30th Annual

CENTRALIA SWINE RESEARCH UPDATE

January 26th, 2011

CentraliaSwineResearch.ca

CENTRALIA SWINE RESEARCH UPDATE
Kirkton-Woodham Community Centre
January 26, 2011

9:00 a.m. REGISTRATION and COFFEE
9:50 Opening Remarks

Adjourn

WRITTEN-ONLY TOPICS

ACKNOWLEDGMENT

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Wed. January 25, 2012

Wed. January 30, 2013

Centralia Swine Research Update
Box 37
Exeter, Ontario
N0M 1S6

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

Ontario

Centralia Swine Research Update - A Look Back

Bob Friendship
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The swine industry in Canada was dramatically different in 1982. According to the Ontario Pork Marketing Board, located in Etobicoke, there were almost 20,000 producers in the province, but there were fewer than 1000 farmers marketing over 1,000 hogs per year. In 1981 a U of G research project was started under the leadership of Mike Wilson to look at the productivity of Ontario pig farms. Roger Hacker and I were part of the research team. The project was funded by OMAF, using funds from the provincial lottery, and was unofficially known as the "Wintario Project". This was the age just before personal computers and production records were for the most part lacking. The goal of the Wintario project was to randomly select a group of farms and then to record production in order to determine what the average producer was doing. The results weren't well received because the research revealed that productivity was poorer than expected.

The average herd size of participants (randomly selected from those who shipped more than 1000 pigs the previous year)of the Wintario study was 115 sows, with the largest farm being a huge 380-sow farm and the smallest at 25 sows. The average number of pigs weaned per sow per year was 16.7 with a range of 12.3 to 19.6. The average days from birth-to-market was 195 days with an amazing range from an average of 154 days on the best farm to an average of 239 days on the worst. Preweaning mortality was about 20% on most farms with *E.coli* diarrhea being a major problem for newborn piglets. The injectable vaccine given to sows prior to farrowing had just been developed by Guelph researchers (Wilson and Povey, creators of Langford Labs). As part of the Wintario study some of the market hogs were followed through the abattoir and lungs and noses were assessed. Results showed that about 75% of pigs had lung lesions consistent with enzootic pneumonia and 60% showed evidence of atrophic rhinitis. In 1982 the vaccine for enzootic pneumonia was not yet available and the causative agent for atrophic rhinitis was just beginning to be identified. Over 10% of the hogs checked at slaughter in our study had lesions of pleurisy or pleuropneumonia. The "big bug" of the early 1980's was "hemophilus", the disease we now call Actinobacillus pleuropneumonia or APP. The other major disease problems of pigs in 1982 were: mange and lice, swine dysentery, mulberry heart disease, parvovirus (SMEDI), TGE and a syndrome called "mastitis-metritis and agalactia (MMA)". New diseases besides "hemophilus", that were just emerging as problems on Ontario farms included; coccidiosis, strep suis meningitis and porcine proliferative enteropathy. There were small outbreaks of swine flu in 1981 and 1982, which was clinically something new although the presence of flu virus in the Ontario pig population had been demonstrated years earlier.

Most pigs in 1982 were housed in renovated structures, generally an old wooden bank barn, often with modern additions. It was common to find pigs housed in the original stable as well as the second floor where originally hay or straw would have been stored. These barns were difficult to properly ventilate and difficult to clean. The idea of all-in/all-out pig movement was new and not widely practiced even at the room level. For example it was not uncommon to not only have all the farrowing crates in one room but at one end of the room would likely hold weaner decks as well. Feed was almost exclusively home-mixed. Artificial insemination was only used by those in the breeding-stock supply business. Almost all commercial farms used close to 100% natural breeding. One common source of replacement boars was the ROP boar test station at New Dundee, where young boars from multiple sources were housed together for months and then sold by auction. Similarly, a common source of pigs for the grower-finisher barns was sales barns. It was a time when 1000 head modern grower-finisher barn had to source feeder pigs from farrowing operations producing 25 to 50 pigs per week so single source all-in/all-out barns were out of the question. It was no wonder that disease was a huge problem.

In 1982 at the first CSRU, I was asked to speak about the most important disease of the day "Hemophilus". I don't think this was because the meeting organizers considered me an expert on the subject but I suspect they thought that, as a new researcher at Guelph, I should be on the program so that producers could see who I was. It has been a very good tradition of the meeting, to use short presentations by young researchers as a means of introducing them to the industry and giving them both recognition and practice in public speaking. The program has always had a good mixture of "seasoned" professionals and less experienced speakers, and a good mixture of applied practical talks and a few presentations that describe more basic research ideas often years from making their way to the farm.

The 30 years of CSRU proceedings are a wonderful archive of the research advances that have helped to transform the industry. I will leave it to Dr Josephson to cover some of the key highlights and important moments in the history of the Centralia meeting.

Centralia Swine Research Update – 30 years – What Have We Learned

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When one considers the Ontario swine industry of the 1980s and compares it to the industry today, it is apparent that great strides/changes/improvements have been made.

But just what have we learned, how far have we come, has CSRU been of any value to the industry? The answers – we HAVE learned a lot, we HAVE come a long way, and CSRU has been in the forefront of technology transfer to the industry. It is apparent that many of the technologies identified at the CSRU have been successfully implemented.

Since 1982, there have been 465 oral presentations, and 377 written-only topics. Subject matters have mirrored the interests and concerns of the producer, with 96 oral presentations on disease related concerns, 80 on nutrition, 54 on economics, 54 on facilities, 31 on management issues, and 29 on reproduction. In addition, other subjects such as manure management, animal welfare, and human resources have also been covered.

Major advances in the industry as identified by CSRU presentations

In 1984 Cathy Scott, University of Guelph, (Cathy Aker, OMAFRA, then OSI, followed by Maple Leaf) spoke on the advantages of AI-AO vs CF feeder barns – a new concept at that time. In the same year, Richard Smelski outlined the cost advantage of 3 week weaning vs the traditional 7-8 week weaning. In this study, the number of pigs reared per sow per year increased from 16.5 to 19.2.

In 1988, B.I. Kalow and PJ O'Brien introduced a novel blood test that could identify swine that were susceptible to PSS – an inherited muscle disease apparent in as much as 20% of Ontario swine, with a death loss of approximately 1%. This test replaced the previously used halothane test – one that led to death in many of the tested animals, and often failed to detect carrier animals. In 1993, Cathy Aker, OMAF, reported on the successful development of this DNA test.

Dr. Ernest Sanford made the first of several presentations on "Mystery Disease", now known as PRRS in 1990. Subsequent presentations have taught us the value of intervention strategies such as homologous vaccination (serum inoculation) (Dr. Zvonimir Poljak, 2009); the PRRS Risk Assessment Program (Dr. Doug MacDougald, 2008); and brought us to a paper today on the control and eradication of PRRS in the Niagara Peninsula (Dr. Jane Carpenter, Ontario Swine Health Advisory Board).

Two important papers were presented in1991. The first by Dr Soren Rosendal, OVC, introduced the topic of effective vaccination against Mycoplasma hyopneumoniae, the cause of enzootic pneumonia. Dr Jens Peter Nielsen, Denmark, finally identified the real cause of progressive atrophic rhinitis – a toxigenic strain of Pasteurella multocida. Control and elimination of this disease then became possible, and it has been almost, if not completely eradicated.

In 1994, Dr. N. Hussar, Miracle Feeds, introduced Ethanol feed by-products, and the possibility of incorporating DDGS into swine rations.

L. Kirk Clark, Purdue University, Indiana, outlined several recent innovations that had a tremendous impact on the health status and reproductive efficiency of swine in 1996. These included AI-AO, SEW, biosecurity, phase feeding and artificial insemination.

Dr. Beverly McEwen, Animal Health Laboratory, U. of Guelph, introduced Post- Weaning Multisystemic Wasting Syndrome in 1998. The causative organism was identified as a circovirus, the syndrome being called Porcine Circovirus Associated Disease (PCVAD). Dr Gordon Allen, Belfast, Ireland, gave a comprehensive review of the disease in 2006. In 2008, Dr Brent Jones spoke on the successful use of vaccines to reduce the impact of this pathogen.

Realizing the importance of early identification of disease outbreaks, Dr RM Friendship gave an update on the Ontario Swine Veterinary-based disease surveillance project in 2009. This project was a continuation of the original Wintario Sentinel herd project, first reported in 2002.

The 2 major diseases PRRS and PCVAD have emphasized several points:

- we must implement and maintain good management practices (follow the Madec principles)
- farm biosecurity is of utmost importance
- additional research is needed in controlling and eliminating pathogens in sow, nursery and grow-finisher operations
- we need an effective, timely information system that can identify production, health and financial data in the Ontario swine industry.

In preparation for this presentation, I looked through the 29 CRSU proceedings, and was impressed by several things:

1) The continued financial support of the many industry partners
2) The willingness of the numerous researchers who have made oral presentations or submitted written updates
3) The timeliness, breadth and depth of the topics presented

THANK YOU

Investigation of "Ear Necrosis Syndrome" in Pigs

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What is "Ear Necrosis Syndrome"?

On many farms you can find young pigs in the nursery or grower barn with tissue damage at the tips (sometimes the lesions are at the base or margins) of the ear. There may be only a small number of pigs affected or almost all pigs on the farm. The damage can vary from a very small sore to the loss of most of the ear. Lesions of ear necrosis usually become obvious around 4-6 weeks of age and may remain visible until approximately 14-16 weeks of age. When first noticed there is usually nothing more than a black greasy deposit on the ear tip but over a matter of a few weeks the ear tip slowly erodes with a blackened edge which may attract pen mates to chew resulting in bleeding. If there is no secondary trauma or infection, healing will occur but a substantial part of the ear may be missing by the time this occurs. The cause is unknown but believed to be at least partly due to an infectious agent. The prevalence is also unknown but the syndrome is reported from many countries and it is generally considered to be more and more common.

What causes the problem?

The primary objective of our investigation is to examine the bacteria isolated from ear necrosis lesions and determine if these bacteria might be capable of creating the disease, and secondarily we hope to determine the risk factors that might help explain why the disease appears to be much worse on some farms than on others. We suspect that ear necrosis is an infectious disease and that not all herds are infected with the causative organism, but we also believe that there are additional factors such as the environment that influence the prevalence and severity. So a herd that does not have a problem may be free of the causative agent or possibly have the agent but not have the major risk factors. This creates a problem for researchers until we figure out what the causative agent is. At present we are examining two possible bacterial causes. *Staphylococcus hyicus*, which is the bacteria that causes "Greasy pig disease", is commonly found on normal skin and readily enters skin wounds. Certain strains of these bacteria can release exfoliative toxins causing severe skin damage. This damage may be enough to explain the lesions or it is possible that the damaged tissue is then invaded by other bacteria such as invasive streptococci. Another possible cause of the lesion is *Treponema* (spirochetal bacteria). These organisms have also been found in the ear lesions and the mouths of pigs with ear necrosis, but they may be secondary invaders. Ear tip lesions attract the attention of other pigs, and the bacteria, *Treponema* in the mouths of pigs may infect the initial mild wounds and thus create a more severe disease.

What have we found at this point?

We visited 11case farms and 6 control farms up until, later 4 more for control farms in order to investigate risk factors. From 11 cases farms, the youngest age group was 3 weeks old pigs and oldest age group was 16 weeks age old pigs. Most cases were found in from 5weeks olds to 13 weeks olds pigs. The most ear necrosis lesions were shown from tips of ears but margin and lobe (bottom) of the ear lesions were seen too. Examination of tissue that we have collected so far clearly suggests that the problem begins on the outside of the ear and is not a disease carried in the blood to the ear. It has been suggested that it could be caused by something that damages the blood supply to the tip of the ear but this does not appear to be the case.

S. hyicus and *S. aureus* were found in all pigs exhibiting clinical signs of ear necrosis that were tested. Most of the isolates were resistant to beta-lactam antibiotics such as penicillin and ampicillin. We will further examine these bacteria to determine what toxins they are producing. We also found *Treponema* (spirochetes) in the tissues collected from a few of the pigs affected by ear necrosis, but this was not a consistent finding.

What to do for ear necrosis?

It is hard to make any specific recommendations at this point but we assume that any steps to reduce ear damage from fighting would be beneficial, so reducing stocking density and minimizing mixing, as well as ensuring adequate access to feed and water. Staphylococci require high humidity to thrive and so if these bacteria are responsible for the disease then increasing air exchange and reducing humidity as well as attention to hygiene might be helpful. If you are treating severely affected pigs with injectable antibiotics we recommend not using penicillin because of the problem with resistance.

Who is supporting this work?

Ontario Pork, the Animal Health Strategic Initiative Fund, OMAFRA and the University of Guelph. We are very appreciative of the farmers who have allowed us to sample pigs and who have answered our survey.

References

1) Bush, M.E.; Wachmann, H.; Nielsen, E.O.; Baekbo, P. 2008. Risk Factors for ear necrosis and tail lesions in weaners. Proceedings of the 20th IPVS Congress.
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3) Pringle, M.; Backhans, A.; Otman, F.; Sjolund, M.; Fellstrom, C. 2009. Isolation of spirochetes of genus *Treponemma* from pigs with ear necrosis. Veterinary Microbiology. 139:279-283.

New Tool for Determining Estrus and Ovulation in Weaned Sows

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Introduction

Optimal sow fertility is achieved by insemination of fresh extended semen during the 24-hour period before ovulation. However, among sows, there is a great variation in the wean-estrus interval, duration of estrus and consequently also in the estrus-to-ovulation interval (EOI). This variability in EOI presents a challenge in determining a reliable AI schedule since the onset of estrus is not a good predictor for the optimal time of insemination. Adequate estrus detection as well as the use of exogenous pharmaceutical products for the synchronization of estrus and ovulation are frequently used tools to help determine the correct time to breed in order to achieve pregnancy. A new device that measures the electrical resistance (ER) of the mucus in the sow's vagina seems to offer another option in determining the time of estrus and ovulation.

Ovarian follicular growth and corpus luteum formation and regression are associated with histological and histochemical changes in the vagina that are accompanied by alterations in its passive electrical properties. The use of ER of the vagina or vaginal vestibule as an aid to identify the optimum breeding time has been examined with several commercial instruments. Significant changes in vaginal ER during the estrous cycle have been observed in pigs and other species and it has been documented that ER in pigs is lowest in the follicular phase and highest in the luteal phase of the estrous cycle. These changes throughout the estrous cycle may indicate changes in the property of the vaginal mucus.

We measured EI from the day after weaning until day 7 after weaning using a Draminski estrus detector (Draminski electronics, Poland; Figure 1) to determine its usefulness as a predictor of estrus and ovulation.

Figure 1. The Draminski estrus detector

Materials and Methods

Over 5 weeks of weaning, 113 mixed parity sows were used to obtain ER readings from day 1 to day 7 after weaning as follows:

Day 1-3 - 1 reading per day
Day 4-5 – 3 readings per day
Day 6 – 2 readings per day
Day 7- 1 reading per day

The probe is inserted in the vagina and a reading is obtained within 20 seconds.
Real time ultrasound was done from day 4 after weaning to determine time of ovulation, and sows were checked for estrus in the presence of a boar from day 1 to day 7 after weaning.

Results

The results of the ER readings are shown in Figure 2. Estrus started from the time of the second reading on day 4 and last standing estrus was observed at the second reading on day 6. Estrus was observed after the lowest ER readings were recorded. Ovulation occurred between late day 5 and late day 6 after weaning, while ER values were still increasing.

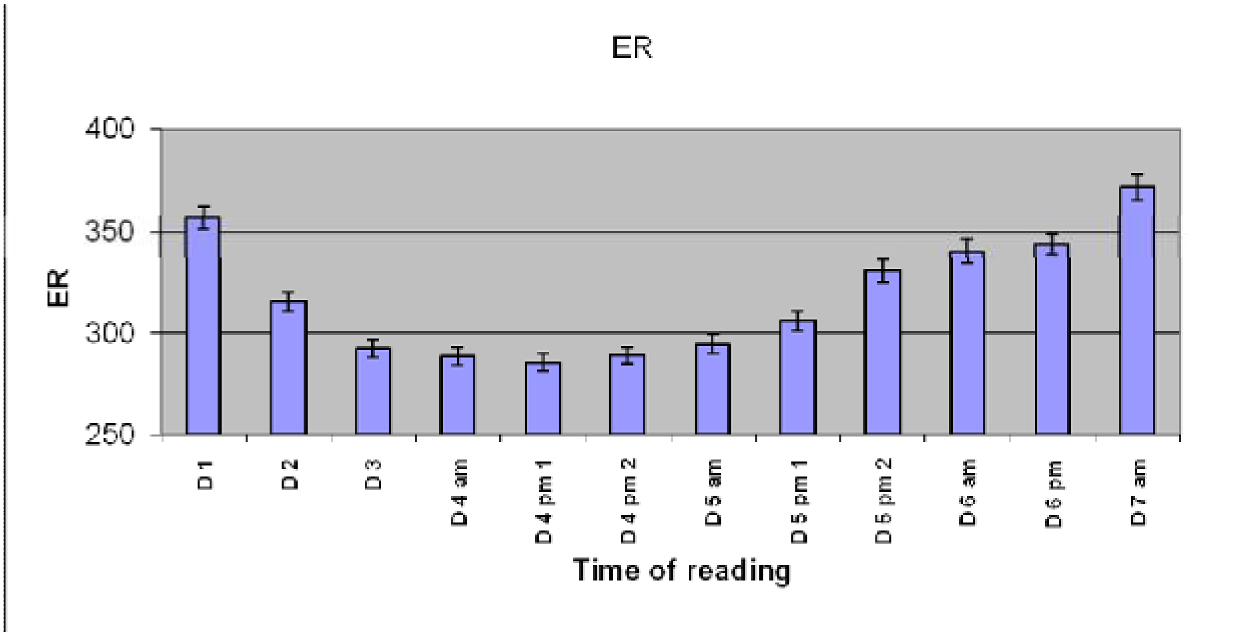

Figure 2. Vaginal Electrical Resistance reading from day 1 to day 7 after weaning.

Discussion

A definite trend was observed in the ER readings from day 1 to day 7 after weaning. This indicates that these values may be useful as a predictor for ovulation. It this can be shown in the future, it will offer the opportunity to do a single insemination to achieve pregnancy. There is also the possibility of doing readings on only a sample of sows to reduce the time spent on this exercise. Further research is required to further characterize the trend of ER values and to look into the possibility of achieving pregnancy with a single insemination.

Plant-to-Plant Differences in DDGS Nutrient Content and Digestibility

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Background:

Many swine producers are now feeding up to 20% corn distillers dried grains with solubles (DDGS) in grower/finisher diets. When properly formulated, diets with DDGS can help reduce feed costs with no adverse effects on growth performance or carcass traits. However, there are still concerns within the swine industry about the variability that can exist in the nutrient content and availability of DDGS which could impact performance. For example, product color (light versus dark color) can vary from batch to batch. Presently product color is often used as an indicator of the feedstuff's available amino acid contents, with a darker colored product often associated with lower lysine availability for the pig. Therefore, this trial was undertaken to evaluate alternative methods that can more accurately quantify the quality differences in DDGS from corn based ethanol plants supplying this feedstuff to Ontario swine producers.

Objectives:

The project is evaluating methods for determining the feeding value of DDGS from corn-based ethanol production based on product color, nutritional analyses and different in vitro assays.

DDGS sample collection and analyses completed:

Eighty-four (12 samples per plant) DDGS samples were collected from seven participating ethanol plants (4 from Ontario, 1 from Quebec, 1 from Michigan and 1 from New York). Each sample (1 kg) was analyzed for dry matter, organic matter, crude protein, ether extract, starch, neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent insoluble nitrogen (ADIN) contents. In addition, objective measures of product color were determined on all samples using a Minolta colorimeter with data collected using the CIE, $L^* a^* b^*$ scale. *In vitro* digestibility values for organic matter, dry matter and crude protein have also been completed with *in vivo* analyses scheduled for Spring of 2011.

Results to Date:

Some significant plant differences for DDGS colour ($L^* a^* b^*$ scale) , nutrient content, and *in vitro* nutrient digestibility are presented in Table 1. Colour readings were conducted before and after samples were ground through a 1-mm screen using a Thomas-Wiley mill. *In vitro* digestibilities were determined using set procedures to mimic the digestive processes of the pig. Various enzymes and solutions were added to determine total DM digestibility while the soluble fraction (%) was determined without enzyme inclusion. The difference between total and soluble digestion is due to enymatic digestion.

Table 1. Plant to Plant Differences in DDGS nutrient content and availability.

Product Colour Assessed Using a Colorimeter							
	A	B	C	D	E	F	G
Colour L*	59.2[b]	50.7[c]	62.3[a]	62.3[a]	62.9[a]	63.6[a]	51.0[c]
a*	10.9[a]	11.2[a]	8.0[b]	8.3[b]	8.3[b]	7.8[b]	8.6[b]
b*	52.4[a]	40.8[c]	47.3[b]	52.5[a]	48.6[b]	48.7[b]	39.5[c]
L* = lightness (0 = black, 100 = white). The higher the a* and b* values, the higher the amount of redness and yellowness, respectively.							
Nutrient Analysis (% as fed)							
DM	89.2[cd]	89.3[c]	90.5[b]	88.8[de]	89.4[c]	88.7[e]	92.5[a]
CP	26.7[b]	28.6[a]	25.8[c]	25.8[c]	26.9[b]	26.2[bc]	28.5[a]
LYS	0.90[a]	0.76[d]	0.84[bc]	0.80[cd]	0.87[ab]	0.84[bc]	0.85[b]
THR	1.03[b]	1.08[a]	0.98[c]	0.98[c]	1.02[b]	1.00[bc]	1.07[a]
TRP	0.22[b]	0.22[a]	0.21[bc]	0.21[bc]	0.22[b]	0.21[c]	0.23[a]
***In vitro* Dry Matter (DM) Digestibility (%)**							
Total	67[c]	73[a]	63[e]	65[d]	65[d]	65[cd]	70[b]
Soluble	32[b]	37[a]	31[b]	31[b]	32[b]	32[b]	38[a]
Enzymatic	35[ab]	36[a]	31[d]	33[bc]	33[cd]	34[bc]	32[cd]

[a,b,c] LS means within row that do not share a common superscript differ significantly ($p < 0.05$).

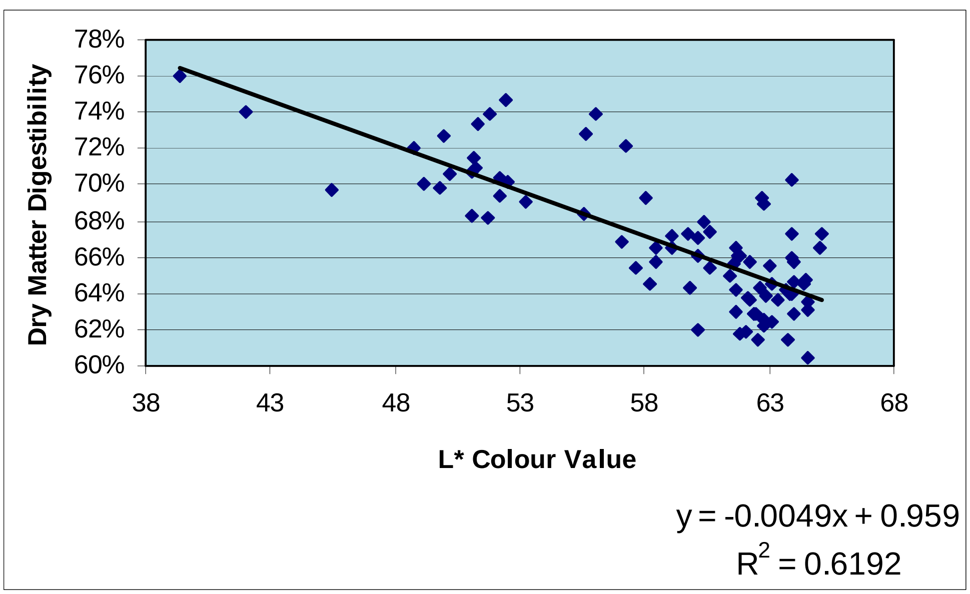

Figure 1. Relationship between DDGS colour (L*) and *in vitro* DM digestibility.

Results and benefits to swine industry:

In vivo analyses will be completed in spring of 2011 to verify *in vitro* DM digestibility results. However the present relationship between DDGS colour and *in vitro* DM digestibility was not expected as digestibility values decreased as L* values increased. This trend was also found with *in vitro* crude protein digestibility, while L* values were positively correlated with lysine content. An important observation is the between plant variability in lysine content, which was independent of variation content of protein or other key amino acids. Especially, in samples with an L-value below 45, lysine contents were reduced. The latter should be considered carefully in feed formulation.

Acknowledgements:

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The Effect of Dried Distillers Grains with Solubles on Swine Ration Choice and Environmental Quality

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Alfons Weersink and Kees de Lange, University of Guelph

Background:

The ethanol industry in Ontario has experienced rapid growth in recent history. This growth has increased provincial demand for corn and has the potential to increase the cost of raising hogs in Ontario. This increase has the potential to be partially offset by the inclusion of Dried Distillers Grains with Solubles (DDGS) in swine feeds. The supply of DDGS in Ontario is growing; it is estimated that annual production of DDGS or DDGS equivalent feedstuffs will reach 1,300,000 Metric Tonnes (MT) by 2013. Historically, poor product quality and nutritional variability were barriers to the adoption of DDGS as a feed ingredient for swine however these concerns are abating as technological improvements to the manufacturing process have made DDGS a more desirable feedstuff.

Research Problem:

The economic impact of including DDGS in hog diets in Ontario has not been determined. Furthermore, the nutrient composition of the manure is changed when DDGS are fed to swine. The change in manure nutrient values will affect the potential impact that the manure could have on environmental quality, however the magnitude of these changes are not known. This study will estimate the changes in feed cost and the nutrient content of manure when DDGS are included in a 3 phase feeding program for grow-finish pigs. These estimations can be used to determine the aggregate effect that DDGS can have when they are utilized on an Ontario hog farm.

New knowledge in this field is important for Ontario hog farmers because ethanol production in Ontario is rapidly expanding. Increased availability has made DDGS an important potential feedstuff for Ontario swine producers as they seek for ways to offset rising feed costs stemming from ethanol production. Limited knowledge of the impact that DDGS can have on feed costs will lead to inefficient ingredient purchasing. Additionally, the minimal understanding of how DDGS affects the nutrient value of manure can lead to inefficient fertilizer purchasing decisions and improper nutrient management strategies.

The growth of a regional ethanol industry and the impact that it can have on swine producers is not a question that is specific to Ontario. This phenomenon has taken place across Canada and the United States and further research is required to determine the impact that the adoption of DDGS can have for all swine farmers in North America.

Regional research is important in this case because Ontario has specific regulations surrounding nutrient management. To fully understand the impact that DDGS can have on Ontario hog producers the environmental impacts of DDGS must be evaluated using the current regulatory structure in Ontario.

Research Methods:

A least-cost feed ration model was developed for two separate three phase grow-finish feeding programs; one allowed the use of DDGS while the second excluded DDGS from the available ingredients. The nutritional requirements of each phase were developed using the National

Research Council's (NRC) 10th edition of "Nutritional Requirements for Swine" (1998). Fourteen ingredients available to the model were consistent with locally available feed ingredients and prices used were provided by a commercial feed manufacturer. The nutrient content of the manure was estimated using the Swine Manure Estimator (SME), a model that was built at the University of Guelph by Dr. Kees de Lange and Dr. Stephen Birkett.

Research Findings:

The inclusion of DDGS reduced the cost of feed by 12.8%. DDGS acted as a substitute for multiple nutrients, most notably energy, crude protein, and phosphorus. The majority of savings from DDGS were incurred through the partial replacement of corn, soybean meal, and di-calcium phosphate. The rations including DDGS had higher levels of crude protein, total phosphorus and available phosphorus than the DDGS free rations. Higher nutrient levels in the feed, together with lower nutrient retention ratios when DDGS are fed, led to increased levels of nitrogen and phosphorus in the manure. When DDGS was included in the diets, excretion of nitrogen increased by 20.3% while phosphorus excretion increased by 6.5%. The nutrient retention efficiency for nitrogen was reduced to 31.4% from 36.3% while phosphorus retention was shrunk to 28.4% from 29.6%.

The reduction in feed costs when DDGS is present is consistent with Fabiosa (2008) and is consistent with recent trends noted by commercial feed sellers. This reduction lends to the conclusion that DDGS should be incorporated in swine feeds. The result suggests that ethanol production may not have the significant negative effects on feed costs and the resulting competitive position of Ontario hog sector.

While increased emissions of nitrogen and phosphorus from DDGS can be seen as negative, the overall impact of these increases depends on the nutrient management situation of the individual farm. Higher emissions of nitrogen and phosphorus may be overcome in certain environments, i.e. cropping strategies can be altered to increase the ability of crops to remove excess nutrients. Ontario's Nutrient Management Act has stringent regulations surrounding nutrient management and manure application. Plans are formulated using nutrient content of manure, soil type, proximity of water sources, and planned crop rotation. Hog farmers with existing plans will need to re-examine their manure if DDGS are included into their feeding program. The Clean Water Act must also be considered when evaluating the implications of these findings; increased awareness will be necessary for farms that fall in source protection zones under the act.

Save $ with New Feeding Standards for Sows

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Take Home Message

Phase feeding of pregnant sows supplies the amino acids and energy needed just when the sows need them. This can result in reduced feed cost, better sow condition at farrowing, better rebreeding success and prolonged productive life of sows.

Introduction

In the last few years, our new research in sow nutrition has provided evidence that the feeding regimen of gestating sows needs revision. In particular, the change of amino acid requirements from early to late gestation and the energy deficit of young sows in late gestation give a clearly show that phase feeding of pregnant sows may be of economic advantage. I will review recent research, introduce future perspectives in sow nutrition and suggest options for feeding strategies for sows.

Gestation Feeding

Current recommendations for nutrient and energy intake during gestation are constant (NRC 1998). However, practical experience has shown that feed and nutrient intake must be increased during late gestation to maintain performance and sow longevity.

Genetic improvement in lean yield and reproductive parameters such as litter size require that the AA requirements for sows should be re-evaluated. Currently, NRC (1998) recommends a constant value for amino acid requirements during gestation (NRC 1998), which assumes an equal distribution of nutrient demand throughout gestation. However; the metabolic focus of the sow changes from the recovery of sow body tissue following weaning to the synthesis of fetal tissue in late gestation. Fetal weight, fetal protein content and mammary protein content increase 5-, 18- and 27-fold, respectively, in the last 45 d of gestation. These dramatic increases in fetal weight and protein gain indicate that the requirement for AA must be greater in late gestation compared to early gestation. Ignoring these dynamics by applying a single phase feeding program will lead to overfeeding during early gestation and underfeeding during late gestation. Overfeeding in early gestation results in a waste of feed and money, while underfeeding in late gestation leads to sows entering lactation in a severe catabolic state.

New data by our group, and others, support our proposed changes in amino acid requirements during gestation (Table 1). These changes in amino acid requirement have several important consequences. First, the magnitude of change in requirements makes it nearly impossible to satisfy the requirements using a single diet in gestation. Second, these data show that the threonine to lysine ratio changes as pregnancy progresses and as sows age. Third, lysine may not be the first-limiting amino acid for older sows. This last point deserves attention during diet formulation because the familiar order of limitation in growing finishing pigs may not apply to pregnant sows. We have recently shown that threonine was likely the first limiting amino acid in multiparous sows in late gestation, tryptophan second limiting, and lysine and branched-chain amino acids third limiting, based on indicator amino acid oxidation and rates of protein turnover (Levesque et al 2011, Advances in Pork Production). Therefore, diet formulation for pregnant sows must account for markedly different ideal amino acid ratios compared to growing pigs. We are currently conducting experiments to determine tryptophan and isoleucine requirements during pregnancy. We are also assessing lysine and threonine requirements during lactation.

Table 1. New requirements of gestating sows for total lysine and threonine and resulting threonine to lysine ratios.

		1st parity	**2nd parity**	**3rd parity**
Lysine	Early gestation	15.0	13.1	8.1
	Late gestation	18.0	18.4	13.0
Threonine	Early gestation	n/a	7.0	5.0
	Late gestation	n/a	13.6	12.3
Threonine: lysine ratio	Early gestation	n/a	53	62
	Late gestation	n/a	74	95

Nutrient Availability for Sows

The data on digestibility of dietary amino acids have been obtained almost exclusively from research with growing-finishing pigs. Although age or body weight has long been recognized as a factor influencing protein and energy digestibility there are few studies of nutrient digestibility in sows. We have recently shown that availability of threonine in corn is greater by 6% in sows compared to growing pigs (Levesque et al. 2011, Advances in Pork Production). Levesque et al. (2011b)* also reported greater threonine availability in barley for sows than for growing pigs. This indicates that before we can accurately re-formulate diets for sows to maximize the potential economic savings from the new data on amino acid requirements that we need more data on amino acid digestibility of ingredients in sow diets.

The digestibility of energy, protein, lipids and fiber is also greater in in sows compared to growing pigs, on average sows obtain 0.6 MJ/kg more energy from the same diets than growing pigs, and this difference increases with increasing dietary fiber content.

Conclusions

Our recent results for amino acid and energy requirements of sows strongly support the need for parity-segregated phase feeding of pregnant sows. The phase feeding program should consist of two diets that satisfy the higher and lower amino acid requirements. The feed amounts should be increased for the last four weeks of gestation. The increase in feed offered should be 0.6 kg/d for gilts, 0.5 kg/d for 2nd parity sows and approximately 0.4 kg/d for older sows. Such a feeding program supplies slightly less feed during gestation compared to single phase feeding but supplies amino acids and energy to the sows at the right amounts at the right time.

*A full text, references and additional information may be found in reviews and abstracts of the proceedings of the Banff Pork Seminar available on the website- www.banffpork.ca.

Manure Pit Foaming in Swine Barns

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Background

In late March of 2010 OMAFRA was contacted by a contract Swine Finisher who had foam issues. The foam had pushed the lids off of the pump outs and was running down the driveway.

As the US Midwest has been experiencing similar issues in the past while, Larry Jacobson, Engineer Professor, Bioproducts and Biosystems Engineering – St. Paul, University of Minnesota, was contacted. Minnesota is part of a group of swine extension personnel also including Iowa, Illinois and Nebraska that all have experienced foaming issues, primarily in deep pit swine finishing facilities. Tests done by Minnesota had shown that the foam itself is made up of 60% Methane by volume. Methane gas is 50% the weight of air and therefore rapidly rises into the barn space above the pit, several flash over fires and explosions have been reported when the foam has been disturbed by agitation or pressure washing.

With this in mind the producer had the pit emptied with a vacuum tanker system with no agitation being used. The barn was monitored with a LEL (Lower Explosive Limit) and Hydrogen Sulfide detector. With full ventilation the manure pit was emptied without incidence.

Other Incidents

There were no reported incidents of foaming pits until July when 2 more barns reported foaming issues. Both barns had foam coming up through the slats and into the animal space. In September of 2010 Ontario Pork and OMAFRA sent a notice to all swine producers to contact OMAFRA or Ontario Pork if there were or had experienced excessive foaming in their manure pits.

Producers that responded were visited by OMAFRA and Ontario Pork for observations and to obtain manure samples.

Obervations

The only commonality was that all the barns involved were swine finishing barns. Barn construction, ventilation system, genetics, pit depth, feed supplier, age of the barn were all different. Manure samples that were collected showed no indication of being radically different that other swine manure submitted to the OMAFRA manure database.

The foaming manure group in the US produced and distributed a survey to two farm groups and received 105 responses from producers experiencing foaming issues. Some production systems are experiencing some foaming problems in 25% of their barns with 10% of the barns experiencing 0.15m (6 inches) of foam or more. There was no clear link between diet, barn construction or barn management and foaming issues. Incidence of foaming appears to be less in Nebraska and Illinois than in Minnesota and Iowa. In measuring different gas levels between a non foaming barn and a foaming barn during pit agitation, Methane levels were 1800ppm (well below the explosive limit) in the non-foaming barn air space and at 80 000ppm (well into the explosive limit) in the foaming barn air space.

Next Steps

Though DDGS (Dried Distillers Grain Solubles) were initially suspected, some farms had foaming issues before their use in feed rations. In order to assist in determining their involvement, if any, the team will be following a research project to be conducted at College d'Alfred in eastern Ontario. Anna Crolla is studying the effects of using DDGS in a biodigester.

The US group planning to do DNA type lab work to identify specific methane producing bacteria that are known "foamers" in other anaerobic digestion processes.

Conclusions

While Ontario has some barns with foaming issues, at this time, they are limited in number. While no one or series of factors have been identified as the cause, the focus is on the methane producing bacteria.

If producers are experiencing foaming in their pits, they should be made aware that the levels of Methane that are present can overwhelm the ventilation system and cause explosions and/or flash fires. Both OMAFRA and Ontario Pork can provide technical support to any producers experiencing excess foam in their manure pits

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Lameness in Sows and Gilts

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Introduction:

Lameness is a welfare and economic concern in hog production. Lame sows are 1.7 times more likely to be removed from a herd compared to non-lame sows within 350 days of initial lameness assessment (Anil 2009). In 2007, American commercial herds participating in the PigCHAMP datashare program reported locomotor disorders including lameness and down sows as the reason for 14.5% of removals (Engblom 2009). Lame sows may also have poor reproductive performance including reduced number of pigs born alive compared to non-lame sows (Anil 2009). If lameness persists in a herd, it becomes a serious welfare issue. The prevalence and severity of lameness in gilts and sows has not been well documented. In the United Kingdom, the prevalence of abnormal gait in pregnant gilts and sows is 14.4% and 16.9% respectively (Kilbride 2009). To address this, our surveillance project records the prevalence and severity of sow lameness on Ontario hog farms. Currently we are in year two of the project and have expanded since year one to accommodate more herds.

Methods:

A scoring system was devised to score a sow or gilt's gait based on three categories: no lameness (0), mildly lame (1) and clearly lame (2). A mildly lame sow/gilt was defined as a sow/gilt that moved freely from one location to another but had an abnormal gait. A clearly lame sow/gilt was a sow/gilt that needed encouragement to move. The scoring system focuses on the gait of the sow/gilt and does not identify the cause of lameness, if observed in the animal. A lameness scoring video was created to provide a tutorial on using this 0, 1, 2 scoring system. Each enrolled farmer was given this video and briefed on the scoring system by TB (Tim Blackwell) or PC (Paisley Canning). The producers would score sows/gilts upon weaning and entering the farrowing rooms and record these values on a lameness scoring sheet, which was submitted by email, mail or fax each week.

Results:

Currently we receive weekly data from 15 hog operations in southwestern Ontario; this is an increase of 8 herds from year 1 of the project. Data has been collected on 9494 sows entering farrowing rooms and 7442 sows at weaning (Table 1). During the study period, 50 sows have died in the farrowing rooms for reasons unrelated to lameness. Participants indicated that they found the 0, 1, 2 system easy to apply. TB and PC visited farms to score sows/gilts with producers and found high inter-rater reliability between TB/PC and producers.

Table 1. Average prevalence of lameness in sow and gilts from 15 farms in Southwestern Ontario.

Score	Sows/Gilt entering the farrowing rooms		Sow/Gilt exiting the farrowing rooms	
	Average n=15 farms	Range	Average n=15 farms	Range
Score 1 (mildly lame)	2.16%	0% to 7.69%	2.81%	0% to 10.0%
Score 2 (clearly lame)	0.25%	0% to 1.52%	0.53%	0% to 1.79%

Discussion:

The prevalence of lameness reported in this study is below reported averages from the UK, Finland and Australia (Heinonen *et al*. 2006; Karlen *et al.* 2007; Kilbride 2009). Due to the small sample size used, our results may not be representative of all Ontario farms. As well, previous studies used stricter scoring systems involving foot lesion identification, limb palpation and assessments at walking, trotting and standing. This study does provide a strong framework for a producer-oriented scoring system and for a lameness data collection system that could be expanded to a larger sample size.

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30 Year Perspective of Swine Research

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After 30 years in pig research you might think that a scientist would have answered all the questions that they found interesting - but I haven't! There are many areas in swine nutrition where I think that there is potential for a breakthrough that could result in lower costs for producers and healthier, better pigs.

This presentation will discuss 6 areas where I would focus my future research - if I were 30 years younger! These areas include:

- Nutrient regulation of gene expression
- Immuno-nutrition
- Inter-organ regulation of nutrient partitioning and utilization
- 'True' nutrient availability and utilization
- Minimizing nutrient inefficiency
- Nutrition and the future environment

Assessing the Effectiveness of Euthanasia Methods for Suckling Piglets Using Signs of Sensibility and Behavioural Indicators

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Introduction

On-farm euthanasia is a topic that every producer has to consider. With both economic and welfare concerns at stake, it is essential to determine when euthanasia is necessary and how best to carry out the process. When done properly, euthanasia can free the animal from unnecessary suffering and allow for greaterwell-being within the group.

In terms of both welfare and economics, timely euthanasia offers several benefits. Low birth weight piglets (< .9 kg) are often recommended for euthanasia due to low pre-weaning and nursery survival rates (Smith et al., 2007). These higher mortality rates negatively impact the producer particularly in terms of lost feed costs and a reduction in market value of the surviving low quality piglets. Euthanasia of most piglets in this low birth weight category cuts feed and maintenance costs for the producer as well as improves the overall finishing market value of the entire herd (Fix et al., 2010). Selecting out compromised piglets improves the overall welfare scores of the herd and provides a greater chance of success for the remaining piglets (Morrow et al., 2006; Fix et al., 2010).

Acceptable Methods for Euthanasia

Three methods are accepted for euthanasia of suckling piglets. The most common method remains blunt force trauma (BFT) for piglets up to 12 lbs; however, anaesthetic overdoseand carbon dioxide (CO_2) gas inhalation are considered acceptable alternatives (Ontario Pork, 2008).

While blunt force trauma remains the most common technique practiced, there has been recent controversy over the aesthetics of this method. As a physical means of euthanasia, the cranium of the piglet is struck by either a heavy instrument or a hard flat surface with enough power to cause concussion and irreversible brain damage (Chevillon et al., 2004; Widowski et al., 2008). Widowski et al. (2008) confirmed that blunt force trauma reliably rendered piglets immediately insensible without return to consciousness. Although aesthetically objectionable, BFT is humane. A possible alternative to blunt force trauma is a non-penetrating captive bolt (NPCB). Recent research showed the NPCB effectively causes immediate insensibility in neonatal piglets (Widowski et al., 2008) and, following a modification of the bolt head to a more conical shape, consistently inflicted irreversible brain damage leading to a timely death, averaging 3 minutes and 45 seconds (Casey-Trott et al., 2010). Using a conical bolt head with a depth of depression of at least 9 mm is recommended (Widowskiunpublished data).NPCB is currently recognized by the National Pork Board as an acceptable means of euthanasia for piglets less than 5.5 kg, and research is underway assessing the effectiveness of NPCB on piglets up to 9 kg (NPB, 2009; Casey-Trott in progress).

Carbon dioxide gas inhalation is another methodeuthanasia accepted for neonatal piglets. Euthanasia by CO_2 requires exposure to $\geq 90\%$ CO_2 for at least five minutes in either a pre-charged or gradual fill system (NPB, 2009). Although CO_2 is effective for causing death, this method is controversial; loss of consciousness is not immediate (Chevillon et al., 2004), and vocalizations, signs of breathlessness and active avoidance are observed during the inhalation phase (Raj and Gregory, 1996). It has been suggested that the pre-charged system is more humane for piglets than the gradual fill; however, both methods have reported asphyxiation, escape attempts, and consciousness for piglets up to 6 weeks of age (Bryer et al., 2010). The dramatic rise in cortisol following euthanasia by CO_2 inhalation (Bryer et al., 2010) suggests the process is stressful to the piglet and perhaps the acceptability of this method should be reconsidered.

With any euthanasia it is essential to choose a method that causes the animal minimal pain and distress and ensures the safety of the personnel completing the task. A proper protocol should be designed and discussed with all employees responsible for care and euthanasia of any piglets (AVMA, 2007). Key features should be identified that designate specific piglets for euthanasia followed by a clear outline of subsequent steps required to carry out the process. The producer should also ensure that all responsible personnel are both physically and emotionally capable of completing the task and are comfortable with the chosen method.

Assessing signs of sensibility

A simple way to ensure that euthanasia is effective and humane is to observe the procedure until it is complete. It is essential to check signs of sensibility immediately followingeach technique to guarantee the animal does not perceive any pain and is progressing towards a timely death. Observing brainstem and spinal (nociceptive) reflexes provides insight into whether the animal is sensible or experiencing any pain (Erasmus et al., 2010). Some of the key brainstem reflexes include the corneal, palpebral, and pupillary light reflexes. The animal is considered insensible when they do not exhibit a blink response when either the eyelid or cornea is touched, and when the pupil remains fixed and dilated in the presence of light (Gregory, 2008). If any natural blinking is noted, the animal is considered sensible (Grandin, 2010),and the technique must be reapplied or an alternative method must be immediately completed. Spinal reflexes should also be used to assess insensibility.Examples ofspinal reflexes are the pedal reflex, response to nose prick, or anal reflex (Kaiser et al., 2006). The absence of a withdrawal response to the above painful stimuli indicates the animal no longer senses pain.

Behavioural indicators also aid in insensibility assessment. Behavioural observations are particularly useful when direct contact with the piglet is not possible (CO_2gas inhalation). Absence of rhythmic breathing, absence of vocalizations, and loss of muscle tone indicate an effective euthanasia (Gregory, 2008). Ideally, behavioural indicatorsshould be considered in conjunction with direct observation of the reflexive signs of sensibility previously mentioned. Return of rhythmic breathing has been recorded as one of the first signs of returning consciousness (Anil, 1991). Vocalizations are a sign of pain or distress and should not be present at any time during the euthanasia process (Warris et al., 1994). Loss of muscle tone is associated with loss of consciousness and a limp jaw or tongue is a reliable indicator of insensibility in pigs (Grandin, 2010).

Conclusion

When any euthanasia is properly carried out, the handler should, at a minimum, observe the following signs to ensure that the euthanasia was effective: absence of a corneal and palpebral reflex, a fixed and dilated pupil nonresponsive to light, no withdrawal reflex to a painful stimulus, and the absence of any rhythmic breathing, vocalization, and muscle tone. With physical methods of euthanasia (blunt force trauma and non-penetrating captive bolt) the onset of clonic muscle spasms, characterized by kicking or paddling movements, and tonic muscle spasms, characterized by rigid extension of the limbs, can be expected. Both convulsive episodes are considered involuntary muscle spasms and should not be confused with voluntary movements or deliberate escape attempts (Grandin, 2010).

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Towards NRC 2012 - Nutrient Requirements of Pigs

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The publication 'Nutrient Requirements of Swine' from the National Research Council (NRC) and National Academies of Science in the USA can be considered a benchmark publication that provides unbiased information on energy, amino acid, mineral, vitamin, fatty acid and water requirements of pigs at various stages of production. In addition, it is a source of information on the nutritional value of feed ingredients and feed additives. It was first published in 1944. Of the last and 10th revised edition that was published in 1998 6,897 copies have been distributed around the world.

In 2009 a committee of 9 scientists from the USA and 1 from Canada was established to produce the 11th revised edition.

Information that will be included in the new publication is confidential until its release, which is expected in the fall of 2011. However, background information and key aspects of the publication are described in the 'identification of needs' and 'statement of tasks' that are posted on the website from the National Academies of Science.

Key aspects of the new publication will be:

1. An updated listing of energy and nutrient requirements. All life phases and types of production will be addressed. New recommendations, especially for amino acids, will be made with appropriate consideration of the increased productivity of modern genotypes of swine.
2. New knowledge about energy utilization by swine, including net energy systems and values, will be added.
3. Information about feed ingredients from the biofuels industry and other new ingredients (e.g., novel soybean products) will be included.
4. Requirements for digestible phosphorus and concentrations of digestible phosphorus in feed ingredients will be added.
5. A review of the effects of feed additives routinely used in swine diets (e.g., antibiotic growth promoters, enzymes, acidifiers, and beta-agonists) will be included.
6. Effects of feed processing (e.g., pelleting, extrusion, and reduced particle size) on the utilization of feed by different categories of swine will be addressed.
7. Strategies to increase nutrient retention and thus reduce fecal and urinary excretions that could contribute to environmental pollution will be reviewed.
8. The computer model that was included in the NRC 1998 publication to calculate nutrient requirements of different categories of pigs will be updated.
9. Tables of feed composition will be expanded with relevant new information.
10. Future areas of needed research will be identified.

For further information visit the website from the National Academies of Science: www.nationalacademies.org/ (search for 'nutrient requirements of swine').

Field Edge Tire Inflation Adjustment System

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Soil compaction risk is increased by both high axle loads and high tire inflation pressure. Large radial tires on high axle load equipment such as manure tankers generally represent an opportunity to carry large loads at relatively low inflation pressures. One of the key limitations to minimizing inflation pressure is high road travel speeds during some part of the manure spreading operation. The suitable inflation pressure for traveling 30 KM/hour down the road will be much higher than the pressure allowed while spreading in the field at 8 KM/hour. Systems for automatically adjusting manure tanker tire inflation are used regularly in Europe in order to minimize the soil compaction risk by deflating tires as they enter the field.

This project set out to acquire an inflation pressure system, equip a manure tanker, conduct testing of the system itself and evaluate soil compaction and crop growth response to various wheel traffic scenarios. In 2010 the tanker was completed (Figure 1) and testing will be ongoing over the next two years.

Figure 1. The project tanker complete with compressor, airlines and control system.

This project was funded in part through Growing Forward, a federal-provincial-territorial initiative. The Agricultural Adaptation Council assists in the delivery of several Growing Forward programs in Ontario.

Canada | Agricultural Adaptation Council | Ontario | Growing Forward

Clostridial Infections in Pigs

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Introduction

Mortality and morbidity among newborn piglets due to enteric disease caused by *Clostridium perfringens* types A, and *Clostridium difficile* is a substantial problem in the swine industry. *C. perfringens* can be found in the intestinal tract of healthy animals but can multiply to a large number in a few hours and cause an enteric disease by producing exotoxins. *C. perfringens* Type A can produce neonatal enteritis associated with creamy or pasty diarrhea. The presence of the Cpb2 toxin is associated with type A infections (Songer and Uzal, 2005). *C. difficile* can cause infections among neonatal pigs at 1-7 days of age. It can produce toxin A (an enterotoxin) and toxin B (a cytotoxin) causing diarrhea. Diagnosis of *C. perfringens* infection in piglets is based on the histopathology and culture to demonstrate the presence of the organisms. However, it is necessary to exclude presence of other pathogens including enterotoxic *E. coli*, *Salmonella*, rotavirus, transmissible gastroenteritis virus (TGE), and *Isospora suis* (Straw et al., 2006). The objective of this project was to investigate the association between Type A Cpb2-producing *C. perfringens* and diarrhea in neonatal piglets.

Materials and methods

Eight farms with a history of diarrhea associated with *C. perfringens* infection were identified. On each farm, 3-5 neonatal diarrheic piglets and one healthy piglet were submitted to Animal Health Laboratory at University of Guelph. Live animals were euthanized, necropsied, and intestinal samples were collected for histology and microbiologic testing. Samples were tested for presence of *C. perfringens* , *C. difficile* toxin, *Salmonella*, enterotoxigenic *E. coli*, rotavirus, transmissible gastroenteritis virus (TGE), and coccidia. A sample of the intestinal contents was stored at – 70°C to be tested for the presence of *C. perfringens* alpha and Cpb2 toxins by ELISA.

Results

To date, 38 piglets including 28 diarrheic (cases) and 10 healthy (controls) from eight farms with history of *C. perfringens*-associated neonatal diarrhea have been tested. The results are shown in Table 1. The presence of *C. perfringens* in the small and large intestine of diarrheic and healthy pig did not differ ($P > 0.05$). There was no correlation between the presence of *C. perfringens* and histological changes observed in these piglets. *C. difficile* toxins were detected in the intestinal contents of 5 of 16 (31.3%) diarrheic piglets. No significant correlation was observed between presence of *C. difficile* toxins and lesions in the intestine. Eight diarrheic piglets were tested for rotavirus on the basis of histological findings, of which four (50%) piglets were positive. Rotavirus group C and *Salmonella* were present coincidently in one diarrheic piglet. Indeed, *Salmonella* was recovered from only one scouring piglet and it was serotyped as *S.* Orion Var.15+34+. Enterotoxigenic *E. coli* was recovered only from one scouring piglets with a very low number of *C. perfringens*. Coccidia were not identified in histologic sections or feces of any piglets.

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Table 1: Microbial and histopathological findings among healthy and scouring piglets.

	Number of tested piglets/total (%)		
	Healthy	Scouring	Total
C. perfringens	8/8 (100)	13/15 (86.7)	21/23 (91.3)
C. difficile toxin	0/1 (0.0)	5/16 (31.3)	5/17 (29.4)
Salmonella	0/9 (0.0)	1/17 (5.9)	1/26 (3.9)
ETEC	0/9 (0.0)	1/17 (5.9)	1/26 (3.9)
Rotavirus	0/2 (0.0)	4/8 (50.0)	4/10 (40.0)
Coccidia	0/0 (0.0)	0/0 (0.0)	0/0 (0.0)

Discussion

Large numbers of *C. perfringens* were detected in intestinal contents of both scouring and healthy piglets in this study. The intestinal contents need to be tested for *C. perfringens* toxins (both Cpb2 and possibly alpha toxins) in order to identify a possible role for *C. perfringens* in neonatal diarrhea in piglets. *C. difficile* toxins were detected in 30% of scouring piglets suggesting that *C. difficile* may play an important role in neonatal diarrhea piglets that requires more investigation. These findings indicate the complexity of diagnosis of type A *C. perfringens* and confirm the need for more definitive diagnostic criteria. Also the histopathological examinations need to be interpreted in combination of microbial testing in particular with detection of *C. perfringens* toxins (Cpb2 and alpha toxin), since there are no definitive histopathological changes for type A *C. perfringens* diarrhea.

Acknowledgements

We would like to acknowledge the OMAFRA- University of Guelph Research Program, and the OMAFRA Animal Health Strategic Initiative for funding this project. We thank the pork producers for their participation.

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Ontario Pork Research

Jean Howden, Ontario Pork

In 2010, as in previous years, Ontario Pork's research expenditures have focused on production. Included below is a brief synopsis of projects that received funding from Ontario Pork in 2010.

Moving forward in 2011, the plan is to continue development of a more balanced approach to research that will correspond with the strategic direction of Ontario Pork while maximizing value for producer dollars. Research funding will include new areas such as product and marketing development. Work is also continuing to improve research efforts with other provincial organizations and nationally.

Research is an industry cornerstone that requires continual development and refinement to create growth and improvement. Research funded in 2010 and prior has established a foundation that will be built upon.

2010 Research Recommendations

Project No. 10/001 **Researcher:** Tina Widowski
Title: A comparison of three animal welfare assessment programs on Canadian swine farms
Synopsis: Swine Farms from across Canada will be visited and Researcher:s will evaluate these farms using three different assessment programs. Results will be used to rank farms within and between programs. Animal welfare may be included as part of the discussion in developing trade agreements in the near future. Canadian producers need to be aware of different standards and to be able to translate these differences into on-farm situations.

Project No. 10/003 **Researcher:** Ron Ball
Title: Reducing feed cost per unit of pork produced
Synopsis: Amino acid (AA) requirement determined using indicator AA oxidation. Concurrent indirect calorimetry for energy requirement and dietary net energy (NE). Inclusion of gestation and lactation performance data in model for individual sow AA and NE requirement.

Project No. 10/012 **Researcher:** Brandon Lillie
Title: Genome-wide identification of genetic defects in innate disease resistance genes of swine
Synopsis: Using newly available genome wide microarray technology, we will identify disease resistance genes with widely variable hepatic expression. We will then identify genetic polymorphisms responsible for the variation and examine their effects on disease resistance and production traits.

Project No. 10/015 **Researcher:** Chandra Tayade
Title: Promotion of litter size in commercial swine using an immune-stimulant
Synopsis: The current application proposes evaluation of a formulation of the successful compound developed as a prototype, low cost immune adjuvant from the platform technology of the successful human biologic. This low cost immune adjuvant is specifically developed for use in livestock. Aim 1 of this proposal will compare systemic injection versus intra-uterine infusion of Mycobacterial cell wall composition® (Bioniche Life Sciences, Inc.) in gilts and sows administered at the time of insemination on pregnancy outcomes. Longer term effects of this compound will also be analyzed by infusion of gilts at first estrus followed by insemination at second estrus. The information derived from this aim will be useful to determine the optimal treatment protocol for this drug. Aim 2 will address overall postnatal health in piglets born to treated dams. Responses to standard vaccines as

well as rates of weight gain to market age and reproductive parameters will be assessed. Aim 3 will specifically look at the effects of this drug on the quality of semen used for insemination in our study. In this aim, a dose of Mycobacterial cell wall composition® in 15 ml physiological saline will be mixed in vitro with 80 ml volume of frozen semen. This will determine if it is safe to administer both, the drug and semen at one time. Results from this application should permit commercial advancement towards therapeutic promotion of litter size in commercial swine.

Project No. 10/017 **Researcher:** Robert Friendship
Title: Controlling gilt reproduction to ensure efficient use of physical resources and sow longevity
Synopsis: Gilts will be assigned to 1 of 2 groups. The first group will be induced to cycle using boar exposure. The second group will use hormone manipulation (PG600 and Regumate) in an attempt to create a more synchronized group. After first farrowing P1 sows will be weaned and assigned to 1 of 2 treatment groups-group 1 relying on boar exposure to stimulate heat and group 2 receiving hormones to induce estrus and ovulation. Sow performance in the first 4 parities will be measured.

Project No. 10/020 **Researcher:** C.F.M. de Lange
Title: Towards management of entire male pigs for commercial pork production.
Synopsis: A combination of serial slaughter and nutrient balance studies will be used to establish the dynamics of nutrient utilization in early and late castrated males, entire males, and immunocastrated male pigs. These nutritional observations will be combined with monitoring of metabolic parameters such as growth-controlling hormones and indicators of boar taint. Based on observed nutrient retention rates, feeding recommendations will be generated for entire males and immunocastrated entire males.

Project No. 10/021 **Researcher:** Glenn Fox
Title: Environmental Compliance Costs and the Competitiveness of Ontario Hog Industry
Synopsis: This project will assess the effect of environmental policies on profitability of hog farms and the implications of differences in stringency of environmental standards across jurisdictions for industry competitiveness.

Project No. 10/025 **Researcher:** Lori Moser
Title: Regional PRRS Elimination Trial
Synopsis: The goal of this project is to implement regional PRRS elimination pilot projects in Ontario. These projects will advance the Ontario pork industry in disease control and biosecurity, assess the applicability of PRRS elimination approaches executed in the U.S. to date and add to those elimination strategies for our region. As the U.S. considers PRRS eradication at the state level, further development of PRRS elimination methodologies in Ontario that expand beyond the herd level are essential to maintain competitiveness with trading partners and to avoid any possible future disease related trading barriers.

Project No. 10/026 **Researcher:** Andrew Thompson
Title: Development of loin bacon
Synopsis: A pilot project for Ontario Pork to assess the logistics of funding research into product development. The project with a further processor is assisting to bring an innovative pork product to market.

Project No. 10/18 **Researcher:** Suzanne Burlatschenko
Title: To establish a protocol for the successful eradication of Coronavirus by segregatied early weaning
Synopsis: This proposed project involves early weaning and segregation of piglets from a farm endemically infected with Porcine Respiratory Coronavirus (PRVC). Piglets will be weaned from sows and moved to an off-site nursery. The nursery will be cleaned and disinfected prior to piglet entry, and once piglets have entered, will be closed to further entry of animals.

Ontario Industry Update – Production, Processing and Trade

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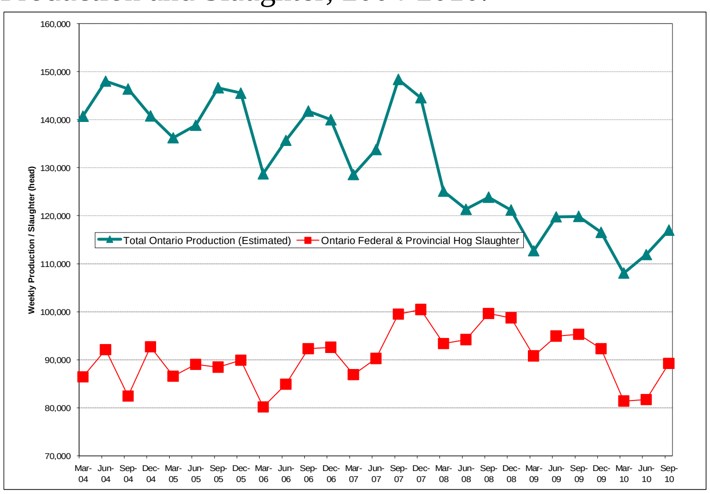
Introduction

This paper is intended to provide a brief update on selected figures relating to Ontario production, processing and trade data. Figure 1 provides a comparison of estimated weekly total pig production and total federal and provincial slaughter for 2004 to 2010 by quarter. Figures are not complete for the fourth quarter of 2010, but so far weekly pig production averaged 117,000 head while slaughter averaged 88,000 head. Of the 117,000 head produced, 96,000 head were processed in Canada (Ontario and Quebec), while 15,000 head were exported to the U.S. as feeder pigs and 6,000 head were exported to the U.S. as market hogs. There still exists a gap between Ontario production and processing but this spread has narrowed over time.

Figure 1. Ontario Estimated Weekly Total Pig Production and Slaughter, 2004-2010.



Source: AAFC; USDA. Notes: Pig production = Ontario hogs processed in Canada plus live pig exports to the U.S. through Ontario border crossing points.

Table 1 shows the estimated distribution of Ontario's total pig production in more detail for 2006 to 2010. Total annual production has decreased from 7.25 million head in 2006 to approximately 6.06 million head in 2010 with weekly production decreasing from 139,000 head to 116,000 head. The volume of production that has been exported live to the U.S. had steadily decreased from 2006 to 2009 but increased slightly in 2010 to 22%. Live exports to other provinces in 2010 were estimated at 4% of total production. Production exported in the form of pork accounted for approximately 47% with exports to the U.S. representing 31%. If live and pork exports are combined, the U.S. market was the destination for approximately 53% of Ontario's total production in 2010.

Table 1. Ontario Production Distribution, 2006-2010.

	2006	2007	2008	2009	2010*	Average
Estimated Annual Production (million head)	7.25	7.31	7.06	6.48	6.06	6.83
Estimated Weekly Production (‘000 head)	139	141	136	125	116	131
Live exports to U.S.	30%	28%	24%	19%	22%	25%
Live exports to other provinces	8%	6%	3%	4%	4%	5%
Pork exports to U.S.	21%	22%	23%	28%	31%	25%
Pork exports to ROW	13%	13%	16%	16%	16%	15%
Domestic Consumption	29%	31%	33%	32%	26%	30%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Source: AAFC, USDA. Notes: Figures have been rounded. *Estimated based on January-October data. Production = Ontario hogs processed in Canada plus live pig exports to the U.S. through Ontario border crossing points.

Table 2 provides data for estimated gross margins in $C per kg of dressed pork for Canadian and U.S. pork processors for 2006 to 2010. Gross margin is calculated as the pork wholesale value less the hog value and does not include all costs. It is a relative indicator of profitability and indicates the margin left to cover all other non-hog procurement costs. Table 2 shows that gross margins were quite comparable in Canada and the U.S from 2006 to 2009 with U.S. processors showing a higher gross margin in 2010.

Table 2. Estimated Canadian and U.S. Processor Gross Margins ($C/kg), 2006-2010.

	2006	2007	2008	2009	2010	Average
Canadian Pork Wholesale Value	1.68	1.60	1.64	1.47	1.79	1.63
Canadian Hog Value	1.47	1.41	1.41	1.30	1.58	1.43
Canadian Gross Margin	**0.20**	**0.20**	**0.22**	**0.17**	**0.21**	**0.20**
U.S. Pork Wholesale Value	1.80	1.72	1.76	1.60	1.99	1.77
U.S. Hog Value	1.61	1.53	1.53	1.43	1.71	1.56
U.S. Gross Margin	**0.19**	**0.20**	**0.23**	**0.17**	**0.27**	**0.21**

Source: University of Guelph, Ridgetown Campus calculations using data from USDA, Ronald A. Chisholm Ltd., Ontario Pork Marketing Services, and various other industry sources. Figures have been rounded. Note: Gross Margin = Pork Wholesale Value less Hog Value.

Table 3 displays Ontario pork exports to all countries and Ontario pork imports from all countries in $C million from 2006 to 2010. 2010 data is for the period January to October. The trend in exports has seen a nice rebound in 2008 ($620 million) and 2009 ($595 million) with 2010 on pace for higher value than any of the previous four years. Over the 2006 to 2010 period, the U.S. has accounted for 70% of the value of all pork exports. The trend in imports has seen the value steadily increasing each year from $394 million in 2006 to $497 million in 2009. Over the 2006 to 2010 period, the U.S. has accounted for 97% of the value of all pork imports. It is important to note that Ontario is a major entry point for imports of pork into Canada and it is likely that much of this product is distributed to other provinces.

Table 3. Ontario Pork Exports and Imports ($C million), 2006-2010.

	2006	2007	2008	2009	2010*	Average
Exports to all countries	540	527	620	595	566	570
Exports to U.S.	393	375	405	413	416	400
Imports from all countries	394	415	472	497	448	445
Imports from U.S.	380	405	459	484	440	434
Net Trade with all countries	146	112	148	99	118	125
Net Trade with U.S.	13	-30	-54	-71	-24	-33
Live Swine Exports to U.S.	190	175	128	89	78	132
Net Trade with U.S. (pork + live swine)	203	145	74	18	54	99

Source: AAFC. Notes: Figures have been rounded. *based on January-October data.

Ontario's net pork trade position (i.e. total exports value less total imports value) is positive and has averaged $125 million during the five year period. However, the net pork trade position with the U.S. turned negative in 2007 (-$30 million) and has remained negative every year since. It should be noted that although the $ value of the net trade position with the U.S. is negative, in terms of trade volume (i.e. tonnes), Ontario enjoys a positive net pork trade position with the U.S. (i.e. +33,056 tonnes in 2009). Accordingly, the net trade position volume with all countries in 2009 was 123,219 tonnes.

Live swine exports to the U.S. have averaged $132 million during the five year period. When the value of live swine exports to the U.S. are factored in, Ontario has a positive net pork and live swine trade position with the U.S.. The average net pork and live swine trade with the U.S. has averaged $99 million from 2006 to 2010.

Benchmarking Study Update

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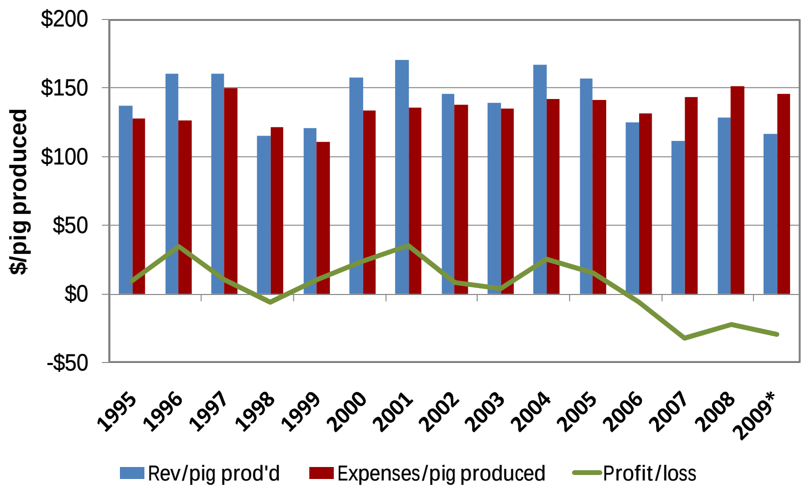
Background

University of Guelph, Ridgetown Campus has been conducting a farrow to finish benchmarking study called the Ontario Data Analysis Project (ODAP) for 20 years. Participants provide production and financial data and in return receive a personalized farm analysis that compares their farm business to the group average and top half of producers. It is believed that the results are fairly typical of a farm that has about 100 to 500 sows.

ODAP results are on a "pig produced" basis and this reflects the number of market hog equivalents produced on the farm taking into account all production and inventory changes. In 2008 the average ODAP participant had 207 sows and produced 4,145 pigs. In the swine enterprise, total revenue was $128.46/pig produced, not including government payments, and expenses were $151.14 resulting in a loss of $22.68/pig produced. Expenses related to family labour were not included. Figure 1 provides a historical depiction of average revenue, expenses and profit over time for ODAP and highlights the variability at the farm level.

Figure 1. Historical ODAP Profit per Pig Produced ($).



* 2009 data is preliminary.

Online Benchmarking Tool

A spreadsheet program based on the ODAP data is being developed to enable interested individuals to input their own farm information and compare it to the group results. A draft version of this program is available at http://www.ridgetownc.uoguelph.ca/research/documents/mcewan_ODAP_Benchmark_Template.xls. An example of the data entry page based on the 2008 template is shown in Figure 2. Individuals are required to enter information regarding animal inventory levels as well as financial data in the shaded areas. Graphs are created from the data entered into the program.

Figure 2. Farrow to Finish Comparison for 2008 Business Year – Online Tool.

	Inventories Beginning	Inventories Ending	Pigs Sold	Pigs Purchased
Nursing Pigs	0	0	0	
Weaner Pigs	0	0	0	0
Grow/Finish Pigs	0	0	0	0
Gilts	0	0	0	0
Sows	0	0	0	0
Boars	0	0	0	0
Pigs produced on your farm	0	ODAP: 4,145 pigs produced		
Average # of sows	0	ODAP: average 207 sows		
Pigs produced/sow	#DIV/0!	ODAP: 20 pigs produced/sow		
# of family members working in the swine enterprise in full-time equivalent (FTE)	0.00	full-time equivalent (FTE)		

Farm Revenue/Income	Total for Your Farm	% attributed to Swine Enterprise	Your Farm $/pig produced	ODAP Group Average $/pig produced
Sales from swine	$0	100%	#DIV/0!	$127.02
Purchases of swine	$0	100%	#DIV/0!	$2.15
Change in value of market pig inventory	$0	100%	#DIV/0!	$3.48
Change in value of breeding stock inventory	$0	100%	#DIV/0!	-$0.85
Change in accounts receivable	$0	100%	#DIV/0!	$0.95
Total Revenue	$0		#DIV/0!	$128.45

Farm Expenses	Total Farm Costs	% attributed to Swine Enterprise	Your Farm $/pig produced	ODAP Group Average $/pig produced
Feed	$0	100%	#DIV/0!	$105.19
Depreciation	$0	100%	#DIV/0!	$17.63
Interest	$0	100%	#DIV/0!	$6.84
Barn & Equipment	$0	100%	#DIV/0!	$7.14
Hired Labour	$0	100%	#DIV/0!	$1.04
Health	$0	100%	#DIV/0!	$4.32
Other	$0	100%	#DIV/0!	$8.98
Total Expenses	$0		#DIV/0!	$151.14
Net Farm Income	$0		#DIV/0!	-$22.68

A second version is being tested that will incorporate results from the 2009 data. This version will provide more detailed information regarding expense allocations. It will provide results of the group average and also the average of the top half of the producers for comparison. Individual producers will be able to use this program in their decision making and to improve their own competitive position. The benchmarking tool incorporating 2009 data will be released early in 2011.

Individuals who wish to participate in the ODAP project and receive a personalized farm analysis can contact Ken McEwan for more information.

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

This project was funded in part through *Growing Forward*, a federal-provincial-territorial initiative. The Agricultural Adaptation Council assists in the delivery of several *Growing Forward* programs in Ontario.

Neonatal Immune Response Modulation by Probiotic *Lactococcus lactis*

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Introduction, Background and Rationale

Newborn and neonatal mammals acquire intestinal bacterial flora the nature of which is relatively beneficial or harmful depending on environmental variables controlling composition such as indoor vs outdoor housing or use of antibiotics. The most favourable bacterial populations in which potential pathogens are in low frequency relative to beneficial species, are associated with outdoor, antibiotic-free husbandry conditions most like those in which the pig has evolved and to which it is adapted as a species (Mulder et al.2010). It is increasingly recognized that in modern environments human and animal immune response (IR) is frequently dysregulated most probably due to lack of developmental signals usually derived from components of the normal intestinal bacteria. Typically such environments are associated with high prevalence of immune-mediated diseases including allergy and autoimmunity which are at low prevalence in more natural, "unhygienic" environments (Garn and Renz, 2007). Bacteria commonly isolated from low risk locations such as barns, include *Lactococcus lactis* (LL) which when fed to mice modulates IR, reduces risk of allergy (Debarry et al. 2007) and induces innate and adaptive IR-mediated protection against infectious disease (Ramirez et al. 2010). Immune response function is significantly better in pigs having normal intestinal microflora (Mulder et al. 2010). Using experimentally induced allergy to the major egg allergen ovomucoid (Ovm) as a quantifiable measure of IR phenotype we have reported significant beneficial effects of feeding probiotic LL to newborn and neonatal pigs (Rupa et al. 2010).

Hypothesis and Experimental Design

It was hypothesized that LL given orally at 10^9 live bacteria per dose on days of age 1-7, 10, 12, 14, 21 and 28 would favorably alter IR as indicated by reduced allergic sensitization to egg white given orally on day 46 after intraperitoneal sensitizing injections of Ovm with cholera toxin on days 14, 21 and 35. Outcome criteria were standardized clinical scores of allergic signs, skin test (ST) reactivity to Ovm (day 45) and serum antibody to Ovm (day 14 and 45) associated with IgE and IgG_1 (type 2 IR) relative to IgG_2 (type 1 IR). Type 2 cytokines, IL-4 and IL-10 expressed by mitogen (PHA-P)-stimulated blood mononuclear cells were quantified on day 45. Allergy is mediated by a dysregulated type 2 IR hence it was anticipated that LL treated pigs (3 litters, n = 30) vs controls (C, 3 litters, n = 32) would have reduced clinical signs and ST positivity, lower ratios of type 2/ to type 1 antibodies as well as reduced type 2 cytokines.

Results

The LL-treated and C pigs were 3% and 40% positive for clinical signs and 50% vs 93.75% expressed ST positivity ($p \leq 0.05$; Fisher's exact test). Antibody associated with all Ig isotypes was increased on day 45 vs 14 (pre vs postsensitization; $p \leq 0.0001$; unpaired Student's t test). In the LL vs C pigs anti-Ovm antibodies were in lower ratios of IgG_1/ IgG_2 ($p \leq 0.0004$) and IgE/ IgG_2 ($p \leq 0.0245$) indicating an LL treatment-related type 1 IR bias as hypothesized. Type 2 IR-related cytokines IL-4 and IL-10 were significantly less from mitogen-stimulated blood mononuclear cells of LL [IL-4, 8.15±2.21 (pg/ml, mean ± 95% confidence interval); IL-10, 6.58±0.06] than of C (IL-4, 27.98±43.37; IL-10, 35.21±23.69) ($p \leq 0.05$).

Conclusions and Implications

Results indicate that LL treatment of newborn and neonatal pigs significantly steers IR to type 1 hence inducing a more favourably balanced type 1/type 2 ratio. The type 2 IR mediated indicator, food allergy to Ovm, was very significantly reduced by LL treatment. This is taken to indicate that LL as a probiotic can be remedial in correcting immunoregulatory deficits associated with unfavourable intestinal microbiota reported to predominate in currently practiced pig husbandry (Mulder et al. 2010).

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Periweaning Failure to Thrive Syndrome (PFTS): Experiences from Saskatchewan

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The first reported case of Periweaning Failure to Thrive Syndrome (PFTS) in Canada was in a 100 sow farrow-finish barn experiencing illness in nursery piglets shortly after weaning resulting in increased nursery mortality from baseline (about 2%) to about 7%. The farm is well managed with excellent stockmanship skills, and of high health status in a reasonably isolated location. Replacement gilts and boars were purchased from a single genetic company until 2010, although the source farm was changed in 2006. The genetic company supplying the gilts and boars was changed in 2010 and the barn has continued to experience PFTS in both genetic lines. Feed is manufactured on farm using mostly grains grown on the farming operation. Premixes are purchased commercially. Routine vaccinations are given including a one-dose piglet PCV2 vaccine. Early in the outbreak, PCV2 vaccination was administered at processing, but this was changed in 2008 to be administration at weaning based on the lack of effect in preventing nursery cachexia. The timing of PCV2 vaccination has not subsequently changed.

Piglets are robust and appear healthy at weaning. Within 1-2 weeks of weaning, affected pigs demonstrate lethargy, anorexia and become thin and hairy. Within 3-4 weeks of weaning these pigs are emaciated, and most are euthanized. Many have diarrhea for a short period of time, but this was not a consistent finding. The affected pigs are not runts in that skeletal growth indicates they are normal-sized pigs before becoming anorexic. The loss in condition does not appear to be associated with an inability to swallow. Video footage demonstrates that pigs are able to pick up feed pellets, chew and swallow, albeit very slowly, suggesting suppressed appetite rather than a physical inability to eat. Regurgitation has not been observed. The most peculiar clinical sign, which appears to be unique to PFTS-affected farms, is a repetitive, obsessive oral behaviour (chewing, licking, chomping) along with excessive investigatory behaviour (nosing, rubbing) when affected pigs are placed in new surroundings. This behaviour is observed in a small proportion of affected pigs but is remarkable when noted because it is so intense and focused, and appears to be a subconscious activity. Compared to healthy control pigs in the same environment, the affected pigs appear unaware of their surroundings, and do not respond to soft or loud noises in their immediate vicinity.

Dr. Steve Henry proposes there are 4 stages to PFTS which can be used to discern humane endpoints: "Active", "Oral/chomping behavior", "Standing" and "Terminal". Following the oral behaviour period, affected animals stand with drooped head and demonstrate minimal if any progressive movement in any direction. They appear markedly depressed, lethargic and have demonstrated progressive loss of body condition by this stage. We agree with Dr. Henry that this stage is past the point of return, and an appropriate time for humane euthanasia if not already performed.

Many management and medical interventions involving the Saskatchewan farm's diets, ventilation, sanitation, and medication and vaccination programs have been attempted, but most interventions have been ineffective. The only exception to this is the use of hydrated lime as a dessicating agent in empty farrowing and nursery rooms in the Sasaktchewan farm. Field observation suggests it is at least partially effective in preventing PFTS mortality for a period of time following dessication. Given the occupational health and safety issues pertaining to the use of hydrated lime, and the perceived need to aerosolize the product, the authors do not advocate its widespread use in the industry. However, its apparent success on this farm helps to support that PFTS may have an infective etiology.

The cause of PFTS is unknown. We have undertaken an extensive diagnostic examination of PFTS-affected and age-matched unaffected pigs from other Saskatchewan farms in order to identify all of the common known pathogens and characterize the pathology associated with PFTS. A total of 33 pigs were examined including 18 PFTS-affected (PFTS-sick) and 7 age-matched healthy cohorts (PFTS-healthy) from the affected farm, and 4 healthy age-matched pigs from each of two non-affected farms (Ctrl). All pigs were humanely euthanized and necropsy examinations performed immediately. Fresh and fixed tissues were collected and processed routinely. It is our conclusion based on this work that PFTS, at least in this farm, is not caused by or is not a classical presentation of several common porcine pathogens including: PRRS, PCV2, SIV, TGEV, rotavirus, haemaggluntinating encephalomyelitis virus (HEV) and porcine cytomegalovirus (PCMV), *Clostridium perfringens,* pathogenic *E. coli, Brachyspira hyodysenteriae and pilosicoli., Bordetella spp., Streptococcus spp., Haemophilus parasuis, Pasteurella multocida* and coccidiosis The potential roles of enteric Calicivirus as well as uncommon or novel swine pathogens need further investigation.

On necropsy, the most prominent lesions observed in Saskatchewan PFTS-affected pigs included: superficial lymphocytic fundic gastritis, atrophic enteritis, superficial colitis, thymic atrophy, and chronic active rhinitis. As some of these lesions may develop following periods of anorexia post-weaning, we are uncertain if they are causally associated with PFTS. Ironically, we have been unable to detect remarkable lesions in any section of brainstem, cerebrum or cerebellum examined to date in spite of the unusual neurologic clinical signs.

Proposed case definition*

Since there are no definitive gross or histopathologic lesions, or a diagnostic test the case definition is based on clinical presentation. The following proposed case definition for PFTS was developed by a group of researchers and clinicians in July 2010 and is published (or submitted for publication) [1, 2] elsewhere in more detail:

> "A pig on a farm with no obvious clinical diseases in suckling pigs, being representative of a larger group of clinically normal pigs that are afebrile, with normal behavior and body condition at weaning and initially lacking evidence of respiratory, systemic and enteric diseases, and that within 7 days of weaning is not eating, is depressed, may show chewing or chomping behavior and becomes progressively debilitated within 2-3 weeks of weaning."
>
> **Herd Context:**
>
> There are a multitude of risk factors associated with post-weaning debilitation. This syndrome is usually first recognized in groups/populations of pigs where current mortality exceeds expected mortality. Sufficient examination to confirm absence of common discernible infectious, nutritional, management, and environmental contributors that would elevate the "runt-rate" above basal threshold is expected. PRRSV infected pigs do not qualify for this case definition.
>
> *Proposed case definition developed collectively by: Bob Friendship, Henry Gaurvreau, John Harding, Hank Harris, Steve Henry, Dick Hesse, Howard Hill, Yanyun Huang, Randy Jones, Kent Schwartz, Mike Sheridan: Vancouver, July 21, 2010.

Future plans

We have received research funding from the Saskatchewan Agriculture Development Fund to enable continued research, with the ultimate goal of finding the cause(s) and developing diagnostic test(s) which will lead to improved control strategies. A North American collaborative research team has been established and includes: Steve Henry, Darin Madsen, Kent Schwartz, Bob Friendship and John Harding. Yanyun Huang, a PhD student at the Western College of Veterinary Medicine, is investigating the pathology and etiology and is credited for completing most of the diagnostic data presented in this paper. To help us with this research I am inviting producers to contact one of the collaborating researchers if they observe clinical signs indicative of PFTS, or have questions about the syndrome.

Acknowledgements
The authors wish to acknowledge the many people who have contributed their expertise to help solve these cases. This includes the colleagues and technicians at Prairie Diagnostic Services, Warman Veterinary Services and Western College of Veterinary Medicine, including but not limited to Drs. B. O'Connor, J. Hill, and colleagues from out of province including J. Delay, B. Jones, S. Henry, P. Provis, B. Friendship, D. Madsen, K. Schwartz, and M. Swendrowski. Funding for this project has been provided by the Saskatchewan Agriculture Development Fund, the Saskatchewan Agriculture and Food (WCVM Disease Investigation Program), and the Saskatchewan Pork Development Board. A special note of thanks is offered to the producers for their patience and continued cooperation. They will remain anonymous for reasons of confidentiality.

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Elimination of Porcine Respiratory Coronavirus

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Porcine respiratory coronavirus (PRCV) is a variant of the TGE virus that infects cells of the respiratory tract including those of the nares, trachea, bronchioles and alveoli. Transmission of this virus is via pig to pig contact or can be airborne. This virus also infects a few unidentified cells in the intestinal tract and there is limited to no shedding in the feces, unlike the TGE virus.

PRCV infections are usually subclinical and the virus spreads rapidly. Maternal antibodies to PRCV may persist for 8 to 16 weeks of age (S. Carman, personal communication). Most pigs are infected before the age of 20 -26 weeks, after maternal antibodies have declined, and the shedding lasts for approximately two weeks. PRCV persists in herds through infection of piglets in the nursing stage or after weaning. . Antibodies to PRCV from natural infection will decline to negative at 42 – 48 weeks post challenge.

Most swine herds in Ontario are seropositive for PRCV antibodies. These antibodies are distinguished from TGE antibodies by a blocking ELISA test. Antibodies to PRCV provide partial protection against TGE virus, and this explains the decline of TGE infections in swine herds

Some countries that claim to be free of PRCV in their swine industries require a negative serologic status for PRCV for imported animals. This can be a difficult requirement when exporting animals from high-health Ontario herds that test positive for PRCV antibodies and are TGE negative.

A case report at the 2008 IPVS meeting (Fano and Torremorell) discussed how pigs from a PRCV negative sow herd became infected in an all-in, all-out nursery. The PRCV status was returned to negative in the nursery by strict all-in, all-out measures, improved sanitation measures and strict attention to biosecurity. Other than this report, little information exists on removal of the virus from a group of pigs.

Research

A research protocol was designed to eradicate the virus in pigs sourced from a PRCV positive sow herd. The sow herd is a 150 farrow to finish herd, under one roof, and is PRRS and Mycoplasma hyopneumoniae negative. Forty piglets were weaned from nursing gilts/sows at 5 days of age and removed to a separate nursery which had been thoroughly disinfected and cleaned.

Piglets were treated with Draxxin at label dose at weaning and again with Excede at label dose one week later. CTC/Denagard (1 kg/1.75 kg/tonne) was included in the first two weaning rations.

Piglets were blood tested on entry and at intervals of one month for a total of 4 tests. Nasal swabs were taken on entry and again at the end of the study, when piglets were approximately 3 months of age.

Results

Initial swabbing revealed that none of the piglets were PCR positive on nasal swabs for porcine respiratory coronavirus.

12 of 40 piglets were initially antibody positive on the July test (the first bleeding). These were assumed to be maternal titres.

Of these 12, 4 remained positive in August on the second bleed, and by the third bleed all piglets were negative and remained so for the fourth bleeding in October.

The final nasal swabbing in October showed that none of the piglets were positive for virus.

A second trial is scheduled to begin in March of 2011.

Discussion

Medicated early weaning of piglets at 5 days of age was successful in avoiding exposure of the piglets to PRCV virus. This implies that the virus was circulating at a later stage of production in the home barn; however, this project was not designed to determine where the virus was circulating.

12 piglets were positive on blocking ELISA for PRCV; this implied that their dams had been exposed and that antibody had been transferred to the piglet via colostral intake.

During the first two months of the study, the maternal antibodies declined sufficiently that they were no longer detectable by blocking ELISA. The lack of seroconversion to positive status confirmed that the piglets were not exposed to live virus after the transfer to the nursery.

This technique demonstrates that it is possible to eliminate PRCV from swine using a segregated early weaning technique. This technique would be useful for those producers who would be interested in providing swine for export and who have a herd that is positive for PRCV.

However, it would be prudent to determine where the virus is circulating in a swine facility prior to attempting to eradicate the virus, as transferring piglets to a nursery after they have already been exposed to virus would require an extended period of time (up to one year) in the isolation barn in order to become seronegative.

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Utilizing Condensed Distillers Solubles (CDS) in a Dry Feed Ration for Gestating Sows

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Project description:

Research has shown that dried distiller grains with solubles (DDGS) and condensed distillers solubles (CDS) can be a beneficial and cost effective ingredient in hog diets relative to corn and soybean meal. At the farm level, adding these ingredients into on-farm mix rations poses a series of challenges. In particular, the mechanical addition of a liquid product into a dry feed ration requires careful design and calibration. This project focuses on the mechanical addition of liquid CDS into a dry feed ration for gestating sows. An optimal inclusion rate was determined based on the mechanical limitations, specifically how well it mixed. Based on this information, an appropriate ration containing CDS was formulated and a short feed trial in which gestating sows were fed the CDS ration vs. non-CDS ration was conducted. If proven successful, CDS could become an integral part of the gestating sow ration and a feed cost savings realized.

Farm Background:

The Fleuren farm is comprised of 350 sows farrow-to-finish with an adequate land base to supply most of the feed requirements. All feed is manufactured on-farm with a horizontal batch mixer. The sows are hand fed a ration primarily consisting of high moisture corn, soymeal and premix. The weaners and growers are fed a ration consisting primarily of dry corn, soymeal and premix. The finishing pigs are fed a liquid ration with a liquid feed system. Historically, CDS has been a feed ingredient in the liquid ration which is how this project evolved.

System Design Conclusions:

- The system requires a 5hp worm pump with a 4" intake line and 3" line to the dry feed mixer. The flow was considered adequate at a consistent 60kg/minute of CDS. The CDS is being pumped approximately 40m and a total rise of 4m.
- We determined the optimal location to add CDS into the dry batch mixer to be in the centre between the top two mixing augers.
- A timer was installed to set the inclusion rate of CDS into the dry feed mixer.
- An agitation pump was installed in the CDS storage tank.
- CDS must be introduced into the ration when the batch is 50% of the way completed to allow for proper mixing with dry ingredients. We discovered that inclusion timing is critical to prevent the development of clumps of feed along with CDS building up in the mixer.

Project Conclusions:

Gestating sows can be fed a dry feed ration that contains 60kg CDS/ MT as fed based on mechanical limitations when using high moisture corn (23%). There is no impact on feed intake or manure consistency at the 60kg/MT inclusion rate. The financial return is $7.05/MT as fed or $3.41/sow which in our case translates to $1,194/yr. The price of corn was $157.50/MT and CDS was $40/MT at the time this trail was conducted. If dry corn was used in our sow ration instead of high moisture corn, the inclusion rate could be increased to 140kg/MT as fed which translates to savings of $16.45/MT as fed or $7.97 per sow.

The adoption rate of this technology on other farms will depend on the infrastructure present at each farm. Probably the single largest factor in question is what existing infrastructure is in place on a farm. Installing a storage tank along with the pump, plumbing and electrical would likely make the technology cost inhibitive. However, if there is some existing infrastructure this technology could be a cost effective addition. While it was beyond the scope of this project, there is also opportunity to use this technology for market hogs on a non liquid ration. In that case, the economics could become more attractive. Inclusion rate limits due to physical (flowability) and nutritional factors would need to be worked out. This information provides farmers with basic considerations relevant to setting up a similar project and provides some indication of financial savings it could realize.

This trial was conducted by pork producer Marijn Fleuren (marijn.fleuren@gmail.com) and Dr. Paul Luimes of the University of Guelph's Ridgetown campus. More information about the study and its results can be found online at www.ontariopork.on.ca

This project was funded in part by the Farm Innovation Program.

2010 Update on the Development of an Integrated Mycotoxin Management System in Ontario Corn

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Swine are particularly vulnerable to mycotoxin exposure. This exposure causes feed refusal, weight loss and immune-suppression at lower doses. *Fusarium/Gibberella* ear mould infestation and subsequent mycotoxin contamination are present in southwestern Ontario with different degrees of severity every year, potentially threatening our competitiveness in the export market. As well, there is a concerned about the effect of elevated levels of mycotoxins in feed on the health of individuals working in the barn. This update is a compilation of data from our first year of monitoring and study strategies for prevention, control and surveillance of mycotoxins in corn in order to mitigate mycotoxin contamination in *Fusarium* epidemic years. This report also provides an overview of the studies being conducted in the areas of in-crop surveillance; weather based forecasting, analytical support and hybrid selection and fungicide application technologies.

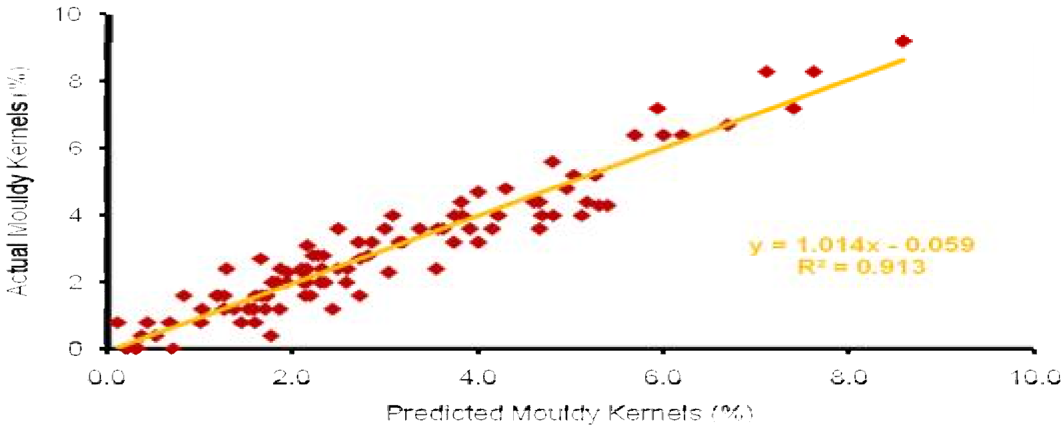
Crop Surveillance:
In 2009, More than 500 corn samples were collected from 55 fields at harvest from across the corn growing region of south western Ontario. Moderate Deoxynivalenol (also known DON or vomitoxin) contamination levels were found in the Ottawa valley area. In 2010, preliminary results based on 300 samples, indicate relatively low levels of DON with 76 per cent of the samples recording less than 1 ppm. Farmers should be aware that small isolated pockets of high vomitoxin contamination existed in few areas in both years. The average concentration in 2009 and 2010 was 1.6 ppm and 0.8 ppm, respectively. These levels are below the recommended tolerance level specified in the Canadian regulatory guidelines for swine, young calves and lactating dairy animals.

Analytical support:
Near Infrared technology shows promising results to predict the percentage of *Fusarium* damaged kernels in corn samples (Fig 1). However, using ELISA as a reference method, the model was not very accurate when predicting DON concentrations. Liquid chromatography mass spectrometry (LC-MS) will be used in this project as the reference analytical method. DON recovery level (78%) obtained was comparable to other LC-MS methods reported. This system was able to chromatographically separate DON and closely related compounds in corn and wheat samples. The validated LC-MS method can accurately determine 5 mycotoxins down to 0.25 ppm.

Weather based forecasting:
The difference found between the predicted and actual forecast values for DON in 2009 was explained by the distribution of hybrids with different degrees of sensitivity to *F. graminearum* infection and/or mycotoxin accumulation. A pilot DONcast model developed to predict DON in corn with five pork/corn producers was launched in 2010 (results still under analysis). We will continue developing and validating this model and its delivery further through collaboration with Weather Innovations Inc (WIN) and the swine industry in the remaining years of this project. Data obtained during the current cropping season will be used to correlate weather information with various stages

of the corn crop development to determine which stage is most susceptible and which stage shows the highest correlation to the final production of DON (measured at harvest).

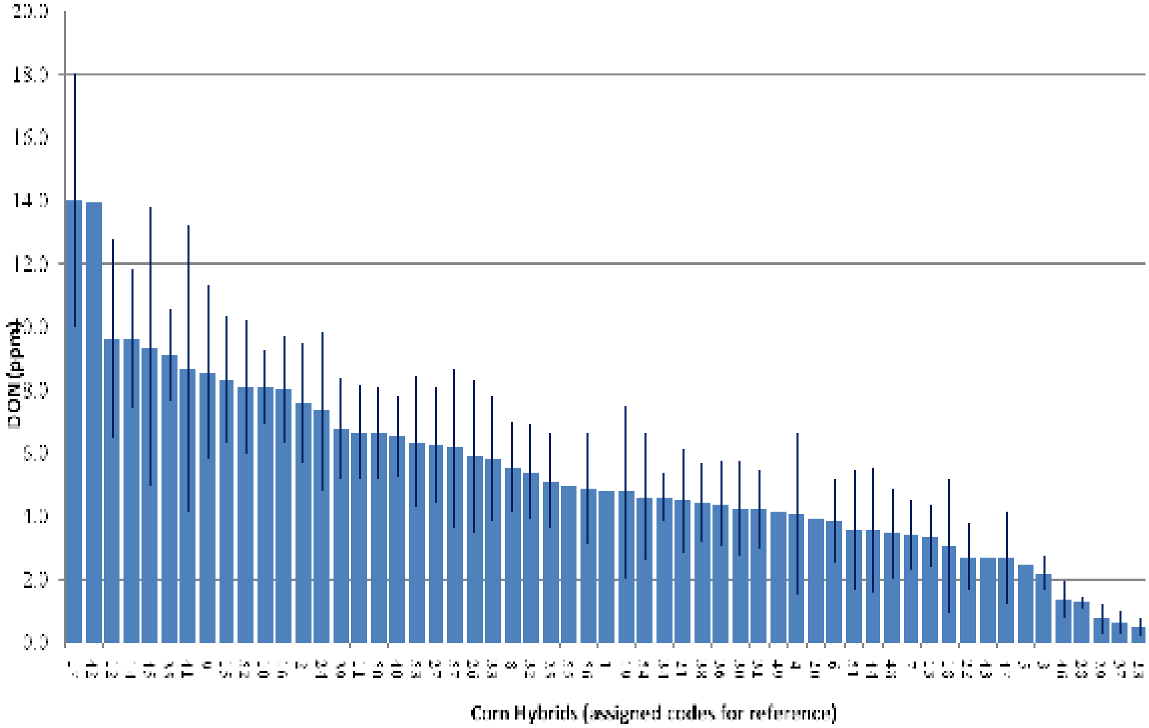
Figure 1. Correlation between percentages of actual and predicted mouldy corn grains.



Hybrid selection: High infection rates in corn ears were achieved through late planting and inoculation at silk browning, when ears are most susceptible to infection, followed by application of an overhead mist irrigation system. Early information confirms the feasibility to evaluate large numbers of commercial hybrids through a controlled environmental screening program on campus. Using this methodology, a total of 57 advanced and commercial hybrids were evaluated in the 2009 cropping season (Fig 2). The accumulation of DON in kernels varied significantly depending on the hybrid ($p < 0.05$). These hybrids showed a wide range in their response to DON accumulation from 0.5 to 14 ppm. Four hybrids were able to significantly inhibit the accumulation of DON in kernels under strong pathogen pressure.

Fungicide application: A new generation of triazoles, including prothioconazole and metconazole were evaluated for their ability to reduce DON contamination levels under misting irrigation and on farm scale application. Up to 60% toxin reduction was observed in inoculated corn ears under misting irrigation with fungicide application. Up to 50% reduction was observed in on-farm trials using a high clearance sprayer equipped with flat fan drop nozzles. The timing of fungicide applications for control of *Fusarium* infection/DON accumulation was studied under inoculated and artificially irrigated plots. The window of application for prothioconazole seems to be wider than originally expected. Multi-year data needs to be collected to confirm these results.

Figure 2. DON accumulation in corn hybrids inoculated with F. graminearum under overhead mist irrigation.



Update on Swine Liquid Feeding Research

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Introduction

The use of relatively inexpensive co-products from the bio-fuel and food industries continues to be an important means to reduce pork production costs. This applies in particular to the use of liquid co-products in computer controlled liquid feeding systems. At the University of Guelph, a research program is in place aimed at further developing liquid feeding technology for pigs, based on liquid and dry feed ingredients that are available in Central North America.

Specific objective are to:

1. explore manipulation of dietary electrolyte balance and use of enzymes or bacteria to increase usage and nutritional value of co-products;
2. explore physical aspects of liquid feed delivery to enhance feed intake, gut health and gut development in pigs, and to minimize feed spoilage;
3. quantify overall energy usage, environmental impact, pork quality and gut health associated with liquid feeding diets that contain large amounts of co-products; and
4. extend the positive effects of liquid feeding to conventional dry feeding systems.

Main results of research activities in 2010 (objectives 1, 2 and 4)

A series of laboratory bench top studies were conducted to explore adding fibre-degrading enzymes and microbial inoculants to swine rations to enhance the nutritional value of high fibre co-products, such as wheat shorts and corn dried distillers grains with solubles (DDGS). When enzymes (glucanases and xylanases) were used in combination with various microbial inoculants (*Lactobacillus acidophilus* and *Pediococcus acidilactici)*, fibre was degraded and fibre degradation products were converted to organic acids that can supply energy to pigs. Pig performance studies were then conducted to further explore the applications of exogenous enzymes and microbial inoculants.

Initially, it was our intent to steep wheat shorts for at least 24 h prior to feeding. However, soaking turned wheat shorts into a very thick porridge-like substance, which proved impossible to pump. This steeping approach was abandoned. Instead wheat shorts were dosed in dry form and directly into the liquid feed mixing tank.

In the performance study, 192 finishing pigs (4 barrows and 4 gilts per pen; 12 pens per treatment) were assigned to liquid or conventional dry feeding. All pigs received the same diet that contained 40% wheat shorts, 43% corn, 13% soybean meal and appropriate levels of supplemental amino acids, vitamins and minerals. For both feeding methods, pelleted and crumbled supplement were prepared that included all feed ingredients except wheat shorts. For conventional dry feeding, wheat shorts and the finisher supplements were blended at the University of Guelph feed mill. For liquid feeding, wheat shorts and the finisher supplements were managed as two different feed ingredients and dosed in the computer controlled liquid feed mixing tank in the same proportions as those for conventional dry feeding. Body weight was monitored at bi-weekly intervals and carcass quality was evaluated according to the standard Canadian carcass grading system.

In general, excellent growth performance was achieved for both treatments, with daily BW gains exceeding 1 kg/d (**Table 1**). Pigs on liquid feeding showed an improvement in BW gains and feed efficiency of more than 10%. This is consistent with European studies that show that liquid feeding wheat or barley-based diets improved feed efficiency when compared to conventional dry feeding. It demonstrates that even when feeds are not steeped, feed efficiency is better on liquid feeding than on dry feeding, and that liquid feeding enhances in particular the feeding value of fibrous ingredients, such as wheat shorts. However, improvements in growth performance of liquid fed pigs were offset by a slight reduction in carcass lean yield, which should be considered when conducting cost-benefit analyses.

Table 1. Impact of feed form on growth performance of finishing pigs (72 to 118 kg body weight) fed diets containing 40% wheat shorts.

	Feed Form		SEM*	Probability of treatment effect
	Dry	Liquid		
Body weight gain (kg/day)	1.04	1.18	0.02	<.0001
Feed intake (88% DM, kg/day)	3.48	3.47	0.07	0.95
Feed:Gain (88% DM)	3.35	2.96	0.05	<.0001
Carcass weight (kg)	91.46	91.61	0.49	0.84
Estimated carcass lean yield (%)**	61.26	60.45	0.17	0.0007
Back fat depth (mm)**	17.28	18.78	0.35	0.003
Loin muscle depth (mm)**	62.03	59.53	0.52	0.001

* Standard error of treatment mean with 12 pens per treatment; 8 pigs per pen; no pigs were removed during the performance study; initial BW used as co-variable for all responses except initial BW.
** Values obtained according to the Canadian pig carcass grading scheme.

Two finishing pig performance studies were conducted to explore the interactive effects of adding enzymes and microbial inoculants to liquid diets containing 30% DDGS. In each of the two studies, 24 pens with 8 pigs per pen (initial BW approximately 60 kg) were assigned to one of four dietary treatments: (1) Control, DDGS only; (2) DDGS + enzymes; (3) DDGS + microbial inoculants; and (4) DDGS + enzymes + inoculants. Diets were prepared and delivered to the feed troughs using the Big Dutchman computer controlled Hydrojet liquid feeding system.

In both experiments, the use of enzymes and microbial inoculants increased feed intake and body weight gains of pigs. When both products were used in combination, enzymes and inoculants increased feed intake and body weight gain by as much as 15% (Table 2). In one of the two studies, enzymes alone improved feed efficiency by 5%.

Table 2. Growth performance of finishing pigs (60 to 118 kg body weight) that were liquid fed diets containing 30% DDGS. Enzymes and microbial inoculant were used to treat DDGS prior to feeding (combined results of two studies).

	Treatment				
	Control	+Enzymes	+Inoculant	+Enzymes + Inoculant	SEM (n=12)
Days to market	48.8[b]	45.0[a]	45.3[a]	42.9[a]	0.77
Body weight gain (kg/d)	1.04[a]	1.15[b]	1.16[b]	1.22[b]	0.02
Feed intake (kg/d)	2.50[a]	2.73[b]	2.78[b]	2.87[b]	0.05
Feed:Gain	2.40	2.36	2.40	2.34	0.03

Benefits and implications

These studies demonstrate that there is a considerable opportunity to enhance the feeding value of high fibre containing co-products for growing-finishing pigs, through liquid feeding and the combined use exogenous enzymes and microbial inoculants. In future studies, the impacts of added enzymes and microbial inoculants on nutrient losses, carcass and meat quality will be evaluated. In addition, the use of enzymes and microbial inoculants in conventional dry feeding systems deserves to be explored further.

Acknowledgements

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Consumer Acceptance of Omega-3 Fatty Acid Enriched Pork

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Introduction

It is widely recognized that consuming omega-3 (**n-3**) fatty acid enriched diets can provide health benefits, such as reducing the risk of heart disease and stroke. The typical western diet contains insufficient amounts of n-3 fatty acids. Therefore, there is considerable potential to market n-3 enhanced pork products. In order to produce n-3 fatty acid enriched pork, pigs need to be fed n-3 fatty acids containing diets. This can contribute to the production of soft or oily pork, especially when using corn-based diets. The latter can negatively impact shelf life and consumer acceptance of pork products.

Research Objective

The aim of this research program was to develop feeding strategies for cost-effective production of value-added pork products that contain predictable and uniform levels of beneficial n-3 fatty acids without compromising carcass quality and consumer acceptance of pork products. These feeding strategies were developed for pigs fed corn-based diets.

Main activities in 2010 – consumer panel studies

Our previous studies indicated that feeding low levels (up to 10%) of flaxseed in corn-based diets to pigs throughout the grower-finisher phase of pig production results in predictable levels of n-3 fatty acids in pork products, without compromising carcass and meat quality.

In 2010, a combined pig growth performance and serial slaughter study was conducted to determine the rate of incorporation and retention of n-3 fatty acids in loin and belly from pigs that were fed either ground flaxseed (**FS**) or fish oil (**FO**) containing diets at different stages of growth. At 25 kg body weight (**BW**) equal numbers of barrows and gilts (8 pigs per treatment) were exposed to each of 7 dietary treatments:

1: (FSE-FS early) feeding a corn and soybean based diet containing 10% FS to pigs between 25 and 65 kg BW; thereafter a n-3 fatty acid free control diet (CON) until pigs reach commercial slaughter BW (approximately 115 kg BW).

2: (FSL-FS late) feeding CON diet between 25 and 85 kg BW and thereafter FS (10%) until 105 kg BW, followed by CON until 115 kg BW. The purpose for CON at the end was to increase uniformity in days on FS and thus n -3 FA levels in pork).

3: (FSC-FS continuous) FS (3.5%) diet between 25 and 105 kg BW, followed by CON diet until 115 kg BW.

4: (FOE-FO early) FO (3%) diet between 25 and 65 kg BW, followed by CON diet until 115 kg BW.

5: (FOC-FO continuous) FO (1%) diet between 25 and 105 kg BW, followed by CON until 115 kg BW.

6: (FOL-FO late) CON diet between 25 and 85 kg BW, thereafter FO (3%) until 105 kg BW, followed by CON until 115 kg BW.

7: (CON) CON diets between 25 and 115 kg BW. At slaughter loin and belly (bacon) samples were obtained from the pigs for evaluation of consumer acceptance by trained panels.

In this study, pig growth performance was not influenced by dietary treatment (P>0.10). As planned, cumulative (per pig) intake of flaxseed was similar for treatments 1 to 3 (P>0.10; 6.8, 7.2 and 7.2 kg/pig, respectively), while intake of fish oil was similar for treatments 4 to 6 (P>0.10; 2.0, 2.0 and 2.2 kg/pig, respectively).

The results in Table 1 show treatment effects on various palatability attributes of cooked loin. In general, cooked loin samples from pigs fed flaxseed containing diets continuously (treatment FSC) was considered most favorably by the consumer panel, while loin samples from pigs fed fish oil during the finisher phase (treatment FOL) where perceived to be least favorable.

Table 1. Impact of alternative feeding regimes on palatability attributes in cooked loin meat samples (see text for details).

Item	FSE[1]	FSL	FSC	FOE	FOC	FOL	CON	SEM[2]	P[3]
Overall tenderness[4]	6.15[ab]	5.56[ab]	6.78[a]	6.01[ab]	6.27[ab]	5.40[ab]	5.10[b]	0.48	0.04
Pork flavor intensity[5]	6.40	6.26	6.18	6.07	6.24	6.12	6.57	0.46	0.95
Off flavour[6]	1.10[ab]	0.95[ab]	0.54[b]	1.27[ab]	1.30[ab]	1.47[a]	0.91[ab]	0.44	0.04
Overall juiciness[7]	5.34	4.57	4.99	4.53	5.06	4.50	4.70	0.54	0.81
Flavor desirability[8]	5.79[ab]	6.25[ab]	6.78[a]	5.65[b]	5.45[b]	5.50[b]	6.13[ab]	0.39	0.02
Overall acceptability[9]	5.94[ab]	5.93[ab]	6.67[a]	5.53[ab]	5.55[ab]	5.39[b]	6.02[ab]	0.40	0.10

[1] See text for description of treatments; [2] Mean SE across all treatments; [3] Probability of treatment effects; the effects of gender (barrows vs. gilts) and interactive effects between treatment and gender were not significant (P>0.10) ; [4] **9 point scale for all criteria**, ranging from extremely tough (score =1) to extremely tender (score = 9); [5] Extremely bland pork flavour (score =1) to extremely intense pork flavour (score = 9); [6] None (score =1) to extremely intense (score = 9); [7] Extremely dry (score =1) to extremely juicy (score = 9); [8] Extremely undesirable (score =1) to extremely desirable (score = 9); [9] Extremely unacceptable (score =1) to extremely acceptable (score = 9); [a,b] Values within rows followed by different letters differ (P<0.10).

Benefits and implications

Pigs that are fed n-3 poly-unsaturated fatty acids can store these fatty acids in muscle and fat tissue, resulting in pork products that can provide health benefits to consumers. Cooked loin samples from pigs fed diets containing 3.5% flaxseed throughout the growing and finishing phase was considered most favourably by a consumer panel. Loin samples from pigs fed fish oil during the finisher phase where perceived to be least favourable.

Acknowledgements

This research was supported by the Ontario Ministry of Agriculture, Food and Rural Affairs, Ontario Pork and the Natural Sciences and Engineering Research Council of Canada.

Impact of Immune System Stimulation on Sulfur Amino Acid Metabolism and Requirement in Growing Pigs

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Introduction

Disease contributes to immune system stimulation (**ISS**) and alters nutrient metabolism and utilization. Nutrition of several amino acids including glutamine, arginine, tryptophan, and in particular sulfur containing amino acids (SAA; methionine plus cysteine), should be considered during ISS. The SAA serve as precursors for synthesis of immune proteins and metabolites such as albumin, defensins and, particularly, glutathione. Glutathione is an important anti-oxidant in the animals' body, especially during ISS. It is thus likely that disease and ISS influence the pig's utilization and requirements of SAA.

Research objectives

Experiments were conducted to evaluate the impact of ISS (disease) on utilization and metabolism of SAA, including synthesis of glutathione, nutrient digestibility and SAA requirements for maximum body protein gain in growing pigs.

Main research activities and results

Various metabolism studies were conducted with individually housed growing pigs at approximately 20 kg body weight. Disease symptoms (ISS) were induced with repeated injections of increasing amounts of bacterial lipopolysaccharide. Pigs were fed restricted to eliminate the confounding effect of ISS on feed intake. Diets were formulated to be first limiting in SAA; up to five levels of SAA were fed.

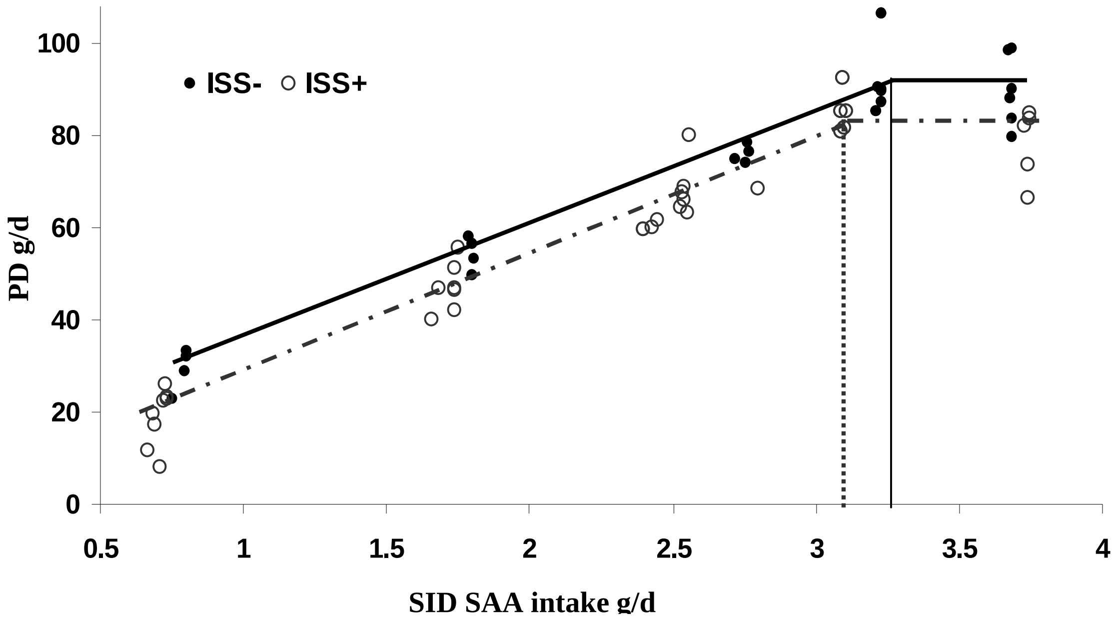
In our studies, ISS did not alter ileal digestibility of energy, crude protein and vital amino acids ($P > 0.05$), indicating that the impact of ISS on nutrient utilization efficiency is attributed largely to post-absorptive metabolic processes.

We observed that ISS reduced plasma SAA levels but increased plasma cysteine flux, which is a measure of the rate of SAA metabolism ($P < 0.05$). ISS increased the rate of synthesis of glutathione in liver, small intestine, large intestine, heart, lung, kidneys and muscle ($P < 0.05$), but had no effect on appearance of sulfur (S) in cysteine catabolism products (taurine and sulphate; $P > 0.05$). These metabolism studies suggest increased utilization of SAA for synthesis of glutathione and reduced catabolism of SAA during ISS.

As a result of ISS, urinary N excretion was increased (+24 %; $P < 0.02$) while urinary sulfur excretion was reduced (-12 %; $P < 0.05$). These results confirm the substantial negative effect of ISS and disease on whole body protein gain, and thus lean tissue growth, in growing pigs. It also shows that SAA and their metabolites are preferentially retained in the pigs' body during ISS, and confirming increases SAA requirements during ISS, relative to other amino acids.

Based on the relationship between SAA intake and whole body N retention (Figure 1), ISS reduced ($P < 0.03$) dietary SAA requirement for maximum protein deposition by about10 %. However, in order to achieve a constant rate of body protein gain (e.g. 70 g/d in Figure 1) ISS pigs have higher daily requirements for SAA. Previous studies have shown that such an effect does not exist for lysine. Therefore, when expressed relative to lysine, requirements for SAA are higher in ISS pigs than healthy pigs.

Figure 1. Impact of immune system stimulation (ISS) and standardized ileal digestible methionine + cysteine (SID SAA) intake on whole-body protein deposition (PD) in growing pigs.



Benefits and implications

Exposure to disease and stimulation of the pigs' immune system limits expression of lean growth potential in pigs and impacts amino acid metabolism. As a result, the optimum amino acid balance in pig diets is impacted by the animal's health status. In particular the requirements for the sulfur containing amino acids (methionine and cysteine), relative to those for lysine, are increased during immune system stimulation. The impact of disease and immune system stimulation on amino acid requirements should be considered in practical feed formulation.

Acknowledgements

This research is supported by Ontario Pork, Evonik Degussa GmbH, OMAFRA and the Natural Sciences and Engineering Research Council of Canada.

The Niagara PRRS Area Regional Control & Elimination (ARC&E) Project

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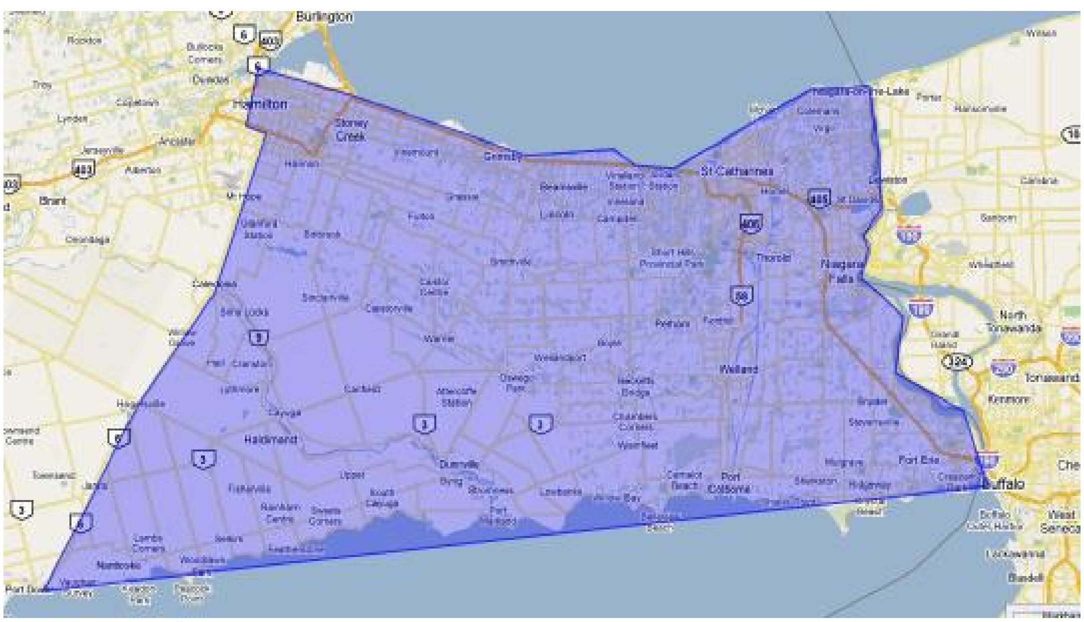
The first planning meeting for the PRRS area regional control and elimination project (PRRS ARC & E) was held on February 18, 2010. This was a joint meeting including both the Ontario Swine Health Advisory Board (OSHAB) and Ontario Association of Swine Veterinarians (OASV). The discussion included an outline of the project and budget, background information on U.S. projects and areas for consideration. From this meeting four geographical areas were proposed for consideration for a PRRS area regional control and elimination trial based on the following criteria:

- Moderate pig density
- Motivated producers and service providers
- Likelihood of a project "champion" in the area
- Physical borders (lakes, highways, stand of trees etc) and/or reduced density on perimeters
- Balance of pig flow is out of area
- Limited pig transportation through the control zone, or border crossing zones
- Consideration of herd size and dynamics

Following a series of meetings and discussions with producers and service providers, the Niagara Peninsula area was selected on June 18, 2010 as the project region for Phase 1.

The Niagara ARC&E project is a voluntary program in all aspects including participation and implementation of control and/or elimination strategies. The project has a two year time frame.

Map of the Niagara Peninsula Trial Region



Project Objectives:

- Develop a culture of openness, transparency, cooperation and collaboration
- Lead a change in attitude: from independent to interdependent

- Greater than 90% producer participation
- Model biosecurity advancements and assess possible solutions to key disease transmission risks
- Improve communications and share knowledge (biosecurity and disease control) with the whole industry
- Change/maintain the PRRS status of participating farms in the area: if positive with viral shedding change to no viral shedding; maintain non shedding or negative status
- Maintain competitiveness with trading partners and avoid any possible future disease related trading barriers

Two area producer meetings were held in the Niagara region on August 10 and 11, 2010 to discuss the project details and review the producer participation agreement. The participation agreement addresses issues related to sampling, diagnostic testing, data sharing and confidentiality. A total of 77 sites have been identified in the project area. Currently, 64 signed producer participation agreements have been received.

Dr Karen Hand (Strategic Solutions Group) has been chosen to provide the mapping support for this project, in consultation with Dr Zvonimir Poljak (University of Guelph). To date, all the participating farms, with Premises ID and coordinates, have been mapped.

The sampling and diagnostic protocol has been developed. The site sampling will only be done once a signed producer participation form is received. Sampling will be done at a 90% confidence level and a 10% population prevalence level (22 PRRSV – IDEXX X3 antibody ELISA samples) for most sites with flexibility for special situations. All sites will be tested. The results of the last site PRRSV test will be used if the testing was done within the last 6 months.

The first site was sampled on September 14, 2010. To date, a total of 40 area sites have been tested of which 23 are PRRS ELISA negative and 17 are PRRS ELISA positive.

Protocols for enhanced biosecurity for service providers will be developed utilizing materials produced by OSHAB and the American Association of Swine Veterinarians (AASV). A PRRS risk assessment using the Production Animal Disease Risk Assessment Program (PADRAP) will be utilized to assess the biosecurity practices on-farm (site). This assessment will identify the site's biosecurity risk factors for PRRSV transmission and facilitate the design of the on-farm biosecurity, control and elimination strategies.

The project funding per site includes the sampling and diagnostic costs, the PRRS risk assessment and the design of the on-farm biosecurity, control and elimination strategies. The initial diagnostic area survey will be completed, the site PRRS status mapped and the area PRRS status assessed by March 2011.

Funding for this and supporting projects has been provided by OMAFRA, OSHAB and industry partners, the Animal Health Strategic Initiative (AHSI) and the Ontario Pork research fund.

Oral Saliva Sampling for Surveillance of Swine Influenza

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Introduction

Clinical influenza in pigs typically results in pigs being off feed, coughing and showing high body temperatures for a week before they recover. In more endemically affected herds, the influenza virus becomes part of the porcine respiratory disease complex along with PRRS, Porcine circovirus type 2 and *Mycoplasma hyopneumonia*. Influenza in pigs is caused by either the classical swine H1N1 virus or the H3N2 virus. Influenza viruses are spread from pig to pig through coughing and inhaling virus particles. The virus grows in the upper respiratory tract of the pig (nose, throat, lungs) and then in 5 to 7 days, the pig is able to eliminate the virus from its body. The most common method to test pigs for the virus is to use nasal swabs. However, recent work from Iowa State University illustrated that the virus can be identified in the saliva of infected pigs.

Two years ago, the novel H1N1 human influenza pandemic had a crippling effect on Ontario's swine industry. Unfortunately, the media called the novel virus the "swine flu", even though the virus originated in people and was not the same virus as the classical swine H1N1 influenza virus. The media fueled concerns that the general public would become infected with an influenza virus due to exposure to pigs.

The purpose of the current research project was to test market weight swine to determine whether or not they carry classical swine H1N1 or H3N2 or the novel H1N1 influenza that originated in Mexico.

Materials and Methods

The surveillance study included the collection saliva samples from finisher pigs from 5 different pens on each of 20 commercial farms and 1 pen from a hobby farm. This was a convenience sample of farms. Producers participated because their pigs had exhibited clinical signs of influenza or the producer wished to learn how to conduct saliva sampling or the producer volunteered to participate in research.

Saliva was collected by allowing pigs to chew on cotton ropes held in the pen for 10 to 15 minutes. On average, 5 pigs chewed on the rope at one time and up to 8 pigs per pen were included during the sampling time. Once the rope was saturated, it was put in a plastic sealable bag and then squeezed to remove the saliva. Fluid was then put into 10 ml serum tubes. The tubes kept cold using a cooler and then refrigerator prior to processing. The samples were centrifuged for 20 minutes at 1400 rpm. The supernatant was stored in two micro tubes in a -80ºC freezer. Samples were tested for influenza viruses using a Polymerase Chain Reaction (PCR) test at the Animal Health Laboratory (AHL) at the University of Guelph.

Results

Samples were collected from December 2009 to May 2010. All 101 samples tested negative for swine influenza virus by PCR. The commercial herds included from 275 to 4000 finisher pigs, with an average herd size of 1500 finisher pigs. Therefore, in total, these samples represented approximately 30,000 finisher pigs. Farms were located within a 2 hour NE, W, NW and SW of Guelph. Pigs on 4 of the farms had exhibited clinical signs of classical swine influenza (SIV) during the fall or winter season. No farms had vaccinated against SIV.

This saliva sampling technique enables a large number of pigs to be sampled at one time with minimum stress to the pigs and people. It can be used for widespread surveillance. Previous research indicates that pigs infected with influenza viruses are able to clear the virus from their upper respiratory tract in 5 to 7 days. This pilot surveillance project, although not from a random sample of farms, did include four farms whose pigs exhibited clinical signs of SIV. Finisher pigs are not shedding influenza viruses in their saliva. The swine industry can assure the general public and public health officials that the pig is a very unlikely source of influenza virus.

Benefits to the swine industry
Commercial finisher pigs are not a concern for the general public with respect to spread of influenza viruses.

Acknowledgements: This study was supported by University of Guelph/ OMAFRA partnership. We are greatly indebted to the pork producers who participated and OMAFRA personnel who assisted by identifying the collaborating producers.

The Association Between Submission Counts to a Veterinary Diagnostic Laboratory and the Economic and Disease Challenges of the Ontario Swine Industry from 1998-2009

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Introduction: Many animal disease outbreaks have initially been identified by attending veterinarians and pathologists in diagnostic laboratories aided by the result(s) of diagnostic testing (1). An intuitive assumption is to believe that the number of submissions made to a veterinary diagnostic laboratory is strongly dictated by the financial state of the industries using the laboratory (2). However, no research is available to document how the economics of a food animal industry affects laboratory submissions and therefore disease monitoring and surveillance efforts. The objectives of this study were to determine if swine submissions made to a veterinary diagnostic laboratory fluctuated over time and to subsequently determine if a disease outbreak and economic indices associated with the Ontario swine industry can account for the variability seen in these submissions.

Materials and Methods: Records of retrospective swine submissions made to the Animal Health Laboratory (AHL) at the University of Guelph, Guelph, Ontario from Jan '98 to Jul '09 were compiled and averaged into monthly counts. The following economic, demographic, and health variables impacting Ontario swine production were selected for analysis: auction price, lean-hog futures, currency exchange rate, price of corn, disease outbreak, government incentive program, number of farms in province, and average farm size. The relationship between submission counts, disease outbreak and economic indices of the Ontario swine industry were examined by negative binomial regression. A parsimonious model was identified by a backwards elimination process.

Results: A total of 30,432 swine submissions were made. The total number of observed months was 139 and the overall mean of the monthly counts was 212.94 (SD=55.95). After controlling for farm size and the number of farms in Ontario, higher submission counts were associated with a weaker CAD$ vs. US$, higher auction prices, and a disease outbreak (P<0.05).

Discussion: The results of this study show that between 1998 to 2009 swine submission counts to the AHL varied over time and were associated with a disease outbreak and economic fluctuations associated with hog production in Ontario. The study demonstrates that a disease outbreak increased laboratory submissions even after controlling for economic and demographic variables of the Ontario swine industry. In other words, the economic volatility of the industry did not "overwhelm" disease with respect to its ability to influence submissions to a laboratory. The results support the importance and utility of using passively collected disease information for disease monitoring and surveillance of a food animal industry. Future research and surveillance activities should focus on using a submission rate adjusted for economic variables effecting the industry using the laboratory. The use of adjusted submission rates would enhance surveillance efforts as it would control for significant economic variables associated with the industry under surveillance and could enhance the accuracy of predictions/alarms in the surveillance population.

Acknowledgements: Thank you to the AHL for providing the laboratory submission data and for their assistance with this project. This study was financially supported by the OVC Fellowship program and the OMAFRA, University of Guelph research program.

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Effect of Pain Relief at Castration on Performance of Piglets

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Introduction

All male pigs must be castrated to make them acceptable for the current market and there are no alternatives to commercial pork producers. The procedure is generally performed without analgesia, but castration of even very young pigs is a painful procedure and as such, raises a concern regarding animal welfare[1]. General and local anesthesia have been examined and do not appear to be good solutions, and possibly make the welfare situation worse[2,3]. Analgesics are not readily available for use in food producing animals. At the time this project was started ketoprofen (which provides pain relief for about 24 hours) was the only injectable product licensed for use in swine. The use of analgesia in pork production will have poor compliance unless farmers can be shown a production advantage or be rewarded in some other way because they are constantly faced with financial constraints.

Objectives

To determine if analgesia at the time of castration produced a positive benefit such as faster growth or reduced mortality.

Materials and Methods

A total of 1491 seven-day-old piglets from 301 litters were used in the following treatment groups

a. Saline given by IM injection 30 minutes before castration (n=736).
b. Ketoprofen given by IM injection (0.15 ml per 5 kg bodyweight) 30 minutes before castration (n=755)

All piglets were ear notched for identification and weighed at the time of castration and at 21 days of age to determine average daily weight gain (ADG). Mortality between castration and day 21 was recorded. Piglets were observed approximately 15 minutes after castration for signs of discomfort.

Results

There was no significant difference in ADG and mortality between the control (avg 272 g/d, 3.5%) and treatment (279 g/d, 2.9%) groups ($P>0.05$). Based on subjective evaluation 15 minutes after castration there was little evidence of behaviour suggesting discomfort in either group.

Discussion and Acknowledgements

The cost of analgesia is small on a per pig basis but for a moderate sized pig operation the cost associated with extra labour and drug costs represents thousands of dollars. This work suggests that there is no financial motivation for a producer to begin using analgesia routinely, and therefore there needs to be some other means to compensate the pork producers if such practice is considered necessary. This study was supported by Ontario Pork.

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Evaluation of Methods for Controlling and Monitoring Occupational Exposure of Workers in Swine Facilities

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SUMMARY
This study was aimed to assess the effectiveness of selected engineering and management measures, namely, oil sprinkling, low protein diet, high level of cleaning and manure pH manipulation, in reducing ammonia (NH3) and respirable dust concentration in swine production rooms. Six grow-finish rooms at PSCI research facility were used with two as control and four as experimental rooms each employing one of the measures being investigated. Sampling equipment was installed in each room for measurement of ammonia and respirable dust concentrations within the room airspace. Worker exposure to ammonia and dust from the rooms was also assessed by equipping workers with a personal monitoring gear similar to those installed in the rooms. Ammonia levels were monitored using both the standard method and using commercial gas sensors. Results from completed trials so far showed that low-protein diet, pH manipulation of manure and employing high level of cleanliness could potentially reduce ammonia concentrations in swine production rooms. Among these various measures, only spraying of canola oil reduced dust levels inside the rooms. Moreover, average daily gain of pigs was relatively similar between control and experimental rooms. A benefit-cost analysis will be conducted after all trials are completed.

INTRODUCTION
Various engineering and management measures have been shown to control air contaminant levels in swine production facilities. Additionally, barn operators have come up with innovative measures to address issues with ammonia and dust levels within their facilities. However, there is a gap in translating the results observed in previous contaminant control studies to actual reduction of personal exposure of workers to these contaminants throughout their workday. Thus, there is a need for these innovative measures to be assessed under actual swine barn conditions to determine the actual reduction of exposure of workers to air contaminants. The goal of this project is to assess the effectiveness of selected engineering and management measures (i.e. oil sprinkling, low protein diet, high level of cleaning and manure pH manipulation) in reducing ammonia (NH3) and respirable dust concentration in a swine production room. In addition, the performance of commercial gas monitoring devices was assessed using standard gas measurement method as reference.

EXPERIMENTAL PROCEDURES
Six grow-finish rooms at the PSCI barn were used for this study. The four (4) types of engineering and management measures were applied individually in 4 of the rooms (Experimental) while the other 2 rooms were managed as conventional rooms (Control). Each 16-week grow-out period was considered as one replicate trial and a total of 5 trials will be conducted to cover each climatic season (winter and summer conditions) at least twice. Every 3 weeks, the personal exposure of workers to NH3 and dust was assessed by outfitting 3 workers with gas monitors and personal dust samplers over their work shift over a 2-day period. Two workers were assigned to work in the experimental rooms while the other worker was assigned in the control rooms. Each worker was assigned a logbook to document their activities during their workshift while wearing the personal monitoring gear. After each 2-day personal exposure monitoring event, area sampling within the rooms were conducted over 24 hrs to determine NH3 levels and over 48 hrs for respirable dust concentrations.

RESULTS
Ammonia and respirable dust levels are the average of measurements obtained over 4 sampling events in each trial. Ammonia concentrations in rooms with measures such as feeding low protein

diet, manure pH manipulation, and high level of cleanliness were found to be substantially lower than in the control rooms. Furthermore, it was observed that the readings from the commercial gas monitoring devices were considerably higher than the concentrations determined from the standard NIOSH method. However, the measured values from all rooms were below the threshold limit value of 25 ppm NH.

For the dust levels, only spraying of canola oil showed the potential to reduce dust concentration as shown in Figure 1; this was expected since the canola oil spray helped keep dust on the surfaces from being entrained into the air. Nevertheless, it should be noted that the dust levels in all the rooms were below the threshold limit value of 3 mg/m3. Comparison of area and personal sampling methods for monitoring dust levels showed that the concentration values obtained from personal sampling were significantly higher than the values obtained from area sampling. This could be due to the different sampling durations; area sampling was conducted over the 48 hours while personal sampling was done in a much shorter period. Sampling duration is a significant factor in the calculation of dust concentration since it directly affects the amount of volume of sample air. Longer sampling durations would lead to larger sample volumes and therefore lower calculated dust concentrations.

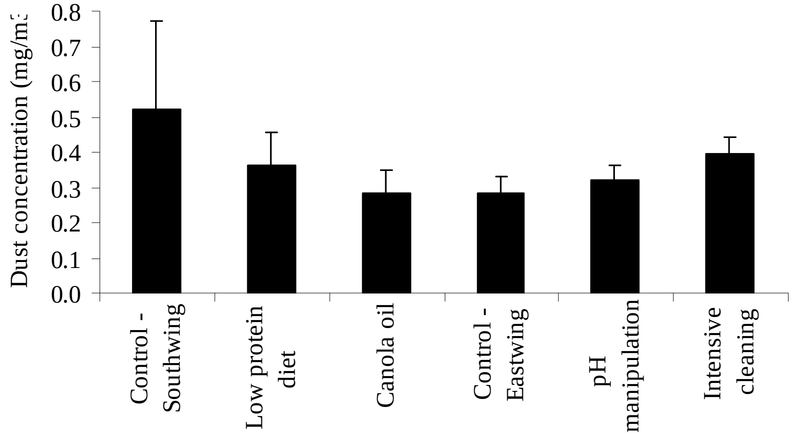

Figure1. Respirable dust concentrations measured in the control and experimental rooms. ACGIH Threshold Level Value (TLV) for respirable nuisance dust is 3 mg/m3.

Pig performance

Average daily gain of pigs in all rooms was relatively similar ranging from 0.95-1.03 kg/day-pig. However, mortality rate was higher in the control rooms with 6.94% compared to the experimental rooms (0-4.0 %). From data collected so far, the difference in pig mortalities between the treatment and control rooms could not be attributed to the levels of ammonia measured in the rooms.

IMPLICATIONS

The results from the completed trials of this study showed that providing pigs with low protein diet, manipulation of manure pH, and employing high level of cleanliness inside barn facilities could potentially reduce ammonia concentrations. On the other hand, only the spraying of canola oil showed the potential to reduce respirable dust concentration. The different engineering measures employed in this study showed no significant impact on the animal performance. Three more trials will be implemented and a benefit-cost analysis of the various engineering measure employed in this study will be conducted.

ACKNOWLEDGEMENT
The authors would like to acknowledge the Manitoba Livestock Manure Management Initiative Inc for the financial support to this research project. Strategic program funding provided to Prairie Swine Centre Inc. by Sask Pork, Alberta Pork, the Manitoba Pork Council and the Saskatchewan Ministry of Agriculture is also acknowledged.

Free Space Utilization of Sows in Free Access Stalls

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Introduction

With announcements by the largest producer/packers in both the USA and Canada that they will transition all of their production facilities to group housing for sows over the next ten years, all North American producers are anticipating a change to group housing. This can be a challenging step for producers, and it is made more difficult by the lack of scientific information currently available on the implementation and design of alternative systems. Group housing systems can be complex to initiate and require greater input from stockmen, however when done correctly, can produce sows that are able to socially interact with one another and have the freedom to move.

Sows currently housed in gestation stalls have almost no opportunity to exercise and perform natural behaviours, leading to a possible decline in well-being. It has previously been suggested that exercise is required to maintain bone composition and strength, and when exercise is insufficient, calcium will be mobilized from the bone itself (Lanyon, 1984 and 1987). Exercise is important to allow the development of bone and muscle to their maximum potential. Decreased muscular strength (which is commonly observed in confined sows) can contribute towards difficulty in lying and standing, and higher susceptibility to lameness due to increased slipping. Lack of exercise in confined housing has also been shown to cause bone weakness in other species. For example, confined laying hens have significantly weaker humeri and tibiae than birds housed in non restrictive environments (Knowles and Broom, 1990). One possible alternative to gestation crates are free access or walk-in/lock-in stalls. This system provides sows with opportunities to interact as a group in a communal area, or remain alone in a free access stall.

There is some concern regarding the degree to which sows use free space group areas, and how to avoid aggression, particularly when new sows are mixed into a group. This study investigates the implementation of walk-in/lock-in stalls for group housed sows. More specifically, the objectives of this study were to compare two different pen configurations by determining the proportion and type (size/parity) of sows that are using the free space areas of the walk-in/lock-in stalls, and also how sows utilize the free space areas.

Experimental Procedures

Eight groups of 25 sows (± 3; mean ± SD) were used in the study, and were housed in walk-in/lock-in stall gestation pens at the Prairie Swine Centre, Saskatoon. Groups were selected according to how many individuals were confirmed pregnant in a batch of animals within a 2 week breeding date window, therefore group size was not always the same. Each of the groups were exposed to one of two configurations of free space areas. The first is referred to as the ‘I’ pen as it consisted of an alley (10ft x 35ft) with slatted flooring running between two lanes of 16 stalls on each side. Any additional stalls, surplus to the group number, were locked off for the purpose of the trial. The second pen configuration is referred to as the ‘T’ pen as it consisted of an identical alley with an additional solid floor loafing area at one end (12ft x 23ft). Sows were weighed when moved from their breeding stall to the gestation pen, and individually marked with livestock paint.

Photographs were taken from mounted cameras at 2 minute intervals over a 24hr period, once a week, for 11 weeks throughout gestation. Two cameras were set up in the ‘I’ pen, one at each end of the pen. Four cameras were used in the ‘T’ pen in order to also observe the free space area. The pens were divided into 3 areas (I pen) and 9 areas (T pen) (see Fig. 1). The individual sow and location was recorded numerically by a trained observer. Measurements recorded from the photographs include the percentage of time spent out of the stall over 24hrs, and also the location and position of sows in the free space areas.

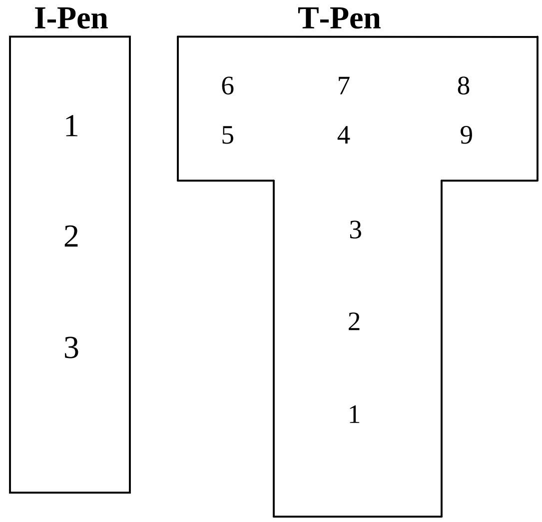

Figure 1. Location of free space areas used for space utilization analysis.

Results and Discussion

The majority of sows did use the free space areas (> 95% of sows) although not on a regular basis or for extended periods of time. The average usage for the 'I' and 'T' pens were both relatively low, however, the sows housed in the 'T' pens used the free space area significantly more than the sows housed in the 'I' pens (P<0.001). More than half the animals in the study spent < 5% of their time in the free space area, however the average usage was ~18% (with considerable individual variation). Heavier sows appeared to use the free space area significantly more than lighter sows (P<0.0001), and older (higher parity) sows also used the free space significantly more (P<0.001). In the 'I' pens, the far end of the pens was the most preferred place to lie, with the highest recorded usage in Area 3 with 8.9% of the average total usage. Similarly, with the 'T' pens, the most preferred place to lie was also in the corners (Areas 5, 6, 8 and 9).

Although many sows did use the free space, it was at a much lower level than expected. This could be due to several possibilities, such as lower ranking animals feeling threatened by higher ranking sows, or larger sows utilizing the free space due to crowding in the stalls. It has been suggested that due to the rigorous selection for improved meat production, the body shape of modern domestic pigs has been changed (Whittemore, 1994). Selection has resulted in larger pigs which can have difficulty lying and standing, and may not fit comfortably into conventional stalls.

The areas where sows have shown a preference to lie down all have more walls than the other available areas, which can act as support. This finding is in agreement with previous studies (mostly in the farrowing environment) where sows also show preference to use support when lying down. Marchant et al., (2001) reported that 89% of lying down events were carried out using either a sloping wall, or a wall fitted with a piglet protection rail.

With the transition towards group sow housing it is important that scientific research is used to design the optimum housing system which can facilitate social interactions and minimize aggression and competition. Future research resulting from this study will focus on methods for encouraging the sows to utilize the free space areas. This will include improving the comfort of the free space area with rubber mats, providing environmental enrichment, or possibly allowing sows access to the free area in different social groups (alternate groups) i.e. gilts and sows.

Implications

Group housing of sows is recognised as an alternative system for improving animal comfort and well-being however, we found that not all sows used the free space areas on a regular basis, or for extended periods of time. It is apparent that the older, heavier sows are utilising the space the most, therefore further research in this area will involve reducing social stress perceived by younger animals, and making the free space area more comfortable.

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The Effect on Growing Pig Performance of Changes in Energy Intake Achieved Through Restriction of Feed Intake versus Changes in Dietary Energy Concentration

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INTRODUCTION

The pig's energy intake can be manipulated through restriction of its feed intake or by altering the energy density of its diet. The former approach is commonly taken in a research setting while the latter is generally the more common approach in commercial pork production. Restriction of the growing pig's feed intake results in decreases in energy intake and in average daily gain. Some authors report analogous findings when dietary energy concentration is manipulated while others report that changing dietary energy concentration does not affect energy intake or growth performance. The objective of the present experiment was to compare the pig's response to changes in energy intake brought about by either a change in feed intake or altering dietary energy concentration.

MATERIALS AND METHODS

Dietary treatments were arranged in a 3 x 3 factorial design with 3 feeding levels (80, 90 and 100% of ad libitum) and 3 dietary net energy concentrations (2.18, 2.29 and 2.40 Mcal/kg). Net energy concentrations were adjusted through proportional changes in the inclusion levels of wheat (15.00, 39.55 and 64.51 % as-fed), barley (55.45, 31.33 and 6.80 % as-fed) and canola oil (1.00, 2.25 and 3.50 % as-fed) in the experimental diets.

Seventy-two individually-housed barrows (initial body-weight 30 ± 2 kg) each received one of nine dietary treatments. On a weekly basis, the pigs were weighed, the feed allowances of the restricted-fed pigs were adjusted and the feed intake (disappearance) of the ad libitum-fed pigs recorded. Pigs were removed from the experiment at a body-weight of 60 ± 2 kg. Data analysis was performed using the MIXED procedure of SAS (SAS Institute, 1996) to examine the fixed effects of feeding level, energy concentration and their interaction.

RESULTS AND DISCUSSION

No interactive effects between feeding level and dietary energy concentration were found ($P > 0.10$). Average daily gain (ADG), average daily feed intake (ADFI), gain:feed (G:F) and protein deposition rate (PDR) increased with increasing feeding level (Table 1; $P < 0.05$). Increasing diet net energy concentration reduced ADFI ($P < 0.05$) but had no effect on ADG, G:F or PDR ($P>0.10$).

As feeding level increased, daily NE intake increased and a greater quantity of NE was available to the pig for body-weight gain ($P < 0.001$); however, the efficiency with which this portion of dietary NE was utilized for growth was unaffected by dietary treatment (Table 1; $P > 0.10$). Diet NE concentration has no effect on NE intake or NE available for body-weight gain ($P > 0.10$). The utilization of NE for gain was unaffected by feeding level or by energy concentration ($P > 0.10$).

The response of growing pigs to changes in dietary energy concentration differed from their response to changes in feed allowance. Each of the two approaches to studying the pig's response to dietary energy provides very useful information on energy metabolism, but extrapolating the findings of one to circumstances of the other must be done with great care. This is particularly noteworthy since most pigs in commercial production are fed ad libitum.

IMPLICATIONS

The present study indicates that, in terms of swine energy metabolism, it may not be universally appropriate to apply knowledge obtained using restriction of feed intake to scenarios in which dietary energy concentration is to be manipulated, and vice versa.

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Table 1. Effects of feeding level and energy concentration on the performance of growing pigs

	Feeding level, % ad lib			NE Concentration, Mcal/kg			
Item	80	90	100	2.18	2.29	2.40	SEM
N	24	23	23	24	23	23	-
Initial BW, kg	30.4	30.4	29.6	30.2	30.2	30.0	0.34
Final BW, kg	59.6	60.3	60.2	60.3	59.7	60.0	0.45
ADG, kg[1]	0.72	0.85	1.06	0.89	0.85	0.88	0.02
ADFI, kg [1, 2]	1.61	1.87	2.05	1.93	1.81	1.78	0.04
G:F, kg/kg[1]	0.45	0.46	0.52	0.46	0.47	0.50	0.02
PDR, g/d[1]	135	153	172	147	156	158	5.5
NE_{Intake}, Mcal/d[1]	3.69	4.26	4.68	4.20	4.14	4.27	0.10
$NE_{Maint.}$, Mcal/d[3]	1.36	1.37	1.36	1.37	1.36	1.36	0.01
NE_{Gain}, Mcal/d[1,4]	2.33	2.92	3.32	2.83	2.78	2.91	0.07
$NE_{Efficiency}$, Mcal/d[5]	3.30	3.43	3.19	3.24	3.31	3.36	0.12

PDR: Carcass protein deposition rate,
[1] Main effect of feeding level (P<0.001),
[2] Main effect of NE Concentration (P<0.001),
[3] $NE_{Maint} = 0.75*106*BW^{0.75}$ (NRC, 1998; Noblet, 2007),
[4] $NE_{gain} = NE_{Maint}$ [5]NE_{gain}/ADG

Enriching Pork Products with Omega-3 Fatty Acids May Affect Pork Quality

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Introduction

It has been shown that the consumption of omega-3 fatty acids, such as α-linolenic (C18:3) is beneficial to human health. Pork fat is representative of the fatty acids consumed by the pig, and the consumption of flaxseed, or flaxseed oil, by finishing pigs will result in a carcass enriched with omega-3 fatty acids. Several recent experiments conducted at the PSCI have examined dietary regimes required to effectively increase omega-3 fatty acid concentration of pork. The flaxseed used has been co-extruded with peas giving a product (Linpro®) with improved handling properties and amino acid balance (i.e. PSCI annual report 2008). However, primarily because unsaturated fatty acids are susceptible to rancidity and are “oilier” in nature this experiment was designed to investigate whether increasing the omega-3 fatty acid content of the pork fat had any effect on carcass quality or sensory properties of pork chops and ground pork prepared from these carcasses.

Materials and Methods

A total of 96 animals with an initial body weight of 48 ± 2 kg (mean ± SD) were used with 12 pens of barrows and 12 pens of gilts (4 animals per pen). Dietary treatments included 3 levels of flaxseed (0, 5 and 10 %) co-extruded 50:50 with field peas (Linpro®, supplied by O&T Farms, Regina, Saskatchewan, Canada). All diets had equal amounts of field peas and diets were formulated and adjusted every 4 weeks to meet the nutrient requirement of the pigs as they grew (NRC, 1998). After 76 days on test, animals were shipped to Lacombe Research Centre (Lacombe, AB, Canada) and slaughtered in a simulated commercial manner. A trained 8-member panel tasted fresh, frozen loin chops and hamburger and scored each for various attributes using a nine point scale.

Results

Performance

Similar to what we have observed in previous studies, feeding 10% flaxseed for 11 weeks had no effect on performance of growing pigs (data not shown).

Carcass quality

Dietary flaxseed did not affect carcass temperature or pH measured 45 min post-slaughter however there was a slight increase in pH at 48 hours post-slaughter. Increasing dietary flaxseed also resulted in higher lean yield and reduced belly firmness and fat hardness ($P < 0.05$).

Pork from pigs fed flaxseed was slightly darker as indicated by decreased l* values ($P < 0.01$). No effects of diet ($P > 0.05$) were observed on tenderness of pork chops (shear force), cooking loss or cooking time.

Sensory attributes

Panellists detected slight decreases in pork flavour and off-flavour intensity in the fresh frozen and reheated loin chops ($P < 0.05$). Conversely, except for juiciness, all the sensory attributes measured, including tenderness, pork flavour intensity and off-flavour intensity in ground pork were negatively affected by feeding co-extruded flaxseed ($P < 0.01$). Furthermore, the percentage of panellists detecting a rancid flavour was increased. This may be a result of increased opportunity for oxidation with processing or because the ground pork was prepared with a higher fat content than found in the pork chops.

Fatty acid composition

The fatty acid composition was determined in intramuscular fat and ground pork and the trends were similar. Dietary flaxseed increased the polyunsaturated fatty acid content of the ground pork, primarily due to a dramatic increase in C18:3 ($P < 0.001$). Although the content of C18:2 (n-6) was increased by feeding flaxseed the omega-6 /omega-3 ratio was decreased ($P<0.001$), which is also beneficial to human health. The increased C18:3 levels in the ground pork (20 % added fat) seen following 10% flaxseed supplementation would be sufficient to obtain a source claim of 300 mg per 100 gram serving in Canada. However, in pure muscle, with lower fat levels, the C18:3 levels would not meet this requirement.

Conclusions

Feeding co-extruded flaxseed to increase the ALA content in loin muscle did not result in levels sufficient to meet label requirements in Canada for a source claim if the cuts were trimmed of fat. Moreover, co-extrusion of flax with peas did not provide sufficient antioxidant capacity to alleviate texture and flavour problems in high fat products (ie. ground pork) with elevated PUFA content. Although high fat products are required to allow labelling for an omega-3 enriched product, the added fat may result in some negative effects on palatability. Strategies must be investigated to mitigate these effects.

Implications

Although high fat products are required to allow labelling for an omega-3 enriched product, the added fat may result in some negative effects on palatability. Strategies must be investigated to mitigate these effects.

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Effects of Transport Conditions and Vehicle Design on the Welfare and Meat Quality of Pigs in Western and Eastern Canada

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INTRODUCTION

Transport conditions (including loading and unloading procedures), and the design of transport vehicles can have a significant effect on the welfare of pigs, and on the economics of pork production. A recent Ontario survey found that death losses during transport were 0.17%. The mortality rate across Canada has been estimated at 0.10%, and corresponds to approximately 1.4 million kg of pork lost per year. Most research on the effects of transport conditions on pigs has been done in European countries where moderate temperatures and shorter transport distances prevail. In comparison, swine transport in Canada is highly variable in terms of the types of vehicles used, distance of transport, and seasonal changes in temperature. The objective of this study was to examine the influence of transport conditions on the behaviour, physiology and welfare of pigs in eastern and western Canada, in both summer and winter. Our goals were to evaluate differences between truck types, truck compartments and seasons in each region, and to use this information to identify problem areas and potential solutions.

EXPERIMENTAL PROCEDURES

Trials were conducted both in summer and winter, with 6 trials per season in the east (Quebec) and west (Saskatchewan and Manitoba). Animals transported were market weight pigs, including both males and females, averaging approximately 115 kg liveweight. A total of 24 truckloads (total of 3,756 animals) were transported in the east, and 12 truckloads (total of 2,145 animals) were transported in the west.

In western trials, a dual purpose (cattle and pig) dual-axle pot belly (PB) truck was used to transport pigs, containing 5 internal ramps to move pigs to different levels within the truck. In eastern trials, two types of trucks were used: a double deck 10 wheel truck (10W) and a tri-axle potbelly trailer (PB). The 10W truck had no internal ramps, and the PB truck used two internal ramps to move pigs onto the upper and lower decks. Loading density on all trucks was 0.41 m^2/pig (k = 0.017).

Temperatures on trucks were monitored, as was the behaviour of pigs during loading, transport, unloading, and lairage. Behaviour during transport was recorded on all trucks using still image digital cameras to determine the percentage of animals standing, sitting or lying during transit. During the lairage period, behaviour was recorded using video cameras to determine the number of pigs lying. Physiological measures, including core body temperature, heart rate, and blood indicators of stress (lactate and CPK), were collected on a total of 504 animals in the east, and 330 in the west. Carcass and meat quality data were collected on 792 pigs in the east and 495 pigs in the west. Skin damage was assessed as a measure of aggression. Pork quality was assessed in loin and ham muscles, including pH measured at 6 h and 24 h, light reflectance and drip loss.

Data from the western and eastern trials were analyzed separately. Statistical analysis was used to determine differences between seasons and truck compartments, as well as between truck types in the eastern trails.

RESULTS AND DISCUSSION

The comparison of truck types in the eastern trials indicated that, overall, transporting pigs on the 10W truck provided superior results in terms of reduced death losses and improved welfare. Compared to the PB truck, pigs took less time to load and unload on the 10W truck, and showed fewer incidents of slipping, falling, backing and balking during loading and unloading. The 10W truck provided more consistent internal temperatures, whereas temperatures within PB trucks varied significantly. Measures of CPK and lactate were also lower in the 10W truck. Differences between HR and core body temperatures on the two trucks are less clear in terms of their effects on welfare. Pigs on the 10W truck had lower core body temperatures at the farm, but higher temperatures and HR during transport. These differences are likely due to the study protocol, as the 10W truck was always loaded last, giving pigs on the 10W less time to acclimatize before transport. Thus pigs on the 10W truck experienced the additive effects of loading and transport.

On PB trucks, significant variation was found within the truck, both in terms of truck microclimate and the response of pigs. In both eastern and western trials, compartments that required negotiation of ramps and turns had the greatest impact on physiological measures in pigs. In the western PB truck, the bottom front compartment (or 'nose') was accessed by 2 ramps, and was also the warmest area on the truck. Pigs in the bottom front compartment had the highest HR measures at unloading, and also produced the highest incidence of DFD pork. Pigs in the upper-level compartments had higher HR and core body temperatures during loading and waiting on the farm. The upper compartments were also cooler during the transport period, and this may benefit pigs in summer, but be detrimental in winter. It should be noted that pigs in this study were transported in early morning, and different results may have been found if pigs were transported in midday. Pigs loaded on the middle deck of PB trucks did not have to negotiate any internal ramps, and these animals also showed lower HR during transport, and lower CPK and lactate levels at slaughter.

The effect of season was significant, but the effects varied between eastern and western trials. In western trials, higher HR and core body temperatures were found in winter, and CPK and lactate levels were also higher in winter. Whereas in the eastern trials, HR and core body temperature were higher in summer, as were blood lactate levels. Pigs in the west experienced a much longer transport time (roughly 8 h vs. 2 h in the east) and colder winter temperatures, and thus winter transport may pose a greater challenge in these conditions. In contrast, pigs in the east had a short transport time, and experienced higher summer temperatures and increased death losses in summer, suggesting that summer transport may be a greater challenge under these conditions.

IMPLICATIONS

Transporting pigs on trucks such as the 10W truck, which do not require the use of internal ramps, provides benefits in terms of improved welfare and ease of loading. Unfortunately these trucks are less economical as they have much reduced capacity compared to PB trucks. In the long run, alternative designs should be sought, such as trucks including hydraulic lifts and/or minimal ramps, to minimize handling stress at loading and unloading.

On the PB trucks, compartments involving ramps and turns had the greatest impact on pig welfare in terms of HR and core body temperature. Further studies will examine the effects of ramp angle and alternative ramp configurations on the stress response of pigs. The PB trucks also showed significant variability in temperature between different compartments. Further research should be done to assess ways of controlling truck conditions to retain heat in winter, while exhausting moisture, and to increase cooling in summer. Potential solutions include adjusting panelling/vent configurations to optimize air flow, addition of insulation, use of fans, adjusting pig density, or sprinkling pigs in hot weather to increase evaporative cooling.

Due to the different results observed in eastern and western trials, future studies in the east will focus on ways of cooling pigs in summer, while studies in the west will focus on the effect of transport time on the welfare and meat quality of pigs.

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