33rd Annual

# CENTRALIA SWINE RESEARCH UPDATE

January 29th 2014

CentraliaSwineResearch.ca

**CENTRALIA SWINE RESEARCH UPDATE**
**Kirkton-Woodham Community Centre**
**January 29, 2014**

9:15 a.m. Registration and Coffee
9:50 Opening Remarks

10:00 In-Transit Losses of Pigs: An Investigation of Hog Heart Health
Kathy Zurbrigg, OMAF and MRA/University of Guelph

10:15 Rodenticide Ingestion in Swine: A Project to Assist Veterinarians with Detection and Establishing Possible Withdrawal Times
Dr. Ron Johnson, Dept. of Biomedical Sciences, University of Guelph

10:30 Antimicrobial Resistance – What is it and Why should you care?
Dr. Anne Deckert, Dept. of Population Medicine, University of Guelph

10:45 Hernias – From the Processors Side of the Chute
Frank Wood, Conestoga Meat Packers Ltd

11:00 Genetic Resistance to Disease
Dr. Brandon Lillie, Dept. of Pathobiology, University of Guelph

11:15 Benchmarking Ontario Swine Farms
Randy Duffy, University of Guelph, Ridgetown Campus

11:30 Sow Lameness: Being Aware and Taking Action
Dr. Yolande Seddon, Prairie Swine Centre, Inc., Saskatchewan

**12:15 LUNCH**

1:30 Entire Males for Commercial Pork Production
Dr. Kees de Lange, Dept. of Animal & Poultry Science, University of Guelph

2:00 Identification of Anorexic Piglets During the First Week After Weaning
Dr. Terri O'Sullivan, Dept. of Population Medicine, University of Guelph

2:15 Impact of Nursery Diet Protein Quality and Fish Oil Supplementation on Immune Response of Pigs
Dr. Seema Hooda, Dept. of Animal & Poultry Science, University of Guelph

2:30 Considerations for Providing Quality Space to Loose Housed Sows
Dr. Yolande Seddon, Prairie Swine Centre, Inc., Saskatchewan

2:45 Porcine Epidemic Diarrhea Update
Dr. Mike DeGroot, Ontario Pork

3:15 Adjourn

**WRITTEN-ONLY TOPICS**

# ACKNOWLEDGMENT

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*Wed. January 28, 2015*

*Wed. January 27, 2016*

*(Last Wednesday in January)*



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The Centralia Swine Research Update Planning Committee would like to acknowledge the logistical support from the Ontario Ministry of Agriculture and Food and Ministry of Rural Affairs for the co-ordination, proceedings, and registration of this event.

Ontario

# In-Transit Losses of Pigs: An Investigation of Hog Heart Health

Kathy Zurbrigg, OMAF and MRA/University of Guelph, Kathy.zurbrigg@ontario.ca; 519-846-3418
Dr. Tony van Dreumel, Veterinary Pathology Consulting, Guelph,
Dr. Robert Friendship, University of Guelph, Max Rothschild, Iowa State University,
Dr. Terri O'Sullivan, University of Guelph.

## Background

The specific cause of death for hogs that die in-transit to a packing plant has rarely been investigated. The increase in shipping mortalities during the summer months is often attributed to heat exhaustion or stress. In Ontario, approximately 0.07% of hogs shipped in a year die during transport to the plant. However it is rarely questioned why so many hogs are able to tolerate the shipping conditions and why only a small percentage cannot.

Research from the authors (KZ, TVD) and other published studies have suggested that heart failure from pre-existing heart lesions may be the specific cause of death of the majority of hog shipping losses. However why the hogs develop these heart lesions is not known. The goal of this project was to examine and characterize market hog heart lesions and investigate if there is a genetic association with hog heart lesions.

## The Project: What We Did and What We Found

From May 2012-September 2013, examinations of hogs that died while in transit to one slaughter plant were completed at the Animal Health Laboratory, University of Guelph. The hearts were removed from the carcass and preserved for further examination. For comparison, hearts were also collected from hogs that did not die in transit. Heart weights for hogs that died in transit were compared to the hearts of hogs that did not die in transit. Each heart was examined by one veterinary pathologist (TVD) both visually and microscopically.

Tissue samples from a selection of the hearts were sent to Geneseek Labs Inc. for gene sequencing. These sequence data were analyzed to determine if a common gene or genes could be associated with pigs that die during transport. A second analysis was completed to determine if a common gene or genes could be associated with pigs which had visibly affected hearts regardless of whether or not they died during transit.

- Post mortems were completed on 83 in-transit loss (ITL) hogs and 67 hearts were examined from hogs that did not die in transit. Post mortem findings on ITL hogs indicated cause of death was consistent with heart failure.
- The average total heart weight of hearts from hogs that died in transit was significantly heavier than the average total weight of hearts from the hogs that did not die in transit.
  ITL hearts 442.0 gm $\pm$ 66.4gm vs Non-ITL hearts 368.8gm $\pm$ 37.9gm ($P<0.05$)
- Visible enlargement of the heart was more common in the hearts of hogs that died in transit.
  - 77/83 (93%) of the ITL hearts had visible enlargement (hypertrophy) of the left or right ventricle.
  - 5/67 (7%) of the non-ITL (hearts from hogs that did not die in transit) had visible enlargement of the left or right ventricle.

- Abnormal microscopic lesions were found in the hearts of hogs that died in transit and in those that did not die in transit.
  63/83 (76%) of the ITL hearts and 51/67 (76%) of the non-ITL heart had microscopic lesions similar to those seen in Hypertrophic Cardiomyopathy (HCM).
- Heart lesions were chronic in nature, i.e. the lesions were developing in the pig's heart for weeks to months prior to the truck ride to the plant.
- 38 ITL hearts and 34 non-ITL hearts had samples sent for genetic sequencing and analyses.
- Analysis of the gene sequencing data showed over 40 genes possibly associated with a pig dying during transport. Two of these genes are known to cause HCM in humans.
- The second analysis of the gene sequencing data compared the genes of hogs with visible heart lesions to those that did not have visible heart lesions. This analysis found fewer genes possibly associated but the statistical associations were stronger with these genes compared to the first analysis.

### Heart Lesions to Heart Failure

Heart lesions may cause a heart to not function properly. The heart then has to work harder to maintain normal function. The heart is a muscle. If it has to work harder to function, the heart becomes enlarged. The enlargement of defective hearts resulted in greater heart weights in this study. Compared to most other mammals, a pig's heart is small in relation to its body size (1). As a result, hearts with compromised function have little reserve capacity to respond to challenges. Therefore if the heart is abnormal, any event that increases a pig's heart rate (e.g. hot temperatures, fighting, being loaded on a truck) may result in heart failure.

### Is There a Genetic Link to Hog Heart Lesions?

The visible and microscopic heart lesions found in the hogs in this study were similar to those observed in a genetic heart disease called Hypertrophy Cardiomyopathy (HCM). HCM has been recognized in people and some breeds of dogs and cats. HCM can result in sudden death in young, apparently healthy individuals. HCM-like lesions in pigs have been previously documented by a research group in Taiwan (2). Based on breeding experiments, the researchers suggested that the heart lesions were inherited (3), however no gene sequencing analyses were completed by the Taiwan research group.

The analyses of the gene sequencing data are very preliminary. A greater number of heart tissue samples will need to be tested to determine the specific gene(s) associated with heart lesions in hogs. If this can be established, it could be possible that the swine industry will be able to proactively address shipping mortalities through genetic selection to eliminate a HCM-like heart lesion gene or genes from the Canadian swine population.

### Take Home Messages

- In this study the majority of hogs that died in transit had a pre-existing cardiac abnormality resulting in hogs that were unable to survive standard transport practices.
- The hog heart lesions found in this study were similar to a genetic heart disease of humans, called Hypertrophic Cardiomyopathy (HCM).

- Preliminary analyses from this study appear to demonstrate that HCM-like hog heart lesions have a genetic association, but further testing and analyses are needed to identify specific gene(s) involved. The project is continuing to collect samples for more testing.

**References**


1) Friendship, R., Henry, S. 1998. Cardiovascular system, haematology and clinical chemistry. In Disease of Swine 7th Ed. Chapter 1 pg 3-5
2) Liu S, Chiu Y, Factor S, Chu R, Lin J, Hsou H, Fox P. Hypertrophic cardiomyopathy in pigs: Quantitative pathologic features in 55 cases. Cardiovascular Pathology 1994. Vol 3, 4:261-68.
3) Huang SY, Tsou HL, Chiu YT, Wu JJ, Lin JH, Yang PC, Liu SK. Statistical Method of Characterization of hypertrophy cardiomyopathy by use of morphologic and pathologic measurements in pigs. Lab Anim Sci 1999. Vol 49, 3.


Funding for this project was provided by an Ontario Pork Research Grant and by the Agricultural Adaptation Council's Canadian Agricultural Adaptation Program.

# Rodenticide Ingestion in Swine: A Project to Assist Veterinarians with Detection and Establishing Possible Withdrawal Times

Ron Johnson, DVM, PhD, DACVCP; Biomedical Sciences;
Robert Friendship, DVM, MSc, DipABVP, Population Medicine, OVC

## Introduction

Accidental ingestion of rodenticides in hogs represents significant food safety concerns, animal welfare issues, as well as substantial economic losses to the producers. The emergence of rodent strains resistant to older or first generation anticoagulant rodenticides[1] has spawned the development of more potent, second generation compounds such as bromadiolone, which increases the potential for toxicity following accidental ingestion and the adulteration of carcasses intended for human consumption.

The true incidence of bromadiolone exposures in hogs is not currently known. Inquiries to the Canadian Global Food Animal Residue Avoidance Databank, Ontario Ministry of Agriculture, Food and Rural Affairs, and Animal Health Diagnostic Laboratory (University of Guelph) regarding accidental ingestion of rodenticides in swine supports their increasing occurrence. Additionally, reports of accidental rodenticide ingestion, or possible exposure, in swine usually involve hogs near market weight and include, most commonly, groups containing large numbers of hogs.

Information pertaining to exposure, tissue depletion and possible withdrawal times of rodenticides in suspected swine toxicities would provide substantial guidance to veterinarians and producers regarding animal disposition given the significant food safety concerns to the public and financial considerations to the producer.

## Objectives

- To validate a non-invasive detection test for bromadiolone using blood and fecal samples in swine.
- To determine tissue residue depletion and estimate withdrawal time of bromadiolone in swine.

## Materials and Methods

- Two groups of barrows (n=20) and gilts (n=20) were given a single oral dosage of bromadiolone: high dosage group (HD, 0.5 mg/kg BWT) or low dosage group (LD, 0.05 mg/kg BWT).
- Blood and fecal samples were collected for determination of bromadiolone levels and assessment of coagulation parameters in the blood of treated hogs, specifically prothrombin time and partial prothrombin time.
- Animals were sacrificed at 1, 2, 3, 5, 6 weeks (LD group) and 1, 2, 3, 6, 9 weeks (HD group) post-dosing and tissue samples were assayed using High Pressure Liquid Chromatography coupled with Mass Spectrometry for bromadiolone levels to the appropriate limit of detection (LOD) for each sample type.
- The withdrawal time was calculated (where possible) from the regression lines according to FDA/CVM guidelines[2].

## Results

Table 1. Bromadiolone concentrations (ppb) after single oral administration of low dosage (0.05 mg/ kg) in 20 healthy pigs.

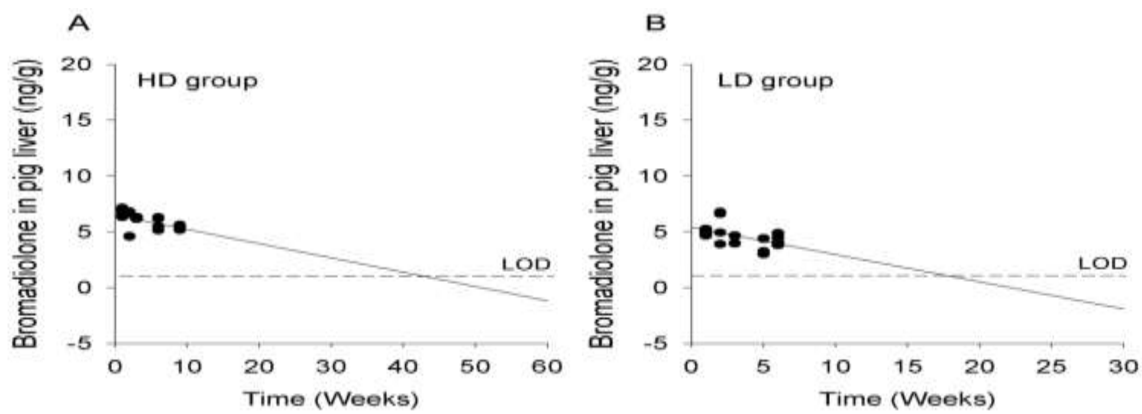
| | Feces | | | Liver | | | Muscle | | | Plasma | | | Skin and fat | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *LOD (ppb)* | *1* | | | *3* | | | *2* | | | *0.5* | | | *0.3* | | |
| | LL | Median | UL | LL | Median | UL | LL | Median | UL | LL | Median | UL | LL | Median | UL |
| week-1 (n= 4) | 2.9 | 19.9 | 73.5 | 96.9 | 175.1* | 316.5 | | <LOD | | 0.4 | 0.8 | 1.3 | 0.9 | 3.1 | 10.2 |
| week-2 (n= 4) | 3.3 | 8.9 | 24.4 | 87.2 | 137.3* | 216.1 | | <LOD | | 0.4 | 0.6 | 0.9 | 0.6 | 1.6 | 4.1 |
| week-3 (n= 4) | 1.8 | 4.0 | 9.1 | 74.3 | 107.6* | 155.8 | | <LOD | | 0.3 | 0.5 | 0.7 | 0.4 | 0.9 | 1.8 |
| week-5 (n= 4) | | <LOD | | 40.9 | 66.1* | 106.6 | | <LOD | | | <LOD | | | <LOD | |
| week-6 (n= 4) | | <LOD | | 27.8 | 51.8* | 96.8 | | <LOD | | | <LOD | | | <LOD | |

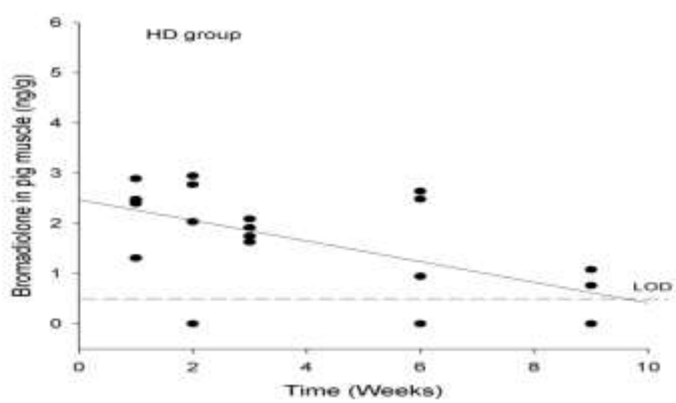
Values are expressed as median (or geometric mean); n = number per group in parenthesis; ppb, parts per billion; LOD, limit of detection. Data were analyzed by an ANOVA followed by multiple t-test. *P < .05, vs. other tissues within a time point.

Table 2. Bromadiolone concentrations (ppb) after single oral administration of high dosage (0.5 mg/ kg) in 20 healthy pigs.

| | Feces | | | Liver | | | Muscle | | | Plasma | | | Skin and fat | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *LOD (ppb)* | *1* | | | *3* | | | *2* | | | *0.5* | | | *0.3* | | |
| | LL | Median | UL | LL | Median | UL | LL | Median | UL | LL | Median | UL | LL | Median | UL |
| week-1 (n= 4) | 20.6 | 67.3 | 220.2 | 348.8 | 596.4* | 1019.9 | 6.1 | 9.6 | 15.2 | 1.4 | 2.3 | 3.8 | 2.7 | 8.2 | 24.5 |
| week-2 (n= 4) | 13.8 | 37.5 | 101.9 | 333.6 | 524.7* | 825.3 | 5.3 | 7.8 | 11.5 | 1.2 | 1.8 | 2.7 | 2.8 | 7 | 17.7 |
| week-3 (n= 4) | 8.8 | 20.9 | 49.6 | 312.1 | 461.6* | 682.6 | 4.5 | 6.4 | 8.9 | 0.9 | 1.3 | 1.9 | 1.8 | 6.1 | 13.4 |
| week-6 (n= 4) | 1.4 | 3.6 | 9.2 | 205.4 | 314.2* | 480.6 | 2.4 | 3.4 | 4.9 | 0.4 | 0.6 | 0.9 | 1.6 | 3.8 | 9.1 |
| week-9 (n= 4) | | <LOD | | 106.7 | 213.9* | 428.8 | | <LOD | | | <LOD | | 0.6 | 2.4 | 10.1 |

Values are expressed as median (or geometric mean); n = number per group in parenthesis; ppb, parts per billion; LOD, limit of detection. Data were analyzed by an ANOVA followed by multiple t-test. *P < .05, vs. other tissues within a time point.



**Conclusions**

- Blood as well as fecal samples could be used, prior to slaughter, to identify suspected bromadiolone rodenticide toxicity in pigs.
- Administration of a single oral low or high dosage of bromadiolone to hogs showed considerable accumulation in the liver with concentrations persisting for a prolonged period of time (see bromadiolone levels in pig liver figure above).
- Administration of a single high dosage of bromadiolone to hogs also showed considerable accumulation in the muscle with concentrations persisting for a prolonged period of time (see bromadiolone in pig muscle figure above).
- Results of this study will provide veterinarians with a non-invasive (blood or feces) bromadiolone detection system that may be used to rule out exposure of hogs to bromadiolone.
- Results of this study may assist CgFARAD with establishing possible withdrawal times in hogs that are exposed to bromadiolone.

**Acknowledgements**

We would like to thank Dr. Saad Enouri, Bryan Bloomfield, Karen Richardson, Glen Cassar, Ryan Tenbergen, Rachel Poppe, Sara Malison, and Mackenzie Slifier for their help with drug administration and samples collection. We would also like to thank Ontario Pork and OMAFRA for providing the financial support of this study and William Sears for his assistance with statistical analysis.

**References**

1. Jackson WB, Brooks JE, Bowerman AM. Anticoagulant resistance in Norway rats. Pest Control.1975;43:14–23.
2. Food and Drug Administration. Guidance for Industry: General principles for evaluating the safety of compounds used in food-producing animals. U.S. Department of Health and Human Services. Food and Drug Administration Center for Veterinary Medicine, Rockville, MD, USA. July 25, 2006.
**http://www.fda.gov/downloads/AnimalVeterinaryGuidanceComplianceEnforcement/GuidanceforIndustry/ucm052180.pdf**

# Antimicrobial Resistance – What is it and Why should you care?

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## What is Antimicrobial Resistance?

When a bacteria (e.g. *Salmonella*) is able to grow when exposed to an antimicrobial/antibiotic (e.g. ceftiofur) at a level which normally would stop growth or kill the bacteria (4μ/ml), then the bacteria is resistant to that antimicrobial.

When we are looking for antimicrobial resistance in humans, animals, or the environment we are looking for specific bacteria (e.g. *Salmonella*) and then testing those bacteria to determine if they are resistant to specific antimicrobials. This differs from the issue of residues where we test the meat or milk to detect the presence of the actual antimicrobial. Antimicrobial resistant bacteria are a microbial hazard and antimicrobial residues are a chemical hazard. We can avoid residues by observing an appropriate withdrawal period that allows the animal's body to break down and remove the antimicrobial. However resistant bacteria cannot be controlled with withdrawal periods since bacteria continue to grow and reproduce over time.

Antimicrobial resistance happens when the bacteria has either developed or acquired specific genes that cause it to become resistant to an antimicrobial. When bacteria with these genes are exposed to the antimicrobial they are more likely to survive and therefore over time make up a larger and larger percentage of the bacterial population. Bacteria may acquire these genes from other bacteria within their environment, including different types of bacteria e.g. from *E.coli* to *Salmonella*.

Cross-resistance to an antimicrobial may develop when bacteria from animals treated with one antimicrobial, develop resistance to other antimicrobials of the same family. Therefore it is critical to remember that antimicrobials that are used on your farms and/or in veterinary medicine can result in resistance to antimicrobials that are only used in human medicine, if they are from the same antimicrobial family e.g. bacteria resistant to ceftiofur which is only used in veterinary medicine are usually also resistant to ceftriaxone which is only used in human medicine.

To further complicate matters, if a bacteria has genes for resistance to multiple antimicrobials, these genes often cluster together and can move from bacteria to bacteria as a group. Genes resulting in resistance to heavy metals and disinfectants can also be found in these groups. Therefore exposure to one antimicrobial may not only result in more bacteria resistant to that one antimicrobial but to all of the antimicrobials in the group. This is called co-selection.

Some important principles regarding antimicrobial resistance are that: antimicrobial use selects for resistant populations of bacteria, particularly if it is long term use and even if the use is at a low dose; organisms resistant to one antimicrobial typically become resistant to multiple drugs; antimicrobial resistance in one area will eventually appear in other areas; and once antimicrobial resistance appears, it is unlikely to decline unless conditions change.

Health Canada has classified antimicrobials used in Canada as I- Very important to human medicine, II – Important to human medicine, III – Medium importance to human medicine, and IV – Low importance to human medicine. These categories are based on the availability of alternative antimicrobials for treating human infections and the severity of infections treated (http://www.hc-sc.gc.ca/dhp-mps/vet/antimicrob/amr_ram_hum-med-rev-eng.php ).

## Why Does It Matter to You?

AMR is an issue of increasing public concern. It can reduce our ability to effectively treat bacterial infections in both humans and animals and increase treatment costs.

AMR has been associated with the misuse of antibiotics in the human population but there is also concern with antimicrobial use in agri-food production. Antimicrobial resistant bacteria from animals and animal products have been identified as a risk for human infections with resistant organisms. The World Health Organization (WHO), the Office International de Epizooties (OIÉ), the United States, Denmark, the European Union, and Australia have all identified AMR as an important issue.

***Trade:*** There is increasing international pressure to provide national data on antimicrobial resistance and antimicrobial use and to take action to reduce use and resistance. Canada participated in the development of Codex guidelines for risk analysis of food-borne AMR, and the guidelines were adopted as final last year. This guidance document may come into play in issues of importation of food products which might be contaminated with an antimicrobial resistant organism or importation of food in countries that have different antimicrobial use practices.

***Animal Health:*** Actions that limit antimicrobial resistance preserve antimicrobials for use in veterinary medicine and protect animal health.

***Consumer confidence and perception:*** There is an increasing awareness of the antimicrobial resistance issue due to high-profile human cases/outbreaks and media coverage. This has resulted in increasing scrutiny of the agri-food sector due to concerns about inappropriate or excessive use of antimicrobials.

***Occupational Health:*** Producers, their families and employees may be exposed to antimicrobial resistant bacteria through occupational exposure. The use of antimicrobials in pigs on farms, the number of hours per week that farmers spent in their pig barns, the handling of sick pigs, and the consumption of antimicrobials by farm residents has been associated with an increased risk of antimicrobial resistance in farm residents (Risk factors for antimicrobial resistance among fecal Escherichia coli from residents on forty-three swine farms. Akwar TH, Poppe C, Wilson J, Reid-Smith RJ, Dyck M, Waddington J, Shang D, Dassie N, McEwen SA. Microb Drug Resist. 2007;13(1):69-76).

## What Can We Do About It?

***Surveillance:*** The Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) began in 2002 and is Canada's national integrated surveillance program to monitor antimicrobial resistance and antimicrobial use along the food chain (Figure 1). For agri-food, this includes sampling of beef, pork and chicken at the farm, abattoir and retail levels to evaluate the level of antimicrobial resistance in bacteria isolated from food production animals and meat products. Salmonella isolates are also recovered from veterinary and human clinical cases of salmonellosis. Antimicrobial use data is collected from pork and chickens at the farm level and from physicians and pharmacies (www.phac-aspc.gc.ca/cipars-picra/index-eng.php).

Ongoing, credible surveillance data provides information to promote prudent antimicrobial use in hospital, community, and agricultural settings and thus prolong the effectiveness of these drugs. The impact of antimicrobial resistance on global health as well as trade reinforces the need for a comprehensive, national Canadian AMR surveillance system. Canada joins its trading partners in maintaining a national AMR surveillance program. The US NARMS is in the 15th year of data collection and Denmark's DANMAP has operated for 16 years.

***Prudent Use:*** It is important to remember prudent use principles when considering antimicrobial usage: use an antimicrobial only when needed; use the correct antimicrobial; use the most narrow-spectrum antimicrobial possible; use at the right dose and the right dosing interval; and strive towards management practices/production systems that limit the need for antimicrobials. It is also important to consider the importance of an antimicrobial to human medicine (Table 1).

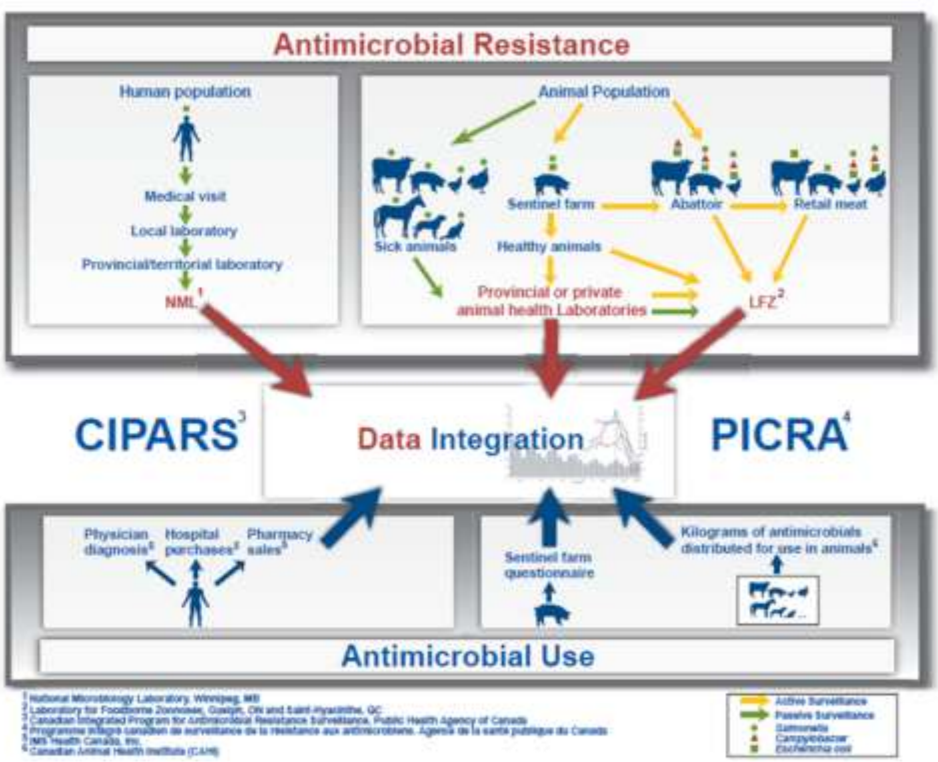


**Figure 1.** Schematic diagram of the Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS).

**Conclusions:**

- Some antimicrobials are more important than others
- AMR arising from food is concerning – there are implications to animal and human health
- Antimicrobial use is a major driver for AMR

- Prudent use begins and ends with every single patient, every presriber and every user: Veterinarians and producers play an important role
- There are few new antimicrobials being developed – the challenge is to slow the development of resistance and preserve the drugs that are currently available
- Surveillance is important – Canada has an excellent surveillance system in place (CIPARS)

**References:**

WHO: http://www.who.int/foodborne_disease/resistance
CODEX: www.codexalimentarius.net/download/standards/11776/CXG_077e.pdf
CIPARS : http://www.phac-aspc.gc.ca/cipars-picra/index-eng.php
NARMS :
http://www.fda.gov/AnimalVeterinary/SafetyHealth/AntimicrobialResistance/NationalAntimicrobialResistanceMonitoringSystem/default.htm
DANMAP: http://www.danmap.org/

**Table 1.** Antimicrobials approved for food animals in Canada by category of importance to human medicine.

| | AGRICULTURAL USE | | |
|---|---|---|---|
| **IMPORTANCE TO HUMAN MEDICINE[1]** | **GROWTH PROMOTION** | **PROPHYLAXIS** | **THERAPY** |
| Category I | | | Ceftiofur<br>Enrofloxacin |
| Category II | Erythromycin<br>Neomycin<br>Lincomycin<br>Penicillin<br>Tylosin | Erythromycin<br>Gentamcin<br>Lincomycin<br>Neomycin<br>Penicillin<br>Spectinomycin<br>Streptomycin<br>Tiamulin<br>Tylosin<br>Virginiamycin | Ampicillin<br>Apramycin<br>Cephapirin<br>Cloxacillin<br>Erythromycin<br>Florfenicol<br>Gentamicin<br>Lincomycin<br>Neomycin<br>Pirlimycin<br>Penicillin<br>Polymixin B<br>Spectinomycin<br>Streptomycin<br>Tilmicosin<br>Tylosin<br>Virginiamycin |
| Category III | Bacitracin<br>Chlortetracycline<br>Oxytetracycline<br>Sulfamethazine | Bacitracin<br>Chlortetracycline<br>Nitrofurazone<br>Oxytetracycline<br>Sulfaguanidine<br>Sulfamethazine<br>Tetracycline | Chlortetracycline<br>Nitrofurazone<br>Ormethorpim<br>Oxytetracycline<br>Sulfadiazine<br>Sulfaguanidine<br>Sulfamethoxine<br>Sulfamethazine<br>Tetracycline<br>Trimethoprim |
| Category IV | Arsanilic acid<br>Bambermycin<br>Salinomycin | | |

[1] I- Very important to human medicine, II – Important to human medicine, III – Medium importance to human medicine, IV – Low importance to human medicine

# Hernias – From the Processors Side of the Chute

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Conestoga Meat Packers Ltd, Breslau

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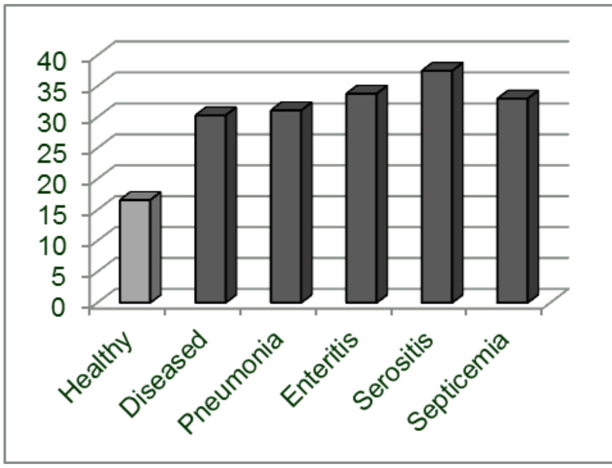
Despite extensive ongoing research, infectious diseases are still a common problem in the swine industry and are a significant cause of production and economic losses. While identifying genetic markers for some non-infectious diseases (e.g. porcine stress syndrome) has been successful, there are currently few genetic markers that allow for selection for improved disease resistance and growth performance. This is in part because infectious diseases are a complex multifactorial problem with various environmental, pathogen and host genetic factors playing a role in the development and impact of these diseases. My research group has been focussing on the idea that within a herd, poor performing pigs (from a production and/or disease standpoint) may carry genetic defects in essential proteins involved in innate disease resistance. We have been identifying genetic defects in the porcine innate immune system and investigating the impact of these variations on resistance to common infectious diseases of pigs. We are concentrating on two main types of defects, those that affect the amino acid sequence of the protein itself (coding region defects) and thus affect the structure and function of the protein, and those that affect how much of the protein is made (promoter or regulatory region defects).

Our initial work focussed on a group of pattern recognition receptors called collagenous lectins [1]. These proteins recognize patterns of sugars on the surface of the bacteria and viruses called pathogen associated molecular patterns (PAMPs). We identified various single nucleotide polymorphisms (SNPs) in genes for some of these lectins (e.g. mannan binding lectins (MBLs), ficolins and surfactant proteins). We then collected tissues from pigs with a variety of infectious diseases submitted for diagnostic necropsies, and determined if these SNPs were more frequent in infected pigs. The results showed significant differences in the frequency of some SNPs between healthy and diseased pigs. Some of these SNPs were in the promoter region and were associated with low expression/production of the protein (e.g. for MBL-C), and expression of MBL-C was lower in pigs with infectious diseases [2, 3].

More recently, we have utilized new technologies and taken a genome-wide approach to the identification of additional variants in the porcine innate immune system. Using pig specific microarrays (Agilent), we compared the levels of expression of > 20 000 genes in the livers of 96 healthy, genetically variable market weight pigs. We focussed on liver expression as many of the important innate immune proteins, particularly those that circulate in the blood, are produced in the liver. The next step involved identifying innate disease resistance genes with variable expression in the liver. To do this we compared the average expression level in pigs with the highest expression, to the average expression in pigs with the lowest levels of expression, creating a gene expression ratio (GER). This analysis identified several innate immune genes with widely variable gene expression, including genes encoding antimicrobial peptides and other pattern recognition receptors. We then sequenced the promoter region of these widely variable genes in pigs with high expression and those with low expression. To date, we have investigated seven of the most variable genes with a known or suspected role in innate immunity and have identified 74 novel genetic variants including 63 SNPs and 11 INDELs, where small groups of nucleotides are either INserted or DELeted as compared to the reference genome published for pigs [4].

Similar to the previously identified SNPs we then investigated the impact of these gene variants on expression to determine which ones had the greatest effect, and looked at whether these SNPs were more frequent in pigs with common infectious diseases and specific pathogens. To do this we used DNA extracted from healthy pigs and from pigs with common infectious diseases and specific pathogens. We then genotyped the pigs for these novel SNPs using the SEQUENOM MALDI-TOF mass spectrometry genotyping system. Many associations have been identified (Figure 1 presents partial results for one SNP in the *MBL2* gene). For example, in the retinoic acid inducible gene (RIG1 aka DDX58), which encodes a protein involved in viral recognition and induction of anti-viral responses, several SNPs were identified that were associated with impaired production of the gene.



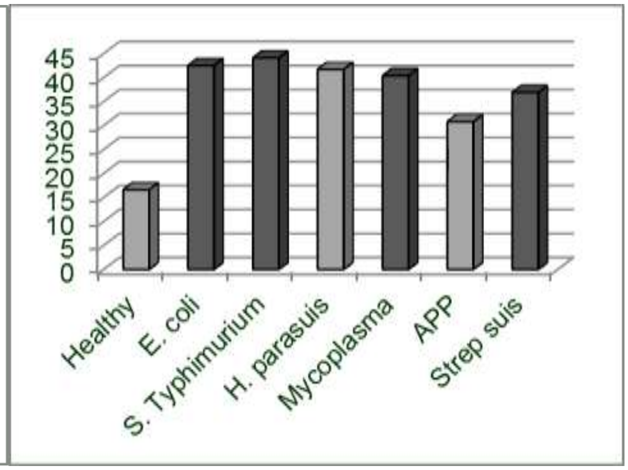




**Figure 1.** *MBL2* g. -1091G>A in diseased pigs (L) and pigs with specific bacterial pathogens (R). *Bars indicate % of animals possessing at least one mutant allele for the MBL2 g.-1091G>A SNP, comparing healthy pigs with pigs having specific infectious diseases (Left) or bacterial pathogens (Right). Dark grey bars indicate the percentage of animals possessing a mutation is significantly different (p<0.05) in that group as compared to the healthy pigs genotyped in this study*.

The next steps of this project involve further investigation of highly variable innate immune genes, currently underway using newly obtained next-generation sequencing equipment (Illumina MiSeq). In addition, several collaborative studies are underway to determine the economic and production impact of these genetic variants in a variety of farm/management conditions. The ultimate goal of these studies is to be able to select for animals that are more resistant to infectious diseases which should result in improved production efficiency for producers as well as improved animal welfare.

This work is a collaboration with Drs. Hein Snyman, Natalie Keirstead, Andrew Brooks, Tony Hayes, James Squires, Robert Friendship, Mohsen Jafarikia, Kees de Lange, Vahab Farzan and Mr. Brian Sullivan with support from Ontario Pork, CCSI, OVC, NSERC and OMAFRA.

**References**

1. Lillie BN, Brooks AS, Keirstead ND, Hayes MA. Comparative genetics and innate immune functions of collagenous lectins in animals. Vet Immunol Immunopathol. 2005 108:97-110.
2. Lillie BN, Keirstead ND, Squires EJ, Hayes MA. Gene polymorphisms associated with reduced hepatic expression of porcine mannan binding lectin-C. Dev Comp Immunol. 31:830-846, 2006.
3. Keirstead ND, Hayes MA, Vander Voort G, Brooks AS, Squires EJ, Lillie BN. 2011. Single nucleotide polymorphisms in collagenous lectins and other innate immune genes in pigs with common infectious diseases. Vet Immunol Immunopathol. 142: 1-13.
4. Snyman HN. Constitutive variation in hepatic expression of porcine innate immune genes associated with novel promoter polymorphisms. DVSc thesis, University of Guelph, November 2013.

# Benchmarking Ontario Swine Farms

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## Introduction

It is important to have access to benchmark information to understand your farm's competitive position. Benchmarking can highlight areas of your farm that are performing well and areas where improvements might be undertaken. A comparison to a group or industry average can provide useful information while looking at the top producers in a group can provide an indication of variability that exists. Data from two sources, the Ontario Data Analysis Project (ODAP) and the Ontario Farm Income Database (OFID), is used for comparison in this analysis.

## Selected ODAP Results

This project has been conducted by University of Guelph, Ridgetown Campus since 1991. It is a benchmarking study based on financial and production data from land-based farrow to finish farms in Ontario. Participants that provide information receive a personalized farm analysis that compares their farm data to the group average. The farms that are involved have about 100 to 500 sows and it is believed that the results generated are fairly representative of a farm this size. The results are calculated on a "pigs produced"/sow basis. This reflects the number of market hog equivalents produced on the farm and it takes into account all production and inventory changes. The group of 15-20 participants varies from year to year. Results do not include program payments or family labour expense.

Table 1 shows the group averages of some key productivity variables over the 11 year period from 2001 to 2011. The averages for the periods 2001-2005, 2006-2009, and 2010-2011 are compared to the top 50% of producers based on accrual net farm income per pig produced. This allows for the tough financial period during 2006-2009 to be isolated out. The top half of producers is not the same group from year to year.

**Table 1.** ODAP Production Variables, Average vs. Top 50%, 2001-2011.

| **Production Variable** | **2001-2005** | | **2006-2009** | | **2010-2011** | |
|---|---|---|---|---|---|---|
| | **Avg** | **Top 50%** | **Avg** | **Top 50%** | **Avg** | **Top 50%** |
| Number of sows | 237 | 249 | 222 | 216 | 229 | 251 |
| Total acres worked | 353 | 346 | 423 | 404 | 422 | 484 |
| Litters/sow/year | 2.29 | 2.26 | 2.27 | 2.31 | 2.21 | 2.19 |
| Born alive/litter | 10.75 | 10.88 | 11.03 | 10.99 | 11.54 | 11.64 |
| Weaned/litter | 9.43 | 9.52 | 9.68 | 9.66 | 10.04 | 10.06 |
| Weaning age (days) | 21.8 | 22.6 | 23.5 | 24.1 | 23.6 | 24.2 |
| Pre-wean mortality % | 12.2 | 12.5 | 12.1 | 12.0 | 13.0 | 13.3 |
| Nursery mortality % | 2.4 | 2.4 | 3.8 | 2.9 | 2.5 | 2.4 |
| Grow-finish mortality % | 2.3 | 1.7 | 3.5 | 2.7 | 2.9 | 2.5 |
| Pigs produced/sow/year | 17.7 | 17.5 | 18.9 | 18.8 | 19.8 | 20.0 |
| Dress weight (kg) | 90.9 | 90.6 | 92.6 | 92.8 | 93.6 | 94.4 |
| Days to market | 163.4 | 168.0 | 166.3 | 168.2 | 165.8 | 170.6 |

Table 2 shows some selected expenses and financial ratios from 2000 to 2011.

**Table 2.** ODAP Expenses and Financial Ratios, Average vs. Top 50%, 2001-2011.

| $ / pig produced | 2001-2005 | | 2006-2009 | | 2010-2011 | |
|---|---|---|---|---|---|---|
| | **Avg** | **Top 50%** | **Avg** | **Top 50%** | **Avg** | **Top 50%** |
| Feed | $87.89 | $81.41 | $95.13 | $87.84 | $110.19 | $105.06 |
| Health | $5.14 | $4.72 | $5.05 | $4.18 | $5.39 | $4.05 |
| Interest | $8.25 | $6.69 | $8.62 | $5.56 | $7.05 | $5.15 |
| Total expenses | $140.47 | $124.79 | $144.95 | $129.77 | $163.84 | $149.43 |
| Total revenue | $156.84 | $161.06 | $121.49 | $124.85 | $160.84 | $162.71 |
| Total debt / sow | $3,690 | $3,217 | $4,248 | $3,462 | $5,055 | $4,108 |
| Equity / sow | $7,934 | $6,893 | $8,961 | $8,415 | $11,803 | $15,170 |
| Debt : assets | 0.33 | 0.33 | 0.38 | 0.34 | 0.38 | 0.32 |

**Selected OFID Results**

The Ontario Farm Income Database contains Ontario tax files that reported farming income. It is used by Ontario Ministry of Agriculture and Food (OMAF) to administer their Business Risk Management (BRM) programs. Only swine farms that participated in BRM programs are included. The dataset consists of five parts: (1) non-financial characteristics of the farm operator; (2) income and expense data from tax files; (3) program payment data; (4) inventory data of commodities for each year; and (5) production data generated from the inventory data.

Table 3 shows selected financial ratios for the period 2003 to 2011 for the group of 180 farrow to finish farms that were in the database every year. The group average is compared to the top 40% of farms based on their accrual operating profit margin ratio. The farms in the top 40% vary from year to year. Results do not include program payments or family labour expense.

**Table 3.** OFID Farrow to Finish Financial Ratios, Average vs. Top 40%, 2003-2011.

| Financial Ratio | Average (%) | Top 40% (%) | Top 40% - Average ($ / market hog*) |
|---|---|---|---|
| Feed : Swine Revenue | 62.3% | 56.2% | -$8.71 |
| Health: Swine Revenue | 3.7% | 3.3% | -$0.52 |
| Utilities: Swine Revenue | 4.8% | 4.6% | -$0.25 |
| Interest: Swine Revenue | 6.6% | 6.4% | -$0.33 |
| Feed : Swine Revenue (accrual) | 62.5% | 56.0% | -$9.18 |
| EBITA : Swine Revenue (accrual) | 18.0% | 31.1% | +$18.59 |
| EBT : Swine Revenue (accrual) | 0.7% | 14.2% | +$19.23 |

Note: EBITA = earnings before interest, taxes and amortization; EBT = earnings before taxes; Farms ranked by accrual operating profit margin; *Difference based on $142 market hog value.

**Summary**

Productivity is important but the most profitable producers have an advantage on the cost side.

**Acknowledgements**

Thank you and appreciation is extended to Ontario Ministry of Agriculture and Food and Ontario Pork for their support and to the farm participants for sharing their time and information.

# Sow Lameness: Being Aware and Taking Action

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## Introduction

Sow lameness is a cause for concern as it compromises sow welfare, reduces sow productivity and longevity[1], and ultimately reduces the efficiency and profitability of any sow herd. Lameness is one of the most common reasons for culling sows after reproductive failure[2]. Sow lameness is a problem that has always been within the industry, yet little is known about the prevalence and severity of sow lameness within herds. There is little recent information available on Canadian herds. Data on culled sows indicates that around 11% of sows are culled due to lameness, with a wide range among farms (0-39%)[3]. It is believed that the true prevalence of lameness is higher as it often remains undetected until the sow's condition deteriorates. A detailed survey of one Canadian herd found that 60% of sows displayed an abnormal gait[4].

## Causes of Lameness

The causes of lameness are often multifactoral, which can make it a challenge to address and to treat individual cases with success. Common causes of lameness include: conditions affecting the structure of the joints (osteochondrosis, osteoarthritis, arthritis), conformation problems leading to weakness in the legs, injury and trauma (particularly from flooring), hoof lesions and osteomalacia (weakening of the bones, particularly after the mineral demands of lactation). Injury and trauma are believed to be major causes of lameness in sows, and may become a more significant problem as the industry moves to group housing, particularly with the widespread use of bedding free systems in Canada.

## Being Aware

Knowledge of the extent of lameness within a herd is a first step to understanding the problem, from which solutions can be developed. Culling and mortality records are a useful start, but on-farm monitoring of sows is more important as it will contribute to earlier detection of lameness which is key to minimizing losses. Currently, the best method for practical on farm monitoring of lameness is to observe sows as they walk. Timely, consistent observation of sows should become part of the regular management routine to detect locomotion problems as they develop. As a subjective method, staff should be given training to develop consistency, and using a simple scale (e.g. 0-3) can be easier.

Any time that sows are moved around the barn provides an opportunity to observe sow locomotion. Observing sows moving from gestation into farrowing is believed to be a useful time, as lameness may become more pronounced as the sow is heavier. Further observation as the sow is moved to breeding is also beneficial to detect any problems which have developed in farrowing, and indicate the need for review of the sow prior to breeding. Group housing of sows provides plenty of opportunity to observe sows' locomotion throughout gestation. Close observation of sows after mixing should be performed to ensure no lameness has developed from injury after fighting. Records of sow locomotion score and injury should be kept, similar to production records, and these can help to show patterns in lameness development within the herd.

## Taking Action

Lame sows need to be dealt with quickly to ensure sow welfare and to minimise production losses[1]. Culling is likely the only option for severely lame sows. Milder cases may be worth treating; followed by culling if the sow does not respond. Research is sparse on effective treatments for lame sows. Treatment is also made difficult as it can be hard to determine the cause of lameness in each case. Thus, where lameness problems exist, investigation with the herd vet should be preformed to try and determine the most common causes, helping to characterise symptoms and tailor treatments.

Providing lame sows with two doses of a non-steroidal anti-inflammatory, a rubber mat and a corrective hoof trim to restore hoof confirmation at eight weeks gestation was able to significantly reduce the number of sows showing lameness, and the severity of lameness observed in sows[4]. However, the cost-benefit of any treatment methods and the continued longevity of the sow in the herd need to be investigated. Certainly, to help improve the chances of lame sows recovering, those that are not coping in the home environment should be removed to a hospital pen. Providing a cushioned surface (sawdust, straw or rubber matting properly secured) can help alleviate pressure on the legs of the sow.

Problems developing early-on in young animals suggests a need to review management of replacement gilts (nutrition, handling, flooring, genetics, selection criteria). Good flooring is essential to prevent injury at all stages of production. Where poor flooring is believed to be a contributing factor, in the long term the poor quality flooring (such as slatted floor with inappropriate gap width), needs to be replaced. To help alleviate problems occurring with group housed animals, refraining from mixing animals on the poor quality flooring can help to reduce injury. Instead provide the animals with a solid footing for mixing, preferably bedded, and move to the gestation pen two to three days later.

## References

1. Anil, S. S., L. Anil, and J. Deen. 2005. Evaluation of patterns of removal and associations among culling because of lameness and sow productivity traits in swine breeding herds. *Journal of American Veterinary Medical Association*, 226 956–961.
2. Boyle, L., Leonard, F.C., Lynch, B. and Brophy, P. (1998) Sow culling patterns and sow welfare. *Irish Veterinary Journal*. **51** (7), 354-357.
3. Dewey, C.E., Friendship, R.M. and Wilson, M.R. (1992) Lameness in breeding age swine - a case study. *Canadian Veterinary Journal*. **33**, 747-748.
4. Seddon, Y.M., Rioja-Lang, F.C and Brown, J.A. (2013) Early detection and interventions for reducing lameness in gestating sows. Prairie Swine Centre report to funders. Unpublished.

# Entire Males for Commercial Pork Production

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## Introduction

Around the globe there is increased interest in using entire males for pork production. This is driven primarily by greater feed efficiency and carcass lean yield in entire males than in barrows, as well as public concerns about routine surgical castration of young males. Key concerns with using entire males are the occurrence of boar taint, attributed to accumulation of skatole and androstenone in meat, and aggression among entire males. The use of entire males for pork production is heavily penalized in Canada, because of concerns about boar taint. This is not an issue if entire males are immunologically castrated with Improvest$^{TM}$. Considerable research is conducted to monitor and control boar taint in meat derived from entire males, and to optimize management of entire males for efficient pork production. Some of this research is highlighted in this short article, with emphasis on research conducted at the University of Guelph.

## Gender Effects on Growth Performance and Nutrient Requirements

Based on an extensive review of the available literature, NRC (2012) estimated typical growth performance for entire males (**EM**), barrows, and immunologically castrated males (**IC**) (Table 1). Clearly EM are more feed efficient and have greater carcass lean yields than barrows. However EM pigs grow slightly slower than barrows and their rate of gain is in fact more similar to that of gilts. Until entire males receive the 2$^{nd}$ injection of Improvest$^{TM}$ – between 3 and about 8 weeks prior to slaughter – IC pigs perform similar to EM pigs. However, after the 2$^{nd}$ injection rapid physiological changes occur in IC pigs, leading to increased feed intake and body fat deposition, and a final carcass lean yield intermediate to that of EM pigs and barrows (Dunshea et al., 2013; Huber, 2013; Huber et al., 2013).

**Table 1.** Typical growth performance (25 to 120 kg body weight) and key nutrient requirements for the various genders of pigs according to NRC (2012).

| | **Gender** | | | |
|---|---|---|---|---|
| | Gilts | Barrows | Entire males (EM) | Immunologically castrated males (IC)** |
| Feed intake, kg/d | 2.18 | 2.36 | 2.11 | 2.21 |
| Body weight gain, g/d | 835 | 878 | 855 | 884 |
| Gain:Feed | 0.383 | 0.372 | 0.405 | 0.400 |
| Feed:Gain | 2.61 | 2.69 | 2.47 | 2.50 |
| Estimated carcass lean yield, % | 61.4 | 59.8 | 62.9 | 61.2 |
| **Standardized ileal digestible lysine requirements, %:*** | | | | |
| 25 to 60 kg body weight | 0.95 | 0.94 | 0.97 | 0.97 |
| 60 to 90 kg body weight | 0.82 | 0.74 | 0.85 | 0.85 |
| 90 to 120 kg body weight | 0.69 | 0.62 | 0.78 | 0.65 |

* At diet ME content of 3300 kcal / kg (diet NE content: 2475 kcal / kg); ** 2$^{nd}$ dose at 90 kg body weight.

These gender effects on feed intake and growth performance require adjustments to feeding programs for optimizing growth performance and profits. In particular, EM pigs – including IC pigs until the 2nd injection with Improvest™ – require increased dietary nutrient levels. This contributes to increased diet costs (expressed as $/ton), which are offset by improved feed efficiencies and carcass lean yields in EM and IC pigs when compared to barrows.

## Alternative Approaches to Controlling Boar Taint

***Immunological castration with Improvest™*** has now been approved in most of the key pork producing regions around the globe and has been proven effective in controlling boar taint and aggressive behaviour among male pigs after the 2nd injection of the product. Limitations to applying this technology widely in Canada are the need to alter carcass processing routines at packing plants and effective quality control. These limitations have been overcome in several countries, especially those with a more strongly vertically integrated pork production system such as Brazil. The use of Improvest™ will require changes to feeding management, as outlined in the previous section, and pig flow management. A key issue with the use of Improvest™ is the timing of administering the 2nd dose in groups of pigs that are shipped for slaughter over a 3 to 4 week period in order to optimize slaughter weights for individual pigs. Recent research at Guelph shows that extending the time between the 2nd injection and slaughter from 4 to 8 weeks is effective in controlling boar taint, but slightly reduces overall body weight gain, feed efficiency and carcass lean yield (Table 2). The latter can be attributed to the extended period of increased body fat deposition in IC pigs receiving the 2nd dose 8 weeks pre-slaughter, which is reflected in the marbling score. These observations indicate that there is considerable flexibility for timing administration of the 2nd dose of Improvest™. Also, controlling the number of days between the 2nd dose and slaughter represents a means to manipulate carcass lean yield and meat quality characteristics.

**Table 2.** Growth performance and carcass traits of entire males (EM) or males immunologically castrated at 4 (IC4) or 8 (IC8) weeks prior to slaughter (Park et al.; University of Guelph, unpublished).

| | Gender | | | | P-value | |
|---|---|---|---|---|---|---|
| | EM | IC 4 | IC8 | SE | EM vs IC | IC4 vs IC8 |
| Initial body weight | 30.2 | 32.0 | 29.1 | 2.46 | 0.10 | <0.01 |
| Final body weight | 129.6 | 129.6 | 134.5 | 1.84 | 0.30 | 0.14 |
| Feed intake, kg/d | 2.22 | 2.34 | 2.38 | 0.055 | <0.01 | 0.59 |
| Body weight gain, kg/d | 1.16 | 1.20 | 1.12 | 0.034 | 0.32 | 0.06 |
| Gain:Feed | 0.521 | 0.509 | 0.469 | 0.011 | 0.09 | 0.04 |
| Feed:Gain | 1.92 | 1.96 | 2.13 | | | |
| Fat androstenone (ug/g) | 1.052 | 0.265 | 0.27 | 0.059 | <0.01 | 0.99 |
| Probe backfat, mm | 18.5 | 19.4 | 21.4 | 0.62 | 0.046 | 0.03 |
| Carcass lean yield, % | 60.3 | 59.9 | 59.2 | 0.30 | 0.025 | 0.12 |
| CMQS marbling score | 0.75 | 1.27 | 1.35 | 0.18 | 0.018 | 0.741 |

***A set of genetic markers to identify EM pigs that are low in boar taint*** has been developed by Dr. Squires' group, which has clearly demonstrated pig genotype effects on the occurrence of boar taint. Extensive field trials are now underway, in close collaboration with Ontario Swine Improvement and the Canadian Centre for Swine

Improvement, to more carefully test these markers and to ensure that genetic selection of EM pigs with reduced boar taint will not lead to reduced growth and reproductive performance.

There is considerable interest in ***nutritional means to control boat taint***. Skatole is generated from the amino acid tryptophan during microbial fermentation in the gut of pigs. Androstenone is a steroid that is metabolized in the liver and transported in bile to the gut of pigs where it can be metabolized before re-absorption. Boar taint can be reduced by lowering dietary levels of protein, or controlling the type and amount of dietary fiber and related compounds that influence skatole metabolism and androstenone reabsorption. Including binding agents, such as activated charcoal, in finishing diets reduces the absorption of boar taint compounds in the gut and thereby reduces the levels of boar taint in the carcass (Jen and Squires, 2011).

**Conclusions and Implications: Take Home Message**

The use of entire males for commercial pork production represents a means to improve feed efficiency (and thus nutrient losses into the environment) and carcass lean content, while addressing increased public concern about routine surgical castration of young male pigs. In Canada the use of entire male pigs for pork production is currently not justified, unless entire males are immunologically castrated with Improvest™. Through genetic selection and dietary control the occurrence of boar taint in the carcass of entire male pigs can be reduced. Provided that a practical method is used to quickly and routinely monitor boar taint in pig carcasses, the use of entire males for pork production will become common practice in Canada.

**Acknowledgements**

Financial support for this research has been provided by Ontario Pork, OMAF/MRA, Swine Innovation Porc and Zoetis (formerly Pfizer Animal Health). Technical assistance provided by Y. Lou, D. Wey, J. Zhu. C. Campbell, is gratefully acknowledged.

**Selected References**

Dunshea, F.R., J.R.D. Allison, M. Bertram, D.D. Boler, L. Brossard, R. Campbell, J.P. Crane, D.P. Hennessy, L. Huber, C. de Lange, N. Ferguson, P. Matzat, F. McKeith, P. Moraes, B.P. Mullan, J. Noblet, N. Quiniou, M. Tokach. 2013. The effect of immunization against GnRF on nutrient requirements of male pigs: A review. Animal. 9:1-10.

Huber, L. 2013. Nutrient Retention in Entire Male Pigs Immunized Against Gonadotropin-Releasing Hormone. M.Sc. Thesis, University of Guelph.

Huber, L., E.J. Squires, and C.F.M. de Lange. 2013. Dynamics of nitrogen retention in entire male pigs immunized against gonadotropin-releasing hormone. J. Anim. Sci. 91: 4817-25.

NRC (National Research Council) 2012. Nutrient Requirements of Swine. National Research Council of the National Academies. Washington, DC. USA. Authors: L.L. Southern, A. Adeola, C.F.M. de Lange, G.M. Hill, B.J. Kerr. M.D. Lindemann, P.S. Miller, J. Odle, H.H. Stein and N.L. Trottier.

Jen, K and E.J. Squires. 2011. Efficacy of non-nutritive sorbent materials as intestinal-binding agents for the control of boar taint. Animal 5:1814-20.

# Identification of Anorexic Piglets During the First Week After Weaning

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## Introduction

Weaning can be a challenging and stressful event for piglets as they transition from a liquid milk diet to ingestion of solid feed. Piglets that remain healthy and transition smoothly onto solid feed after weaning are more likely to continue to thrive through the nursery period. There are a variety of factors that influence the transition period such as the underlying health of the herd and management strategies. Yet, despite optimum health and management policies, there still seems to be a small proportion of piglets that do not readily adapt to solid feed, experience a period of extremely low voluntary feed intake, and subsequently fail to thrive[1]. This period of under-eating can lead to health and welfare concerns and compromise growth and production. Maximizing our ability to rapidly identify off-feed piglets and to further understand the factors that contribute to a successful transition would aid in minimizing these production, health, and welfare concerns. The objectives of this project were to investigate behavioural and biochemical changes associated with anorexia in piglets at weaning and to determine their response, once fasted, to the re-introduction of feed.

## Methodology

The following studies were reviewed, approved, and monitored by the University of Guelph Animal Care Committee.

Study 1: Twelve piglets, all exactly 21 days of age, were randomly assigned to one of two treatment groups and matched by litter and sex. Piglets were housed individually. Group 1 (FED; n=6) was fed a weaned pig diet free-choice for 8 days. Group 2 (FAST; n=6) was fasted for up to 8 days. Free-choice access to water was available to all piglets. Piglets were monitored twice daily and closely examined for evidence of hypothermia, weight loss/gain, general demeanor/posture, infectious disease, and behavioural changes. All piglets had blood samples taken on day 0, 4 and 7 during the study to measure changes in biochemical parameters. Environmental conditions of the room were monitored. At the completion of the trial all piglets were humanely euthanized and comprehensive post mortem examinations were performed.

Study 2: A separate group of piglets, all exactly 21 days of age, were randomly assigned to one of two treatment groups and matched by litter and sex. These piglets were housed in an identical manner to the piglets in Study 1. Group 1 (FED; n=6) was fed a weaned pig diet and water free- choice for 8 days. Group 2 (FAST-FED; n=6) was fasted for up to 8 days, had access to water free-choice, and then had the weaned pig diet introduced on day 8. All piglets had the same monitoring and blood sampling schedule as for Study 1 with the addition of blood sampling after re-introduction of solid feed.

## Results

<u>Study 1:</u> All FAST piglets developed behavioural changes and displayed repetitive chomping and licking starting as early as 3 days fasted with all piglets demonstrating the behaviour by 5 days fasted. None of the FED piglets developed these behavioural changes. The most predominant biochemical change noted between the groups was a higher level of beta-hydroxybutyrate (BHBA), a serum ketone, in FAST piglets by 4 days fasted ($P<0.001$, using multilevel linear regression). Two FED piglets developed mild diarrhea by day 5. None of the FAST piglets exhibited any clinical disease. Body condition scoring was an insensitive method of determining which pigs were fasted, even after 7 days of fasting.

<u>Study 2:</u> The FAST-FED piglets developed the same behavioural and biochemical changes as did the FAST piglets in Study 1. None of the piglets developed clinical disease. All FAST-FED piglets consumed feed when re-introduced, following which their BHBA levels rapidly normalized from elevated levels experienced during the fasting period.

## Take Home Message

This study demonstrated that off-feed piglets will develop high levels of the ketone BHBA in their blood and that this will normalize when eating resumes. This is a potential biochemical marker that could be used for on-farm management and future studies focused on anorexia in the post-weaning period. In this study, body condition scoring and general observations for clinical disease were insensitive measures for identifying off-feed piglets. It was interesting to observe that the fasted piglets looked similar to the pigs that had free choice of food. This suggests that when we identify piglets on-farm that appear to be off-feed in the first week after weaning there is likely some other factor beyond just "not eating" contributing to their lack of feed intake. Further research is being done to investigate the utility of using BHBA measurements and behavioural observations on-farm for identifying these off-feed piglets. Improving our ability to identify piglets that experience a voluntary fast is imperative for our continued understanding of the risk factors associated a smooth transition onto solid feed.

## References:

1. O'Sullivan TL, Harding JCS, Friendship R, *et al*. Estimated prevalence and impact of periweaning failure to thrive syndrome in Canada and the United States. *J Swine Health Prod*. 2014;22(1):24–28.

## Acknowledgements

This study was funded by the Canadian Swine Health Board and the University of Guelph-OMAFRA Research Partnership.

# Impact of Nursery Diet Protein Quality and Fish Oil Supplementation on Immune Response of Pigs

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## Introduction

Feeding low cost and less complex nursery diets reduces growth performance during the nursery phase only, but does not affect growth performance up to market weight and carcass quality at slaughter (Skinner et al., 2013). However, the immune response – indicator of overall resistance to infectious diseases – was compromised in nursery pigs fed less complex diets (Levesque et al., 2013). Thus, the efficacy of less complex nursery diets appears limited during an immune challenge. Fish oil that has well proven immunomodulatory effects may be included in less complex diets to improve the pig's immunological status.

Thus, this study was conducted to evaluate the effect of including 5% fish or corn oil in low and high protein quality starter diets on various aspects of the immune responses (e.g. antibody and cell-mediated) of starter pigs.

An immunization protocol was carried out using the antigens albumin chicken egg white (OVA) and *Candida albicans* (CAA). Vaccination with these antigens stimulates the acute phase response (e.g. secretion of the hepatic acute phase protein haptoglobin, Hp), antibody-mediated immune response (AMIR; e.g. production of IgG1 and IgG2), and cell-mediated immune response (CMIR; e.g. dermal hypersensitivity response).

## Materials and Methods

The study was conducted at the Arkell Swine Research Station (University of Guelph, Guelph, ON). One hundred and twenty Yorkshire pigs (60 barrows and 60 gilts) were weaned at a mean body weight of 6.25 kg and 21 days of age, and assigned to 1 of 4 dietary treatments in a 2 × 2 factorial arrangement based on diet protein quality (**High** vs. **Low**) and 5% oil (**Corn** vs. **Fish**) supplementation. Nursery diets were provided in a 3-phase feeding program with Phase I, II, and III diets fed for 7, 14, and 21 d, respectively. **High** diets contained plasma protein, soybean isolate (highly digestible purified protein), fishmeal, and crystalline amino acids. **Low** diets included mainly soybean meal as a source of protein. All pigs were fed a common grower diet thereafter for 14 d. On d 6 post-weaning, 12 pigs (6 per gender) were vaccinated per treatment using intramuscular injections of different antigens (0.5 g OVA; 0.5 g killed CAA; 0.5 mg Quil A adjuvant in 1 ml saline). On the same days, 6 pigs per treatment were injected with saline to serve as controls. Blood samples were collected on d 20 (primary AMIR) and d 34 (secondary AMIR) for determination of total anti-OVA IgG and OVA-specific isotypes IgG1 and IgG2, and on d 22 and 28 for Hp concentration. On d 17 and d 48 post-weaning, all vaccinated and saline injected pigs were given intradermal injection 100 μg OVA dissolved in 50μL of saline in one ear and 100 μg CAA dissolved in 50μL of saline in another ear to measure the dermal hypersensitivity response; in each ear, 50 μL of saline was also injected as a control. Skin fold thickness (SFT) measurements were taken before injection and 6, 24 and 48h post-injection using a skin-fold caliper. Results were considered significant at $P < 0.05$ and tendencies reported $P < 0.10$.

**Results**

Anti-OVA antibody secondary (d 34) responses were significantly greater ($P < 0.001$) than primary (d 20); however neither starter diet protein quality nor oil inclusion affected anti-OVA total IgG response. However, IgG1 and IgG2 at d 34 were lower ($P < 0.05$) in pigs fed **Fish** oil (Figure 1). At d 17 post-weaning, pigs fed **Low** diet had greater ($P < 0.10$) CMIR to OVA and CAA than pigs fed on **High**. At d 48, **High** and **Fish** oil fed pigs tended to lower ($P < 0.10$) local immune response than pigs that had **Low** and **Corn** diets. The vaccination protocol increased ($P < 0.05$) serum Hp levels and **Fish** oil reduced ($P < 0.05$) Hp level on d 2 and d 6 post-injection in both vaccinated and saline injected pigs as compared to pigs that were fed **Corn** diets (Figure 2).

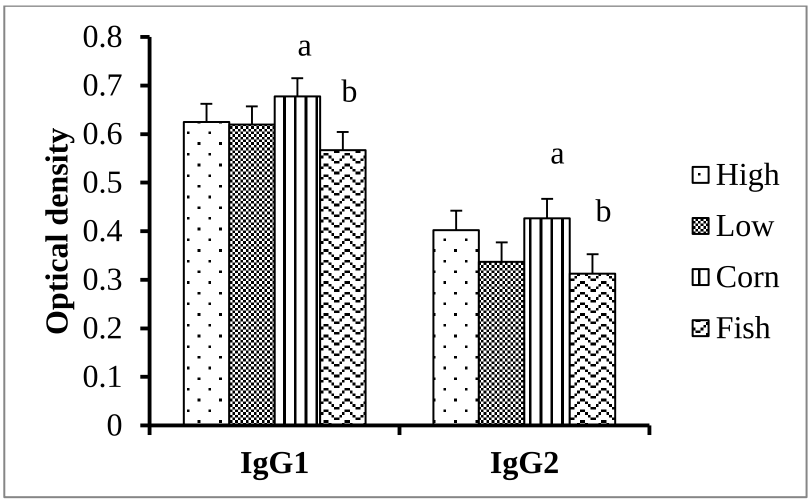


**Figure 1.** Effect of nursery diet protein quality (**High** vs **Low**) and 5 % oil (**Corn** vs **Fish**) supplementation on anti-OVA IgG1, and IgG2.

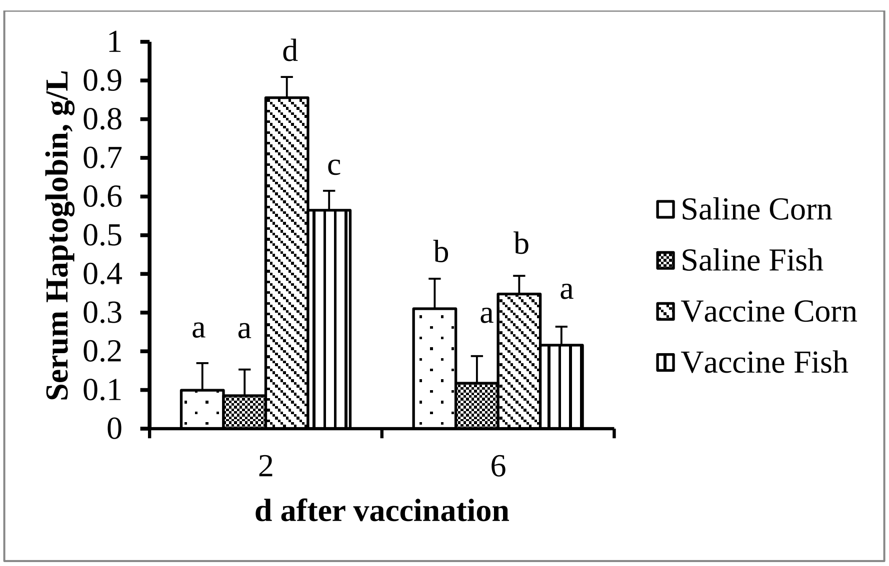


**Figure 2.** Effect of 5% oil (**Corn** vs. **Fish**) supplementation on serum Haptoglobin concentration in control (**Saline**) and vaccinated (**Vaccine**) pigs. Within d after vaccination, values with different super scripts differ (P<0.05).

## Discussion and Implications

Antibody-mediated and cell-mediated immune responses were measurable in all vaccinated pigs, which indicate that the vaccination protocol was efficacious. Fish oil supplementation seems to affect immune response more than starter diet protein quality. Fish oil supplementation in starter diets attenuated the AMIR and CMIR indicated by IgG1 and IgG2, and SFT measurements, respectively. Inclusion of fish oil in starter diets also lowered early stages of the host acute phase response as indicated by serum concentration of Hp. However, the net benefit of fish oil in severe and natural disease challenges should be evaluated in future studies. In addition, maternal feeding and dose-dependent effects of fish oil on immune response should be explored.

## References

Levesque C. L., E. Miller, J Zhu, and C.F.M. de Lange. 2013. Simple assessment of piglet robustness to nursery diet quality and feeding antibiotics. J. Anim. Sci. 9: S2 Abstract 90.

Skinner L. D., C. L. Levesque, D. Wey, M. Rudar, J. Zhu, S. Hooda, and C.F.M. de Lange. 2014. Impact of nursery feeding program on subsequent growth performance, carcass quality, meat quality, physical and chemical body composition of growing-finishing pigs. J. Anim. Sci. Accepted.

# Considerations for Providing Quality Space for Loose Housed Sows

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## Introduction

Loose housing is a husbandry system that provides sows with greater behavioural freedom than stalls, and is thus intended to improve sow welfare. Many variations on loose housing exist, differing primarily by the type of feeding system and group size. To ensure good sow welfare and productivity, every loose housing system must be designed and managed such that each sow can obtain sufficient resources (feed and water), that sows are given sufficient space, and do not have to cope with undue aggression. However, often overlooked are considerations for the quality of the pen environment over and above the basic requirements of feed, water and floor space. Positive pen features should promote optimal sow welfare, while allowing for good production and ease of management. This paper discusses some positive pen features for sows:

## Quality Flooring and Comfortable Rest Areas

Pen features that promote sow comfort are an important consideration, and one that affects the well-being of the animals. Good quality flooring, with non-slip surfaces are essential to prevent injury and provide stable footing on which sows can easily manoeuvre. The comfort of the lying area is worth considering. Indoor sows are known to spend up to 80% of their day lying down[1]. Given a choice, under thermo neutral conditions, sows show a preference for flooring characteristics that promote physical comfort; such as rubber flooring[2]. The provision of bedding provides sows with a greater ability to control their microclimate (burying under the straw, lying on top of it, or choosing to not lie on it). Bedding is being successfully incorporated into part slatted systems by European producers through use of a lowered or raised section to contain the bedding within a designated area of the pen. This gives the benefit of bedding while maintaining liquid manure management. For unbedded systems, solid flooring appears to be preferred by sows over slats. Dominant sows have been observed occupying the solid resting areas, with gilts resting in the least preferred, slatted dunging area[3,4,5]. In addition to providing comfortable lying areas, solid or bedded areas give sows a break from slatted floors and can be beneficial for hoof and leg health, helping to reduce lameness. EU legislation requires an established minimum amount of solid floor be provided for gestating sows, which emphasises the importance of this feature.

## Pen Design

Sows in a group regularly interact yet also perform subtle avoidance behaviours, and the design of the pen should provide sufficient space to accommodate this behaviour. Problems can arise when lack of space hinders the sow’s ability to avoid an antagonistic interaction. With medium to large group sizes, the provision of barriers can help sows to distance themselves from individuals within the group when needed. Pigs are thigmotactic and thus have a tendency to remain in close physical contact with another animal or vertical wall[6]. The addition of physical barriers gives pigs the opportunity to express this behaviour, and also promotes lying in groups, promoting the formation of social subgroups. There is no information available on whether solid barriers work best, or if spindle penning can provide the same effect.

**Enrichment**

Pigs have a strong motivation to perform species specific exploratory behaviour, such as rooting. Most modern production facilities do not provide an outlet for this behaviour, but provision of suitable enrichment can help, providing sows with daily stimulation. Straw is one of the best enrichments for pigs, being chewable and deformable, and every new addition of straw brings novelty. With gestating sows being feed restricted, the provision of straw also helps improve gut fill and satiety. Enrichments need not be expensive or cumbersome, and many satisfactory enrichments can be made on farm using low cost materials. For systems managing liquid manure, straw can be provided successfully in a rack. Examples of enrichments will be given in the talk.

**Conclusion**

In addition to the basic requirements necessary for successful group housing, including sufficient resources (feed and water), space allowance, and not having to cope with undue aggression, considerations for pen design that promote sow comfort and the expression of natural sow behaviour can help to create a group environment that brings further positive benefits for the welfare of the sow.

**References**

1. Ekkel, E.D., Spoolder, H.A.M., Hulsegge, I. and Hopster, H. (2003) Lying characteristics as determinants for space requirements in pigs. *Applied Animal Behaviour Science*. **80**, (1), 19-30.
2. Calderón Díaz, J.A. and Boyle, L.A. (2013) Effect of rubber slat mats on the behaviour and welfare of group housed pregnant sows. *Applied Animal Behaviour Science*. Article in press.
3. Hodgekiss, N.J. and Eddison, J.C. (1995) Resting behaviour of group-housed sows. *In*: Proceedings of the 29th International Congress of the International Society for Applied Ethology. 3-5th August, Exeter, UK, 179-180.
4. O'Connell, N.E., Beattie, V.E. and Moss, B.W. (2003) Influence of social status on the welfare of sows in static and dynamic groups. *Animal Welfare*. **12**, 239-249.
5. Strawford, M.L., Li, Y.Z. and Gonyou, H.W. (2008) The effect of management strategies and parity on the behaviour and physiology of gestating sows housed in an electronic sow feeding system. *Canadian Journal of Animal Science*. **88** (4), 559 – 567.
6. Lamprea, M.R., Cardenas, F.P., Setem, J. and Morato, S. (2008) Thigmotactic responses in an open field. *Brazilian Journal of Medical and Biological Research*. **41**, (2), 135-140.

# Porcine Epidemic Diarrhea Update

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Porcine Epidemic Diarrhea (PED) is a viral disease causing diarrhea across all ages of pigs and high mortality in young pigs. The PED virus (PEDv) is a specific pathogen of pigs and does not infect humans or other animals. It is transmitted directly or indirectly by the fecal-oral route. Direct transmission involves pig to pig contact, while the indirect route may include contaminated fomites such as vehicles, boots, coveralls, and other farm equipment. Since PEDv survives longer in colder temperatures, increased spread is observed in the late fall and winter. PED was diagnosed in the 1970s in Europe and in Asia in the 1980s.

On May 17th, 2013 PED was diagnosed in the United States. It was the first time the disease was ever reported in North America. PED quickly spread across many states and has become an endemic disease in the US. Since October, the number of cases of PED diagnosed per week has increased dramatically (Figure 1). As of January 4th, there had been 2,084 positive cases of PED (diagnosed at US laboratories) across 20 states.

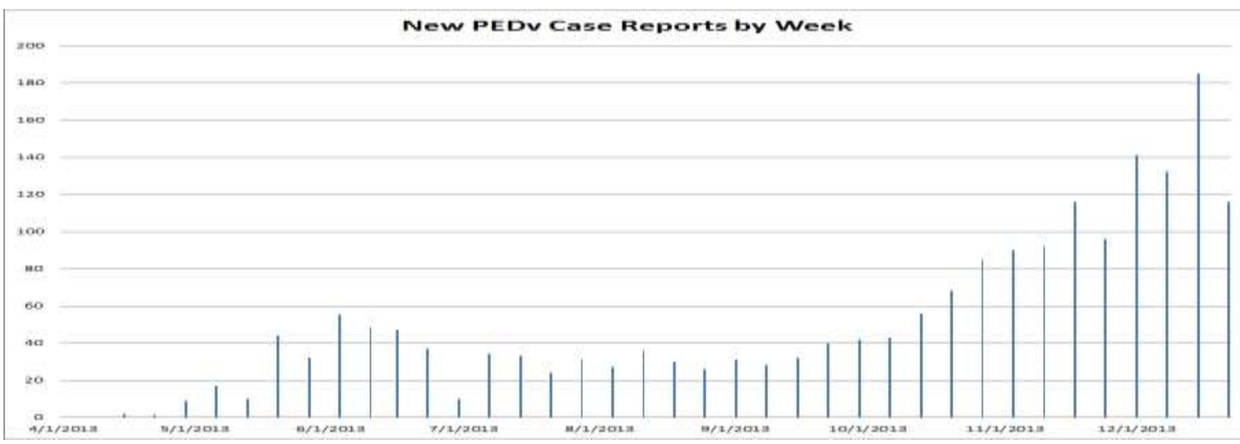


**Figure 1**. Number of PED case reports in the US by week (Source: American Association of Swine Veterinarians).

To date, PED has not been diagnosed in Canada. Due to the negative economic impact it would have on the Ontario pork industry, many actions are being taken to prevent the introduction of PEDv into the province. Of primary importance is creating an increased awareness of PED among pork producers and industry stakeholders to keep the pork industry engaged with PED prevention in Ontario. Newsletters, newspaper ads, telephone town hall conferences, and producer meetings are communication tools that have been utilized to communicate risks of PED and provide the industry with updates on PED prevention activities.

The greatest risk factor to Ontario for PED transmission is from the transport of pigs to the US, especially if they have had contact with a US slaughter plant. A U.S. study (J. Lowe,

2013) found that 11.4% of trucks that delivered pigs to US slaughter plants became contaminated with PEDv during the unloading process.

To reduce the risk of PEDv being transmitted to Ontario via a contaminated trailer, several strategies have been implemented. First, it has been recommended to pig transporters that all trailers be washed, disinfected, and dried prior to returning to an Ontario pig site.

Transporters hauling pigs in the U.S. have also increased the number of dedicated trailers, reducing the contact points of these trailers with Ontario pig sites. Transporters have also been advised to use specific totes (with dedicated boots and coveralls) when hauling pigs in the U.S. In addition, biosecurity visits have been completed with transport companies involved in U.S. pig movement to improve transport biosecurity and wash bay protocols.

Another significant risk factor identified has been at cull sow assembly yards. All cull sows are transported to the U.S., resulting in multiple loads returning from U.S. slaughter plants each week. To reduce the risk of cross contamination at assembly yards, biosecurity visits have been made to these sites to address load/unload protocols. Loading chutes have been designated for U.S. trailers and transfer stations are being utilized where necessary, to minimize contact between U.S. trailers and assembly yards. Efforts are being made to ensure all trailers returning from the U.S. are washed and disinfected before returning from the U.S. to the assembly yard.

If PEDv is identified on an Ontario farm, the goal will be to contain the spread of PED from the infected site and undergo procedures to eliminate the virus from the herd. Since the disease is not a federally reportable disease, the Canadian Food Inspection Agency (CFIA) will not be involved and it is likely that there will be no quarantine issued on the affected farm. An epidemiological investigation will be carried out to determine the number of sites potentially affected. Biosecurity practices will need to be implemented on farm and service providers notified to aid in the containment of the virus. Orderly marketing of pigs from the affected farm will be necessary to reduce the risk to other farms.

Biosecurity visits are taking place at processing plants in Ontario to develop protocols to segregate PED infected loads of pigs if necessary. Dedicated trailers for any pig movement off farm will be required. Protocols for handling of deadstock (e.g. on-farm composting) will be needed to ensure dead pigs are not moved off site. The specific strategy utilized to eliminate the virus will depend on a number of factors including farm type, number of sites affected, resources available, etc. It will be critical to eliminate the virus from the herd as soon as possible, using available resources to reduce the risk to other Ontario farms.

# Ontario Pork Research

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In 2013 Ontario Pork worked with producers and researchers and compiled research outcomes used to determine which research to fund. The outcomes represent four priority areas; Production, Economic, Societal Trends and Perception, and Innovation; and can be found on the Ontario Pork website at http://www.ontariopork.on.ca/Research/Submissions.aspx.

The first stage of the process began with a call for proposals, and the committee received 29 letters of intent. Working with the expertise of the Livestock Research Innovation Corporation (LRIC) 14 of the submissions were invited to submit full proposals. LRIC staff coordinated a scientific review of the proposals that was then presented to the Ontario Pork research committee. Of the 14 proposals reviewed, potential funding was offered for the following 8 projects:

## Canadian Health Claim Feasibility Assessment Report for Pork Products

A report will be generated that aims to provide support for a potential food health claim for pork. The communication of the report findings will increase industry awareness of the evidence-based health benefits of Ontario pork products and the potential for human health improvement. Moreover, the findings of this report may serve as a basis to provide insight for future clinical research initiatives, and provide the foundation to guide strategic investment in, for example, further health trend monitoring, preparation of a complete food health claim submission dossier and/or stakeholder review session.

## Improved understanding of nitrogen nutrition for growing pigs to improve flexibility in feed formulation and reduce nitrogen losses into the environment

The research will evaluate and hypothesizes to show that improved Amino Acid (AA) and Nitrogen (N) utilization for (lean tissue) growth will reduce feed costs and N losses into the environment. The overall aim is to better understand N utilization, and more accurately define the response of growing pigs to dietary N and AA intake. It is hypothesized as a result from more efficient utilization of dietary N and AA a modest reduction of $1.00 per pig may be realized.

## Minimum duration of teat use required in first lactation to ensure optimal milk yield in second lactation

Sows do not produce enough milk to sustain optimal growth of their suckling piglets and this problem has been made worse with the development of hyperprolific sow lines. Indeed, development of these new sow lines has led to two problems: 1) first-parity sows have to produce too much milk and draw on too much body reserves, therefore becoming too thin and compromising their longevity in the herd and 2) almost all teats must now be suckled to accommodate such litters so that reduced mammary function of a few teats in multiparous sows can have a great negative impact. One possibility to alleviate the problem of primiparous sows becoming too thin is to reduce litter size of these sows by using cross-fostering. However, this would mean that some teats would not be used in first lactation and it has recently been shown that non-use of a teat in first lactation will reduce its milk yield in second lactation. More precisely, leaving teats unused in first parity was found to reduce body weight of the piglet suckling that teat by 1.12 kg on day 56 in the next parity. Considering that most teats need to be used in second lactation, the following question then arises: how long does a teat need to be used in first lactation so that its milk yield is not impaired in the next lactation? The answer to that question will lead to the potential strategy of weaning piglets from certain teats early in first lactation to decrease litter size, and avoid taxing the mother too much, but leaving piglets nursing teats long enough to ensure adequate milk yield in the second lactation. The objective of the current project is, therefore, to determine the duration of teat use required in first lactation to ensure its adequate milk yield in the subsequent lactation.

**Study of the relationship between feed, genetics, health, and growth performance up to market weight in pigs**

A recent study, conducted under controlled conditions, indicated that lower cost- reduced animal-protein diets can be fed to nursery pigs without any negative impact on subsequent performance up to market weight as long as pigs do not become diseased. Several identified pig genotypes that are associated with improved growth rate and infectious disease resistance have also been identified. The cumulative impact of feed quality, pig genotype, and health on pig growth performance under commercial farming conditions is unclear. This study will identify main parameters that are known to impact growth performance under commercial conditions and resistance to infectious agents during the various stages of growth and relate these to productivity up to market weight and carcass quality, particularly in pigs fed with alternative less expensive nursery diets.

**An investigation into the effects of in-feed zinc oxide on the gut microflora and on the persistence of antibiotic resistance**

High levels of zinc oxide are routinely used in starter rations for growth promotion and as an aid in controlling post-weaning diarrhea on many Ontario pig farms. The mechanism of action is not fully understood but zinc does have some antimicrobial action. The impact of zinc on gut microflora is not known. The objectives are to determine: how the microbiome of pigs fed a diet containing high levels of zinc oxide differs from pigs not exposed to high levels of zinc oxide; the prevalence of the zinc-resistance gene in S. hyicus and methicillin resistant Staphylococcus aureus (MRSA) from swine farms, and if a high level of in-feed zinc oxide is associated with increased prevalence of antibiotic-resistant staphylococci.

Zinc may be a cause for the persistence of multi-drug resistant bacteria like MRSA on farms that do not use antibiotics. As a result of this research the swine industry will have a better opportunity to make an informed decision regarding the use of high levels of zinc oxide in nursery rations as an alternative to antibiotics.

**Prevalence of iron deficiency in suckling piglets**

The iron status of pigs at weaning is seldom evaluated to determine if the current practice is sufficient to maximize performance. Iron supplementation is routine. It is possible that on some farms the dosage is less than 200mg or the timing is later than a week of age resulting in insufficient supplementation leading to slow growth and increased levels of disease, but without triggering investigation. It is also possible that the standard iron supplementation that was appropriate 20 years ago is no longer sufficient to meet the needs of today's pigs. The objectives of the study are to determine if anaemia or iron deficiency is present in pigs at weaning and whether inadequate iron supplementation is associated with lower weaning weights and reduced post-weaning health and performance.

**Evaluation of Compounding Iron-dextran with NSAIDs for Use in Piglets at Time of Castration**

When non-steroidal anti-inflammatory agents NSAIDs (meloxicam, flunixin meglumine) are used at the time of processing piglets, a practice to mix (compound) the NSAID with iron-dextrans (ID) may be used. Drug interactions between ID and NSAIDs can yield sub-therapeutic drug levels and therapy failure. To date, no studies are available that have examined drug interactions between commonly used veterinary approved NSAIDs (meloxicam and flunixin meglumine) and ID.

The results of this study will provide veterinarians and their producer clients with pharmacologic evidence that mixing NSAIDs with iron dextrans at the time of piglet processing is rational and produces similar blood drug levels compared to administering the NSAID alone.

**Testing for a genetic defect associated with the pre-existing heart lesions in pigs that die in-transit**

The number of hogs that die in-transit increases during the summer months in Canada and as such the cause of death has been arbitrarily attributed to heat stress. Recent research funded by Ontario Pork has demonstrated that these deaths are actually due to heart failure, not heat stress. In the recent study, the majority of the hogs that died in transit had heart lesions comparable to Hypertrophic Cardiomyopathy (HCM), a genetic disease recognized in humans, dogs and cats.

The genes associated with the development of heart lesions in market hogs will be investigated. If consistent genetic differences are identified, it should be possible to eliminate the detrimental gene or genes from Ontario swine herds thereby reducing the number of in-transit losses in Ontario.

# National Swine Traceability Program

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Traceability is the ability to track an animal by means of a documented movement history. In the event of animal health or food safety emergencies, this allows officials to "traceback" the source of an incident, then "traceforward" to any other locations that may have been impacted. Traceability systems improve the ability to quickly respond to emergencies within a production-chain. Reducing the length of investigations leads to faster corrective actions, which in turn can shorten economic recovery time and mitigate further damage.

Over 50% of Canadian pork is exported. A foreign animal disease outbreak would very likely disrupt export markets. It was recognized that a Canadian swine traceability system was needed to help minimize the economic, social and environmental impacts of a foreign animal disease outbreak and improve the industry's chances of returning to international trade as soon as possible following major disease outbreak.

Consumer concern over food safety and security has also made traceability a standard business practice in many sectors. The development of the traceability system was also seen as a way to reinforce both domestic and export market access, and improve the competitiveness of Canadian pork products in the marketplace.

PigTrace Canada is the program name for the Canadian Pork Council's (CPC) Canadian Swine Traceability System. The program, developed in 2002, was designed and is administered by the CPC in collaboration with other provincial pork organizations including Ontario Pork. Ontario Pork has had representation on the CPC Traceability Working Committee since its inception.

PigTrace Canada has been built on three pillars of traceability:

1) The identification of farms
2) The identification of animals
3) Tracking of Animal Movement

Canadian swine producers registered their premises beginning in 2006. At that time, they were also issued nationally unique tattoo numbers which are registered to the last farm of residence before market hogs are sent to slaughter.

The next pillar to be executed was the addition of a national ear tag designed for breeding stock and animals shown at fairs and exhibitions. Tag numbers will eventually be used to report the movement of individual animals from premises to premises. Tags are currently available for order by Ontario producers.

The final pillar, tracking of animal movement, comes into effect on July 1, 2014. Since proposed amendments to the *Health of Animals Regulations* were published by the Government of Canada during the summer of 2012, the CPC and its partners have worked with the Canadian Food Inspection Agency (CFIA) to prepare an appropriate timeline to implement the traceability program and make it mandatory under federal law to be able to respond to disease outbreaks and food safety emergencies.

Under the program, shippers and receivers of animals will be required to:

- Report all pig movement to the PigTrace Canada system within 7 days of departure or reception of pigs including:
    - Date/time of pig movement (departure or reception)
    - Number of animals moved (loaded or unloaded)
    - Departure and destination location
    - Vehicle license plate (trailer if tandem unit)
- Ensure pigs have the proper type of identification, when necessary (i.e. herd mark/shoulder slap tattoo or approved PigTrace ear tag)
- Ensure operations/facilities have a valid premises identification number

On behalf of Canadian Pork Council, Ontario Pork will be distributing a more detailed PigTrace Canada information package in the coming months.

Producers can familiarize themselves with the program requirements prior to its commencement in July, 2014 by visiting pigtrace.ca.

# Participants at Swine Knowledge Transfer Events and Their Information Preferences

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## Introduction

Communication of University of Guelph's research findings is critical for effective application of new knowledge. Numerous extension or technology transfer events and publications help communicate research knowledge to about 1600 pork producers in Ontario, as well as researchers and others who support the pork industry. Few details are known about the results of the various knowledge translation/transfer initiatives or participants at extension events. The purpose of this study was to characterize the attendees at different events, assess their level of knowledge about the sector and awareness of University of Guelph research results, and identify their preferred sources of and approaches for receiving extension information.

## Materials and Methods

A structured survey with 18 questions (open, closed and rank order) was developed for a descriptive study for the knowledge translation and transfer project in the animal production systems research program at the University of Guelph. The study received Research Ethics Board approval. The researchers obtained a convenience sample from three 2012 research/extension events about the **pork** production sector, which limits the generalizability of results. The events were Centralia Swine Research Update (CSRU) in Kirkton, South-western Ontario Pork Conference (SWOPC) at the University of Guelph Ridgetown Campus, and Mike Wilson Swine Research Day (MWSRD) at the University of Guelph. This provided 161 useable surveys. Data were analyzed using SPSS (V21, IBM Corp.). Results were considered significant at $P < 0.05$ and tendencies at $P < 0.10$.

## Results

The majority of respondents were post-secondary educated males who accessed the internet daily through a broadband system. Differences in demographics made further characterization impractical. Analysis of occupation groups showed differences in attendance at the three events ($P < 0.001$; Table 1). Respondents (n=147) perceived themselves as moderately knowledgeable about the pork industry on a scale of 1 to 9 (M=6.16, SD=1.57). They were somewhat less aware of University of Guelph research results related to the industry (M=5.37, SD=1.98; $P < 0.001$). Respondents at MWSRD were more aware of University of Guelph research results than those at the other events ($P < 0.001$).

**Table 1.** Main occupation of program participants.

| | Mike Wilson Swine Research Day (n=56) | Centralia Swine Research Update (n=68) | SW Ontario Swine Conference (n=37) |
|---|---|---|---|
| **Occupation** | **% of n** | **% of n** | **% of n** |
| Farmer/Farm Worker | 21.4 | 13.2 | 70.3 |
| Veterinarian | 1.8 | 4.4 | 5.4 |
| Public Service | 7.1 | 1.5 | 2.7 |
| Researcher | 21.4 | 13.2 | 2.7 |
| Student | 25.0 | 36.8 | 0 |
| Agri-business | 10.7 | 22.1 | 13.5 |
| Other | 12.6 | 8.8 | 5.4 |

The ranked preferences by occupation groups for (a) sources of reliable information about the pork sector and (b) media/approaches for receiving reliable information differed.

a) **Farmers/farm workers ranked agri-business and veterinarians as their preferred sources of reliable information** (Table 2). They ranked agri-business and veterinarian sources higher than the other occupation groups ($P < 0.001$ and $P = 0.06$, respectively).

**Agri-business representatives ranked scientists/researchers, government and in-house training as their preferred sources** of reliable information (Table 2). They ranked in-house training higher than the other occupation groups ($P < 0.001$).

b) **Farmers/farm workers preferred industry magazines/newspapers for receiving reliable information** (Table 2). They ranked this category higher than the other groups ($P < 0.001$). They also ranked farm/commodity organization reports higher than agri-business representatives and researchers ($P < 0.001$ and $P < 0.01$, respectively).

**Agri-business representatives preferred internet/websites, email/e-news, scientific journals/articles and industry magazines/newspapers for receiving reliable information** (Table 2). They ranked internet/websites higher than farmers/farm workers ($P < 0.001$).

**Table 2.** Preferences for sources of reliable information and media for reliable information.

| | Farmer/Farm worker n=47 | | Agri-business Rep. n=26 | | Veterinarian n=6 | | Researcher n=22 | |
|---|---|---|---|---|---|---|---|---|
| **Item** | **Mean[1]** | **SD** | **Mean** | **SD** | **Mean** | **SD** | **Mean** | **SD** |
| **a) Sources of reliable information** | | | | | | | | |
| Agri-businesses (e.g. input suppliers) | **2.5[a]** | 2.1 | 1.2 | 1.6 | **0.5[a]** | 1.2 | 0.5 | 1.1 |
| Veterinarians | **2.3[ab]** | 2.0 | 1.2 | 1.6 | **2.3[a]** | 2.3 | **1.2[b]** | 1.8 |
| Commodity Organization(s) | **1.4[b]** | 2.0 | 0.3 | 0.9 | 0.0 | 0.0 | 1.1 | 1.8 |
| Scientists/Researchers | 1.3 | 1.8 | **2.6[a]** | 2.3 | **3.2[a]** | 2.5 | **4.0[a]** | 1.6 |
| Government (e.g. OMAFRA) | 1.3 | 1.5 | **1.4[a]** | 1.8 | **1.7[a]** | 2.6 | **2.3[b]** | 1.9 |
| In-house company training | 0.2 | 0.8 | **2.1[a]** | 2.1 | 0.0 | 0.0 | 0.5 | 1.2 |
| **b) Media for reliable information** | | | | | | | | |
| Industry Magazines/ Newspapers | **2.7[a]** | 1.9 | **1.8[a]** | 2.0 | 0.0 | 1.6 | **1.8[ab]** | 2.2 |
| Farm/Commodity Organization Reports | **1.8[b]** | 1.9 | 0.4 | 1.1 | **0.8[a]** | 2.0 | 1.1[b] | 1.9 |
| Email/E-news | **1.7[b]** | 2.0 | **2.0[a]** | 2.0 | **2.8[a]** | 1.7 | 1.4[b] | 1.9 |
| Small Group Meetings | **1.5[b]** | 2.0 | 1.4 | 1.8 | **0.2[a]** | 0.4 | 1.8[b] | 1.8 |
| Internet/Website(s) | 0.9 | 1.6 | **2.4[a]** | 1.9 | **1.7[a]** | 1.4 | 1.5[b] | 1.9 |
| Scientific Journals/Articles | 0.5 | 1.2 | **1.9[a]** | 2.1 | **2.8[a]** | 2.3 | **3.1[a]** | 2.1 |

[1]A higher number indicates a greater preference for the item. Scale is 0 to 5, with 5 as top preference.
[a,b]Top preference(s). No difference ($P < 0.05$) in rank with same letter value.

**Conclusions and Take Home Messages**

Results showed that the three events attracted different audiences. Respondents were primarily students and agri-business representatives at CSRU; students, researchers and farmers/farm workers at MWSRD; and, farmers/farm workers at SWOSC. Results also indicated that different audiences prefer different information sources and approaches to receiving information. Farmers/farm workers at the events preferred agri-business and veterinarians as information sources, and preferred receiving information through industry publications (magazines and newspapers). Agri-business representatives preferred scientists and government as sources of information, and liked to access information through the internet and email, as well as scientific and industry publications. **Researchers may find it efficient and effective to communicate to farm audiences through agri-businesses and veterinarians, and work with industry media to provide information to farmers.** Further research is needed to know how to enhance research communications to increase uptake of University of Guelph pork production research.

This study was supported by the Knowledge Translation and Transfer (KTT) Funding Program, OMAF/MRA-University of Guelph Partnership.

# Development and Field Trial of Producer Driven PRRS Area Regional Control and Elimination Projects (PRRS ARC&E)

Ontario Swine Health Advisory Board
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## Executive Summary

The purpose of the project was to develop and pilot an interactive producer driven approach to disease control and elimination where producers work together to reduce farm specific and area risks. Porcine Reproductive and Respiratory Syndrome (PRRS), the most economically significant endemic disease in Ontario, was used to model this approach. The project developed tools required to initiate these producer-driven PRRS Area Regional Control and Elimination (ARC&E) projects and piloted delivery of advanced biosecurity and disease control facilitated by communications and area support.

This project is significant to the swine industry for a number of reasons. Perhaps most importantly, it models an approach which can be applied to PRRS as well as other emerging and re-emerging diseases which may impact our industry. It fosters transparency and cooperation around disease control and elimination – concepts that in some ways are new within the swine industry. It looks at farm-specific and area-wide risks and considers ways to reduce those risks, often resulting in solutions which would not be possible if addressed in isolation. As well, it has developed a framework to initiate the control and elimination of PRRS in a number of areas across Ontario. PRRS is a disease model with clear financial implications and with understood modes of transmission and so provides clear motivation for the implementation of practices that reduce the risk of PRRSV transmission and in turn, many other diseases.

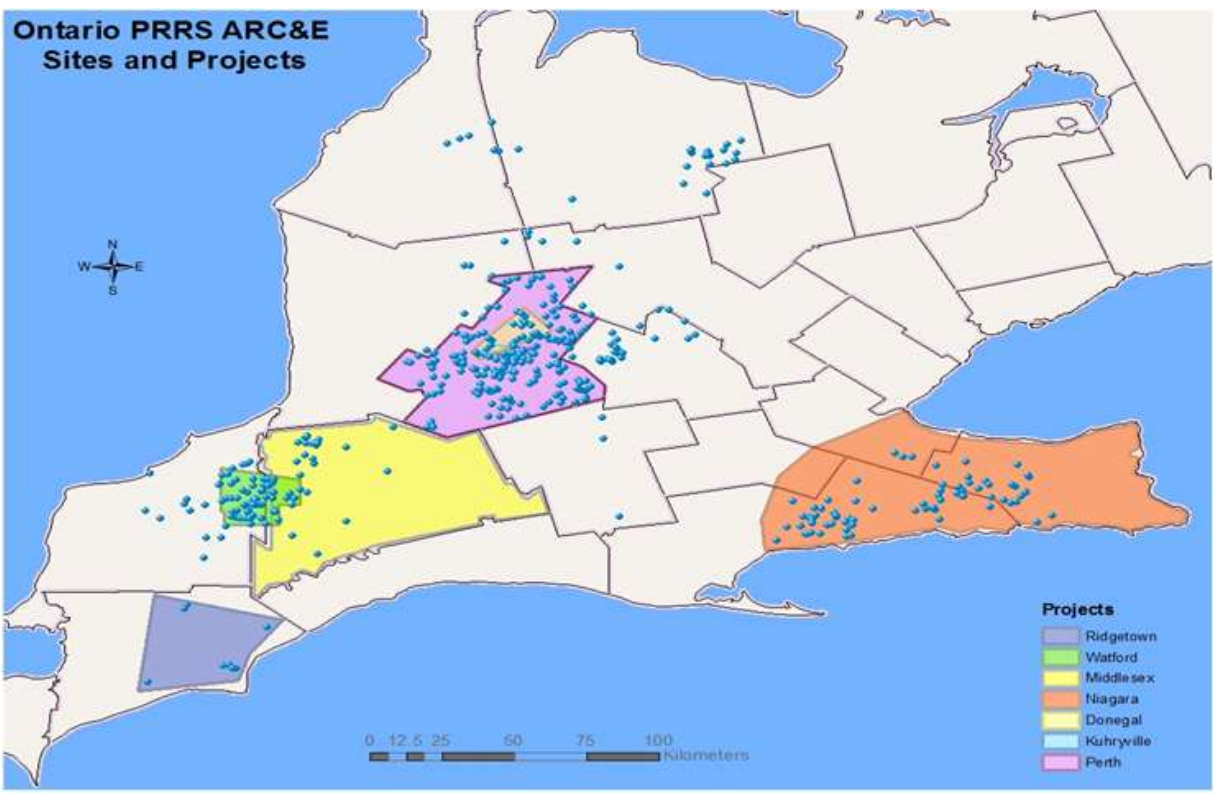
Project outcomes have included:

- The development of confidentiality agreements and an application process for producers to apply to participate in the program.
- A data collection form which includes site tombstone data (address, contact information etc.) as well as supplier, pig flow and biosecurity practices has been developed and delivered in an on-line format to facilitate data collection and area analysis.
- ARC&E areas have been established in a number of regions throughout Ontario and a total of 546 sites have been enrolled (468 of them under CAAP funding – if the Niagara sites are excluded from the total). This has included determination of PRRSV site status, site visits for training and collection of site information. See summary in Table 1 and map below.
- Development of sampling protocols and use of easy, cost effective sampling methods to promote rapid determination of site status changes based on clinical triggers and event driven sampling
    - Clinical Triggers: the use of ear swabs from aborting sows for PCR testing and rope test/oral fluids in the growing herds
    - Event Driven Sampling: change of pig source, prior to spreading manure, local breaks, seasonal testing, gilt introduction (testing in isolation), gilt testing – at multiplier before shipment
    - Protocols can be found at www.prrsarce.ca under resources
- Communication systems for disease alerts, meeting notices and newsletter distributions have been set-up for each region.
- Producer to producer communications across projects has been fostered
- Areas have held meetings and set goals
- Area projects has been initiated to reduce the risk of PRRS transmission and/or reduce the prevalence of PRRS e.g. transport pyramiding, load out design with positive pressure and one-way pig flow, incoming pig control – known status/testing schedule.

- A number of areas have active elimination projects underway including a 12 site trial of continuous flow nursery/finisher strategies in ARC&E areas throughout Ontario. This methodology may provide a more cost effective PRRS elimination strategy for continuous flow sites. Results will be tabulated and reported on when the trial is complete.
- Communications to the industry have included a press release, website postings and OPIC enews inclusions, area and county meetings and newsletters. A newsletter feature was also included in all issues of the Ontario Hog Farmer. An annual Big Bug Day meeting provided information about the project for the industry and producers. Q&A, case studies and recruitment materials have also been developed

**Table 1.** Ontario PRRS ARC&E Areas.

| ***Area*** | ***Number of Sites (signed participation agreements)*** |
|---|---|
| Niagara | 78 |
| Watford and Lambton County | 94 |
| Dundalk and sites related by pig flow | 68 |
| Kuhryville | 13 |
| Donegal | 12 |
| Perth | 216 (all Perth sites = 241) |
| Middlesex County | 43 |
| Ridgetown | 22 |
| **Total** | **546** |



**Area Progress**

**Niagara** – this area, which includes 78 sites has made significant progress in PRRS elimination strategies with a 40% reduction in the number of PRRS positive sites over the 2 years of the project and continued efforts to control and eliminate PRRS and reduce PRRSV transmission risks are underway (summarized in Table 2).

**Table 2.** Niagara ARC&E PRRS status.

| June 2011 | | September 2013 | |
|---|---|---|---|
| **PRRS Status** | **% of Sites** | **PRRS Status** | **% of Sites** |
| Negative | 58% | Negative | 70% |
| Total Positive | 39% | Total Positive | 15% |
| Field Strain | 28% | Field Strain | 11% |
| Vaccine Strain | 12% | Vaccine Strain | 4% |
| Empty Sites | 0% | Empty Sites | 12% |
| Unknown | 3% | Unknown | 3% |

**Watford** – located in Lambton County has 94 sites registered. The project covers a fairly large geographic area and so has elected to divide the area into 5 regions with producer leads for each region to identify and address specific issues in each region. This area has completed PRRSV sequencing and a phylogenetic analysis of the PRRSV strains identified in this area. Producers in the area have initiated some continuous flow finisher elimination projects and other PRRS elimination strategies.

**Dundalk** – located in Wellington-Dufferin County, this area elected to map and establish status for all sites with pigs that flow into the area and have mapped 68 sites to date - modeling an approach for pig production systems within ARC&Es. The area has also initiated an assessment of transport and pig movement risks and best management practices to reduce disease transmission risks in this area.

**Perth County** – a funding extension was approved to start off Perth County in a county level PRRS ARC&E. This project modeled the ARC&E process on a larger scale. A leadership team has been established and meetings have been held to develop a plan for producer enrollment and plans forward. The area has met its goal of 240 sites enrolled.

**Donegal and Kuhryville** – these two mini-ARC&E's located in Perth County were enrolled more quickly and so were available to model the ARC&E process for Perth County. Both have initiated work to reduce risk with an air filtration study conducted in Kuhryville and improvements in biosecurity, flow changes and elimination projects initiated in the Donegal area.

**Middlesex County** – Middlesex County is located adjacent to Lambton County and this group submitted applications to participate in a PRRS ARC&E project after the program was filled. OSHAB participated in 3 area meetings with area producers and due to strong participation; this area was added to the program once OSHAB determined that sufficient funds remained in the project to support their enrollment in the summer of 2013. Given their short timeline, the area has been working actively on enrollment and has enrolled 43 sites.

**Ridgetown** – This area had a very similar situation as Middlesex and has actively worked at enrollment and engagement over the last 4 months, enrolling 22 sites and holding 2 area meetings.

This high level of interest and participation is very encouraging as it indicates willingness on the part of producers to map sites and share information on PRRS status – one of the challenges of Area Regional Control programs. Producers seem to be prepared to help drive these initiatives and many have put significant efforts into building area consensus, data collection and goals development and are willing to continue in this leadership role. A number of other producer groups and county organizations have expressed interest in participating in future projects.

OSHAB has been impressed by the willingness of producers to make changes – often at their own expense to reduce risk for the area. Some changes that have occurred include working together to find new barns in lower risk areas for PRRS positive pigs, undertaking various elimination strategies including herd depopulation which can be an expensive undertaking, changing flow and changing transport routes.

This project has generated many lessons learned including the importance of producer guidance and leadership for project success, clear communications on the disease alert process and when disease happens, consultation with the producer even though prior permission to share information has been given, the time required for enrollment is longer than many producers expect and so communications and results take time – this needs to be clearly communicated when a new area is initiated, the step from enrollment to action can be challenging and works better with strong engagement of the veterinarians that service the area to help identify priorities and outline options. Finally, although producers engaged in the program are willing to invest funds to facilitate change, support for infrastructure and enrollment for this project greatly assisted with initiation and coordination of the ARC&E areas.

The project success can be contributed to a strong and committed team and outstanding producer engagement and industry support. As well, a commitment to reduce the high costs associated with disease losses seems to have been a real motivator to communicate openly, resulting in fewer stigmas associated with a disease break and greater community support in many cases.

Next steps for this work are anticipated to be expansion of the concept across Ontario as well as advances in data management, communications systems and interactive mapping to improve producer access to information on disease status changes in “near-real-time”. Because this approach is anticipated to be effective for any emerging disease, consideration will be given to adjustments needed to address new disease threats.

*Funding for this project has been provided by Ontario Pork, industry support and by Agriculture and Agri-Food Canada through the Canadian Agricultural Adaptation Program (CAAP). In Ontario, this program is delivered by the Agricultural Adaptation Council.*

# The Economic Impact of Porcine Reproductive and Respiratory Syndrome (PRRS) on Nursery and Grower-Finisher Production in Ontario

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## Background

Porcine reproductive and respiratory syndrome (PRRS) is considered to have a major economic impact on the pork industry in Ontario and worldwide. However, very few studies have been conducted using production data from nurseries and grower-finisher barns associated with herd outbreaks of disease to determine the financial impact of PRRS on these stages of production.

The objective of this study was to estimate the economic impact in nursery and grower-finisher stages associated with a PRRS outbreak using production records provided by 6 Ontario pork production enterprises. Cost was estimated to reflect the impact of PRRS on the total Ontario pork industry as well as on a per pig basis.

## Methods and Materials

The cost of a PRRS outbreak for the nursery and the grower-finisher phase was determined by combining the total cost due to increased mortality, reduced growth and changes in the feed conversion ratio. The time period used in this cost estimate was divided into two 6-month periods (i.e., the first 6-months following the outbreak, and the 6 to 12 month period after the outbreak). Our data suggests that the effect of PRRS differs in these two time periods. Likewise, the cost model was stratified by the type of pig flow (all-in/all-out vs. continuous) because our investigations of cases showed a difference in the effect of PRRS between these two types of flow. In addition, the incidence of PRRS (assumed to be 10%) was included in the cost model. As a general principle, production losses were based on a summary of actual production data from documented outbreaks of PRRS in 6 Ontario pork production enterprises. The production loss attributable to PRRS was calculated as the difference between the average production parameter during a specific phase of the outbreak (i.e. the first or the second 6-month period of the outbreak), relative to the 6-month period before the outbreak.

## Results

In Ontario during the study period, the total annual number of pigs raised in continuous flow (CF) and all-in/all-out (AIAO) nurseries was estimated to be 2,080,000 and 3,330,000, respectively, for a total of 5,410,000 per year. In the finishing barns 3,120,000 market hogs were produced in a CF system and 1,680,000 per year in AIAO. Total number of grow-finish pigs raised in both systems was estimated to be 4,800,000 per annum.

A total cost associated with reduced nursery performance for herds experiencing PRRS outbreaks based on the cost of mortality, reduced feed efficiency and slower growth rate was estimated to be $2,485,831 per year or for an affected farm this represents a loss of $4.50 per nursery pig in the year following a PRRS outbreak. For the grower-finisher stage, the total cost of PRRS outbreaks for Ontario in a year was estimated to be $1,464,012, or for an affected farm this represents a loss of $1.87 per grower-finisher pig in the year following an outbreak.

## Discussion

The one study (Neumann et al., 2005) in the literature that is constantly quoted estimates the cost of PRRS in the U.S. to be approximately $560 million. The Neumann paper identified a cost of $6.01 and $7.67, for a nursery pig and a grower-finisher pig, respectively. This estimate for nursery impact was based on 2 operations and the grower-finisher performance was based on data from 6 operations. In this American study no distinction was made regarding the type of flow, but our data suggest the impact is less in AIAO type operations compared to continuous flow. It is possible that the outbreaks documented in the American paper were caused by a more pathogenic strain of virus or that the herds involved had other health issues that complicated the picture. It is well recognized that an important way that PRRS exerts its effect on the health of a pig is by reducing the pig's immunity to other respiratory diseases, so depending on what other diseases are also present, the impact of PRRS in the grower barn can be severe. The cost estimates in our study are much lower than the American study primarily because the Ontario case herds that provided the data were impacted to a lesser extent with respect to mortality, growth rate and feed efficiency in the nursery and the grower-finisher phase than reported in the small number of herds used in the American calculation. In our cases the PRRS outbreak affected the farrowing herds as well as the other production phases. Obviously different scenarios might produce a more severe disease in the grower-finisher stage. For example, if a PRRS-positive grower-finisher barn operated as CF and received feeder pigs from a PRRS-negative source, then one would expect a much worse outcome than our model predicts. However, such a scenario is relatively rare compared to the situation documented in the 6 production systems used to create the baseline for our study.

## Implications

The calculation of the cost of PRRS for nursery and grower-finisher production based on Ontario data and accounting for different production practices and recognizing the change in effect over time may be a more accurate estimate than is currently available and as such may be useful in making decisions regarding implementing PRRS control programs.

## Acknowledgments

This work was supported by Agribrands Purina Inc., OMAF/MRA and OSHAB.

## References

Neumann EJ, Kliebenstein JB, Johnson CD, Mabry JW, Bush EJ, Seitzinger AH, Green AL, Zimmerman JL. Assessment of the economic impact of porcine reproductive and respiratory syndrome on swine production in the United States. J Amer Vet Med Assoc. 227: 385-392, 2005.

## Spatial Trend for PRRS in Swine Herds in a Control Area

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### Background

Porcine Reproductive and Respiratory Syndrome (**PRRS**) is the most costly and complex disease affecting swine herds in Canada. A better understanding on disease transmission and control is needed.

The objectives of this study are to describe herd demographics/ biosecurity practices and investigate the presence of areas of high risk for being positive and localized disease clusters.

### Methods and Materials

Seventy-seven swine herds were enrolled on the Watford PRRS Area Regional Control and Elimination Project (ARC&E) on a voluntary basis during 2012-2013. Information on demographics, biosecurity practices and geographical location were collected by region coordinators. Sampling was conducted by herd veterinarians to establish PRRS status (ELISA, PCR, gene sequencing).

### Results

Mean herd size was 1,712 (154 – 7,000) pigs, and the region has a moderate pig density (218 pigs/km$^2$). The 77 sites belonged to 23 different producers. Overall prevalence of positive herds was 48% (see Table 1 and Figure 1).

**Table 1.** Description of herds by production type.

| Production type (n) | Use of AIAO %(n) | Use of shower in %(n) | Danish entry % (n) |
|---|---|---|---|
| Farrow- wean (6) | - | 83 (6) | 100 (1) |
| Farrow-finish (9) | 89 (9) | 67 (9) | 50 (2) |
| Farrow-feeder (5) | 80 (5) | 100 (5) | - |
| Nursery (4) | 25 (4) | 75 (4) | 100 (1) |
| Wean- finish (8) | 25 (8) | 50 (8) | 25 (4) |
| Finish (43) | 58 (41) | 31 (36) | 70 (30) |
| Iso/ Acclim[4] (2) | 100 (1) | 50 (2) | 100 (1) |

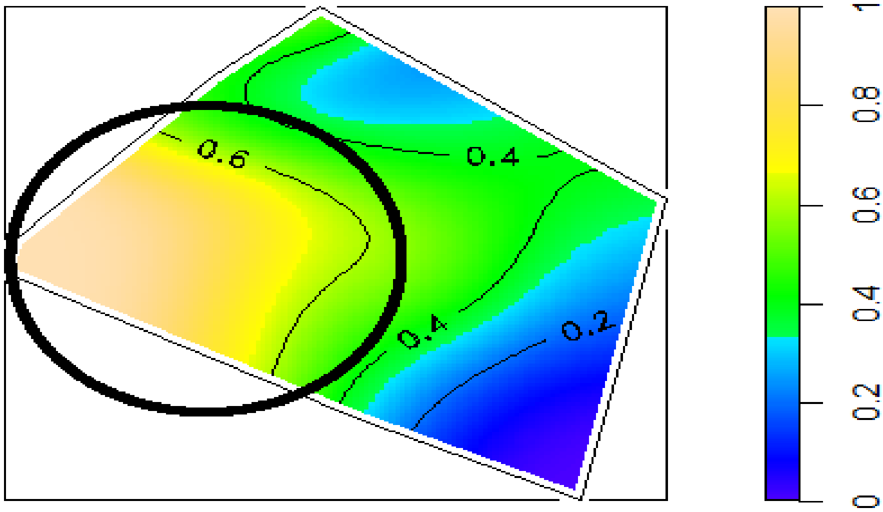


**Figure 1.** Smoothed risk map and cluster of positive herds located on the Watford region (Satscan v. 9.1.1 and R v. 2.15.0).

## Implications

The southwest area of the Watford region appears to be at a higher risk than the other parts of the region for being positive for PRRS according to the risk map. A cluster of positive farms was detected in this location; therefore this specific area should be targeted for surveillance and disease control purposes. The majority of the herds are part of production systems, therefore alternative transmission patterns such as pig flow and network structures will be explored in the future.

## Acknowledgments

This research was supported by OMAF and MRA, OSHAB, CSHB, AAC, AHL, Ontario Pork and industry partners.

# Genetic Diversity of *Haemophilus parasuis*

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**Background**

Glässer's disease, caused by the bacterium *Haemophilus parasuis*, is a major source of loss in the swine industry. The majority of pigs carry *H. parasuis* in their nose, most frequently without any sign of disease. Our lack of understanding of the factors contributing to the development of Glässer's disease makes its control difficult. It is assumed that environmental, host, and pathogen factors interact to trigger the disease, but these factors are still unknown.

The objectives of this study were to develop and apply a new efficient typing method for *H. parasuis*, and to assess the presence of associations between newly described virulence factors and the propensity of *H. parasuis* strains to cause disease.

**Materials and Methods**

A *H. parasuis* collection consisting of 54 clinical isolates, 25 isolates from the nose of healthy pigs, and the reference strains of the 15 known serotypes was setup. A new multilocus variable number of tandem repeat analysis (MLVA) scheme was developed and used to type the 94 isolates from the collection. The isolates were also tested by PCR for the presence of 9 recently described putative virulence genes. The presence of association between the source of the isolates (i.e. sick versus healthy pigs) and specific MLVA types, clusters of types, or putative virulence factors was assessed.

**Results**

Fifty-four MLVA types were identified among the 94 isolates tested (discrimination index of 97.4%). These types clustered into two major genetic groups. Serotype 5, 13, and 14 all belong to one of the groups and serotype 2 isolates to the other, while isolates of serotype 4 where evenly distributed between the two groups. A strong association was observed between seven out of the nine putative virulence genes investigated and one of the two genetic groups. However, no significant association was observed between the source of the isolates and the two major genetic groups or the presence of specific virulence genes. One single MLVA type lacking the majority of the putative virulence genes investigated contained 20% of all the clinical isolates examined. The results of this study also suggest that exchange of genetic material occurs between strains within each one of the two major genetic groups, but not frequently between the two groups. Overall, the results of this study demonstrate the diversity of the *H. parasuis* population present in Ontario and the ability of MLVA to type large numbers of *H. parasuis* isolates efficiently at an affordable cost. The results also show the lack of correlation between *H. parasuis* genetic groups or the presence of recently described putative virulence genes and the ability to cause disease in pigs. However, this study has identified a specific *H. parasuis* strains frequently involved in disease, which may be worth investigating in more details to identify what makes it different from the others.

**Implications**

An efficient and affordable typing method was developed in the course of this study, which will allow the tracing of *H. parasuis* strains and provide a better understanding of the transmission and epidemiology of this pathogen at the animal, farm, and local level. Furthermore, this study has identified candidate strains for comparative genomics studies needed for the identification of new virulence genes potentially important for control strategies for Glässer's disease.

**Acknowledgments**

This research project was funded by NSERC. We thank G. Chalmers, V. Nicholson, and G. Soltes for their technical assistance in this project.

# Microbiome of the Tonsils of the Soft Palate of Swine – Possible Roles in Health and Disease

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## Background

The last decade has seen a tremendous increase in the use of culture-independent techniques to characterize microbes present in humans and animals. Much of this work is concerned with the role that these microbial communities play in health and disease. For example, it has been shown that microbiome members can provide protection against infection through competitive exclusion or can contribute to disease by providing nutrients to pathogens. In pigs, the role of microbiomes in nutrition has been studied, but complex bacterial communities in the upper respiratory tract are only beginning to be investigated. In addition to harbouring a large number of poorly-characterized commensal organisms, the tonsil of the soft palate in swine is known to be the reservoir of many primary and opportunistic pathogens, but much remains to be learned about interactions at this site.

## Materials and methods

Swabs and tonsillar samples were obtained from unfit animals in closeout groups and from healthy pigs at slaughter. Routine microbiological analysis was performed and both tissue and culture samples were characterized by Terminal Restriction Fragment Length Polymorphism (T-RFLP) analysis using the Phusion® Bacterial Profiling kit from Finnzymes. The distribution of T-RFLP fragments in healthy and unfit pigs was compared and tentative identifications were made by searching the Finnzymes, RDP, and a custom "pig-specific" database. Cluster analysis of the OTU data of healthy and unfit pigs was done to see if there was an association with 13 clinical signs or with the presence of porcine reproductive and respiratrory syndrome virus (PRRSV), porcine circovirus type2 (PCV2), or *Mycoplama hyopneumoniae* infection.

## Results

When the data were analyzed as anonymous OTUs, greater diversity was seen in the microbiomes of unfit vs. healthy animals. Comparison of the T-RFLP results with clinical data revealed significant associations with the presence of anemia, abscess, PRRS virus, and *Mycoplasma.* For example, a statistically significant association was seen between abscess and membership in clusters II and IX while membership in clusters III, VI, and X was positively associated with the presence of PRRSV. Putative identifications of the T-RFLP bands were done using several databases. At the phylum level, the microbiomes of unfit pigs were more likely than those of healthy animals to contain *Actinobacteria* and *Fusobacteria* and less likely to have *Firmicutes* and *Spirochaetes*. At the genus level, *Streptococcus* sp., *Flavobacteria* sp., *Clostridia* sp., *Lactobacillus* sp., *Bacillus* sp., and *Fusobacterium* sp. were present in more than 50% of both healthy and unfit animals although *Streptococcus* sp. was more frequently found in healthy than unfit animals (94.4 vs. 69.2%, respectively).

## Implications

This work provides information about the bacterial communities present in diseased and healthy pigs and allows us to begin to identify organisms that might promote pig health or exacerbate disease.

## Acknowledgements

This work was supported by the OMAFRA Animal Health Strategic Investment program and the Natural Sciences and Engineering Research Council.

# The Etiological Diagnosis of Diarrhea in Neonatal Piglets in Ontario Between 2001 and 2010

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## Background

Neonatal piglet diarrhea is a major cause of pre-weaning mortality, resulting in significant economic loss for swine producers. The relative importance of different diseases contributing to neonatal piglet diarrhea appears to be changing, possibly because of changes in husbandry and management practices, advances in diagnostic techniques, and/or the emergence of new diseases. In particular, the emergence of a new disease, porcine epidemic diarrhea (PED) in the United States illustrates the importance of monitoring cases of piglet diarrhea.

## Objective

The purpose of the study was to use laboratory diagnostic data to identify the frequency and trends of different pathogens contributing to neonatal piglet diarrhea on Ontario swine farms from 2001 to 2010.

## Materials and methods

The data were provided by the Animal Health Laboratory (AHL) at the University of Guelph, and included laboratory submissions from Ontario swine farms from 2001-2010. The data included gastrointestinal tract (GIT) cases where live or dead piglets between 1 to 7 days of age were submitted. Multivariable logistic regression models were used to analyze the association between the diagnosis of enterotoxigenic *E. coli* (ETEC), *Clostridium perfringens*, *Clostridium difficile*, rotavirus, and *Cystisospora suis*, respectively, and independent variables. The independent variables included in the analysis were the age of piglet in days, year of submission, season of submission, and diagnosis of other enteric pathogens.

## Results

A total of 237 GIT cases involving the submission of live or dead piglets, 1 to 7 days of age were submitted to the AHL, from 2001 to 2010. The number of these GIT cases submitted per year ranged from 10 to 39, with an average of 24 cases per year. There were 79 (33%) GIT cases submitted to the AHL where an etiological agent was not identified. There were a total of 51 (22%) GIT cases in the fall, 50 cases in the spring (21%), 46 (19%) cases in the summer, and 90 (38%) cases in the winter.

ETEC was diagnosed as the cause of GIT disease for 63 cases that involved a single etiological agent, and 10 cases that involved multiple etiological agents (31% of total cases). ETEC was less likely recovered from a GIT case if *C. difficile*, *C. perfringens*, or rotavirus were detected ($P < 0.05$). ETEC was more likely diagnosed for GIT cases that occurred in the winter compared to the spring and the summer. *C. perfringens* was diagnosed as the cause of GIT disease for 19 cases that involved a single etiological agent, and 9 cases that involved multiple etiological agents (12% of total cases). A total of 155 GIT cases were cultured for *C. perfringens*, and the organism was isolated in 133 (86%) cases. GIT cases were less likely to be diagnosed with *C. perfringens* with increasing age of the piglets and if ETEC was detected. Rotavirus was diagnosed as the cause of GIT disease for 18 cases that involved a single etiological agent, and 10 cases that involved multiple etiological agents (12% of total cases). Rotavirus was more likely diagnosed for GIT cases that occurred in the fall compared the spring and the summer. *C. difficile* was diagnosed as the cause of GIT disease for 10 cases that involved a single etiological agent, and 11 cases that involved multiple etiological agents (9% of total cases). *C. difficile* was less likely diagnosed with increasing age of the piglets. *C. difficile* was less likely diagnosed if ETEC was detected, but more likely diagnosed if *Salmonella sp.* was detected. *Cystisospora suis* was diagnosed as the cause of GIT disease for 13 cases that involved a single etiological agent, and 2 cases that involved multiple etiological agents (6% of total cases). *Cystisospora suis* infection was more likely diagnosed for GIT cases that occurred in the summer compared to the spring, and the winter. Transmissible gastroenteritis virus was diagnosed as the cause of GIT disease for 6 cases that involved a single etiological agent and 1 case that involved multiple etiological agents (3% of total cases).

**Discussion**

Neonatal diarrhea cases were most frequent during winter, a well-established finding in countries with harsh winters. The major known pathogens that contributed to neonatal piglet diarrhea from 2001 to 2010 were ETEC, rotavirus, *C. perfringens*, and *C. difficile.* The combined GIT cases involving these pathogens contribute to more than half of the GIT cases submitted to the AHL. In one third of the GIT cases involving piglets less than a week of age no causative agent was identified. The lack of diagnosis for some GIT cases is possibly due to inappropriate samples submitted to the diagnostic laboratory; piglets in the acute stage of disease have the highest pathogen load, and therefore are more likely to yield diagnostically useful information. There may be other unknown pathogens involved in the undiagnosed GIT cases submitted to the AHL and further investigation is required to determine the current causes of piglet diarrhea in Ontario swine farms.

**Conclusion**

This study identified several current pathogens involved in neonatal diarrhea for Ontario swine farms. *Clostridium difficile* appears to be an emerging pathogen, and ETEC and rotavirus remain as pathogens of concern for neonatal piglet diarrhea. Further research in the diagnostic method of these pathogens may be useful in improving the diagnostic rate for GIT cases. The data suggested that *C. perfringens* type A may be an important pathogen for neonatal piglet diarrhea, but the lack of specific diagnostic criteria made it difficult to determine the significance of isolating this bacteria from a pig with diarrhea.

**Acknowledgements**

The research was funded by the Ontario Ministry of Agriculture Food and Rural Affairs, in part by a grant through the Animal Health Strategic Initiative.

# An Investigation into the Effects of Zinc Oxide in Pig Starter Rations on the Persistence of Antibiotic Resistance

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## Introduction

High levels of zinc oxide (ZnO) is commonly used as an alternative to antibiotics in the starter ration. It is well documented that ZnO will inhibit enterotoxigenic *E. coli* and thus is useful in helping to control diarrhea and therefore is widely used in the Ontario industry. The action of ZnO as a therapeutic agent and its effect on the bacterial population of the gut is not well understood and needs further investigation. In addition, it has recently been demonstrated that some bacteria carry resistance to zinc. From a severe case of greasy pig disease in weaned pigs we have identified *Staphylococcus hyicus* carrying zinc resistance genes. It appears that at least in the case of staphylococci, the genetic material that confers resistance to zinc is carried in combination with the genetic material associated with multidrug resistance including methicillin resistance. It is possible that feeding high levels of ZnO in starter rations creates selective pressure so that multidrug resistant bacteria predominate, for example bacteria like methicillin resistant *Staphylococcus aureus* (MRSA). From a public health standpoint it is important we identify why drug resistance persists and spreads in the absence of antibiotics and therefore we should look at this possible link with zinc oxide. But also for the sake of pig health it is important that the value of antibiotics as therapeutic agents be preserved by minimizing the presence of multi-drug resistant bacteria on pig farms.

The objective of this study was to determine if a high level of in-feed zinc oxide is associated with increased prevalence of antibiotic-resistant staphylococci.

## Methods

A randomized-controlled trial was completed using 110 pigs from 23 sows from a herd naturally colonized with *czrC*-positive MRSA. The pigs were enrolled into the trial at birth (day 0) and followed for 49 days. At weaning (day 21), stratified randomization was used to ensure pigs testing positive for MRSA prior to weaning were equally distributed among 8 pens. The pens were located within the same nursery room, containing individual feeders and solid partitions. Four pens (n=49 pigs) received a starter ration containing 100 ppm ZnO and the remaining 4 pens (n=50 pigs) received an identical ration containing 3,000 ppm ZnO. All pigs were raised without exposure to any other antimicrobial agents.

Nasal swabs were taken from each pig on days 1, 3, 7, 14, 21, 28, 35, 42 and 49. Samples were transported at 4 °C in transport broth to laboratory facilities at the Centre for Public Health and Zoonoses at the University of Guelph where microbiological analysis was performed. The samples were tested for the presence of MRSA using selective plates, coagulase testing, agglutination tests, and PCR. Isolates of MRSA were also tested for the presence of the methicillin-resistance gene (*mecA*), the zinc-resistance gene (*czrC*), and the Staphylococcal Cassette Chromosome *mec* (SCC*mec*) using PCR. The statistical analysis was performed in STATA 10.0 (College Station, TX)

## Results

In this trial, diarrhea was absent in both the treatment (3000ppm zinc group) and the controls (100ppm zinc group). There was no difference in growth rate or feed intake between the two groups (Table 1). The prevalence of MRSA in suckling piglets was low (5.6%) but increased rapidly after weaning, particularly in the piglets receiving 3000 ppm ZnO (Figure 1). MRSA prevalence was statistically higher at 1-week and 2-weeks post-weaning (*P*<0.01) for pigs fed 3,000 ppm ZnO compared to those fed the minimal dietary levels of 100 ppm ZnO.

## Take Home Message

The use of high levels of zinc oxide, often considered as an alternative to antibiotics, may be causing selective pressure for multidrug resistant bacteria such as MRSA.

**Table 1.** Growth performance and feed intake between groups.

| Parameter | Pigs fed 100 ppm ZnO | Pigs fed 3,000 ppm ZnO |
|---|---|---|
| Body Weight (kg) | | |
| Birth | 1.55 | 1.61 |
| Weaning | 6.37 | 6.45 |
| 2 weeks post-weaning | 9.25 | 9.39 |
| 4 weeks post-weaning | 17.50 | 17.25 |
| Average Daily Gain (g/day) | | |
| Pre-weaning (1 – 21 d) | 241.2 | 242.0 |
| Early Nursery (21 – 35 d) | 205.6 | 210.1 |
| Late Nursery (35 – 49 d) | 589.1 | 561.7 |
| Average Feed intake (g/day) | 578.7 | 595.2 |
| Average Zinc intake (g/day) | 0.052 | 1.786 |

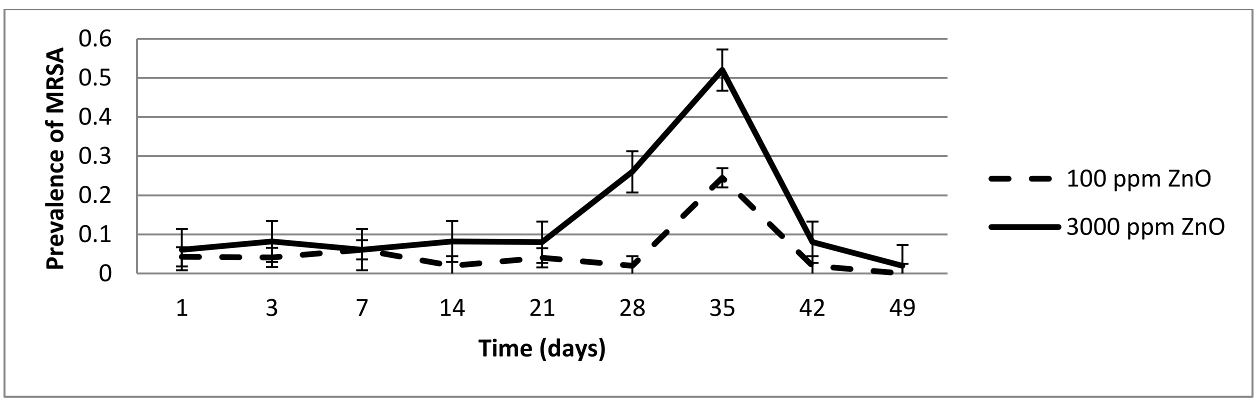


**Figure 1.** Prevalence of MRSA from birth to 4-weeks post-weaning.

## Acknowledgments

Research support was received from Ontario Pork and from the University of Guelph-OMAF research partnership and from NSERC.

# EMERGENCE OF MUCOHAEMORRHAGIC DIARRHEA ASSOCIATED WITH *"B. HAMPSONII"* IN WESTERN CANADA[1]

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## Introduction and Objectives

In October 2009, finisher pigs with clinical signs indistinguishable from swine dysentery were observed in two intensive farms in western Canada. Following this discovery, our laboratories at the University of Saskatchewan expanded diagnostic capabilities to include species specific quantitative PCR for *"B. hampsonii"* clades 1 & 2, agar and broth culture, and speciation based on sequencing of the NADH oxidase (*nox*) gene from feces, tissue and isolates. The objective of this abstract is to report our microbiologic and molecular diagnostic findings for samples received between October 2009 and April 2013 from pork farms in western Canada.

## Material and Methods

At the University of Saskatchewan, two laboratories work collaboratively on the *Brachyspira* diagnostic service. Prairie Diagnostic Services Inc. (PDS), the regional veterinary diagnostic laboratory, provides traditional diagnostics including pathology, *B. hyodysenteriae* and *B. pilosicoli* PCR, immunohistochemistry and routine culture. The Molecular Microbiology Research Laboratory provides "novel" *Brachyspira* testing (Table 1). Our diagnostic testing has evolved over time based on available resources. *"B. hampsonii"* clade 2 RT-PCR and *nox*-based sequencing was introduced in 2010; *Brachyspira* culture in 2011. In 2012, *"B. hampsonii"* clade 1 RT-PCR was initiated. Collectively, we aim to understand if and what *Brachyspira* species are present in a given sample, and provide confidential tracking of cases by farm, system and region.

Samples are received from veterinarians, generally following overnight delivery. Although we encourage clients to submit carcasses or fresh/fixed intestinal tissues enabling a thorough workup including histopathology and special stains, the most common sample we receive is feces collected from pen floors. A survey accompanying the submission enables the collection of clinical data including fecal consistency scores, medication history and age.

## Results

Three hundred and seventy-seven samples from 68 farms in Alberta (221), Saskatchewan (86), Manitoba (49) and British Columbia (15) were received since 2009. A "sample" refers to feces, tissue, or carcasses from farms demonstrating loose, bloody or mucoid diarrhea in nursery and grow-finish stages. Approximately two-thirds of samples were submitted by inter-related farms within one of several productions systems. Two-thirds of samples were feces; the remainder tissues or carcasses. One or more species of *Brachyspira* were detected or isolated in 80% of farms and 59% of samples. "*B. hampsonii"* was detected in 34% of samples; ~9% clade 1, ~26% clade 2, and ~1% dual detection of clade 1 and 2. By contrast, *B. hyodysenteriae* and *B. pilosicoli* were detected only in 11% and 13% of samples, respectively. *B. murdochii*, some

[1] Published in Proceedings of the Sixth International Conference on Colonic Spirochaetal Infections in Animals and Humans, University of Surrey, September 5-6, 2013. (Pg 61)

strongly beta hemolytic, were detected in ~9% of samples; *B. intermedia* from 4% of samples. Multiple species were detected in ~15% of samples. Neither *"B. suanatina"* nor *Serpulina* sp. P280/1 were detected or isolated. The number of samples submitted increased from 29 in 2010 to 144 in 2012. To date, *"B. hamsponii"* has been detected or isolated from 32 farms in western Canada.

**Table 1.** Novel *Brachyspira* testing. Tests performed by the WCVM Molecular Microbiology Research Laboratory

| Assay | Reference |
|---|---|
| *Brachyspira* culture | Rubin, 2013(1) |
| PCR: *Brachyspira* spp. | (*nox;* Rohde, 2002) (2) |
| RT-PCR *"B. hampsonii"* | (clade 1; Hill, unpublished)<br>(clade 2; Rubin, 2013)(1) |
| PCR: *B. hyodysenteriae* | (*cpn60*; Hill unpublished) |

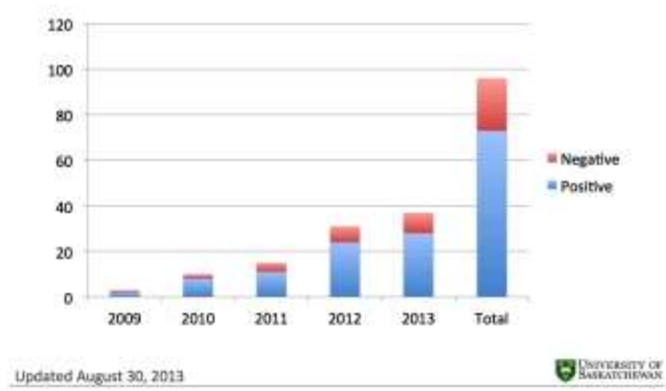


**Figure 1.** Number of farms investigated and diagnosed with Brachyspira-associated colitis in western Canada by University of Saskatchewan (2009-2013)

## Discussion

As of January 2013, there were approximately 2500 farms raising pigs in western Canada. The 32 farms in which we have detected or isolated *"B. hampsonii"* are few by comparison but do represent influential industry players. Some of these farms however are inter-related, and some clustering of species within production systems is evident. That being said, "*B. hampsonii*" is more commonly diagnosed in western Canada than *B. hyodysenteriae* based on diagnostics completed to date.

## References

1. Rubin JE, et al. 2013. *PLoS One.* 8:e57146.
2. Rohde J, et al. 2002. *J. Clin. Microbiol.* 40:2598-2600.

# Improving Soybean Meal Nutrient Value via Fermentation Using Newly Isolated Bacteria

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## Background

Soybean meal continues to be a valuable source for protein in adult animal feed but cannot be used to its full potential for piglets due to an immature gastrointestinal tract which limits its ability to digest oligosaccharides, polysaccharides, and large proteins. Glycinin, one of the major proteins in the soybean meal, stimulates local and systemic immune allergic responses and has negative effects on piglet performance. Past studies have shown encouraging results on the elimination of these antigenic and anti-nutritional factors, as well as an increase in essential amino acids, when soybean is fermented using bacteria. Overall piglet performance has also been found to improve when piglets are fed fermented soybean. The objectives of the current study are to improve the soybean meal fermentation by first isolating novel strains of bacteria that have high enzymatic activity via screening and then test their efficacy to improve the fermentation of soybean meal.

## Methods and Materials

**Bacteria screening and speciation:** Bacteria were isolated from different fermented food sources and screened for protease, amylase, and cellulase activity. Bacteria with high enzymatic activity were selected and speciated using MALDI-TOFF.

**Fermentation:** The selected speciated bacteria were used to ferment soybean meal in an 85% moisture level. Microbial counts and pH measurements were taken at 0, 24, and 48 hours as a quality control. Fermented samples were lyophilized and homogenized for further analysis.

**Protein profile analysis:** Total soluble protein was measured using a DC Protein Assay. Proteins were then separated using SDS-PAGE and stained using Coomassie-Blue Staining.

## Results

Ten out of the hundred bacteria screened demonstrated protease, amylase, and/or cellulose activity. MALDI-TOFF results revealed some of these microbes to belong to the *Bacillus*, *Enterococcus*, *Lysinibacillus*, and *Staphylococcus* genera, with some of them being members of bacteria which have demonstrated probiotic properties. SDS-PAGE results of the fermented soybean meal demonstrated a decrease in the allergenic proteins, while also increasing the amount of low molecular, more digestible peptides. Isolate 2 was observed to be the best at decreasing high molecular weight protein and thus the best isolated to efficiently improve the nutrient value of soybean meal. Further investigation of the effect of crude protein, amino acid profile, and oligosaccharide degradation is ongoing.

## Benefits to Swine Industry

This research benefits the swine industry by effectively improving the soybean fermentation technique by making it an applicable, more cost-effective, highly digestible, and a less allergenic protein source for piglets.

## Acknowledgements

This work is supported by OMAF/MRA-University of Guelph Research Partnership

# Research Update: Enrichment Devices for Nursery and Grow-Finisher Pigs

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## Study Objectives

Environmental enrichment for growing pigs has received increased attention in the last few years in modern swine producing countries. Enrichment devices are designated as necessary in the most recent draft of the Canadian Code of Practice for the Care and Handling of Pigs. Many Ontario swine producers have been incorporating enrichment devices into their pig pens for years. Items such as hanging chains, tires, bowling balls, and straw are commonly used. These objects, however, may not be the most durable or practical for environmental enrichment. The purpose of this study was to gather information regarding what constitutes a preferred enrichment device by testing a variety of pig toys in nursery and grow-finisher pens.

## Pilot Project

The initial pilot project for this study compared a rooting style toy to a teeter-totter style toy (Figure 1). These toys were installed on several farms and producers recorded the number of pigs playing with each toy twice daily. Initial data showed much higher pig interest in the teeter-totter than the rooting toy. This difference in usage may have been due to the observation that the rooting toys became contaminated with feces and urine, which may have discouraged pig interactions. The focus of the project then switched to the teeter-totter and the number of pigs that demonstrated sustained interest in playing with this toy. Preliminary analyses showed that farms had the most pigs playing with the toys during the first week after installation. Most farms saw a 30-50% decrease in toy use in the 2nd week of the study. For the remainder of the four month observation period toy use remained relatively stable with only one or two days a month when no pigs were recorded as playing with the toy.

**Figure 1.** Teeter-totter with KONG toy attachments (left), and rooting toy (right).

This pilot project demonstrated that pigs will consistently play with some types of toys over several months. The project also revealed some problems with the study and toy design. Problems related to toy design included: pigs getting their heads stuck in the chains of the toy attachment, pigs destroying the toys, and toys falling off the teeter-totter. These events resulted in producers having to spend time fixing the toys and ensuring pig safety, which were detrimental to the practical application of the devices in commercial settings. In addition, questions arose with respect to the design of the study including: do all the pigs in the pen play with the toy or only a few? Would toys that produce noise increase pig interest? Are there superior styles of toys available for swine environmental enrichment? In an attempt to address these questions, a second pig toy study was undertaken.

**Current Pig Toy Research**

The second swine environmental enrichment study began in Fall 2013. This study used the same format as the initial project. Farmers recorded the number of pigs playing with each toy every morning and afternoon for a four month period, but compared four different styles of toys: teeter-totter with a bell, teeter-totter without a bell, tri-star with a bell, and tri-star without a bell (Figure 2). The teeter-totter toy is the same style as the original study (having toy attachments that are wood, KONG dog toys, or PVC pipe). The tri-star is a plastic circle with 3 plastic arms and hanging chains, which can be hung from the ceiling of the room. Half of the toys have a bell attached to test whether pigs play more with toys that make noise.

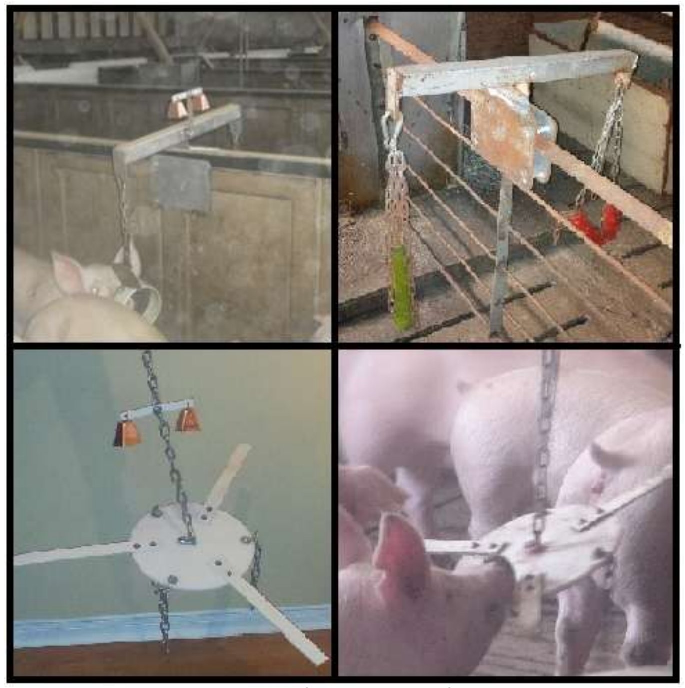

**Figure 2.** Clockwise from top left: Teeter-totter with bell, teeter-totter without bell, tri-star without bell and tri-star with bell.

So far, the data, as well as input from the producers, suggest that there are more pigs playing with the tri-star toys. This may be due to more pigs being able to access the tri-star from all sides. While the tri-star may be more popular, it is also more destructible. On several farms finisher pigs have completely chewed away the plastic arms within a month of installation. The teeter-totter appears to be more durable, but it, too, is not fully indestructible (Figure 3). The fact that the tri-star's arms can be chewed may also increase pig interest, as pigs are more attracted to materials they can manipulate. Producers report that the bells do not appear to influence pigs' interest in the toys.

**Figure 3.** Chewed off tri-star arms (left), and teeter-totter broken off attachment plates (right).

The next part of this study involves marking pigs in the pen with a unique identification number and observing if the same pig always plays with the toy or if different pigs in the pen take turns playing. The data and information gathered from this swine environmental enrichment study will be valuable in understanding how pigs play, interact with enrichment devices, and what types of objects they prefer to interact with. Thank you to all of the participating producers on this project!

# Impact of Nursery Diet Quality and Fish Oil Supplementation on Growth Performance of Pigs

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## Introduction

Expensive, high quality protein ingredients have been included in nursery diets to improve growth performance of newly weaned pigs. In our group, we have demonstrated that feeding low cost and less complex nursery diets reduced growth performance during nursery phase only, but did not affect growth performance up to market weight and carcass quality at slaughter (Skinner et al., 2014). However, the immune response was compromised in pigs fed less complex diets (Levesque et al., 2013) and growth performance was reduced during a disease challenge (Skinner et al., 2014). Inclusion of immune response modulating ingredients, such as fish oil, may be used in less complex diets to improve growth performance. Thus this study was conducted to study the effect of 5% fish or corn oil inclusion in high and low protein quality nursery diets on growth performance of pigs during the first 8 weeks post-weaning.

## Materials and Methods

The study was conducted at the Arkell Swine Research Station, University of Guelph, Guelph. One hundred and twenty Yorkshire pigs (5 barrows and 5 gilts per pen; 3 pens per treatment) were weaned at a mean body weight of 6.25 kg and 21 ± 3 d of age. At weaning, pigs were assigned to 1 of 4 dietary treatments in a 2 × 2 factorial arrangement based on diet protein quality (**High** vs. **Low**) and 5% oil (**Corn** vs. **Fish**) supplementation. Nursery diets were provided in a 3-phase feeding program with Phase I, II, and III diets being fed for 7, 14, and 21 d, respectively. **High** diets contained plasma protein, soybean isolate (highly digestible purified protein), fishmeal, and crystalline amino acids. **Low** diets included mainly soybean meal as a source of protein. Thereafter, all the pigs were fed a common grower diet for 14 d. Pigs were weighed individually and per pen feed usage was determined every 7 d until the end of trial (d 56). Data were analyzed statistically as a randomized block design with repeated measures using the MIXED procedure of SAS (V 9.2 SAS Inst. Inc., Cary, NC) with pen as the experimental unit. Results were considered significant at $P < 0.05$ and tendencies reported $P < 0.10$.

## Results

There were no interactive effects of diet protein quality and oil supplementation on growth performance. Body weight, average daily gain (ADG), average daily feed intake (ADFI) and feed efficiency (Gain: Feed) were affected by both protein quality and oil supplementation (Table 1). Feeding **Low** diets decreased ($P < 0.05$) ADG as compared to feeding **High** diets during Phase I, II, and the nursery period (Phase I to III). There was no effect of **Fish** oil inclusion on ADG during the nursery period and grower phase. ADFI (Phase I, II, nursery period) were lower ($P < 0.05$) in pigs fed **Low** diets as compared to pigs fed **High** diets. Pigs fed **Fish** oil in nursery diets had lower ($P < 0.05$) ADFI during nursery period and tended to have lower ($P < 0.10$) ADFI during phase I, II and III. Pigs fed **High** diets have greater ($P = 0.05$) Gain: Feed as compared to pig fed **Low** diet during phase I and nursery (0-42d). Similarly, **Fish** oil fed pigs had improved Gain: Feed ($P < 0.05$) during Phase III, the nursery period and overall as compared to **Corn** oil fed pigs.

## Discussion and Implications

These results indicate that feeding **Low** quality protein nursery diets compromised growth of pigs during the early nursery period. However, during nursery Phase III and the grower phase ADG and ADFI were not different between **High** and **Low** quality protein nursery diets. These results further strengthen the concept that diet protein quality is critical during the early nursery phase (Phase I & II) to stimulate feed intake and – possibly – the immune system. Thereafter, diet protein quality can be reduced to lower feed costs, while pig performance can be maintained. Independent of diet protein quality, fish oil supplementation improved Gain: Feed, which may be explained by the effect of fish oil supplementation on the pig's response to immunological stress (Liu et al., 2003; Gaines et al., 2003). However, more research is needed to understand the dose response of fish oil at varying diet protein quality to optimize both growth performance and the pig's immune response, while lowering feed cost.

**Table 1.** Effect of nursery diet quality (**High** vs **Low**) and 5% oil (**Corn** vs **Fish**) supplementation on growth performance of starter pigs.

| | **Treatment** | | | | | ***P value*** | |
|---|---|---|---|---|---|---|---|
| | **Diet Protein Quality** | | **Oil** | | | | |
| **Item** | **High** | **Low** | **Corn** | **Fish** | **SEM** | **Quality** | **Oil** |
| ADG, g | | | | | | | |
| Phase I, d 0 to 7 | 138 | 100 | 127 | 110 | 20.0 | 0.011 | 0.170 |
| Phase II, d 7 to 21 | 290 | 239 | 264 | 264 | 13.2 | 0.025 | 0.995 |
| Phase III, d 21to 42 | 593 | 582 | 574 | 602 | 18.3 | 0.689 | 0.306 |
| Nursery, d 0-42 | 422 | 385 | 395 | 411 | 8.75 | 0.019 | 0.222 |
| Grower, d 42 to 56 | 794 | 817 | 791 | 820 | 21.4 | 0.460 | 0.365 |
| Overall, d 0 to 56 | 509 | 494 | 496 | 506 | 14.1 | 0.461 | 0.618 |
| ADFI, g | | | | | | | |
| Phase I, d 0 to 7 | 181 | 147 | 172 | 156 | 11.7 | 0.004 | 0.065 |
| Phase II, d 7 to 21 | 491 | 423 | 469 | 445 | 8.8 | 0.006 | 0.085 |
| Phase III, d 21to 42 | 996 | 999 | 1030 | 965 | 22.0 | 0.935 | 0.071 |
| Nursery, d 0-42 | 555 | 523 | 557 | 521 | 9.35 | 0.038 | 0.028 |
| Grower, d 42 to 56 | 1498 | 1514 | 1507 | 1505 | 48.8 | 0.821 | 0.974 |
| Overall, d 0 to 56 | 898 | 877 | 902 | 873 | 22.4 | 0.526 | 0.401 |
| G:F | | | | | | | |
| Phase I, d 0 to 7 | 0.748 | 0.652 | 0.712 | 0.688 | 0.057 | 0.083 | 0.606 |
| Phase II, d 7 to 21 | 0.589 | 0.565 | 0.560 | 0.594 | 0.023 | 0.482 | 0.328 |
| Phase III, d 21to 42 | 0.586 | 0.568 | 0.543 | 0.611 | 0.047 | 0.317 | 0.004 |
| Nursery, d 0-42 | 0.750 | 0.721 | 0.695 | 0.775 | 0.046 | 0.042 | 0.002 |
| Grower, d 42 to 56 | 0.532 | 0.541 | 0.526 | 0.546 | 0.016 | 0.695 | 0.387 |
| Overall, d 0 to 56 | 0.566 | 0.563 | 0.550 | 0.579 | 0.007 | 0.742 | 0.021 |

**References**

Gaines A. M., J. A. Carroll, G. F. Yi, G. L. Allee, and M. E. Zannelli. 2003. Effect of menhaden fish oil supplementation and lipopolysaccharide exposure on nursery pigs II. Effects on the immune axis when fed simple or complex diets containing no spray-dried plasma. Dom. Anim. Endo. 24: 353-365.

Levesque C. L., E. Miller, J. Zhu, and C.F.M. de Lange. 2013. Simple assessment of piglet robustness to nursery diet quality and feeding antibiotics. J. Anim. Sci. 9: S2 Abstract 90.

Liu Y. L., D. F. Li, L. M. Gong, G. F. Yi, A. M. Gaines, and J. A. Carroll, 2003. Effects of fish oil supplementation on the performance and the immunological, adrenal, and somatotropic responses of weaned pigs after an Escherichia coli lipopolysaccharides challenge. J. Anim. Sci. 81: 2758-2765.

Skinner L. D., C. L. Levesque, D. Wey, M. Rudar, J. Zhu, S. Hooda, and C.F.M. de Lange. 2014. Impact of nursery feeding program on subsequent growth performance, carcass quality, meat quality, physical and chemical body composition of growing-finishing pigs. J. Anim. Sci. Accepted.

# Non-Protein Nitrogen is Used Efficiently for Improving Protein Deposition and Feed Efficiency in Growing Pigs

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## Introduction and research objectives

When formulating diets for pigs, the balance between essential amino acids (**EAA;** lysine, methionine, threonine, tryptophan, etc.) and total nitrogen (**N**) should be considered, especially when large amounts of crystalline EAA are supplied in the diet and dietary N levels are lowered. When lowering dietary N, the dietary supply of non-essential amino acids (**NEAA**) is reduced, and the need of N for endogenous synthesis of NEAA (occurring primarily in the liver of pigs) to support muscle protein gain is increased. The N may be derived from either breakdown of EAA and NEAA that are supplied in excess of requirements or from non-protein nitrogen (**NPN**). Previously we have shown that NPN absorbed by the large intestine of pigs can be used efficiently to support body protein gain in growing pigs (Mansilla et al., 2013).

The objective of the present study was to determine the effect of supplementation of NPN, in the form of ammonium salts, to diets deficient in NEAA-N on growth performance of pigs.

## Materials and methods

In total 48 gilts with an initial body weight (**BW**) of 15.2 ± 1.3 kg were randomly assigned to 4 diets: (1) positive control (**Pos Ctrl**), not deficient in EAA and NEAA-N and all N supplied from intact protein (casein and soybean meal, **SBM**) or crystalline EAA, (2) negative control (**Neg Ctrl**), supplying the same amount of potentially limiting EAA as Pos Ctrl, but deficient in NEAA-N, (3) Neg Ctrl with 3 g/kg added ammonium (**Low NPN**), and (4) Neg Ctrl with 6 g/kg added ammonium (**High NPN**), containing the same amount of digestible N as Pos Ctrl. Pigs were grouped in 2 pigs per pen with 6 pens per treatment. BW gain and feed intake were monitored weekly during a 3 week period, and blood samples were taken on day 14 and 21 to determine plasma urea concentration.

## Results

Week 1 yielded rather poor growth performance and was considered a week of adaptation. During weeks 2 and 3, BW gain was not affected by NPN supplementation ($P > 0.10$); while feed intake (including feed wastage) tended to decrease with increasing supplementation of ammonium salts ($P < 0.10$). Feed efficiency, improved linearly with dietary supplementation of NPN in diets ($P < 0.05$). Feed efficiency for High NPN was similar to that for Pos Crtl ($P >$ 0.10:). Plasma urea concentration was low and not different between diets ($P > 0.10$).

## Conclusions and implications

Dietary supplementation with non-protein nitrogen (NPN) can improve growth performance when pigs are fed low protein diets deficient in non-essential amino acid nitrogen. This illustrates that pigs have requirements for nitrogen, in addition to requirements for essential amino acids, for supporting muscle protein gain. Availability of nitrogen can be assessed based on fecal digestibility, as nitrogen that is absorbed by the large intestine - as well as dietary NPN -

can be used by pigs for endogenous synthesis of non-essential amino acids. Further research is required to evaluate the use of alternative dietary NPN sources for pigs, including urea.

**Table 1.** Body weight gain, feed intake and feed efficiency in growing pigs fed diets deficient in NEAA-N with increasing inclusion levels of N supplied from of ammonium salts or intact protein.

| | **Neg ctrl (no NPN)** | **Low NPN** | **High NPN** | **Pos ctrl** | **SEM[1]** | **P (Diet effect)** |
|---|---|---|---|---|---|---|
| Ammonium ($NH_4^+$), g/kg | 0.0 | 3.0 | 6.0 | 0.0 | -- | -- |
| Dig. N content in diet, g/kg | 14.44 | 16.76 | 19.07 | 19.07 | -- | -- |
| Initial BW, kg | 15.6 | 15.1 | 15.3 | 14.8 | 0.6 | 0.78 |
| Final BW, kg | 26.6 | 26.9 | 26.6 | 26.9 | 0.9 | 0.99 |
| Plasma urea, week 02, mM | 0.089 | 0.090 | 0.092 | 0.091 | 0.001 | 0.55 |
| Plasma urea, week 03, mM | 0.099 | 0.104 | 0.109 | 0.114 | 0.009 | 0.70 |
| BW gain, week 2 & 3, kg/d | 0.63 | 0.64 | 0.65 | 0.68 | 0.02 | 0.41 |
| Feed intake, week 2 & 3, kg/d | 1.39 | 1.35 | 1.28 | 1.30 | 0.04 | 0.24 |
| Gain:Feed, week 2 & 3 | 0.45 [a] | 0.47 [ab] | 0.51 [ab] | 0.52 [b] | 0.02 | 0.019 |

[1] Standard error of means based on 6 observations (pens of 2 pigs) per treatment.
[a,b] Values in the same row followed by different superscripts differ significantly (Main effect of the diet, $P<0.05$).

**Acknowledgements**
Financial support for this research was provided by Ontario Pork, Evonik Industries AG, NSERC and OMAF/MRA. Technical assistance provided by Julia Zhu and Doug Wey is gratefully acknowledged.

**References**

Mansilla, W., D. Columbus, J.K. Htoo and C.F.M. de Lange. 2013. Urea nitrogen absorbed from the hindgut is used efficiently for body protein deposition in pigs fed a diet deficient in non-essential amino acid nitrogen. In (Oltjen, J.W., E. Kebreab, H. Lapierre ed.). Energy and protein metabolism in sustaintable animal production. EAAP Publication no. 134. Wageningen Academic Publishers, Wageningen, The Netherlands. pp. 413-414.

Mansilla, W. 2013. Non-Protein Nitrogen is Used Efficiently for Improving Protein Deposition and Feed Efficiency in Growing Pigs. M.Sc. Thesis. University of Guelph, Guelph, ON.

# Patterns of Nitrogen Retention in Gestating Gilts

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## Introduction

Whole body nitrogen (N) retention is a main determinant of amino acid and energy requirements of gestating sows. As the industry is moving towards phase and parity specific feeding of gestating sows (Moehn et al. 2011), information on N retention patterns is becoming more critical. However, based on the most recent review, empirical data on the dynamics of whole body N retention in gestating sows is limited (NRC, 2012). Particularly for parity 1 and 2 sows, where maternal N gain is relatively large and affected by energy intake, more data is needed.

## Objectives

To assess the dynamics of N retention in gestating parity 1 sows (gilts) and investigate the effect of energy intake on maternal protein deposition.

## Methodology

Two consecutive blocks of 10 gestating purebred Yorkshire gilts each at Arkell Swine Research Station were used for this trial. Based on average bodyweight and P2 backfat of each block at breeding and the current NRC (2012) modelling program, high and low feeding levels were determined and corresponded to 15% above and 15% below estimated requirements for gestating gilts (2.59 and 1.87 kg/day, respectively). A corn and soybean meal diet was used for both feeding levels, containing 3.5Mcal/kg DE and 17.5% crude protein and fed from day 30 to 110 of gestation. Throughout gestation there were 5 N-balance periods of 4 days in length and starting at day 35, 49, 63, 85, and 106 of gestation. Urinary N was collected quantitatively via urinary catheters and fecal N was calculated from N intake and fecal digestibility; the latter was determined using an indigestible marker. Bi-weekly bodyweight and P2 backfat was measured throughout gestation.

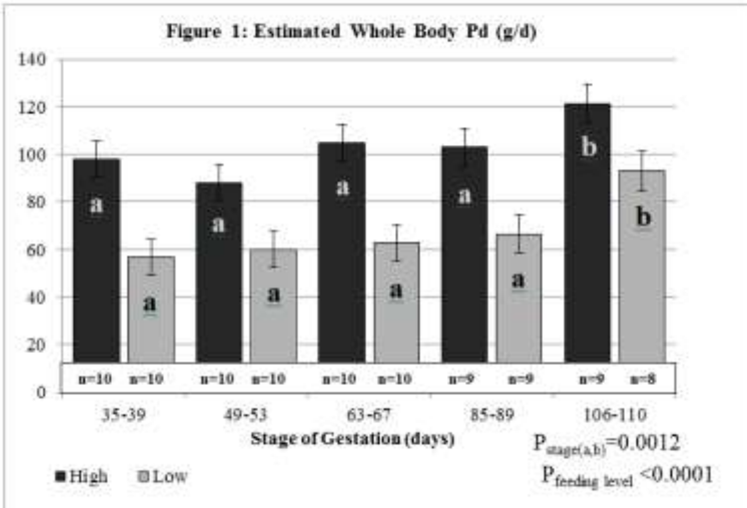
## Results

Estimated whole body protein deposition (Pd; N retention x 6.25; N retention corrected for systematic differences between N balance observations and whole body Pd, including products of conception) at various stages of gestation in gilts is shown in Figure 1. Feeding level and stage of gestation had an effect on Pd ($P<0.01$), but there was no interaction ($P=0.85$). The effect of increasing energy intake leads to a substantial increase in Pd, which is consistent with NRC (2012). The observed increase in Pd during late gestation is somewhat lower than that predicted according to NRC (2012). The latter may be attributed to an underestimation of maternal Pd during mid-gestation and an over-estimation during late gestation based on NRC (2012).

When all data is collected, the pattern of maternal body protein gain needs to be re-assessed, as well as their implications for changes in daily amino acid requirements during gestation.

## Conclusions and Implications

The differences between feeding levels and stages of gestation demonstrate the dynamic changes in N retention during gestation in gilts. The current NRC (2012) appears to underestimate maternal Pd during mid-gestation and overestimate it during late gestation in gilts. Determining the pattern of whole body N retention in gestating sows allows nutritionists to more closely estimate the changing nutrient requirements during gestation and formulate rations accordingly. Feed costs and excess nutrient excretion can be decreased by more closely meeting the nutrient requirements of gestating sows at the various stages of gestation, which poses a benefit to the producer and the environment.




**Acknowledgements**
Thanks to lab mates and technical staff. Financial support provided by Ontario Pork, Ontario Ministry of Agriculture and Food, de Heus Animal Nutrition, and Heartland Lysine Inc./ Ajinomoto.

**References**

Moehn, S. D. Franco, C. Levesque, R. Samuel and R.O. Ball. 2011. New Energy and Amino Acid Requirements for Gestating Sows In: Advances in Pork Production. Volume 22, pg. 1-9
NRC (National Research Council). 2012. Nutrient Requirements of Swine. National Academy Press, Washington, DC.

## Mucosal Bacteria Associated with Periods of Reduced and Compensatory Growth in Pigs

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### Introduction

Reduced quality diets and removal of in-feed antibiotics negatively impacted nursery performance but not days to market or carcass characteristics (Skinner et al., 2014). Physiological mechanisms involved in periods of reduced and improved growth could be related to digestive capacity and digestive enzyme activity (Levesque et al., 2012a). Results of denatured gradient gel electrophoresis of ileal microbial community diversity suggested that post-weaning nutrition had a long-term effect and permanently altered ileal mucosa-associated, but not ileal digesta, microbiota composition (Levesque et al., 2012b). The objective of this study was to 1) describe the ileal bacterial profile during periods of reduced and compensatory growth and 2) determine whether early nutritional insult permanently altered the profile of ileal mucosa bacterial populations.

### Materials and Methods

Forty eight pigs, weaned at 21 ± 1 d of age (6.4 ± 0.3 kg BW), were fed diets ad libitum containing either high (H) or low (L) quality protein sources with (A+) or without (A-) chlorotetracycline for 6 wks in a 3 phase regime (Phase 1, 7 d; Phase 2, 14 d; Phase 3, 21 d). The H diets contained highly digestible protein sources, whereas, the L diets were primarily corn-soybean meal based diets with a small amount of whey protein and fishmeal in Phase 1. Pigs were killed at 2 and 8 weeks post-weaning and a 40 cm section of the distal ileum was taken for DNA extraction of mucosa-associated bacteria. Ileal sections were rinsed, washed vigorously to remove mucosal bacteria, and the wash was centrifuged to pellet the cells. Total DNA was extracted using a commercially available kit (Powersoil® DNA isolation kit). After PCR amplification, pyrosequencing of the PCR amplicons was performed using a 454 Genome Sequencer. Data presented as sequence percentage at each taxonomic level were analyzed as repeated measures using the MIXED procedure of SAS.

### Results

Mucosal bacteria clustered more closely by wk post-weaning than starter diet treatment and there was no starter diet effect on bacterial diversity at wk 2 or 8. Firmicutes made up 91 and 96% of total reads at wk 2 and 8, respectively. Bacterial genera (expressed as percentage of sequences) in ileal mucosa of pigs collected at 2 and 8 wk of age indicated *Lactobacillus* were more abundant at week 2 and *Clostridium* were more abundant at week 8 post-weaning (Figure 1). Regardless of week post-weaning, *Clostridium, Lactobacillus, Sarcina, and Streptococcus* were the predominant genera. The proportion of *Clostridium paraputrificum* increased ($P$ = 0.003) from wk 2 to 8 in pigs fed L (0.8 vs 13 ± 2%) but didn't change in pigs fed H (3 vs 6 ± 2%; Table 1). The proportion of *Clostridium leptum* decreased ($P$ = 0.02) from wk 2 to 8 in pigs fed L (27 vs 1 ± 6%) but didn't change in pigs fed H (11 vs 5 ± 6%). Furthermore, the proportion of *Sarcina* genus tended to decline from wk 2 to 8 in pigs fed Low but tended to increase with wk post-weaning in pigs fed High ($P$ = 0.08).

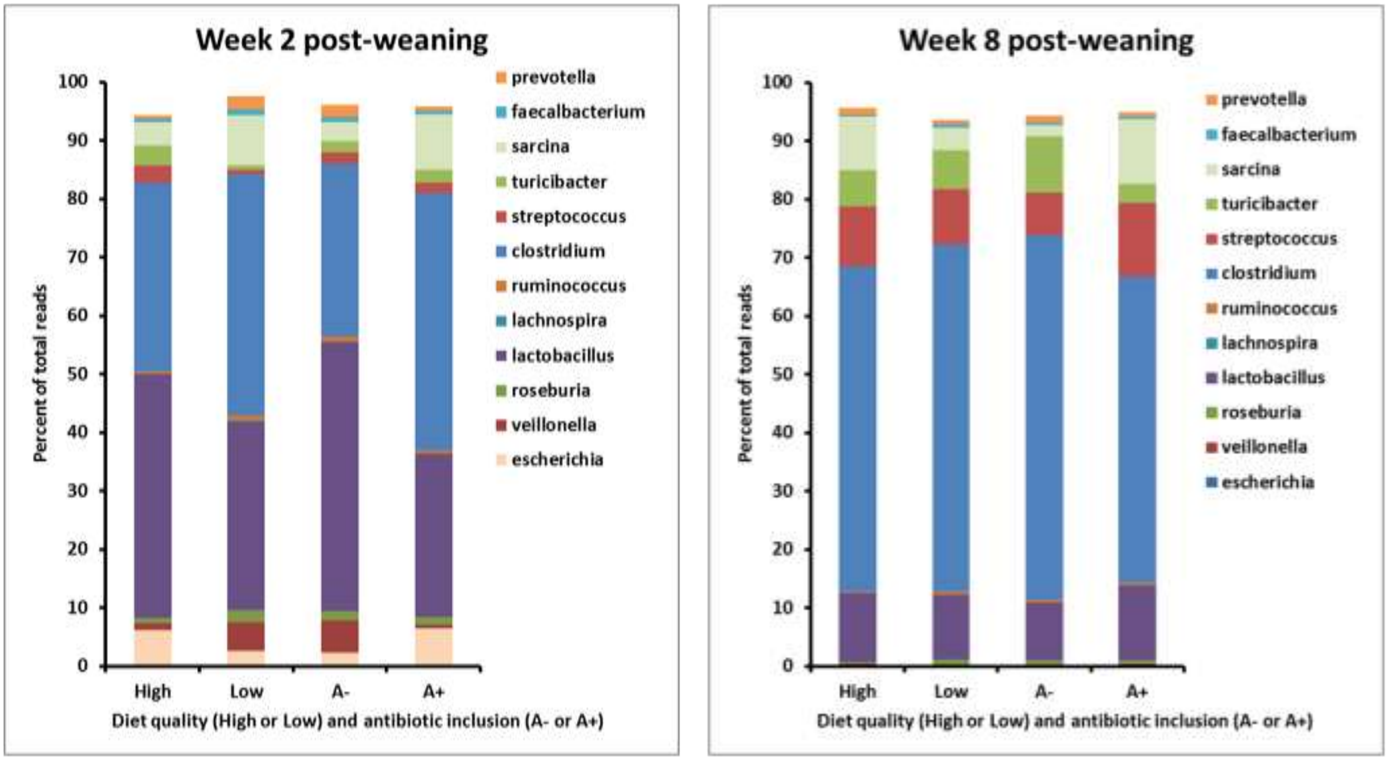


**Figure 1.** Bacterial genera (expressed as percentage of sequences) in ileal mucosa of pigs collected at 2 and 8 wk of age fed High or Low quality protein with (A+) or without (A-) in-feed antibiotic.

**Table 1.** Mucosa bacterial species (expressed as percentage of sequences) with a significant interaction between week post-weaning and protein quality or antibiotic inclusion based on 16S rRNA sequencing. Within protein quality or antibiotic inclusion, means within a row without common superscript differ; $^{ab}$ $P < 0.05$, $^{xy}$ $P < 0.10$.

| | **Protein Quality** | | | | | |
|---|---|---|---|---|---|---|
| | **High** | | **Low** | | | *P* |
| Species | **Week 2** | **Week 8** | **Week 2** | **Week 8** | **Pooled SEM** | **Interaction (Week x Prot; Week x A)** |
| *Clostridium paraputrificum* | 3·24$^{ax}$ | 6·51$^{x}$ | 0·77$^{ax}$ | 13·3$^{by}$ | 2·4 | 0·05 |
| *Escherichia albertii* | 2·24$^{a}$ | 0·09$^{b}$ | 0·42$^{b}$ | 0·05$^{b}$ | 0·48 | 0·06 |
| *Lactobacillus salivarius* | 0·91$^{a}$ | 0·05$^{b}$ | 0·05$^{b}$ | 0·03$^{b}$ | 0·13 | 0·001 |
| *Clostridium leptum* | 11·6$^{ab}$ | 5·3$^{b}$ | 27·2$^{a}$ | 1·0$^{b}$ | 6·4 | 0·10 |
| | **Antibiotic Inclusion** | | | | | |
| | **A-** | | **A+** | | | |
| | **Week 2** | **Week 8** | **Week 2** | **Week 8** | | |
| *Veillonella parvula* | 2·12$^{x}$ | 0·08$^{y}$ | 0·09$^{y}$ | 0·03$^{xy}$ | 0·61 | 0·10 |
| *Clostridium sordellii* | 0·60$^{x}$ | 4·61$^{xy}$ | 9·18$^{y}$ | 2·56$^{xy}$ | 2·25 | 0·04 |
| *Clostridium difficile* | 0·14$^{x}$ | 1·35$^{y}$ | 0·78$^{xy}$ | 0·54$^{xy}$ | 0·38 | 0·06 |
| *Clostridium bifermentans* | 0·67$^{a}$ | 6·84$^{b}$ | 2·76$^{ab}$ | 3·15$^{ab}$ | 1·62 | 0·07 |
| *Lactobacillus salivarius* | 0·95$^{a}$ | 0·04$^{b}$ | 0·01$^{b}$ | 0·03$^{b}$ | 0·13 | 0·005 |

**Discussion and Implications**

Ileal mucosa bacterial profiles were affected more by week post-weaning than by nursery diet. The impact of nursery diet quality was primarily at the species level. The increase in potentially beneficial bacteria and decrease in potentially pathogenic bacteria at wk 8 in pigs on low quality may, in part, explain the compensatory growth observed at wk 8 in these pigs. This further stresses the importance of considering long-term changes in gut microflora when evaluating feeding strategies for young pigs.

**References**

Skinner L. D., C. L. Levesque, D. Wey, M. Rudar, J. Zhu, S. Hooda, and C.F.M. de Lange. 2014. Impact of nursery feeding program on subsequent growth performance, carcass quality, meat quality, physical and chemical body composition of growing-finishing pigs. J. Anim. Sci. Accepted.

Levesque C. L, H. Yu, J. Gong, and C. F. M. de Lange. 2012b. Ileal mucosa-associated, but not digesta, bacterial profiles in grower pigs are influenced by nutrition and use of antibiotics for starter pigs. J Anim Sci. 90 Suppl 4:448-50.

Levesque C. L, L. Skinner, J. Zhu J, and C. F. M. de Lange. 2012a. Dynamic changes in digestive capability may contribute to compensatory growth following a nutritional insult in newly-weaned pigs. J Anim Sci. 90 Suppl 4:236-8.

**Acknowledgement**

Financial support for this research was provided by Ontario Pork, NSERC and OMAF/MRA. Technical assistance provided by Emily Miller, Julia Zhu and Doug Wey, is gratefully acknowledged.

# Development of an Air Filtration System for Swine Transport Vehicles to Protect Against Airborne Diseases During Transport

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**Summary**
The overall goal of this project is to protect high-value pigs during transport using a trailer with an air filtration system. A comprehensive literature search and a survey of various information sources on trailer filtration were conducted to identify components of a trailer air filtration system and the various options available for each component. Using a set of relevant design criteria, the different options were evaluated to select the components included in the prototype design. Presently, the proper components are being assembled for retrofit into the prototype trailer. Remaining steps to complete the project include prototype testing, design optimization, and feasibility analysis.

**Introduction**
The growth and success of the Canadian pork industry over the past decades depended significantly on access to highly improved genetics. Transporting breeding stock is a daily occurrence across Canada, and individual farms have biosecurity procedures to reduce the potential for disease outbreaks. However, the risk of infection of the breeding stock during transport can be significant, particularly during passage through pig dense areas, where disease outbreaks can still happen despite current biosecurity protocols in place. Thus, it is imperative that measures be developed to protect breeding stock during transport, thereby avoiding infection of these high-value animals and the consequent significant economic loss, and more importantly, to close this biosecurity gap through which potential infection can be introduced to high-health commercial herds. The overall goal of this work is to design, develop, and evaluate an air filtration system that can be fitted to a transport vehicle to prevent infection of the high-value breeding stock during transport.

**Results and discussion**
In this project, an air filtration system was designed and developed to filter the air entering an animal transport trailer, to protect high-value animals from infection with airborne transmissible diseases during transport. A literature review supplemented with a survey of relevant resources (i.e., veterinarians, truckers, genetics companies, etc.) was conducted to compile information on existing and potential designs for an air filtration system for transport vehicles, followed by selection of best design based on comprehensive evaluation of various options available for each component of the filtration system.

Information on designs of air filtration systems of existing filtered animal transport vehicles was gathered from literature and by contacting and interviewing different contact persons and organizations with filtered trucks/trailers. Organizations based in Europe (France, Netherlands) and USA were interviewed, which belonged to the following categories: swine genetics company; swine technical support/consulting firm/swine research; swine transport service and swine/livestock trailer/truck manufacturer.

The length of the filtered trailers from these organizations varied from 20 to 53 ft. The trailer/truck manufacturer based in Netherlands has multi-deck filtered trailers, which were used for transporting smaller pigs (e.g., 23-kg pig); the rest has one-deck filtered trailers. Unfortunately, only the general design of its air filtration system was described and shared by the company. From the literature search and survey results, the critical factors that need to be considered in the design of the ventilation and air filtration system for the trailer were identified as: 1. animal spacing requirement and trailer capacity, 2. pig heat generation and equivalent air conditioning requirement, 3. ventilation requirement as a function of air temperature inside the trailer and pig size, 4. available filter technology; and 5. power generation needed to run the whole system.

**Engineering**

The major parts of a trailer filtration system were components for: 1. temperature control, 2. filtration, 3. ventilation, and 4. air distribution. Additionally, there are secondary components of the system that were identified; these include components for: 1. air exhaust, 2. emergency openings, 3. parameter monitoring, 4. cleaning and disinfection, and 5. bedding and watering supply. Based on the designs of the surveyed trailers, the type of fans commonly used in these filtered trailers were axial fans. High efficiency particulate air (HEPA) filters and Di-octyl Phthalate (DOP)-tested filters were the type of filters installed in these filtered transport vehicles, with five currently using HEPA filters. Typical source of power needed to operate the fans was the diesel-type generator.

After gathering all the available information on trailer components and the associated options for each component, the specific option that will be included in the design of the prototype system was selected by having each project team member evaluate the different options according to the following criteria: 1. robustness, 2. impact on trailer environment (air quality, air flow, thermal environment), 3. power requirement, and 4. costs. The project team evaluated each option and based on the ratings, the design of the air filtration system for the prototype trailer includes the following major components: 1. non-air-conditioned, 2. MERV filters, 3. axial fans, and 4. no air diffuser.

In the current phase of the project, the required components of the trailer filtration system will be gathered and installed on the trailer. Ventilation system of the prototype design will consist of high performance axial fans to overcome pressure drop across the filtration system. Incoming air will be filtered in a sealed chamber operating under negative pressure, and the filtered air will be distributed to the trailer decks. Air filtration will consist of minimum efficiency reporting value (MERV) 14 and MERV 16 air filters (90 - 95 % composite average particle size arrestance efficiency) and high efficiency particulate air (HEPA) filters. Calculation of stocking density per deck, ventilation rate per deck, air velocity per deck, heat generation by pig per deck, and expected air temperature inside the trailer were done according to applicable recommended guidelines for Canadian conditions.

**Conclusions**

Comprehensive literature search and survey of different information sources on trailer filtration were conducted to identify the major trailer filtration components and the various options for each component. Based on evaluation of the different options, the components included in the prototype design of the air filtration system that will be fitted to a swine transport trailer were selected. The prototype system will be installed in an actual livestock trailer and will be tested for effectiveness in preventing airborne-transmitted pathogens transmission during transport, and in providing suitable thermal environment to the animals under Canadian conditions. Finally, after re-design and optimization steps, a feasibility analysis will be conducted to assess the viability of installing air filtration systems on swine transport trailers.

**Acknowledgements**

The authors would like to acknowledge the Canadian Swine Health Board and the Canadian Agricultural Adaptation Program for the financial support to this research project. The authors also acknowledge the strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and the Saskatchewan Ministry of Agriculture to Prairie Swine Centre Inc.

# Investigation of Translactational Analgesia for Reducing Piglet Pain at Castration

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## SUMMARY

Public concern regarding painful livestock procedures such as castration is increasing. Piglet castration has been criticized, largely because pain medication is not commonly used. The cost and time required to administer analgesics to individual piglets are the main deterrents to the swine industry adopting this practice. Having an affordable and practical method of delivering pain medication would likely increase the use of pain medication by producers, and increase the acceptance of this procedure.

The objective of this study was to determine if pain medication can be transferred to the piglet through the sow's milk, and if so, to determine how effective this technique is for reducing acute pain at the time of castration, and for reducing pain and inflammation after surgery. A novel technique for measuring pain in piglets using a handling chute was also developed.

Results showed that the transfer of the analgesic, Metacam®, to piglets via the sow's milk was not effective, as the maximum concentration of analgesic in piglet blood (up to 5 hours after injection of the sow) was less than 1/200th of that found in sow's blood, and 1/80th of that found in milk. Thus, the concentration of analgesic transferred to piglets via milk was too low to provide effective pain relief. Modification of the drug could result in increased transfer to piglets. Work is ongoing to validate the use of the handling chute for measurement of castration pain in piglets.

## INTRODUCTION

Concerns regarding painful procedures in livestock production are increasing, with the castration of piglets being one of the key issues related to pig production. Castration of male piglets is done to avoid 'boar taint', the development of undesirable odours which can occur in the meat of adult boars. The main concern related to piglet castration is that it is typically done without the use of analgesics.

The cost and time required to administer a pain medication to individual piglets reduces its adoption by producers. It is estimated to cost the Canadian industry $2 million on an annual basis. However, if an affordable and practical method of delivering pain control were available, its use would likely increase. Studies with cattle have found that pain medication can be transferred through the milk at lactation. However, there is a lack of research in this area in pigs and no knowledge of the extent of passive drug transfer to offspring through the milk. This study examined analgesic drug levels in paired samples of sow blood and milk, and the amount of drug transferred to piglets through the consumption of milk.

Work was also done to develop a novel behavioural test to assess pain in piglets, as currently our ability to assess pain responses in young piglets is very limited. Previous studies have shown there is little difference in the behaviour of castrated and non-castrated piglets after castration, as piglets generally continue to feed and rest with their littermates following the procedure, with only minor changes in posture and movement. However, physiological research has demonstrated that piglets do experience pain following castration, and refining behavioural methods for pain assessment are needed as such tests will aid in the development and refinement of pain control techniques. The pain assessment research is ongoing, and will be completed in late 2013.

## EXPERIMENTAL PROCEDURES

The first objective of this project was to determine the levels of pain medication (Metacam®) that are excreted via the milk, and to compare concentrations of the drug in sows' blood and milk over a five hour period. The second objective was to determine the amount of drug transferred to piglets via the sow's milk, and to identify the optimum time period that will provide the maximum transfer of drug to piglets. A final objective of the study is to evaluate the use of a handling chute with hurdles for assessing piglet pain responses following castration.

## MATERIALS AND METHODS

Our first experiment studied the transfer and excretion of analgesic in milk. Twelve sows were injected with Metacam® at seven days post-farrowing, with each sow receiving one of three dosages (0.50, 0.75, or 1.00 mg/kg). After the injection, eight blood samples were collected from each sow using an ear vein jugular catheter over a five hour period to determine the kinetics of absorption and distribution. Three milk samples were collected from each sow at approximately 1, 3 and 5 hours following injection. Methods for analyzing the drug concentration in blood and milk by high performance liquid chromatography (HPLC) were developed and validated at the University of Saskatchewan.

In the second experiment, examining drug transfer to piglets, we injected sows with Metacam® and then collected blood samples from two male piglets per litter to determine the levels of analgesic that are transferred to piglets through the sow's milk. A third experiment to assess whether translactational analgesia is effective at reducing pain was initially planned, but was not performed due to the low levels of drug found in piglets.
A further study is now underway to assess the pain responses of piglets to castration, comparing piglets given pain relief via an injection of Metacam® prior to castration, with sham castrated piglets (handled for castration, but not castrated). Metacam® is a non-steroidal anti-inflammatory (NSAID) drug, similar to aspirin, and is expected to reduce pain and inflammation following castration. However it not likely to have a significant effect on acute pain experienced at the time of castration.

As a method to more clearly identify pain responses following castration, we have developed a chute with hurdles which piglets are placed at different time intervals following castration. The chute will help assess piglet pain responses on the assumption that piglets will take longer to travel down the chute and over two hurdles (requiring lifting of the rear legs), if they are experiencing pain. The stride length of the rear legs will also be measured as the piglets traverse the chute by painting the piglet's feet with ink and recording stride length. Other measures will also be used to assess pain, including monitoring behaviour following castration (lying, standing, time spent suckling).

## RESULTS AND DISCUSSION

Metacam® concentrations in blood peaked between one and two hours after injection, with peak concentrations of approximately 450 ±200ng/ml. Concentrations in milk were greatest at three hours after injection, with peak concentrations of approximately 200 ±100 ng/ml following injection of 1 mg/kg Metacam. A high degree of variation was found in the drug concentrations in blood and milk samples from different sows.

*Drug transfer to* piglets

In the second study, analgesic concentrations in the sows' milk were found to follow a similar pattern to those observed in the first study. Average Metacam® concentrations in milk at 1, 3 and 5 hours following injection are shown in Table 1. Analgesic concentrations in

the sow's milk peaked at 3 hours post injection at 188 ng/ml, similar to the level observed in the first study at the same drug dosage. Average analgesic concentrations found in piglet blood in the 5 hours following injection of the sow are shown in Figure 1. Drug levels were found to increase significantly over time, with a peak concentration of approximately 2.5 ng/ml at 295 minutes post-injection, and the largest increase being between 90 to 175 minutes post-injection. A drop in analgesic concentration was not observed over the five hour sampling period, and therefore the peak analgesic concentration achieved over time is unknown.

The low levels of Metacam® detected in piglet serum are not promising in terms of the potential for this technique to offer pain relief. For example, sows given 1 mg/kg in the second experiment achieved drug levels in serum up to 470 ng/mL, and is approximately 150 times higher than levels found in piglet serum. In order for this technique to be successful, it may be necessary to modify the active drug to promote excretion via the milk.

*Assessing pain responses in* piglets

A chute was developed which can be installed behind the farrowing crate, and allows piglets to move down a 1 m corridor to return to the sow and her litter (see Figure 2). Piglets were trained to negotiate the chute on the day before castration, and then on the day of testing, the responses of castrated and non-castrated piglets in the chute were compared. Initial results suggest that at 20 minutes after castration, castrated piglets were slower to move down the chute than non-castrated controls. Additional validation work on use of the handling chute for pain assessment in piglets is being performed currently, with completion in September 2013.

## CONCLUSIONS

With growing awareness of animal welfare issues in the retail market, practical and economic methods for pain mediation are needed for producers to meet increasing animal welfare standards. Directly injecting analgesics into piglets involves drug administration and extra handling time. If effective, translactational medication could reduce the handling time involved and stress on piglets. Unfortunately the initial results presented here indicate that the level of Metacam® transferred to piglets in milk is less than 1% of that in sow blood and is not likely to reduce pain following castration. A modified drug, or other analgesics (e.g. Ketprofen®), may be more effective at delivering pain relief with this technique.

Further trials are in progress to evaluate the use of a handling chute for assessing piglet pain. If successful, the device will be a useful tool for evaluating and comparing techniques for providing pain relief at castration.

## ACKNOWLEDGEMENTS

Strategic program funding for this research was provided by Sask Pork, Alberta Pork, Manitoba PorkCouncil, and the Saskatchewan Agricultural Development Fund.  Specific project funding was provided by the US National Pork Board.

**Table 1.** Average Metacam® concentrations in milk over a 5 hour period in experiment two.

| Time post injection (m) | Mean calculated conc.(ng/mL) | Standard deviation |
|---|---|---|
| 60 | 148.67 | 11.33 |
| 180 | 188.33 | 80.03 |
| 300 | 139.03 | 84.11 |

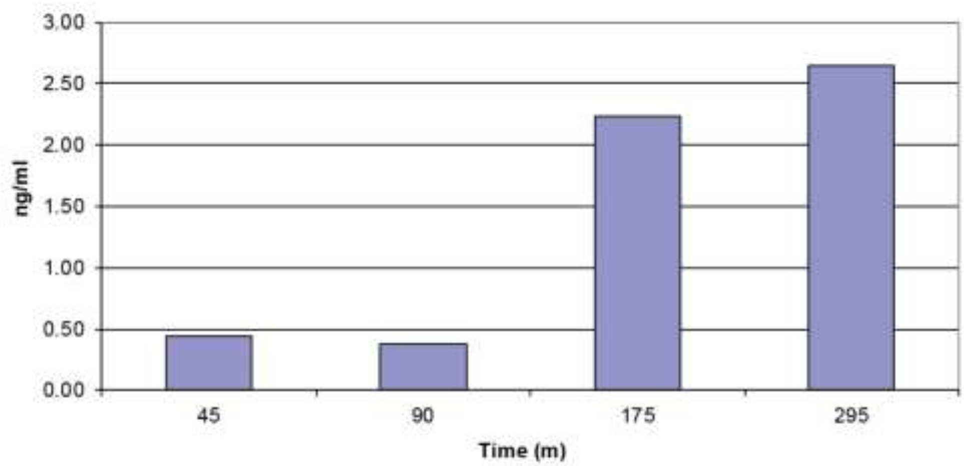


**Figure 1.** Average Metacam® concentrations in piglet blood serum over time.

**Figure 2.** Piglet moving through the handling chute.

# Benchmarking and Standardization of Swine Production Systems

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## SUMMARY

Previous work have shown that even though the ultimate goal of a swine production operation is to raise hogs in the best possible manner, there is a wide variation in the different operational systems in place in swine facilities across the industry, leading to variability in performance, efficiencies, production costs, and overall productivity. The overall goal of the project was to evaluate the current performance of various operational systems in swine production to determine whether standardization and optimization can improve efficiencies and overall productivity. From the work conducted in this project, 14 key areas of swine barn design and management were identified by pork producers and other stakeholders as areas that could potentially benefit from standardization and optimization efforts.

## INTRODUCTION

During the investigation of past projects involving characterization of various swine production systems, it became apparent that inefficiencies and added costs in many hog barns can be traced to a number of areas: wide variations in building design, construction, barn equipment, management, and other operational systems.

Results also indicate, for the most part with no clear reason for the variability except for the lack of applicable standards to guide the producers. Ultimately, this wide variability makes it difficult to develop improvement measures that can be easily applied from barn to barn, or at least to the majority of hog barns currently in operation.

The lack of standards or optimization is evident in a number of examples pertaining to swine production. A Prairie Swine Centre study showed a four-fold difference in total energy usage between barns employing energy-efficient practices compared to other barns of the same type but has not put emphasis on efficient use of energy in their operations. Within barns, various issues related to animal welfare such as lameness and stress could be avoided if appropriate standards are available for loading ramps, floor surface roughness, floor slat designs, pen walls, and alleyways. Anecdotally, there are other various examples that can be found across the industry that illustrate the wide variations in the manner by which 'common' production practices are implemented from barn to barn.

The overall goal of this project was to benchmark the existing operational systems in a modern swine production operation in order to develop recommendations for optimization and standardization of these various systems.

## RESULTS AND DISCUSSION

An initial survey of pork producers and related industry stakeholders to assess the awareness and application of existing standards and guidelines in current pig production systems showed: a. heavy reliance on "rules of thumb" for most of the decisions on design, construction and operation of pig barn systems (e.g., manure storage, flooring, ceiling height, pen size, stocking density), and

b. most of the operational issues commonly encountered in the surveyed production barns seemed to be related to these areas. In contrast, for areas where there are numerous existing regulations and standards covering product specifications, installation, and performance, producers did not report many associated problems (e.g., 96% of pork producers reported no problem with their electrical system, which is a system governed by several existing codes and standards).

From the survey and interviews, the 14 key problem areas identified by pork producers include:

a) dry sow stall
b) farrowing crate
c) ceiling height
d) alley and/or hallway width
e) space requirements for pigs
f) load out
g) flooring type
h) slatted floor
i) manure handling inside the barn
j) manure storage external to barn
k) manure handling activities
l) feeders and drinkers
m) commissioning and calibration of equipment
n) emergency power and water systems

A second survey focusing on the above areas was conducted with invited respondents from among pork producers across Canada. Out of all respondents, only 18% reported no problems with any of the 14 areas identified. Among those who reported encountering issues, the areas most frequently cited are feeders and waterers (40.9%), space requirements and crowding (39.4%), loadout (34.8%) and farrowing crates (31.8%). The specific problems reported include over-crowding, caused by increased prolificacy of breeding herd surpassing the original barn design specifications and changing market conditions resulting to higher or lower market weights of finished animals. Other physical system commonalities among producers include over 90% of complaints on barn load out designs implicating ramp angle and width as the primary problem, as well as 15-17% of all respondents having identified flooring type and slatted floor designs as problem areas associated with sow lameness and longevity.

## CONCLUSIONS

The project determined the main gaps regarding the building, equipment and manure storage/handling proved to be the most common problem areas for pork producers. By identifying widespread problem areas, we can develop priorities for swine barn research to fill the gaps determined in this project and focus efforts on improving these areas to the benefit of producers and pigs.

## ACKNOWLEDGEMENTS

Strategic funding provided by the Saskatchewan Pork Development Board, Alberta Pork, Manitoba Pork Council and the Saskatchewan Ministry of Agriculture. The authors would like to acknowledge the Saskatchewan Agriculture Development Fund and the Canadian Swine Research and Development Cluster (CSRDC) for the financial support to this research project.

# Creep Feeding in the Farrowing Room: Do the Outcomes Depend on Weaning Age?

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## SUMMARY

Creep feed could benefit older weaned piglets by supplementing nutrients in sows' milk. Additionally, it could aid the transition to solid feed at weaning, perhaps more of a benefit to the younger weaned piglet. In our experiment, body weight at nursery exit was greater in piglets offered creep feed for one week prior to weaning, regardless of weaning age (3 vs 4 wk weaning). However, less than 4 % of the piglets weaned at 3 weeks of age showed evidence of creep feed consumption.

## INTRODUCTION

Offering supplemental feed in the farrowing room (creep feeding) is thought to benefit piglets by 1) providing supplemental nutrition, 2) introducing piglets to solid feed prior to weaning and 3) adapting the gastrointestinal tract to nutrients not found in the sow's milk.

In 2010, however, we reported that providing creep feed for 7 days prior to weaning did not improve litter performance post-weaning and this was irrespective of piglet weaning weight (Beaulieu et al., 2010 Annual Report; Weaning at 28 days: Is creep feeding beneficial?). We followed this up with a study in which we tracked consumption of creep feed and phase one diet by individual piglets. This study demonstrated that, while only a small proportion of piglets consumed creep feed during the 7 days pre-weaning, those who did had improved growth performance throughout the nursery period (Beaulieu et al., 2011 Annual Report; Creep feed provision in the farrowing room provides benefits to piglets showing evidence of intake). The present study aims to expand on these findings by investigating whether the benefits of creep feeding depend on weaning age.

## MATERIALS AND METHODS

This experiment consisted of 4 treatments in a 2 × 2 factorial arrangement. The factors were: provision, or not, of creep feed in the farrowing room and weaning at 3 or 4 weeks of age. For piglets assigned to receive it, creep feed was made continuously available in a multi-space creep feeder (Figure 1) for 7 days prior to weaning. Both the creep feed and the phase one nursery diet were marked with an inert food dye (Brilliant Blue and ferric oxide (red), respectively). Anal swabs taken from the piglets receiving creep feed 1 day prior to weaning and from all piglets 2 days post-weaning allowed us to relate post-weaning growth performance to consumption of creep feed and to explore whether consumption of creep feed pre-weaning encourages consumption of phase one diet immediately post-weaning.

## RESULTS AND DISCUSSION

As expected, piglets weaned at 3 weeks weighed less at weaning than those weaned at 4 weeks ($P < 0.0001$; Table 1). This pattern persisted through the first 14 days post-weaning ($P < 0.0001$); however, by nursery exit (8 weeks of age, regardless of age at weaning) piglets weaned at 3 weeks were heavier than those weaned at 4 weeks ($P < 0.05$; Table 1).

The provision of creep feed in the farrowing room did not affect piglet body-weight at weaning and there were no creep feed by weaning age interactions ($P > 0.50$; Table 1). Growth ($P < 0.05$)

and ADFI ($P < 0.0001$) of piglets who had been offered creep feed in the farrowing crate were greater than those who had not and piglets who had been offered creep feed in the farrowing room were heavier at nursery exit than piglets not offered creep feed ($P \leq 0.01$; Table 1).

**Figure 1.** Configuration of the creep feeder used in the experiment.

In the 3 week weaning age group, only 8 piglets (4%) showed evidence of having consumed creep feed; whereas 73 four-week weaned piglets (34%) showed evidence of having consumed creep feed (Table 2). Creep feed disappeared at a rate of 57 g per litter per day for litters weaned at 3 weeks of age and 203 g per litter per day for litters weaned at 4 weeks of age ($P < 0.0001$).

Within the 3 week weaned piglets, creep-feed "eaters" were the lighter birth-weight piglets. Although these piglets had a greater rate of body-weight gain during the second week in the nursery, they were still lighter than the "non-eaters" at nursery exit (Table 2).

Piglets weaned at 4 weeks of age, identified as "eaters" of creep feed had greater rates of body-weight gain throughout the nursery phase than those identified as "non-eaters" of creep feed. Piglets who consumed creep feed in the farrowing crate were heavier, both at weaning and at nursery exit than those who did not (Table 2).

Within the 3 week weaning age group, 84 piglets (19%) showed evidence of having consumed phase one diet within the first 24 h post-weaning; whereas 142 (32%) of 4 week weaned piglets showed evidence of having consumed phase one diet within the first 24 h post-weaning.

Irrespective of creep feed status in the farrowing room, consumption of phase one diet within 24 h of weaning was associated with improved rates of BW gain during the first week in the nursery in both 3 and 4 week weaned piglets. In 4 week weaned piglets, this improvement in ADG persisted throughout the nursery period (0.42 vs. 0.38 kg/d for "eaters" and "non-eaters" of phase one, respectively), such that 4 week weaned piglets who consumed phase one diet within 24 h post-weaning were heavier at nursery exit than those who did not (19.01 vs. 18.07 kg, respectively). Irrespective of creep feed status in the farrowing room, consumption of phase one diet within 24 h of weaning was associated with improved rates of BW gain during the first week in the nursery in both 3 and 4 week weaned piglets. In 4 week weaned piglets, this improvement in ADG persisted throughout the nursery period (0.42 vs. 0.38 kg/d for "eaters" and "non-eaters" of phase one, respectively), such that 4 week weaned piglets who consumed phase one diet within 24 h post-weaning were heavier at nursery exit than those who did not (19.01 vs. 18.07 kg, respectively).

**Table 1.** The effects of weaning age (3 versus 4 weeks) and the provision of creep feed in farrowing on the post-weaning growth performance of piglets[a]

| Performance Parameter | Weaning Age | | Creep Status | | SEM | P-Values | | |
|---|---|---|---|---|---|---|---|---|
| | 3 weeks | 4 weeks | Creep[b] | No Creep | | Age | Creep | Age x Creep |
| n, litters | 40 | 40 | 40 | 40 | | | | |
| n, piglets | 435 | 442 | 430 | 447 | | | | |
| Body-Weight, kg | | | | | | | | |
| Day -7[c] | 3.79 | 5.24 | 4.56 | 4.47 | 0.12 | <0.0001 | 0.55 | 0.66 |
| At Weaning (Day 0) | 5.51 | 6.96 | 6.33 | 6.13 | 0.13 | <0.0001 | 0.26 | 0.78 |
| Day 7 post-wean | 6.15 | 7.87 | 7.18 | 6.84 | 0.14 | <0.0001 | 0.07 | 0.68 |
| Day 14 post-wean | 7.81 | 9.92 | 9.15 | 8.59 | 0.18 | <0.0001 | 0.03 | 0.50 |
| Nursery Exit[d] | 20.04 | 18.50 | 19.90 | 18.64 | 0.38 | 0.01 | 0.01 | 0.91 |
| Average Daily Gain, kg | | | | | | | | |
| 7 d Pre-Wean | 0.24 | 0.25 | 0.26 | 0.23 | 0.25 | 0.85 | 0.02 | 0.63 |
| Day 0 to 7 | 0.09 | 0.13 | 0.12 | 0.10 | 0.01 | 0.001 | 0.03 | 0.06 |
| Day 7 to 14 | 0.22 | 0.30 | 0.28 | 0.25 | 0.01 | 0.0002 | 0.01 | 0.29 |
| Day 0 to Nursery Exit | 0.40 | 0.40 | 0.42 | 0.38 | 0.01 | 0.61 | 0.01 | 0.65 |
| Average Daily Feed Intake, kg | | | | | | | | |
| Day 0 to 7 | 0.10 | 0.13 | 0.13 | 0.10 | 0.003 | <0.0001 | <0.0001 | 0.01 |
| Day 7 to 14 | 0.26 | 0.33 | 0.31 | 0.28 | 0.005 | <0.0001 | <0.0001 | 0.0004 |
| Day 0 to Nursery Exit | 0.52 | 0.49 | 0.52 | 0.49 | 0.01 | 0.001 | <0.0001 | 0.24 |
| Gain:Feed, kg/kg | | | | | | | | |
| Day 0 to 7 | 0.96 | 1.02 | 0.96 | 1.02 | 0.06 | 0.57 | 0.42 | 0.56 |
| Day 7 to 14 | 0.89 | 0.88 | 0.90 | 0.88 | 0.03 | 0.79 | 0.66 | 0.49 |
| Day 0 to Nursery Exit | 0.78 | 0.81 | 0.80 | 0.79 | 0.01 | 0.17 | 0.63 | 0.81 |

a Data is presented as litter averages
b Includes data from all litters to which creep feed was offered, regardless of whether or not individual piglets showed evidence of creep feed consumption
c Creep feed was made available to those litters assigned to receive it for 7 days prior to weaning
d All piglets exited the nursery at 8 weeks of age, irrespective of whether they were weaned at 3 – or 4 weeks of age

Regardless of age at weaning, piglets who consumed both creep feed in the farrowing crate and phase one diet within 24 h post-weaning were heavier and had greater rates of body-weight gain throughout the nursery period than any other group of piglets (Data not shown).

**Table 2.** Effects of creep feed consumption[a] on the growth performance of piglets weaned at 3 – or 4 weeks of age

| Growth Performance Parameter | Treatment: Weaned at 3 Weeks | | Treatment: Weaned at 4 Weeks | | Main Effects of Creep | |
|---|---|---|---|---|---|---|
| | Creep Feed "Eater" | Creep Feed "Non-Eater" | Creep Feed "Eater" | Creep Feed "Non-Eater" | Creep Feed "Eater" | Creep Feed "Non-Eater" |
| n, piglets | 8 | 206 | 73 | 143 | 81 | 349 |
| **Body-Weight, kg** | | | | | | |
| Birth | 1.51 | 1.79 | 1.62 | 1.68 | 1.61 | 1.75 |
| Day -7[b] | 3.43 | 3.89 | 5.22 | 5.00 | 5.04 | 4.35 |
| Day 0 (weaning) | 5.11 | 5.66 | 7.02 | 6.74 | 6.83 | 6.10 |
| Day 7 | 5.74 | 6.30 | 8.37 | 7.65 | 8.11 | 6.86 |
| Day 14 | 7.64 | 7.94 | 10.88 | 9.70 | 10.56 | 8.66 |
| Nursery Exit[c] | 20.14 | 20.53 | 19.97 | 18.07 | 19.99 | 19.53 |
| **Average Daily Gain, kg** | | | | | | |
| Day -7 to 0 | 0.24 | 0.25 | 0.26 | 0.25 | 0.26 | 0.25 |
| Day 0 to 7 | 0.09 | 0.09 | 0.19 | 0.13 | 0.18 | 0.11 |
| Day 7 to 14 | 0.27 | 0.23 | 0.36 | 0.29 | 0.35 | 0.25 |
| Day 0 to Exit | 0.42 | 0.41 | 0.45 | 0.39 | 0.44 | 0.40 |
| **Average Daily Feed Intake kg** | | | | | | |
| Day 0 to 7 | 0.11 | 0.10 | 0.15 | 0.14 | 0.15 | 0.12 |
| Day 7 to 14 | 0.26 | 0.26 | 0.38 | 0.36 | 0.36 | 0.30 |
| Day 0 to Exit | 0.53 | 0.52 | 0.52 | 0.51 | 0.52 | 0.52 |
| **Feed Conversion Efficiency, kg/kg** | | | | | | |
| Day 0 to 7 | 0.90 | 0.92 | 1.25 | 0.89 | 1.22 | 0.91 |
| Day 7 to 14 | 1.05 | 0.89 | 0.94 | 0.80 | 0.95 | 0.85 |
| Day 0 to Exit | 0.79 | 0.79 | 0.85 | 0.76 | 0.85 | 0.78 |

a Data-set includes only those piglets to whom creep feed was offered. Data unbalanced and not analyzed statistically

b Creep feed was provided from day -7 to day 0 i.e. for the week prior to weaning

c All piglets exited the nursery at 8 weeks of age, irrespective of their age at weaning

## CONCLUSIONS

Creep feeding in the farrowing room improved the weaning and nursery exit weights of the piglets who actually consumed it. Although the benefits of creep feeding were similar in piglets weaned at 3 or 4 weeks of age, there was a dramatic difference in the number of piglets that consumed the offered creep feed. Further research into ways of encouraging creep feed consumption among piglets is required.


## ACKNOWLEDGEMENTS

The authors thank Masterfeeds for donating the creep feed used in this experiment. Strategic funding provided to the Prairie Swine Centre by Sask Pork, Alberta Pork, the Manitoba Pork Council, Ontario Pork and the Saskatchewan Agriculture and Food Development Fund is gratefully acknowledged.

# Early Detection and Interventions for Reducing Lameness in Gestating Sows

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## SUMMARY

Lameness in sows is a painful condition that can affect fertility, mobility, feed intake and culling rate. Methods for the early detection and prevention of lameness have not been studied extensively, but if effective, such measures could improve overall herd health, welfare and the productivity of sows. Poor hoof condition is increasingly believed to be a contributing factor to lameness development.

The objective of this study was to, i) conduct a survey to assess the prevalence of lameness and hoof condition in a large commercial sow herd, ii) assess the effectiveness of preventative hoof trimming on reducing the occurrence and severity of lameness, and iii) assess the effectiveness of an early intervention treatment, including analgesics, provision of rubber stall matting to aid recovery and a corrective hoof trim, at reducing the prevalence and severity of lameness.

Results to date show that from a survey of 3,286 sows (55% of the herd), almost 60% of sows showed signs of lameness in at least one leg, and a large percentage of sows had multiple hoof lesions. Although the completion of objectives ii and iii is ongoing, preliminary data suggest that preventative hoof trimming reduces the occurrence and severity of lameness in gestation. The results so far indicate that true prevalence of lameness on farms is likely to be underestimated.

## INTRODUCTION

Lameness is a common problem among sows and is believed to be one of the most common reasons for culling. Prevention and treatment of lameness is of great importance for sow welfare, productivity and overall herd profitability, sows need to remain in the herd for at least three parities before generating a profit, and therefore premature culling of sows results in financial loss. As well, as producers shift to group housing systems, sow mobility will become more important and having options for prevention and treatment of lameness will be of increased benefit to producers. Methods for the early detection and prevention of lameness in sows have not been studied extensively, but would have the potential to reduce veterinary and euthanasia costs and to improve the productivity and profitability of pork production. Increasingly, along with joint issues, there is evidence suggesting that hoof condition contributes significantly to the development of lameness in sows and gilts. Currently, there is a lack of knowledge of techniques to prevent or treat lameness. Hoof trimming is commonly used to maintain hoof condition in many hooved species, including dairy cattle, sheep and horses, however it is not commonly performed in pigs. This study examined the role that corrective hoof trimming has on foot health and lameness using the Feet First® chute. The chute was recently developed by Zinpro Corporation (Minnesota, USA), and is designed to safely restrain and lift a sow, allowing examination of the sow's hooves and completion of a corrective hoof trim. This study used the FeetFirst® chute, and is the first examination of it's use in a Canadian swine herd.

## EXPERIMENTAL PROCEDURES

A 6,000 sow commercial operation was recruited to participate in the study, with the aim of observing incidences of lameness more representative of commercial production than is found in the Prairie Swine Centre's 300 sow research herd. Sows were stall housed for the duration of gestation.

*Objective one: Survey of prevalence, type and severity of lameness*
At four weeks gestation, sows were removed from their gestation stalls and lameness was assessed as sows walked on a solid concrete hallway. A trained technician observed the sows as they walked a distance of 20ft, and sows were given a locomotion score in accordance with the Zinpro Feet First© scoring system, as follows:

0: Sow moves easily with very little inducement. She is comfortable on all four feet.

1: Sow moves relatively easily but visible signs of lameness are apparent in at least one leg although it may be difficult to determine which leg is causing the lameness.

2: An abnormal gait is observed. Lameness could be observed in one or more limbs. The sows may exhibit compensatory behaviours such as dipping and raising her head in time to foot falls and arching her back.

3: An abnormal gait is observed and the affected limb(s) are able to be identified. The sow may be reluctant to bear weight on the affected limb and will avoid using it. Sow will be reluctant to move, and it is difficult to move her from place to place in the barn.

Following the locomotion observation, each sow received a hoof assessment on all four feet. Each hoof was assessed for hoof wall cracks (both vertical and horizontal), toe length, dewclaw length, heel overgrowth and white line cracks. Hooves were scored for each lesion on a scale of 0-3 in accordance with Zinpro's hoof lesion scoring guide (Table 1). A healthy hoof with no sign of lesions was given a score of zero. Any injuries observed (e.g. open wounds, bruising, joint swelling) were also recorded. The parity of each sow was recorded, and a number of the sows were then selected for objectives two and three of the study.

**Table 1.** Zinpro FeetFirst© hoof lesion scoring guide.

| Lesion description | Toes (T) | Dew Claws (DC) | White Line (WL) | Heel overgrowth and erosion (HOE) | Cracked wall (CW) |
|---|---|---|---|---|---|
| 1 | One or more toes slightly longer than normal | Slightly longer than normal | Shallow and/or short separation along white line | Slight overgrowth and/or erosion in soft heel tissue | Haemorrhage evident, short/shallow crack in wall. |
| 2 | One or more toes significantly longer than normal | Claws extend to floor surface when the pig is standing | Long separation along white line | Numerous cracks with obvious overgrowth and erosion | Long but shallow crack in wall |
| 3 | Long toes that affect gait when walking | Claw is torn and/or partially or completely missing | Long and deep separation along white line | Large amount of erosion and overgrowth with cracks through-out | Multiple or deep cracks in the wall. |

*Objective two: Preventative Hoof Trimming*

A total of 200 non-lame sows (locomotion score 0, as determined in phase one) were allocated to either a treatment group (received a hoof trim at eight weeks gestation), or a control group (received no treatment, observed only), with 100 sows per group. In addition to the locomotion and hoof lesion scores collected in phase one at four weeks gestation, all sows received a hoof examination at eight weeks gestation using the Zinpro FeetFirst© chute (Figure 1). Sows were restrained in the chute and raised off the ground to allow a detailed examination of all four feet. Sows allocated to the treatment group received a corrective hoof trim (Figure 2), while those allocated to the control group did not. The goal of the hoof trimming was to restore good conformation to the hoof and to correct the weight distribution and balance. The hoof trimming procedure followed was developed by Zinpro, and conducted as follows:

Step 1. Reduce toe length: Using nippers, make the toe length of both claws as equal in length as possible. A hand grinder is used to smooth any sharp edges.

Step 2. Straighten the hoof wall: If the toe has any curve to it, remove excess wall growth and straighten the hoof wall.

Step 3. Balance the hoof: Balance the sole and the heel of the foot using the grinder on the bottom of the foot to restore normal weight bearing. Any excess heel growth is removed.

Step 4. Trim the dew claws: Overgrown dew claws should be shortened removing the hoof in gradual steps. A grinder was then used to round off and remove any sharp edges.

All sows were given a second locomotion score at 13 weeks gestation to observe any changes. Following gestation, standard production measures were collected per sow, including the number of piglets born, live born, stillborn, mummified and weaned.

**Figure 1.** Zinpro FeetFirst Chute

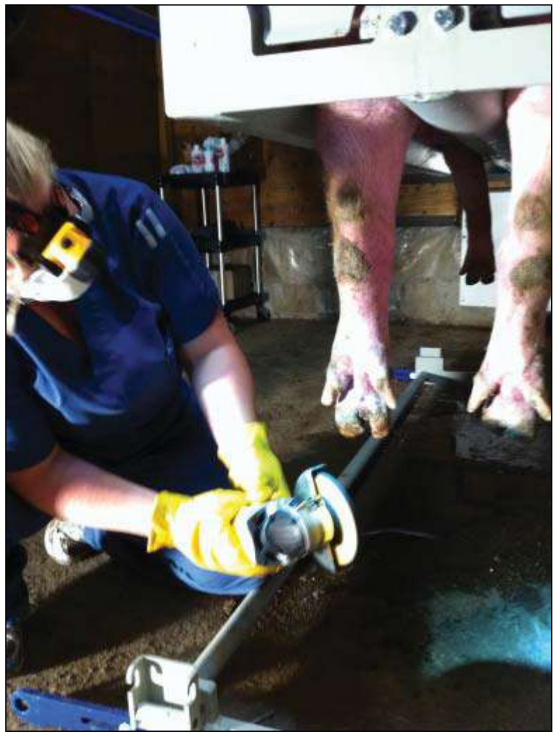

**Figure 2.** Performing a hoof trim on a sow with use of a hand grinder.

*Objective three: Lameness intervention*
Objective three of the study investigated the effectiveness of early intervention (treatment) for lame sows. Two-hundred lame sows (locomotion score 1-3) were randomly assigned to one of the following:

1) Early Intervention: Hoof evaluation and trimming, housed on rubber flooring, and administered 2 NSAID injections (n=100)

2) Control Treatment: Hoof evaluation, housed on concrete flooring (n=100)
An additional control group of non-lame sows (given a '0' in the lameness assessment) were also monitored (n=100) for comparison purposes. The data collection for this phase is still ongoing.

## RESULTS AND DISCUSSION

*Objective one - Sow lameness survey*
A total of 3,286 sows (55% of the total sow herd) were assessed for locomotion and hoof lesions. Of the sows surveyed, 40.9% were not lame, 53.2% were mildly lame (a score of 1), 5.7% moderately lame (a score of 2), and 0.2% severely lame (a score of 3), (Figure 3). Together these results indicate that almost 60% of the herd showing signs of lameness in at least one leg, which is considerably higher has been reported in literature. Although this study has found an elevated incidence of lameness, there were very few severely lame animals, with only 0.2% (7 sows) having a locomotion score of 3. The number of sows scoring 1 was very high, however, at this level of lameness the majority of cases may go largely unnoticed by stockpersons, as it can be slight and difficult to pinpoint. The mild nature of early lameness thus contributes to the general underreporting of the problem. Examining parity differences, between 42 and 59% of sows in parities 0-3, were found to be lame. This illustrates a significant problem, and risk, if young parity sows are showing lameness and may be prematurely lost from the herd due to lameness.

Thus identifying effective treatments that can be implemented at this early stage may have a significant impact.

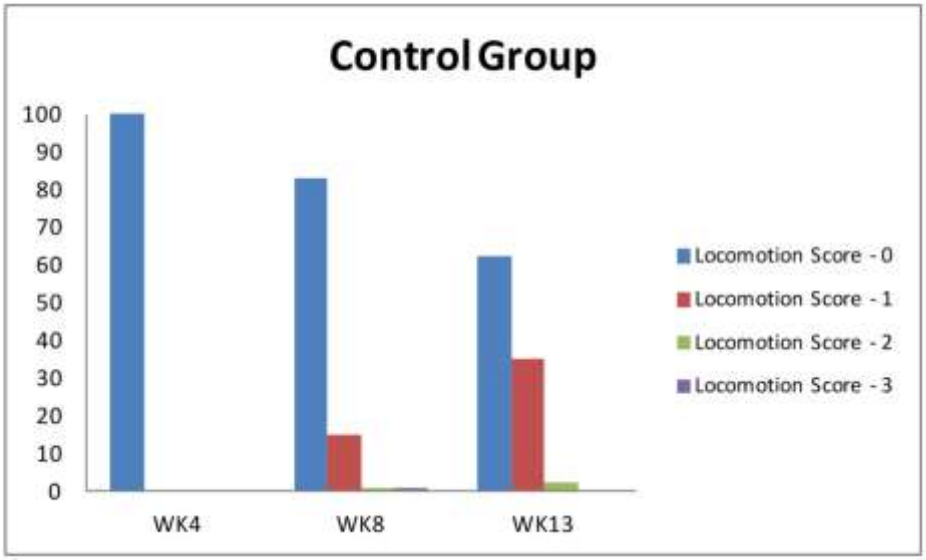


**Figure 3.** The number of control group sows observed in each locomotion score at three observations over gestation.

Concerning the condition and health of the hooves, 80% of sows had a correct toe length, with a score of 0. Long dew claws were prevalent in 67% of sows, and 52% of sows had heel erosion. Wall and white line cracks were less prevalent with 26% and 36% of sows affected, respectively. There was significant missing data related to heel erosions and white line scores in this phase of the study due to sows being assessed while standing, making it difficult to observe the underside of the hoof, thus these results may not be representative. It is likely that a higher prevalence of these conditions exists than is reported here. The quality of flooring is believed to be strongly linked to the prevalence of foot lesions.

*Objective two - Preventative hoof* trimming*:*
Preliminary results suggest that when comparing the control and treatment groups at week 13 of gestation (five weeks after hoof trimming for treatment sows) a greater number of the hoof trimmed sows remained sound (locomotion score of 0), and fewer sows showed increased lameness, compared to sows in the control group (Figure 4). These preliminary results, comparing trimmed and untrimmed sows, suggest that trimming may be beneficial for preventing the further development of lameness, and for reducing the severity of lameness that does develop. Data collection is nearing completion for this phase of the trial, and a full analysis is needed before firm conclusions can be drawn. The final analysis will also consider the extent to which hoof lesions are related to lameness.

**CONCLUSIONS**
This study provides detailed results on the prevalence of lameness in a large commercial sow herd. The preliminary results indicate that the prevalence of lameness on the study farm is high, with roughly 50% of low parity sows being affected. Observations of hoof condition indicate that hoof lesions, long dew claws and heel erosion are the most common problems. Previous research indicates that hoof lesions are related to the partially slatted concrete floors that sows are housed on. The sows in this study were housed in gestation stalls, and in this setting mild lameness may

be largely unnoticed. As producers move to group housing systems for sows, the effects of lameness may be more easily observed, and thus further work to improve management of sows (good nutrition, genetics, flooring and hoof care) to reduce lameness will be of increasing importance to the swine industry. Corrective hoof trimming may be one option to help farms manage and reduce lameness, with the initial results here suggesting that hoof trimming can reduce the development of lameness.

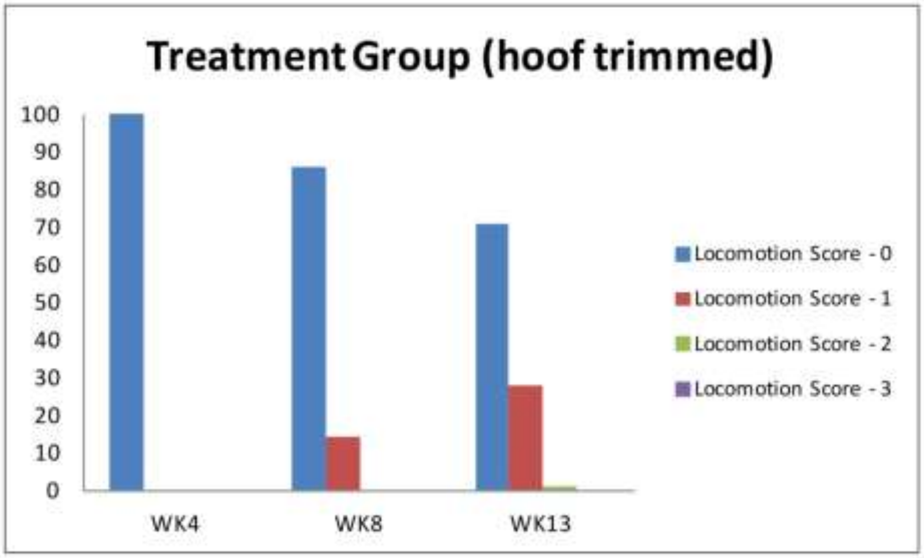


**Figure 4.** The number of treatment group sows observed in each locomotion score at three observations over gestation, having received a hoof trim at week 8 of gestation.

**ACKNOWLEDGEMENTS**
The authors gratefully acknowledge specific project funding for this study provided by Agriculture and Agri-Food Canada's Canadian Agricultural Adaptation Program, which is managed in Alberta by the Agriculture and Food Council of Alberta. Strategic program funding to the Prairie Swine Centre was provided by Sask Pork, Alberta Pork, Manitoba Pork Council, and the Saskatchewan Agricultural Development Fund.

# Spray-Dried Animal Plasma Mitigates the Negative Impact of Deoxynivalenol (DON) in Nursery Pigs

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## SUMMARY

Deoxynivalenol (DON) is a mycotoxin of concern to grain and livestock producers in Canada. It is prevalent in cool, temperate regions and often occurs on wheat and barley. The use of DON contaminated grain in livestock feed leads to depressed feed intake and growth performance. Pigs are especially susceptible to its negative effects relative to other livestock species, and thus a study was carried out to determine if the negative effects observed with feeding DON contaminated diets could be mitigated by feeding a clay binder and/or spray-dried animal plasma (SDAP). Pigs fed a DON contaminated diet plus SDAP performed as well as those consuming a non-contaminated diet in terms of ADFI and ADG.

## INTRODUCTION

The presence of DON contamination in grain is directly related to the presence of head or ear blight produced by Fusarium fungi, which in turn is directly related to the moisture content at flowering and/ or harvest. Possibly due to recent high stress growing seasons, we have seen an increase in the presence of DON contaminated grains in the Prairie Provinces, and it is expected that DON contamination will continue to spread. Grains contaminated with DON are often downgraded, and either fed to livestock or destroyed. The best strategy for dealing with contaminated grains is to reduce the final concentration of the mycotoxin by dilution; however, this may not be possible if large quantities of contaminated grain are available.

Feeding DON contaminated diets to pigs has negative effects on performance, and can also affect intestinal integrity. Contrary to this, including SDAP into swine rations leads to improved performance and has positive benefits on gut health and integrity. This led to the hypothesis that feeding SDAP to pigs consuming DON contaminated diets would mitigate the negative effects on performance. The use of activated clay binders is another strategy designed to help reduce the negative effects of certain mycotoxins in livestock, and thus we also hypothesized that adding an activated clay to the diet would improve animal performance in DON fed pigs.

## MATERIALS AND METHODS

Two blocks of 100 nursery pigs each were used for this trial. Pigs were housed in groups of 5/pen with a total of 8 pens per dietary treatment. Pigs began consumption of experimental diets 3 days post weaning and remained on trial for 20 days. Body weights and feed intakes of the pigs were measured on days 0, 3, 11 and 20. Intestinal samples were collected from the jejunum and ileum for 8 pigs per diet at the end of the trial for histological analysis.

Diets consisted of a negative control (NC; 0 ppm DON), a positive control (PC; 3.9 ppm DON) and 3 treatment diets which consisted of the PC diet plus clay (PC+clay), SDAP (PC+plasma) or both (PC+both). Diet formulations are shown in Table 1.

**Table 1.** Diet Formulations.

| Ingredients [1,2], % as fed | Treatment | | | | |
|---|---|---|---|---|---|
| | NC | PC | PC + Clay | PC + Plasma | PC + Both |
| Wheat | 50.8 | 28.8 | 28.6 | 27.8 | 27.6 |
| DON Wheat (9.3 ppm) | 0.0 | 22.0 | 22.0 | 22.0 | 22.0 |
| Soybean Meal | 19.0 | 19.0 | 19.0 | 18.1 | 18.1 |
| Whey Powder | 11.7 | 11.7 | 11.7 | 11.4 | 11.4 |
| Fish Meal | 9.0 | 9.0 | 9.0 | 0.0 | 0.0 |
| Barley | 4.9 | 4.9 | 4.9 | 5.8 | 5.8 |
| Canola Oil | 2.3 | 2.3 | 2.3 | 2.4 | 2.4 |
| LS 20 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Activated Clay | 0.0 | 0.0 | 0.2 | 0.0 | 0.2 |
| SDAP | 0.0 | 0.0 | 0.0 | 8.0 | 8.0 |
| Analyzed DON, ppm | 0.0 | 3.2 | 3.6 | 4.2 | 4.4 |

1 All diets contained equal amounts of vitamin and mineral premixes, choline chloride, salt and CuSO4-5H2O
2 Amino acids, limestone, and mono/di-calcium phosphate were added to balance diets

**RESULTS AND DISCUSSION**
Throughout the course of the experiment we observed no evidence of animals being ill (no vomiting or diarrhea). Overall, relative to the negative control (NC; no DON), ADG and ADFI of pigs fed the positive control (with DON) were reduced by 60 and 100 g/d respectively ($P < 0.01$). There was no obvious benefit of supplementing the diets with the clay binder, as ADG of pigs consuming the PC+clay diet was similar to those consuming the PC diet ($P > 0.05$); feed intake, however, of pigs fed the PC+clay was numerically improved relative to the PC but was less than the NC (PC+clay 450 g/d, PC 400 g/d, NC 500 g/d).

When SDAP was added to the DON contaminated diet (PC+plasma), ADG of pigs was similar to the NC pigs (420 g/d vs. 390 g/d; $P > 0.05$). The ADFI however, was greater for pigs consuming PC+plasma than the NC pigs (550 g/d vs. 500 g/d; $P < 0.01$). Performance of pigs fed the PC+both diet was also similar to the NC and PC+plasma fed pigs. Overall, gain:feed averaged 0.79 and was unaffected by DON, SDAP or the activated clay ($P > 0.05$). The effects of dietary treatment on ADG and ADFI are shown in Figures 1 and 2.

In the intestine, mucosal thickness and villus height were unaffected by dietary treatment. Pigs fed a DON contaminated diet plus SDAP (PC+plasma) had reduced crypt depth ($P = 0.04$) and thus the villus height to crypt depth ratio tended to be higher.

**CONCLUSION**
Inclusion of SDAP improved ADFI and ADG relative to the positive DON control, and pigs consuming SDAP with DON performed as well as the negative controls. SDAP alleviated the negative effects of DON. In this experiment, SDAP was more effective than the activated clay. SDAP should be included into nursery diets if DON contaminated feed is suspected or known.

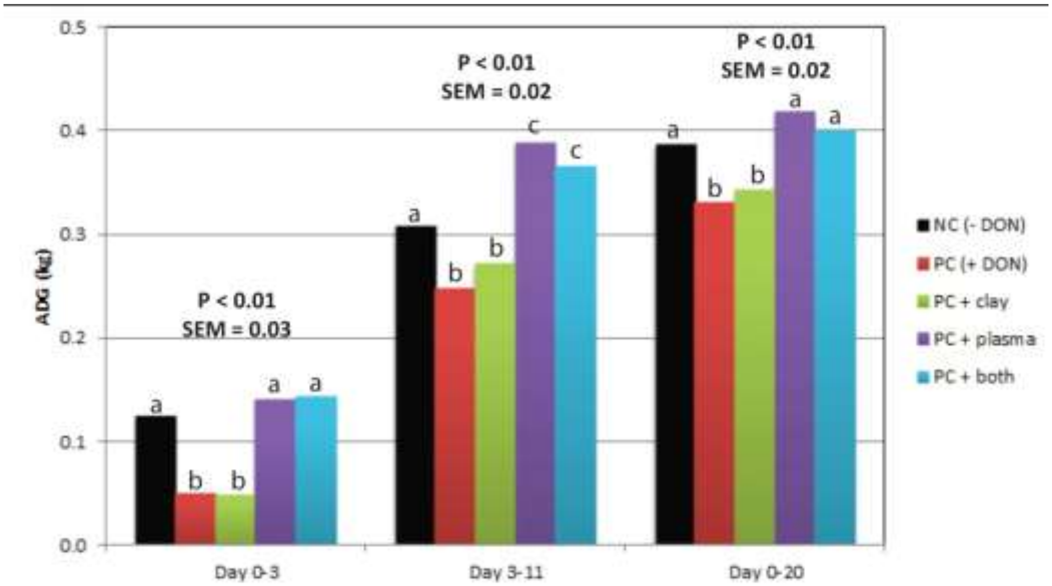


**Figure 1.** Average daily gains of piglets fed diets containing DON contaminated wheat +/- additives relative to a negative control.

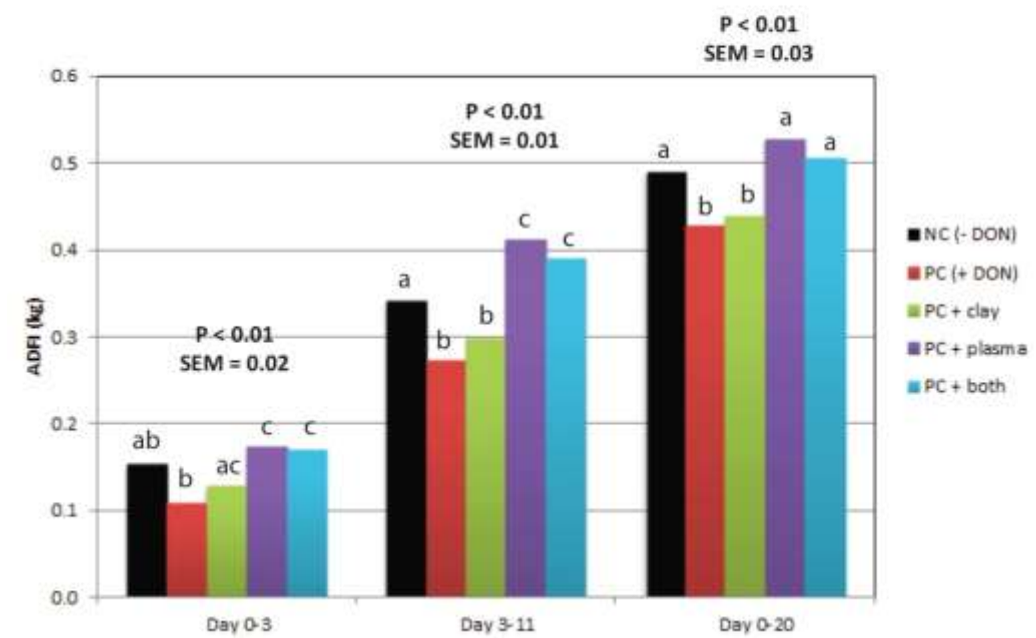


**Figure 2.** Average daily feed intakes of piglets fed diets containing DON contaminated wheat +/- additives relative to a negative control


## ACKNOWLEDGEMENTS

Strategic program funding was provided by Sask Pork, Alberta Pork, Manitoba Pork Council, Ontario Pork and Saskatchewan Agriculture and Food Development Fund. Specific funding for this project was provided by Saskatchewan Agriculture and Food Development Fund.