



The University of Manitoba, Faculty of Agricultural and Food Sciences, in conjunction with the National Centre for Livestock and the Environment (NCLE) carries out extensive industry-driven research and development. Our team of swine researchers, interdisciplinary collaborators, students, government support, and industry partners enables us to stay dynamic, informed, and relevant to pork production today. Some of our recent projects relevant to environmental sustainability, production systems, nutrient management and welfare are outlined below.

SWINE RESEARCH

THE UNIVERSITY OF MANITOBA

Environmental Sustainability

Dietary Phosphorous Nutrition in Swine and Poultry to Minimize Environmental Impact: Potential Role of Low-phytate Barley

Investigators: Martin Nyachoti, Wole Akinremi, Don Flaten, Bill Guenter, Brian Rossengal

Status: Ongoing

Purpose: 1) To compare the digestibility of low-phytate barley to that of regular barley; 2) to evaluate the effect of a low-phytate barley diet on manure phosphorous; 3) to determine the solubility of manure phosphorous from low-phytate barley; and 4) to examine the interactive effect of low-phytate barley and phytase (enzyme required for breakdown of phytate) addition on phosphorous utilization and manure characteristics.

Impact: Current results show that low-phytate barley has higher digestible contents of phosphorus, energy, and amino acids compared with regular barley. Thus, low-phytate barley may be used to mitigate phosphorus and nitrogen excretion into the environment.

Funding: MRAC, CWB, CIGI

Mitigating Phosphorous Release into the Environment from Swine Production Units in Manitoba

Investigators: Martin Nyachoti, Wole Akinremi, Don Flaten

Status: Ongoing

Purpose: 1) To determine the phosphorus requirements of the main pig genotypes used in Manitoba; 2) to develop and assess the effectiveness of various combinations of dietary manipulation strategies on manure phosphorus excretion and its interaction with different soils; 3) to determine pig performance and the economic implications of such strategies for practical pork production; and 4) to determine the effect of manure handling system (liquid versus solid) on manure phosphorus mobility in different soil types.

Impact: Combining phytase and high available phosphorus ingredients such as DDGS obviates the need for inorganic phosphorus sources in growing pig diets. Phosphorus requirements among genotypes are similar and may be less than often recommended.

Funding: MLMMI

Nutrient Management Planning for Nursery, Finisher Pig, and Sow Operations Using Extant and New Feed Consumption Models and Manure Analysis

Investigators: Ermias Kebreab, Martin Nyachoti

Status: Completed

Purpose: 1) To generate detailed datasets on nitrogen and phosphorus balance from sows fed diets used in Manitoba; 2) to evaluate a feed consumption model using sows under controlled conditions; 3) to standardize a manure sampling methodology; and 4) to develop a user-friendly nutrient balance model.

Impact: Results are to be used to evaluate models used by Manitoba Conservation to calculate phosphorus excretion rates and limit manure applications. The model was based on Quebec datasets; therefore, Manitoba-based results are required to evaluate its robustness and applicability in the province of Manitoba.

Funding: MAFRI, SDIF, Manitoba Pork, MLMMI

Nutrient Management Planning for Finisher Pig and Sow Operations Using Extant and New Feed Consumption Models and Manure Analysis – Greenhouse Gas Measurements

Investigators: Ermias Kebreab, Martin Nyachoti, Mario Tenuta

Status: Completed



Purpose: To gather data to better understand the effect phytase addition to the diet may have on manure nitrogen.

Impact: Contribution of knowledge of manure application rates in regards to greenhouse gas emissions. The results indicate supplementation of phytase may contribute to a slight increase in greenhouse gas emissions, particularly during wet season application.

Funding: MAFRI, Manitoba Pork, ARDI

Achieving Manure Phosphorus Balance in Manitoba: Technical Workshop

Coordinating Committee: The National Centre for Livestock and the Environment along with partners Manitoba Livestock Manure Management Initiative (MLMMI), Manitoba Agriculture, Food and Rural Initiatives (MAFRI) and the Manitoba Manure Management Advisory Committee (MMMAC)

Status: Workshop – completed; Addressing workshop research and extension priorities - ongoing

Purpose: To better equip Manitoba's livestock producers to comply with phosphorus-based manure management regulations while remaining economically competitive by sharing current information on available management options and working to identify, evaluate and adopt management options for achieving manure phosphorus balance in Manitoba.

Impact: Stakeholders at the workshop identified priorities for research & technology evaluation and extension & technology transfer targeting feed, field and manure management towards achieving manure P balance in Manitoba. MLMMI leads the coordination of these activities. The University of Manitoba and MAFRI have active roles in delivering on the research and extension priorities.

Funding: Growing Forward



NCLE Long Term Manure and Crop Management Field Laboratory: Long Term Nutrient Cycling, Pathogen and Microbial Community Dynamics and Greenhouse Gas Emissions under Different Livestock Manure and Crop Management Scenarios

Investigators: Don Flaten, Denis Krause, Mario Tenuta

Status: Ongoing

Purpose: The long term manure management and cropping system trial is a field laboratory that will be used to optimize nutrient and energy cycling within integrated, environmentally and economically sustainable livestock and crop production systems.

Impact: This detailed trial looks at these parameters with liquid and solid swine manure applied at N-based and various P-based application rates under both annual and annual-perennial cropping systems. Manure types will be expanded to include composted swine manure and processed manure (s/l separation products) in 2011. The ongoing information generated from this study will be used to develop BMPs for manure and crop management for environmental sustainability, including manure P balance.

Funding: ARDI

La Broquerie Pasture and Manure Management Study (hog manure on grasslands)

Investigators: Kim Ominski, Mario Tenuta, Denis Krause, Don Flaten, et. al.

Status: Completed

Purpose: To identify best management practices for the integration of hog and cattle production systems – in terms of cattle productivity, manure nutrient management, greenhouse gas emissions and pathogen dynamics

Impact: Identification of BMPs related to improved overall system productivity – improved cattle and forage performance, higher removal and export of nutrients, environmental risk mitigation. See <http://www.umanitoba.ca/afs/labroquerie> to learn more

Funding: Multiple agencies

Downward Movement of Nutrients for Different Manure Sources, Soil Type and Crop Management Scenarios

Investigators: Wole Akinremi, Dupe Ige, Francis Zvomuya, Don Flaten, Martin Entz

Status: Ongoing

Purpose: 1) To compare the amount of nitrate and phosphorus that is lost below the root zone from liquid and solid manure production systems; 2) To determine the influence of cropping system (i.e. perennial vs. annual), nutrient management system (i.e. nitrogen-based versus phosphorus-based) and soil type on the loss of water, phosphorus and nitrate below the root zone.

Impact: The long term objective is to use this information in developing a model to be used as a tool for minimizing leakage of manure phosphorus and nitrate to the environment.

Funding: MLMMI, ARDI, SDIF



Forms of Phosphorus in Different Manures and Their Impact on P Runoff and Leaching Losses from Manure Amended Soils

Investigators: Darshani Kumaragamage, Don Flaten, Wole Akinremi

Status: Completed

Purpose: 1) To quantify and compare runoff and leaching losses of P from soils amended with different manures (liquid hog manure, solid hog manure, solid beef cattle manure, liquid dairy cattle manure) and commercial synthetic fertilizer; 2) To determine

the forms of P in manure that is best related to P loss from runoff and leaching in manure amended soils; 3) To determine if the forms of manure P can be used as an index of the risk of P loss by runoff and leaching.

Impact: Livestock producers can use this information in selecting appropriate BMPs such as injecting or incorporating liquid forms of manure and managing in-field manure use so that long term rates of P application closely match rates of P removal by crops.

Literature Review: Manure Treatment Options to Achieve Manure P Balance in Manitoba

Investigator: Nazim Cicek

Status: Completed

Purpose: To conduct a review of manure treatment/processing technologies towards assessing the feasibility for use in Manitoba to achieve manure phosphorus balance in Manitoba.

Impact: Along with another literature review by PAMI, this information was used to identify treatment technologies to undergo evaluation in Manitoba planned for 2011.

Funding: MLMMI

Assessing the Efficacy of Chemically-enhanced Solid-liquid Separation for Management of P in Hog Manure

Investigator: Francis Zvomuya

Status: Ongoing

Purpose: To identify viable chemical treatment options for separating the P-rich solids fraction of manure from the liquid fraction.

Impact: Promising options will expand the manure phosphorus management “tools” available to pig producers.

Funding: MLMMI

Generating Value Added Treatment Products from Liquid Manure

Project: Reclaiming phosphorus from liquid pig manure: Precipitation of P as struvite ($MgNH_4PO_4$) from liquid pig manure

Investigator: Nazim Cicek

Purpose: To determine the feasibility of recovering P as struvite at a bench-top scale prior to scaling up to recover P at a commercial scale from on-farm liquid manure storages

Status: Ongoing

Funding: ARDI

Project: Anaerobic digestion (liquid manure): Capacity of co-digestion with processing byproducts (e.g. glycerol) to boost methane production from liquid pig manure and other options for improving the energy balance of methane production in cold climates

Investigators: Nazim Cicek, Jan Oleszkiewicz, Richard Sparling

Status: Ongoing

Odour Mitigation: Development of Dispersion-based Setback Distance Guidelines for Manitoba

Investigator: Qiang Zhang

Status: Ongoing

Purpose: 1) To develop odour impact criteria for defining the acceptable odour exposure; 2) To develop models for odour emission rates for various types of livestock operations in the prairie provinces; 3) To evaluate and select a dispersion model(s) for predicting the odour distribution surrounding livestock operations.

Impact: The information generated during this project will be used to form a dispersion-based setback guideline.

Funding: MLMMI

Biofiltration for Mitigating Methane Emission from Covered Hog Manure Storage: Preliminary Phase of Designing and Testing a Biofiltration System

Investigator: Qiang Zhang

Status: completed

Purpose: This project is the preliminary phase of designing and testing biofiltration systems for removing greenhouse gas (GHG) emissions from covered hog manure storage. The specific objectives of this phase are: 1) to conduct a thorough literature search to compile information on the use of biofilters in mitigating GHG emissions from livestock operations; 2) to assess the technical feasibility of using biofilters in mitigating GHG emissions from covered hog manure storage based on the literature review; 3) to conceptualize a biofiltration system design for covered hog manure storage typical in Manitoba.

Impact: As only the preliminary phase has been completed, the impact is not yet known.

Funding: MSAPP



Whole Farm Nutrient Balance in Swine Operations

Investigators: Martin Nyachoti and Carole Ferudi

Status: Ongoing

Purpose: By 2013 farmers will be required to apply manure to fields based on the phosphorus (P) requirements of the crop. Since hog manure is typically rich in P but low in nitrogen (N) this would mean that hog manure may no longer be an attractive substitute for synthetic fertilizer for increasing soil N. Furthermore, the incorporation of ingredients into swine diets should be assessed not only on their nutritional profiles and cost of formulation but also on their impact on hog growth, carcass characteristics, water intake and manure nutrient levels. Therefore, it is necessary to assess the impact of feed ingredients on hog manure P and N contents with the ultimate goal of reducing P in manure while maintaining N levels in order to continue to have manure that is valuable to crop farmers.

Impact: Inclusion levels of ingredients such as corn-DDGS, zero-tannin faba bean (ZTFB), and grains to optimize cost of production and limit the environmental impact will be determined. Furthermore, utilizing locally available ingredients in commercial pork production may not only create a market for these feedstuffs, but may help in mitigating the cost of producing pigs and the challenges associated with manure management through reduced importation of nutrients from other regions into Manitoba.

Funding: Puratone, MRAC, MPGA, MLMMI



Validating Net Energy System for Manitoba Pork Industry

Investigators: Martin Nyachoti and Bogdan Slominski

Status: Ongoing

Purpose: This project will determine the net energy value of locally available feed ingredients for swine using the indirect calorimeter system. Determined values will then be used to formulate diets for studies evaluating the performance and carcass characteristics of growing-finishing pigs when fed diets formulated either on the net energy system or the conventional ME system.

Impact: The net energy system is a superior descriptor of the useful energy in pig feed ingredients. Its utility will allow a more effective use of alternative feed ingredients in swine diets while allowing a more predictable animal performance. Adoption of this system will also help minimize nitrogen emission into the environment.

Funding: ARDI, Canadian Biosystems Inc., Canola Council of Canada

Dietary Nitrogen Utilization and Gut Health Benefits Associated with the Use of Low-protein Amino Acid Supplemented Diets in Pork Production

Investigators: Martin Nyachoti

Status: Completed

Purpose: To test whether using low-protein amino acid supplemented nursery diets will reduce the susceptibility of weaned pigs to post weaning diarrhea caused by *E. coli*.

Impact: Provided evidence that low-protein amino acid supplemented diets may be used as part of an overall strategy for nutritional management of piglets in an antibiotic-free feeding system.

Funding: Evonik-Degussa, ARDI

Wheat Distillers Dried Grains with Solubles (DDGS) in Swine and Poultry Nutrition

Investigators: Martin Nyachoti, Bogdan Slominski

Status: Ongoing

Purpose: To characterize the nutritive value of wheat DDGS, to determine the variability in nutrient composition within and among processing plants, and to determine nutrient bioavailability values for poultry and swine.

Impact: Will help swine nutritionists better formulate rations using DDGS to optimize performance.

Funding: Husky Energy, ARDI, Western Economic Diversification

Enhancement of Ethanol Yield and Distillers Dried Grains with Solubles (DDGS) Nutritive Value Using Enzyme Technology

Investigators: Bogdan Slominski, Martin Nyachoti, David Levin, Karin Wittenberg

Status: Ongoing

Purpose: To increase the yield of ethanol and to add value to the DDGS co-products in Husky Energy's grain-based ethanol production process. This will be accomplished by using a novel multi-enzyme preparation during the fermentation phase of the ethanol production process.

Impact: This research will increase the ethanol yield and will contribute to the improved nutritive value of new generation DDGS co-products, which, in turn, will promote the effective use of both wheat and corn DDGS, important Canadian feed resources, in animal nutrition.

Funding: Husky Energy, NSERC

Effects of Exogenous Microbial Enzyme Supplementation on Performance and Nutrient Utilization in Growing Pigs Fed Wheat DDGS-Containing Diets

Investigator: Martin Nyachoti

Status: Completed

Purpose: 1) To determine the performance of growing pigs fed diets with a multi-enzyme (phytase and carbohydrase enzymes) blend, and 2) to determine nutrient containing wheat DDGS with or with supplementation balance, digestibility, and manure volume in growing-finishing pigs fed diets containing wheat DDGS with or with enzyme supplementation.

Impact: This is part of an overall enzyme program working with swine and poultry, looking at prebiotic effects of non-starch polysaccharide hydrolysis products. Work is continuing with promising results evolving from this project. Applications to wheat DDGS, new yellow-seeded canola, and yellow-seeded flax are underway.

Funding: ARDI, WED, Husky Oil

Natural Means of Controlling Gut Health and Optimizing Performance in Early-Weaned Pigs: Research On A New Generation Enzyme-Antibody Supplement

Investigators: Martin Nyachoti, Bogdan Slominski and Denis Krause

Status: Ongoing

Purpose: 1) To further improve and assess the efficacy of multi-enzyme blends on enhancing the digestive function and performance of the early-weaned pig; 2) to investigate the potential for feed enzymes and/or enzyme hydrolysis products to modulate intestinal health and function and bacterial growth in the early-weaned pig; 3) develop a novel colicinogenic based *E. coli* probiotic effective against ETEC K88; and 4) to investigate possible interactive and/or synergistic effects of feed enzymes and egg yolk antibodies, and *E. coli* probiotics in modulating intestinal health and function in the early-weaned pig using an experimental disease model.

Funding: Manitoba Pork Council, Canadian Biosystems Inc., NSERC

Response of Weaned Pigs Fed Diets Containing Inovapure to an Enterotoxigenic Escherichia coli K88 (ETEC)

Investigators: Martin Nyachoti and Denis Krause

Status: Completed

Purpose: To determine the response to an ETEC challenge when piglets consuming non-medicated diets are provided with drinking water containing inovapure and to determine the effect of dose on these responses.

Impact: Demonstrated that inovapure, a product containing lysozyme, is effective in preventing *E. coli* infection in weaned pigs and therefore has potential as an alternative therapy for controlling post-weaning diarrhea in piglets.

Funding: Neova Technologies, Inc.



Nutritional Evaluation of Egg Products for Weaned pigs

Investigators: Martin Nyachoti and Laurie Connor

Status: Ongoing

Purpose: Egg products containing high levels of antibodies against specific pathogens responsible for causing diarrheal disease in pre- and post-weaning piglets are routinely utilized in commercial pork production. Thus, far the nutritional value of these products to the piglets has not been taken into consideration in diet formulation, mainly because the nutritive value of these products has not been characterized. Therefore, this project will 1) determine the apparent and standardized ileal amino acid digestibility in Hyper-Egg products fed to weaned pigs, and 2) determine the effect of supplementing pig starter diets with a Hyper-Egg product on growth performance of newly-weaned piglets.

Impact: With knowledge of the nutritive value of these whole egg products, the swine industry in Manitoba will be in a better position to utilize them in formulating effective nursery pig diets.

Funding: J.H. Hare and Associates

Optimal Amino Acid Requirements for Piglets in Antibiotic-free Feeding Programs

Investigators: Martin Nyachoti

Status: Ongoing

Purpose: The current trend in the swine industry world-wide is to minimize or eliminate the use of sub-therapeutic levels in pig diets; a practice that has been used especially in nursery diets to control incidences of post-weaning diarrhea and to maintain growth performance. Available evidence suggest that under stressful conditions (e.g. disease infection), animals respond by diverting nutrients (especially amino acids) away from supporting growth to supporting the immune system. Therefore, it is prudent to postulate that the availability of essential amino acids that play a role in immunological responses for growth will be limited when piglets are subjected to less than optimal conditions, as is often common in farms. Thus, the proposed research will determine the lysine requirement for piglets under unsanitary conditions and establish the optimal ratios to lysine of sulfur amino acids, threonine and tryptophan.

Impact: Knowing the additional requirement for dietary amino acids when pigs are raised under antibiotic-free feeding programs is critical for the formulation of diets that not only optimizes performance but also minimizes nitrogen excretion into the environment.

Results of this project will contribute towards the goal of designing diets to optimize piglet performance under antibiotic-free feeding programs.

Funding: Evonik-Degussa, NSERC

A New, High-energy Canola Meal for Poultry and Swine: The Effect of Yellow Seed Coat, Processing and Enzyme Supplementation

Investigators: Bogdan Slominski and Martin Nyachoti

Status: Ongoing

Purpose: To investigate the potential for the new and improved yellow-seeded *B. napus* and *B. juncea* canola to become a valuable and cost effective energy, protein, and phosphorus supplements in poultry and swine nutrition.

Impact: The outcome of this research will promote the effective use of canola, an important Canadian feed resource, in poultry and swine nutrition. In addition, higher protein, energy, and available phosphorus and lower fiber content of the yellow-seeded *B. napus* and *B. juncea* canola will open new markets for these products and will be welcomed by feed manufactures. It is believed that high quality traits, including seed yield and disease resistance would make the yellow-seeded *B. napus* and *B. juncea* canola an excellent commodity for animal feeding.

Funding: Canola Council of Canada

High Inclusion Levels of Canola Meal in Swine and Poultry Feeds

Investigators: Bogdan Slominski and Martin Nyachoti

Status: Ongoing

Purpose: To investigate the potential for the new and improved low-fiber, yellow-seeded canola to be used at high inclusion levels in poultry and swine nutrition.

Impact: This research will facilitate commercialization of the new low-fiber canola and will assist poultry and swine nutritionists in ration formulation.

Funding: Agriculture and Agri-Food Canada, Canola Council of Canada (Canola Cluster Research)

Production & Welfare

Sow Longevity: Modeling as a Method of Economic Analysis

Investigators: Nora Lewis*, Laurie Connor, Gary Johnson, Martin Nyachoti, Bob Kemp, Mark Fynn

Status: Completed

Purpose: 1) To identify the major factors which contribute to longevity in the breeding herd through comparison of production performance and monitoring of physical characteristics of sows in two types of group gestation housing. 2) To develop a computer program which can be used by producers to determine the long term economic effects related to gilt selection and sow culling.

Impact: Most significant factors associated with longevity in both conventional (slatted-floored) and alternative (straw-based) housing systems were determined to be parity and lameness, with differences between housing type in early parity animals. A model developed from this project will help producers to determine best practices associated with gilt selection, housing type and optimal parity for culling from an economic perspective.

Funding: Manitoba Pork, ARDI

Transportation of Early Weaned Pigs

Investigators: Nora Lewis*, Steiner Wamnes, Agnieszka Giegel, Laurie Connor

Status: Completed

Purpose: To determine the best management practice to reduce transportation stress and prevent the weaning growth check. 1) Use of different bedding and depths to reduce cold exposure for extended transport periods. 2) The potential benefit and optimum electrolyte concentration for weanlings.

Impact: Provide guidelines for development of recommendations for best practices for transport and post transport management to benefit the health and welfare of early weaned piglets. Results indicate that commercial electrolytes, at label dose, may be consumed to excess and delay feed intake.

Funding: Manitoba Pork, ARDI, NPB

Transportation of Market Hogs

Investigators: Harold Gonyou, Nora Lewis*, Tina Widowski, Cate Dewey, Luigi Faucitano, Trevor Crowe, Rene Bergeron

Status: Completed

Purpose: A four-year national study of transport environment, hog behaviour, loading/unloading, and meat quality measurements.

Impact: Probably the most comprehensive study of hog transport under Canadian conditions, this is providing invaluable information on the influences of transport conditions on welfare of slaughter hogs and meat quality, and is providing scientific data for development of regulations/legislation on transport.

Funding: NSERC, AAFC, Manitoba Pork, Sask Pork, Alberta Pork, Ontario Pork



Regulation of Farrowing by Time of Feeding

Investigators: Laurie Connor, Martin Nyachoti, Mike Sheridan

Status: Ongoing

Purpose: To identify strategies that may reduce cost of production and increase efficiency. Specifically, examination of the potential of regulating time of farrowing through nutritional management rather than relying on the use of hormones.

Impact: If swine producers can synchronize sow farrowing using nutritional management strategies, they will be able to save on the cost of current treatments, and will potentially increase the number of pigs born alive per litter as a result of having an attendant present at all farrowings. Also, if successful, this strategy may be more acceptable to consumers from an animal welfare point of view.

Funding: Manitoba Pork, ARDI

Comparison of Sow Group Housing Systems

Investigators: Laurie Connor, Martin Nyachoti *et al*

Status: Ongoing

Purpose: To compare animal performance, environment, and costs in conventional (slurry-based) and alternative (straw-based) group housing systems over the short and long term. To compare manure nutrient, handling, and degradation characteristics as they impact soil and environmental characteristics.

Impact: Will provide information on animal performance and environmental implications of group housing systems that can aid producers in deciding current and future best management practices.

Evaluation of a Commercial Group Sow Housing Alternative

Investigators: Laurie Connor, Ron Bazyl

Status: Ongoing

Purpose: To evaluate sow performance and management strategies in a commercially operated 1000-sow group housing system which uses electronic sow feeders. Results of assessment of sow interaction, performance and well-being along with management strategies and challenges will be compiled into a final report available through MAFRI, University of Manitoba websites and other producer directed media

Impact: This information will be readily available to pork producers seeking viable alternatives to sow gestation crate systems and will be invaluable in their decision making about what can work best for their production system.

Funding: MRAC, Manitoba Pork



*Dr. Nora J. Lewis, deceased. Her collaborative research projects have been completed and her significant contributions always remembered.

For more information, please contact researchers through our web sites: www.umanitoba.ca/afs/ and www.umanitoba.ca/afs/ncle

Updated November, 2010