement by Olymel that it would reduce its pricing structure in Red Deer will accelerate the attrition in producer numbers on the prairies. Furthermore, the prospects for packing plant closures on the prairies and in Ontario are factors that, again, will involve massive challenges for producers. Lastly, the pending US legislation regarding Country of Origin Labeling has the potential to further reduce pricing in Canada relative to the US. There will be a period of two to three years of industry pressure and reduced production in much of the prairies and the hog regions of Eastern Canada.

Antimicrobial Resistance in *Salmonella* on Ontario Swine Farms, 2001-2006

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Introduction

Salmonella serovars demonstrating multiple antimicrobial resistance are important worldwide public health conern (1)**. P**ork products are a source of *Salmonella* infection in humans (2, 3). Antimicrobial resistance associated to *Salmonella* might be transferred to other swine pathogens causing serious problems in treatment and control of infectious diseases. Therefore, epidemiological studies need to be conducted in order to gain a better understanding of antimicrobial resistance in *Salmonella* on swine farms. The point estimate studies cannot represent the true status of *Salmonella* and antimicrobial resistance in swine and it is very important to test swine farms for *Salmonella* over a period of time. The objective of this study was to describe the farm-level prevalence of antimicrobial resistance in *Salmonella* isolated on Ontario swine farms during the years 2001-2006.

Materials and methods

Herd selection and sampling. One hundred and thirteen Ontario swine farms were tested annually for *Salmonella* 1 to 5 times within the time period 2001-2006. In total, 9, 25, 8, 17, and 54 farms were visited one, two, three, four, and five times, respectively. On each farm, 1 grower-finisher barn was chosen and within the barn 5 pens with pigs close to market weight were selected for sampling. Fecal samples were obtained from 2-3 pigs per pen and from the fresh manure found on the floor of each of the 5 selected pens. In total 6844 fecal samples were obtained during 422 visits over the entire study period. In addition to culture, a portion of the fecal samples were stored at –70 °C.

Bacterial isolation and antimicrobial susceptibility testing. The weight of samples, and the media used for culturing were not similar for the five visits. Briefly, 1 g feces collected in the Year 1 and Year 2 visit was enriched in 9 mL BPW followed by culture in RV and plating on MSRV. However, for other visits 25 g of feces were enriched in BPW, cultured into RV, and plated on XLT4. The frozen samples were cultured, for 2, 26, and 40 farms in Year 1, Year 2, and Year 3, respectively. In order to test the frozen samples, the 5 vials belonging to 5 pigs in each pen and the one related pen vial were pooled. The pooled frozen samples were enriched in TT broth, cultured into RV broth, and plated on XLT4. The presumptive *Salmonella* colonies were tested on Triple Sugar Iron agar, Lysine Iron agar, and Christensen's Urea agar and submitted to the Reference Laboratory for Salmonellosis, Laboratory for Foodborne Zoonoses, Public Health Agency of Canada, Guelph for serotyping. Antimicrobial susceptibility was done by the agar dilution (AD) and susceptibility breakpoint levels were those described by the National Committee for Clinical Laboratory Standards (NCCLS) (4).

Results

Salmonella was cultured from at least 1 sample collected on 69 (61.0%) farms over the entire period of the study. *S.* Typhimurium (including var. Copenhagen) was found on 35.5 % of the farms. The most frequent phage type was PT104 seen on 28% of the farms.

No resistance was determined to amikacin and ciprofloxacin and only one nalidixic acid resistant isolate was recovered in the first year of the study. Only 1% of the isolates were resistance against ceftiofur, ceftriaxone, apramycin, apramycin, cephalothin, amoxicillin/clavulanic acid, cefoxitin, and

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gentamicin. Resistance to ceftiofur, ceftriaxone, and apramycin was observed only in the last year of the study in 3, 3, and 4 isolates respectively. Two of the 3 cephalothin resistant isolates, were recovered in 2001 and one in Year 5. Resistance to carbadox was found in 6 isolates of which 1 isolate was recovered in 2003 and 5 isolates in Year 5. The most frequent resistance was seen against sulfisoxazole (Su, 45.1%), tetracycline (T, 43.4%), streptomycin (S, 42.5%), spectinomycin (Sp, 41.6%), chloramphenicol (C, 36.3%), and ampicillin (A, 35.4%) followed by neomycin (N, 23%), kanamycin (K, 23%), and nitrofurantoin (Nit, 18.6%). Resistance against sulfamethoxazole/ trimethoprim (10.6%), trimethoprim (8.8%), cephalosporins (including ceftiofur, ceftriaxone, cephalothin, and cefoxitin) (3.5%) was observed only in Year 2 and Year 5. A significant trend in the prevalence of farm-level antimicrobial resistance was detected. However, the farm-level antimicrobial resistance in the Year 5 did not differ significantly compared to the previous year. The trend in the farm-level resistance against the most frequent antimicrobials is shown in Figure 1. Three groups of farms were defined based on *Salmonella* status for each year of the study. A farm was classified either as Group 1 if no *Salmonella* were recovered during the entire study period, as Group 2 if *Salmonella* without antimicrobial resistance were isolated, or classified as Group 3 if *Salmonella* with antimicrobial resistance were cultured. The distribution of farms into the three groups is shown in Figure 2. When defining these 3 groups for the entire study period, 44 (39%), 30 (27%), and 39 (35%) farms were categorized into Group 1, Group 2, and Group 3, respectively.

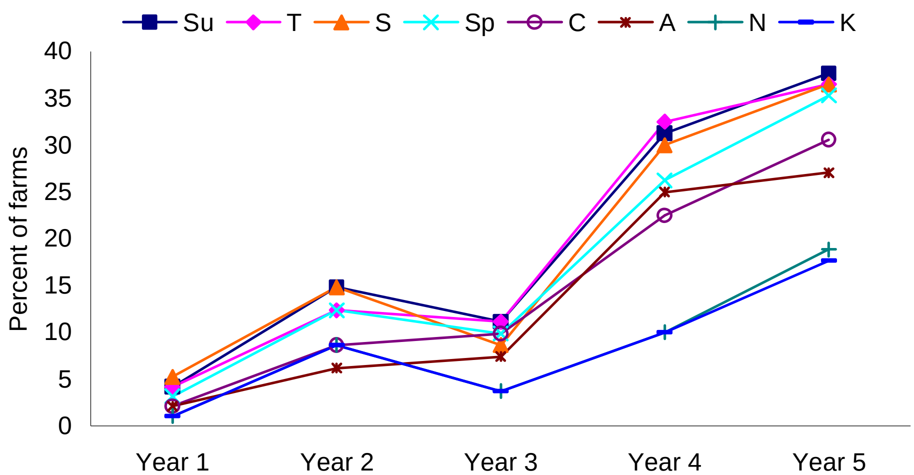

Figure 1: Trends in the farm-level prevalence of the eight most frequent antimicrobial resistances.

Discussion

Significant trends were detected in farm-level prevalence of antimicrobial resistance during 5 years of this study. Although, these trends may denote the dynamics of antimicrobial resistance in *Salmonella* on swine farms, they need to be interpreted with caution since we used different culturing methods, and different types of sample and sampling strategies in each year. However, the sampling strategy and the culturing methods used during the Year 4 and 5 may be comparable. The prevalence of antimicrobial resistance at the isolate level demonstrated a change in the last year of the study compared to the previous year which might be partly attributed to the fact that multiple colonies per sample were tested in Year 5 compared to 2004 when only 1 colony per sample was tested. However, the farm-level antimicrobial resistance in the last year of the study did not differ significantly from the previous year.

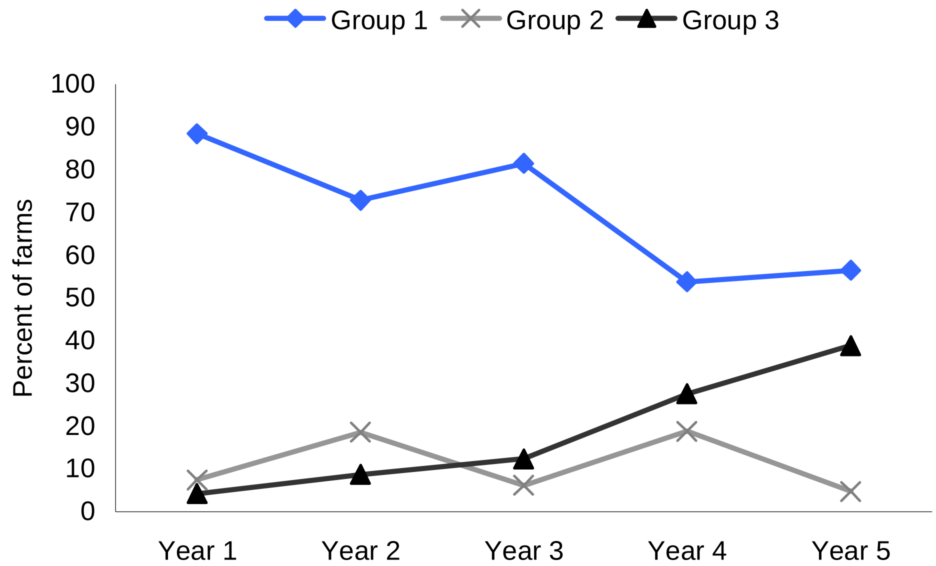

Figure 2: Trends in the distribution of swine farms into three groups of the outcome regarding *Salmonella.*

Resistance to the cephalosporins and carbadox which had not been used in Canada since 2001, was found on 2 farms each in the last year of the study. Emerging resistance to cephalosporins is of importance from a public health point of view because these antimicrobials are common choices for treating human salmonellosis. Resistance to carbadox deserves a serious consideration and follow up because the use of this drug in swine industry has been banned in Canada since 2001. Among the three groups of farms which defined in the current study, the Group 3 is of particular concern from a public health standpoint and pig production and warrants attention. Further studies need to be conducted to compare the risk factors that distinguish these three groups of farms. These findings indicate that monitoring over time may be useful to detect changes in antimicrobial resistance patterns on swine farms.

Acknowledgements
We would like to acknowledge the Public Health Agency of Canada, the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), Ontario Pork, the Canadian Research Institute for Food Safety (CRIFS), and the University of Guelph – OMAFRA Animal Research Program for financial and technical support.

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A Toolbox to Manage Mycotoxins in Corn

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Initial estimates indicate that the episodic Fusarium event of 2006 cost Ontario's corn industry over $60 million. This does not include the millions in cost due to loss of production and feed replacement in the swine industry. Clearly, the lack of an early warning system and communication tools resulted in a crisis at harvest time, and the same lack of effort created dissentions and differences amongst industry stakeholders. Pork producers are left vulnerable to future epidemics because hybrids that are more tolerant to mycotoxin accumulation are hidden amongst those that are highly susceptible when produced in favourable environments.

There is a need for a systematic and proactive, cost-effective approach towards the control of mycotoxins throughout the whole production and processing chain, rather than relying entirely on expensive end-point testing-segregation strategies. Therefore, we are developing a program in collaboration with industry based on the Hazard Analysis and Critical Control Point (HACCP) approach that involves strategies for prevention, control, good manufacturing practices and quality control at all stages of production, from the field to the final consumer. HACCP is a preventive system of food safety control based on the systematic identification and assessment of hazards in food and the definition of means to control them.

Before harvest in the fall of 2006, corn samples were retrieved across southern Ontario from 72 field locations by OMAFRA, from over 300 on-farm grower-submitted strip trials, and from more than 2,000 plots of corn hybrid entries in 11 environments of the Ontario Corn Performance Trials (OCPT). In addition, we have over 1,000 hybrid-environments of data from on-farm surveys between 1993 and 2000. The majority of these data points are georeferenced and linked to specific weather and agronomic field information.

In 2006, a preliminary analysis showed that the majority of locations in southern Ontario had corn samples exceeding 5 ppm DON (Figure 1). Even though 1986 has been remembered as the previous episodic event in corn since 2006, the on-farm random surveys between 1993 and 2000 indicate local hotspots in southern Ontario in nearly every year within those eight years (Figure 1). In particular, the hotspots appear to be more frequent in the southwestern counties of the province. Based on these observations, we can argue that contamination of corn does not occur in a one year of ten or twenty events, but rather with substantial risk in localized areas in nearly every year, a risk noted by many pork producers as substantial and significant.

While there have been many attempts to look at mitigating solutions such as blending and cleaning, reducing the levels of toxins in the grain is the better approach; hybrid selection is one. It is well documented in the literature that some hybrids are more tolerant to mycotoxin accumulation than others. For example, differences were widely noted between the old hybrids Pioneer 3790 and Pioneer 3737, which were demonstrated in our misted trial system setup in the 1990s (Table 1). Similar differences were noted in two modern hybrids from the OCPTs in 2006 (see illustration in Table 2). A preliminary relationship between visual ratings and toxin concentrations may be useful as an early in-field indicator of contamination (Figure 2). We can argue that modern hybrids are no more tolerant to mycotoxins than hybrids grown in the 1990s, despite advances in the technology available to breeding efforts; grain yield is still the predominant and overwhelming factor driving seed sales. This study will at least seek to develop a system to identify hybrids that are more susceptible to mycotoxin accumulation and one that is amicable to the seed industry and producers alike.

Forecasting DON in wheat has been extremely useful for management, and is an effective teaching tool for understanding the dynamic-responsive nature of the toxin to weather and crop management. In corn, real time monitoring data of mycotoxin contamination will provide immediate feedback on potential health risks associated with the sample and permit the development of a more focused and cost effective sampling and product segregation strategy for grains at the mills and distiller's grains in ethanol plants. Using numerous data points collected since 1993, in addition to those collected in 2006, this project offers a strong opportunity to evaluate forecasting tools, hybrid screening platforms and to increase the accuracy of analytical techniques to develop a surveillance system and early warning tools that were lacking in the 2006 outbreak.

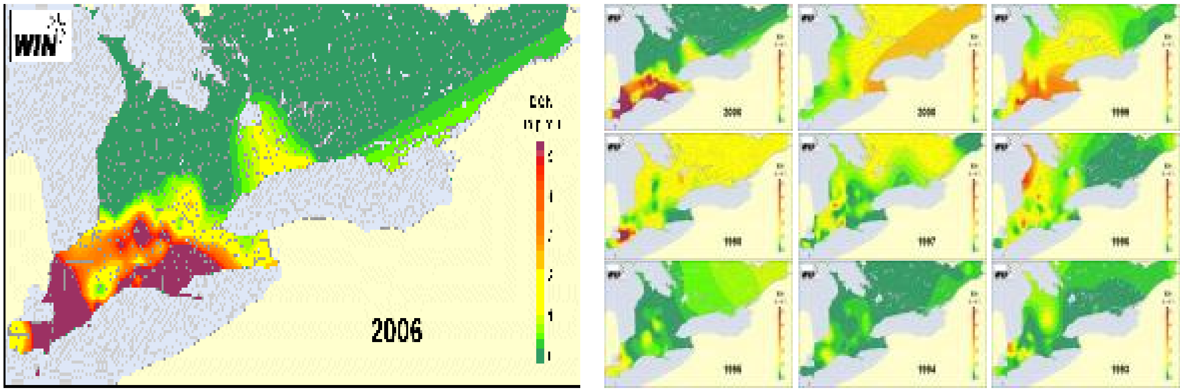

Figure 1. Concentrations of vomitoxin (DON) in grain corn samples across southern Ontario in 2006 (left), and from 1993 to 2000 compared to 2006 (right).

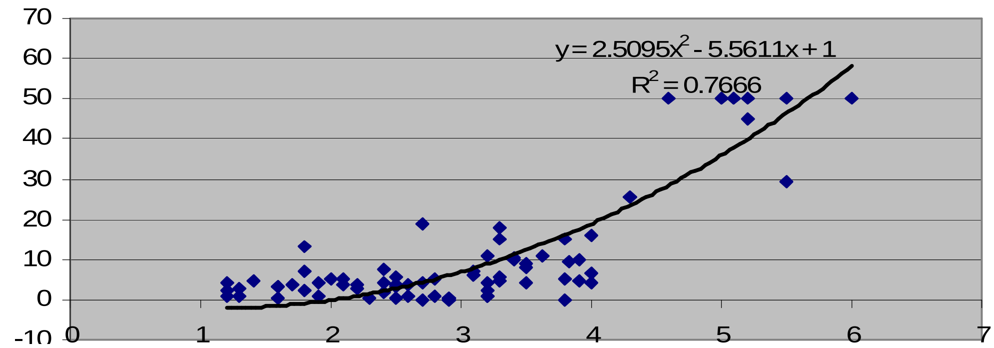

Figure 2. Relationship between visual ear ratings (1=clean; 7=100% coverage with mycelium) and DON concentration in preliminary data.

Table 1. Comparison of visual ear severities and DON of two popular corn hybrids in 3 replications in 1992

		Ear mold severity 1-7 n=10							DON 1992 (ppm)	
Hybrid	Rep	91	92	93	94	95	Rep mean	Hybrid mean	Rep	Hybrid mean
P3737	1	6	3.4	2	3.4	4	3.8		10	(>10)
P3737	2	6	3.9	2.0	4.5	5	4.1		0.5	
P3737	3	5	4.6	2	3.6	5	3.9	3.9	3.0	4.5
P3790	1	3	1.6	2	2.3	3	2.3		0.2	
P3790	2	3	2.9	2	3.4	2	2.5		0.2	
P3790	3	3	2.7	2	2.7	3	2.6	2.5	0.5	0.3

Table 2. Comparison of visual ear severities and DON of two modern hybrids from the Ontario Corn PerformanceTrials (OCPT) in 2006

			Ear mold severity 1-7									DON (ppm)	
Hybrid	Location	Rep	1	2	3	4	5	6	7	Rep mean	Hybrid mean	Rep mean	Hybrid mean
Hybrid A	G. Pointe	1	2	3	6	1	3	6	5	3.7		14.0	
Hybrid A	G. Pointe	2	5	5	1	1	3	2	3	2.9		16.0	
Hybrid A	G. Pointe	3	4	5	5	4	4	1	1	3.4	3.3	17.0	15.7
Hybrid A	Rtown	1	7	7	6	5	2	4	5	5.1		18.0	
Hybrid A	Rtown	2	1	7	7	7	5	5	6	5.4		15.0	
Hybrid A	Rtown	3	3	5	6	2	4	6	6	4.6	5.0	4.2	12.4
Hybrid B	G. Pointe	1	1	2	3	1	4	1	3	2.1		3.0	
Hybrid B	G. Pointe	2	1	1	1	1	2	1	3	1.4		3.4	
Hybrid B	G. Pointe	3	2	3	1	1	2	1	1	1.6	1.7	3.3	3.2
Hybrid B	Rtown	1	2	3	2	3	3	2	2	2.4		3.5	
Hybrid B	Rtown	2	3	2	2	3	3	2	4	2.7		4.8	
Hybrid B	Rtown	3	2	3	2	5	5	5	4	3.7	3.0	2.2	3.5

Control of PCVD/PCVAD with Special Emphasis on Vaccination Results

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Beginning in fall 2004 Ontario and Quebec swine producers began experiencing significant increases in mortality in growing finishing pigs. At this point a diagnosis of PMWS with a subsequent name change to Porcine Circovirus Associated Disease (PCVAD) in North America was made. PCVAD rapidly became a 'hot topic' in the North American swine industry and the focus of intense research efforts.

At that time "many different intervention strategies" were tried and in my clinical experience had little to no value. Fortunately, since then, there have been significant changes in the PCVAD control landscape. Within Canada, there are now four vaccines labeled for the control of disease related to Porcine Circovirus Type 2 infection: Circovac® from Merial, Ingelvac® CircoFLEX™ from Boehringer Ingelheim, Circumvent PCV™ from Intervet and Suvaxyn™ PCV2 One Dose vaccine from Wyeth.

The positive impact of these vaccines on mortality appears to have been equally as dramatic as the negative impact of the emergence of PCVAD (**Table 1**). I have, on more than one occasion and in all due seriousness, commented that the developers of these vaccines should be considered for recognition with a Nobel prize.

Table 1 – Summary of finisher mortality data from MacDougald and Jones.

	1Q '05	2Q '05	3Q '05	4Q '05	1Q '06	2Q '06	3Q '06	4Q '06	1Q '07	2Q '07	3Q '07
Max	4.8%	5.8%	9.2%	16.3%	17.3%	15.5%	12.7%	15.3%	8.8%	7.7%	4.3%
Min	1.3%	1.3%	1.5%	1.5%	2.1%	3.0%	2.4%	1.0%	1.3%	0.7%	0.9%
Avg	3.6%	4.3%	5.9%	5.5%	6.9%	8.2%	6.4%	9.3%	5.0%	3.5%	6.4%

You 'never get something for nothing' though and the advent of the 'vaccine era' brought with it new challenges and new questions. At the outset supplies of PCV2 vaccines were insufficient to meet demand. In response many swine production systems used all of the available commercial products concurrently in order to vaccinate as many piglets as possible. At the same time off-label use (e.g. half dosing or administering a single injection of vaccines labeled for use as two dose vaccines) became common place in an attempt to 'stretch' vaccine stores and protect as many pigs as possible.

Over the past 12 months increased supplies of PCV2 vaccines have become available to our practice and so one of the key challenges presented by PCVAD has become selecting and implementing the 'right' vaccine and the 'right' vaccine protocols for our clients. To that end our practice continues to invite practices throughout Canada and the USA to **collect and share** as much data as possible about PCVAD, its impact and its control.

Presented in Figure 1 is a summary of the data that we have so far. The information presented here has been collected in the field and over time, and must be interpreted accordingly. Be ever wary of the simple, easy, and all too often, wrong (or at the very least) incomplete answer. In particular, the BI Circoflex data presented here has been significantly confounded by concurrent infection with both PRRSv and M. hyopneumoniae in the system that provided the data.

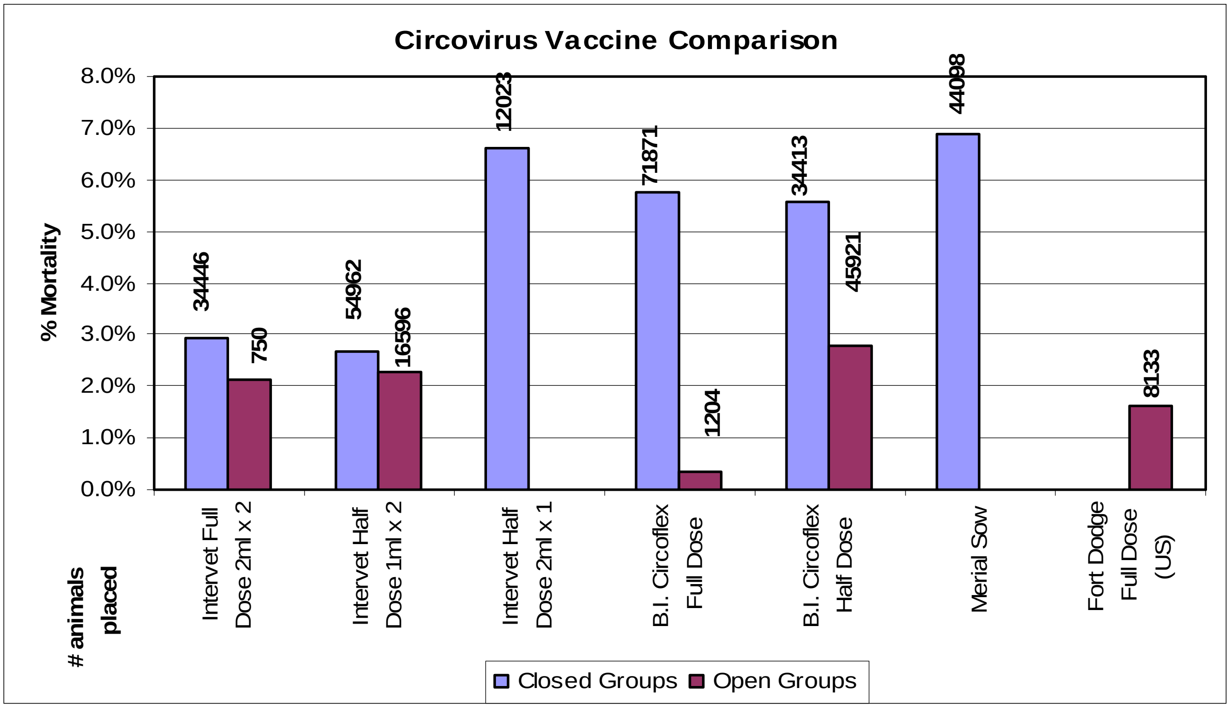


Figure 1 – Summary of mortality data for varying vaccine intervention strategies as collected by and provided to MacDougald and Jones. Note: Open groups have been placed for greater than 7 weeks but have not yet been closed out.

As we analyze the data we have collected so far and get about the business of trying to answer the complicated questions surrounding how best to implement PCV2 vaccination protocols, it is important that we take a step back from this narrow focus and examine the other important lessons that this devastating disease can teach us. For me, PCVAD has served to:

- Remind me of just how far we as a North American pig industry have strayed from long term effective large population management.
- Put a spotlight on eliminating or controlling circulating primary pathogens in sow, nursery and finisher populations. More than one of my clients embarked on a PRRSv or M. hyopneumoniae elimination program in response to PCVAD.
- Driven home yet again the importance of having an effective information system that delivers timely and accurate information that links production, health, and financial data into a cohesive whole. We can't manage what we don't measure!

We must not allow the effectiveness of PCV2 vaccines to substitute for good management and long term industry wide strategic planning. The next 'new' pig disease may be just around the corner and effective vaccines and control strategies may well be a lot further off.

Making the Most of PRRS Risk Assessment

Dr. Doug MacDougald, Chair of the OSHAB Board

The PRRS Risk Assessment Program (PRA) is administered through the American Association of Swine Veterinarians (AASV) in collaboration with Iowa State University. PRA training and development of the program in Ontario has been coordinated by the OPIC Swine Health Advisory Board (OSHAB). This tool is designed to evaluate current biosecurity protocols and/or to develop new biosecurity protocols to avoid risk. The program has been administered by the AASV since March 2006 and has been used to assess more than 750 sites in the US and Canada. The current program is designed for assessment of breeding herds.

How is it being used? It can be used to demonstrate improvements in biosecurity over time, as an aid in the decision to initiate a project to eliminate PRRSV from a site, as a tool when assessing a breeding herd site to produce genetic animals and as part of the due diligence process for purchases or contracting agreements. However, perhaps most importantly, it is a tool to identify areas in your production system that you can improve on in an effort to decrease your risk of becoming infected with a new PRRSV strain.

What is involved in a PRA? A PRA must be conducted by a trained veterinarian. It includes a series of questions to provide demographical and historical information as well as questions design to assess internal risk (includes factors such as circulation risks, herd and site characteristics, PRRSV status and management practices) and external risks (includes factors such as isolation and acclimation procedures, movement of supplies and equipment and proximity to other pig operations).

The Ontario PRA Project PRA training was organized by OSHAB in collaboration with AASV in the spring of 2007. 20 veterinarians and veterinarian students were trained to conduct PRAs by Dr. Derald Holtcamp of Iowa State University. OSHAB initiated a pilot PRA project in collaboration with the University of Guelph and two veterinary students were hired to assess farms throughout the summer of 2007. 165 sites have been assessed in Ontario to date. The breakdown of the PRRS status and type of the farms assessed is illustrated in Figure 1.

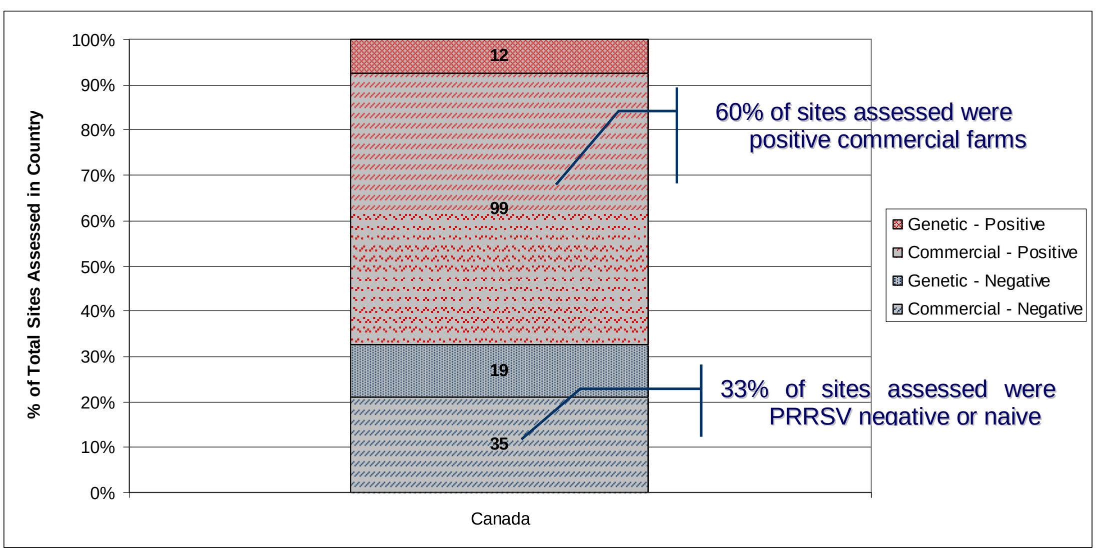
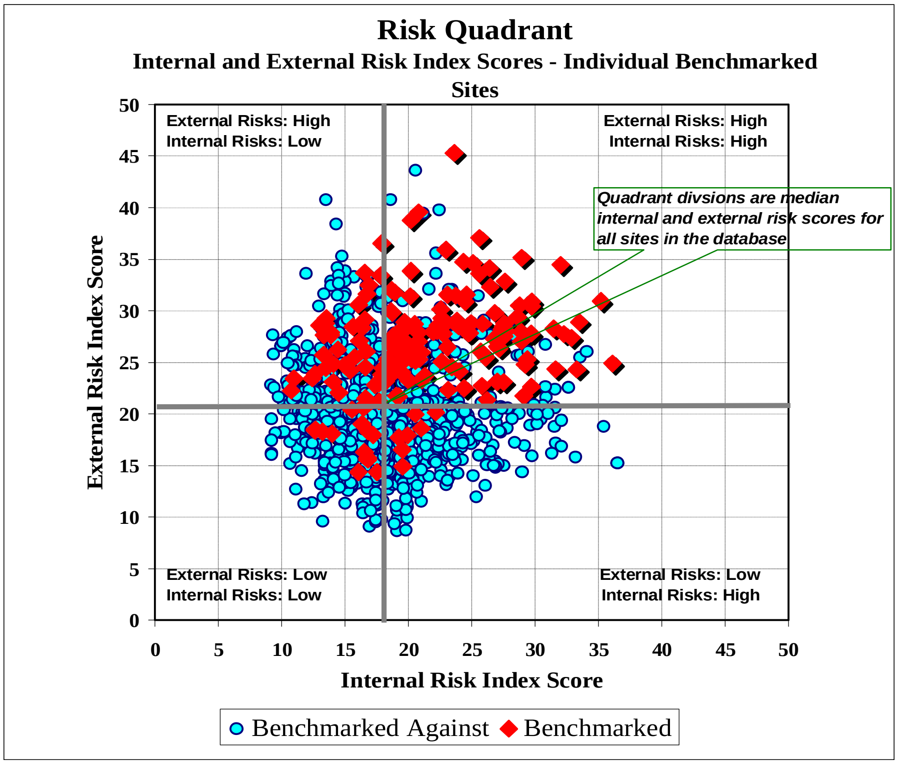


Figure 1. Type of production and PRRSV status of sites assessed for the OSHAB PRRS Risk Assessment Project

How Did We Measure Up? The risk data generated from the Ontario sites was compared to the U.S. farms in the database. As illustrated in Figure 2, the Ontario farms predominantly fell into the quadrant denoting high internal and external risk. The data indicated that 68% of the Ontario farms assessed had factors that resulted in high internal and external risk of PRRS infection suggesting that there are many areas with potential for improvement to reduce the risk of PRRS breaks on Ontario farms.



Red triangles are Ontario breeding herds

Blue circles are US breeding herds

Figure 2. Risk Plot Comparing Canadian and U.S. Herds

However, when the number of PRRS breaks seen in the previous 2 years at each of these facilities was analyzed, Canadian farms saw significantly lower incidences of breaks in all categories of risk when compared to their U.S. counterparts as shown in Figure 3. This may be a factor of pig density as proximity to nearest pig farm and pig density within a 5 mile radius of the site being assessed were significant risk factors for a PRRS break.

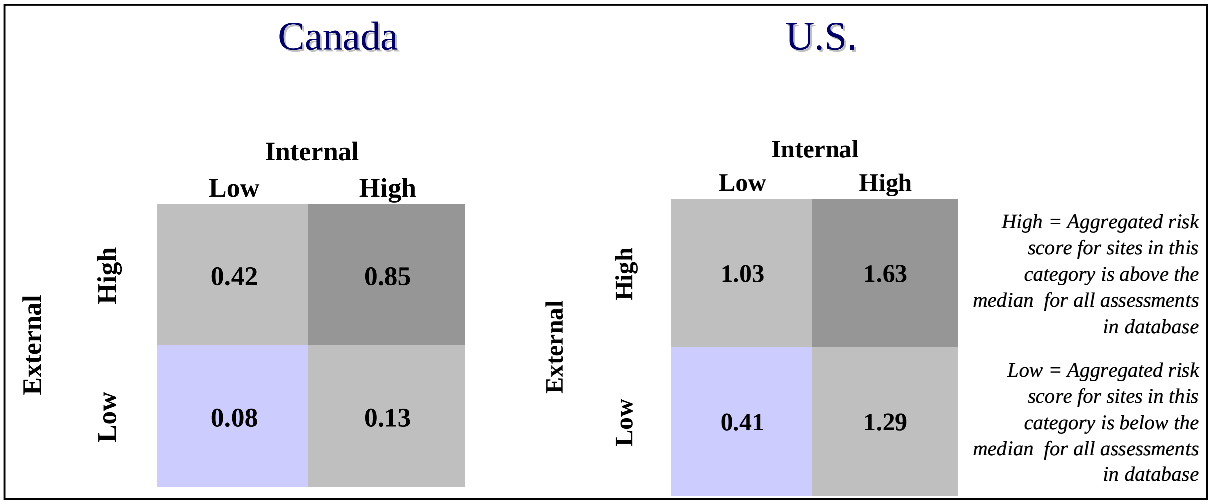


Figure 3. Comparison of Frequency of PRRS Breaks in the Previous Two Years

Future Plans for PRA The AASV and Iowa State University plan to continue to improve and refine the PRRS Risk Assessment for the Breeding Herd. There are also plans to expand the tool to include other diseases and other stages of production. OSHAB sees this tool as an effective way to measure the risk of exposure to a new PRRS virus and to implement measurable improvements. OSHAB will continue in its efforts to provide education and support in the use of this tool.

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Survival Tips – When Every Penny Counts

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Introduction

It is a significant challenge to suggest how a Canadian pork producer in today's economic environment can turn a loss into a profit. Indeed the "perfect storm" of prices, exchange rate and input costs has made losses of $30-$50/hog the norm the last several months. It is the intent of this paper to reinforce production practices backed by research and actual commercial practice that can produce savings of not just $2-3 per market animal but multiples of that. Too often do we hear "I am doing everything possible already" in reference to cutting costs. Production systems are living entities with fluctuations in productivity, management and staff that are overwhelmed with distractions daily, and procedures which evolve whether you want them to or not. There are opportunities, and every dollar saved is one less dollar borrowed under the present conditions. The following is a checklist to take to the barn and help you evaluate where the opportunities exist in your operation.

The focus is on the cost areas with the greatest potential for payback for the efforts invested. These are in order of importance and relative size of annual expenditure: feed (52.7%), wages & benefits 11.2%, and utilities & fuel 4.7%. These three account for nearly 70% of all expenditures on a typical farm in western Canada in 2007. So our approach to addressing costs will be confined to these areas.

Feeding Program

This begins with defining the objective of the feeding program which can be any one of the six objectives in Figure 1. The purpose of defining the program makes it possible for the nutritionist to assist in diet formulation and ingredient selection to achieve that end. So the first opportunity for cost reduction is are we formulating to minimize operational losses? This includes a review of selecting optimum energy, defining lysine:energy ratios, linking other amino acids to lysine, setting mineral levels (even withdrawing in late stage finisher diets) and making use of bargain ingredients. The outcome should be a feed budget similar to Figure 2. The regular matching of actual feed usage by diet type to the budget is the exercise in Figure 3 which shows that after a 5 month period in fact this 600 sow farrow-to-finish farm had excessive use of some of the most expensive diets on the farm and resulted in an average cost increase of almost $6 per market hog. But the owner though they were doing "everything they could" because they had a competitive feed budget. The problem was not the budget but the fact it was not being adhered to for any number of reasons, perhaps as simple as not explaining to the person making or delivering the feed that the number of pigs in the nursery was below budget because of PCVAD.

Other aspects of the feeding program that need to be evaluated include evaluating the energy content of the final diets and implementing the Net Energy system to seek further savings by taking advantage of ingredients available. Reformulating frequently is important when commodity prices move up or down. Reformulating weekly would have been an advantage over the past 120 days.

Utilities

This is an area that has seen significant increases across Canada over the past 5 years. In 2003 we did extensive analysis on the effect of ventilation rate, and set point temperature adjustments that can save on energy costs. At the time we found savings of a magnitude of $1 per pig marketed when we over ventilate finisher barns in the winter. Today electricity prices are three times what we paid in 2003. Our opportunity for savings of up to $3 per hog marketed is possible by ensuring our ventilation systems are performing properly. An extensive analysis of utility costs is being undertaken in a variety of barns across Saskatchewan. The initial results are reported in Figure 4 show that the range of energy use is four fold in farrow-to-finish operations. Although disappointing for those farms at the high end it does indicate that there is significant opportunity to reduce costs incurred for utilities at least $3-5 per pig marketed.

Productivity

When prices are low and losses are high it is easy to turn our attention away from the demanding management of sow reproduction, “so what if we wean a few less pigs, they are not worth anything any way”. However each pig does do its share to carry the overhead of all those fixed costs our barns incur. Actually outside of the growing feed, and trucking, most costs are fixed in our systems so the impact of sow productivity can be profound. For example if we move from 22 pigs weaned (20.7 pigs sold) per year to 28 pigs weaned (26.3 pigs sold) per year our breakeven price for producing a market hog drops from $1.39/kg to $1.26/kg.

Conclusions

There are opportunities for savings on every farm in Canada. Finding these savings takes a methodical and careful process of comparing our targets to what we are actually achieving - doing this on a regular basis will frequently find opportunities to save. In today’s presentation we found in excess of $15 or more per market hog. These savings don’t all exist on all farms but some of these exist on all farms and it is our job to find them and correct them. Then next month look again and find those that escaped our gaze the first time, and be committed to doing it over and over again as we work to maintain margins in a challenging commodity market.

In addition to the items in this paper you will find an extensive management checklist at www.prairieswine.ca, look for the Survival Strategies icon and print down a checklist and associated factsheets detailing where to look and what value you can expect to gain from savings in each area.

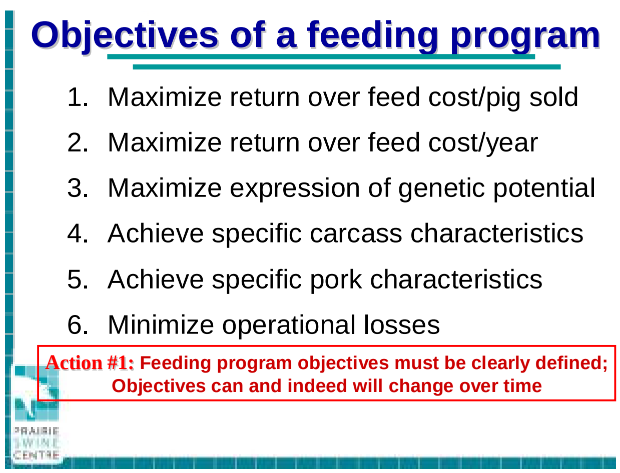

Figure 1. Objectives of a Feed Program

Select phasing of the diets

Diet	Pig Wt., kg	Days	A.D.G., g/d	A.D.F., g/d	Feed, kg/pig
St #1	6	4	115	125	0.5
St #2	7 to 8	6	300	330	2.0
St #3	8 to 14	13	475	620	8
St #4	14 to 22	13	600	870	11
St #5	22 to 35	17	765	1,224	21
Gr #1	35 to 50	16	865	1,900	31
Gr #2	50 to 65	16	920	2,300	38
Fi #1	65 to 80	16	930	2,600	46
Fi #2	80 to 95	16	930	2,850	46
Fi #3	95 to 105	11	880	3,000	38
Fi #4	105 to Mkt	12	830	3,000	32

PRAIRIE SWINE CENTRE

Figure 2. Developing a Feed Budget.

Feed budget versus actual usage

Diet	Budget	Actual (5mo avg)
Wean diet	2.5	3.3*
Starter 1	8	9.1*
Starter 2	11	12.8*
Starter 3	21	23.4*
Grower 1	31	40.1*
Grower 2	38	43.3*
Barrow fin1	46	41.6
Barrow fin2	46	42.9
Barrow fin3	38	43.1*
Barrow fin-mkt	32	46.5*
Gilt fin1	46	48.0
Gilt fin2	46	46.6
Gilt fin3	36	46.1*
Gillt fin-mkt	30	47.4*
Gestation	37	18.1
Lactation	22	18.3
Cost	$83.42	$89.35

Difference $5.93

Numbers in RED* are greater than 10% over budget

PRAIRIE SWINE CENTRE

Figure 3. Routine feed budget analysis.

By barn type

Energy $ / 100 kg pig, over 3yrs

Barn type	No. of barns	Mean	Min	Max
Farrow-finish	8	6.76	3.31	12.24
Nursery	2	1.70	1.36	2.48
Finish	4	1.35	0.95	2.07
Farrow	2	13.08	11.83	13.93
Farrow-nursery	2	16.21	8.93	23.06
Nursery-finish	1	2.66	1.71	4.06

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Figure 4. Range of electricity costs measured in Saskatchewan barns (2007).

Feeding For Profit – Back to Basics

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Introduction

Low pork prices combined with high commodity prices have forced producers to re-examine feed costs, the single largest cost in pork production. This applies in particular to growing-finishing pigs that are responsible for about 75% of total feed usage on a typical farrow-to-finish farm. The challenge is to identify key opportunities to reduce feeding costs and improve profits by altering feeding management. These opportunities will likely differ between pig units. In this short contribution, key principles are reviewed that allow a systematic assessment of feeding management on individual growing-finishing pig units. Most of these principles also apply to sows and starter pigs.

The five aspects of feeding management

There are five key aspects to proper feeding management:
1) establish a realistic feed budgets (feed usage per pig for each diet and optimum nutrient levels in each diet for the specific pig genotype, health status, environment),
2) choose feed ingredients that provide available nutrients at the lowest possible cost without compromising feed quality,
3) proper feed preparation (grinding, mixing, proper addition of feed additives, etc.),
4) rigorous feeder management aimed at reducing feed wastage and not restricting feed intake too severely, and
5) monitor feed quality, feed budgets, and animal performance, to confirm expectations.

Alternative feed ingredients: the single largest opportunity to reduce feed costs

In a typical corn and soybean meal based finisher diet, energy and amino acid sources contribute more than 60% and 30% to the nutrient costs, respectively. Given the high corn costs, consideration should be given to alternative energy sources, such as dried distillers grains, bakery, wheat shorts, fats and oils. In operations with liquid feeding systems, co-products such as distillers solubles, whey, corn steep water and brewers yeast may be used. Research has shown that co-products can reduce feed costs, provided that contents of available energy, amino acids and phosphorus are estimated properly and diets are prepared accurately. In this regard, commercial feed mills have an advantage, because they can purchase large amounts of co-products to reduce costs, apply more detailed quality control, and enhance the feeding value of these ingredients by additional processing, such as pelleting. Table 1 shows the nutrient or ingredient costs of a typical corn and soybean meal based finisher diet, versus a co-product based diet. These diets are similar in available nutrient content and should support similar levels of performance.

Don't forget about costs of minerals, vitamins and feed additives

Calcium, phosphorus, vitamins and trace minerals contribute about 10% to diet nutrient costs. Our research has shown that finishing diets that are based on high-moisture corn or that contain considerable amounts of co-products do not require supplemental phosphorus and phytase. The use of feed additives such as growth promoters and usage of excessive amounts of vitamins should be evaluated carefully, especially in pre-slaughter diets.

Key on-farm factors: grinding, mixing and feeder adjustment

In terms of on-farm feed preparation and management, fineness of grinding and reducing feed spillage at the feeder are still the two key factors. For every 100 µm reduction in average feed particle size, feed efficiency will improve by about 1.2%. Regular feeder adjustment is essential to minimize feed wastage. In studies at Kansas State University, regular feeder adjustment has been shown to reduce feed usage by at least 10%.

Benchmarking: know where you are at, and how you can get to where you should be

To ensure that feeding programs are appropriate, it is critical that pig performance is monitored, either in the whole barn or in a representative group of at least 50 pigs. As a minimum, monitor average body weight of pigs entering the barn, per group feed usage for each of the diets, days in the barn, carcass weight, carcass lean yield, and feed costs per pig. This will allow some real benchmarking against industry standards for your pig genotype and health status, and monitoring of changes over time. Moreover, based on this information your nutritionist can determine opportunities to reduce feeding costs.

Conclusions and take home messages

On every pig unit there will be opportunities to improve profits by manipulating the feeding program and feeding management. Important opportunities are to replace high price commodity ingredients with less expensive co-products from the food and bio-fuel industry, to reduce feed particle size and adjust feeder settings, and to work closely with a nutritionist to develop a realistic and cost-effective feed budget. Several case studies on Ontario farms have shown that fine-tuning feeding programs based on actual performance levels can reduce feed costs by at least $1.00 per pig, and improve profits by at least $1.50 per pig.

Table 1. Impact of feed ingredient composition on nutrient or feed ingredient costs*.

	Ingredient cost	Ingredient content (kg/tonne)	
	($/tonne)	Corn & SBM based diet	Co-product based diet
Corn	155	794.9	368.7
Soybean meal	360	168.6	49.3
Wheat shorts	120		250
DDGS	150		200
Bakery	165		100
Fat	600	8.5	9.6
Lysine HCL	2500	1.5	3.3
Threonine	3500	-	0.4
Dicalcium phosph.	550	8.2	1.3
Limestone	70	11.8	13.9
Salt	165	0.50	0.5
Micro nutrient mix	4500	1.5	1.5
Cost ($/tonne)		**205.65**	**174.66**

* Both diet were formulated to contain 3500 kCal/kg DE; 0.70% SID Lysine; SID threonine / SID lysine 0.67; SID tryptophan / SID lysine 18.5; 0.66% calcium; 0.22% available phosphorus; feed handling and processing is not included in the feed cost.

Update on the Ontario PRRS Mapping Project

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In Ontario, the first reported outbreaks of a PRRS-like disease occurred in the late summer and early fall of 1987. The virus spread rapidly throughout the Ontario swine population and it has since been estimated that between 40-80% of herds in central Canada are seropositive. In the fall of 2004 and winter of 2005, there was a perceived increase in the number and severity of clinical disease due to new PRRS outbreaks in Ontario swine herds. This project was designed as a case-control study with cases being identified through the Animal Health Laboratory (AHL), and control herds being identified by the veterinarians from participating clinics.

Data from 513 herds was collected from herds that had PCR-positive submissions between September 2004 to August 2007 inclusive. On 455 herds, PRRS virus strains were collected and sequenced and farm management data was obtained through a survey tool. The same farm management data was also collected from 58 PRRS virus negative herds. In total, there were 382 premises represented in the study. Some premises were sampled multiple times during the study period when they experienced new clinical problems due to the PRRS virus. On average these samples were taken 200 days apart. The ORF5 region of the PRRS virus has been sequenced from 493 strains. This information was used to calculate the similarities among the strains and to generate RFLP patterns. Two viruses were considered identical if the gene sequence measured at the ORF5 region was at least 98% the same.

Preliminary risk factor analysis was done for factors in three major groups: (i) herd demographics, (ii) frequency of purchasing breeding stock and number of sources, and (iii) biosecurity protocols related to trucking breeding stock in recipient herds. Farms were classified by farm type as follows, farrow-to-finish, farrow-to-feeder, farrow-to-wean, nursery only and finisher only. The current analysis was based on farms that included a farrowing unit. Farms were classified as negative, positive with a wild-type virus or positive with any PRRS virus (wild type or vaccine virus). PRRS positive herds did not differ from PRRS negative herds by the frequency of gilt purchases or number of external gilt and boar sources. However, case herds differed from control herds with respect to a number of biosecurity practices related to trucking breeding stock. Farms with PRRS were 10 times more likely to receive gilts on an unwashed truck, 4 times more likely to receive gilts from a truck not disinfected and 2 times more likely to receive gilts from a truck that was not dried between loads than farms that were negative for PRRS. Wild-type viruses were more often isolated from herds where gilts were delivered on trucks that were not always washed between deliveries compared to farms that were PRRS negative.

Most field strains [77% (n=379)] were wild-type viruses, whereas 23% were vaccine-like viruses. No strains were similar to the European Lelystad strain. In the group of vaccine-like strains, 19% were RespPRRS MLV-like (≥98% similar) and 4% were RespPRRS ATP-like, but none were PrimePac vaccine-like. If we describe the RFLP pattern, 27% of the strains had a RFLP pattern of 1_4, 11% were classified as 134 and 8% were classified as 1_2. It is important to recognize that gene sequencing is a more appropriate method of describing a PRRS virus strain than is RFLP pattern.

On average, each strain in the study population was identical to 4.3% of the other strains in the study. This means that, on average, each virus that was isolated was equal to 21 other strains. The vaccine-like virus strains were, on average, identical to 12% of the other strains. However, if we remove the vaccine-like viruses from this analysis, and restrict our discussion to the wild-type viruses, the number of similar viruses is reduced. On average, each wild-type virus strain was identical to 2% or 9 other strains. Wild-type PRRS viruses with at least 2 identical strains will be targeted to investigate the spread of wild-type viruses within the Ontario industry. There was also a high variability in the number of identical strains for each of the wild PRRS strains (Fig 1). Some viruses were found only once, but one virus was to 55 other virus strains.

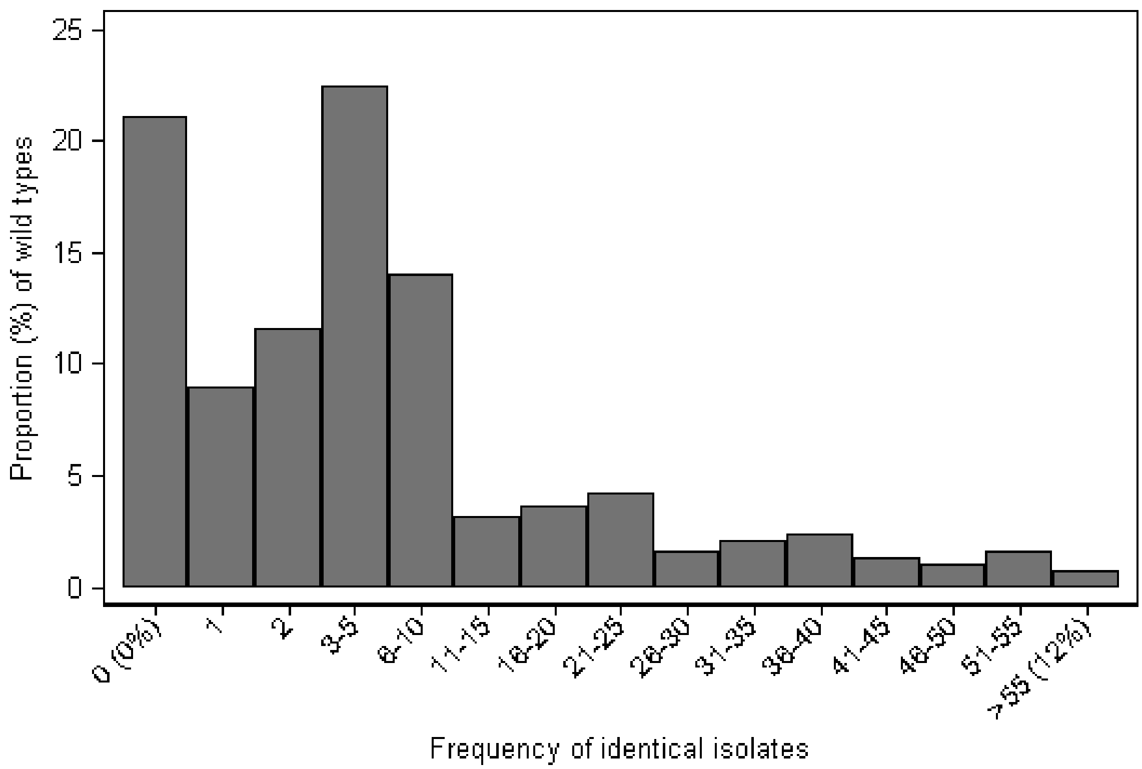

Figure 1. Frequency distribution of identical strains in a group of wild-type PRRS viruses included in the study. The first bar shows that 21% of the wild-type PRRS viruses was not identical to any other strain in the study. The second bar shows that 9% of the wild-type PRRS strains were identical to only 1 other virus in the study. The last bar shows that 1% of wild-type PRRS viruses had more than 55 strains that were identical, representing approximately 12% of the study population.

Understanding the spread of PRRS or any disease in the Ontario Swine Industry is limited by whether or not we know the exact location of the barn from which the sample was taken. In future we hope that all veterinarians and producers will use the unique premise ID on their submission forms to the laboratory. This will increase the efficiency of this data for research and monitoring purposes.

Key points:

1.) Delivery of replacement gilts may be associated with the spread of PRRS.
2.) 77% of viruses were wild-types and one virus was often found on multiple farms.
3.) Please consider using premise ID for submissions to the AHL.

Liquid Feeding Research Update

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Introduction

During the last year swine liquid feeding research at the University of Guelph has been aimed at (1) evaluating the feeding value of liquid co-products, and (2) enhancing the feeding value of high moisture corn through controlled fermentation with microbial inoculants and steeping with enzymes. Key findings are presented here.

High dietary potassium levels may limit co-product usage

Increasing demand for corn as a bio-fuel will increase co-product usage in pig diets. However, there are concerns about the negative impact of high co-product usage on growing-finishing (G/F) pig performance and carcass traits. Previous trials have indicated decreased pig growth performance when more than 15% corn steep water (CSW) is included in diets. Negative effects of feeding high levels of CSW may be attributed to high potassium levels in co-products. For example, CSW contains 4.5% potassium compared to 0.4% in corn.

A performance trial was conducted to determine the impact of feeding high levels of co-products (whey permeate and CSW) and high-potassium diets on growth performance and carcass quality of G/F pigs. The four treatments were: i/ standard corn and SBM based diets, ii/ 10% additional whey permeate and either 2% CSW (grower pigs) or 3% CSW (finisher pigs), iii/ 20% additional whey permeate and either 4% CSW (grower pigs) or 6% CSW (finisher pigs), and iv/ standard diet with added potassium carbonate to achieve potassium levels similar to those for treatment iii/ (i.e. 1.4% in diet).

Feed intake and growth were reduced by about 8% in pigs fed the high co-product diets (treatm. iii). The high potassium diets (treatm. iv) showed a slight (5%) reduction in growth performance. Carcass quality did not differ among treatments. However, pigs fed the high co-product and high-potassium diets showed similar signs of kidney damage. Even though growth performance was not drastically reduced, animal well-being appeared compromised when feeding high dietary potassium levels. ***Dietary means to reduce the negative effects of feeding high dietary potassium levels are now explored and may allow even higher levels of co-products usage in swine liquid feeding.***

Simple means to control fermentation of high-moisture corn (HMCorn)

During storage, HMCorn undergoes some fermentation, due to the high water content and anaerobic conditions in the silo, yielding small amounts of short chain fatty acids (SCFA) and ethanol. However, the content of beneficial SCFA, especially lactic acid, in stored HMCorn is insufficient to provide performance or health benefits to pigs. In our laboratory, studies have been conducted to further ferment stored HMCorn aimed at increasing lactic acid production. In these studies HMCorn is mixed with water in about a 1 to 2 ratio (about 25% dry matter) and storing at room temperature for at least 24 h.

When grains and water are combined it is inevitable that (uncontrolled) fermentation occurs resulting in a mix of desirable (i.e. lactic acid) and un-desirable products (e.g. ethanol and acetic acid). In order to control undesirable fermentation products it is common practice in Europe to add a bacterial inoculum, for example lactic acid bacteria. However, largely because of the lack of easily fermentable substrate and the large amounts of endogenous bacteria in stored HMCorn, we have found it difficult to improve fermentation characteristics of HMCorn by adding bacterial inoculums. In order to obtain a 'good' fermentation of stored HMCorn we have explored the use of enzymes to breakdown complex substrate to more simple and easily fermentable sugars, and mixing HMCorn with whey permeate, which is an easily fermentable carbon source. With the addition of whey permeate to HMCorn (10% on a dry matter basis) there was an improved lactic acid production, but also a significant increase in ethanol production. We established that a minimum of 50 mM propionic acid should be added to HMCorn in order to reduce ethanol production. ***Based on in vitro studies, adding a combination of propionic acid and whey permeate is an effective means to control fermentation of HMCorn; this combination in now evaluated in a starter pig performance study.***

Phytase is effective in enhancing phosphorus availability in HMCorn

The availability of phosphorus in MHCorn is about double when compared to that in dry corn (15%). However, more than 50% of phosphorus present in stored HMCorn is still tied up in phytate complexes and thus unavailable to pigs. Exogenous phytase is effective in improving phosphorus availability in conventional dry corn and soybean meal based diets, but little is known about the use of phytase in liquid diets. Studies were conducted to explore the use of phytase in liquid HMCorn based diets for starter pigs.

First, in vitro studies were conducted to establish the minimum amount of phytase needed to release phytate bound phosphorus. Ground stored HMCorn was mixed with water (1:2) and phytase (Ronozyme P) was added at 62.5, 125, 250, and 500 FTU/kg dry matter. A sample with no added phytase served as a control. Samples were allowed to steep at room temperature (25^{o}C) under continuous agitation. Subsamples were taken over a 24 hour period. There were no differences in the amount of phytate-phosphorus release among the three highest phytase activities, which were all considerably higher than the control treatment. Therefore, release of the majority of phytate-bound phosphorus in HMCorn mixed with water is achieved when phytase is added at 125 FTU/kg dry matter.

Based on in vitro observations, five liquid feeding treatments were evaluated in a starter pig performance study: i/ HMCorn with no phytase, ii/ HMCorn with 62.5 FTU added with dry supplement, iii/ HMCorn with 125 FTU added with dry supplement, iv/ HMCorn steeped with 62.5 FTU, and v/ HMCorn steeped with 125 FTU. Total dietary phosphorus contents were 0.48, 0.38, and 0.37 for Phase I, II, and III diets, respectively. The addition of phytase to the diet had no impact on growth performance in this trial, but increased urinary phosphorus excretion and whole body phosphorus content. ***These results suggest that total phosphorus requirements are relatively low when pigs are fed HMCorn based diets, and that phytase was effective in improving phosphorus availability. However, adding phytase to the dry supplement was just as effective in improving phosphorus utilization as steeping HMCorn with phytase.***

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Porcine High Fever Disease in China

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In the summer of 2006, news coming out of China indicated a disease epidemic was sweeping across China and killing large numbers of pigs. The disease outbreak started in Southeastern China then spread inland to eventually involve pigs in 23 Chinese provinces, including the peri-urban commercial farm sectors around Guangzhou, Shanghai and Beijing. The disease acquired the names "Porcine High Fever Disease" (PHFD) and "Mystery Fever Disease Syndrome" as fever was the most common and consistent clinical sign seen in diseased pigs. Pork shortages across China drove supermarket pork prices in Eastern China up from 7.5 yuan ($1.00) to 18.6 yuan ($2.50) per kg by mid-2007 and to 30 yuan ($4.18) on January 10, 2008. Various Chinese-based news media reported anywhere from 400,000 to 100 million pigs dead in 2006 and 2007. "Official" Chinese government mortality figures accounted for about 180,000 to 200,000 deaths in the same period. The usually dependable Robobank analysts estimated a 20% die-off of pigs. With China marketing >520 million pigs a year, the higher estimates reported by the media would seem to be in line with driving pork prices up >100%. In addition, foreign visitors familiar with Chinese pig densities report that on their most recent visits pigs are noticeably absent everywhere they went, giving further first-hand credence to the higher "unofficial" mortality figures.

Clinical Signs of Porcine High Fever Disease

Clinical signs of PHFD include, as the name implies, very high fever (up to 42C), blotchy red discolouration of skin and extremities, red rashes especially over the ears, face and inner thighs, anorexia, vomiting, diarrhea and central nervous system signs. Growing and finishing pigs and pregnant sows were more frequently and severely affected. Sows aborted. Morbidity and mortality were both very high with mortality estimated at 20%. Mortality in some herds approached 80%. The disease course is rapid, lasting 5 to 20 days. PHFD is highly contagious, spreading to adjacent pig populations within 3-5 days. Post mortem findings typically consist of widespread hemorrhages and edema in multiple organs. Diffuse lung edema and petechial hemorrhages in kidneys are common and large blood clots (infarcts) in the spleen and hemorrhages in the bladder wall and lymph nodes are common.

Cause of Porcine High Fever Disease

The cause of PHVD is still in doubt. Researchers in Dr. George Gao's laboratory at the Chinese Academy of Sciences in Beijing isolated a new, highly virulent mutant strain of PRRS virus (PRRSV) from post mortem tissues submitted from affected pigs. Other independent sources, however, including pathologists who have conducted post mortem examinations on representative cases, indicate the outbreaks are due to combinations of PRRS, Classical Swine Fever (CSF) (ie. Hog Cholera), Porcine Circovirus Disease (PCVD), and possibly other, as-yet-unidentified diseases. More recently Russian authorities have reported outbreaks of African Swine Fever (ASF) in Heilongjiang Province in Northern China, near the Russian/ Chinese border. Chinese authorities insist there is no ASF anywhere in China. Furthermore, Heilongjiang is far removed from where the major outbreaks of PHFD have occurred in the south of China. Chinese government publications and news releases have maintained that PHFD and the high mortality are due exclusively and entirely to the mutant atypical and highly pathogenic PRRSV strain. A whole-genome sequence of the mutant PRRSV conducted by researchers at the Chinese Academy of Sciences in Beijing has identified a 30-amino-acid deletion in the NSP2 region as the cause of the increased pathogenicity of this new PRRSV strain. This 30-amino-acid deletion in NSP2 however, is not novel as it has been identified elsewhere in previous PRRSV isolates and has not resulted in the type of disease and mortality reported in China. Nevertheless, experimental trials conducted by the Chinese researchers using the mutant PRRSV isolate have reproduced the high mortality seen in the field in China.

Social and Political Fallout from PHFD

PHFD has had a significant social and political impact in China. The high death losses due to PHFD have acted as a deterrent to prospective pig farmers who became reticent about rearing pigs further exacerbating pork shortages and driving up pork prices even more. Inflated pork prices were a key component in accelerating the annual inflation rate to 6.9% by November 2007, more than double the target benchmark of 3%, raising fears of disturbances in the streets over food prices. These factors have negatively impacted Chinese government policies of enhanced rural development, social cohesion and food security, prompting Premier Wen Jiabao of China to stop for a photo-op at a supermarket pork counter on May 26, 2007, to publicly support and reassure the populace about the safety of the nation's pork. In December 2007 the Chinese government announced their intention to spend 6.5 billion yuan ($800M) over the next year to keep pork prices in check. About half of that amount will be spent on an insurance scheme covering gilts and sows against illness and death from disease. The plan aims on encouraging farmers to stay in and to return to pig rearing. The latest announcement brought Gov't subsidies over the past year to the swine industry up to 15.2 billion yuan ($2.2 B).

Resolution with Vaccination?

The Chinese authorities have issued several news releases announcing development of a new PRRS vaccine. The vaccine was widely distributed, free of charge, to producers and, according to the reports, in very short order widespread vaccination had solved the problem. The jury is still out on so rapid a resolution especially since this immediate and rapid resolution of PRRS problems with vaccination has not been the experience anywhere else in the world.

What's the Significance to Us in Canada?

China has recently become the world's 5th leading exporter of pork. That pork can and does end up anywhere. Until we can be sure just what is causing the PHFD outbreaks, we might be at the mercy of spread of an unknown emerging disease that has not been well characterized and has had perhaps limited international investigation. Above all else, those of us in countries with major pork production want to know with certainty "What's going on with the pigs in China?" We are left somewhat uncomfortable not knowing for sure just what is going on in China.

Summary and Concluding Remarks

Chinese scientists have isolated a highly virulent strain of PRRS virus which purportedly is the cause of a disease epidemic sweeping across China causing severe mortality. There is great concern, however, that PRRS is not the sole cause of the epidemic. PRRS, porcine circovirus, hog cholera and possibly other, as-yet-unidentified disease entities might be involved.

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Making it work: Housing Gestating Sows in Group Pens

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In January, 2007 Maple Leaf Foods made the decision to stop purchasing pigs in the future from farms using gestation crates. There is also an increased interest from consumers in "humane-raised" pork. Together this means that Ontario producers may want to investigate the possibility of switching from crated gestation to group sow housing.

Sows naturally establish a hierarchy when kept in groups. Establishing this hierarchy involves a certain number of aggressive encounters for 1-3 days after sows are mixed together. Good pen design, feeding techniques, and management will decrease the frequency and intensity of these aggressive encounters. The techniques listed below are used successfully by producers in Ontario who use pen gestation for their sows. Since group sow housing systems vary dramatically, producers may need to modify or use a combination of these suggestions to limit aggressive encounters between sows. The suggestions below are listed in order from least to greatest difficulty (based on labour and cost) to implement.

1. Wean sows into breeding crates.
This is only difficult to achieve if your converted facility does not have enough crates for one week's weaned sows. Producers using group sow housing hold weaned sows in breeding crates for various times, but very few wean directly into pens. During estrous, sows will ride each other and can injure themselves and others in the process. Weaning into breeding crates prevents this. Many producers wait until the 28 day pregnancy confirmation ultrasound before mixing a group of sows. Others have success mixing after 7 days in the crates, i.e. directly after breeding. Since implantation occurs around 12-14 days post breeding, it is best to group the sows before or after this time.

2. Put extra feed on the floor of the pen before a group of sows enters.
This is a distraction technique. A similar technique is to put a bag of shavings on the floor of the pen. The sows are too busy eating (or investigating-in the case of shavings) to bother fighting with each other. Some producers feed extra feed (1.5 times the normal ration) for 2-3 days after a new group is mixed.

3. Add a boar to the pen.
The boar assumes the role of "leader" and keeps aggressive encounters between sows to a minimum. If the boar is too aggressive he may injure a sow. If he is not aggressive enough, a dominant sow may attack him, so you need a boar with the correct temperament for this work.

4. Mix the new group at the end of the day and turn out the lights.
Many producers combine this technique with adding extra feed on the floor. The theory is that the sows are calmer when they are full and the barn is quiet and dark.

5. Mix groups of sows by size.
Try to prevent groups from having one or two very small or very large sows as these "outlier" sows can often be quite dominant or submissive. This is notwithstanding that some small sows (particularly gilts) can be very aggressive sometimes.

6. Larger groups of sows (20 or more)
Larger groups of sows seem to reduce the number of aggressive encounters. Aggressive sows don't bother to pursue a sow through a larger group and the sow being chased can hide within the larger group. Smaller groups of sows (generally less than 10) are more prone to the establishment of strict dominant hierarchies than larger groups of sows. It appears that groups can be so large that sows "give up" trying to establish a hierarchy.

7. Add partition walls

The addition of partition walls (either cement or hanging rubber mats) provides sows with hiding places when being pursued by an aggressor. Often if the sow can get out of sight, the attacking sow stops the chase.

N.B. If you have converted partially slatted grower-finisher pens into housing for gestating sows, it is possible to combine #5 and #6 by opening the partition at the back of the pen (over the slats) that separates two pens. In this manner sows are able to choose which side of the pen and which sows they prefer to congregate with. The solid pen divider over the solid area now serves as a visual barrier. By thus combining two pens one also gets the benefit of increased sow numbers. This may increase the work load for staff pre-farrowing, if they need to sort sows that need to go to the farrowing room. Batch farrowing can sometimes overcome this problem.

8. Spread out the feed

Aggressive encounters between sows occur most often during feeding. By spreading the feed over the entire solid floor surface, there will be more distance between the sows as they are eating. This decreases aggressive sow encounters. The addition of an inverted "Y" PVC pipe or a cone underneath the drop feeder is an inexpensive way to spread out feed as it drops. A second but more costly method is to add a second row of drop feeders, set apart from the first.

N.B Having two or more separate solid surface areas for feeding (ie separated by partition walls or a centre dunging area) is the best way to reduce aggression when feed drops. Submissive sows then have the ability to move away from dominant sows to a different area to eat.

9. Feed the sows multiple times a day

Sows are often fed once a day. This results in a large amount of anxiety just prior to and during feeding and causes more aggressive sows to hoard feed increasing fighting between sows. Feeding smaller amounts 3 to 8 times throughout the day, results in calmer sows during feeding as they are not as frantically hungry prior to being fed.

10. **Create one or two "ideal" sow mixing pens

** This idea has not been tested in Ontario (that I have seen). If producers are renovating a conventional crated barn to group housing, they may not have the space or the extra money to invest in having all the group sow gestation pens being the "ideal" model (eg. partition walls, separate feeding areas, multiple rows of feed drops). One idea would be to have a few "ideal" mixing pens. After their time in the breeding crates, a new group of sows would be mixed and held in these pens for 1 week. The same group would then be moved to a more traditional group pen for the rest of their gestation. However, since this idea has not been tested, it is possible that the intensity and frequency of aggressive encounters may again increase once the sows are moved into the second, more traditional pen.

The work that resulted in the above suggestions was performed on Ontario farms with group sow gestation housing. Swine producers tested these methods, through trial and error, and came up with solutions that resulted in limited aggression between sows when mixed after breeding. These techniques were considered successful for several reasons: the sows have fewer scratches, injuries, and lamenesses and their body condition remains very even. The farrowing rates are greater than 80% and producers rarely pull a sow out of a pen that is not doing well in the group situation. Finally, producers find working in group sow housing barns a quiet and pleasant alternative to crated gestation.

If you have questions regarding group housing or converting a conventional crated barn to group pens please feel free to contact me.

Canadian Pig Production: What Are The Numbers Telling Us?

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Canada has a very diverse market for pigs. Pigs are marketed as market pigs (barrows and gilts at approximately 110 to 115 kilograms), feeder pigs (typically 18 to 25 kilograms), weaned pigs (typically weighing less than 6.8 kilograms), breeding stock (boars and gilts), and cull pigs for slaughter (sows, boars, BBQ pigs). These pigs are mainly marketed in Canada and the United States with the breeding stock being exported to several international countries.

Canadian Hog Slaughter

In 2007, preliminary data from Agriculture and Agri-Food Canada shows that 21.09 million pigs were slaughtered in Canada. This is down 2.5% from 2006 and the third year with a decrease since the peak slaughter in 2004 of 22.71 million pigs. The slaughter numbers include all types of pigs slaughtered (market pigs and culls) and pigs slaughtered in both provincial and federal inspected plants.

Table 1 shows the breakdown of the slaughter numbers on a provincial basis for 2007. Province of Origin numbers indicate how many pigs were raised within each province for slaughter in Canada and the Province of Slaughter numbers indicate the number of pigs slaughtered within each province. The percentages in the "Change" columns indicate the percentage change from 2006 and the percentages in the "Total" columns indicate the provincial share of the Canadian total. The 39,396 pigs slaughtered in 2007 in Saskatchewan is the provincial inspected slaughter only. The Manitoba number for province of slaughter also includes the federally inspected pigs from Saskatchewan.

Table 1 – Canadian Hog Slaughter in 2007

	Province of Origin			Province of Slaughter		
	Number	**Change**	**Total**	**Number**	**Change**	**Total**
B. C.	235,529	10.3%	1%	490,020	0.2%	2%
Alberta	3,342,295	-9.8%	16%	2,937,014	-9.4%	14%
Sask.	911,856	-18.2%	4%	39,396		
Manitoba	3,682,736	-4.0%	17%	4,705,986	10.1%	22%
Ontario	5,239,365	2.7%	25%	4,809,209	6.5%	23%
Quebec	7,236,667	1.3%	34%	7,742,100	-1.0%	37%
Maritimes	436,237	-14.3%	2%	360,960	-14.2%	2%
Total	**21,084,685**	**-2.5%**	**100%**	**21,084,685**	**-2.5%**	**100%**

Data Source: Ag Canada Red Meat Market Information, www.agr.gc.ca/redmeat/

Canadian Pig Exports

The export data from Agriculture and Agri-Food Canada for January to October 2007 show the following results:

- 13,148 head of breeding stock exported to 19 countries with Russia, United States, and Mexico being the major customers. Quebec, Saskatchewan, and Ontario were the three major breeding stock suppliers.
- 5,464,790 pigs that weighed less than 50 kilograms (weaned pigs and feeder pigs) exported with the United States being the major customer. This is up 21% from the same time period in 2006. USDA import data indicates that 56% of these pigs would be pigs weighing less than 6.8 kilograms (weaned pigs). This number is up 4% from the same time period in 2006. Two-thirds of these pigs originated from Manitoba with 17% from Ontario and 9% from Saskatchewan.
- 2,607,320 pigs that weighed over 50 kilograms (market hogs and cull pigs for slaughter) were exported with the United States being the major customer. This is up 36% from the same time period in 2006. Fifty two percent of these originated from Manitoba, 28% from Ontario, and 9% from each of Saskatchewan and Alberta.

Canadian Pigs Marketed

By using the total number of pigs marketed (pigs slaughtered in Canada + breeding stock exported + weaned and feeder pig exports + slaughter pig exports) for January to October 2007, the following calculations result:

- 68% were marketed as pigs for slaughter in Canada, 21% as weaned or feeder pig exports, 10% as slaughter pig exports, and less than 1% as breeding stock exports
- Compared to the same time period in 2006 (January to October), pigs slaughtered in Canada were down 3%, weaned and feeder pig exports up 9%, and slaughter pig exports up 17%.
- Total pigs marketed were up 1.4% in January to October 2007 as compared to the same time period in 2006.

Canadian Slaughter Pigs Exported to United States

The following information is derived from the data provided in the weekly USDA Canadian Live Animal Imports into U.S. by State of Entry (WA_LS635) for 2007. A total of 351,985 sows and boars were imported for slaughter from Canada which was up 1% from 2006 data. Approximately the same number entered through the North Dakota border point in 2007 and 4% more entered through the Michigan border point in 2007 as compared to 2006.

University of Guelph / OMAFRA Partnership Pork Research Program Projects

Kees de Lange, Pork Research Co-ordinator, University of Guelph

Under the research partnership agreement between The University of Guelph and OMAFRA, pork research is now managed as part of the ***Sustainable Production Systems Research Program***. This program supports large, multi-disciplinary and integrated research projects.

Based on an extensive review process two large swine and pork related research projects were approved in 2006. In addition, swine reproduction research is managed as part of a larger reproductive technology research project. The three approved projects are:

1. **Sustainable pork production: Healthy pigs and safe pork.** Leader: **B. Friendship (**Department of Population Medicine; rfriends@)ovc.uoguelph.ca); team members: **C. Dewey** (swine health management and epidemiology), **P. Boerlin** (bacteriologist), **C. Gyles** (bacteriologist), **S. McEwen** (public health), **K. Warriner** (meat scientist) **T. Widowski** (ethologist), **S. Millman** (ethologist), **A. Brooks** (pathologist), **B Wilkie** (immunologist), **J. MacInnes** (microbiologist), **C. deLange** (nutritionist), **T. Hayes** (pathologist), **J. Squires** (biochemistry and gene expression).

2. **Sustainable pork production: from gene expression to nutrient utilization efficiency and pork meat quality.** leader **C. de Lange** (Department of Animal and Poultry Science; cdelange@uoguelph.ca); team members: **S. Barbut** (meat science), **C. Dewey** (swine health management and epidemiology), **M. Fan** (swine nutrition and ecology), **C. Forsberg** (microbiology), **J. France** (mathematical modeling), **I. Mandell** (meat science), **P. McEwen** (pork production), **P. Purslow** (meat science), **A. Robinson** (genetics), **J. Squires** (biochemistry and gene expression), **A. Weersink** (Agriculture economy), **T. Widowski** (ethology).

3. **Reproductive technologies – from test tubes to animals.** Leader **W.A. King** (waking@uoguelph.ca) Department of Biomedical Sciences;); team members: **P. Bartlewski** (Reproductive imaging and endocrinology, **G. Bédécarrats** (Neuroendocrine control of reproduction), **D. Betts** (Gene expression, epigenetics and cloning), **M. Buhr** (Cryobiology, sperm technology), **A. Croy** (Reproductive immunology and uterine function), **A. Hahnel** (Spermatogenesis, spermatogonial transplantation), **W. Johnson** (Reproductive health and management), **J. LaMarre** (Gene expression and message stability, **J. Leatherland** (Fish brood stock health markers), **J. Li** (Gamete and Stem cell biology), **J. Petrik** (Ovarian biology).

Highlights of these programs are presented I this issue of the Centralia swine research update. For further information on these research programs contact the leaders or visit www.uoguelph.ca/research/omafra/animals/pork.shtml.

Healthy Pigs and Safe Pork

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Introduction

Under the newly organized OMAFRA/University of Guelph research program a large multidisciplinary project was undertaken. Originally sixteen research scientists were recruited to work on this project along with a large number of graduate students and support staff. The objectives of this study are:
1. Explore interactions among pathogens, endogenous microflora, biosecurity, host animals and environment, both on-farm and in the laboratory, to identify key risk factors or contributing factors that cause increased persistence and disease expression with losses from mortality and reduced performance.
2. Explore a wide range of intervention strategies or methods that would reduce these losses due to disease including vaccination, bacteriophage therapy, and genetic and environmental manipulation of the pigs' disease resistance, diet, or environmental conditions.
3. Use health management to reduce use of antibiotics, prevalence of human pathogens in pork products and improve animal welfare.

Methods

Researchers have used a variety of approaches in performing this work. Several hundred pork producers have answered surveys and submitted samples to the laboratory. On certain farms clinical trials have been performed to test various disease control strategies. Controlled challenge studies have been undertaken in the isolation facilities at the OVC and nutrition, behaviour and genetics studies have been carried out at the University of Guelph swine research facilities at Arkell, Ponsonby and Ridgetown. In addition a great of the research associated with this project is bench-top in nature and conducted in the laboratory.

Highlights of the Results

- Genetic tests have been developed for 27 single nucleotide polymorphisms (SNPs) in 15 innate immune genes of pigs to determine which are associated with susceptibility to common infectious diseases in pigs.
- Blunt trauma appeared to be a more effective means of euthanizing low viability neonatal piglets than the use of a captive bolt gun.
- PRRS PCR-RFLP type 1_4 has been found to be common in Ontario pig herds and associated with high reproductive losses.
- *Salmonella* Typhimurium var. Copenhagen expressing resistance to multiple antibiotics is the most common serovar identified on Ontario pig farms.
- Bacteriophages were shown to be effective in lowering levels of *Salmonella* in the pig and the environment.
- Porcine IgE, the allergy mediating, type 2 immunoglobulin isotype has been characterized functionally, molecularly and by immunological cross reactivity. It has been purified and reduced to obtain a heavy chain that is being used to produce anti-pig IgE antibodies, a currently unavailable reagent.

Significance to Ontario Agriculture and Food Industries and/or Rural Ontario

This work has lead to Improved understanding of disease in commercial pig herds and will result in more efficient production and less variability in pig performance and will reduce economic uncertainty for pork producers. At the same time pig welfare will improve leading to a more positive view of pork production by the consumer. Furthermore this research has identified approaches to reduce zoonotic pathogens and the use of antibiotic alternatives resulting in improved human safety and reduced risk of losing export or domestic markets due to public health fears.
Specifically the genetic sequencing and mapping of PRRS has created a tremendous database of information that can be used to identify how the disease spreads. We have also gained a better understanding of the gut microflora and have made advances in developing methods to manipulate this ecosystem so that *Salmonella* and other pathogens are discouraged from colonizing and causing disease. The use of phages, essential oils and probiotics in controlled trials have uncovered limitations but have also shown that these types of novel approaches to disease control have promise but require rigorous evaluation before they are ready for commercial use. These studies have been directed at both diseases that cause production losses but also against diseases that are of human health concern.
The identification of genetic markers to identify lines of pigs with defective innate immunity as well as methods of identifying pigs with above average ability to defend against pathogens due to effective innate and adaptive immune response will provide the Ontario pig industry with the tools to breed and create healthier and more profitable animals. As a whole this work is helping to create healthier and safer pigs in Ontario.

This project is expected to run for two more years and will provide a framework for other health related research initiatives sponsored by Ontario Pork and others.

Members of the research team includes: R. Friendship, C. Dewey, S. McEwen, S. Millman, Z. Poljak, K. deLange, T. Widowski, J. Squires, B. Wilkie, C. Gyles, K. Warriner, P. Boerlin, J. MacInnes, A. Hayes, and A. Brooks.

Sustainable Pork Production:
From Gene Expression to Nutrient Utilization Efficiency and Pork Meat Quality

Project leader: Kees de Lange
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Research objectives

The main aim of this integrated and multi-disciplinary research program is to explore the underlying molecular, biological and physiological mechanisms that contribute to interactive effects of the pigs' genotype and environment (sensory environment, feeding management) on pork meat and carcass quality, nutrient utilization, and pig behavior. The ultimate goal is to develop cost-effective strategies to enhance pork meat quality, minimize the negative impact of pork production on the environment, and enhance animal well-being.

Research activities and main results

A comprehensive survey of on-farm behavioural assessments and carcass and meat quality data involving 47 recorded variables was made on 648 pigs (24 pigs from each of 27 Ontario operations). Variations in drip loss (2% - 12%, average 7.4%) are high and represent loss of potential yield as well as quality. We have carried out gene expression analysis and biochemical measurements of calpain enzyme activity in subsets of animals representing high and low shear force, colour and drip loss meat quality values. Statistical analysis shows that variations between individual producers and the interaction of this with day at the packing plant are of overwhelming importance in determining variations in colour, tenderness and water holding capacity of pork. These factors alone account for 16% - 33% of variation in quality measures in both ham and loin.

Based on gene expression analyses, a number of genes were identified that are associated with extremes in drip loss in harvested ham and loin muscle samples. Further investigation of the roles of these genes in biochemical pathways is ongoing. Of particular interest is the CYP3A29 gene, which displayed opposite gene regulation in different sub-sets of pig tissue samples. This gene was up-regulated in samples that were chosen for high drip loss and lighter colour and down-regulated in samples that were selected for high drip loss only.

Two sets of trials were conducted to evaluate management regimes aiming to reduce variations in pork meat quality. In both trials, the same sets of behavioural, packing plant and meat quality measures were taken as in the earlier studies. The first set of trials was designed to test the effect of behavioural management (by modifying the type and amount of human interactions with the animals on farm) on end-product quality. Repeated exposure of animals to humans walking through their pens or to being herded into crowds or through doorways resulted in significant reductions in drip loss from their pork compared to controls. The second set of management trials was designed to test the effect of nutritional strategies on end-product quality. Preliminary studies involving supplemental tryptophan or low dietary protein levels yielded no effects on growth performance or meat quality. Separate trials involving a low glycogenic diet (beet pulp feed) or ractopamine both showed increased feed efficiency over control diets. Feeding of beet pulp tended to produce pork with less marbling but increased tenderness. Neither diets improved drip loss.

In performance studies aimed at evaluating inexpensive co-products from the biofuel and food industry, such as corn distillers grains plus solubles (DDGS), corn steep water and whey permeate showed that these co-products can be effective feed ingredients for pigs. However, the high potassium content in these ingredients may limit the maximum inclusion levels; when pigs were fed diets with elevated potassium levels (1.4% total potassium), slight reductions in pig growth performance were observed and a buildup of calcium salts in the kidney was noted at slaughter.

In nutrient balance studies it was shown that changes in the dietary Ca to P ratio have significant effects on growth performance, and efficiency of P utilization. Dietary true digestible Ca to true digestible P ratio of 0.96:1 to 1.35:1 should be used to guide the formulation of diets for the post-weaned pig.

Using isotope tracer studies, it was shown that microbial protein in the upper gut of pigs is produced mainly from amino acids that are derived directly from dietary and endogenous proteins. A large proportion of ammonia in ileal digesta is produced via microbial fermentation of dietary and endogenous protein. Dietary inclusion of fermentable fiber (pectin) led to minor changes in the relative contributions of the different sources of nitrogen to microbial protein production, or to ammonia in ileal digesta, but increases dietary requirements for some amino acids, and threonine in particular.

Different mathematical modeling approaches are used to improve or simplify the prediction of growth performance and nutrient utilization in growing pigs, or to better represent the specific aspects of the biology of growth in the pig. On-farm studies are conducted to demonstrate the value of applying models on Ontario pig farms.

Take home messages

- A large multi-disciplinary research program at the University of Guelph is aimed at develop cost-effective strategies to enhance pork meat quality and/or minimize the negative impact of pork production on the environment, while enhancing animal well-being.
- Considerable variations in pork quality exist in the Ontario pork industry, in common with the pork industry worldwide. Drip loss represents a large economic loss to the industry and can be significantly reduced by either pen walking or crowding treatments. These strategies reduce the susceptibility of animals to stress at slaughter, and so improve animal welfare as well as pork quality.
- Several case studies on Ontario farms have shown that fine-tuning feeding programs, based on monitoring actual performance levels and the application of mathematical pig growth models, can reduce feed costs by at least $1.00 per pig, and improve profits by at least $1.50 per pig.

Ontario Pork's Research Investment

Jean Howden, Ontario Pork

Research serves as the fundamental building block for the advancement of our industry and is the cornerstone of the industry's success. In recent years, Ontario Pork has focused and supported research on herd health, food safety, nutrition, reproduction, animal welfare, and the environment. The resulting knowledge and improvements have advanced the Ontario industry. The projects range from building a baseline of herd data for food safety confidence to increasing the knowledge and treatment of swine illnesses and diseases. Enhanced detection methods have been funded to minimize the effect of illness and diseases on animals and herds. Research into feeding and nutrition has lead to improved feed and growth efficiencies; and manure and dead stock disposal effects on the environment have been and continue to be studied for continual improved. It is critical that the industry continue to more forward and this requires a strong research base.

In 2007, Ontario Pork invested over one million dollars directly into research and development projects. These projects are not funded by Ontario Pork alone. Both federal and provincial government, producers and industry alike have significantly contributed funding. Ontario Pork's funds has been enhancing at least three times with some researchers excelling far above this level.

Our continual contribution to research is imperative for the industry to grow and prosper. The research committee of Ontario Pork continually strives to fund research projects that will benefit this industry and all producers involved, as detailed in the following list of projects.

Project No. 07/103**Researcher:** Monte McCaw
Title: Are they REALLY PRRSv Negative??? Detection of Very low rates of Infection in Nursery Pig Groups
Synopsis: Objectives of Research Proposal: 1) Evaluate the relative sensitivity and cost of pen-based hanging-chew-rope oral fluids sampling vs random blood sampling of 28 pigs per nursery by PRRSv RTPCR. 2) Determine if there is sufficient virus concentration and quality in oral fluids collected by hanging chew-ropes for accurate PRRSv sequencing. Brief Description of the Project: This project is designed to compare the costs and ability to detect PRRSv infection (sensitivity) in nursery pigs of a novel sampling method (pen-chew-rope oral fluids collection) vs industry-standard random blood-sampling of 28 pigs (95% confidence of detecting > 10% infection rate). We will also evaluate whether these oral fluids samples can be used for accurate PRRSv ORF5 sequencing. The project will be performed in two 2400 sow genetic multiplier herds known to be weaning groups of pigs with < 5.0% infection rate (predictably seen by CoI Harms 8 to 12 weeks following whole-herd homologous wild-type PRRSv inoculation). Their weaned pigs will be sent to single-source single-weaning-group nurseries. Blood samples will be randomly collected from 374 pigs (95% confidence of detecting > 1.0% infection rate) at 4, 7, and 10 weeks of age. Oral fluids samples will also be collected at 4, 7, and 10 weeks of age by hanging cotton chew-ropes in each pen for 60 minutes. Serum and oral fluids will be tested by RTPCR to determine the exact number of PRRSv-infected samples. These data will then be used to compare the relative sensitivity of pen oral fluids sampling vs random bleeding and testing of 28-30 pigs per nursery group by computer modeling. If pen saliva sampling is able to detect infection rates as low as 1%, it will improve detection of nursery PRRSv infection by 10 fold for a per – group diagnostics cost of equal-up-to-double that for RTPCRs on 30 sera run in pools of 5. Several economically critical decisions for herd owners hinge upon the assumption they are producing PRRSv-free nursery pigs. These include: 1) determining initial success of gilt-acclimatization programs, 2) herd PRRSv-elimination attempts, 3) monitoring long-term success of gilt acclimatization (greater confidence weaned / feeder pig groups are PRRSv-free at entry into finisher), 4) PRRSv-elimination, 5) sow herd PRRSv vaccination programs, or 6) early detection of new PRRSv infection. Saliva sampling could also be used to easily monitor groups of developing boars

Project No. 07/107**Researcher:** Andrew Peregrine
Title: Control of Coccidiosis in pigs
Synopsis: This project will investigate control methods to reduce the effects of coccidiosis and to determine the impact of coccidiosis on post-weaning performance. Ten farms where coccidiosis has been previously diagnosed will be used in this study. They will examine pigs in the nursery to determine the prevalence of coccidiosis and its effect. Field trials will be conducted to evaluate preventative measures. As a result of this work Ontario pig farmers will have a much greater awareness of how important it is to control coccidiosis. Implementing preventive measures should result in increased weaning weights and improved post-weaning

Project No. 07/108**Researcher:** Scott Weese
Title: Evaluation of the prevalence of methicillin-resistant Staphylococcus aureus (MRSA) colonization in pigs and pig farmers in Ontario
Synopsis: MRSA is a of major concern in human medicine. MRSA is present in the pig population in certain countries and in such cases pig farms and

veterinarians are at high risk for MRSA colonization. It is necessary to know the status of MRSA in pigs and pig farmers in Ontario to determine the public health risks. Objective 1. To determine the prevalence of MRSA colonization in pigs in Ontario 2. To compare the prevalence of colonization from nasal and rectal screening sites 3. To determine the prevalence of colonization of MRSA in pig farmers Nasal and rectal swabs will be collected from 450 pigs from 30 farms in Ontario. Nasal swabs will be collected from volunteering farmers. MRSA culture and typing

Project No. 07/110**Researcher:** Tony Hayes
Title: Gene defects that impair resistance to infectious diseases of swine
Synopsis: We are developing tests for mutations in five genes that code for lectins involved in innate resistance to various bacterial and viral infections. Previously, we have identified two mutations that are more frequent in diseased pigs submitted for post mortem diagnosis. The work proposed will determine which tests are useful in identifying breeders whose progeny are less susceptible to health impacts of PRRS, PMWS, and other common infections. We will also determine if any of these defects are associated with reduced growth performance. The substantial impact of PRRS and/or PMWS on production could be more quickly reduced if we can eliminate breeders that carry mutations that increase their susceptibility to illness when exposed to the primary viral infections. Mutations that impair growth by increasing the impact of other infections will also benefit producers whose herds are not exposed to PRRS or PMWS. The development of a method to bank DNA samples from pigs with confirmed diagnoses will be a resource for future discovery of other mutations that predispose to disease.

Project No. 07/111**Researcher:** Douglas Hodgins
Title: Cloning and expression of porcine complement C3d for enhanced vaccines
Synopsis: Improved vaccine additives are needed, especially for use in vaccines for neonatal piglets. C3d, as a vaccine adjuvant, has potential to stimulate early (active) immune responses to maintain protection against pathogens as concentrations of maternal (passive) antibodies decline. Objectives of Research Proposal: a) To clone DNA coding for the porcine C3d protein, and b) express the recombinant protein in a form suitable for subsequent investigations of its enhancing effects in vaccines

Project No. 07/116**Researcher:** Ira Mandell
Title: Mechanisms affecting pork meat quality in protein-restricted total feed-restricted dietary regimes
Synopsis: This initiative will investigate the potential mechanisms of improved meat quality (increased tenderness, decreased drip) that may be accessed by restricted protein versus restricted total energy dietary regimes, followed by high rates of compensatory growth. The pork industry is seeking a faster growing, leaner pig with good meat quality characteristics. Restricted feeding followed by compensatory growth can achieve target slaughter weights with high feed efficiency. The research aims to find efficient restriction diets that also improve meat quality.

Project No. 07/119**Researcher:** Peter Purslow
Title: Enhancing the Pork Meat Quality Value Chain
Synopsis: Twenty commercial farms were identified and contacted with the cooperation of a major Ontario packing plant. To date, data have been collected on 23 occasions from 20 farms with a total of 672 pigs sampled. For each farm, genetic, management, nutrition and behaviour information were collected, and 24 pigs were identified and individually marked for tracking from farm through processing. At the plant, video records were used to quantify behaviour during handling, with blood samples collected for analyses of stress parameters. Temperature and pH were recorded over the first 48 hours in the ham and loin, and tissue samples were collected at 1.5 hours postmortem and stored at – 70 C for analyses of gene expression and biochemistry. Loin and ham samples were also sent to U of G Meats Lab for subjective evaluation of meat quality (colour, marbling, firmness, wetness) and objective determination of colour (L* a* b* scale), pH, drip loss and Warner-Bratzler shear force (an instrumental measure of tenderness). Shear force measurements were conducted on cooked longissimus chops and smoked ham. From the first set of 312 samples statistical analyses were conducted to identify outliers based on drip loss and colour of the loins. Individual farm/day effects were accounted for in the model. Samples from the extremes have been extracted for microarray analysis to determine patterns of gene expression peri-mortem in pigs with differing meat quality parameters.

Project No. 07/122**Researcher:** Nigel Bunce
Title: Pilot Plant for Electrolytic Deodorization of Liquid Hog Manure
Synopsis: A pilot plant of approximately 1500 L will be constructed and equipped with commercially available electrodes and power supplies. Odour mitigation and bactericidal properties of the technique will be monitored in both short- and longer- term operation If the technology can be successfully demonstrated at this scale, the way would be open for electrolytic remediation to be applied at full scale on working hog farms.

Project No. 07/125**Researcher:** Ron Fleming
Title: Possibilities for Anaerobic Digestion on Ontario Swine Farms
Synopsis: Objectives of Research Proposal: To digest liquid swine manure in 4 typical recipes (i.e. by itself and with 3 organic additions), measuring biogas production and digestate quality; to document logistical considerations for each recipe tested; to calculate gas yields and electrical power costs for the various recipes.

Project No. 07/127**Researcher:** Ann Huber
Title: Survival of pathogens during storage of livestock manures
Synopsis: The effect of a variety of on-farm manure storage conditions, including seasonal temperatures and static vs dynamic storage, on the survival of indicator organisms and pathogens will be determined; populations of pathogens at typical spreading times will be assessed The results are expected to provide producers with management options based on cost-effective manure storage practices that reduce the load of pathogens prior to manure application and thus reduce the risk of subsequent pathogen contamination of surface and ground waters; further, they are expected to provide science-based information to allow for improved flexibility in regulations and protocols. Schedules A,B,C are not applicable to this project

Project No. 07/131**Researcher:** David Rudolph
Title: Evaluating the spatial and temporal effects of tile drains on the partitioning of liquid swine manure constituents between surface-water and ground-water
Synopsis: The objective of this proposal is to provide information to improve Better Management Practices (BMP's) for land application of swine manure and minimize impacts to water quality. The main objective is to understand how macropores (i.e., mud cracks, worm holes and root holes) regenerate after tillage and how they act as preferential flow paths for liquid manure constituents to enter tile drains. A primary goal is to quantify seasonal and spatial variations in macropore generation, infiltration, and tile-water quality and the impact on overall water quality.

Project No. 07/135**Researcher:** C.F.M. de Lange
Title: Reducing the negative impact of high dietary potassium levels on growth performance and carcass characteristics of growing-finishing pigs fed large
Synopsis: The aim of the project is to (1) establish whether the negative impact of feeding high levels of co-product on growth performance and carcass characteristics of growing-finishing pigs can be attributed to high dietary potassium levels, and (2) reduce negative effects of high dietary potassium levels by increasing dietary chloride levels or adjusting the dietary electrolyte balance.

Project No. 07/136**Researcher:** C.F.M. de Lange
Title: Production of phytase expressing Lactococcus Lactis and its potential for enhancing swine productivity, gut health and reducing environmental loading
Synopsis: The aim of the project is to genetically modify a lactic acid bacteria, for the expression of the enzyme phytase. The resulting modified bacteria will be examined for phytate phosphorus release in swine liquid feed.

Project No. 07/137**Researcher:** C.F.M. de Lange
Title: A decision support tool to evaluate the impact of between animal variability and alternative management strategies
Synopsis: The aim of the project is to modify an existing and well-tested pig growth and nutrient utilization model, as well as simple decision support system, as user-friendly tools for optimization of profits and nutrient use on individual growing- finishing pig units in Ontario. The main refinements of the current versions of these computer programs will be to represent between animal variability and alternative shipping strategies. Two versions of the model will be made available for commercial use: (i) the full- scale biological and dynamic model and (ii) a simplified and very user-friendly decision support system. The latter will allow untrained model users to evaluate financial and environmental impacts of a large number of alternative

Project No. 07/141**Researcher:** Art Schaafsma
Title: New Mycotoxin Management Strategies in Grain Corn Arising from the 2006 Fusarium Epidemic in Ontario
Synopsis: To determine i) the relationship between visible mould and toxin, ii) the reasons behind why some fields are contaminated/infected more than others, iii) factors that contributed to grain corn contamination, and iv) the number of ears needed to examine and estimate the problem in a field

Mechanisms Affecting Pork Meat Quality In Protein-Restricted Versus Total Feed-Restricted Dietary Regimes

Phil McEwen, Peter Purslow, Ira Mandell and Kees de Lange - University of Guelph.
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Introduction

Most on-farm feeding systems try to maximize feed intake during the growing and finishing phases. However, Therkildsen et al. (2002) observed improved feed efficiency, protein synthesis, meat quality and tenderness when pigs were limit fed during the growing period. This trial further investigated growth performance, carcass and meat quality ramifications of limit feeding during the growing period.

Objectives:

To determine the effects of feeding strategy (full feeding, energy restriction, protein restriction, and combined energy and protein restriction) in the growing phase on pig growth performance, feed intake, carcass and meat quality.

Specific objectives:

I. *To determine the effects of limit feeding and the interaction with pig gender on average daily gain, feed intake and efficiency, and carcass and meat quality characteristics.*

II. *To determine the effects of limit feeding and the interaction with pig gender on expression of calpain-1 and calpain-2 activities, the major proteolytic enzymes involved in post-mortem conditioning of pork.*

Experimental Procedures:

Ninety-four feeder pigs were assigned to the trial at the Ridgetown Swine Research Station, incorporating a 2 x 2 x 2 factorial design with 2 dietary protein levels, 2 levels of feeding in the growing period and 2 genders (barrows and gilts) represented. Four dietary treatments were used during the growing phase (35 to 65 kg body weight):

1) Control: *ad libitum* feeding of a standard grower diet formulated to contain 18.3% CP and 0.9% lysine.
2) Energy restriction: 70% of *ad libitum* consumption of the control diet fed during the growing period.
3) Protein restriction: *ad libitum* feeding of a lower protein grower diet (14.0% CP & 0.63% lysine) level with similar energy content as the Control diet.
4) Energy AND Protein restriction: 70% of the normal *ad libitum* consumption of diet 3 during the growing period.

On reaching 65 kg bodyweight, all pigs (by pen) were switched to the control diet and fed *ad libitum* to allow restricted pigs to exhibit compensatory growth. Ultrasound measurements for backfat thickness and loin depth were also taken when pens averaged ≥ 65 kg BW and immediately prior to slaughter.

After an overnight chill, carcass measurements were taken. A section of the loin was cut into chops for determination of drip loss, lean color (CIE, L^* a^* b^* scale), muscle pH, collagen, Warner-Bratzler shear force (an instrumental measure of tenderness) and cooking losses. Calpain-1 and calpain-2 enzyme activities in the longissimus muscle were determined using standard zympography techniques (Therkildsen, 2002, Purslow et al, 2006).

Results

1. Animal Growth Performance:

- Average daily gains (ADG) for limit fed pigs (both high and low protein diets) were lower during the growing phase than for *ad libitum* fed pigs (0.7 versus 1.1 kg/d).
- Conversely, ADG for limit fed pigs (both high and low protein diets) were higher in the finishing period due to compensatory growth (1.3 versus 1.1 kg/d).
- There were no differences in ADG between *ad libitum* fed pigs with either the high or low protein diets.

2. Meat quality parameters:

- A slaughter, backfat thickness and marbling scores were similar across dietary treatments.
- Warner-Bratzler shear values (toughness), drip loss, and color were not affected by dietary protein level or feeding level.

3. Enzymatic activity:

- Calpain-1 activity was negatively correlated with overall ADG and ADG in the growing phase but not with ADG in the finisher phase. In contrast, Calpain-2 activity was not correlated with any ADG measurements.

Take home message

Feed intake, but not protein intake restriction, during the grower phase induced compensatory growth during the finisher phase. Compensatory gain was not associated with key aspects of meat quality.

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Ontario Swine Veterinary-based Surveillance (OSVS) Project

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Introduction and background

There is a great deal of interest in developing reliable surveillance systems to provide "early warning" systems to identify outbreaks of disease in animal populations. Practicing veterinarians are often the first to notice the signs of a new disease on a farm, and changes in the incidence of specific syndromes (e.g. respiratory diseases) may provide the first warning of an outbreak before laboratory samples are submitted and final diagnoses are reported. The identification of changes in the incidence of specific problems should allow more rapid and efficient collection of diagnostic samples and the implementation of disease control strategies.

The overall objectives of this project are first to assess options and make recommendations for longer term implementation for syndromic animal health surveillance in a sentinel veterinary-practice system, and secondly to improve food safety, animal health, public health in a cost effective manner.

Methods

A pilot study with 8 volunteer swine specialist from 6 clinics began in the summer of 2007. The veterinarians are summarizing the number of farm visits and/or calls they have conducted each week according to the body system affected and in what manner production is being affected (eg. respiratory illness associated with poor growth rate). Information on treatment response is also recorded. The data are collected either on carbon paper forms or with an electronic version of the form designed for Palm®, a personal digital assistant (PDA).

The OSVS group receives the information on weekly or biweekly basis and looks for trends of syndromes. If an increase in the incidence of a syndrome (cluster of disease) is found, an investigation will be initiated by the veterinarians within the network to determine if there is a problem of public or swine health significance.

As part of the assessment of this pilot program, the program also is planning to determine whether other sources of swine health data (the AHL submission data, swine condemnation data from federally and provincial inspected abattoirs) could provide similar information, offer complementary data, or help validate the trends reported from veterinary practices.

Veterinarian-specific reports providing feedback on recorded diseases are produced on a monthly electronic newsletter to summarize the information such as the overall distribution of syndromes reported by clinicians, the trends of the distributions over time, disease issues reported by clinicians in the network, industry, and the Animal Health Laboratory (AHL), concerns and issues associated with the administration of the network, and swine health research being conducted at the University of Guelph.

Results

No significant statistical clusters have been identified from July to December 2007. However, it is the researchers' hope that with veterinarians, government and the University of Guelph working together, response to any emerging swine disease outbreaks can be rapid, complete and effective.

A preliminary retrospective study was performed in the summer of 2007 to determine the usefulness of a secondary data source for syndromic surveillance, and to identify the evidence of spatial temporal or space-time clusters using AHL respiratory disease submission data (2003-2005) as a model. This data set covered the time period when Ontario broke with a more severe version of PRRS, PCV2 and swine influenza but evidence of these problems was not particularly obvious in our retrospective study. One obvious limitation identified was that more than 50% of the AHL submission records did not include a clinical history and therefore could not be used in a syndromic study. Further research is planned to determine the suitability of these data for the OSVS program

Challenges of the program

- Create a standardized data recording system that is functional for all veterinary clinics
- Some fields in the data collection form are not always recorded consistently
- Compliance
- Timeliness

Acknowledgements
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Biosecurity Risk Assessment – Farm Service Providers

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In the swine industry several endemic diseases such as Porcine Respiratory and Reproductive Syndrome (PRRS) and Porcine Circovirus infections have caused a great deal of loss to the industry. Major Foreign Animal Diseases such as Classical Swine Fever (Hog Cholera), Swine Influenza and Foot and Mouth Disease are occurring in several countries and it appears only a matter of time before North America is exposed. The Canadian hog industry is very dependent on export for its survival and an outbreak of one of these diseases would cause major disruptions and losses.The four pillars of disease control are Preparation, Prevention, Response and Recovery. Biosecurity focuses on Preparation and Prevention. Preventing an outbreak is far less costly than dealing with it after it occurs.

The recently released Circovirus Program Options Task Team (CPOTT) from Agriculture and Agrifood Canada (AAFC) reinforced industry thinking that, “A biosecurity system based on prevention, detection and response is needed to adapt to the changing and emerging risks that threaten a wide range of species, including humans. The Canadian industry needs a robust set of bio-security and best business management practices (BBMP) that will assist in preventing and mitigating the impacts of circovirus and other emerging diseases in the industry. These BBMPs’ must be integrated with current initiatives (food safety, traceability) such as the CPC’s CQA Program and be easily audited to confirm adherence to the national standards.”

Farm Service Providers:

Individuals visiting farms are clearly a potential source of contamination of swine herds. This group has been identified as a gap in the industries’ barriers to disease transmission in disease simulations operated by the Ontario Livestock and Poultry Council. Recent work for AAFC on poultry farm service providers and for the Canada Ontario Research and Development Fund on farm service providers in non-supply managed livestock (both available on www.agbiosecurity.ca) identified these groups as a significant “hole in the biosecurity blanket”.

From the investigation undertaken by these project teams, the farm services identified as active among the livestock industries include:

> Barn Cleaners, Bedding Suppliers, Board Inspectors, Breeders, Catching Crews, Commodity Buyers, Dead Stock and Rendering, Drivers, Drovers, Employees, Equipment Sales/Service, Feed Suppliers, Fuel Suppliers – Home, Fuel Suppliers – Barn, Hatcheries, Hoof Trimmers, Live Haul Truckers, Manure Managers, Milk Inspectors and Drivers, Municipal Employees, Private Purchasers, Processor Sales/Service, Provincial/Federal Employees, Veterinarians/Vet Service. Visitors/Neighbours/Friends and off-premise activities (Shows, Fairs, Stockyards etc.) also pose a risk.

These studies have developed a methodology for biosecurity protocol development, compiled a list of the farm service providers in various sectors, and identified a set of roadblocks and issues that need to be addressed. These are key building blocks in the development of a biosecurity program for swine and other livestock and poultry farms.

In an attempt to control potential disease spread on and off farms, national biosecurity protocols need to be developed and implemented for all service providers. These should be auditable so that farmers can be assured of their suppliers’ biosecurity status.

Risk Assessment: In preparation for the detailed design of a Plan to address the biosecurity requirements for service providers, a risk assessment of their particular activities in the swine industry would be required. Risk Assessment is a science-based process that uses scientific information to describe the risk and potential magnitude of harm caused by a specific hazard. The risk assessment process has four main steps: hazard identification, exposure assessment, hazard characterization and risk characterization, and attempts to answer the following questions: What can go wrong? How likely is it to happen? What are the consequences?

With the risk assessment understood, the Plan for developing a biosecurity program for the farm services providers for the swine industry could follow six main steps:

1. **Awareness and Buy-in:** Communication and discussion at industry forums, meetings and privately-arranged sessions, with representatives of the farm services and the industries involved.

2. **Infrastructure and Funding**: Preparation of a funding proposal(s) for the execution of the plan and the establishment of the infrastructure required to manage it, including the activities of a program steering committee and the establishment of an incorporated, not-for-profit association of farm services to focus, manage and maintain the programs.

3. **Preparation of Farm Services Biosecurity SOPs:** Establishment of working groups of farm services practitioners to adapt and/or develop biosecurity protocols for their services. Integrate farm services SOPs with CPC's CQA food safety program and other on-farm programs.

4. **Implementation:** Documentation and testing of training programs and materials for each service, pilots and trials in each segment to demonstrate and prove the program elements, "classroom" training and on-line information availability for all services sectors.

5. **Certification and Information Management:** Establish a certification process and a third-party auditing program to ensure ongoing adherence to the biosecurity program(s) and design and implement an independent data management facility to maintain participation and certification information for participants and their supply-chain partners

6. **Program Maintenance:** Establish a procedure, managed and executed by the Farm Services Association, for the ongoing maintenance and improvement of the biosecurity program(s) in the farm services sectors.

Many Farm Services organizations work at the fringes of the industry, and are neither organized nor sufficiently profitable to support the costs of development and implementation of these types of programs. Producers and producer groups, while they are partners with the services industry, are not prepared to absorb these costs. Therefore, government funding for the costs of development and implementation of the program will be required.

Participation in the programs by Farm Services organizations is a key factor for success. Participants will be encouraged by three factors: the demand, by the producers whom they serve, for their participation in a biosecurity program, the possibility of insurance against disease losses would force participation and the establishment of a legislated requirement for their participation.

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OSHAB PRRS Position Statements

Dr. Martin Misener
Chair of the OSHAB Science and Technology Committee

The OPIC Swine Health Advisory Board (OSHAB) has a mandate to take a leadership role for major swine health issues in Ontario by providing direction for swine research, advancing industry communication, and encouraging collaboration among swine industry sectors. Our goal is to obtain better control, reduction of transmission and elimination of significant swine diseases such as PRRS through the initiatives outlined in Figure 1.

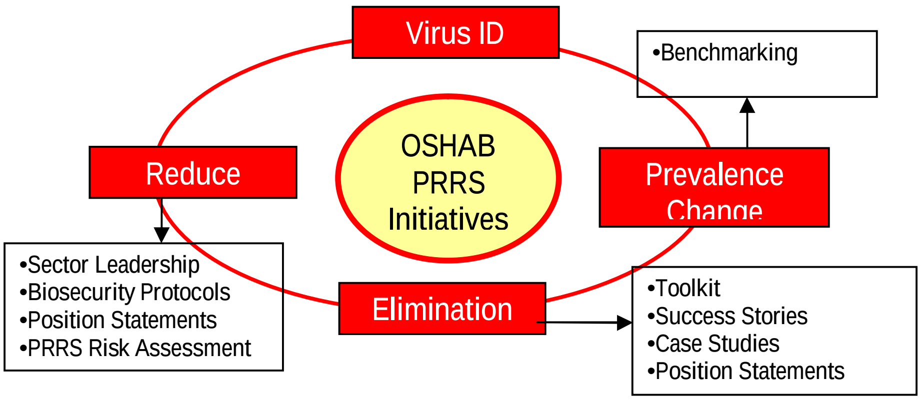

Figure 1. OSHAB PRRS Control and Elimination Initiatives.

As a step to achieving this goal, OSHAB has issued position statements with respect to swine handling and management practices as they pertain to PRRS. These position statements are based on current knowledge of diseases and have been developed with consultation from industry stakeholders. The statements may be modified in the future as science-based knowledge of PRRS diagnosis and control continues to evolve. The intent of the position statements is to give clear, concise direction to the swine industry. To achieve our objective of a healthier and more competitive Ontario swine industry, it is a *necessity for every sector in the swine industry to work together*.

Background

PRRS viruses have high mutation rates resulting in great strain diversity. This strain diversity is advantageous to PRRS virus survival as introduction of new strains is an adaptation that avoids host immunity. PRRS virus strains are very different when compared across unassociated sow herds. The immunity developed by a pig to one strain of PRRSV does not necessarily provide complete protection against all other PRRSV strains. Multiple strains of PRRS virus can co-exist and circulate within an individual herd.

The long-term reduction of the prevalence of PRRS in the Ontario swine population therefore requires that the introduction of new strains of PRRS virus be minimized. This is a high priority in both PRRSV- naïve herds as well as PRRSV-infected herds. Minimizing introduction is directly linked to improved biosecurity and surveillance. The current position statements address issues related to these topics.

Position Statements

The position statements cover a range of swine handling and management practices and address mechanical transmission of PRRS virus through adequate transport and service vehicle biosecurity protocols (1). The importance of a biosecure entrance to the pig barn such as a Danish entry to prevent the movement of PRRS virus from “on-site” to “in-barn” is also outlined (2). As well, guidance is provided on the importance of minimizing transmission risks through selection of PRRSV negative replacement stock (3) and use of semen from PRRSV negative sources with appropriate monitoring programs in place (4). Risk can be further reduced by utilization of appropriate isolation protocols to separate incoming animals of unknown disease status from the breeding herd to prevent entry of PRRS virus into the sow herd (5). Suggestions on modifications to pig flow that provide for increased usage of all-in, all-out by room, barn or site to reduce the transmission of disease from the resident population to the incoming animals are outlined (6). The final two position statements detail the importance of assessing your biosecurity risks through the use of a PRRS Risk Assessment administered by your veterinarian (7) and the value of sequencing PRRS virus from all new clinical cases or outbreaks to create a farm history to allow better understanding and decisions on control or elimination initiatives.

The position statements currently available are listed below and can be found in full at www.opic.on.ca/oshab.htm.

1. Pig transport & service vehicle biosecurity is essential to prevent the spread of disease agents between pig units.
2. Every pig barn should have a minimum of a Danish Entrance.
3. All breeding stock should be PRRSV negative.
4. All boar studs should be negative for PRRSV and have a monitoring program that minimizes the risk of virus transmission.
5. Every sow farm needs an isolation unit.
6. Nursery and finisher pig flow should be all-in, all-out.
7. All swine breeding herds should conduct a PRRS risk assessment.
8. All new clinical cases or outbreaks in which PRRS virus is identified should have the virus sequenced, and the Ontario pig industry should have a centralized database of PRRS virus sequences.

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Bacteriophage Control of Salmonella in Pig Production: Not all viruses are bad

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Salmonella is a highly virulent pathogen that can infect pigs and humans alike with potentially fatal consequences. It is estimated that more than 50% of the pig herds within Ontario harbour *Salmonella* and that the enteric pathogen results in 3000-5000 cases of foodborne illness every year within the province.

In addition to animal and human health, the carriage of *Salmonella* has become a significant issue in the marketability of pork. For example, to supply pork to lucrative export markets it is necessary to ensure the prevalence of *Salmonella* is low. This is the primary reason why Denmark spends over $20m per year on *Salmonella* control.

Through various studies it has been established that the most significant source of *Salmonella* is at the farm (primary production) level. There are several strategies the pig farmer can apply to reduce the prevalence of *Salmonella* including administration of antibiotics. However, due to reasons of antibiotic resistance in *Salmonella* and health risks associated with residues, there is a sustained effort to find alternative control measures. To this end we have been evaluating the potential of bacteriophages as an alternative to antibiotics for controlling *Salmonella* in pork production. Bacteriophages, or phages, are viruses (from 'bacteria' and Greek *phagein*, 'to eat) that infect bacteria in order to replicate which ultimately brings about the death of the bacterial cell (Figure 1). Not only do bacteriophages represent a “natural” biocontrol method but they are also self-perpetuating and self-limiting. That is, if a suitable host is present in the environment a single phage can replicate to form hundreds of new bacteriophage particles per cell. However, if no host is present the bacteriophages naturally are inactivated over time. It should be emphasized that bacteriophages do not cause illness in pigs or other animals and only infect specific target bacteria. Bacteriophages have a long history in Eastern Europe to treat infections although they have yet to receive significant attention in the West due to the dominance of antibiotic based therapies.

Although bacteriophages are specific for the target bacteria, they vary with respect to host range, lytic ability and tolerance to environmental stress. For phage based interventions, the ideal bacteriophage would have a broad host range that can infect any type of *Salmonella* encountered, strong lytic ability and tolerance to environmental stress. In the course of the study five phages were selected from over 500 originally isolated and taken forward to animal trials. Trials were performed whereby pigs were orally administered bacteriophages in addition to daily spraying of bacteriophage cocktail in the environment. The pigs were then administered *Salmonella* with fecal and environmental samples being taken over the course of 28 day trial. At the end of the trial the presence of *Salmonella* and bacteriophages in internal organs (lymph nodes, cecal contents and spleen) was determined. The results from the trial suggested that the prevalence of *Salmonella* associated with pigs and the environment can be decreased but not eliminated by applying bacteriophages.

A second part of the study investigated the effect of bacteriophages on the dynamics of *Salmonella* populations. Specifically, sampling trials within pig pens were performed over an extended time period to determine if the presence of phages would ultimately select for bacteriophage resistant strains/mutants. The generation of phage resistant mutants is frequently observed in the laboratory setting and has been proposed to be the ultimate limitation of phage therapy. Contrary to laboratory based studies, no evidence of the emergence of phage resistance or mutations occurred in natural environments with the *Salmonella* host and phages attaining an equilibrium. The co-existence of infecting bacteriophage and its *Salmonella* pray makes sense if one considers that complete elimination host cells would ultimately result in the extinction of the phage.

The conclusions from our studies would suggest that bacteriophage control of *Salmonella* does hold promise for the future although should not be considered a golden-bullet and needs to be applied in combination with other interventions. To this end we hope to initiate studies in the near future whereby bacteriophages will be used in combination with antagonistic bacteria (for example, probiotics). Early studies using a combination of bacteriophages and antagonistic bacteria to inhibit *Salmonella* have proven successful in the laboratory but the results need to be verified in animal models.

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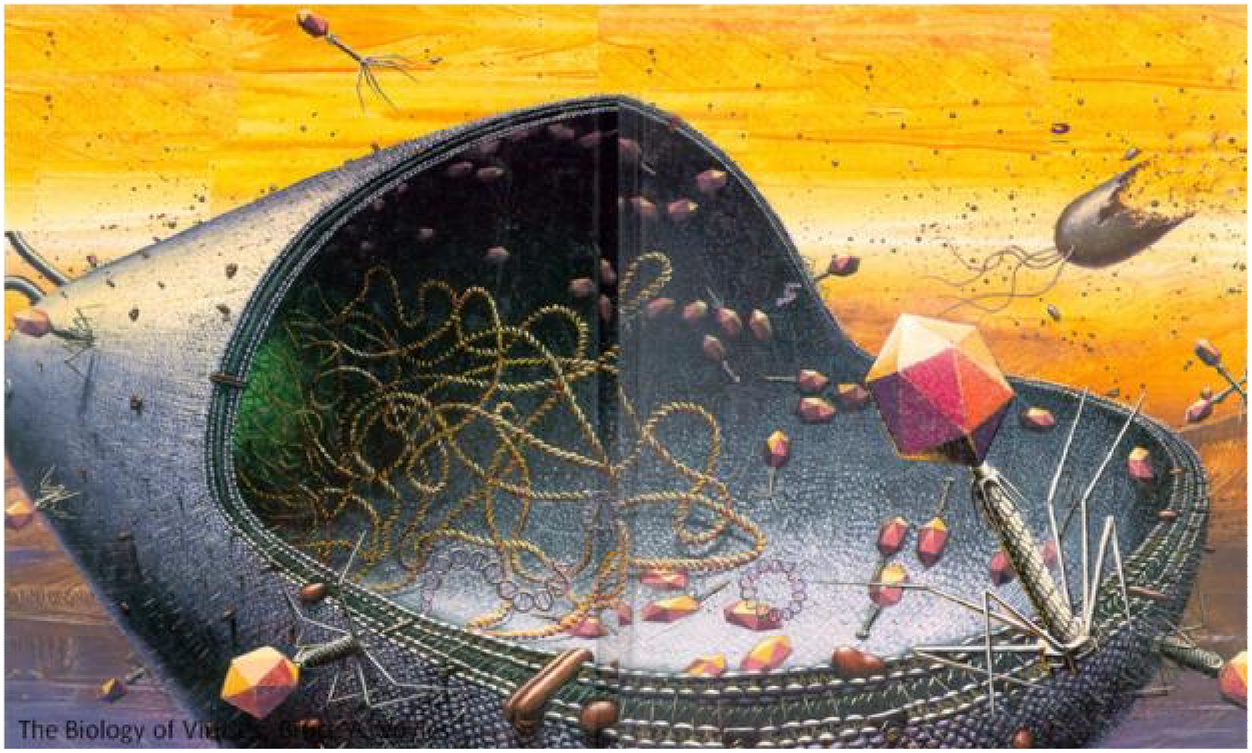

Figure 1: Illustration of the bacterial cell lysis by bacteriohage. Bacteriophages absorb onto a specific receptor on the cell surface and inject nucleic material which causes the resources of the bacteria to be diverted into producing new phage particles. When the phages have been produced the cell bursts open and the new phages (up to 800 per cell) are released to infect further host cells. Reproduced by permission of Dr S Ripp University of Tennessee.

The Possible Use Of Essential Oils To Control Salmonellosis In Weanling Pigs

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Introduction

Salmonella is an important and widespread disease problem in swine, causing not only clinical illness in pigs but also more significantly foodborne disease in humans. It is generally believed that to prevent the foodborne spread of *Salmonella* to humans, efforts should be directed at all aspects of the food production chain "from farm to fork". In the case of Ontario pigs, the serovar of primary concern is *Salmonella* Typhimurium. Most of the isolates of S. Typhmurium express multiple antimicrobial resistance and therefore this serovar is of particular public health concern.
One novel approach that has been suggested is to use essential oils. These are products of plants (herbs) that have been used for centuries as flavourings and fragrances. Some essential oils have been shown to have good antimicrobial properties. Herbs or essential oils (EOs) with medicinal properties are being considered as possible alternatives to antibiotics. The advantage of using this novel approach is that in general essential oils are considered safe by the general public and several are approved for use in animal feeds as flavourings.

The objective of a series of studies was to evaluate the efficacy of selected essential oils on reducing clinical signs of diarrhea and reducing the number of pathogenic organisms in the cecal contents of pigs challenged with *Salmonella* Typhimurium DT104.

Materials and Methods

In each trial weanling pigs were housed in the University of Guelph isolation facility and allowed to acclimatize to the feed and environment before being exposed to *Salmonella*. The *Salmonella* challenge at first was performed by inoculating each pig with 5ml of broth containing 10^7 organisms. This resulted in all pigs developing diarrhea and some becoming quite ill. Subsequently the challenge dose was changed to inoculating a single seeder pig in each pen and allowing that pig to contaminate the environment. This more natural exposure resulted in generally less severe clinical disease but at the same time all pigs in the pen quickly became carriers.
During our first trials we compared pigs fed 200 ppm of carvacrol, with pigs fed a mixture of 200 ppm carvacrol, 400ppm of eugenol, and 300ppm of geraniol, and a control group receiving the same basic starter ration but without essential oils.
Because of a lack of response we experimented with using various emulsifiers with essential oils to help ensure better mixing and distribution. Trials using high and moderate levels of cinnamaldehyde plus an emulsifier were performed in a similar manner. Pigs were challenged with *Salmonella* using seeder pigs and then monitored for two weeks. At the end of the trial all pigs were euthanized and the contents of the cecum was cultured for *Salmonella*.

Results and Discussion

In general these trials showed no value in using essential oils. Overall there was no difference in clinical signs, and no indication that essential oils reduced the number of carrier animals. It is possible that higher concentrations of essential oils would result in a more favourable response but

such levels would be economically prohibitive. In addition at higher levels we may have witnessed feed refusal.
It appears that when essential oils are mixed with feed the binding of oil to feed particles appears to interfere with the antimicrobial activity of the essential oils and this can be demonstrated in the lab. In order for essential oils to be more effective as an antimicrobial product this limitation must be overcome. Work has been done on micro-encapsulation and other methods of presenting the essential oils and hopefully this will produce more favourable results.

Significance of the research

This work suggests that, at present, *Salmonella* cannot be controlled by adding essential oils to feed even though some of these herb products are very effective at killing *Salmonella* under laboratory conditions.

Acknowledgments

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Evaluation Of The Impact Of Coccidia On Post-Weaning Performance

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Introduction

In 2006, a study was carried out on 50 farms in southwestern Ontario to determine the prevalence and impact of coccidia (*Isospora suis*) in pigs at 7 to 21 days of age. Coccidia were found on 35 (70%) of the farms, and litters that had coccidia were 4-times more likely to have diarrhea than non-infected litters. In addition, coccidia-positive farms had a mean standardized weaning weight that was 400 g lighter compared to non-infected farms.[1] Collectively, these data indicated that coccidia infections occur commonly on Ontario swine farms and are a cause of diarrhea at 7-21 days of age.

In most countries, the only treatment available for coccidia infections in pigs is Baycox (toltrazuril). However, in 2005 the drug was banned in Canada, leaving pork producers without an effective drug against coccidia. In order to maximize the chance of an alternative drug being licensed for use against coccidia in Canadian pigs, information on the total impact of coccidia infections was required. Since the 2006 Ontario study sampled pigs up to only 21 days of age, it may have underestimated the total impact of coccidia. A study was therefore carried out to determine the impact of coccidia infections up to 8 weeks of age.

Materials and methods

In previous work, shedding of coccidia oocysts has only been examined in pigs up to 3 weeks of age. We therefore first needed to determine the optimum time(s) to sample pigs up to 8 weeks of age to determine whether or not they are infected with coccidia. A **pilot study** was therefore carried out on a farm with a coccidia problem to answer this question. In May 2007, rectal fecal samples were collected from 188 randomly selected pigs, representative of animals from 1 to 8 weeks of age on the farm. All fecal samples were examined for coccidia oocysts.[2]

For the **main study**, to determine the impact of coccidia on growth rates up to 8 weeks of age, three representative swine farms were selected that had a coccidia problem. Between May and September 2007, rectal fecal samples were collected from 218 randomly selected pigs on the three farms at 2, 3 and 5 weeks of age. In total, 655 fecal samples were collected from 218 pigs belonging to 72 litters. As before, all fecal samples were examined for coccidia oocysts.[2] Lastly, the weights of all 218 pigs, and all their littermates, were recorded at 1, 2, 3, 4, 5 and 8 weeks of age. In total, 3928 weight data were recorded.

Results

(a) Pilot study:

In total, 34 of the 188 sampled pigs were detected infected with coccidia. No pigs were detected infected under 15 days of age or over 40 days of age. The highest numbers of coccidia oocysts occurred in feces from pigs aged 15 to 24 days. In combination with data collected from 50 Ontario farms in 2006, the results indicated that the optimal, practical, protocol for determining the coccidia-infection status of pigs up to 8 weeks of age was to sample animals at 2, 3 and 5 weeks of age.

(b) Main study:

Of the 218 pigs that were sampled, 162 were detected positive for coccidia on at least one occasion. When controlling for age, weight and farm:

- At 4 weeks of age, pigs that originated from litters that were positive for coccidia at 2 or 3 weeks of age were an average of 435 g lighter than pigs that originated from litters that were negative for coccidia (p=0.065).
- At 5 weeks of age, pigs that originated from litters that were positive for coccidia at 2 or 3 weeks of age were an average of 703 g lighter than pigs that originated from litters that were

negative for coccidia (p=0.007).

- At 8 weeks of age, pigs that originated from litters that were positive for coccidia at 2 or 3 weeks of age were not significantly different in weight from pigs that originated from litters that were negative for coccidia (p=0.78).

Discussion

Coccidia infections in swine have generally been assumed to only occur in pigs from 7-21 days of age. However, this study has demonstrated that infections may occur in weaned pigs up to 5 weeks of age. Fecal samples were therefore collected from pigs at 2, 3 and 5 weeks of age and, in combination with weekly weight data, were used to determine if coccidia infections were associated with an impact on growth in the post-weaning period. Quite surprisingly, at 4 weeks of age, pigs that originated from litters that were detected positive for coccidia at 2 or 3 weeks of age were an average of 435 g lighter than pigs that originated from litters that were negative for coccidia. Similarly, at 5 weeks of age, pigs that originated from litters that were positive for coccidia at 2 or 3 weeks of age were an average of 703 g lighter than pigs that originated from litters that were negative for coccidia. However, at 8 weeks of age, pigs detected positive for coccidia at 2 or 3 weeks of age were not significantly different in weight from pigs that were negative for coccidia. It would appear that a compensatory growth mechanism is likely responsible for this latter finding.

In summary, coccidia infections at 7-to-21 days of age were shown to be associated with a significant reduction in body weights at 4 and 5 weeks of life. Furthermore, the data indicated that, in addition to the suckling period, coccidia may be associated with diarrhea in the post-weaning period.

Acknowledgements

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Is Severe Porcine Circovirus-Associated Disease (PCV-AD) Caused By A New Strain Of Porcine Circovirus 2?

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Introduction

In 2005 the Animal Health Laboratory at the University of Guelph reported a huge increase in cases diagnosed as Porcine Circovirus type 2 (PCV2)- associated disease (Carman et al, 2005). As a preliminary study we performed a phone survey involving members of the Ontario Association of Swine Veterinarians. Almost all veterinarians reported that PCV2-associated disease (PCVAD) had become a problem, estimating it affected 25% of their clients' herds and describing disease specific mortality rates ranging from 5 to 40%. They commented on the fact that the disease appeared to have suddenly changed from a sporadic minor problem of the nursery to a serious problem primarily affecting pigs in the grower-finisher stage. There was a lot of controversy about PCV2-associated disease including what the causative agent was and why some herds had severe outbreaks of disease, particularly in light of the fact that the suspected causative agent PCV2 was present in every herd in Ontario and has been for decades (Cottrell et al, 1999).

A possible explanation for the outbreak of severe PCVAD in Canada was that the strain of Porcine Circovirus changed. The Animal Health Laboratory showed that the PCR-RFLP type of PCV2 virus previously isolated was mainly type 422 and in late 2004 type 321 appeared. When 4 Ontario RFLP type 321 viruses were sequenced they were all found to have greater than 98% homology with the PCV2 viruses from France and the UK and only 92% homology with the old "strain" 422 (Carman et al, 2005). It was hypothesized that the more severe clinical signs observed in 2005 and 2006 were a result of the introduction of a new and more virulent strain of PCV2.

The primary goal of our study was to determine if the new PCV2 virus (321) was present in herds that had experienced a severe PCVAD outbreak causing greater than 5% mortality in grower-finisher pigs and characterized by wasting and other clinical signs, whereas it was absent in herds that had not experienced such a problem.

Materials and Methods

We visited a convenience sample of 50 Ontario pig farms. A short survey was filled in and 3 poor-doing pigs were submitted for post-mortem examination and PCR testing was performed on tissue. We defined a case as a farm with a history of high grower-finisher mortality, with wasting as a prominent feature of the outbreak, and some type of confirmation of PCVAD. Control farms were herds with no history of a disease outbreak in the finisher barn that might be suspicious of PCVAD.

Results and Discussion

PCV2 virus with RFLP 321 (the new strain), was the only type of PCV2 isolated except for one farm where the old 422 strain was found. The one farm with the old strain was a case farm that had a very severe form of the disease beginning in early 2005. We were not always able to identify PCV2 from each farm. This was particularly the case in herds using PCV vaccine (which was generally the case farms). When we found PCV2 on control farms it was always the new 321 strain. These farms for the most part were not using a vaccine. Clearly type321 has become the predominant strain of the virus in Ontario, and this shift must have occurred relatively quickly and is now widespread.

These findings do not support the theory that it is simply the entry of a new virus (321) that has resulted in the sudden change in the severity and clinical presentation of PCVAD. If that were the case one would have expected to find the new virus on case farms and the old virus in control herds. It is well accepted that there are other factors that influence the clinical expression of PCVAD so one could expect that this division of case and control would not be 100%, but these findings offer no support to the theory whatsoever. It is possible that within the 321 category there are sub-strains that differ in pathogenicity. It is also possible that there are important contributing factors that are as yet unrecognized.

Implications

The finding of PCV2 RFLP 321 on a farm does not necessarily mean that the herd will encounter the severe form of PCVAD characterized by high grower-finisher mortality.

Acknowledgments

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Discoloured Bones In Pigs At Slaughter Associated With Medication Of Tetracyclines

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Introduction

In the final quarter of 2005, 524 pigs from 10 producers were identified at slaughter with unacceptable yellowing of their bones. In 2006, over 7000 pigs from a single Ontario packer were identified with discoloured bones. Bone samples analyzed using an unvalidated HPLC method contained 15-95 ppm of chlortetracycline, and fluoresced when exposed to UV light. It was assumed that the yellow colour was caused by tetracycline residue. Investigation into the farm history revealed varied levels of tetracycline administration ranging from a high dosage of 12 weeks of 660ppm of chlortetracycline in feed to as little as 5 days of water medication. Tetracyclines are used to some extent on almost all pig farms in the province and have been widely used in feed, water and as injectable products for over 50 years. It is unknown why yellow discolouration of bones has recently become more prevalent. The purpose of this research was to determine whether the yellow discolouration is related to; the dosage, timing, or method of administering tetracycline.

Materials and Methods

Tetracyclines were administered to pigs for various lengths of time and at various dosages and using different routes of administration. The carcass was assessed for yellowing of bones and tetracycline residues in muscle, liver and bone.

<u>Group1</u> (high exposure and long duration)

A pen of 5 pigs was fed a ration containing chlortetracycline at 660 ppm for 12 weeks from 8 weeks of age until 20 weeks of age.

<u>Group 2</u> (high exposure and short duration)

A pen of 5 pigs was fed 660 ppm of chlortetracycline for 3 weeks from 8 weeks of age until 11 weeks of age.

<u>Group 3</u> (low exposure and long duration)

A pen of pigs was fed a ration containing 110 ppm of chlortetracycline for 12 weeks from 8 weeks of age until 20 weeks of age.

<u>Group 4</u> (low exposure and short duration)

A pen of 5 pigs was fed a ration containing110 ppm of chlortetracycline for 3 weeks from 8 weeks of age until 11 weeks of age.

<u>Group 5</u> (water medication)

A pen of 5 pigs was treated with 1 gm tetracycline per 8 L of water for 5 days during the grower-finisher stage.

<u>Group 6</u> (injectable)

Five pigs were injected IM with 300 mg per 45kg body weight of oxytetracycline for 3 days during the grower-finisher stage.

Pigs from these trials were slaughtered at 24 weeks of age at the University of Guelph abattoir and the right metatarsal bone, sacral vertebrae and a rib were removed and assessed for colour. The metatarsals were ground and assessed using high-pressure liquid chromatography (HPLC) for tetracycline residues. A sample of skeletal muscle and liver will also be analysed for levels of tetracyclines.

Bones from 5 pigs identified as having discoloured bones were collected from a packing plant as well as bones from a pig with no tetracycline exposure, and these samples were also subjected to HPLC analysis.

Results

Tetracyclines were not present at detectable levels in liver, kidney or muscle tissue. All bones from pigs fed tetracyclines showed some degree of fluorescence under ultra-violet light. Bones from the negative control pig did not fluoresce. Bones from the two long duration exposure experiments (high and low for 12 weeks) were not analysed because of an accident during processing. Discolouration of bone was only detected in the samples from pigs receiving 660 ppm of chlortetracycline for 12 weeks in the feeding trials. The results of HPLC analysis are presented in Table 1. The levels of chlortetracycline that were measured from the bones of pigs receiving 660 ppm of chlortetracycline for 3 weeks in feed during the early grower stage ranged from 12 to 23 ppm. Levels found in bones from pigs detected at slaughter with discoloured bones were on average slightly higher, averaging 23 ppm of chlortetracycline. Pigs injected IM with 300 mg per 45 kg body weight of oxytetracycline for 3 days were found to have oxytetracycline levels of around 20 ppm.

Table 1. Average levels of tetracyclines (ppm) in bone from pigs in various exposure groups as measured by high-pressure liquid chromatography

Source	Feed 110ppm/3wks	Feed 660ppm/3wks	Water 1g/8 L	Injectable 300 mg per 45 kg	unknown Discoloured bones
Tetracycline	0.502	1.45	2.54	0.278	3.2
Chlortetracycline	2.756	16.75			22.54
Oxytetracycline				21.4	0.936

Significance

Tetracyclines used at relatively moderate treatment dosages of 660 ppm for 3 weeks or longer resulted in concentrations similar to those found in bones from pigs identified by discolouration at slaughter, so care is needed when using tetracyclines at high levels or for prolonged periods of time.

Acknowledgments

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Feeling the pressure:
Determining the pressure on a sow's shoulder while she is nursing

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Objectives -This pilot project was designed to determine if a human pressure measurement system could effectively measure the pressure at the point of a sow's shoulder. Measurements were taken on two types of slatted farrowing crate flooring, (cast iron or triangular bar) to determine which flooring exerted the least amount of pressure on the sow's shoulder. Measurements were also taken after the addition of rubber mats to farrowing crate floors to compare to the pressure measured on uncovered crate flooring.

Procedures -Selected sows were fitted with a vest containing 2 pressure sensing devices, one over each shoulder (Figure 1). After a sow lied down, the sensor mat was connected to the computer. Once a clear image of the contact area was displayed on the screen while the sow was in a completely lateral lying position, data recording was started. A pressure reading was taken once per second for 30 seconds. The vest and sensors were removed when the sow stood after data recording was complete.

Figure 1. Sow wearing pressure vest

After the sensors were removed, a 60 cm x 60 cm rubber mat was secured to the crate floor with cable ties. The mat remained in the crate for 2-5 days in order for the sow to become accustomed to it. Once the sow no longer considered the mat a "novel" object, the vest was again fitted to the sow and another series of shoulder pressure recording was taken again in the same manner.

Results -Paired data recordings from 8 sows were used for all analyses. The average peak pressure without a mat was 153 mmHg. With a mat, the average peak pressure data was 156 mmHg. The difference between the average peak pressures (with and without a mat) was not statistically significant ($p=0.8748$).

Separating the data by crate flooring type, the average peak pressure was greater for triangular bar slatted flooring (185 mmHg) then for cast iron slatted flooring (139 mmHg). The difference between the average peak pressures of the two floors was not significant ($p=0.1743$).

Since peak pressures can vary greatly with slight movements of the sow, the data was also analyzed using the percent of sensors that registered over a specific pressure. The percent of sensors registering a pressure over 32 mmHg, 45 mmHg, 70 mmHg, 100 mmHg, 120 mmHg and 150 mmHg, for sows on slatted crate flooring and for the same sows on rubber mats are found in Table 1. Sows with floor mats had significantly fewer sensors over 150 mmHg than those without rubber mats ($p=0.04$). The percent of sensors over 100 and 120 mmHg of sows with floor mats showed a similar trend.($p<0.1$). .

Discussion- The pressure sensors were not durable enough to withstand the hooves and curious investigations of a standing sow if fixed to the farrowing crate floor. The vest effectively positioned and secured the sensor mats to the sow's shoulder. The average peak pressures recorded over the shoulders of sows lying laterally were comparable to pressures that humans experience over large bony prominences. Paraplegic and quadriplegic people often experience pressures ranging between 40 and 300 mmHg over the ischial tubers, depending on the surface they are sitting on (Daniel et al, 1981). These patients are commonly afflicted with pressure lesions, with a prevalence ranging from 25-85% depending on the level of patient care (Nola and Vistnes, 1980).

The type of crate flooring has been suggested to be a risk factor for sow shoulder lesions (Zurbrigg, 2006). While not statistically significant in this small pilot study, the higher average peak pressures recorded on the triangular bar flooring are consistent with theoretical principles. The triangular bar flooring has narrower slats and wider slots (the openings between slats) than the cast iron slatted floor. The resulting decreased surface area for contact with the shoulder increases the pressure exerted on those areas that contact the slats, particularly the bony prominence of the scapula because there is less surface area over which to distribute the sow's weight. Though not statistically significant, the triangular bar flooring was consistently higher in all of the "percent of sensors registering over.." categories, and this further lends support to the weight distribution theory.

The most common method used to prevent and treat pressure ulcers in humans is to increase the padding under the patient's sitting or lying surface. This decreases the pressure exerted over bony prominences by increasing the body's contact area with, redistributing the pressure over the larger contact surface (Makleburst and Sieggreen, 2001). In this study, the addition of a rubber mat significantly reduced the percent of sensors registering pressures over 150 mmHg and there was a trend towards significance for the over 100 and 120 mmHg categories.

This pilot study included data from 8 sows and was designed to test the possibility of using human pressure recording equipment on sows. The study did not have enough subjects to provide adequate power to accurately evaluate many of the differences tested. Future investigations will involve a larger number of sows.

If you have sows on your farm with shoulder sores try securing a rubber mat over the slats. This should help the sore to heal more quickly. Please feel free to contact me if you have questions or need help with sow shoulder sores.

Table 1. The mean and SD for the "percent of sensors registering over" categories for slatted flooring and flooring covered by a rubber mat.

Flooring Type	**% over 32 mmHg (SD)**	**% over 45 mmHg (SD)**	**% over 70 mmHg (SD)**	**% over 100 mmHg (SD)**	**% over 120 mmHg (SD)**	**% over 150 mmHg (SD)**
Slatted	52.8 (11.4)	42 (11.9)	24.7 (9.4)	11.5 (4.6)	7.1 (3.0)	3.1 (1.4)
Rubber mat	42.8 (15)	31.4 (13.6)	16 (9.3)	6.1 (4.8)	3.7 (3.0)	1.4 (1.1)

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Pilot Plant for Electrolytic Deodorization of Liquid Hog Manure

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In previous work supported by Ontario Pork we demonstrated that electrolysis of liquid hog manure leads to the mitigation of offensive odor. Experiments conducted at a laboratory scale as well as in a farm-installed 27 liter reactor proved that the electrolysis also gave substantial reduction in bacterial counts with preservation of total nitrogen content.

In the present project, a pilot plant of capacity ~1800 L was constructed at the Arkell Research Station, University of Guelph, to evaluate the technical promise of direct-current electrolysis for ameliorating the adverse odour of liquid hog manure. The anodes were titanium metal coated with a micrometer-thick layer of iridium dioxide (Ti/IrO_2), and the cathodes consisted of mild steel grids. Two different electrode configurations were studied: (A) planar electrodes of dimensions 24"x 16" immersed in the solution from above (Figure 1); (B) an external flow-through electrolyzer unit with electrodes of dimensions 16"x 1" (Figure 2). Six experiments, each lasting one week, were carried out, three with each electrode configuration. Each experiment was initiated after filling the pilot plant with manure from the storage lagoon of the swine barn and allowing it to equilibrate for several days. The experiments were concluded by allowing the electrolyzed manure to stand without further treatment for at least 1 week, in order to demonstrate that the odour did not regenerate. The objective of the work was to improve the quality and intensity of the odour to an acceptable level, rather than to eliminate it entirely.

All the experiments were successful with respect to the following criteria.

1. Electrolysis successfully ameliorated the odour of the manure, usually within 1-2 days, from the offensive smell of raw manure to what was described as a "barn-like" odour, with concomitant reduction of the Threshold Odour Number by a factor of 5-6.
2. Odour did not regenerate following treatment even, in one experiment, for more than one month after the electrolysis was discontinued.
3. Bacterial counts were reduced by 1-2 orders of magnitude, and in particular the counts of anaerobic bacteria, which are chiefly responsible for odour, were reduced by 2 orders of magnitude in almost every experiment.

We conclude that the project met the initially set objectives. Any further work into the commercialization of this approach into a commercial technology will require a full-scale on-farm demonstration.

Acknowledgements: We thank Ontario Pork for financial support and the staff of Arkell Research Station for technical assistance.

Figure 1. Electrodes mounted in configuration A; left: cathode (mild steel grid); right: anode (Ti/IrO_2 grid); direct electrical contact by alligator clips. Note that the electrodes are almost completely immersed in the liquid.

Figure 2. Electrodes mounted in configuration B (electrodes contained in an external bypass). The electrode unit is contained inside the horizontal pipe between the two grey fittings.

Space Allowance for Finishing Pigs Affects Productivity, Health and Behaviour

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SUMMARY
The reduction in average daily gain due to reduced space allowance for pigs in both small and large groups occurs at a similar point as that previously reported in the literature (k = approximately 0.033 – 0.036 m2/BW(kg)0.667). Lameness was more common in the less spacious treatment during the final weeks of the study. Pigs in crowded conditions had fewer meals and less total time spent eating compared to the more spacious treatment. Space allowance can affect health and behaviour as well as productivity.

INTRODUCTION
Space allowance is an important consideration in finishing pig production
as it has both economic and animal care implications. Producers must balance the efficiency of production while maintaining acceptable levels
of animal care. Most studies on space allowance have been limited to the effects on animal productivity, and were designed to 'stand alone' and yield results specific to the conditions studied. In the case of space allowance, for which numerous studies have been published, it is possible to conduct an analysis of all of their results to obtain a more precise measure of the effects on productivity. We conducted such an analysis on previously published results on space allowance. We also conducted a study combining both space allowance and group size as a part of a larger series of studies on the effects of space allowance.

EXPERIMENTAL PROCEDURE
We collected previously published material on the effects of space allowance on animal productivity. We restricted our analysis to average


A small-pen, crowded scenario was one of the four scenarios examined within the experiment.

daily gain, feed intake and feed effi ciency as these were consistently reported while few other variables were. We analyzed the data on a relative basis, that is, the results of the more crowded treatments were expressed as a proportion of the least crowded treatment within each study. In this way we were able to control for housing conditions, general health, genotype and nutritional programs that differed among studies, but were consistent within each study. We expressed space allowance using the allometric equation Area = k * body weight0.667, which allowed us to use studies based on different final weights.

To obtain a precise estimate of the point at which reduced space allowance results in a reduction in performance, we conducted a broken line analysis of the data.
We conducted a study on finishing pigs kept in either small (18 pigs/ pen) or large (108 pigs/pen) groups, under two space allowances (0.52 vs 0.78 m2/pig; 5.6 vs 8.4 sqft/pig). Within group size we analyzed production variables on a relative basis and applied a broken line analysis. We also examined the pigs for injuries and lameness, and observed their behaviour at 2-week intervals throughout the study. We limit our analysis of this study to the effects of space allowance for this article.

RESULTS AND DISCUSSION
The data obtained from the literature resulted from studies in Canada, Europe and the United States (see Figure 1). Analysis of this published data published identified the point at which space allowance began to reduce average daily gain as a 'k' value of 0.0336 m2/kg0.667. For a typical finishing barn with a target market of 115 kg, and making their first pull when 10% of their pigs reach this target, this 'k' value represents 0.72 m2/pig (7.75 sq^{ft}/pig). The space allowance per pig would differ if market weight or the 1st pull percentage varied from these levels. For every 1% reduction in space allowance below this level, average daily gain over the entire trial was reduced by an average of 0.33%. The same pattern was detected in the data on average daily feed intake. No effect of space allowance was seen for feed efficiency.
In our study we saw no significant difference in the effect of space allowance in the two group size treatments (Table 1). Average daily gain was reduced by crowding in both small and large groups. The broken line analysis indicated that average daily gain began to be depressed when space allowance fell below a k value of 0.036, slightly higher than the literature value. However, the difference would not be considered statistically significant. The key production result is that our average daily gain results identified a break point similar to previous studies.
In terms of health and injuries, the pigs in our less spacious treatment evidenced more lameness during the fi nal weeks of the study. This is in agreement with our expectations that health problems associated with space allowance should only develop at the end of the study when pigs become more crowded. A second difference that we observed was that crowded pigs had fewer meals, of the same length as uncrowded pigs, and therefore less eating time. This pattern is that of an animal with a reduced appetite. In contrast, pigs in large groups, that had to travel further to eat, had fewer but longer meals, and maintained their total daily eating time. This 'reduced appetite' effect of crowding is supported by previous research indicating that crowded pigs will reduce their energy intake even if the feed is made more energy dense, which should have enabled the pigs to maintain daily nutrient intake if they wanted to.

IMPLICATIONS
Results obtained under conditions more typical of commercial production confirm that reductions in space allowance below a 'k' value of approximately 0.0336 m2/kg0.667 will reduce productivity. The effects of reduced space allowance may also be seen in health variables, such as lameness, but only near the end of the finishing period. The eating patterns of pigs in crowded conditions

suggest a reduction in appetite rather than a simple restriction of feeder access.

ACKNOWLEDGEMENTS
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(reprinted from Prairie Swine Centre Inc. Annual Research Report)

Table 1. Effects of crowding on productivity of pigs in large and small groups

	Average Daily Gain (grams)		Reduction Due to Crowding	
	Uncrowded	Crowded	Grams/Day	Percent
Small group (18 pigs)	1,098	1,049	49	4.4
Large Group (108 pigs)	1,055	1,016	39	3.6

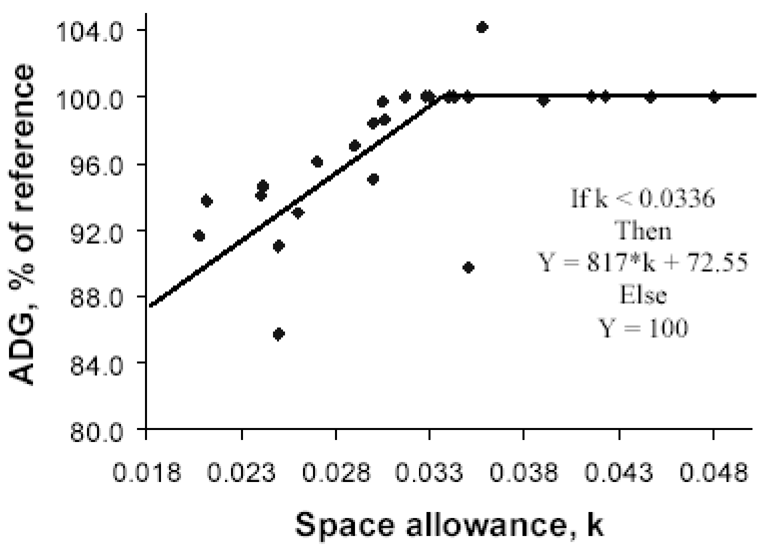

Figure 1. Broken line analysis of ADG for grower-finisher pigs on fully slatted fl oors. The allometric expression of space allowance is k where k = Area (m2) / BW (kg).667. ADG is expressed as a percentage of that in the most spacious treatment within each experiment. r2 = 0.90, P < 0.001.

Impact of Prod Use on the Incidence of Highly Stressed Pigs

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SUMMARY
We subjected pigs to three different handling treatments as we moved them through a 300m handling course. Despite traveling the same distance as the others, pigs moved at a moderate pace with only a board, quiet voice and gentle slaps, were essentially unstressed by the procedure. Pigs handled aggressively, at a fast pace, with shouting and slapping, but without use of electric prods had a higher incidence of stress, but none showed extremes that might lead to animal losses. Use of the electric prod resulted in a large proportion of the pigs showing both behavioural and physiological signs of stress, with some being extreme to the point of stumbling and falling. We should minimize the use of the electric prod by changing our handling techniques and/or modifying our load out facilities.

INTRODUCTION
The shipping of finishing pigs is a stressful time for the animals, and each year several thousand pigs die or are euthanized in Canada during this process. Although the percentage of animals that are lost is quite low, at less than half of a percent, these animals represent a considerable financial loss to the industry and are a major welfare concern. Although many factors such as temperature and genotype likely contribute to these losses, the data strongly suggest that poor handling is a major cause. We were involved in a study to develop an experimental protocol to study stress induced losses of finishing pigs. The protocol has since been used to study the physiological responses of pigs to handling. As part of our study we examined the role of prod use during handling on the incidence of highly-stressed pigs.

EXPERIMENTAL PROCEDURES
Our study included 192 near market weight animals. These animals were taken from their fi nishing pen, in groups of six, and herded through a handling course. The course was approximately 300 m in length, and involved numerous turns, reversals, and partially obstructed alleys. It took approximately 10 minutes to herd the animals through the course. We imposed three handling treatments on the animals. The Gentle treatment involved herding the animals with a herding board, voice and occasional slapping, at a comfortable walking pace. No electric prod was used in the Gentle treatment. We also used an Aggressive treatment that herded pigs at a fast walk, used a louder voice and involved slapping and/or use of the electric prod. Within each group of six pigs in the Aggressive treatment we identified two animals that were not to be prodded. They were encouraged to move only with slapping by the hand and pushing. The remaining four pigs were prodded frequently.
We attempted to identify signs of stress in the animals before they reached the extreme of falling down. These signs included laboured breathing, blotchy skin, stumbling and a strained squeal. If a pig evidenced two or more of these signs it was left behind the remainder of the group and termed a highly stressed animal. Approximately 4% of the animals stumbled and fell during handling and were euthanized if they did not show immediate signs of recovery. Although this level of loss is high compared to the industry average, some commercial loads of pigs will reach similar levels. Numerous physiological measures were taken before and after the handling procedure.

RESULTS AND DISCUSSION
Within the Gentle handling treatment only 1 of 48 pigs was considered to be highly stressed by the procedure (Table 1). The Aggressive treatment, including the use of the prod resulted in over 40% of the animals being highly stressed, including all of the pigs which actually went down and had to be euthanized. When the pigs were moved aggressively, but without the use of the electric prod, the proportion of highly stressed pigs was intermediate to the other treatments. The Gentle treatment pigs moved the same distance as the Aggressively handled animals, so the stress was not due to the exercise per se, but rather to the handling methods. The Aggressive treatment components of more rapid movement, additional shouting and slapping did increase

Loading and unloading pigs with paddles can be an effective method of minimizing stress.

the level of stress, but did not put the lives of the pigs in danger. Only when we used the electric prods did we see an extreme stress response in the animals. Prod use in the study would be higher than typical when loading pigs, but under commercial conditions it would be possible for individual pigs that were confused or overly hesitant to be prodded as frequently as our experimental pigs were. These are the pigs that would be susceptible to extreme stress.
The physiological measures indicated that highly stressed pigs had higher temperatures, lower blood pH, and higher blood ammonia levels than did the pigs with no overt signs of stress. Among Aggressively handled pigs, those that received the electric prod showed extremes in these measures. It is also noteworthy that although blood lactate was similar in those showing low and high levels of stress, it was considerably higher in prodded animals than in non-prodded.

IMPLICATIONS
Clearly we should be minimizing the use of the electric prod when handling animals. Before prodding a pig while it is being loaded the handler should consider if another means of encouraging movement could be effective, even if it took slightly longer. If one pig is repeatedly being difficult to move it should be left behind and perhaps herded separately rather than prodding it again. If a producer finds that they must use the electric prod frequently during the load out process, they should consider changes to their load out design and/or general handling techniques.

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(reprinted from Prairie Swine Centre Inc. Annual Research Report)

Table 1. The incidence of highly stressed pigs in three different handling treatments.

	Gentle	Aggressive	
		No-Prod	Prodded
No signs of stress	47	41	54
Highly stressed but not falling	1	7	23
Highly stressed and falling	0	0	9
Total # of Pigs	48	48	96
Handling time in course (sec)	701	467	467