

Feeding programs for growing–finishing pigs to enhance global competitiveness: Opportunities across Canada

► Twelve researchers from seven different research institutions worked in collaboration on this project

Project Status: Completed in 2018

Feed cost is by far the greatest cost of pig production (65-70%) and growing-finishing pigs account for about 80% of feed consumed. The continued high cost of feed demonstrated the need to develop cost-effective feeding strategies for growing-finishing pigs to ensure the long-term competitiveness of the Canadian pork industry. To address these challenges, researchers worked on the subprojects below.

Nutritional value of emerging Canadian feedstuffs

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Kees de Lange,
University of Guelph

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University of Alberta

More information is now available on nutritive value of the following feedstuffs:

- Canola meal
- Hemp co-products
- Camelina cake
- Low-fat corn Dried Distillers Grains with Solubles (DDGS)
- Faba bean, field pea and chick pea
- Wheat millrun

Why were these studies done?

The nutrient content of some ingredients has been characterized to develop unique Canadian databases. Researchers have also explored different means to maximize nutrient utilization from such ingredients and dietary inclusion levels.

What was done and what was the outcome?

Canola meal (M. Nyachoti)

Canola meal is widely used as a protein source but also contains relatively high levels of fiber. Energy values of fibrous or high protein ingredients are often overestimated by digestible energy (DE) and metabolizable energy (ME) systems. Therefore, the energy value of canola meal was evaluated using net energy (NE) system to provide a more accurate estimate of the energy available for pigs.

The NE of canola meal determined in this study was, on average, 2099 kcal/kg (as-fed basis).

Table 1: NE of canola meal

NE (Kcal/kg)	2099
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Hemp co-products (M. Nyachoti)

The following information was determined:
 1) the net energy content of hemp co-products,
 2) the digestibility of phosphorus in hemp hulls and extruded hemp hulls, as well as 3) the impact that supplementing with microbial phytase may have on phosphorus digestibility.

Table 2: Net energy (NE) content and digestibility of phosphorus, with or without phytase, of hemp co-products.

	Hemp hulls		Extruded hemp hulls		Blended hemp hulls & peas
	Without phytase	With phytase	Without phytase	With phytase	
NE (Kcal/kg)	2375		2320		2399
ATTD ¹ of phosphorus	18.8%	44.5%	22.5%	45.5%	
STTD ² of phosphorus	22.0%	48.5%	26.3%	48.6%	

¹ Apparent total tract digestibility

² Standardized total tract digestibility

The relatively high NE content of hemp hull and processed hemp hull products may be attributed to the high levels of residual oil in these ingredients.

It was found that supplementing with phytase increased the digestibility of phosphorus in both hemp hulls and extruded hemp hulls. It also increased calcium digestibility.

Camelina cake (M. Nyachoti)

Trials were conducted with growing pigs to characterise camelina cake. Results are presented in Table 3.

Table 3: Digestible energy (DE), metabolizable energy (ME), net energy (NE) and digestible content of lysine, methionine and threonine of camelina cake.

	Camelina cake
DE (Kcal/kg)	3755
ME (Kcal/kg)	3755
DE (Kcal/kg)	2383
Digestible content	
Lysine (g/kg)	10.0
Methionine (g/kg)	1.6
Threonine (g/kg)	8.9

The average standard ileal digestibility of indispensable amino acids in camelina cake fed to growing pigs was 67.2%, while the digestibility of dispensable amino acids was 58.8%.

Low-fat corn Dried Distillers Grains with Solubles (DDGS) (K. de Lange)

Digestibility trials with growing pigs were conducted to compare standard DDGS with low-fat DDGS. As presented in Table 4, low-fat corn DDGS has a higher concentration of digestible amino acids and energy than regular DDGS. Low-fat DDGS samples had also greater standardized ileal digestibility content of indispensable protein and crude protein than the regular DDGS.

Table 4: Digestible energy (DE), crude protein and standardized ileal digestibility of lysine, methione and threonine of standard DDGS and of low-fat DDGS (2 samples).

	Standard DDGS	Low-fat DDGS	
		Sample 1	Sample 2
DE (Kcal/kg)	3614	4494	4555
Crude protein (%)	30.1	42.3	43.1
Standardized ileal digestibility			
Lysine (g/kg)	4.9	6.1	7.4
Methionine (g/kg)	4.6	6.8	7.4
Threonine (g/kg)	6.8	9.5	10.1

Providing an adequate supply of energy in swine diets is not only the most expensive component of feed, but it is the greatest contributor to the growth and efficiency of pork production. This data suggests that low-fat DDGS could replace a significant amount of corn and soybean meal compared to regular DDGS. The next logical piece of research is to investigate and determine the most economic and optimal amount to include in pig diets in order to replace corn and soybean meal.

Faba bean, field pea and chick pea (R. Zijlstra)

In Canada, the net energy system is gradually being adopted by the pork industry. Currently, in North America, only total starch is considered in feed evaluation and formulation. Defining two different fractions of starch may enhance accuracy when predicting the net energy value of feedstuffs: 1) the fraction digested by enzymes (in the small intestine), and 2) fermentable fraction (in the large intestine). Therefore, researchers wanted to characterize some Canadian pulses and cereal grains and study how processing can increase nutritional value, particularly starch digestibility.

Faba beans, field peas and chick peas have a lower starch digestibility than cereal grains (wheat, barley and corn), but can be increased by the following processing methods:

- Grinding: Fine grinding of field pea increased the amount of starch digested by enzymes and reduced starch fermentation.
- Heat processing methods: Steam pelleting and extrusion increased starch digestibility of grounded faba bean and barley. These heat processing methods had more impact in faba bean because its starch matrix is more resistant to digestion than barley.

Wheat millrun (R. Zijlstra)

It was found that processing wheat millrun through extrusion increased its digestibility (amino acids and energy). This process modified the properties of nutritional components of millrun, making them more available to the pigs.

Fermentation of soybean meal

Julang Li,
University of Guelph

Researchers improved a fermentation procedure for soybean meal in order to increase its nutritive value for pigs.

Why was this study done?

Soybean meal is a plant-based protein source commonly used in swine diets. However, its use has been restricted in pigs, especially those of younger age, due to the presence of anti-nutritional factors as well as allergens and relatively high levels of non-starch polysaccharides.

Therefore, using enzymes and/or bacteria to ferment soybean meal is an attractive approach to improve its nutrient value.

What was done and what was the outcome?

Researchers improved the fermentation procedure for soybean meal to allow it to be done on a larger scale that is less energy intensive, and thus more practical for farmers and more environmental friendly. To achieve this, fermentation procedures were optimized to allow at least 2 kg of soybean to be fermented at 50% moisture levels, which resulted in eliminating allergen proteins. In addition, fermentation also decreased oligosaccharides in soybean meal.

A digestibility trial to examine if fermented soybean meal improves nutrient digestibility for growing pigs was carried out. Results showed that fermentation of soybean meal by a specific bacteria increased the digestibility of protein and ash, suggesting an improved nutritive value for pigs.

High-fibre diets for growing-finishing pigs

Marie-Pierre Létourneau-Montminy,
Laval University

Results showed that pelleting is an interesting process to improve the nutrient digestibility of both classic corn-soybean meal diets and diets containing co-products with high levels of fiber.

Why was this study done?

In Eastern Canada, co-products like bakery meal, corn DDGS and wheat middlings can be interesting alternatives to replace a part of soybean meal and corn in growing-finishing diets when prices are high. However, these ingredients are high in fiber, which has low digestibility and could negatively impact the digestibility of other nutrients. Researchers wanted to verify if xylanase and/or pelleting could help to successfully integrate these ingredients in growing-finishing pig diets.

What was done and what was the outcome?

A digestibility trial was conducted with growing pigs to study a high-fiber diet, a high-fiber diet with xylanase and a classic, low-fibre corn and soybean meal diet. All three of the tested diets were either in mash or pelleted form, for a total of six diets studied. The impacts of these diets on the digestibility of nutrients were studied.

The two high-fiber diets that were tested in this trial included co-product feedstuffs containing soluble non-starch polysaccharides. They were composed of corn, soybean meal, wheat middling, DDGS and bakery meal, either with or without xylanase.

This trial showed that pelleting was an interesting process to improve nutrient digestibility. Pelleting increased the digestibility of classic corn-soybean meal diets, but also of diets containing co-products with high level of fiber. Even if pelleting represented an additional cost, these results showed that it was worth it as more nutrients were made available to the pigs.

Xylanase, however, did not improve the use of nutrients in the tested high-fiber diet. It may be more interesting to use xylanase when including by-products that have a higher xylans or arabinoxylans content, such as wheat DDGS.

Low energy feed for growing-finishing pigs

Eduardo Beltranena,
Alberta Agriculture and Forestry

Results showed that providing lower net energy diets (2.2 Mcal NE) to growing-finishing pigs resulted in greater profitability, even when pigs were crowded together.

Why was this study done?

It was previously shown that feeding low, constant net energy diets (2.1 Mcal NE) to growing-finishing pigs resulted in more than \$10 profit per pig (gross revenue after subtracting feed costs) than feeding higher energy levels (2.4 Mcal NE). However, pigs must be able to increase feed intake to make up for the lower energy density. Researchers wanted to verify if, in crowded pen conditions, there was enough access to feeders for pigs to take advantage of low energy diets.

What was done and what was the outcome?

A feeding trial was conducted with 1920 pigs. Gilts and barrows were fed low (2.2 Mcal NE) or high (2.35 Mcal NE) energy levels and had either two or three feeder spaces per pen. These pigs were housed at two different stocking densities (18 or 22 pigs per pen).

For the overall trial, pigs fed low energy diets consumed more feed and had a reduced feed efficiency compared to pigs given high energy diets. However, their average daily gains were similar. In pens with three feeders, pigs ate and grew more than in pens where only 2 feeders were available. Pigs in lower stocking density pens had higher average daily gain than the ones in more crowded pens. Surprisingly, there were no interactions between the different items studied (NE level, stocking density and number of feeder spaces).

Regarding cost vs. benefit, the income margin after subtracting feed cost (ISFC) per hog was calculated. Knowing that the low NE diets cost, on average, \$21.87 less per tonne, the ISFC per pig was \$1.82 greater feeding the low energy diet than for the high energy diet. The ISFC was also \$1.98 greater for pigs housed at a lower stocking density. The number of feeder spaces per pen did not affect the ISFC.

Collaborators

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Precision feeding for growing-finishing pigs

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François Dubeau,
University of Sherbrooke

Results from this project include:

- Knowledge was gained on how individual growing finishing pigs use phosphorus and calcium present in their diets.
- The 'ideal protein' concept used to formulate feeds in conventional systems does not apply to precision feeding.
- A new mathematical feed formulating model demonstrated potential in reducing feed costs by 5.2 %, phosphorus excretion by 2.2 %, and nitrogen excretion by 17.8 %.



Finisher pigs. Image: Public Domain

Why was this study done?

Precision livestock farming is viewed as a tool to enhance sustainability and competitiveness of the swine industry by providing each pig, on a daily basis, with a diet containing an optimal concentration of nutrients.

Results have demonstrated that feeding growing-finishing pigs individually with daily tailored diets can reduce lysine intake by more than 25% and feed costs by more than 8%. Therefore, the objectives of this project were to:

- Refine a previously-developed mathematical model regarding nutrient requirements for growing-finishing pigs, along with use of these nutrients by these animals.
- Improve an existing mathematical model regarding the formulation of feed to be used in precision feeding of growing-finishing pigs.

What was done and what was the outcome?

Pig nutrient requirements and metabolism

Researchers worked on determining the efficiency of dietary phosphorus and amino acids. To do this, they developed mathematical models representing the metabolism of phosphorus and calcium in order to estimate individual pig nutrient requirements.

It was found that using phosphorus and calcium depletion-repletion sequences is a good strategy for reducing calcium and phosphorus intake. However, before using this kind of dietary strategy, more work needs to be done to better understand the digestive and metabolic adaptations that develop.

Researchers reviewed certain nutritional concepts in order to develop precision feeding strategies. Therefore, it was confirmed that:

- Precision-fed pigs use amino acids more efficiently than pigs provided with conventional diets, partly due to the fact that nutrient efficiency is not constant across animals and is affected by production conditions.
- The content of amino acids found in the feed has an impact on the composition of the protein in the pig's body.
- Restricting amino acids in feed affects body proteins differently, depending on the type of body protein.

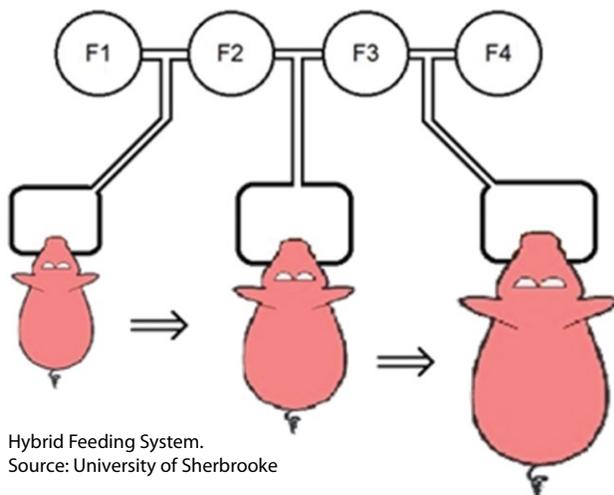
As a result, the 'ideal protein' concept used to formulate feeds in conventional systems does not apply to precision feeding.

These results suggest that changes in body composition in pigs are induced by changes in dietary levels of amino acids. Therefore, growth could be modulated according to the optimal body composition desired by the consumer.

System for formulating feed

Based on previous work, researchers developed a feed formulation system called the Hybrid Feeding System. This new model combines phase-feeding with a precision feeding system using two feeds.

For instance, in the Hybrid Feeding System, if three phases are used, two feeds will be blended during each phase. Between two consecutive phases, one feed would stay the same and one would change. Therefore, four different feeds would be used when using three phases.



Hybrid Feeding System.
Source: University of Sherbrooke

This new mathematical model reduced feed costs by 5.2 %, phosphorus excretion by 2.2 %, and nitrogen excretion by 17.8 %.

Collaborators

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Nutritional approach for controlling boar taint

Ira Mandell and Jim Squires,
University of Guelph

Different feeding additives were tested to control boar taint. However, while some additives showed promise, boar taint was not able to be effectively controlled in this experiment.

Why was this study done?

Uncastrated male pigs can produce meat having an unpleasant odour and flavor, known as 'boar taint.' Researchers evaluated certain feed additives for controlling boar taint and for providing alternatives to surgical and chemical (immunocastration) castrations.

What was done and what was the outcome?

An initial evaluation was carried out on the potential of certain feed additives to control boar taint, and therefore improve the quality of meat produced by intact male pigs. *In vitro* results have showed that diatomaceous earth, bentonite, spent filter aids, and a hydrated sodium- calcium aluminosilicate (Jumpstart 360) were the most effective feed additives for binding androstenone and skatole, two compounds responsible for boar taint in intact male pigs.

Three feeding trials took place after this evaluation. Based on the dietary concentrations as well as the length of time the feed additives were given to the pigs, the tested feed additive did not allow boar taint to be controlled effectively. Further work would be needed.

Growing better pigs - a review of nurseries in Ontario

Robert Friendship and Vahab Farzan,
University of Guelph

Results showed that, in participating nurseries:

- Piglet average daily gain ranged from 300 to 600 g/day
- Age at weaning influenced the average daily gain
- Diarrhea and meningitis were the most commonly reported diseases

Why was this study done?

If a pig has grown poorly or was sick during the nursery phase it can affect performance and health during the growing-finishing phase. The nursery is the most challenging stage of production because the immunity gained from colostrum begins to disappear by 3 weeks of age and weaning involves a number of stressors. Therefore, researchers wanted to determine benchmarks for weight gain, mortality and morbidity in Ontarian nurseries.

What was done and what was the outcome?

Forty-seven nursery barns in Ontario representing a variety of farm types across a wide geographical area were visited. The following actions were carried out on these farms:

- A management survey was completed.
- A group of 20 piglets was weighed, and blood and fecal samples collected twice.
- Treatments received by these pigs, as well as mortality, were recorded.

Average daily gain

Results showed that performance in nurseries varied and that there was room for improvement to have “better” pigs when starting the growing-finishing phase. Among the participating farms, piglet average daily gain (ADG) ranged from 300 to 600 g/day, with an average of 452 g/day. It was also found that the age at weaning influenced ADG.

Table 1: Average daily gains according to weaning age

Age at Weaning	ADG
Less than Day 21	420 g/day
Between Day 21 and Day 28	455 g/day
Later than Day 28	491 g/day

Mortality rates

Regarding mortality, it was found that the mortality rate ranged from 0.1% to 7.5%, where most groups recorded mortality between 2% to 3%. For 12 of the nurseries, data was available regarding feed efficiency and other information. After analysis, the average feed conversion rate for these farms was found to be 1.66, the growth rate was 480 g/day, and mortality was 2.2%.

Diseases in the nursery

The most commonly reported diseases were:

- Diarrhea (generally thought to be caused by enterotoxigenic *E. coli*)
- Meningitis (considered caused by *Streptococcus suis*)

The most commonly reported diseases resulting in mortality were:

- Streptococcal meningitis
- Post weaning diarrhea

PRRS (porcine reproductive and respiratory syndrome) and influenza were also commonly mentioned. In addition, medication use varied from no antibiotics used to multiple antibiotics used at a treatment level to the entire nursery.

Researchers also found that:

- Supplementing flavomycin in nursery diets was ineffective for the control of *Salmonella* in pigs.

Additional project information

Click on the links below for further information on this project
Links were last updated in 2022

R&D Featured Articles—by Geoff Geddes for Swine Innovation Porc

Articles may be found at: <http://www.swineinnovationporc.ca/resources-e-newsletters.php>

- [Finisher Nutrition a Growth Industry](#)
- November 2019 (Vol. 4, No. 17.)
- [Science Helps Hogs to the Finish\(ing\) Line](#)
- September 2019 (Vol. 4, No. 14.)
- [Feed Research has a Finger on the Pulse](#)
- May 2019 (Vol. 4, No. 4.)
- [Fed Up With High Feed Costs? Chew On This](#)
- December 2018 (Vol. 3, No. 18.)
- [Precision Feeding Can Nourish Your Bottom Line](#)
- September 2018 (Vol. 3, No. 12.)
- [Enhanced DDGS Aims to Perk Up the Pigs](#)
- August 2018 (Vol. 3, No. 9.)
- [Boar Taint Research in Good Taste](#)
- June 2018 (Vol. 3, No. 6.)

Farmscape Interviews:

- [Precision Feeding Offers Opportunity to Select More Efficient Feed Converters](#)
- July 27, 2018
- [Precision Feeding Reduces Swine Herd Nutrient Requirements and Manure Nutrient Excretions](#)
- July 18, 2018
- [Fermented or Acidified Grains Added to Swine Diets Offers Health Benefits](#)
- May 24, 2018
- [Combination of Soluble and Insoluble Fibre Recommended](#)
- May 14, 2018
- [Added Fibre to Gestating Sow Diets Offers Range of Benefits](#)
- May 10, 2018
- [Formulating Diets for Individual Pigs Reduces Feed Costs and Environmental Impacts](#)
- February 5, 2018



Farmscape Interviews:

- [Precision Feeding Technology Offers Opportunity to Maximise Use of Co-Products](#)
- October 7, 2016
- [Precision Feeding Promises Reduced Environmental Impact](#)
- September 15, 2016
- [Customising Rations for Each Pig Improves Feed Nutrient Utilization](#)
- September 1, 2016
- [Use of Alternative Feed Ingredients Can Dramatically Improve Profits](#)
- January 15, 2016
- [Formulating Rations for Pigs Individually Cuts Overall Costs](#)
- December 14, 2015
- [National Research Effort Focuses on Improved Feeding Programs to Improve Competitiveness](#)
- July 28, 2015
- [Commercial Trials on New Precision Feeder Expected to Start in Early 2016](#)
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- [Swine Nutritionists Strive to Improve Nutritional Value of Feed](#)
- January 21, 2015

Peer-reviewed articles and abstracts:

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