

# 2001 Research Report

Science working for you



# Mission Statement

**Foster the sustainability and prosperity of the pork industry for the good of hog farmers and all Manitobans.**

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## Fellow Producer:

This second annual edition of Council's Research Report is a direct result of the requests for information that you the producers have made to Directors and the members of the Research and Environment Committee. As producers, the Committee members continue to direct research funds to programs and projects that can be of use to all hog farmers in their day-to-day operations. Research is focused on food safety, animal care, workplace health and safety and environmental stewardship. When considering funding the Committee ensures that the research institution's work focuses on our priorities and also considers the ability of the research to leverage additional funds. These additional funds enable access to research that would cost many times more than we would be able fund on our own.



The funding and sponsorship of this research is just the first step in the process. The second step is to communicate the information and knowledge gained from research to our members. This is done in a variety of ways, including monthly "Research News" pieces included in Council's newsletter, on the Council website at [www.manitobapork.com](http://www.manitobapork.com), seminars provided by funded institutions like the Prairie Swine Centre and the University of Manitoba, and an annual Research Report.

The bottom line is that research funded by Council is producer focused, producer directed, and designed to assist all hog farmers in Manitoba. It is truly putting science to work for you.

Best regards,

A handwritten signature in dark ink that reads "Kerry Church". The signature is written in a cursive, slightly slanted style.

Kerry Church  
Chairman  
Research & Environment Committee  
Manitoba Pork Council



UNIVERSITY  
OF MANITOBA

## The Department of Animal Science Faculty of Agricultural and Food Science

# 2001

### Manitoba Pork Council Funded Research

#### **Overview**

The swine research team at the University of Manitoba is committed to advancing the excellence of our swine industry through teaching, research, and service. In 2001, 11 projects were directly allocated funds from the commitment that Manitoba Pork Council made to our program to strengthen this vision. The \$150,000 received from Manitoba Pork, with commitments from other industry partners, was critical to our ability to attract matching funds from the Agri-Food Research & Development Initiative (A.R.D.I.) established by the Government of Manitoba. Manitoba Pork Council and A.R.D.I. funds have led to numerous practical findings, such as candidate processing techniques for the removal of vomitoxin from barley, and the impact of transportation conditions on the subsequent performance of weaned piglets. While the data generated with these research funds will strengthen decision making processes by our industry, a critical result of the investment by Manitoba Pork Council is the training and development of graduate students and post-doctoral fellows. In 2001, 9 graduate students and 2 post-doctoral fellows were funded with the assistance of Manitoba Pork Council, ensuring that highly qualified people will be available to play critical roles towards ensuring the future success of our industry.

The year 2001 also marked a year of success for new infrastructure acquisition. Dr. Martin Nyachoti, in conjunction with Dr. Jan Plaizier, Department of Animal Science, were successful in attracting over \$700,000 from the Canada Foundation for Innovation, the Province of Manitoba, and our industry supporters, including the Manitoba Pork Council, to build a Centre for Advanced Animal Metabolism at the Glenlea Research Station. This unit will permit the study of energy and amino acid metabolism in swine, with the goal of acquiring knowledge to improve swine production.

In addition to direct matching from A.R.D.I., funds received from Manitoba Pork Council are working in concert with in-kind contributions from our other industry partners, and the investments in infrastructure and research personnel made by the University of Manitoba and Manitoba Agriculture and Food. Financially independent of the 11 projects outlined herein, funding secured from other industry players (ie: Manitoba Hydro), provincial granting bodies (ie: Manitoba Livestock Manure Management Initiative) and national granting agencies (ie: NSERC) are addressing additional areas where the acquisition of new knowledge is critical, including issues related to the environment, food safety, and swine health and welfare. The potential for research excellence is substantial due to our ability within the University of Manitoba setting, to foster the interdisciplinary research teams needed to address these critical issues. In total, the

contributions from the Manitoba Pork Council make a substantial contribution to the total operating budget of approximately \$1,200,000, from all sources, for swine-related research. This translates to over \$8 of research funding for every \$1 of funding received from the pork producers of Manitoba. Together, the investments in and commitments to swine research at the University of Manitoba are helping to ensure a competitive and sustainable pork production industry in the province of Manitoba.



## Manitoba Livestock Manure Management Initiative Inc.

# 2001

### Manitoba Pork Council Funded Research

#### *Overview*

The Initiative was established out of an appreciation in the hog industry and in government of the importance of ensuring the growth of the industry without damage to the environment and without compromising goodwill among neighbours of producers in the industry. A meeting was convened by the Economic Development Board and the Department of Agriculture in September, 1997 to facilitate the establishment of an organization which would seek out and fund, where applicable, promising technological solutions to environmental challenges facing the industry. Various stakeholders in the hog industry attended the meeting. Those in attendance identified representatives of each stakeholder group which would serve on the governing council of the organization. The groups represented were: Manitoba Government, Consumers Associations, Financial Institutions, Livestock Producers, Technology Providers, Feed Companies, Livestock Research (Academia), Livestock Processors and Municipal Governments.

In January, 1998, the Manitoba Livestock Manure Management Initiative was incorporated as a not for profit Manitoba Corporation without capital shares with a Chairman, eleven Directors and a Secretary – Treasurer. The Board of Directors serves as volunteers, while the chairman is paid an honorarium by the Initiative. The Department of Agriculture pays the salary of the Secretary – Treasurer and provides office space and services as its contribution to the Initiative. The Initiative's mandate is to encourage sustainable development of the livestock industry in an environmentally sound and community-friendly way, through research and development and demonstration.

The Initiative received \$100,000 start-up funds from the Sustainable Development Innovations Fund. The Initiative's ongoing operations are funded by industry stakeholders with the largest portion of funding provided by Manitoba Pork Council and the feed manufacturers in the province. As well, the Initiative has leveraged its funds by obtaining the participation of other funding agencies in the funding of investigative work into better methods of manure management.

Since its inception, the Initiative has funded a total of thirty eight projects exploring better methods of manure management with a combined value of \$2,553,081. This amount is broken down as follows: Initiative Funds \$1,006,053, Funding by Other Agencies \$604,803 and Contribution by Project Performers \$942,225. The funds are released in the form of progress payments upon the receipt of quarterly reports on the progress of the projects. The projects are managed by the Chairman and the Secretary – Treasurer.

While the Initiative accepts applications for funding on an ongoing basis, there have been six calls for proposals issued with the most recent having closed on February 15, 2001. The Initiative has received and considered a total of 125 applications for funding.

In March of this year, the Initiative embarked on a pro-active approach in calling for proposals for investigative work. In the past we have issued a general call for proposals, usually twice a year, and asked researchers to come forward with recommendations for projects. The Board of Directors decided that it would be useful to request proposals for specific research based on priorities determined by the Initiative.

The Hog Environmental Research Strategy Focus Group was formed, consisting of representatives from Manitoba Pork Council, Manitoba Agriculture and Food, Manitoba Conservation, University of Manitoba, the engineering profession and the Initiative.

The Focus Group met several times in the ensuing months. Their first task was to establish priorities based on the total hog production system, covering: inputs & outputs from animals, animal housing – waste handling & waste storage and land application- crop uptake & residues. From this research, the group developed and recommended that the following Requests for Proposals be considered by the Board of Directors:

1. A study of the role and fate of Phosphorous in livestock and crop production systems
2. A study of regional nutrient balances from both organic and inorganic fertilizers in three Manitoba municipalities
3. A study of food-, water-, and air-borne pathogens and an assessment of health risks associated with manure storage and application
4. A study of odour production, evaluation and control as applicable to current Manitoba conditions and practices in hog production.

The Board of Directors decided to act on all four studies and on October 1st issued the Requests for Proposals as developed by the Focus Group. The closing date for the Requests for Proposals was November 9, 2001. A total of six proposals were received. Proposals on Odour Production, Regional Nutrient Balances and Study on Pathogens were approved for funding in the amount of \$181,546 effective January, 2002. A study on the role and fate of Phosphorous is under further review and funding approval is expected later in 2002.



**Prairie Swine Centre Inc.**

2001

## **Manitoba Pork Council Funded Research**

### **Overview**

Prairie Swine Centre Inc. is a non-profit research and technology corporation with expertise in four disciplines – behaviour, nutrition, engineering and the environment. The mission of Prairie Swine Centre Inc. is *“to provide a centre of excellence in research, education and technology transfer, all directed at efficient sustainable pork production.”* The research program, with a decidedly near-market emphasis, seeks to improve the financial position of pork producers by defining feeding and management systems that maximize net income. In addition, the Centre carries out research to address issues and opportunities in environment, barn air quality and animal well-being.

Dr. Harold Gonyou's team of applied ethologists are addressing such issues as floor space requirements, optimal group size, improved feeder design and dry sow housing alternatives. Dr. Lemay and his team of agricultural engineers are evaluating manure pit additives, ammonia control, green house gases and odour and dust control. Even nutritionists are refocusing, as Dr. Zijlstra and the nutrition team investigate dietary ways to reduce nitrogen and phosphorus emissions in the slurry. Multidisciplinary projects are addressing water conservation, young pig management and environmental management. While the Prairie Swine Centre cannot solve these problems, we can provide information that the pork industry can use to make important decisions about its future.

The Technology Transfer Program utilizes a wide range of activities, from a quarterly newsletter and web page to an annual technical conference, all with a view to communicating research results as quickly and efficiently as possible to the pork industry.

Education activities are diverse and involve partnerships with universities and community colleges. Undergraduate and graduate students at the University of Saskatchewan utilize the facilities as part of their training programs. Students resident at the Centre and enrolled in the College of Graduate Studies and Research at the University of Saskatchewan conduct their research in our extensive animal facilities and complete their work on campus. The result is a graduate program that blends a strong academic foundation with exposure to the commercial pig industry.

Prairie Swine Centre Inc. is located near Floral, Saskatchewan, 10 km southeast of Saskatoon, off Highway #16. The facility includes a 280 head sow herd, annual production of about 7,000 market hogs and feeder pigs, and more than 7,900 m<sup>2</sup> of barn and office space. In April 2000 the Centre populated the new 600 sow farrow-to-finish commercial-like facility (PSC Elstow Research Farm Inc.) which finishes a further 13,000 market hogs, making the Centre Canada's largest swine production research facility.



## VIDO - Veterinary Infectious Disease Organization

# 2001

### Manitoba Pork Council Funded Research

***“Mandated to serve the livestock and poultry industry by conducting animal health related research, communicate livestock management techniques and information, and facilitate the transfer of technology for international commercial development.”***

#### **Overview**

VIDO is excited about its future! Recent announcements with regard to a \$14 million expansion to our building will usher in a major step forward into the world of “Genomics” research. The use of this new technology will keep VIDO on the cutting edge and assure our reputation as a “World Class” food animal infectious disease institution. Construction is scheduled to start early in 2002 with completion in 2003. Our present staff of 85 will increase to approximately 125 once the new labs are operational.

VIDO is recognized as an international biotechnology leader in the development of innovative vaccines and vaccine delivery systems. We are a preferred partner in the development and commercialization of products used by producers in the food animal industry. VIDO currently holds, or has pending, 50 biotech patents. We are proud of our partnerships with our stakeholders, which include producers, pharmaceutical firms, government, universities and other research institutions. Collaborative opportunities with scientists around the world are firmly established. Similarly, Canadian livestock producers are encouraged to regard VIDO with a “Sense of Ownership” as their research facility for infectious disease in food animals and poultry.

VIDO, established in 1975, is a “not for profit” institution located on the campus of the University of Saskatchewan. Wholly owned by the U. of S., VIDO is financed by donations, grants and contract work from producer organizations, government and the pharmaceutical industry respectively. Funding comes from all parts of Canada and around the world. Operating with a budget of \$7 million and growing, our present facility includes 50,600 sq. ft. of modern virology, immunology, bacteriology and biochemistry labs as well as a 160-acre research farm. Public visits are encouraged and welcomed, preferably by appointment.

#### **VIDO’S Major Achievements Include:**

- Establishment of collaborative agreements and specific research contracts with a number of multinational animal health companies.
- Establishment of the VIDO Swine Technical Group and VIDO Beef Technical Group, multidisciplinary teams established to investigate swine and beef production methods.

- Vicogen™, world's first calf scours vaccine protecting against K-99 E. coli enteritis.
- Ecolan-RC™, vaccine for calf scours, protecting against K-99 E. coli, rotavirus and coronavirus enteritis.
- Hevlan-TC™, type II adenovirus vaccine against hemorrhagic enteritis in turkeys and splenomegaly of chickens.
- Pneumo-Star™, the world's first genetically engineered commercial veterinary medicine, Somnu-Star Ph™, and Somnu-Star™.
- Pleuro-Star 4™, a recombinant subunit vaccine for Actinobacillus pleuropneumoniae infection in swine.



## Canadian Research Network on Bacterial Pathogens of Swine

# 2001

### Manitoba Pork Council Funded Research

#### Overview

The Canadian Research Network on Bacterial Pathogens of Swine is the first collective research effort of specialists in porcine bacterial diseases across Canada. The Network, now approaching the end of its second year of operation, regroups 32 researchers from 11 research-based institutions across Canada, including all four Canadian Veterinary Colleges. Last year, three new members joined the Network: Dr. Ronald Ralph Marquardt from the University of Manitoba and Drs. Catherine E. Dewey and Robert M. Friendship from the Ontario Veterinary College, University of Guelph. They all collaborate with the *Escherichia coli* research team of the Network and their expertise is an important asset to this team.

The total five year funding period (2000-2005), which represents an investment of more than 4.2 million dollars, is insured at 73% by the Natural Science and Engineering Research Council of Canada (NSERC), at 7 % by the provincial affiliates of the Canadian Pork Council and at 20% by the private sector i.e. Elanco Animal Health, Pfizer Animal Health and the Institute for Veterinary and Alimentary Biotechnology of the Université de Montréal.

The primary objective of our Network is to establish nation-wide collaborations that foster the sharing of knowledge and expertise in the development of new products destined to improve the health of Canadian swine herds. Our main objectives are: **a)** to study and characterize virulence factors associated with bacterial diseases of swine, **b)** to develop molecular diagnostic tools aimed at more efficient diagnosis of porcine bacterial diseases, **c)** to develop new vaccines and immunization strategies to prevent bacterial diseases of swine and **d)** to train highly qualified personnel by providing opportunities for collaborative graduate studies and post-doctoral fellowships. To fulfill these objectives, the Network has developed 6 research themes:

- Infections caused by *Escherichia coli*
- Infection caused by *Actinobacillus spp.*
- Infection caused by *Streptococcus suis*
- Vaccine development
- Development of Molecular and immunological Diagnostic tools
- Public Health.

We are particularly proud of the work that has so far been accomplished during our first two years of operation. Excellent graduate students and post-doctoral fellows are now working on different research projects and a bilingual website as well as a bilingual Newsletter that is published 3 times a year have been developed. We believed that the concerted effort on behalf of pork producers

and scientists across Canada will yield a net benefit for all parties involved and will assist in maintaining the internationally acclaimed superior reputation of the Canadian pork industry.

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# Section I. Feed & Nutrition



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## COMPARATIVE PERFORMANCE OF PIGS WHEN FED DIETS CONTAINING SPRAY-DRIED PIG PLASMA COMPARED TO THOSE FED EGG-YOLK ANTIBODIES PLUS AN INEXPENSIVE PROTEIN SUPPLEMENT

### Introduction

The objectives of this research were to demonstrate that the inclusion of a vegetable protein concentrate such as pea protein isolate (PPI) and egg yolks containing a high concentration of diarrhea inhibiting antibodies (EYA) can replace spray-dried pig plasma (SDPP) in the diet of weaned pigs. Currently SDPP is widely used in the diet of young pigs with the inclusion rate being from 3 to 10%. Although SDPP has been shown to dramatically improve pig performance (10 to 100% in some experiments) it is expensive (\$5/kg or \$150 to \$500 per tonne feed) and its use in North America or Europe may be banned because of the scare of bovine spongiform encephalopathy (BSE or mad cow disease). The hypothesis for this study was that the beneficial effects obtained with SDPP could be achieved by using a protein supplement with a high content of lysine and protein such PPI plus EYA from chickens that have been hyper-immunized to diarrhea causing bacteria; enterotoxigenic *Escherichia coli*, strain K88 (ETEC-K88). The cost of this combined supplement (3 to 10% of PPI at \$1.50/kg and 0.15 to 0.5% EYA at \$40/kg) would be from \$105 to 200/tonne of feed which is about 30% lower than that of diets containing the SDPP. Also the products are safe and will not be banned.

### Results and Discussion

Early weaned pigs (10 days of age) were fed three diets; PPI-EYA (no antibodies), PPI + EYA (contains chicken anti-diarrhea antibodies) and SDPP (contains pig anti-diarrhea antibodies) over a two week period. The EYA were obtained from Nutratech, Winnipeg and the PPI (79% protein) was from Parrheim Foods (Portage la Prairie). The pigs were monitored for growth rate, incidence and severity of diarrhea, condition of the intestinal tract (villi height) and incidence of mortality and morbidity, and the shedding of ETEC. The respective performance of pigs fed diets containing PPI-EYA, PPI + EYA and SDPP-EYA were: 114, 157 (38% increase compared to the diet with no antibodies) and 167 (46%) grams/day (g/d) weight increase; 85, 123 (45%) and 127 (49%) g/d average daily gain; 25.7, 14.6 (-43%) and 12.3 (-52%) mg/dL plasma urea nitrogen; and 474, 669 (41%) and 651 (37%) micrometer duodenal villous height. The corresponding groups also had mild scours, no scours, and no scours, and 40, 6 and 6%

mortality. All measured parameters in the first treatment (PPI-EYA) were significantly different to those in gains that were dramatically greater (38 to 49%) than for pigs fed diets without the specific anti-diarrhea antibodies. In addition, it was shown that there were no differences in the performance values of pigs fed diets containing SDPP or EYA + PPI. The trends for all other comparisons were similar to those obtained for weight gain or feed intake. It, therefore, should be possible to replace SDPP in the diet of early weaned pigs using a supplement of plant proteins high in lysine and protein, and egg yolk containing anti-diarrhea antibodies. A second experiment confirmed the observations obtained in the first experiment. In addition, they demonstrated that the performance characteristics of pigs fed either SDPP or EYA + PPI were similar to those fed the control diet containing an antibiotic (carbodox, which is now banned). The diets fed and the corresponding daily weight gains over two weeks were: PPI (no additives), 101; PPI + EYA, 151; SDPP, 156; PPI + antibiotics, 152. The average improvements compared to the control diet were dramatic being 50% or more.

### **Implications**

Egg yolk antibodies (EYA) against specific intestinal pathogens such as ETEC are as effective as SDPP at controlling diarrhea and associated mortality in young pigs. EYA also provides a safe, sustainable, environmentally friendly and relatively inexpensive source of antibodies that should not be banned in the future. In contrast, the use of SDPP and many or most antibiotics as feed additives have or may be banned. In addition, SDPP is expensive and has an inconsistent antibody concentration. EYA, as a feed additive, provides an attractive alternative to other antimicrobials. Their use should increase dramatically in the future.

### **Funding**

Manitoba Pork Council, ARDI, NSERC, University of Manitoba

### **Researchers**

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## DEVELOPMENT OF A NEW GENERATION OF ENZYMES FOR SWINE AND POULTRY

### Introduction

Non-starch polysaccharides (NSP) in feedstuffs affect nutrient utilization by non-ruminant animals mainly due to the antinutritive effects associated with water-soluble and viscous polysaccharides and nutrient encapsulating effect of the cell walls. In vitro and in vivo studies were carried out to determine if various carbohydrase enzyme complexes contained appropriate activities to target NSP of soybean meal, canola meal and peas.

### Results and Discussion

A more pronounced depolymerization of the NSP was achieved when selected enzyme preparations were used in concert. When compared to the control (non-enzyme) treatment, the degree of NSP hydrolysis and/or disruption of the cell wall structure averaged 19.5, 34.0 and 24.7% for soybean, canola meal and peas, respectively. Effective enzyme combinations were studied further in digestibility trials with poultry and swine. In the broiler chicken assay, the digestibility of NSP increased from 2.0 to 16.9 % in birds fed enzyme supplemented soybean/canola meal/peas/wheat based-diet. In a subsequent, three week growth performance trial, an improvement in body weight gain (646 vs 682g) and feed conversion ratio (1.43 vs 1.39) was noted with enzyme supplementation. In adult roosters fed the coarsely ground canola seed, the digestibility of NSP increased from 11.1 to 30.1% for the enzyme supplemented sample and resulted in an improvement in energy utilization (4133 vs 4735 kcal/kg DM). In the pig trial, ileal NSP digestibility averaged 10.2 and 26.0 % for the control and enzyme supplemented corn/soybean/canola meal/peas-based diets, respectively. This was followed by the same magnitude of difference in dry matter digestibility (62.5 vs 71.3%). A trend towards improved ADG (231 vs 251g) and FCE (1.87 vs 1.66) with enzyme supplementation was noted.

### Implications

It would appear evident from this study that the application of an effective blend of carbohydrase enzymes can allow for more effective utilization of nutrients by swine and poultry.

### Funding Sources

Canadian Bio-Systems Inc., Manitoba Pork Council, ARDI, University of Manitoba

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## **DIETARY CEREAL AFFECTS INTESTINE BACTERIA NUMBERS IN WEANED PIGS (PSC)**

### **Summary**

Dietary ingredients may be an important component of control of intestine health. A study was conducted with 45 weaned pigs fed diets based on corn, barley, or wheat. Digesta was collected from the small intestine and caecum. Dietary cereal grain or dietary fiber may affect bacteria populations in the intestine.

### **Introduction**

Intestine health in weaned pigs is presently partly manipulated by dietary antibiotics. Cereal grain may compose up to 70% of diets of weaned pigs, and cereal fiber may impact bacteria populations in the intestine. The objective was to characterize the bacteria populations in the small intestine of weaned pigs fed the three main cereals in western Canada.

### **Experimental Procedures**

Diets containing corn, barley, or wheat as the main cereal but not antibiotics were formulated to a similar nutrient content. Diets were fed for 3 weeks to weaned pigs. Fifteen pigs per treatment were killed to collect digesta, which was analyzed for bacterial profiles using plating techniques. Performance was measured on a pen-basis.

### **Results and Discussion**

Switching dietary cereal caused some changes in profiles of the major bacteria populations at the end of the small intestine (ileum) and in the caecum. Diarrhea was not observed in the experiment. Changes in dietary ADF were correlated to enterobacteria in the ileum, and lactobacilli and clostridia in the caecum. Feed efficiency but not body weight gain or feed intake was correlated to lactobacilli in the ileum.

## Implications

The fiber composition of ingredients and therefore diets may impact intestinal bacteria populations. The relation between ingredients and intestinal health is presently ignored in diet formulations. Further research is required to characterize this relationship and bacteria populations in further detail, because control of intestine health may become an increasing challenge with ongoing reductions in access to antibiotics.

## Acknowledgements

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## DIETARY PARTICLE SIZE AND NUTRIENT SUPPLY AFFECT NITROGEN EXCRETION

### Summary

Diets based on barley and peas ground to two particle sizes and with one of two diet formulations (either limiting in energy or amino acids) were fed to cannulated grower pigs. Energy digestibility was affected by particle size but not diet formulation. Total nitrogen excretion was affected by diet formulation, but not by particle size.

### Introduction

Nutrient management may impact the sustainability of the pork industry. Particle size reduction may reduce fecal nitrogen excretion; however, it may also result in an increase in urinary nitrogen excretion (Research Report 2000). In this study, effects of particle size and diet formulation on energy digestibility and nitrogen excretion patterns were investigated.

## **Experimental Procedures**

Diets (barley, peas, soybean meal) with particle size 600 or 900 micrometers were formulated to be either high in amino acids (High AA; 2.8 g dig. Lys/Mcal DE, 3,150 kcal DE/kg) or high in energy (High DE; 1.8 g dig. Lys/Mcal DE, 3,400 Mcal DE/kg). Diets were fed to grower pigs cannulated at the end of the small intestine (ileum). Feces, digesta, and urine samples were collected. Daily feeding rates were adjusted to three times maintenance.

## **Results and Discussion**

Reducing particle size from 900 to 600 micrometers increased total-tract and ileal energy digestibility by 3 and 11%, respectively. Energy digested at the small intestine is more efficiently used than energy digested in the large intestine; thus, particle size reduction may improve energy utilization more than expected from improvements in total-tract energy digestibility. Reducing particle size from 900 to 600 micrometers did not alter urinary or total nitrogen excretion, but reduced faecal nitrogen excretion 11%, indicating that particle size reduction improved nitrogen digestibility but did not reduce total (faeces + urine) nitrogen excretion. Pigs fed High AA-diets excreted 29% more nitrogen, but also retained 31% more nitrogen than pigs fed High DE-diets. Total nitrogen excretion and nitrogen retention (as % of nitrogen intake) were not different between diet formulations.

## **Implications**

Particle size reduction may improve overall energy utilization more than explained by improvements in total-tract energy digestibility. Reducing particle size was effective in reducing fecal but not total nitrogen excretion. Diet formulation is more effective in reducing nitrogen excretion.

## **Acknowledgements**

Strategic program funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council, and Saskatchewan Agriculture and Food Development Fund. Project funding was provided by NSERC.

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## DIETARY PROTEIN AND FERMENTABLE FIBER AFFECT NITROGEN EXCRETION

### Summary

Nitrogen excretion is of concern because of its potential impact on the environment inside and outside the barn. The effects of reducing dietary protein content and inclusion of dietary fermentable fiber sources on reducing urinary nitrogen excretion were additive, together resulting in a 55% reduction. Urinary nitrogen excretion could be predicted from plasma urea (PU) concentration.

### Introduction

The intensification of pig production has raised environmental concerns. Urinary nitrogen is emitted easily as ammonia while fecal nitrogen is less volatile because it is bound within proteins. Reduction of dietary protein is a direct way to reduce nitrogen excretion and ammonia emission. Nitrogen excretion can be shifted from urea in urine to bacterial protein in feces with dietary fermentable carbohydrates. Effects of two levels of protein and three fermentable fiber sources on nitrogen excretion patterns were investigated.

### Experimental Procedures

Diets (wheat, barley, soybean meal; soybean hulls or sugar beet pulp as fiber source) supplemented with synthetic amino acids were formulated to 3300 kcal DE/kg and 2.40 g Dlys/Mcal. Feces, urine and blood samples were collected. Pigs had free access to feed.

### Results and Discussion

For low compared to high protein diets, urinary and total nitrogen were reduced 27% and 16%, respectively, while nitrogen retention was reduced 7%. Urinary nitrogen was reduced 9% units for soybean hulls and 10% for sugar beet pulp-diets; whereas, fecal nitrogen (as % of nitrogen intake) was increased 5% units for soybean hulls and 9% for sugar beet pulp-diets, compared to control. Dietary fermentable fiber did not affect nitrogen retention. Urinary and total nitrogen excretion was not affected by a protein x fiber interaction, indicating a cumulative effect. Both soybean hulls and sugar beet pulp are good sources of fermentable fiber for pigs. Comparison of urinary nitrogen excretion to PU by regression analysis indicated that PU could predict urinary N excretion.

### Implications

Lower total nitrogen excretion may reduce land base needed to apply manure in a sustainable manner. Lower urinary nitrogen excretion will reduce ammonia emission inside and

outside the barn. Models to predict urinary nitrogen excretion may be useful to assess nitrogen status on farms. Further studies are required to validate these models under various conditions.

### **Acknowledgements**

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## **DIETARY MANIPULATION TO OPTIMIZE PHOSPHORUS UTILIZATION IN PIGS**

### **Introduction**

Dietary manipulation has been identified as a potential means to minimize the impact of pork on the environment. The effect of microbial phytase and organic acid supplementation in starter diets on dietary phosphorus utilization and growth performance was investigated in an *in vitro* assay and a 4-week growth trial using 96 pigs weaned at  $18 \pm 1$  days. Pigs were fed a standard starter diet or the standard diet without added inorganic phosphorus with or without microbial phytase and organic acid supplementation.

### **Results and Discussion**

Addition of microbial phytase increased the breakdown of phytate 54.5% compared to control; this was further increased by 2.9% by adding organic acid. Increased phytate breakdown means that more dietary phosphorus will become available for animal use instead of being excreted in manure. These observations were confirmed in the growth trial as the pigs fed diets supplemented with enzyme or a combination of enzyme and organic acid had a higher bone ash content, which is an indication more phosphorus being deposited in the bones. Average daily feed intake, average daily gain, and feed conversion efficiency were similar among diets, although average daily gain was 6.5% higher in pigs fed the diet containing enzyme and organic acid compared to those fed

the non-supplemented starter diet. Digestibility of dry matter and crude protein were similar among diets and averaged 80.7 and 79.4%, respectively. Of all amino acids, only apparent digestibility of isoleucine, histidine and aspartic acid were increased by microbial phytase and organic acid addition. Digestibilities of other amino acids were only numerically improved by microbial phytase and organic acid addition. Apparent digestibility of phosphorus was increased and the amount of phosphorus excreted reduced by 19.9% due to microbial phytase plus organic acid addition compared to control.

### **Implications**

The results of this study show that addition of microbial phytase and organic acid to pig starter diets can improve dietary phosphorus digestion and utilization, thereby reducing the amount of phosphorus excreted in pig manure. Also, with these supplements, pig diets can be formulated without added inorganic phosphorus thus providing opportunities for reducing feed cost.

### **Funding Sources**

Manitoba Pork Council, A.R.D.I., Canadian Bio-Systems Inc. and Cotswold International.

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## THE EFFECT OF ERGOT ON THE PERFORMANCE OF WEANLING PIGS

### Summary

Ergot contains numerous poisonous substances (alkaloids), which upon ingestion by animals may lead to poor growth rate, decreased feed consumption and poor feed efficiency. The effect will depend on the age or physiological stage of the animal, and the amount consumed. The results obtained in this study indicate that the consumption of diets containing more than 0.10% high alkaloid ergot by weanling pigs severely reduces growth rate, and feed consumption and efficiency.

### Introduction

Ergot infection in cereal grains, especially wheat, is of great economic importance. An ergot infection may not result in reduced grain yield but will reduce quality due to the replacement of grain kernels with a number of poisonous alkaloid-containing ergot sclerotia. These grains may end up as feedstuff in swine diets. Ergot ingestion may impair growth and development. Also, the plasma concentration of certain hormones, especially prolactin may be reduced. However, information is lacking on the safe inclusion level of ergot in the diet of the weanling pig. This experiment was conducted to investigate the impact on performance of including ergot-contaminated wheat in the diet of weaned pigs and determine the level that can safely be included in the diet.

### Experimental Procedures

Ground ergot sclerotia were added to diets at 0% (control), 0.05%, 0.10%, 0.25%, 0.50%, and 1.00% (weight basis). Ground wheat ergot sclerotia contained 1880 mg alkaloid/kg with ergocristine, ergotamine, ergosine, ergocryptine and ergocornine constituting 40, 36, 11, 7, and 6%, respectively. Thus, diets contained 0.00, 1.04, 2.07, 5.21, 10.41, and 20.82 mg alkaloid/kg, respectively. Each diet was fed to 8 pens of 4 pigs (2 barrows and 2 gilts) for 4 weeks. Average daily gain and feed efficiency were calculated from the performance data. Prolactin analysis was conducted on serum samples collected from pigs on day 28. Regression analysis was used to determine the effect of ergot level on performance and serum prolactin concentration.

### Results and Discussion

Average daily gain was similar for pigs that consumed diets up to 0.10% ergot, but was depressed at higher levels. The effects were most pronounced in weeks 1 and 2 with pigs fed the 1.00% ergot gaining 82 and 38% less than control (211 vs. 39 g/d, and 432 vs. 269 g/d, week 1 and 2, respectively).

Average daily feed intake was decreased over the entire period but was unaffected by ergot during wk 1 and 2. Feed efficiency (gain:feed ratio) was increased at low levels of ergot inclusion but was reduced with ergot levels above 0.10% (0.685 vs. 0.435, 0.10% vs. 1.00%). Serum prolactin concentration was reduced at all levels of ergot. The maximum level of alkaloids that can be included in weanling pig diets without adverse effects on ADG and feed efficiency was 2.31 mg alkaloid/kg. This is based on the alkaloid content and profile of ergot sclerotia used in this study and corresponds to 0.12 g ergot sclerotia per 100 g diet.

### **Implications**

Feeding high levels of ergot alkaloid caused severe reductions in the growth performance of weanling pigs. Prolonged exposure depressed feed intake. Serum prolactin concentration was depressed which indicates that ergot may impair normal mammary gland development in gilts. When the level of ergot in wheat is known, the level that can be used in weanling pig diet can be calculated. For example, wheat contaminated with 1.0% ergot, should not comprise more than 10% of the diet of weanling pigs.

### **Acknowledgement**

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## EFFECTS OF FIBRE IN CEREAL GRAINS ON PERFORMANCE OF WEANED PIGS

### Summary

Variation in voluntary feed intake and nutrient digestibility restricts use and efficiency of use of Canadian feed ingredients. The weaned pig was used to characterize differences in voluntary feed intake and nutrient utilization in wheat and barley samples that differed in fibre content. Voluntary feed intake, average daily gain, and energy digestibility differed among wheat and barley diets, and correlated negatively with fibre for wheat diets.

### Introduction

Variation in nutritional value of feed ingredients may be related to nutrient content or voluntary feed intake. Fibre content limits digestibility and availability of nutrients, and negatively affects use of Canadian ingredients in the pork industry. An accurate assessment of feed ingredients may lead to a better utilization of nutrients, and lower formulation cost.

### Experimental Procedures

Four wheat and 4 barley diets were each fed to 6 pens for 3 weeks to determine performance of weaned pigs. Four corn diets (control + three levels of purified fibre) were used as a benchmark for variation in fibre content. Diets were formulated to 3.16 g digestible lysine/Mcal DE. Differences in digestible nutrient content were compensated for with purified energy and amino acid ingredients. Faeces were collected and actual DE content was measured. Regression analysis determined relationships between fibre content in feed and pig performance.

### Results and Discussion

Diets ranged from 4.2 to 7.6% in ADF and 11.7 to 21.4% in NDF with barley > wheat > corn. The DE content of diets differed and was consistently overestimated, except for wheat 1. Overall, voluntary feed intake ranged from 0.67 to 0.96 kg/d, ADG ranged from 0.30 to 0.57 kg/d, and feed efficiency ranged from 0.45 to 0.59. Inclusion of purified fibre in corn diets reduced ADG from 0.47 to 0.30 kg/d, and feed intake from 0.81 to 0.67 kg/d. Pig performance differed among diets and within each of the three diet categories. Performance correlated negatively with fibre for corn and wheat diets, but positively for barley diets. Variation in performance and energy digestibility may be related to changes in fibre content of cereals or differences between actual and formulated DE.

## Implications

Feed ingredients differ in nutritional value. Voluntary feed intake of weaned pigs fed wheat diets decreased while voluntary feed intake of pigs fed barley diets increased with increasing fibre content. A complete description of negative effects of fibre will allow development of specific treatments to improve performance.

## Acknowledgements

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## EFFECTS OF PELLETING, EXPANDING PLUS PELLETING, AND ENZYME SUPPLEMENTATION ON BARLEY DIETS WITH WHEAT MILLRUN ON DE CONTENT

### Summary

Individually-housed grower pigs were fed barley or barley-millrun diets with or without supplemental enzyme and processing. The DE content and subsequent performance did not differ between barley and barley-millrun diets indicating grower pigs may be fed high-fiber diets without negative impact on performance. Supplemental enzymes improved DE content of barley but not barley-millrun diets.

### Introduction

Feed costs may be reduced if high-fiber ingredients could be included in diets fed to grower-finisher pigs without affecting performance negatively. Successful inclusion of these ingredients (for example, barley and wheat millrun) may be accomplished by treatment of diets with processing or enzyme supplementation.

## **Experimental Procedures**

Barley and barley-25% wheat millrun diets that were formulated to limit in energy (3200 kcal/kg) but not amino acids (3 g dig. Lysine/Mcal DE). Barley diets were mash, pelleted, or pelleted + expanded and barley- millrun diets were pelleted, or pelleted + expanded. Diets were fed with or without enzyme (beta-glucanase + xylanase) to 6 individually-housed grower pigs.

## **Results and Discussion**

Barley and barley-millrun diets did not differ in DE content, feed intake, or growth performance, indicating that up to 25% of wheat millrun may be included in diets for grower pigs. Supplemental enzyme increased DE content and nutrient digestibility of barley diets, but not of barley-millrun diets. Pelleting versus mash improved DE content of barley diets. Supplemental enzyme increased voluntary feed intake across all diets in week 1 but not week 2; however, improvements in growth performance were not detected.

## **Implications**

Up to 25% wheat millrun may be successfully incorporated in diet formulations for grower pigs without reducing performance, a finding that should be confirmed with group-housed pigs. Supplemental enzymes improved DE content of barley, but not barley-millrun diets, indicating that barley but not millrun contains fibrous fractions that reduce energy digestibility.

## **Acknowledgements**

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## FEED INTAKE AND PERFORMANCE OF SWINE CONSUMING BARLEY-BASED DIETS WITH LOW LEVELS OF VOMITOXIN

### Introduction

The presence of vomitoxin (deoxynivalenol; DON) in swine feeds has been shown to lead to reductions in feed intake, with subsequent negative impacts on performance. The heavy presence of DON-contaminated cereal grains in the eastern prairie region of Canada necessitates the development of strategies to cope with this mycotoxin. Of primary importance is the development of regionally-specific models for the determination of the impact of DON-contamination on the performance of improved genotypes of pigs. To this end, an experiment was designed to determine the impact of low levels of DON on feed intake and growth performance of swine.

### Results and Discussion

144 Cotswold pigs (initial age & weight = 61 days & 23.4 kg) were randomly assigned to barley-soybean meal diets containing either 0, 1 or 2 ppm DON in the final feed (4 pens, each containing 6 barrows and 6 gilts, per treatment) and formulated to contain 13.4 MJ DE/kg and 0.81% total lysine. The final DON contents of the diets was derived by diluting clean barley (<0.2ppm DON) with DON-contaminated barley (DON = 4.9 ppm). Diets contained barley, 48% soybean meal, vegetable oil and a complete vitamin-mineral premix. The same diets were used throughout the grow-finish period. Feed intake, body weight gains were measured on a weekly basis. Over the full grow-finish period, pigs consuming the 2 ppm DON had a 7.5% lower feed intake and a 5% reduction in average daily gain relative to pigs consuming the 0 ppm DON diet, with those pigs consuming the 1 ppm DON diet having intermediate reductions between the 0 and 2 ppm treatments. These reductions translated to a significantly higher number of days required to reach 110 kg (0 ppm = 162.9 days; 1 ppm = 164.0 days; 2 ppm = 166 days) for those pigs consuming DON contaminated diets.

### Implications

Feeding DON-contaminated diets to improved genotypes of pigs results in significant reductions in feed intake, average daily gains, and increases the days to market. These data provide benchmarks for which strategies can be derived to improve performance of grow-finish swine receiving DON-contaminated cereal grains.

## **Funding Sources**

Manitoba Pork Council, A.R.D.I., Manitoba Agriculture and Food, University of Manitoba

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## **NUTRITIONAL VALUE OF DEBRANNED WHEAT**

### **Summary**

Removing bran from wheat produces debranned wheat. The nutritional value of debranned wheat was analyzed using grower and weaned pigs. Using grower pigs, DE content of debranned wheat was 6% higher than the parent wheat. Diets based on 35% debranned wheat, wheat, or oat groats were formulated to an equal nutritional value and fed to weaned pigs. Performance was similar among the three diets, indicating that debranned wheat does not have any adverse effects on voluntary feed intake and is a worthwhile product to include in least-cost diet formulation.

### **Introduction**

Dehulling or debranning of cereal grains results in separation of the hull or bran from the groat. The dehulled or debranned grain or groat should have a nutritional value superior to that of the original grain, because removal of the fibrous hull or bran will reduce the fibre content of the end product. Oat groats are recognized for their palatability and high energy density. The nutritional value of debranned wheat has not been explored to date.

### **Experimental Procedures**

Wheat, debranned wheat, and oat groats were analyzed by proximate analyses. Diets consisting of 96% test product, and vitamins, minerals, and chromic oxide as an indigestible marker were fed to grower pigs. Using estimated nutritional values, mash diets based on 35% debranned wheat, wheat, or

oat groats were formulated to an equal nutritional value (3,490 kcal DE/kg; 1.3% total lysine) and then fed to 3-week-old weaned pigs for 4 weeks.

### **Results and Discussion**

The fibre content was lower for debranned wheat than the parent wheat (NDF, 9.3 versus 12.4% DM). The DE content (as is) was 3,407 kcal/kg for debranned wheat, 3,216 kcal/kg for the parent wheat, and 3,736 for the oat groats, indicating that the DE content of debranned wheat may be up to 200 kcal/kg or 6% higher than wheat. Overall, feed intake was similar among diets fed to weaned pigs, indicating that debranned wheat is a palatable ingredient for weaned pigs. Overall, average daily gain for pigs fed debranned wheat was slightly higher than for pigs fed oat groats, and similar to pigs fed wheat, indicating that the nutritional value of debranned wheat may be higher than calculated based on book values.

### **Implications**

The DE content of debranned wheat was higher than the parent wheat, but did not reach the DE content of oat groats. Debranned wheat does not have any adverse effects on voluntary feed intake and is a worthwhile product to consider for least-cost diet formulation. The nutritional value of debranned wheat should be assessed for a range of wheat samples.

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## NUTRITIONAL VALUE OF HIGH-OIL OAT GROATS

### Summary

High-oil germplasm should increase the DE content of feed ingredients. The nutritional value of high-oil oat groats was analyzed using grower and weaned pigs. Using grower pigs, DE content of high-oil oat groats was 5% higher than regular oat groats. A subsequent performance trial with weaned pigs indicated that high-oil oat groats resulted in a similar performance as regular oat groats if replaced on an equal weight basis.

### Introduction

High-oil is a natural variant in oats, similar to high-oil corn (Research Report 2000). Subsequent dehulling produces high-oil oat groats that should have a nutritional value superior to regular oat groats, because of an assumed higher DE content. Regular oat groats are recognized for their palatability and high energy density. The nutritional value of high-oil oat groats has not been explored extensively.

### Experimental Procedures

High-oil and regular oat groats were analyzed by proximate analyses. Diets consisting of 96% high-oil oats or oat groats, plus vitamins, minerals, and chromic oxide as an indigestible marker were fed to grower pigs. Mash diets based on corn, wheat, or regular oat groats (50 or 100% replacement of wheat) were formulated to an equal nutritional value (phase-1, 3,540 kcal DE/kg, 1.4% total lysine; phase-2, 3,430 kcal DE/kg, 1.24% total lysine) and then fed to 3 week old weaned pigs for 4 weeks (2 wk phase-1, 2 wk phase-2). High-oil oat groats replaced regular oat groats on a weight basis to create a total of 6 dietary treatments.

### Results and Discussion

The fat content was higher for high-oil oat groats than regular oat groats (10.1 vs. 7.2 % DM); however, protein content was lower (11.3 vs. 12.1% DM). The DE content (DM) was 2,920 kcal/kg for high-oil whole oats, 4,341 kcal/kg for high-oil oat groats, and 4,149 for regular oat groats, indicating that the DE content of high-oil oat groats is 5% higher than regular oat groats. The DE content of high-oil whole oats remained low. Average daily gain was higher for 100%-oat groats than wheat diets fed to weaned pigs, indicating that oat groats are a palatable ingredient with a high nutrient density for weaned pigs. Overall, performance of pigs fed high-oil oat groat was similar to pigs fed regular oat groats, indicating that the increase in energy intake did not result in improved performance, perhaps due to the lower than expected protein content of the high-oil oat groats.

## Implications

The fat content of high-oil oat groats was higher than regular oat groats, and did result in a 5% higher DE content. High-oil oat groats did not have any adverse effects on performance and seems a worthwhile product to pursue to increase energy intake of young pigs.

## Acknowledgements

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## PREDICTION OF TRUE ILEAL DIGESTIBLE AMINO ACIDS IN DIFFERENT VARIETIES OF FIELD PEAS

### Introduction

The digestibility of important nutrients such as energy and amino acids is reported to vary widely among different pea cultivars. This variation limits the routine use of peas in swine feeds, as the accuracy of feed formulation cannot be guaranteed. Prediction equations based on simple chemical components offer a means of assessing the feeding value of a given batch before use in diet formulation. Also, true as opposed to apparent ileal digestible amino acid contents should be used in swine feed formulation.

### Progress Update

The animal part of an intensive study on amino acid digestibility has been completed and samples are being analyzed. Once completed, true ileal digestibility coefficients for four Manitoba grown pea cultivars will become available. Furthermore, prediction equations for predicting true digestible

amino acid content in pea will be developed. In addition to the animal study, nine varieties of pea from Morden Agriculture and Agri-Food Canada Research Centre have been characterized in terms of their nutrient content. Although the average dry matter content in green and yellow-seeded cultivars was similar at ~89.5%, yellow-seeded cultivars had higher crude protein content than the green-seeded cultivars; these values were 23 and 21%, respectively.

### **Funding Sources**

Manitoba Pork Council, A.R.D.I., University of Manitoba, Manitoba Agriculture and Food.

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## **REPLACEMENT OF SOYBEAN MEAL WITH CANOLA MEAL IN WEANED PIG DIETS**

### **Summary**

Fibre content is three times higher in canola meal than soybean meal, and may limit nutrient availability in canola meal. The present study determined whether canola meal could replace soybean meal in weaned pig diets with a balanced digestible nutrient content. Increasing content of canola meal increased fibre content in diets, and decreased voluntary feed intake, ADG and feed efficiency. Performance correlated negatively with fibre content in diets, and was reduced when canola meal replaced 75% or more soybean meal.

### **Introduction**

The lower nutritional value of canola meal than soybean meal may be related to a high fibre content. Fibre limits digestibility and availability of nutrients, and negatively affects use of canola meal in the pork industry. An accurate assessment of nutritional value of canola meal may lead to a better utilization of canola meal and reduced nutrient wastes to environment.

## **Experimental Procedures**

Diets with 0, 4, 8, 12, or 16% canola meal, were fed to 5-week-old weaned pigs for 3 weeks to determine effects of canola meal on performance. Canola meal replaced 0, 25, 50, 75, or 100% soybean meal on an equal weight basis. Diets were formulated to equal DE and 3.15 g digestible lysine/Mcal DE. Differences in digestible nutrient content were compensated for with purified energy and amino acid ingredients. Faeces were collected to measure actual DE content. Fibre and glucosinolate contents in feed were determined. Regression analysis determined relationships between fibre content in feed and pig performance.

## **Results and Discussion**

Diets ranged from 4.3 to 6.3% in ADF and 11.5 to 15.2% in NDF from low to high canola meal diets. Dietary glucosinolates were below detection limits, but  $\approx 0.2$  micromoles/g of 3-butenyl or 2-OH-butenyl glucosinolates was measured in 12 and 16%-canola meal diets. The measured DE content of diets differed, and was highest for the 16%-canola meal diet. From low to high canola meal diets, voluntary feed intake reduced from 0.92 to 0.81 kg/d, ADG reduced from 0.56 to 0.46 kg/d, and feed efficiency reduced from 60 to 57%. For each percent increase in canola meal in diet, ADFI, ADG, and feed efficiency decreased by 6.2 g/d, 5.5 g/d, and 2.5, respectively, even though DE was compensated for by addition of canola oil. Performance correlated negatively with fibre content in diets. Reduction in performance may be related to fibre but not glucosinolate content of canola meal.

## **Implications**

Inclusion of canola meal increased fibre content of the diet and reduced performance of weaned pigs. Inclusion of more than 8% canola meal in weaned pig diets may not be economically beneficial to the pork industry, without additional processing to reduce negative effects of fibre content.

## **Acknowledgements**

Strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council, and Saskatchewan Agriculture and Food Development Fund. Project funding was provided by Finfeeds International Ltd., Canola Council of Canada, and National Sciences and Engineering Research Council of Canada.

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## **RESPONSE TO DIETARY ENERGY CONCENTRATION AND STOCKING DENSITY IN WEANED PIGS**

### **Summary**

Understanding the effect of energy intake on growth performance and body composition of pigs is critical for the development of economical feeding strategies. However, knowledge is limited on the influence of varying amounts of DE content on growth and body composition according to the growth potential of the pig. A study was conducted to examine the effect of increasing dietary digestible energy (DE) concentration on weaned pig performance at the farm level. Results indicate that higher dietary DE concentration may not improve weaned pig performance.

### **Introduction**

Gut capacity is assumed to be the primary limitation in growth in the young pig because it limits their daily energy intake. Thus concentrating dietary DE has been assumed to be an effective way to overcome this limitation in gut size. However, increasing dietary DE concentration increases the cost of the diet. In a previous study, increasing DE concentration did not result in improved pig performance. This lack of response to increased dietary DE may have been due to the absence of external stressors. Commercial groups of pigs are under additional stressors such as crowding. Crowding is known to negatively affect pig performance. Concentrating dietary DE may have a greater impact on weaned pig performance in the presence of external stressors.

### **Experimental procedure**

Piglet response to dietary DE concentration and stocking density was studied in 600 pigs weaned at 19 days of age. Pigs were assigned to a low (3.75 ft<sup>2</sup>/pig) or a high (2.50 ft<sup>2</sup>/pig) stocking density and one of 5 dietary DE concentrations (3.19, 3.33, 3.47, 3.61, 3.75 Mcal DE/kg). Pigs received commercial starter diets from 19 to 25 days of age and experimental diets from 25 to 53 days of age. Body weight and feed disappearance were measured weekly. Cost per kg of gain was calculated using overall gain and feed intake.

## **Results**

Final pig body weight ( $20.25 \text{ kg} \pm 0.06 \text{ SEM}$ ) was not affected by diet or stocking density; however, from 46 to 53 d of age, pigs at the low stocking density had higher feed intake (0.93 vs. 0.88 kg/d) and higher daily gain (0.67 vs. 0.62 kg/d) than crowded pigs. Feed intake decreased (0.64, 0.64, 0.63, 0.63, 0.59 kg/d) and feed efficiency (0.74, 0.75, 0.78, 0.79, 0.80) improved with increasing dietary DE concentration. Overall, piglet gain did not improve with increased dietary DE concentration, regardless of stocking density. Cost per kg of gain was greatest for the highest DE diet (0.48, 0.50, 0.50, 0.50, 0.51 \$/kg gain).

## **Conclusions**

A high stocking density can negatively impact piglet performance. In this study, crowded pigs had a 9.2 % slower growth rate than the uncrowded pigs during the last week of the experiment. The weanling pig was able to compensate for reduced dietary DE through increased feed intake. Growth limitations in the weanling pig are not overcome simply by increasing dietary DE concentration. The increased cost of the high DE diets and hence increased cost per kg of gain may not justify the use of higher DE diets in weaner pigs.

## **Acknowledgements**

Strategic program funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development Fund.

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## SOIL FERTILITY EFFECTS ON FEEDING QUALITY OF BARLEY

### Introduction

Sulphur is required as a nutrient for crop yield, but it is also an important component of the amino acids methionine and cysteine, which can be limiting in the diets of pigs. Since sulphur fertility can vary dramatically across the province, as a result of agronomic practices, cropping history and soil type, an experiment was conducted to determine the effect of adding supplemental sulphur, to marginally sulphur-deficient soils, on the yield and nutrient profile of barley.

### Results and Discussion

Barley was seeded in plots at the Carman Research Station on two soil types, sand and clay, and subjected to two different fertilizer regimens: 100 lb N/ac with or without 30 lb S/ac. Four plots were seeded per fertility treatment and soil type, resulting in 16 plots seeded in total. Plots were mechanically harvested, and grain yields, moisture content, crude protein, sulphur content, and amino acid composition determined. There was no significant effect of sulphur fertility on the yield, or protein content of the barley. While grain sulphur levels did increase, this was not reflected in increases in the sulphur amino acids methionine and cysteine in the barley grain.

### Implications

These data provide evidence that, for soils marginally deficient in sulphur, additions of sulphur are not required to maximize the feeding value of the barley, from an amino acid composition standpoint. Further studies are required to determine if fields with poorer sulphur fertility than those studied would yield different results.

### Funding Sources

Manitoba Pork Council, Manitoba Agriculture and Food, University of Manitoba

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## STRATEGIES FOR THE REMOVAL OF VOMITOXIN FROM FEED BARLEY

### Introduction

The contamination of cereal grains with the mycotoxin vomitoxin (deoxynivalenol; DON) presents a challenge to swine producers due primarily to its negative effects on feed intake when present in excess of 1 ppm in the diet. Effective strategies for the removal of DON from grains are critical, especially in regions where this mycotoxin is well established. Studies were conducted to determine the impact of removing the hull fraction of DON-contaminated barley on DON reduction and subsequent effects on the feeding quality of the grain.

### Results and Discussion

One hundred gram samples of hulled barley, with varying DON concentrations (4.8, 9.8, & 21.1 ppm), were subjected to an abrasive-type dehulling procedure, using a Strong-Scott pearling machine, for 0, 15, 30, 45, 60, 75, 90, 105, & 120 seconds (n=4 per time point per barley sample). Following the prescribed pearling times, the remaining grain fractions were analyzed for weight remaining (%), DON (ppm), crude protein (%CP), neutral detergent fibre (%NDF), ash (%ASH), gross energy (GE; kcal/kg), and calculated digestible energy values (DE; kcal/kg). Following the initial 15 seconds of pearling, 85% of the grain mass remained. Additional pearling resulted in a linear decline of 4.5% of grain mass per 15 seconds. Following 15 seconds of pearling, the grain contained 34% of the initial DON content, irrespective of the initial level of contamination (ppm). Additionally, 15 seconds of pearling produced a grain sample containing (relative to un-pearled samples) 103.6% CP, 70.8% ASH, 60.3% NDF, 101.2% GE, and 113.3% DE. Further pearling resulted in continued significant reductions in the % of DON remaining to a level of 7.9% after 120 seconds but with significant losses in grain mass.

### Implications

Our data provide evidence that pearling (de-hulling) can serve as an effective means of reducing the DON content of barley, with improvements in other nutrient parameters. However, the need to reduce the DON content of contaminated barley to less than 1 ppm will necessitate the removal of a significant amount of the grain mass for highly contaminated samples.

### Funding Sources

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UNIVERSITY  
OF MANITOBA

## SUPPORT FOR “CENTRE FOR ADVANCED ANIMAL METABOLISM RESEARCH-CFI NEW OPPORTUNITIES GRANT”

### Introduction

To effectively address current and future challenges in the livestock industry, an in-depth understanding of how animal responds to nutritional as well as management conditions is critical. To achieve this goal, Drs. Martin Nyachoti and Jan Plaizier, both of whom are new faculty members in Department of Animal Science, have recently received funding to establish the required state of the art facilities at Glenlea Research Farm. The funding for this facility was obtained from Canada Foundation for innovation-New Opportunities grants program (40%), Government of Manitoba (40%) and matching from the University of Manitoba and Manitoba Pork Council (20%). Total project value: \$701,157.

Brief description of the aspects of the facility important for swine research Indirect calorimeter:

Will consist of four variable-size calorimetric chambers designed to accommodate pigs of various sizes. They will be used to determine energy metabolism in pigs fed different diets as well as in those subjected to different environmental conditions. This equipment will also allow energy metabolism at whole-body or individual organ level to be determined. Such measurements are critical for advances in converting dietary nutrient into edible animal products.

Associated with these chambers will be metabolism crates designed to allow separate and quantitative collection of nitrogen and feces for nutrient digestion and balance studies. The facility will also include an on-site laboratory fully equipped with various analytical equipments and sample handling facilities.

Examples of research to be enabled by the facility:  
Some of the important research areas to be enabled by this facility include:

- 1) Development of better methods for feed ingredient evaluation. Understanding how specific dietary factors impact on energy and amino acid utilization in pigs will provide critical knowledge required to advance our ability to optimally feed pigs.
- 2) The impact of environment on energy and amino acid metabolism in pigs, including requirements for these nutrients by different pig genotypes.
- 3) Development of means for manipulating gut function to enhance nutrient utilization particularly in young pigs. This area is important as the industry continues the search for alternatives to in-feed antibiotics.
- 4) Development of a database for net-energy values of commonly used and alternative feed ingredients used in swine feed.

### **Impact**

The research to be enabled at this facility will enable the swine industry in Manitoba to address important production issues relative to sustainable production (i.e. optimal nutrient utilization for efficient growth and environmental safety, production without reliance on in-feed antibiotics, cost-effective production systems, etc.).

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**See also the following summaries from other sections:**

***The impact of feeder adjustment and group size/ density on weanling pig performance***

***Ingredient processing and enzyme supplementation for minimizing nutrient excretion and manure volume***

## Section II. Animal Care



### EFFECT OF GENDER AND CROWDING ON VARIATION IN DAYS TO MARKET

#### Summary

Marketing strategies are affected by variation in days to market within groups of pigs. This study determined effects of gender and crowding on variation in body weight (BW) gain and days to market. Pigs were marketed individually at an identical market weight resulting in uniform carcass characteristics. Crowding did not increase variation; however, pigs marketed first were the heaviest pigs when traced back to farrowing. Thus, raising the growth curve of all pigs may be more practical than reducing variation. The latter appears very difficult on most farms.

#### Introduction

Managing variation in the production chain is receiving increasing attention. The economic impact of variation when marketing groups of pigs is enormous, yet few research programs focus on this issue. Uniformity of pigs reaching market weight may be affected by variation in growth caused by gender or crowding during the entire grower-finisher phase.

#### Experimental Procedures

At weaning, 493 pigs were assigned randomly within gender to a pen containing either 16 pigs/pen (0.35 m<sup>2</sup>/pig; Control) or 21 pigs/pen (0.26 m<sup>2</sup>/pig; Crowded). In the grow-finish room, pigs were allowed 0.88 m<sup>2</sup>/pig (Control) or 0.67 m<sup>2</sup>/pig (Crowded). Pigs were weighed at birth, days 21, 56, 77, 112, and 140 of age, and at market (~ 115 kg).

#### Results and Discussion

Crowding did not affect BW until day 77 when Control pigs were 1.6 kg heavier than Crowded pigs. Gender did not affect BW until day 56 when barrows were 2.7 kg heavier than gilts. Coefficient of variation (CV) for BW at day 140 or days to market was not affected by gender or crowding. Together, results indicate that crowding reduced mean BW gain, but not variation around the mean. Marketing individual pigs at a specific BW resulted in similar carcasses between Control and Crowded pigs. Overall, for an extra kg BW at weaning, 1.9 kg extra was gained at day 56 (8 weeks), 2.4 kg extra at day 77 (10 weeks), and 4.2 kg extra at day 140 (20 weeks), indicating the importance of increasing weaning weight.

### **Implications**

Marketing strategies should be developed based on variation within groups of pigs. Holding gilts longer than barrows may improve market value of a group. Less crowding reduced days to market (115 kg) by 4 days. Barrows reached market weight 6 days earlier than gilts.

### **Acknowledgements**

Strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development Fund.

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## **EFFECT OF GROUP SIZE ON AGGRESSION OF GROWER-FINISHER PIGS**

### **Introduction**

Research on management and performance of grower-finisher pigs has generally been conducted with small group sizes while the swine industry has shifted towards larger group sizes. Our previous study has shown that productivity of pigs was not affected by group sizes up to 80 pigs/pen. However, there are still concerns about aggression and injuries among pigs in a large group. The objective of this study was to determine effects of group size on aggression and injuries of pigs.

### **Materials and Methods**

Each of 2 replicates was comprised of two pens of 10 pigs, and one pen each of 20, 40 and 80 pigs. Each pen contained an equal number of males and females with initial body weight of 23.2kg. One wet/dry feeder was provided for every 10 pigs. Space per pig was constant among group sizes. Aggression was observed for the initial 8 hours post-regrouping. The number and duration of fights were recorded by continuous observation. Injury scores were collected 48 hours post-regrouping on four body zones. Time spent lying, standing, eating, and sitting was determined at week 3 and week 10 during the study period.

## Results and Discussion

Pigs in large groups did not show more aggressive behaviours than those in small groups. Total duration of aggression was similar among group sizes. Fighting time was longer during the initial 2 hours post regrouping and declined thereafter. About 95% pigs fought during the first 2 hours post-regrouping, and there were no differences among group sizes. Injury scores were similar among group sizes. Injury was closely related to aggression. There were no differences in time spent on lying, standing, eating, and sitting among group sizes. Three weeks after regrouping, pigs in both large and small groups spent 75~80% and 7% of total time on lying and eating, respectively.

## Conclusion

Large group size did not cause higher aggression or more severe injuries in pigs. At regrouping, most aggression causing injuries occurred during the first two hours post-mixing. Pigs in large groups behaved similarly to those in small groups.

## Acknowledgements

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

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## IMMUNE DEVELOPMENT OF THE SWINE UPPER RESPIRATORY TRACT

### Introduction

The immune system at the respiratory tract has focused much attention in the recent years because respiratory infections and hypersensitivities still are important problems for humans and animals. Besides, age is an important factor since it is recognized that children and young animals are more susceptible to respiratory diseases than adults. Mucosal immunization at the respiratory tract has several advantages when compared to oral immunization. For example, the antigen

access to the lymphoid organs is more readily achieved using this route and antigen degradation is less important than in the digestive tract. Developmental studies on the lymphoid tissues of the respiratory tract will allow us to understand both internal and external factors influencing its development and to determine the appropriate age to immunize children and animals to protect them against the most common respiratory diseases.

### **Results and discussion**

Using a swine model of unweaned piglets we propose a longitudinal study to analyze the development of the lymphoid organs after birth and the use of an experimental model of pig bronchopneumonia to study the effect of vaccination on protection and immune induction at the upper respiratory tract in early weaned animals. Tissues to analyze include tonsils, regional lymph nodes in the neck, trachea and bronchi and trachea. The analysis will include number and phenotype of cells in the organ, antigen specific cell activation, cytokine and antibody production.

### **Implications**

Developmental studies will allow the understanding of the maturational stages in the mucosal immune system of the upper respiratory tract, interphase between the environment and the organism. This will generate information for the rational design of appropriate vaccine formulations and will shed light about the proper age and route of immunization.

### **Funding sources**

Manitoba Pork Council, Sask Pork, Alberta Pork, Western CARD, NSERC Swine Network, CIHR

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## THE IMPACT OF FEEDER ADJUSTMENT AND GROUP SIZE / DENSITY ON WEANLING PIG PERFORMANCE

### Summary

An experiment was conducted to examine the impact of group size / density and feeder adjustment on the performance of weanling pigs. Providing more floor space resulted in increased body weight at 10 weeks of age. Performance was maximized when the feeder gap allowed for 40% of the trough to be covered with feed. Moreover, proper adjustment of the feeder reduced the time spent eating and thus increased feeder capacity.

### Introduction

Crowding and/or reduced floor space allowance negatively affects nursery performance and exacerbates social vices such as tail-biting, side-nudging and ear chewing. Feeder adjustment impacts feed intake and can alter feeder capacity. Since some of the detrimental effects of crowding are due to decreased feed intake, adequate floor space and proper feeder adjustment may act in a synergistic fashion to improve pig performance.

### Experimental Procedures

Seven hundred and sixteen pigs weaned at an average of 18.2 days of age were assigned to: 1) 24 pigs per pen, 2.5 ft<sup>2</sup> per pig, 2) 20 pigs per pen, 3.0 ft<sup>2</sup> per pig [approximates commercial conditions] and 3) 16 pigs per pen, 3.75 ft<sup>2</sup> per pig [approximates the Canadian Code of Practice] for a 42 day trial. Eight days later (day 0 of experiment) feeders were adjusted to provide gap openings of 9.2, 11.8, 17.9, 24.8 and 31.5 mm. Only a small bead of feed was available with an opening of 9.2 mm while the entire trough was covered with an opening of 31.5 mm. Feeding behaviour was videotaped on days 3 to 6 and on days 39 to 42 and on day 42 each pig was scored for incidence and severity of tail biting, side nudging and ear chewing.

### Results and Discussion

The effect of treatment on body weight and feed intake were not apparent until the second half of the experiment. Body weight, daily gain and feed intake were maximized with a minimum feeder gap size of 18 mm or when at least 40% of the feeder trough was covered with feed. Younger pigs spent more time eating with a reduced feeder gap; however feed intake and daily gain were lower. Assuming that feeder capacity is achieved when it is being used 90% of the time, the maximum capacity of a nursery feeder space would be 9 pigs when adjusted to a 9 mm gap, but 11 pigs when adjusted to a 25 mm gap. The optimal feeder gap would change with

different feed particle size and form; however it is achieved when at least 40% of the trough is covered with feed. Feeders with smaller gaps also required frequent unclogging.

Decreasing group size and providing more floor space per pig resulted in increased final weight, daily gain, and feed intake. When expressed on pork produced per ft<sup>2</sup> of floor space the results favour crowding. However, previous research at PSC Elstow revealed that for every 1 kg increase in body weight at 11 weeks of age, body weight at 17 weeks of age increased by 1.5 to 1.8 kg. The economics favour reduced crowding when considering the increased growth rate.

The effects of density/group size on final weight was more dramatic with a reduced feeder gap opening. Neither floor space allowance or feeder adjustment affected the incidents of aggression, measured by skin lesion scores.

### **Implications**

Body weight at 10 weeks of age was greater with increased floor space allowance, however, the kg of pork produced per ft<sup>2</sup> of floor space was increased with crowding. Nonetheless, when, considering the increased net income due to the increase in nursery exit weight, the present results favour reduced crowding.

Optimal feeder gap is obtained when at least 40% of the feeder is covered with feed. Proper feeder gap adjustment reduced the time spent eating and thus increased feeder capacity. Assuming that feeder capacity is achieved when it is being used 90% of the time, the maximum capacity of a nursery feeder space would be 9 pigs when adjusted to a 9 mm gap, but 11 pigs when adjusted to a 25 or 32 mm gap.

### **Acknowledgements**

Strategic program funding provided by Sask Pork, Alberta Pork, the Manitoba Pork Council, and the Saskatchewan Agriculture and Food Development Fund. Direct funding from the Pig Improvement Co. of Franklin, KY is greatly appreciated.

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## **INDUCTION OF PROTECTIVE MUCOSAL IMMUNE RESPONSES USING NOVEL ADJUVANTS, DELIVERY SYSTEMS AND IMMUNIZATION PROTOCOLS**

### **Introduction**

The digestive and respiratory mucosae are the main targets of great number of pathogens. Therefore, immunization at those sites would prevent infection in humans and animals. Also those sites are one of the most viable alternatives for needle-free antigen administration increasing the number of patients or animals covered and reducing the risk of cross contamination, the use of expensive sterile material and the need of trained personnel. However, current mucosal immunization protocols have no practical use in humans and large-scale vaccination because they require large doses or live antigens, and bacterial toxins as adjuvants. Therefore, novel delivery systems, non-toxic adjuvants and effective mucosal immunization protocols are needed.

We are studying the combination of the outer membrane lipoprotein A (OmlA) of *Actinobacillus pleuropneumoniae* (App) with novel adjuvants (CpG-DNA) and delivery systems (VTA) using different routes of immunization in an experimental model of pig bronchopneumonia to induce mucosal and systemic protective immune responses.

### **Results and discussion**

Our preliminary studies have shown that two subcutaneous (SC) immunizations with OmlA, using CpG-DNA in VTA, induced specific nasal and systemic immune responses and protection. In order to increase the respiratory immune response, SC immunization and intranasal (IN) boost induced anti-OmlA specific antibodies in serum and nasal secretions, although protection remains to be demonstrated. During the next 12 months we will assess the transcutaneous route using microneedles, and needle-free alternatives such as the IN/IN and percutaneous immunizations using delivery systems that allow the antigen penetration through the mucosa and the skin.

### **Implications**

This research is of paramount importance in the design of protective vaccines using alternative routes of immunization (some of them needle-free) and novel adjuvants that induce strong immune response but not extensive tissue damage through especially designed antigen delivery systems.

### **Funding sources**

Manitoba Pork Council, Sask Pork, Alberta Pork, Qiagen, NSERC/CRD, Western CARD, CARD.

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## PORCINE ADENOVIRUS-3 VECTOR BASED PORCINE VACCINES

### Introduction

Significant economic losses are caused in the pig industry by infection. Developing effective preventive measures such as vaccination could prevent these losses. Since many disease-causing organisms enter at mucosal surfaces (respiratory and gastrointestinal tract), immunity is required at the mucosal site to block the initial infection and thus reduce the chances of development of disease. As compared to sub-unit vaccines, live vaccines are best inducers of mucosal immunity when administered orally or intranasally. In addition, production of live vaccines is cost effective. However, use of live vaccines produced by conventional means ensures that the live organism is always present in the animals which many times can mutate back to virulent form (in vivo recombination) and cause fatal disease. Thus, new approaches have to be developed for the safe and cost effective production of viral vaccine antigen. One way to achieve this is to develop live-vectored vaccines. This will not only improve vaccination, but will also reduce the cost of producing vaccines. This grant is designed to develop a generic delivery system for viral antigens for use in porcine as effective vaccines.

### Results and Discussion

We have chosen porcine adenovirus-3 (PAV-3) for the development of such vaccines as it infects porcine respiratory and gastrointestinal tract and induced mild disease. By genetically engineering this virus, we can cripple (E3 deletion) it so that it will not cause disease. Introduction of foreign genes (respiratory / enteric viruses of porcine) into different regions of PAV-3 genome, will not only reduce the pathogenicity of the virus, but will also make PAV-3 as a safe and effective vehicle for

delivering vaccine antigens at the mucosal surfaces. To date, we have sequenced the genome of porcine adenovirus-3 and determined the transcriptional map. This helped us to identify the regions (e.g. E1, E3 and E4), which can be used for the insertion of foreign genes. We have also developed an easy method of constructing recombinant PAV-3. Using this method, we constructed a full length PAV-3 genomic clone in a plasmid. This plasmid DNA when transfected into porcine cells produced virus, which was identical to wild type PAV-3. In addition, we have demonstrated that while E1 region is essential for virus replication, E3 region and region between E4 and right ITR are non-essential. In the next 12 months, we will construct recombinant PAV-3 expressing vaccine antigens and test their ability in the induction of protective immune responses in pigs.

### **Implications**

Significant economic losses are caused in pig industry by infection. Developing effective preventive measures such as vaccination could prevent these losses. This proposal describes a unique approach to the production of a new generation of safe, cost effective and highly efficacious vaccines for animals. Piglets at birth can be vaccinated by intranasal administration of recombinant porcine adenovirus thus circumventing the problem of passive immunity the piglet receives from the dam. In addition, this route of immunization will eliminate the use of needles, which cause injection site reactions, affecting the quality of meat.

### **Funding Sources**

Manitoba Pork Council, Sask Pork, Alberta Pork, Saskatchewan Agriculture and Food Development Fund, AARI, NSERC.

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## ROLE OF PORCINE CIRCOVIRUS TYPE 2 IN PMWS DISEASE

### Introduction

Humans can become exposed to swine viruses due to increased intensive swine production and the proposed use of pig organs for xenotransplantation. Our objective was to determine the extent of PCV2 in healthy slaughtered hogs. Porcine circovirus (PCV) was initially identified as a contaminant of PK15 porcine tissue culture and was not thought to be pathogenic. A variant of this virus was subsequently isolated from pigs with a clinical syndrome, which has been called postweaning multisystemic wasting syndrome (PMWS).

Isolates from swine with PMWS in several countries were antigenically and genomically similar (called PCV2), but distinct from the isolate of PCV from PK15 cell cultures (called PCV1). There are significant differences between PCV1 and PCV2. The putative structural antigen is encoded by ORF2, which shares only 65% amino acid homology between the two types.

Exposure to PCV has been detected using PCR, serologic and immunohistochemical techniques. Previous studies using whole virus or infected cell culture as antigen to detect antibody to PCV found that infection with PCV was generally common in swine herds, but these studies did not use an ELISA antigen that was specific for PCV2. To overcome this problem, and avoid mixed infection in tissue culture of both PCV types resulting in a nonspecific antigen, we produced a fusion protein of GST and ORF2 from PCV2 that was expressed in *E. coli*.

### Results and Discussion

Overall, 386 serum samples were tested and 318 of these (82.4%) demonstrated antibody to PCV2-ORF2, and PCR tests demonstrated that the DNA from PCV2 was present in 203 of the samples (52.6%). Although these sera were obtained from clinically healthy pigs without discernable lesions, PMWS disease had been observed in swine raised in the area.

### Implications

1. PCV2-ORF2 fusion protein reacted with rabbit antiserum to PCV2, but not with antiserum to PCV1.
2. We detected antibody to PCV2 as well as PCV2-specific nucleotide sequences in a high proportion of healthy hogs slaughtered for human consumption.
3. The widespread occurrence of PCV2 in swine suggests that this virus is adapted to replication in porcine tissue.

4. These studies indicate that a very high proportion of normal swine had evidence of exposure to PCV2. Although PCV2 is clearly associated with PMWS, the health of these pigs shows that infection with this virus is seldom sufficient to result in disease.

### **Funding sources**

Sask Pork, Alberta Pork, Manitoba Pork Council, and Ontario Pork provided strategic funding. NSERC, and other sources provided additional project funding.

### **Researchers**

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## **THERMOREGULATION OF THE NURSERY BY EARLY WEANED PIGLETS THROUGH OPERANT CONDITIONING**

### **Summary**

A study was designed to determine the optimal temperature preferred by early weaned piglets in a standard nursery environment through the use of operant conditioning (a process of changing behaviour by rewarding or punishing a subject each time an action is performed until the action is associated with pleasure or distress).

### **Introduction**

The thermal environment has a large effect on the health and productivity of growing swine. This is especially critical in the case of newly weaned piglets, which require warmer temperatures in the nursery environment. Today's confined pigs are often prevented from selecting their optimal temperature. Instead, it is the farm manager that selects the temperature setpoint. During the colder months, nursery temperatures are frequently kept relatively uniform over space and constant over time, which deprives young pigs of the chance to select an environment more comfortable than the one chosen by the barn manager. Previous studies on thermal preference in swine have concentrated on pigs 4 weeks of age and older, and have not investigated the optimal temperature for early

weaned pigs. Through the use of operant conditioning in these previous studies, pigs have demonstrated the ability to respond to heat rewards and successfully control their thermal environment.

### **Experimental Procedure**

Temperature preference was studied in piglets early weaned at 12-14 days of age in 5 consecutive replications during the winter of 2000. Each replication of the study lasted 21 days and took place in a single nursery room of 6 pens with 8 piglets per pen.

Through the use of operant conditioning, in which an infrared heat lamp was used as a heat reward, one pen of 8 pigs controlled the gas heater in the nursery room. Within the controlling (C) pen, a box was mounted which had both an operating (O) and non-operating (NO) lever. The infrared heat lamp was positioned over the O lever. The position of the O and NO<sub>1</sub> levers were switched between replications. A second pen within the room was also equipped with a box mounted with a NO<sub>2</sub> lever.

Temperature data was collected every 5min. by means of thermocouples positioned throughout the nursery room connected to a datalogger. All hits to the O, NO<sub>1</sub>, and NO<sub>2</sub> levers were recorded via the datalogger as they occurred. Relative humidity readings were taken daily with a psychrometer. Pigs were weighed at weaning and at 21 days post-wean.

### **Results and Discussion**

The results demonstrated that piglets early weaned at 12-14 days are cognizant to a degree which allows them to learn to control their thermal environment successfully through the use of operant conditioning.

As age increased, the average preferred temperature for the early weaned piglets decreased by approximately 1.0°C per week. Average temperature preferences were 26.33°C, 25.71°C, and 25.24°C for days 3-5, 10-12, and 17-19, respectively. While the average maximum temperature each week did not differ significantly, the average minimum temperature was highest days 3-5 post-wean. Furthermore, minimum temperature in the room did not drop below 19°C (lower temperature safety setting), which kept average minimum temperatures between 22-23°C. Thermal preferences consistently ranged between 22-29°C each week post-weaning.

Thermal preferences reflected a circadian sinusoidal pattern in

which the piglets preferred the highest temperatures during the day and the lowest temperatures during the night. These results agree with trends found in studies done in grow/finish hogs.

### **Implications**

While it is known that early weaned piglets require warmer temperatures in the nursery, these data suggest keeping the thermal environment uniform over space and constant over time is NOT preferred by piglets. Temperature settings for the nursery should be based on size and age of the animal as well as time of day. This challenges hog producers to consider more fuel efficient ways of managing the thermal environment of the early weaned piglet.

### **Acknowledgements**

Funding provided by NSERC along with strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development Fund.

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## **TIMED WEANING, ESTRUS ONSET AND REBREEDING PERFORMANCE OF SOWS**

### **Introduction**

The domestic pig, whose ancestors were short-day seasonal breeders, still retain some of their responsiveness to photoperiod change. Modern genotypes rarely realize their genetic potential for litter size. Sub-optimal fertility may be associated with prolonged weaning to estrus intervals (WEI) and variable duration of estrus which makes correct timing of inseminations difficult. The objectives of this research included determining whether the hour of weaning could affect the WEI, timing of the LH surge, timing and number of ovulations and subsequent reproductive performance of sows kept under short photoperiod (9 hours light: 15 hours dark) or long photoperiod (14 hours light: 10 hours dark).

## **Results and Discussion**

In the first phase of the research, 94 sows were kept under a short photoperiod (9 hours) from 105 days of gestation, throughout an 18 day lactation and during the rebreeding period. Sows weaned as soon as lights came on at 8 AM had a WEI of  $99.6 \pm 27.9$  h, which was similar to those weaned just before lights went off at 5 PM ( $106.6 \pm 42.3$  h). However, there was significantly less variation in the WEI of sows weaned at 8 AM and more of the AM weaned sows were first detected in estrus during the morning hours. Both of these features are beneficial for early estrus detection and breeding management. Analysis of blood sera samples, taken from 18 sows at 30 minute intervals from weaning to the second day of estrus, revealed several characteristics of hormone profiles for estrogens, LH and progesterone. Although the hormone characteristics following weaning were similar for the AM and PM weaned sows, more of the AM sows showed synchronous LH surge and presumably subsequent ovulation. Current research is examining the influence of longer photoperiods during lactation and the timing and number of ovulations following timed weaning. Future studies will investigate the potential of timed weaning to allow fixed time insemination.

## **Implications**

Results thus far indicate that hour of weaning can influence the WEI and therefore timing of ovulation. Combined with results from ongoing and future investigations manipulating the time of weaning may prove an effective way to accurately predict the time of the LH surge and ovulation, thus facilitating optimal timing of inseminations for maximizing fertilization rate and subsequent litter size.

## **Funding Sources**

Manitoba Pork Council, A.R.D.I., Cotswold Canada, Manitoba Agriculture and Food, and the University of Manitoba

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## TRANSPORTATION OF EARLY WEANED PIGLETS: CONDITIONS ON COMMERCIAL JOURNEYS

### Introduction

The relocation of early weaned or isoweaned piglets to a separate site in order to reduce the risk of infection from older animals necessitates some form of transportation. These journeys vary in length but typically, in Canada, fall within the 4-20 hour range. Transport is a significant stressor for young piglets, which lose water reserves during the journey and are slow to begin feeding afterwards. As weaning occurs throughout the year, journeys can proceed in a wide variety of environmental conditions. Temperature during transport can vary considerably and is dependent on season. Furthermore there is little information on the preferred transport temperature ranges for piglets. The optimal environmental temperature range for an early weaned piglet based upon Agrifood Canada recommendations is 24-34 °C. Work here at the department has used simulated transport to investigate the effect of transport temperature. Findings showed that long journeys of 24 hours at higher temperatures of 35°C and shorter journeys at temperatures of 20°C had the greatest adverse effects on post-weaning performance. There is a lack of information concerning actual temperature conditions experienced during commercial transport. To remedy this we collaborated with a number of local producers and transport operators by placing a remote temperature datalogger in vehicles transporting early weaned piglets on journeys both within and between provinces.

### Results and Discussion

All trucks monitored were unheated and piglets were grouped in units of 150-200. Deep straw bedding on a layer of sawdust was used for winter journeys while fall journeys utilized less bedding. Commonly the trailer temperatures were low during morning loading, however after commencement of the journey the trailer temperature rises rapidly. Following this rise in temperature conditions remain fairly constant with some short peaks when the vehicle is stationary during routine breaks.

In winter temperatures can fluctuate within a 20°C range as the vehicle moves through differing climatic conditions and ventilation is adjusted accordingly. Temperatures averaged 6.1°C in winter, however temperatures can fall to below freezing and remain there for many hours (minimum recorded -8.8°C) highest recorded temperature during the winter is still well below recommendations for temperature requirements for early weaned piglets. Fall conditions were less variable and conditions averaged 19.3°C with minimum temperatures never falling below freezing. In both fall and winter few problems were reported on reaching the destination.

## **Implications**

Recommendations for transport temperatures need to consider real conditions which can fluctuate dramatically. Research here suggests that low temperatures do not seem to cause undue problems providing there is good transport management ensuring adequate bedding material and control of ventilation into the trailer.

## **Funding Sources**

Manitoba Pork Council, ARDI

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## **TRANSPORTATION OF EARLY WEANED PIGLETS: EFFECTS OF SIMULATED AND REAL TRANSPORT UPON PIGLET PERFORMANCE**

### **Introduction**

The current state of knowledge on the effects of transporting such early-weaned piglets is scant. Most previous transport work focused upon larger, older pigs destined for slaughter. Therefore there is a deficiency in our knowledge regarding the tolerances and production responses following transport for these young animals. Transportation is a multifactorial stress involving varied factors such as journey duration, temperature, noise, motion and stocking density. The effects of transport stress upon the performance and behaviour of 17 day old weaned piglets were studied using both real and simulated transport.

### **Results and Discussion**

Piglets were weaned and assigned to three treatments: No transport, simulated transport and real transport. Simulated transport involved placing piglets in straw floored boxes and depriving them of food and water for specific periods of time whilst for real transport a small 1 ton enclosed truck was used. The temperature in the simulated environment was adjusted to closely resemble conditions in the truck as recorded by a temperature datalogger furthermore bedding and space

allowance was similar in the two environments. Transport durations of 6, 12 and 24 hours were used to represent a range of journeys from a short within province to an U.S. export or between province haul. Following transport the liveweight, feed consumption and behaviour of the piglets was monitored to quantify the adverse effects of the varying lengths of transport. In total two trials were conducted, each using 96 piglets. Trial 1 was conducted in early March while Trial 2 occurred in August. We would hope that conducting trials in both summer and winter conditions would highlight the seasonal differences in transport stress. Data is awaiting detailed analysis but preliminary results indicate that liveweight losses in piglets undergoing real transport were similar to animals that underwent simulated transport, suggesting motion has little effect upon piglets compared to duration and temperature.

### **Implications**

By conducting controlled real and simulated transport experiments, practical guidelines for transporters and producers can be developed.

### **Funding Sources**

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**See also the following summaries from other sections:  
Response to dietary energy concentration and stocking density in weaned pigs**

## Section III. Environment



Manitoba  
Livestock  
Manure  
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### DESIGN AND TESTING OF AN ENCLOSED BIOFILTER

#### Objective

1. To design and fabricate an enclosed biofilter that treats the exhaust ventilation air from a hog barn using woodchips and compost as the biofilter media.
2. To test the effectiveness of the enclosed biofilter over several seasons at a livestock barn in Manitoba.

#### Impact Statement

The hog industry in Manitoba is fully aware of the difficulties associated with odour. There still is a certain amount of debate about which is the greatest source of odour: the barn, the lagoon, or dispersal of manure. Research has been done to address the odour from both lagoons (i.e., straw covers, negative pressure covers) and the dispersal of manure (i.e., development of tillage injection tools) with positive results. Biofiltration is a technology that is well suited to treating the exhaust ventilation air from the barns. Used together with an appropriate lagoon cover and recommended manure injection practices, a biofilter could help a producer to alleviate all possible odour concerns.

A secondary potential impact from the research will be the creation of a market for debris woodchips from Cedar Lake in northern Manitoba. The flooding of Cedar Lake area during construction of Manitoba Hydro's Grand Rapids Hydro-Electric Project in 1964 was an environmental and social tragedy. Flooded forests resulted in lakes with debris wood floating in the water or beached on the shores. Besides being an eyesore, this floating timber is an extreme hazard in Cedar Lake to fishing and pleasure vessels.

Chemawawin Cree Nation is in the process of founding the Cedar Lake Debris Timber Harvesting Corporation for the purpose of harvesting, processing and the sale of debris timber from Cedar Lake. It is estimated that 50% of the debris logs can be processed into pulp chips. However, it has been determined that a significant portion of the timber will be unusable as pulpwood. This leaves an abundance of debris timber remaining as an environmental hazard and an economic opportunity.

#### Activity

The first progress report is due March 1, 2002.

**Start Date:** September 1, 2001

**Finish Date:** September 1, 2003

**Amount Funded:** \$70,000 **Performer Funding:** \$22,500

**Total Cost:** \$92,500

**Funding Partners:** ARDI

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## **EFFECTS OF NIPPLE DRINKER HEIGHT AND FLOW RATE ON WATER WASTAGE IN GROWER AND FINISHER PIGS**

### **Summary**

An experiment was conducted to study the effects of height and flow rate of nipple drinkers on water wastage in pigs. The results showed that water wastage could be reduced by up to 20% by adjusting nipple height. High flow rate resulted in higher water wastage.

### **Introduction**

In our previous study on water wastage, grower/finisher pigs wasted 25% of water from the nipple drinker at standard flow rate (700 ml/min) and height (5 cm higher than the shoulder height of the smallest pig). However, on commercial farms, water wastage from a nipple drinker is reported as high as 40-60%. The difference between these results may partly be attributed to the improper drinker height and flow rate on pig farms. This study focused on effects of drinker height and flow rate on water intake and wastage in grower/finisher pigs.

### **Materials and Methods**

Four pens of 8 female pigs were tested during the 12 wk study. Water disappearance, water wastage, and feed intake were measured at two stages, i.e. week 1-4 for growers, and week 8-12 for finishers. In each stage, drinkers were set up at two heights, i.e. 5 cm higher than the shoulders of the smallest pigs in the pen (standard height) or 33 cm (low height). At each drinker height, two flow rates, 500 and 1000 ml/min, were employed. Pigs in each pen were exposed to each treatment combination for one week, and the data were collected during the last four days of the week. Body weight was measured individually at the start of each test and every two weeks thereafter. Feed intake was determined every week on a pen basis.

## Results and discussion

Nipple height did not affect feed and water intake in either growers or finishers. Water intake was about 2 times feed intake. The low nipple height increased water wastage by about 10% (from 26% to 35%) in growers and 20% (from 18% to 39%) in finishers. The flow rate of nipple drinkers did not change feed intake and the ratio of water to feed intake. Water wastage was increased by about 7% at the higher flow rate in both grower and finisher pigs. The flow rates employed in the study were lower than that usually used on commercial farms. Higher flow rates could result in more water spillage from nipple drinkers.

## Conclusion

By adjusting nipple drinker height, water wastage can be reduced by up to 20% in grower/finisher pigs. High flow rate can result in more water spillage from nipple drinkers.

## Acknowledgements

Funding for this project was provided by an NSERC/AAFC grant. Strategic funding provided by Sask Pork, Alberta Pork, Manitoba Pork Council and Saskatchewan Agriculture and Food Development Fund.

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## GREENHOUSE GAS AND ODOUR EMISSIONS FROM SWINE OPERATIONS IN QUÉBEC AND SASKATCHEWAN: BENCHMARK ASSESSMENTS

### Summary

It is estimated that agriculture contributes for about 10% of the total anthropogenic greenhouse gas (GHG) emissions in Canada. About 40% of the agricultural emissions of GHG originate from livestock production. However, there exist a lot of uncertainty relative to the actual GHG emissions from livestock production systems in Canada since many of those estimates have been based on data collected in other parts of the world. In addition to GHG, odour emissions from production buildings and manure storage facilities often constitute an important source of nuisances in livestock production, especially in the pig industry.

The general objective of this on-going research project (January 2001 – September 2003) is to evaluate GHG (carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O)) and odour emissions for swine production buildings and manure storage facilities under liquid manure management in two different regions of the country (Québec and Saskatchewan) in order to better assess the relative importance of those two components of swine production systems in terms of GHG and odour emissions. More specifically, the study is targeted at:

1. determining GHG and odour emissions from different types of swine production rooms (gestation, farrowing, nursery and grower-finisher) and for two different types of floor designs (fully and partially slatted floors) in grower-finisher rooms;
2. determining GHG and odour emissions from different types of manure storage facilities (earthen manure storage and concrete tanks; covered and uncovered; treated vs untreated manure), and
3. determining GHG and odour emissions associated with the agitation and emptying of manure storage facilities.

Emission data relative to objectives 1 and 2 above will be collected over a 2-year period in order to account for seasonal variations in GHG and odour emissions from barns and manure storage. Research work for objectives 1 and 3 is completed at PSCI and PSC Elstow Research Farm Inc. and manure storage facilities located both in Québec and in Saskatchewan are monitored within the scope of objective 2. In relation with objective 2, GHG and odour emissions associated to two different manure treatment systems (Biofertile and Biosor) are also assessed in Québec.

All GHG emission data are expressed in terms of mass of gas emitted per unit animal mass per unit time. Similarly, odour emission intensity is evaluated in terms of odour units per unit animal mass per unit time and odour pleasantness is evaluated by hedonic tone on a –5 (very unpleasant) to +5 (very pleasant) scale. This will allow for the evaluation of the relative contribution of the animal housing and manure storage components of swine production systems to the total GHG and odour emissions, thus facilitating the identification of the sub-systems where potential mitigation measures for the reduction of GHG or odour emissions should be implemented. In addition, it will be possible to more precisely assess the relative importance of the Canadian swine production industry to the total GHG emissions of the country, thus determining if this industry should be a priority target for GHG emissions reductions in the future.

## **Acknowledgements**

Funding for this project was provided by Agriculture and Agri-Food Canada – Climate Change Funding Initiative in Agriculture (CCFIA), Fédération des producteurs de porcs du Québec, Sask Pork

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**Manitoba  
Livestock  
Manure  
Management**  
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## **HOG MANURE ON FORAGE CROPS (MLMMI 01-01-15)**

### **Objective**

1. To conduct an economic and financial evaluation of a forage/livestock system which utilizes hog manure as the fertility source in an environmentally sustainable manner.
2. To measure the economic impact of 2 different livestock/forage systems as compared to traditional grain production.
3. To demonstrate this system under conditions which are relevant to forage/livestock producers of the Eastern/Interlake Region and for other areas of Manitoba.
4. To monitor for any environmental concerns related to spreading of hog manure on forage crops.

### **Impact Statement**

Three years of work has been completed on the use of hog manure on forage and pastureland. Through past work, an excellent opportunity exists to continue the monitoring and assessment on plots and sites that are established with cooperative landowners. This project will provide information on

production and environmental issues associated with hog manure on forages. This project is timely due to:

1. Hog production has increased significantly in the last few years. This recent expansion is being driven by export marketing opportunities in pork and an advantageous cost of production that exists in Manitoba.
2. Hog expansion is moving from traditional grain producing areas of the province to more forage and cattle producing areas.
3. Manitoba has 1.9 million acres of tame hay, 900,000 acres of improved pasture, plus nearly 4.3 million acres of native hay and pasture. Forage crops are often grown on low fertility soils severely limiting yields and quality of forages. Forage crops are heavy users of nutrients and respond well to hog manure application. Additionally, the deep-rooted nature of forage crops is well suited to reduce the risk of nutrient leaching from applications of hog manure.
4. Currently there is limited information regarding manure application to forage and pasture lands that producers can use in decision making and to ensure economic and environmental sustainability within their operations.
5. Hog manure application on forages can greatly enhance profitability of nearby cattle operations by improving forage yields and quality. This can be mutually beneficial to both operations.
6. Most hog operations are not interested in developing cattle operations but do wish to recover their manure application costs. Partnerships between cattle and hog operations have great potential.

### **Activity**

The first progress report is due March 1, 2002.

**Start Date:** September 1, 2001

**Finish Date:** September 2004

**Amount Funded:** \$75,000 **Performer Funding:** \$245,670

**Total Cost:** \$320,670

**Funding Partners:** N/A

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Manitoba  
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## INGREDIENT PROCESSING AND ENZYME SUPPLEMENTATION FOR MINIMIZING NUTRIENT EXCRETION AND MANURE VOLUME (MLMMI 01-01-14)

### Objective

To determine the effect of feeding micronized pea-based diets with or without enzyme supplementation on nitrogen and phosphorous utilization and pig manure characteristics (e.g. manure volume, levels of odour-causing compounds etc.)

### Impact Statement

1. Processing of feedstuffs combined with enzyme supplementation will enhance nutrient utilization thus directly reducing the amount of nutrients excreted in pig manure. This might also reduce the amount of fecal dry matter. These two benefits will:
  - (i) Allow manure from a larger number of pigs to be spread on the same land base.
  - (ii) Provide manure management options for swine operations with limited land base.
  - (iii) Might reduce the emission and strength of odours from swine facilities.
  - (iv) This will remove a major constraint to the sustainability of the swine industry.
2. Means to improve the consistency of the nutritive value of peas will be developed. This should increase the use of peas in commercial swine feed industry. This will in turn enhance the competitive advantage of locally grown peas as a feedstuff for hogs.

### Activity

First interim report received November 5, 2001. Second interim report received February 2, 2002.

**Start Date:** August 1, 2001

**Finish Date:** August 1, 2002

**Amount Funded:** \$29,295 **Performer Funding:** \$15,100  
**Total Cost:** \$44,395

**Funding Partners:** N/A

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## INNOVATIVE DESIGN FOR MANURE STORAGE FACILITIES (MLMMI 01-01-03)

### **Objective**

To investigate innovative design procedures for reinforced concrete manure storage tanks using Fiber Reinforce Polymers (FRPs) as internal or external reinforcing element.

### **Impact Statement**

The use of FRPs materials for the design of new concrete manure storage will produce impervious structures that will remain leakage free for a much longer period of time. Because the useful life of manure storage tanks will be extended, producers will be able to amortize their capital cost over a longer period, improving their cash flow situation. At the same time, potential environmental difficulties associated with less durable storage systems will be reduced.

This study will introduce and develop the use of new advanced composite materials for the design of new concrete technology in manure storage. This investigation will provide the foundation for the selection of an optimum composite material to be used to design and build more economical and environmentally benign manure storage facilities.

### **Activity**

First Interim Report received June 7, 2001. Second Progress Report received September 7, 2001. Third Progress Report received February 5, 2002.

**Start Date:** April 1, 2001

**Finish Date:** June 1, 2002

**Amount Funded:** \$27,000 **Performer/Other:** \$95,000 **Total Cost:** \$122,000

**Funding Partners:** N/A

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Manitoba  
Livestock  
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## MANURE EXPOSURE, ODOUR AND CROP RESPONSE FOLLOWING INJECTION (MLMMI 01-01-07)

### Objective

Part I To determine the optimal injection tool spacing to minimize uneven crop response.

Part II To quantitatively assess manure exposure resulting from liquid manure injection.

### Impact Statement

The results of this research will provide producers and custom applicators information required to select the optimal tool spacing for a given soil and injector type. This will result in an efficient use of manure nutrient. As a result the risks associated with nitrogen losses and phosphorous over-application and other adverse environmental impacts can be reduced. In addition, increased crop yield can be achieved by choosing the right tool spacing to minimize uneven crop response. The results can also be used to establish the relationship between tool geometry, tool spacing and manure application rate. This will provide engineers information for selecting the design parameters of injection tools

The study will also provide two alternatives for the quantitative measurements of exposure of manure associated with liquid manure injection. The relationship between manure exposure and the corresponding odour emission can be used to assess the environmental impact (odour). This will save time and money, which would be spent on odour measurements

### Activity

First Progress Report received February 4, 2002.

**Start Date:** August 1, 2001

**Finish Date:** August 1, 2003

**Amount Funded:** \$86,320 **Performer Funding:** \$36,160 **Total Cost:** \$122,480

**Funding Partners:** ARDI

*For further information please contact:*

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Manitoba  
Livestock  
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Management  
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## MEASUREMENT & SIMULATION OF NITRATE, PHOSPHOROUS AND CARBON LEACHING FROM MANURE & FERTILIZER (MLMMI 01-01-08)

### Objective

To quantify leaching losses of nitrate-N, phosphorous and dissolved organic carbon. To determine the effect of rates of manure and fertilizer on nutrient leaching losses. To use data to formulate and refine nitrate and phosphate leaching simulation models which can then be used to estimate leaching losses from agricultural fields.

### Impact Statement

There are significant potential benefits of determining the amount of nutrient leakages from different rates of manure and fertilizers. This research project will provide reliable and verifiable measures of N, P and C losses from specific agricultural systems. The differences between losses from fall and spring applied manure will be obtained. This information can be used as a management option for manure application. The research findings can then be used to formulate the best management practices that minimize pollution from agricultural practices.

### Activity

The first progress report is due March 1, 2002.

**Start Date:** September 4, 2002

**Finish Date:** September 1, 2003

**Amount Funded:** \$60,000 **Other Funding:** \$127,810 **Total Cost:** \$187,810

**Funding Partners:** N/A

*For further information please contact:*

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## **NUTRIENT MODEL FOR SETTING PHOSPHOROUS APPLICATION LIMITS – YEAR 2 – VALIDATION (MLMMI 01-01-04)**

### **Objective**

In Phase 1 ECOMatters developed a Nutrient Loading Model (NLM) to establish loading limits for P. Year 2 is to review very recent developments – the state of Maryland Phosphorous Site Index Model, compare the models, ensure that NLM has all the required processes included in it and then validate the model.

### **Impact Statement**

Model results that estimate soil P buildup over time will enable agronomists to communicate soil P loading with environmental regulators and the public.

The benefits of this project are to support the sustainability of farm practices, and to prepare agriculture to interface effectively with environmental regulators and the public. This improved management of P, especially as related to land application of manure, will ensure the continued support of the public. It may be especially effective to allow agronomists to be proactive in the discussion about regulating P loading limits and water quality when the issue is raised by Manitoba Conservation.

### **Activity**

First interim report received October 29, 2001

**Start Date:** June 18, 2001

**Finish Date:** September 1, 2002

**Amount Funded:** \$57,200 **Performer Funding:** \$21,300 **Total Cost:** \$78,500

**Funding Partners:** ARDI

*For further information please contact:*

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Manitoba  
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## PILOT SCALE STUDY OF HOG MANURE TREATMENT TECHNOLOGY (MLMMI 01-01-19)

### Objective

To demonstrate the SEI Hog Manure Treatment Technology using a portable pilot scale system at hog operations in Manitoba and Saskatchewan for, 1) odour reduction, 2) production of recyclable water, 3) generation of nutrient-rich biosolids and 4) recover ammonia as a resaleable product.

### Impact Statement

The technology demonstration will show the hog industry and the communities in Manitoba that a viable and affordable technology is available to control odours, produce recyclable water and generate value-added biosolids from the process. This will increase the awareness among the general public about the significant strides that are being made to support the economic growth in the province through livestock development.

The project will address many of the crucial concerns facing the hog industry and allay the concerns about the environmental impact of hog operations. The project will enable the hog operations to produce nutrient-rich and sulphur-containing biosolids, mainly targeted for application to canola crops. Research has shown that Canola yields increase by as much as 30% with sulphur-containing fertilizer application.

The technology's ability to produce recyclable water will be of special significance in view of the projected drought conditions and low declining surface water supplies. In addition, the producer can also take advantage of the ammonia recovery option that the technology offers.

The technology eliminates the production of greenhouse gases and will contribute to the Province's efforts to combat global warming.

**Start Date:** November 26, 2001

**Finish Date:** March 26, 2002

**Amount Funded:** \$80,000 **Performer Funding:** \$155,000

**Total Cost:** \$235,000

**Funding Partners:** N/A

*For further information please contact:*

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## Section IV. Workplace Safety & Health



### AIR-BORNE BACTERIA AROUND SWINE BARNs

#### Introduction

The study was designed to address the question: Are there greater amounts of microbial products that we can detect in dust downwind from swine barns? The study was undertaken in order to provide some scientific basis for addressing the concerns of people living or working near existing or proposed livestock confinement facilities. The swine production facility at the Prairie Swine Centre's Elstow Research Farm Inc. was used for the study.

Endotoxins are pulmonary irritants from the cell wall of Gram-negative bacteria that, when inhaled, may cause coughing, phlegm, wheezing, fever and airway inflammation. The effects of high concentrations of endotoxin are recognized to be a workplace hazard and a recommended upper limit of 800 Endotoxin Units (EU)/m<sup>3</sup> of air in the workplace has been proposed by the Institute for Agricultural, Rural and Environmental Health.

#### Results and Discussion

Specifically, the study was designed to compare the airborne amounts of total dust, endotoxin and microbial DNA downwind from swine facilities with the background amounts present in fresh air upwind from the facility. Three samples were taken at each of 3 time points to represent times of high and low dust loading. High volume sampling was performed at 2400m upwind ("fresh air"), at an outlet (0.1m) and 600m downwind from the barn. The concentrations at the outlet were elevated however; at 600m downwind these levels were not statistically different from the fresh air upwind from the barn. For example, the average amounts of endotoxin in fresh air (80 EU/m<sup>3</sup>) and air 600m downwind (104 EU/m<sup>3</sup>) were not significantly different. Time of the year did prove to have an impact on total dust and microbial DNA concentrations ( $P < 0.05$ ) at the outlet. During periods of soil disturbances, high dust loading was demonstrated. This in turn leads to elevated levels of endotoxin and microbial DNA in the fresh air.

#### Implications

The results support the conclusion that the total dust, endotoxin and microbial DNA had become diluted to that of fresh air by 600m downwind from the barn. This suggests that there is modest environmental concern downwind from the barn, which may be managed with low impact controls such as

landscaping. These results are applicable to modern confinement livestock operations that interact with neighbors or the general public.

#### Acknowledgment of funding sources

Sask Pork, Alberta Pork, Manitoba Pork Council, and Ontario Pork provided strategic funding. CIHR, Saskatchewan Agriculture and Food Agriculture Development Fund, and Livestock Environmental Initiative provided additional project funding.

#### Researchers

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## **HYDROGEN SULPHIDE AWARENESS – A RESPONSE TO PRODUCER NEEDS**

The Prairie Swine Centre training program added a new one-day course, Hydrogen Sulphide Awareness, which addresses the growing industry concern regarding working safety and exposure of hog barn workers to hydrogen sulphide gas (H<sub>2</sub>S).

Mary Petersen, Coordinator of Training Programs, worked closely with the University of Saskatchewan Department of Agricultural Medicine and Department of Saskatchewan Occupational Health and Safety to develop the one-day course designed to increase the safety of hog barn workers.

The course is designed to meet the requirements for worker safety. The course begins by giving the participants some information about the gas. It addresses the properties of H<sub>2</sub>S, the short-term and long term effects on humans and the exposure limits as outlined by Occupational Health and Safety.

Instructor Mary Petersen makes the course fun by keeping the lecture portion to a minimum and by encouraging open discussion among the producers enabling participants to learn from each other. Working in small groups, participants analyze and discuss real life incidents that have occurred in hog barns throughout western Canada. This portion makes them realize that these incidents can happen to anyone who is uninformed and unprepared. "The concepts behind H<sub>2</sub>S and how fast accidents can happen without proper precautions," was a realization expressed by a course participant.

Participants are also introduced to some electronic monitors, which measure the gas levels and to a Self-Contained Breathing Apparatus. Rescue techniques are demonstrated and the importance of protecting oneself in dangerous situations is discussed.

The initial response from the industry was rewarding. The course has been delivered in Saskatchewan, Alberta and Manitoba. Over 800 people have been through this program to date.

One knows when a course has been well received when comments are made such as: *Regardless of your farm set up H<sub>2</sub>S awareness and safety together with SOPs are essential to any hog operation; This course was very timely, informative and useful to my operation; My staff will see improvements to our SOPs; Excellent job done by the instructor and by the people who worked on the manual.*

*For more information please contact:*

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Prairie Swine Centre, Phone: 306-373-9922**

## NOTES

## Committee Responsibilities

Environmental Research and Management

- Environmental Stewardship Program
- Manitoba Livestock Manure Management Initiative (MLMMI)
- Livestock Environmental Initiative
- Peer Advisors Program
- CPC National Standardized Environmental Management System
- Swine Research
- Prairie Swine Centre Advisory Committee

## Outside Committees

CPC National Standardized Environmental Management System (NSEMS) Committee

Kerry Church  
Marcel Hacault (alt.)

Manitoba Livestock Manure Management Initiative

Kerry Church

Prairie Swine Centre Advisory Committee  
Pork Industry Interpretive Centre Development Committee (PSC)

Ron Rempel

Ted Muir

Swine Research & Development Consortium  
Ted Muir

Danny Kleinsasser





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