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**Cover Photo**
Our front cover is a compilation of photos celebrating Prairie Swine Centre's 25 anniversary. See our article on page 6.

# Group sow housing
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Canadian Hog JOURNAL

# Message from the editor

Welcome back to our annual issue dedicated to the research and the researchers delivering the best swine research from across Canada. This is our third summer with this focus, and interest and participation is only growing! It's a great opportunity to get the Canadian Hog Journal into the hands of young agriculturists, and to help spark their love for agriculture AND science as a viable field to get into.

There's no secret that producers are aging and tough economic times have made it difficult for young people to get into agriculture, or even to be able to afford to take over from their parents. Though the path to the barn may have been trodden through the homestead yard in years gone by, these days another path lies through college and university. Organizations like Prairie Swine Centre, our participating universities, government agencies, and the CDPQ are just some of the amazing homes that open doors for their doors to our industry, and for our children. Thank you for all that you do!

Thank you also to our continued support from our many advertisers. Without you, this magazine simply wouldn't be possible. You are valued, and your role in helping deliver the information that producers and stakeholders need is integral to this industry.

From now on, the amazing Charlotte Shipp at the Alberta Pork office will be looking after our addressing system and circulation. I took it over for a few months, but Excel spreadsheets just aren't my thing. Apologies for any address hiccups over the past few months, but everything should be right as rain very soon!

Planning is well underway for our fall issue, and I am pretty excited about some of the stories we are working on for you already. If you have any story ideas, we would love to hear them. And don't forget to find us on Facebook! As always, we welcome photo submissions and I love being able to publish reader-generated front pages. They truly tell the story of what we do and who we are.

Have a wonderful summer full of adventure! ■

sherimonk@gmail.com

S Monk.

Sheri Monk

Editor, business manager

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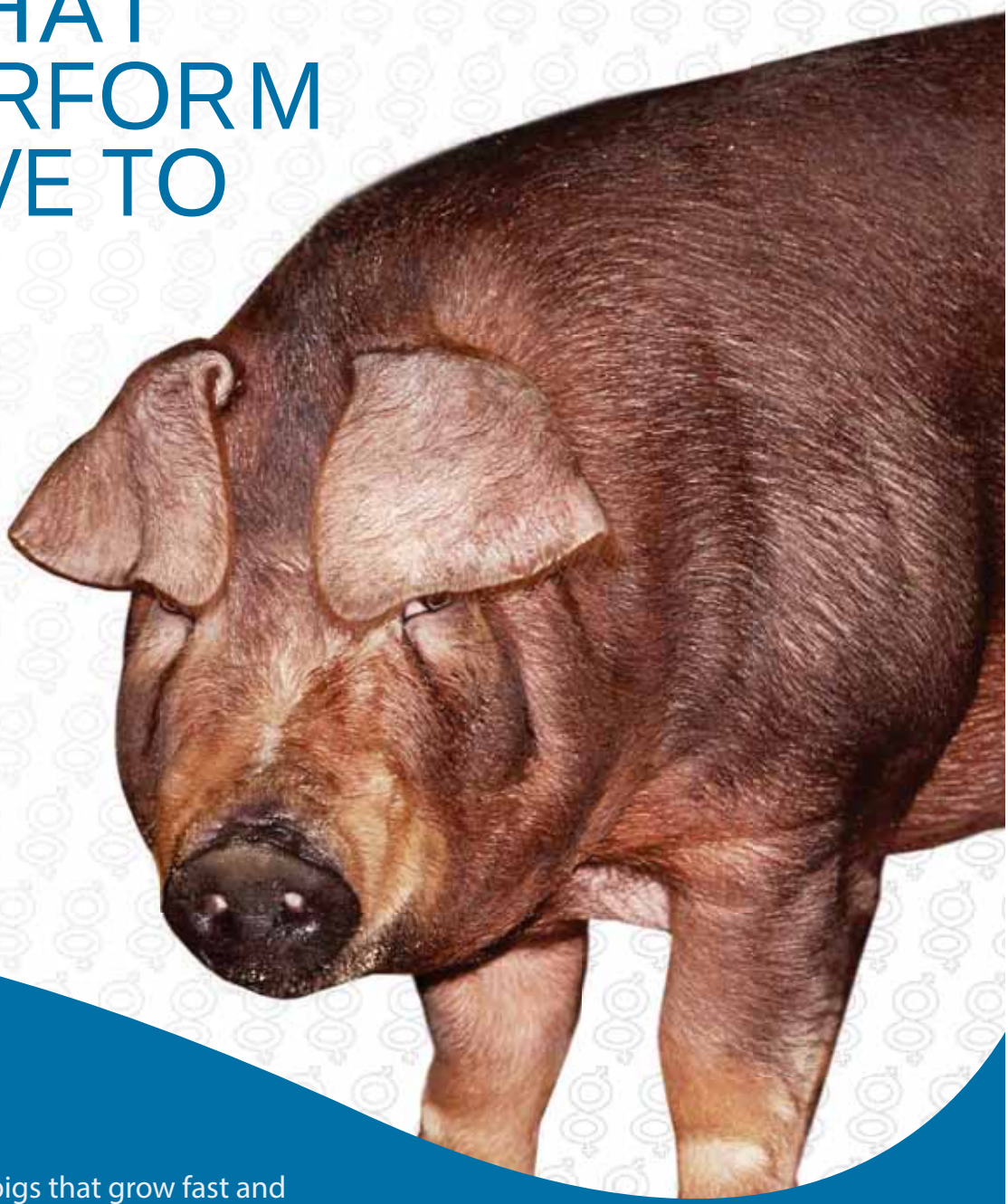

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# Prairie Swine Centre celebrates 25 years of science

By Sheri Monk

Prairie Swine Centre is celebrating 25 years, and the entire industry is celebrating with them. The facility itself pre-dates the organization, and its uncertain future in the 1980s led to the formation of the Prairie Swine Centre (PSC) in 1992.

"The barn itself was managed by the University of Saskatchewan Animal Poultry Science Department and had been losing money and was primarily looking at only doing things that were related to reproduction. The colleges of ag engineering were using it a bit, but essentially it wasn't putting out enough information to get the industry excited, and it wasn't publishing enough papers. The university actually had it up for sale," explained Lee Whittington, president and CEO of Prairie Swine Centre.

Originally built in 1980, the facility featured two side-by-side 150 farrow-to-wean barns. The design was intended to allow researchers to compare the two barns.

"That never really worked out for a variety of reasons, the biggest one being statistics. You just can't have the animals in two different spaces and expect to compare the results," said Whittington.

That's when Saskatchewan's pork producers stepped in, and approached the university promising their support by hiring an executive director for the facility, and forming an advisory committee. The committee, consisting of veterinarians, academics, engineers and pork producers from across Canada, came up with a new plan for the Centre.

"If the Centre was going to be effective, it had to be in grow-finish research, and in order to do grow-finish research, they needed $2 million for an expansion," said Whittington.

The U of S was very supportive, but didn't have the capital needed for the project. The committee instead transformed the organization into a non-profit corporation, spun-off from the university, allowing them to access capital funding from the Western Economic Diversification program. Just like that, the new vision for the Centre was unfurling, and the first employees were hired – including Whittington as manager of information services. The very first founding roster also included Dr. Yuanhui Zhang, engineering research scientist, Dr. Harold Gonyou, ethology research scientist, Dr. Kees Delange, nutrition research scientist, Brian Andries, operations manager, and Dr. John Patience as CEO.

"It was really exciting back then," said Patience. "There was great enthusiasm on the part of the pork producers, on the part of the provincial government, on the part of the federal government and on the part of the senior administration at the University for Prairie Swine Centre to become an independent, non-profit corporation."

The facility was renovated and populated, but the employees had been busy from the very beginning, drumming up support.

"Our focus from the get-go was to be able to bring more players into it so that we began talks almost immediately with Alberta Pork, Manitoba Pork and Ontario. Alberta and Manitoba came on quite quickly," said Whittington.

The advantage to Prairie Swine Centre was clear – by joining forces, producers could fund a multitude of projects instead of just a few individual projects. Of course, PSC didn't just rely on producer dollars. Whittington and the rest of the staff aggressively pursued traditional revenue sources via the usual grant and funding proposal approach.

"At the time, the hog industry was expanding and there was a huge demand for new information, especially in grow-finish,

*CONTINUED ON PAGE 8*


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[1]Mengel H, et al. (2011). *Parasitol Res*. Published online. DOI 10.1007/s00436-011-2633-8.
[2]Kreiner T, et al. (2011). *Vet Parasitol*. 183(1-2):14-20.
[3]Rypula K, et al. (2006). Proc. of 29th Century IPVS Congress, Volume 2: 282.
[4]Driesen SJ, et al. (1995). *Aust Vet J*. 72(4):138-141.
[5]McOrist S, et al. (2012). *Scientific World Journal*. Published online. DOI 10.1100/2012/486324.

so the advisory board hit it right on the nose in terms of what needs there were," said Whittington. "The barn was well designed to be able to replicate anything you could see in commercial farms so it was that flexibility that allowed the Centre to be accepted right across western Canada in terms of the kinds of results it would give."

Universities and researchers right across the country paid attention. Prairie Swine Centre, as a non-profit corporation partnering with producers, was a new concept for many in the academic world.

"They were intrigued because the program that the Centre put together was so much more focused on the producer than the traditional relationship that industry had with universities," said Whittington.

The Prairie Swine Centre also pioneered new communication techniques within the industry. They invested time and money into ensuring their research was made available to producers and stakeholders through a newsletter, and they launched a website in the very early days of the web.

As Prairie Swine Centre grew and developed, elements and dynamics changed.

"We thought we were going to build this elite group of people who were going to do wonderful things and we were all going to stay together as a team, but it became obvious inside of the first five years that the Centre was really a starting point for a lot of young researchers," said Whittington. "Now we take that for granted as an important role of the Centre. We have populated all the institutions in Canada and some in the U.S. with young researchers who got their start at our place."

Researchers at the Centre focused on collaboration and the industry rather than on academic publications.

"That gave them quite an advantage when they did go to compete for faculty positions. They knew how to raise money from the industry, they knew how to talk to the industry, and they had profile and so it became a really legitimate jumping-off point for a lot of young scientists," he added.

Every spring, the Prairie Swine Centre would go on a two-week tour.

"We would literally rent a van and go out and do two meetings a day in everything from the local legion to church basements. It was exceptionally good because the whole senior team went at the same time and we learned each other's material," said Whittington.

The annual excursion became a much-heralded event, and allowed the team at the Centre to become very close.

"We knew we were doing something a little bit different and a little special. I used to think of it as the type of return the pork producers would want, and that was to see us face-to-face not just at Banff or other events, but right in their back yard talking to them about things that were of interest to them."

In the beginning days, there were 14 employees at the Centre's first Christmas and today there are 35 full-time equivalents.

Both Patience and Whittington give producer groups a lot of credit for recognizing the need for research, and the will to fund it.

"Research became a line item in the budgets of producer groups," explained Whittington.

"That was huge," Patience said. "It spurred further investment from the provincial government. The industry is so hungry for new research. They recognized very quickly who was going to help them get that new knowledge and they are very, very supportive."

Today, the partnerships between producers, the Prairie Swine Centre and the University of Saskatchewan are stronger than ever.

"The first 25 years has been an incredible experience," said Whittington. "The next 25 years will be even better." ■

# Swine research, education and outreach at the University of Alberta in the Department of Agricultural, Food and Nutritional Science

**Submitted by Ruurd Zijlstra**

Researchers in the Department of Agricultural, Food and Nutritional Science (AFNS) enhance key value attributes for the pork industry and value chain. Research is focused on enhancing animal health & welfare, reproduction, pork quality, nutrient efficiency and reducing feed cost, together thereby enhancing the sustainability of the pork industry. The pig is also used as model for biomedical research. Professors together with their graduate students drive innovation using an array of facilities and collaborations and teach within two undergraduate student programs: Agriculture (Animal Science) and Animal Health. The Banff Pork Seminar is organized together with an Advisory Committee.

AFNS operates the Swine Research and Technology Centre on South Campus (SRTC) as the main animal facility that is managed by Jay Willis. Professors collaborate with scientists from other organizations to provide access to SRTC or gain access to pigs elsewhere to reach better research outcomes and training opportunities. On North Campus, researchers use central laboratories for Genomics and Proteomics, Chromatography, and Proximate analyses. Genomics and associated research is organized under the umbrella of Livestock Gentec.

The SRTC has a sow herd providing research animals and animal facilities for researchers in AFNS and biomedical researchers in other departments. Sows are housed in gestation and farrowing rooms. Weaned pigs are housed in nursery rooms until reaching 25 kg body weight, and some pigs can reach slaughter weight in a growout facility. Pigs can be surgically modified and housed individually in the metabolism wing of SRTC. The SRTC thereby supports teaching programs for undergraduate students, research programs for graduate students, and training in swine handling.

*CONTINUED ON PAGE 10*

Livestock Gentec CEO Graham Plastow together with Leluo Guan and Paul Stothard apply genomic-based tools to support the livestock industry. For porcine genomics, scientists study mechanisms in pigs that make them genetically less susceptible to disease, provide important new diagnostic tools for breeders, and expand our understanding of disease control mechanisms. Genome projects include Ellen Goddard in our colleague Department of Resource Economics and Environmental Sociology who provide the GE3LS component linking Genomics with its Ethical, Environmental, Economic, Legal, and Social Aspects.

Swine health and immunity is studied by Dan Barreda and Richard Uwiera. Such research is tied to genomics as described above, to create robust pigs that rely less on antibiotics in research program led by Michael Dyck. Research conducted by Ben Willing and Michael Gaenzle links gut microbiology and the effect of bacterial communities and microbial metabolites on swine health. As support, equipment was recently established to perform germ-free piglet experiments.

For biomedical research, the pig model is used by AFNS Human Nutrition professor Spencer Proctor who studies heart disease risk, diabetes and the complications of low birth weight swine. Moreover, Pediatrics Associate Professor Justine Turner studies severe intestinal malfunction in young piglets and has been testing pharmacological solutions to this problem that could translate to life-saving therapies for human babies.

Pork quality and animal welfare are becoming increasingly important for the pork industry. Pork quality is tied to important genomic, nutrition, husbandry and slaughter variables as studied by Heather Bruce. Animal welfare in particular related to group-housed pigs and automated behavior and welfare assessment technology platforms is studied by Clover Bench.

Finally, feedstuff evaluation research is conducted by Alberta Agriculture and Forestry Scientist Eduardo Beltranena and Ruurd Zijlstra. Such research includes new commodity ingredients but also novel feedstuffs that are created using dry or wet fractionation technologies at nearby Agri-Food Discovery Place on South Campus.

To enable the research, our strong industry and government partners are essential and appreciated. Furthermore, strong ties exist among the researchers mentioned and their external collaborators, but the description above provides an entry to access scientists related to swine in our department. ■

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HENDRIX GENETICS

# Does creep feeding work?

By Danielle Hult, Natacha Hogan , Andrew van Kessel, and Denise Beaulieu

University of Saskatchewan, Saskatoon, SK

Successful pork production is highly dependent on sow productivity. The number of pigs born alive per sow per year is a commonly cited benchmark. However, improvements are not fully realized if pre-weaning mortality remains high and/or growth rate post-weaning is not maintained.

*Danielle Hult*

Creep feeding, the practice of providing feed to nursing piglets to supplement milk intake, is a strategy intended to alleviate problems at weaning. In theory, the provision of creep feed should result in larger piglets at weaning. Moreover, since the piglets have been introduced to solid feed, post-weaning feed intake and growth should improve with creep feeding. Results however, are inconclusive and in-fact, some early work that we conducted at PSCI was not able to show a difference in average weaning weights or nursery growth rates between litters that had received creep feed and those that had not. Response to creep feeding can confounded by several factors, including the age at weaning, litter size and the individual variation in creep feed consumption, between and within litters.

Subsequent experiments focused on the individual variation in creep feed consumption. The example shown in Tables 1 and 2 shows the data from 100 sows. Litters were standardized to 11 piglets. We used standard, commercial lactation, gestation and creep feed. The creep feed, supplied in commercial round feeders from day 21 to 26 of age (weaning), also contained blue food colouring during specific time points. Anal swabs taken at prescribed times post-feeding enabled the designation of piglets as "eaters" or non-eaters". This is a proxy for individual feed intake measurements which are not possible in our system with nursing piglets maintained in groups.

As shown in table 1, the provision of creep feed in the farrowing pen from day 21 post-farrowing to weaning did not improve litter weaning or nursery exit weights despite an slight improvement in growth rates in the nursery.

However, piglets with evidence of creep feed consumption ("eaters") had improved growth rates throughout the nursery period and greater nursery exit weights (Table 2). Interestingly, the creep feed "eaters" were the smaller piglets in the litter at day 21 and weaning.

**Table 1. The response of piglets to the provision of creep feed in the farrowing room from day 21 to 26 post-farrowing.**

| | Creep | No Creep | SEM | P value |
|---|---|---|---|---|
| n, (litters) | 48 | 52 | | |
| Sow parity | 3.19 | 3.23 | | |
| Weaning age | 25.94 | 26.06 | | |
| Piglets/litter | 10.77 | 10.60 | | |
| Body weight, kg | | | | |
| Birth | 1.47 | 1.47 | 0.03 | NS* |
| d 21 | 5.75 | 5.98 | 0.15 | NS |
| Weaning | 7.66 | 7.75 | 0.17 | NS |
| Nursery exit (54 days of age) | 20.62 | 20.29 | 0.34 | NS |
| ADG (g/d) | | | | |
| d 21 to weaning | 0.25 | 0.24 | 0.006 | NS |
| Wean to d 3 (nursery) | 0.14 | 0.14 | 0.02 | NS |
| d 4 to d 7 | 0.14 | 0.10 | 0.02 | 0.001 |
| Wean to nursery exit | 0.45 | 0.42 | 0.01 | 0.05 |
| ADFI, nursery (g/d) | | | | |
| d 0 to 3 | 0.13 | 0.12 | 0.01 | NS |
| d 4 to 7 | 0.23 | 0.20 | 0.013 | NS |
| d 7 to 14 | 0.42 | 0.40 | 0.01 | 0.07 |

*NS not significant

**Table 2. The performance of piglets offered creep feed in the farrowing room from day 21 to day 26 of age, classified as "eater" or "non-eater".**

| | Creep eater | Creep non-eater | SEM | P value |
|---|---|---|---|---|
| Piglets, n | 175 | 296 | | |
| % of total | 37 | 63 | | |
| Piglet weight, kg | | | | |
| Birth | 1.51 | 1.48 | 0.04 | NS |
| d 21 | 5.64 | 5.95 | 0.13 | 0.02 |
| Weaning | 7.44 | 7.72 | 0.15 | 0.06 |
| Nursery | | | | |
| d 3 | 7.97 | 8.10 | 0.17 | NS |
| d 7 | 8.64 | 8.61 | 0.17 | NS |
| d 14 | 11.23 | 10.96 | 0.19 | NS |
| Nursery exit (54 d of age) | **20.60** | **19.79** | 0.44 | 0.007 |
| ADG, (nursery) kg/d | | | | |
| Wean to d 3 | **0.18** | 0.13 | 0.02 | 0.001 |
| d 4 to 7 | **0.16** | 0.13 | 0.02 | 0.002 |
| d 8 to 14 | **0.37** | 0.33 | 0.01 | 0.001 |
| d 14 to exit (54 d of age) | **0.66** | 0.62 | 0.01 | 0.005 |
| Wean to nursery exit | **0.47** | 0.43 | 0.01 | 0.001 |

*NS non significant

Our overall conclusion from this experiment therefore is; creep feed does provide benefits, but (not very surprising) only for the piglets that eat it! The question, therefore, is how to get more piglets to consume the creep feed?

Our summer student, Danielle Hult, is conducting an experiment to determine if the addition of a yeast probiotic and prebiotic will improve piglet creep feed consumption and if this will have a positive effect on overall performance post-weaning. Creep feed, supplemented with either a pre- or probiotic will be provided in the farrowing crates from day 7 of age until weaning. Diets post-weaning will also contain these additives. Danielle will be measuring the proportion of piglets with evidence of consumption and the effect on gut health and growth of these piglets. Results from this study will help producers with the weaning transition.

**Acknowledgements.** We acknowledge funding from the Agriculture Development Fund, SK and Phileo-LeSaffre Animal Care. This work is being conducted at the Prairie Swine Centre, Inc, Saskatoon. PSCI receives program funding from the Sask Ministry of Agriculture, Sask Pork, Manitoba Pork, Alberta Pork, Ontario Pork and the University of Saskatchewan. ■

# Feeding weanling pigs acidified high-moisture wheat as alternative to in-feed acidification

Danilo Sotto, Jr., Andrew van Kessel, and Denise Beaulieu, University of Saskatchewan, Saskatoon, SK

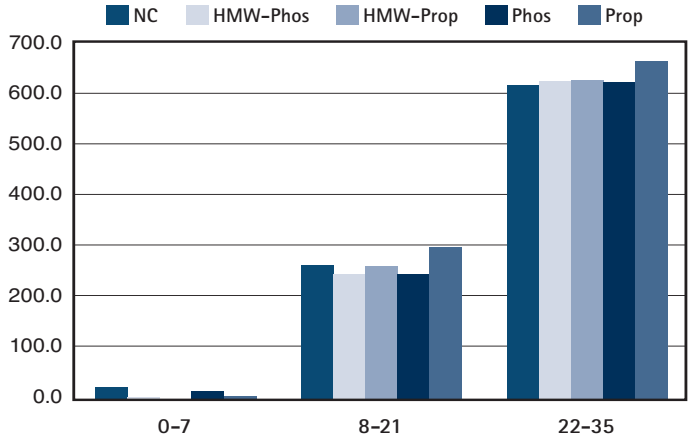
Social and physical stresses at weaning, coupled with insufficient secretion of hydrochloric acid (HCl) may result in a post weaning performance lag characterized by reduced growth rates and increased incidence of diarrhea. A low pH is required for adequate protein digestion. If undigested, protein may be used as substrate for the growth of pathogenic bacteria in the intestines. Weanling pig diets are commonly supplemented with "acidifiers" to mitigate the challenges brought about by insufficient HCl secretion. Various acidifiers have been shown to improve piglet growth rates by 6 to 12% (Tung and Pettigrew, 2006).

Wheat, one of the main energy sources in Western Canadian pig diets, is typically harvested at < 15% moisture to maintain quality during prolonged storage. If this is not possible, artificial drying is employed, however this increases grain cost due to fuel and power use, and specialized structures are required. Preservation of high-moisture grains by acidification is an alternative to artificial drying. An experiment was therefore conducted to determine the efficacy of feeding acid-preserved high moisture wheat as an alternative to in-feed acidification.

A commercial phosphoric acid-based feed acidifier (30 to 50% phosphoric acid, 0.1 to 1% lactic acid, 5 to 10% citric and 1-5% malic) or propionic acid (99%) was added to wheat that had been reconstituted to ~20% moisture and stored for 34 days. Mold count for phosphoric acid-preserved high-moisture wheat reached 7,000 cfu/gram during storage, however, mycotoxin levels were either not detected or were within acceptable limits. Mold count for the propionic acid-preserved high moisture wheat was 20 cfu/gm. During storage, grain pH in phosphoric acid-preserved high-moisture wheat increased from 4.27 to 5.72, while in propionic acid-preserved high-moisture wheat, pH increased from pH 4.56 to 4.85.

Figure. 1. Reconstitution, treatment and storage of wheat.

Figure 2. Growth of newly weaned piglets receiving a wheat basal diet, acid-preserved high moisture wheat diets or wheat diets with acid added prior to feeding.




A total of 160 newly weaned pigs (21±2 days of age, 6.5 kg BW) were weighed and randomly distributed to 80 pens with 4 pigs per pen. Pens were assigned to 1 of 5 treatments in a randomized complete block design. Briefly, treatments were wheat basal without acid (NC), high-moisture wheat with phosphoric acid (HMW-Phos), high moisture wheat with propionic

CONTINUED ON PAGE 16

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Figure 3. Feed intake of newly weaned piglets receiving a wheat basal diet, acid-preserved high moisture wheat diets or wheat diets with acid added prior to feeding.

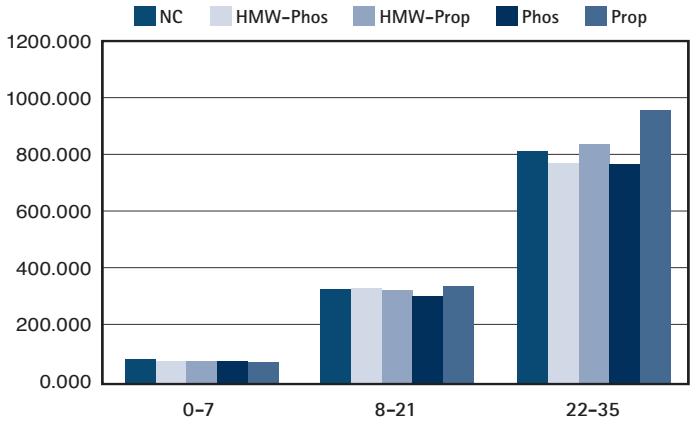
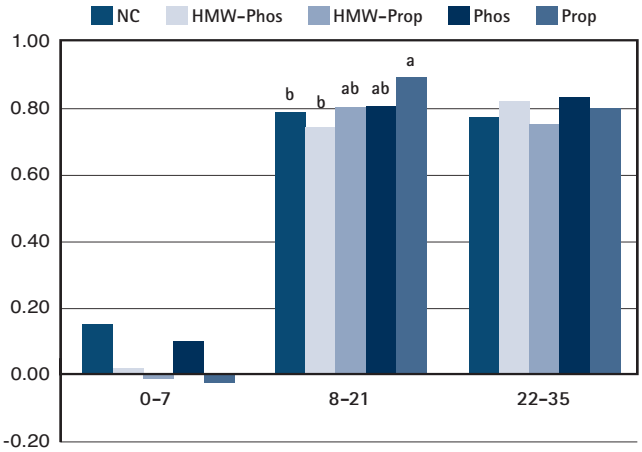



Figure 4. Feed efficiency of newly weaned piglets receiving a wheat basal diet, acid-preserved high moisture wheat diets or wheat diets with acid added prior to feeding.




acid (HMW-Prop), NC with phosphoric acid (Phos), and NC with propionic acid (Prop). Diets were formulated to meet or exceed recommendations by NRC 2012 and did not contain animal by-products except for whey to supply lactose in the stage 1 diet. Treatment diets were given as phase 1 (0-7 days post weaning) and phase 2 (8 to 21 days post weaning). A common commercial diet was given from 22 to 35 days post weaning.

Treatments had no effect on the average daily gain or feed intake of pigs during any of the growth phases (Fig. 2 and Fig. 3 respectively). However, G:F at 8-21 days post weaning of pigs fed diets supplemented with propionic acid (Prop) was higher than with pigs fed the NC or phosphoric acid-preserved wheat (Fig 4).

Galvanized steel and carbon steel coupons (Fig. 5) were embedded in the acid-preserved high moisture wheat to estimate potential corrosive effects of acids on materials that make up storage bins and feeders. Both acids resulted in similar corrosion rates on galvanized steel, but propionic acid resulted in higher corrosion rate compared to phosphoric acid when carbon steel was used. Regardless of acid, galvanized steel had higher corrosion rate than carbon steel.

## Conclusions

Further work is required to determine adequate preparation and storage for the use of phosphoric acid-based acidifier to preserve high moisture wheat. Furthermore, supplementation of a wheat-based diet with phosphoric acid-based acidifier either through acid-preservation of high-moisture grain or in-feed did not affect ADG, ADFI and G:F of pigs. On the other hand, in-feed supplementation of a wheat-based diet with propionic acid resulted in higher G:F in pigs at 8 to 21 days post weaning compared with those fed the negative control and those fed phosphoric acid preserved high moisture wheat. Corrosion however, may be more problematic with the use of propionic acid.

Figure 5. Carbon steel (A) and galvanized steel (B) used to estimate the effect of acid on corrosion rate.




## Acknowledgements

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## Biography

Danilo Sotto, Jr. is a PhD student at the Prairie Swine Centre Inc. and University of Saskatchewan under the supervision of Dr. Denise Beaulieu. He obtained his B. Sc. and M. Sc. from the University of the Philippines Los Banos and has been working with the feed industry in the Philippines before coming to Saskatchewan in 2014. As an animal nutritionist, he is interested in finding ways to improve feeding value of ingredients through feed processing in order to improve animal performance and gut health, and reduce feed cost to improve profitability of pig production. His Ph. D. program is also supported by a study grant provided by industry partner Gowans Feed Consulting. ■

# Nutrition Research Program at Prairie Swine Centre

**Submitted by Prairie Swine Centre**

With new legislation eliminating the use of in-feed antibiotics for growth promotion by the end of 2017 in Canada and increasing consumer pressure to reduce antibiotic use in animal agriculture, it is critical that we develop alternatives to antibiotic use in order to maintain animal performance and health during immune challenge. An increased understanding of the interaction of nutrition and animal robustness (i.e., the ability to cope with an immune challenge), therefore, will be a key component in efforts to replace and/or reduce antibiotic use. Specifically, nutrition-based alternatives to antibiotic use need to be identified.

The incidence of disease results in reduced growth and less efficient use of nutrients as a result of a number of factors including reduced feed intake, increased nutrient requirements for the immune response, and impaired gut health. Immune challenge results in significant physiological alterations to the gastrointestinal tract, including changes in gut motility, permeability, digestive enzyme secretion and absorptive capacity, and mucin production. Stimulation of the immune system also alters protein and amino acid metabolism and utilization, with amino acids redirected from growth towards supporting the immune response. In order to maintain animal performance while reducing antibiotic use we will need to develop feeding programs aimed at supporting the immune response as well as gut health.

Co-products and other alternative feedstuffs commonly used in swine diets to reduce feed costs are typically higher in fibre content and vary in protein content and bioavailability. Dietary fermentable protein content (i.e., undigested protein available for fermentation by colonic microbiota) may have detrimental effects on gut health. Metabolites of protein fermentation, including branched-chain fatty acids, ammonia, biogenic amines, hydrogen sulfide, phenolic, and indolic compounds (Yao et al., 2015; Pieper et al., 2012), have been associated with toxic and pro-inflammatory effects on the gut epithelium. Indeed, diets high in protein are a predisposing factor in the development of post-weaning diarrhea. Furthermore, the presence of antinutrition factors, such as dietary fibre, which reduce protein digestibility and/or increase endogenous pro-

*CONTINUED ON PAGE 18*

tein secretions (e.g., mucins) within the gut contribute to an increase in supply of undigested protein to the colon.

Dietary fibre content may have both positive and negative effects on gut health. For example, high dietary fibre increases the amino acid (i.e, threonine) requirement for body protein deposition through an increase in intestinal mucin production. On the other hand, while fermentable fibre results in increased protein secretion into the gut via mucin and increases maintenance amino acid requirements, the provision of fibre as an alternative fermentable substrate may mitigate the effects of protein fermentation through reduction of microbial fermentation of protein and/or improved incorporation of metabolites, such as ammonia, into the microbial biomass. Fermentation of fibre also produces SCFA which may have a protective effect on the gut epithelium.

We are currently conducting a series of projects aimed at determining the combined effect of dietary fibre, dietary protein, and immune challenge on amino acid requirements in growing pigs. We will further determine if pig robustness is improved through increased levels of selected amino acids during an enteric pathogen challenge. Information obtained can be used to develop feeding programs to improve pig performance during disease challenge.

**Dr. Dan Columbus** is a Research Scientist in Nutrition at the Prairie Swine and Adjunct Professor in the Department of Animal and Poultry Science at the University of Saskatchewan. His current research interests include the impact of nutrition on pig health and robustness, the effect of early-life nutrition on long-term performance and animal health, strategies for the mitigation of mycotoxins in pig feed, and the evaluation of novel feed ingredients and feed additives for use in the pig.

**Michael Wellington** is a PhD student at University of Saskatchewan under the supervision of Dr. Andrew Van Kessel (Department of Animal and Poultry Science) and Dr. Daniel Columbus (Prairie Swine Centre Inc.). His research focuses on examining the effects of high dietary fibre and immune challenge on threonine requirements and robustness of grower pigs. Michael is originally from Accra, Ghana and obtaining his BSc. (Hons) Agriculture with a major in Animal Science from the University of Ghana in 2012; and Masters from the Swedish University of Agricultural sciences and the University of Copenhagen.

**Rochelle Thiessen** is a MSc student at the University of Saskatchewan under the supervision of Dr. Daniel Columbus (Prairie Swine Centre Inc.) and Dr. Andrew Van Kessel (Department of Animal and Poultry Science). Her research focuses on examining the impact of dietary fibre and fermentable protein on the threonine requirements of grower pigs as well as its impacts on animal health/gut barrier function. Rochelle grew up in the small town of Hague, SK and obtained her BSc. Agriculture with a major in Animal Science from the University of Saskatchewan in April 2017. Rochelle had previously developed her passion for working in the livestock industry after working for Fast Genetics in Spiritwood, SK as a Swine Production Technician for the last 3 summers. She also received the P.A. Thacker Undergraduate Scholarship in Swine Production at the University of Saskatchewan in March of 2017. Rochelle recently began her MSc in May 2017 and is training to further her knowledge and research skills in swine nutrition and gut health/function. ■

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# The CDPQ: A multidisciplinary research team working for pig producers

Submitted by Nathalie Plourde (B.Sc.), project manager, Centre de développement du porc du Québec. nplourde@cdpq.ca

The Centre de développement du porc du Québec inc. is a team of 38 employees serving the swine sector through different projects, services and programs. With the support of different committees, the aim of CDPQ's work is to ensure the competitiveness of the sector through the evolution and development of the following fields: Analyzing and evaluating data, Animal well-being and behaviour, Building and livestock management, Feeding and animal nutrition, Genetics, Health and biosecurity, Live animal measurement technologies, Management and economics, Meat quality and Transport of animals.

## Mission

To innovate and contribute to the creation and transfer of expertise, as well as to the acquisition of skills necessary to enable the Quebec swine industry to meet the demands of both markets and consumers and ensure its sustainable development.

The CDPQ team is currently working on a number of projects to address the various needs and concerns of pig producers, particularly in relation to herd management strategies and the use of equipment adapted to the new animal welfare norms.

## Ongoing projects concerning buildings and livestock management:

- **Group-housed sows**

The norms concerning the management of group-housed sows call for the development of new knowledge and the use of specialized equipment to ensure optimal pen management. Two projects focus on this theme; their main objectives are:

- Test 9 different pen layouts, decide on the optimal positioning for ESFs (electronic feeders) and determine whether gilts require special treatment (e.g. preconditioning/training) or if they can be put with multiparous sows.

- Assess the water wastage associated with different watering systems (bowl waterers and nipples) as well as the drinking behavior of group-housed gestating sows, to optimize water management and pen layout.
- CDPQ offers a service on a regular basis for producers wishing to make the transition from their building to management of sows in groups. (Refer to factsheet)

**• Finisher Pigs**

Rearing finisher pigs remains a constant challenge for producers so that they make optimal use of resources, reduce culls and improve animal performances. Two of CDPQ's current projects concern this stage of swine production. In essence their objectives are:

- Evaluate the performances and feeding behavior of animals in a large group or in a conventional pen. At the same time, develop an automated imaging tool that allows real-time evaluation of the occupancy rate of different pen areas, according to various parameters, such as environmental conditions, animal weight, season, type of flooring, etc.
- Validate the impact of six types of watering equipment on wastage and growth performances in finishing.

For further information on these projects, contact Sébastien Turcotte: sturcotte@cdpq.ca

## Project in the field of herd health and biosecurity

**• Air filtration**

Application of biosecurity measures on-farm prevents the introduction and spread of porcine infectious diseases. Moreover, since many pig farms in Quebec lie in close proximity to other pig farms with different health status, and sometimes are even on the same site (e.g. quarantine), one important aspect of biosecurity is the control of airborne dispersion of pathogens/infectious agents. Air filtration is recognized as a technique that significantly lowers the risk of airborne contamination of pig farms.

However, air filtration in livestock barns is a major investment and the results in commercial livestock production are not always as anticipated. Although different filtration strategies are being evaluated more and more, much work remains to be done to show pig producers how to select filter types most appropriate to their situation and also how to recognize the useful lifespan of filters. This is why CDPQ is carrying out a project to develop a method for evaluating the capture efficiency of mechanical or antimicrobial filters.

**• Ozonation**

In a context similar to that of controlling the introduction and spread of airborne diseases, another project is underway

CONTINUED ON PAGE 22

to assess the potential of ozonation to reduce pathogen levels of infectious agents( e.g. PRRS, influenza, etc.) in the air of swine farms. Air ozonation is a recognized treatment for reducing the number of human aerosol transmissible pathogens and could be an interesting tool in swine production to treat incoming or outgoing air from pig barns.

For further information on these projects, please contact Sébastien Turcotte or Christian Klopfenstein: sturcotte@cdpq.ca; cklopfenstein@cpdq.ca

**• Infrared Thermography**

Infrared thermography makes it possible to measure very precisely the temperature variations at the surface of an object (heat radiated). This technology allows non-intrusive measurements on animals, is inexpensive to operate and provides instant information and continuous measurements. It has the potential to detect diseases rapidly and in so doing, improve the treatments, health, performances and welfare of animals, while promoting a more judicious use of antibiotics. The objective of this project is to demonstrate the potential of infrared thermography for the early detection of major swine diseases in a commercial context.





For further information, please contact Frédéric Fortin: ffortin@cdpq.ca

## Project on ultrasound technology and live-animal measurements

CDPQ has always been a leader in live-animal measurement-taking using ultrasound technology on pigs. These devices have facilitated selection of the best purebred pigs over time and enabled us to concentrate our efforts on traits with a positive financial impact on both the meat market and on-farm herd management, e.g. validation of dorsal fat thickness and of loin muscle depth, evaluation of sow body reserves and gestation tests).

The technology has evolved during the last few decades and CDPQ has been mandated to evaluate the new available devices and select the ones adapted for genetic selection needs that can be used on commercial farms to promote herd productivity gains.

For further information, please contact Marie-Pierre Fortier: mpfortier@cdpq.ca

## Project in the Area of Food and Nutrition

In addition to a project on precision feeding of gestating sows, CDPQ is collaborating with Laval University to set up a reference center for the feeding of pork and poultry.

For further information, please contact Laetitia Cloutier: lcloutier@cdpq.ca ■

Story Ideas? Press release? Comments?

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[1]Nipcam Study (2002). QuickBayt Technical Information Manual.
[2]Li QF, et al. (2015). *Parasitol Res*. 114(9):3325-3528.

# Feeding canola meal or soy expeller at two feed energy levels to growout hogs

Miranda Smit[1], José Landero[2], Malachy Young[2], and Eduardo Beltranena[1]*

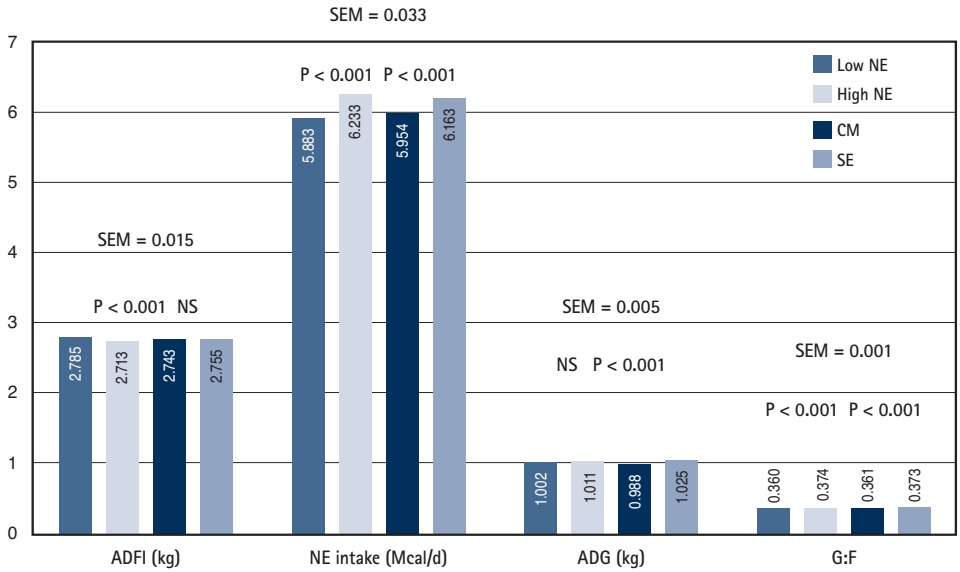
[1]Alberta Agriculture and Forestry, and [2]Gowans Feed Consulting eduardo.beltranena@gov.ab.ca

## Take Home Message

**Feeding lower net energy diets to growout hogs increased profitability without resulting in major changes in growth performance. Abruptly introducing 25% canola meal in the grower phase diets was a challenge to pigs, either because of the fibre content or the taste. Pigs fed canola meal never caught up to those fed more palatable, lower fibre, soy expeller diets, partly because we overestimated the net energy value and digestible amino acid content of canola meal, resulting in a minor reduction in growth performance and loin depth.**

Previous research trials that we've conducted showed that we can feed reduced net energy (NE) diets (≤2.3 Mcal/kg) to growout hogs instead of traditional energy levels (≥2.4 Mcal NE/kg) as long as hogs can increase feed intake to compensate for reduced dietary energy level. Conventional (solvent-extracted) canola meal (CM) has low energy value due to relatively high dietary fibre content. Soy expeller (SE) is now locally produced in Canada (Ontario, Quebec, Maritimes, Manitoba, Saskatchewan, Alberta) and has greater energy value than imported soybean meal because of remaining oil. These feedstuffs therefore offer opportunities to reduce or increase dietary net energy level at low cost. Lowering feed cost is important, as feed is the largest cost of pig production and energy yielding feedstuffs account for 85 to 90% of feed cost. Therefore, nothing impacts the cost of pork production more than the dietary energy level of feed fed to growout pigs. We needed to confirm the response of pigs to reduced dietary net energy levels to endorse previous feeding recommendations and thought to utilize canola meal vs. soy expeller to achieve that. Therefore, the objective of our trial was to compare

Figure 1. Effect of feed net energy (NE) level (low vs. high) and protein source (canola meal [CM] vs. soy expeller [SE]) on growth performance (NS=not significant; SEM=Standard Error of the Mean)



the growth performance, carcass characteristics, and economics of barrows and gilts fed low or conventional NE diets including either canola meal or soy expeller to market weight.

## Trial setup

We conducted this commercial-scale pig trial at a contract grower barn set up as a test facility (Lougheed, AB). In total, 504 barrows and 504 gilts (~33 kg BW at the start of the trial) were housed in 48 pens by sex, 21 pigs per pen. Barrows and gilts were fed two NE levels: low (2.17 or 2.20 Mcal/kg for grower and finisher, respectively) or high (2.32-2.35 Mcal/kg). Within NE level, they were fed either canola meal (25% inclusion in grower and 20% in finisher) or soy expeller (15-12.5%) with 6 pens per NE level x protein source x sex, over 5 growth phases (Grower 1: d0-12, Grower 2: d13-33, Grower 3: d34-53, Finisher 1: d54-74, Finisher 2: d75-slaughter). For all 5 growth phases, diets were formulated to equal standardized ileal digestible (SID) lysine/Mcal NE. Low NE phase diets were based on barley grain, whereas high NE diets were based on wheat grain. Within NE level, the energy value of the canola meal diet was increased to match that of the soy expeller diet by including canola oil. Pig BW and feed disappearance (ADFI) were measured on day 0, 12, 33, 53, 74, every two weeks thereafter, and at slaughter weight (130 kg). Pigs were slaughtered at Maple Leaf (Brandon, MB). Individual warm carcasses were weighed and graded (Destron).

## What we found out

For the entire trial (d0-74), although hogs fed low NE diets consumed 72 g/d more feed than those fed high NE diets, NE intake was 350 calories/d less (Figure 1). Feed intake was lower for hogs fed canola meal vs. soy expeller in the first 12 days on test, but there was no difference in feed intake for the overall trial. Caloric intake was 209 calories/d greater for hogs fed soy expeller that grew 37 g/d faster than hogs fed canola meal. Weight gain per kilo of feed consumed (feed efficiency) was 14 g/kg lower (worse) for hogs fed low vs. high NE diets and 12 g/kg greater (better) for hogs fed soy expeller vs. canola meal (Figure 1).

Carcass dressing was 0.6%-points lower feeding low vs. high NE diets and feeding canola meal vs. soy expeller (Table 1). Lower dressing % is explained by more fibrous feed retained in the gut at slaughter feeding the low energy diets or the canola meal diets. As a result of lower dressing %, carcass weight was 0.8 kg lower for hogs fed low vs. high NE diets and 1.4 kg greater for hogs fed soy expeller vs. canola meal. Hogs fed soy expeller averaged 2.3 mm larger loin than those fed canola meal. Dietary energy level or protein source had no effect on backfat depth, pork yield or carcass index. Hogs fed canola meal stayed 2.6 d longer in the barn than those fed soy expeller (Table 1).

## Dollars and cents

Diet cost averaged $28.38 per tonne less feeding low vs. high NE diet and $7.76 per tonne more feeding soy expeller vs. canola meal. Income margin after subtracting feed cost (ISFC) per hog

*CONTINUED ON PAGE 26*

shipped was $2.75 greater feeding low vs. high NE diet and only $0.32 greater feeding soy expeller vs. canola meal (Table 2). The lower dressing percentage observed feeding low NE diets would require an increase in live ship weight by 1 to 2 kg to achieve target carcass weights. This extra live weight would mean a few days extra in the barn. However, the lower feed cost per hog would make up for the extra cost of keeping hogs on farm for a few days more.

## So what does this all mean?

From our results we concluded again that hogs can be fed diets with reduced feed energy (≤2.20 Mcal NE/kg) instead of traditionally fed energy levels (≥2.32 Mcal NE /kg) as long as pigs can sustain feed intake. Once again our research showed that feeding lower NE diets resulted in greater profit margin after subtracting feed cost than feeding conventional energy levels.

Abruptly introducing 25% canola meal in the grower phase diets was a challenge to hogs, either due to the fibre content and/or the taste. If hogs had been progressively introduced to canola meal, a drop in feed intake in the first 12 days would likely have been avoided. Pigs fed canola meal never caught up to those fed more palatable, lower fibre soy expeller, but this was in part because we slightly overestimated the NE and digestible amino acid content of canola meal resulting in a minor reduction in growth performance and loin depth. This experiment proved that both soy expeller and canola meal are good supplemental protein sources and can be fed to growout hogs without much problems.

**Table 1. Effect of feed net energy (NE) level (low vs. high) and protein source (canola meal [CM] vs. soy expeller [SE]) on carcass traits (SEM=Standard Error of the Mean)**

| | NE level | | Protein source | | | P value | |
|---|---|---|---|---|---|---|---|
| | Low | High | CM | SE | SEM | NE | Protein |
| Days to slaughter from d74 on test | 23.20 | 23.40 | 24.60 | 22.00 | 0.50 | 0.779 | <0.001 |
| Ship weight, kg | 130.10 | 130.20 | 129.70 | 130.60 | 0.30 | 0.925 | 0.081 |
| % of pigs shipped | 94.20 | 95.40 | 95.20 | 94.40 | 1.00 | 0.406 | 0.578 |
| Carcass wt, kg | 101.90 | 102.70 | 101.60 | 103.00 | 0.30 | <0.050 | <0.001 |
| Dressing, % | 78.30 | 78.90 | 78.30 | 78.90 | 0.10 | <0.010 | <0.010 |
| Backfat, mm | 18.40 | 19.00 | 18.50 | 18.90 | 0.20 | 0.064 | 0.172 |
| Loin depth, mm | 61.70 | 61.80 | 60.60 | 62.90 | 0.40 | 0.793 | <0.001 |
| Lean yield, % | 60.80 | 60.50 | 60.70 | 60.60 | 0.10 | 0.061 | 0.755 |
| Index | 115.00 | 115.30 | 115.30 | 115.00 | 0.20 | 0.269 | 0.269 |
| Carcass revenue, $ | 208.47 | 210.85 | 208.61 | 210.71 | 0.75 | <0.050 | 0.052 |

**Table 2. Effect of dietary net energy (NE) level (low vs. high) and protein source (canola meal [CM] vs. soy expeller [SE]) on feed cost and gross income margin subtracting feed cost (ISFC) in CA$ (Spring 2016; SEM=Standard Error of the Mean)**

| | NE level | | Protein source | | | P-value | |
|---|---|---|---|---|---|---|---|
| | Low | High | CM | SE | SEM | NE | Protein |
| Feed cost/tonne | 265.86 | 294.24 | 276.17 | 283.93 | 0.07 | <0.001 | <0.001 |
| Feed cost/ | | | | | | | |
| kg BW gain | 0.80 | 0.84 | 0.82 | 0.81 | 0.01 | <0.001 | 0.070 |
| Feed cost/ | | | | | | | |
| shipped hog | 78.54 | 82.87 | 79.96 | 81.46 | 0.75 | <0.001 | 0.061 |
| ISFC/shipped hog | 68.84 | 66.09 | 67.46 | 67.78 | 0.68 | <0.010 | 0.480 |

## A cautionary tale

Our experiment was not conducted in the summer time, when feeding diets with greater energy may prevent reduced weight gain. Even in the Prairies,

it can get so hot in July and August that hogs may reduce feed intake. During these hot days, only feeding denser energy diets may prevent both decreased weight and lean gain. Our experiment did not include diseased pigs and we did not look at crowding and feeder access, all of which may limit feed intake. We are currently running a trial looking at interactions between dietary NE level, stocking density and feeder space. We will share results of this trial in a future edition of Canadian Hog Journal and on our website.

Our trial showed that the most economically optimal feed energy level was 2.2 Mcal NE/kg, which is lower than current existing feed energy suggestions for hogs (2.4 Mcal NE.kg). Keep in mind also that feed commodities and pork prices vary. Therefore, the profitability shown here is repeatable, but its consistency will vary.

## Acknowledgements

We would like to thank the Drumloche team for caring for the animals and for their expertise in trial conduct. We acknowledge Lewisville Pork Farm for the use of animals, and Sunhaven Farms Milling for supplying the feed. Financial support from the Canola Council of Canada and Agriculture and Agri-Food Canada is acknowledged.

## The research team at Alberta Agriculture and Forestry

We are a small group of researchers within the Livestock Research and Extension Branch of Alberta Agriculture and Forestry (AF) in Edmonton. The Monogastric Feed Research Group conducts research with both pigs and poultry. The Group consists of Eduardo Beltranena (lead) and Miranda Smit (technical writer/research assistant) on the pig side, as well as Matt Oryschak (research associate), Emmanuel Opoku Yeboah (research assistant) and Daniella Batres (research technologist) on the poultry side.

We conduct applied monogastric feed research mostly involving nursery and growing-finishing pigs, although some of our upcoming research trials will involve pregnant and lactating sows. Our activities focus on 3 objectives:

1. Increase utilization of novel and underused cereal grains, legumes, oilseeds, their fractions and bio-industrial co-products.
2. Implement processing methods that improve feeding value and reduce the effects of anti-nutritional factors in feedstuffs.
3. Reduce the adverse effects of feedstuffs and co-products on growth performance, dressing, carcass characteristics, and pork quality.

For an overview of our research priorities, current research projects and results from previous research trials, please visit our website at www.agriculture.alberta.ca/livestockresearch, then choose 'Monogastric Feed Research' from the menu. ■

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# Finding solutions to a phosphorus redistribution problem

By John Carney, Manitoba Livestock Manure Management Initiative

The Manitoba Livestock Manure Management Initiative (MLMMI) plays a vital role in co-ordinating research activities to develop Manitoba-specific solutions to manure management issues. Recent research has focussed on treating and managing manure phosphorus in areas of high livestock intensity.


*Scott Dick, co-owner of Agra-Gold Consulting*

## Spreading the benefits of manure nutrients

While phosphorus (P) is an essential element for sustainable crop and livestock production, too much P can be too much of a good thing. This is especially true in areas of high livestock density, where livestock can excrete more P nutrients than nearby crops can use. To prevent excessive nutrient build up in soil, one answer is to relocate excess nutrients – in other words, to bridge the nutrient gap in farming by moving nutrients to lands that are nutrient-deficient. Fortunately, Manitoba has an abundance of farmland that falls into this category. The problem is that the land isn't always in proximity to livestock operations. Then the question becomes, how cost effective is it to transport liquid pig manure that's mostly water when the transportation costs are higher than the value of the liquid manure?



## Searching for solutions

MLMMI has undertaken an ambitious research program to answer producer's questions on the affordability and effectiveness of various ways to relocate manure phosphorus from high livestock- intensive lands to lower nutrient lands. Every farm is unique and their needs differ. As with any good research, it's important to consider a number of alternatives and MLMMI has certainly examined this problem from a number of angles.

Harnessing the natural power of gravity to draw down heavier P nutrients from surface liquids was one of a number of approaches that was considered for phosphorus separation. Prior to looking at gravity as a solution, MLMMI collaborated with the Prairie Agricultural Machinery Institute (PAMI) to evaluate a number of mechanical manure separation technologies. The objective of these technologies is to separate the solids in manure from the liquids, thereby reducing the need to transport the water portion found in manure. Capital investment, operating costs as well as operating effectiveness of using a centrifuge, press, incline screen, reverse osmosis or belt press all were evaluated on working farms. Each mechanical manure separation technology has a range of investment, operating costs and capabilities.

## The 'Ins and 'Outs' of Two Cell Manure Storages

There are a variety of configurations used by pig farms for manure storage. A two-cell earthen manure storage system (EMS) is an excellent way to manage solids and separate phosphorus from manure. The way this manure system works is to pump liquid manure from the barn into a primary cell or primary holding tank, which is connected, by a channel, to a secondary cell or secondary holding tank. The primary cell typically holds one third (1/3) of the overall volume. The solids, containing organic nitrogen and phosphorus, settle to the bottom of the primary cell, requiring agitation at the time of removal.

The secondary cell contains the remaining two thirds (2/3) of the manure volume. Lighter liquids flow off the top of the primary cell into the secondary cell through the channel. These liquids are rich in ammonia N, and this cell doesn't require agitation at the time of manure application. Two cell Earthen Manure Storages provide a relatively low cost, simple solution for farms using this system.

## Could Gravity be the Answer?

Research undertaken by Scott Dick and Cliff Loewen, owners of Agra-Gold Consulting Ltd., a Manitoba company specializing in nutrient management planning for livestock producers, has investigated the potential of gravity settling.

Agra-Gold recently completed a research project that evaluated different approaches to manure agitation and pumping in two cell manure storages to separate the phosphorus-rich solids in the manure. The goal was to find an approach to manure agitation and pumping that could concentrate the phosphorus into thicker slurry, thereby reducing transportation costs. The most promising approach was to decant some of the surface liquid from the primary cell into the secondary cell to further concentrate the proportion of phosphorus in the remaining liquid in the primary cell. Since liquid pig manure is about 95 to 98%% water, approaches to agitation and pumping were considered to further concentrate the phosphorus. After agitating the remaining manure, the result was a super concentrated phosphorus product that had only 25 to 30 per cent of the original manure volume found in the EMS, but importantly, 90% of the phosphorus.

In addition to the nutrient value in manure, there are many other benefits in making manure available as an organic fertilizer for crop producers.

*Two cell manure storage Agra Gold Consulting*

"Typically, we would have fields that would not get manure because they were too far away from the source," says Dick. "Now we can re-locate this nutrient-rich fertilizer that also brings with it many other micro nutrients and benefits to enhance the nutrient profile of land."

Gravity settling can be an ingenious solution for some producers with nutrient imbalance and two-cell manure storages. Further details on this project including videos describing the work can be found in the "MLMMI News' section on the MLMMI website, www.manure.ca ■

# Impact of rye (Brasetto hybrid) and inclusion level on finisher pig performance, carcass and meat quality

Submitted by Dan Bussières & Jean-Philippe Martineau, Groupe Cérès Inc./HyLife Ltd.

Rye is a cereal that can provide a valuable source of energy and protein when included in swine diets. Its nutrient value for protein and energy are similar for those for wheat and barley. Nevertheless, livestock producers have been reluctant to use rye as a feedstuff. This reluctance is attributed mostly to the concerns over the presence of ergot alkaloids, potential anti-nutritional effect of pentosanes which could lead to potential lower feed intake for animals consuming rye.

A new hybrid of rye (Brasetto) has been developed by KWS Cereals, an European company specialized in plant breeding. This fall hybrid rye was developed to have a better resistance to heat stress drought compared to conventional rye. Also, as a fall crop this hybrid rye can better use the winter humidity for an optimal growing start in spring. This allows a faster pollination and reduces the risk of mycotoxin contamination, especially ergot alkaloids. Finally, the yield advantage of hybrid rye compared to conventional rye is said to be approximatively 26-30% higher per acre.

A trial was conducted to evaluate the effect of feeding up to 50% inclusion rate of rye to pigs during grower-finisher phase on growth performance, carcass characteristics and meat quality. The test barn had 48 pens with 22 pig/pen. A total of 1056 pigs weighing with an average starting weight of 30.3 kg were allotted to either three feed treatments (Table 1). All diets were formulated for the same net energy and SID Lys/NE ratio.

**Table 1. Percentage of added rye in the finisher rations**

| Treatment | A | B | C |
|---|---|---|---|
| Stage 1 | 0 % | 10 % | 20 % |
| Stage 2 | 0 % | 15 % | 30 % |
| Stage 3 | 0 % | 20 % | 40 % |
| Stage 4 | 0 % | 25 % | 50 %* |
| Stage 5 | 0 % | 25 % | 50 %* |

*Xylanase 40 000 G (Danisco) added at 100 g/ton.

**Table 2. Results of performance during feed stages 1 to 4 (using rye at 800 ppb of Ergot)**

| | A | B | C | SEM | P-value |
|---|---|---|---|---|---|
| Live weight (kg) | 118,8 | 118,3 | 117,9 | 1,17 | 0,852 |
| ADG (g/day) | 978 | 971 | 965 | 11,97 | 0,742 |
| ADFI (kg/day) | 2,59 | 2,59 | 2,54 | 0,05 | 0,677 |
| FE (feed/gain) | 2,64 | 2,66 | 2,63 | 0,02 | 0,460 |

**Table 3. Results of performance during feed stage 5 (using rye at 4 980 ppb of Ergot)**

| | A | B | C | SEM | P-value |
|---|---|---|---|---|---|
| Live weight (kg) | 136,2 | 134,5 | 133,1 | 1,21 | 0,205 |
| ADG (g/day) | 938A | 880B | 839C | 12,70 | 0,001 |
| ADFI (kg/day) | 3,13 | 3,08 | 3,00 | 0,07 | 0,334 |
| FE (feed/gain) | 3,34A | 3,50AB | 3,58B | 0,06 | 0,012 |

The rye used to make the feed for the first 4 stages of feed all came out of the same source and contained 800 ppb of Ergot alkaloids. For stage 5 diet, we had to buy extra rye from another source and this rye was tested for ergot and came back with an very high level being at and for 4 980 ppb of ergot alkaloids.

The stage 4 diet was fed up to week 13 in finisher. Results from table 2 show that feeding rye in a step-up program allows similar ADG, ADFI and FE during stages 1-4 (up to week 13) when rye had 800 ppb of ergot alkaloids ($P<0.10$). During Stage 5 which started at week 13, the pigs fed with rye were significantly affected by the high level of ergot alkaloids (table 3). In fact, there was a linear decrease in ADG and FE within treatments with increased rye inclusion rye ($P<0.05$). Mortality, carcass yield and meat quality characteristics were unaffected by the feeding or rye during the finisher period (results not shown).

In conclusion, in iso-nutrient formulated diets, this trial showed that rye can comfortably be an alternative ingredient to wheat and barley, especially when included at moderate levels (10-25%) and in a step-up pattern. It was again confirmed that highly contaminated rye by ergot does have detrimental effects on the performance of finisher pigs. The cereal producers should consider growing rye for its high yield, but they need to choose varieties of rye that reduce the risk of ergot contamination. KWS breeding does have this as one main breeding topic and is able to offer new hybrids with better ergot resistance already now. ■


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# Ethology program at the Prairie Swine Centre

By J. Brown

Ethology is the science of animal behavior, and has become a hot topic in recent years due to concerns raised about the ethics of pork production. At the Prairie Swine Centre topics for ethology research focus on ways to enhance the overall competitiveness of the pig industry by proactively anticipating emerging consumer issues and evolving standards of production. Much of this research relates to issues raised by the Code of practice for the care and handling of pigs.

The revised Code of Practice includes requirements for the use of pain control at castration, space allowances for nursery and grow-finish pigs, enrichment for sows, and promotes the transition to group housing in gestation pens by 2024. Research at the Prairie Swine Centre looks at best practices in these areas. With specific studies comparing the effectiveness of different NSAID drugs for reducing castration pain, piglet performance at various space allowances, and grouping practices and feed systems for gestating sows. Enrichment studies have compared a variety of enrichments for sows, both at the Prairie Swine Centre and the University of Manitoba. The use of fibre enrichment (chopped hay delivered in a hopper) is also being studied and compared against object enrichments.

Transportation is another emerging topic in the field of ethology. Previous research has been done in Canada on finisher pigs, but little information is available on the effects of transport of weaner pigs. Funding was recently received by Dr. Yolande Seddon at the Western College of Veterinary Medicine to work in collaboration with PSC and the University of Guelph to study the effects of long duration transport on weaner pigs. Results from this research will help producers to effectively implement the Code of practice requirements, and will provide clear scientific information on which to base future revisions to the Code and transport regulations.

## Dr. Jennifer Brown

Jennifer Brown is a Research Scientist in Ethology at the Prairie Swine Centre and an adjunct professor in Animal and Poultry Science at the University of Saskatchewan. Jennifer completed her Ph.D. at the University of Guelph in 2009 studying the effects of regular handling on behavior and stress physiology in market pigs and pork quality. Before entering the field of ethology, Jennifer obtained BSc and MSc degrees at the University of Prince Edward Island, and worked in clinical chemistry research.

At the Prairie Swine Centre Dr. Brown leads an applied research program looking at issues related to pig behavior and welfare. Recent work includes studies on the effects of long duration transport, gestation housing and management, sow lameness, pain control at castration, euthanasia and space allowances for weaner pigs. In addition Dr. Brown has been highly involved in the National Sow Housing Conversion project - a national project involving tracking and documenting several groups sow housing conversions across Canada. This information will be used to assist pork producers looking to make the transition to group sow housing. ■

# Matrix coated organic acids blend improves performance in growing pigs

M. M. Hossain, and C. M. Nyachoti, Department of Animal Science, University of Manitoba

Antimicrobial growth promoters (AGP) have been used in swine grower diets as growth promoters and to control gastrointestinal tract pathogens. However, a leading current interest in the livestock industry is to develop a wide range of feed additives with potential to serve as alternatives to AGP due to the mounting public pressure and growing concerns around antibiotic resistance. Our studies and those of others have suggested that organic acids with/or without encapsulation could serve as alternative nutritional interventions for managing growing pigs fed AGP-free diets.

Earlier studies have shown that organic acids and their salts have numerous therapeutic effects in their undissociated form, which may improve intestinal micro-ecology and therefore improve performance in pigs. However, the effectiveness of unprotected organic acids may limit prompt absorption and metabolism in the small intestine of pigs. Therefore, matrix coating or encapsulation techniques have been developed recently to overcome this limitation by protecting organic acids for targeted deliv¬ery to different gut segments. For our study, we hypothesized that a dietary supplementation with matrix coated organic acids (MCOA) blend can improve growth performance and reduce fecal pH and in-vitro noxious gas (i.e. ammonia and acetic acid) emission in growing pigs.

A total of 96 grower pigs were allotted to diets containing 0 or 2 g $kg^{-1}$ of MCOA and 0 or 2.5 g $kg^{-1}$ of AGP. Individual pig body weight was checked at the beginning and at the end of a 6-week experimental period to calculate average daily gain (ADG). In addition, feed disappearance was recorded on a pen basis during the experiment to calculate average daily feed intake (ADFI) and growth efficiency (G:F). For the analysis of in-vitro fecal ammonia and acetic acid gas emission, fresh feces were randomly collected by rectal palpation on the last day of the experiment.

## Key points:

- Matrix coating techniques improve the absorption and metabolism of organic acids in the small intestinal, making it more suitable for growing pigs

CONTINUED ON PAGE 36

- Growth performance and in-vitro noxious gas emission data from the current study indicate that a matrix coated organic acids blend may have a role to play antibiotic-free feeding regimens in growing pigs

## What did we find?

The results from our study showed that pigs receiving MCOA diet had improved G:F compared to those fed MCOA-free diet (Table 1). Moreover, pigs fed diet supplemented with AGP had improved G:F compared to those fed without AGP diet. Pigs fed diet supplemented with MCOA decreased fecal pH than those fed without MCOA diet (Table 2). The MCOA has a greater intestinal tract pH maintaining versatility perhaps linked to manipulation of intestinal microbiota and thereby improves the growth performance. Pigs fed both AGP and MCOA supplemented diets reduced fecal ammonia gas emission. Moreover, MCOA diet reduced fecal acetic acid gas emission in diets lacking MCOA.

**Table 1. The effects of dietary matrix coated organic acids blend on growth performance in growing pigs.**

| Items | AGP | | MCOA | | | P-value | | |
|---|---|---|---|---|---|---|---|---|
| | (-) | (+) | (-) | (+) | SEM | AGP | MCOA | AGP × MCOA |
| Body weight (kg) | | | | | | | | |
| Initial | 48.44 | 47.41 | 47.5 | 48.3 | 1.21 | 0.421 | 0.503 | 0.824 |
| | | | 1 | 4 | | | | |
| Final | 93.18 | 93.02 | 92.6 | 93.5 | 2.04 | 0.937 | 0.638 | 0.172 |
| | | | 2 | 8 | | | | |
| ADG (g) | 1.06 | 1.09 | 1.07 | 1.08 | 0.030 | 0.508 | 0.971 | 0.060 |
| ADFI (g) | 2855 | 2810 | 2876 | 2789 | 103.08 | 0.644 | 0.375 | 0.126 |
| G:F | 0.375 | 0.389 | 0.37 | 0.38 | 0.006 | 0.037 | 0.046 | <0.001 |
| | | | 6 | 8 | | | | |

Note: ADG, average daily gain; ADFI, average daily feed intake; G:F, growth efficiency.

**Table 2. The effects of dietary matrix coated organic acids blend on fecal pH and in-vitro noxious gas emission (ppm) in growing pigs.**

| Items | AGP | | MCOA | | | P-value | | |
|---|---|---|---|---|---|---|---|---|
| | (-) | (+) | (-) | (+) | SEM | AGP | MCOA | AGP × MCOA |
| pH | 6.11 | 6.08 | 6.15 | 6.04 | 0.029 | 0.233 | <0.001 | 0.966 |
| Ammonia | 8.80 | 8.50 | 8.93 | 8.37 | 0.140 | 0.037 | <0.001 | 0.011 |
| Acetic acid | 2.41 | 2.10 | 2.79 | 1.73 | 0.522 | 0.557 | 0.048 | 0.407 |

Note: 300 g fresh fecal samples were used.

There was an interaction effect of AGP and MCOA on fecal ammonia gas emission such that MCOA reduced emission in the absence of AGP more than it did in its presence. It is suggested that MCOA supplementation increases nutrient digestibility that may have allowed less substrate for microbial fermentation in the large intestine. Moreover, reduced gas emission due to supplementation of MCOA in growing pigs is due to the reduced fecal pH because it inhibits the invasion and proliferation of pathogenic bacteria in the gastrointestinal tract, which further limits production of toxic bacterial metabolites and ammonia.

## Recommendation

Supplementation of both AGP and MCOA improved growth performance, suggesting that MCOA may have some growth promoting effects similar to AGP in growing pigs. Similar to AGP, MCOA might reduce in-vitro noxious gas emission. These results imply that MCOA may have a role to play antibiotic-free feeding regimens in growing pigs.

## Acknowledgements

The authors thank Morningbio Co., LTD. (Cheonan, South Korea) for donating MCOA used in the present study. For more information, contact Dr. C. M. Nyachoti at martin_nyachoti@umanitoba.ca ■

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[a]Canadian Veterinary Medical Association guidance on the prudent use of antimicrobial drugs, 2014.
[b]Data on file.

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# A matter of predicting and limiting odour emissions

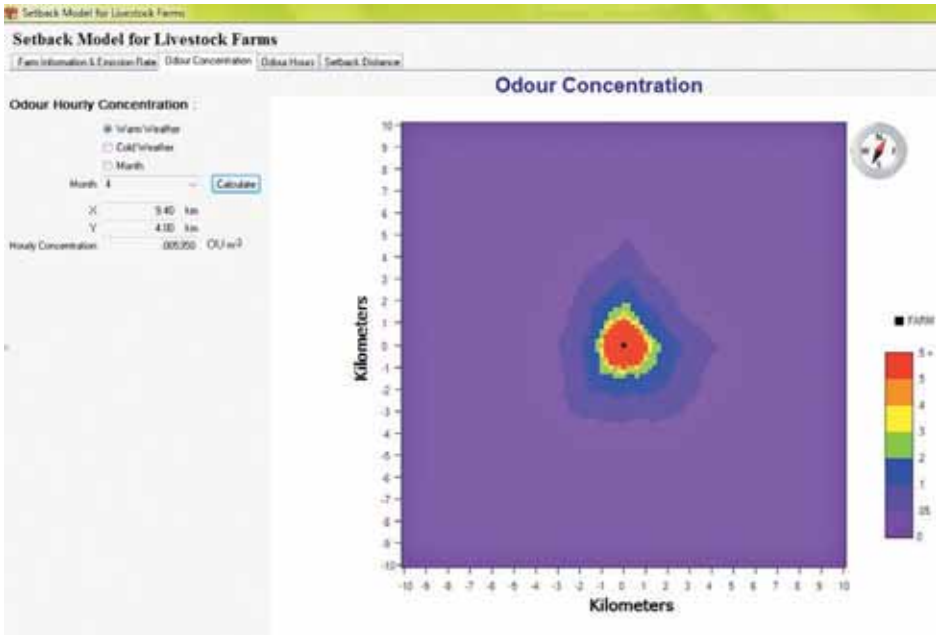
Christine Rawluk, National Centre for Livestock and the Environment, University of Manitoba

Odour is a reality for all livestock operations. Whether or not odour is a problem depends if anyone in the vicinity objects to the smell, or in the case of new barn construction, perceives a risk of being exposed to odour.

Odour may have fallen off the radar the past number of years in Manitoba, but it certainly was not forgotten. As the industry looks to expand, Manitoba pork producers have recently been reminded that odour is as important as ever when it comes to happy neighbours.

Odour for many years was a top priority for the Manitoba Livestock Manure Management Initiative, or MLMMI as it is more commonly known, which was established almost 20 years ago to support the development of manure odour reduction and sustainable manure management solutions. For a decade research dollars went towards assessing odour generation and dispersion from livestock operations, and towards developing and testing odour control measures.

One outcome of this investment was the odour impact assessment tool (OIAT) developed by University of Manitoba biosystems engineer Qiang Zhang. "We developed a dispersion model that could assess the odour impact region and be used for selecting appropriate setback distances," recalls Zhang. "This required that the OIAT could both estimate emissions and predict odour exposure, but that it also incorporated a subjective component - odour acceptability by the surrounding community."




*The setback model OIAT produces results of odour concentrations and hours, plus an odour impact map based on farm information input, calculated emission rate, and desired odour acceptability level input. Shown is a screen shot of the Odour Concentration results.*

While Zhang says they developed a working model, it has not yet been fully validated in the field.

## Reinvesting in odour research

With a resurgence of producers looking to construct new hog barns, odour research is once again a top priority for Manitoba. Recently the MLMMI convened a meeting of regional odour experts to revisit past research investments and identify what odour-related information is required to foster community support for growth of Manitoba's pork sector. Research providing practical, affordable odour emissions reduction strategies and an odour assessment tool tailored to Manitoba's environment emerged as the most pressing need.

Singled out as a promising tool, Zhang's OIAT will be augmented to expand the scenarios it can run and improve the user interface and user-friendly attributes prior to rolling it out to industry.

According to Zhang, the downwind odour impact depends not only on odour emissions and odour sensitivity and tolerance by neighbors, but also on weather conditions, topography and the source of the emissions. The revamped model will include multiple manure storage options, as well as regional weather and topography data where available.

Zhang will also lead a review of approaches used elsewhere to reduce odours and gas emissions that may be suitable for Manitoba's climate and production conditions. Scope includes effective, affordable and easy to use technologies, tools and beneficial management practices targeting barns and manure storages (both in-barn and out). Emphasis is also on understanding the full scope of impact such that there is minimal risk for unintended consequences or complications.

## Happy neighbours

As part of Zhang's initial OIAT design project, they interviewed people living in the vicinity of hog operations in different Manitoba communities. Their final report included some insights about people's acceptance of odour, most notably that new hog facilities would be viewed more harshly than current barns in their neighbourhood.

A large portion of residents that did not complain about odour from neighbouring hog barn(s) indicated they would not tolerate the same odour level from a new facility. Fast forward seven years and this seems to be the case.

Potentially affected communities want evidence and assurances that the introduction of a new barn in the vicinity will not negatively impact their quality of life.

A model that accurately predicts the degree and extent of downstream exposure to odour and new barn designs that incorporate proven effective odour control strategies might provide the evidence necessary to build community support for building new barns in rural Manitoba.

Mike Teillet, Sustainable Development Manager with Manitoba Pork says they are in favour of a tool like OIAT because it brings more science and a more rationally-based application to a matter that is highly subjective. "Different people have different levels of sensitivity and tolerance to odour or the perception of odour. Eventually, a tool like OIAT could be used to assist in establishing more widely-accepted setback distances between farms and non-farm residences."

For more information, contact Dr. Qiang Zhang (Qiang.Zhang@umanitoba.ca). ■

# Keep nursery diets simple and less expensive:

## An investigation of the use of low-complexity lower-cost nursery diets on pig growth performance, carcass value, and *Salmonella shedding* in pigs on commercial farms

Submitted by Heather Reinhardt, research assistant–Department of Population Medicine OVC

This project was designed and directed by Dr. Brandon Lillie (Department of Pathobiology), Dr. Kees de Lange (Department of Animal Biosciences) and Dr. Vahab Farzan (Department of Population Medicine) at the University of Guelph. The research presented here was completed by Margaret Ainslie (MSc) and Heather Reinhardt (MSc), but the project is ongoing. The genetics work was completed in partnership with Dr. Mohsen Jafarikia and the Canadian Center for Swine Improvement Inc., and funding was provided by the Ontario Ministry of Agriculture Food and Rural Affairs, Swine Innovation Porc, Alliance Genetics Canada, and Ontario Pork. In addition, Conestoga Meat Packers, Synergy Services Inc. and all participating producers were instrumental in sample collection.

### Project rationale

Due to digestive limitations of the newly weaned pig, early nursery diets tend to contain complex and highly digestible animal protein sources (i.e. whey protein, blood plasma and fishmeal) that are costly. Therefore, a reduction in the complexity of diets fed to nursery pigs using plant (soybean meal) rather than animal (whey, blood plasma) protein sources could reduce the cost of feed during the nursery phase. Previous studies identified that feeding low-complexity (LC) nursery diets may be an effective way to reduce the cost of pork production without negatively impacting optimal pig growth or carcass quality. However, pigs receiving a low complexity nursery diet may be more susceptible to infectious disease (ex. Streptococcal infection; Skinner et al., 2014).

If a nursery LC diet compromises the immune response, another concern is that the pigs receiving a LC diet during nursery could become carriers for other bacteria such as *Salmonella*, which is an important food safety concern. In fact, *Salmonella* is an important cause of foodborne illness in Canada. The bacteria is commonly found on swine farms, but often goes undetected because pigs rarely show clinical signs of infection. Pigs that carry the bacteria to the meat processing and packing facility are a human food safety concern because they have the potential to increase the spread of bacteria to pork products. Control of *Salmonella* at the farm level could contribute to a reduction in the spread of *Salmonella* through the food supply system. One approach is to identify the pigs that have a genetically robust immune response so they could be fed with a low complexity diet without becoming susceptible to infection or colonization with bacteria such as *Salmonella*. Genetic variants in the porcine innate immune system have been associated with *Salmonella* shedding and colonization and may represent a focus for genetic selection of more robust animals.

It should be noted that the effects of feeding LC nursery diets on overall growth performance and health (ex. *Salmonella* infection) of pigs have not previously been examined in commercial farm settings. The objectives of this study were to investigate the impact of a low-complexity nursery diet on growth performance and carcass traits as well as on *Salmonella* shedding across the lifetime on farm and at slaughter. This study also aimed to identify genetic variants in the innate immune system associated with *Salmonella* shedding and colonization.

### Methods

On eight farms between May 2014 and July 2016, 14 cohorts for a total of 832 pigs were monitored from birth through slaughter. Pigs received either a high-complexity nursery diet (similar to that currently used in industry with whey protein and fish meal being the main protein sources) or low-complexity diet nursery diet (replacing most of the animal protein sources with soybean meal) (Table 1). Pigs were individually weighed and fecal samples were collected (to assess pathogenic presence and *Salmonella* shedding) at birth, weaning, and near the end of each production stage (nursery, grower, finisher). At an average

CONTINUED ON PAGE 42

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**Table 1: Selected nutrient composition of high complexity and low complexity experimental nursery diets. Both diets were formulated to provide the same amount of energy and crude protein, but the source of protein is different.**

| | High Complexity Nursery Diets/Phase | | | Low Complexity Nursery Diets/Phase | | |
|---|---|---|---|---|---|---|
| Ingredient, % | Phase I | Phase II | Phase III | Phase I | Phase II | Phase III |
| Corn | 14 | 32 | 47 | 47 | 48 | 46 |
| Wheat | - | - | - | 10 | 10 | 10 |
| Barley | 25 | 25 | 20 | - | - | - |
| Soybean meal | 11 | 17 | 21 | 24 | 34 | 37 |
| Hamlet protein | 6.00 | 6.25 | 3.75 | - | - | - |
| Fish Meal | 5 | 3 | - | 5 | - | - |
| Whey | 20 | 8 | - | 8 | - | - |

live bodyweight of 118 kg, pigs were processed at a provincial processing plant. Pigs underwent regular processing, and individual carcasses were probed in order to obtain backfat depth, loin eye depth, hot carcass weight and lean yield percent. This information was used to give each carcass a value based off a largely used payment grid in Ontario. Serum samples were collected from individual pigs at the same time as bodyweight, and were analyzed for haptoglobin concentrations. Serum haptoglobin can be used to identify non-specific inflammation and can indicate the pig's health status. Tissue samples were obtained at slaughter to assess internal colonization. Fecal and tissue samples were cultured for *Salmonella*. Genomic DNA was extracted from blood, tail, or ear tissue and pigs were genotyped using MALDI-TOF mass spectrometry for 42 genetic variants that have a role in innate immunity and/or were found to be more frequent in pigs with common infectious diseases.



## Results

Overall, no difference was observed in average daily gain or pig bodyweight at any time point during the study due to nursery diet complexity (Figure 1). The cost of feed per pig during the nursery period was significantly reduced for the LC fed pigs by $2.82/pig. Carcass quality traits such as hot dress weight, loin eye depth, back fat depth and percent lean yield were not influenced by nursery diet complexity. Carcass value was similar for pigs fed HC and LC nursery diets. Serum haptoglobin concentrations were not influenced by nursery diet complexity at any of the sampling times, it is important to note that the serum haptoglobin concentrations for all pigs appeared to be within what is considered a normal range at all sampled points, therefore indicating the population of pigs in the study were generally healthy and that the LC nursery diet did not impact health.

Over the course of the study 3339 fecal samples were cultured from 809 pigs. *Salmonella* could be recovered from 13% (n=421) of samples and from 35% (n=284) of pigs; while 12% (n=99) of pigs shed *Salmonella* more than once. *Salmonella* shedding increased as pigs getting older and decreased in the winter months. The low complexity diet may increase the risk of *Salmonella* shedding over the production period but did not affect presence of *Salmonella* in tissue samples collected at slaughter (Figure 2). In total 23% (134/583) of pigs were positive at slaughter but isolation of *Salmonella* from tissue samples collected at slaughter was not associated with fecal shedding on-farm. A variant allele in MBL1 was associated with an increased risk of *Salmonella* shedding. In addition, the chance of

**Figure 1: Average pig bodyweight at each stage of production. No differences were observed in growth performance of pigs fed either high complexity or low complexity nursery diets.**

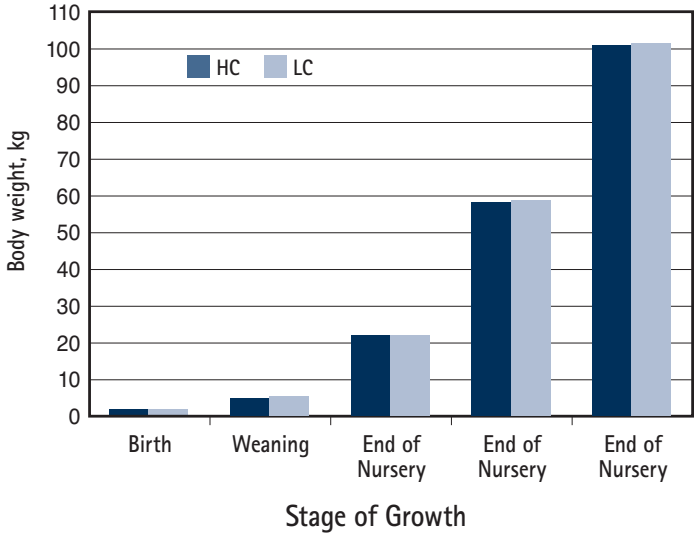
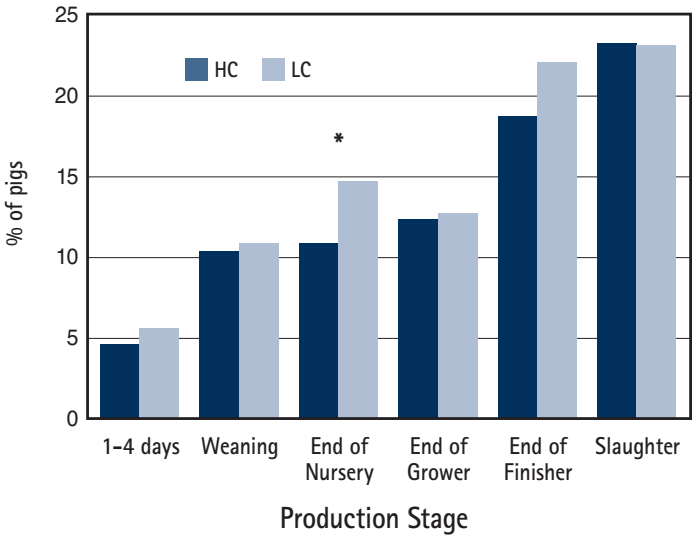


Figure 2: Percent of pigs positive for Salmonella at each sampling point, by diet.




HC=high complexity; LC=low complexity.
*Indicates the levels of Salmonella was different between diet groups at that stage of production (p=0.1).
Samples at 1 – 4 days of age were only collected on two out of eight farms in the first cohort (n=112 pigs), and five out of six farms in the second cohort (n=297).

*Salmonella* isolation from tissue samples at slaughter was approximately twice as high in pigs with a variant allele in NOD1.

## Conclusions of findings:

Utilizing LC nursery diets on commercial farms appear to have no negative impact on lifetime growth performance, carcass traits at the time of marketing. This means that LC nursery diets can reduce the cost of feed during the nursery period, but still produce the same quality of carcass in the same amount of time. No differences in serum haptoglobin concentrations at any measured time points indicates that the pigs were reacting similarly to environmental and pathogenic pressures, indicating that nursery diet complexity may not influence the immune system, however this needs to be further investigated. The LC diet had no impact on internal colonization by *Salmonella* tested at slaughter, but may affect *Salmonella* shedding over the lifetime. Finally, the MBL1 and NOD2 variants may be promising targets in genetic improvement programs geared towards breeding pigs with an improved immune response to *Salmonella*. Both of these genes encode receptors that detect virus and bacteria including *Salmonella* and alert the immune system to improve pathogen clearance. Successful improvement of the immune system may result in pigs that can be fed a LC diet without negatively impacting the immune response to bacterial infection such as *Salmonella*.

## Applications and Future Directions:

Taken together, this work demonstrates the potential of LC nursery diets in commercial settings, which may present a feasible way to reduce feed costs without negatively impacting lifetime pig growth or carcass value. In addition, this work can guide future studies investigating the best times and methods to mitigate *Salmonella* on Ontario swine farms. These findings are important from both a food safety an economic perspective. Reduced salmonellosis attributed to pork products will benefit the public, while reduction of *Salmonella* in swine will benefit animal welfare and the swine industry as a whole. The impact of the diet on the presence of *Salmonella* antibodies and other pathogens of importance to the swine industry is currently being investigated.

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Skinner, L. D., C. L. Levesque, D. Wey, M. Rudar, J. Zhu, S. Hooda, and C. F. M. de Lange. 2014. Impact of nursery feeding program on subsequent growth performance, carcass quality, meat quality, and physical and chemical body composition of growing-finishing pigs. J. Anim. Sci. 92:1044–1054. ■

# Selenium anti-oxidative effects and litter quality in sows: Can we make the job with dietary incorporation of canola meal?

Danyel Bueno Dalto and J. Jacques Matte, Agriculture and Agri-Food Canada, Sherbrooke, QC, Canada

## Introduction

During the last 2-3 decades, swine reproduction has successfully focused on hyperprolificacy. However, this increasing litter size was achieved at the expense of quality of ovulation. In fact, it is known that harmful oxidant metabolites (ROS) are generated during the peri-estrus period in response to the inflammatory condition brought by the naturally occurring rupture of the follicles during ovulation, and this may be especially important in hyperprolific sows. This high oxidative ovarian environment may impact the integrity of ova and consequently embryos quality and within litter weight homogeneity, with effects on post-natal growth performance and quality of carcass and meat. Although reliable improvements in embryos quality and homogeneity require a better understanding of the "in utero" causes of the phenomenon, little information is available on the importance of an adequate antioxidative status for optimal ovulation in terms of quantity and quality and its eventual impact on litter development in pigs.

Selenium (Se) is recognized as an antioxidative element that brings protection against ROS through the activation of antioxidant enzymes, among them the Se-dependent glutathione peroxidase (SeGPX) system. Selenium is an essential element of livestock nutrition with a narrow window of dietary incorporation safety between adequacy and toxicity. Therefore, in modern animal production for human consumption, there is a great interest in meeting Se levels that will optimize metabolic processes leading to better health as well as growth performance and reproductive function. To meet Se requirements, the feed industry has relied completely on supplemental Se delivered with trace mineral premixes from inorganic (selenite) or organic (chelate, yeast or other compound) sources to provide the mandatory maximum of 0.3 mg/kg diet allowed by the Canadian Food Inspection Agency. In such case, the native Se levels in feed ingredients are not usually taken into account.

Our research program on the impact of Se for pig reproduction made us realize that the presence of some specific ingredients in the diet, in particular canola meal, could challenge this approach. Canola meal is the second most common protein source used for animal diets in the world and is known as

CONTINUED ON PAGE 46

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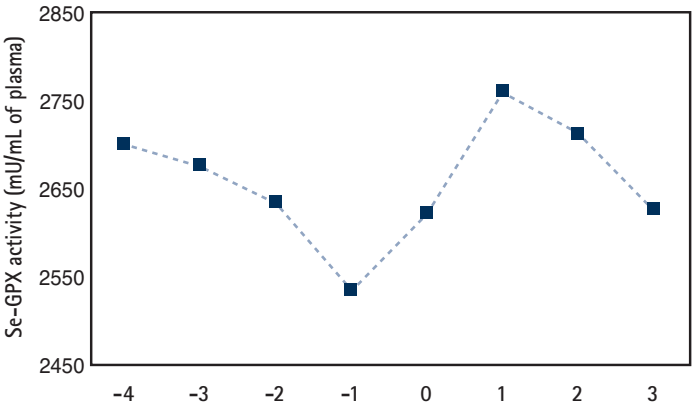
an especially good source of Se. According to the National Research Council, among all plant-based ingredients used in pig diets, canola meal presents the greatest level of Se (over 1.0 mg/kg). Indeed, the only common ingredients with higher levels of Se than canola meal are fish derived by-products. As with any crop, there is some variability in the nutrient (Se) composition of canola meal due to variation in soil and environmental conditions.

## Anti-oxidation and litter quality

We have observed that oestrus oxidative conditions at the ovary level are important enough to alter the activity of anti-oxidant enzymes (SeGPX) at the systemic level in gilts (Figure 1). We have therefore hypothesized that, in hyperprolific sows, the "adequacy" of nutrition especially in relation to dietary antioxidants such as Se is critical during the pre-ovulatory phase of estrous cycle for optimal quality of ovulation and eventually of embryos. In an initial experiment carried out in our laboratories by Fortier et al. (2012), the emphasis was put on the importance of dietary forms (inorganic vs organic) of Se on antioxidant status during estrus cycle and early pregnancy along with uniformity of embryo development at 30 days of gestation. Organic Se (derived from yeast; OSe) was shown to be more bioavailable than inorganic Se (MSe) like selenite (Figure 2). We have demonstrated that OSe increased Se transfer to embryos and their morphologic and physiologic in utero development in early gestation (Table 1). These effects of OSe on embryo development possibly originated from treatment effects at the time of ovulation.

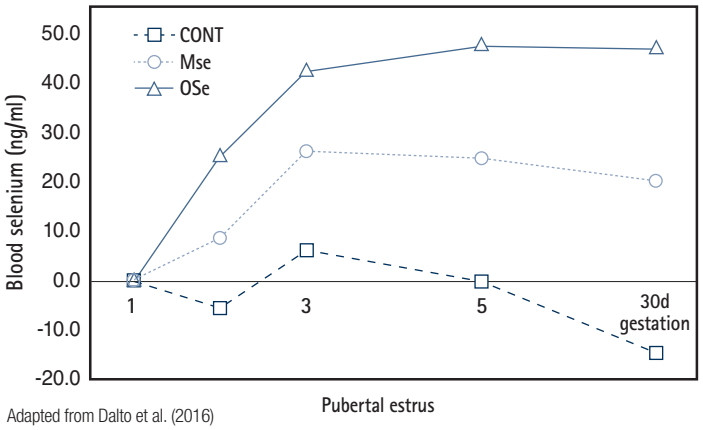
Figure 1 –Blood plasma seleno-glutathione peroxidase (Se-GPX) activity before and after oestrus (day = 0) in pubertal gilts.




Adapted from Dalto et al. (2016)

This concept was addressed in two subsequent studies by Dalto et al. (2015; 2016) using metabolic, physiological and nutrigenomic approaches. These studies confirmed the results of Fortier et al. (2012) in terms of Se content in circulation and in organs of gilts and Se transfer to embryos. In the first study (Dalto et al., 2015) the number of viable embryos at 5 days of gestation tended to be greater in gilts supplemented with OSe and this in absence of degenerated embryos (Table 2). How-

Figure 2. Blood selenium concentrations (ng/ml) on each estrus, expressed as increases relative to the first pubertal estrus in gilts unsupplemented with selenium (CONT) or supplemented (0.3 mg/kg diet) with organic (OSe) or inorganic (MSe) selenium.




Adapted from Dalto et al. (2016)

ever, in the second study (Dalto et al., 2016) no clear effect of Se either organic or inorganic were observed on embryo measurements at 30 days of gestation. Incidentally, for all morphological and physiological measurements made by Dalto et al. (2016), values for the control diet were higher than the best improved performance of Se-supplemented gilts reported by Fortier et al. (2012). Although the predicted nutritional levels of Se in the basal diet were calculated to be similar among experiments, unexpected higher Se levels (0.3 mg/kg) were observed by Dalto et al. Interestingly, the most significant contributor for the increased Se levels was the inclusion of 10% canola meal in replacement of other protein sources in Dalto et al. vs Fortier et al.

## Canola as an alternative source of organic selenium

In commercial canola meal produced in Western Canada, Se levels may range from 0.9 to 2.0 mg/kg (average of different cultivars) according to pioneer data from Bell and Keith (1991). Within this same region, significant effects of cultivars were reported on mineral composition between Brassica napus, Brassica rapa and Brassica juncea, but Se levels were not analyzed.

In Canada, typical levels of canola meal in pig diets range from 10% (weanling pigs) to 20% (finishing pigs ) although it has been shown that levels up to 25% for weanling and finishing pigs do not impair growth performance. Therefore, considering the levels of Se reported above, canola meal alone could bring 0.23 to 0.50 mg/kg of Se in pig diets, a level similar to or higher than the National Research Council requirements for 10-120 kg pigs, gestating and lactating sows (ranges from 0.25 to 0.15 mg/kg). Considering that a regular corn and soybean meal diet contains between 0.05 to 0.2 mg/kg of native Se, the complete replacement of supplemental Se by diets using high inclusions of canola meal appears quite possible. According to data obtained on rapeseed, Arthur and Slinger (1979) showed that the organic form of Se naturally present in this meal was better utilized than inorganic Se from sodium selenite. Moreover, Bermingham et al. (2014) identified, by meta-analysis, that selenium-enriched foods are more effective than synthetic selenomethionine at increasing GPX activity. Arthur and Slinger (1979) also indicated that, at levels of 15-20% of rapeseed meal in corn and soybean type diets for broiler chickens, laying hens or growing-finishing pigs, no inorganic Se needs to be added to prevent Se deficiency, and the meat and eggs produced contained desirable levels of Se for human consumption.

Considering that most data on Se levels in canola were obtained more than 25 years ago, more research is needed to update the Se content in canola according to actual cultivars and to regions within Canada. Additionally, due to the antioxidant characteristics of Se and the higher body tissue incorporation of the organic versus inorganic source, the higher levels of organic Se brought by a greater inclusion of canola meal in pigs' diets needs to be assessed. This is important not only for their potential to prevent risks of selenium deficiency in pigs, but to maintain high Se content in pork and positively impact the antioxidant status during the estrus cycle and early preg-

CONTINUED ON PAGE 48

**Table 1. Selenium content and development of embryos at 30 days of gestation in gilts unsupplemented with selenium (CONT) or supplemented (0.3 mg/kg diet) with organic (OSe) or inorganic (MSe) selenium.**

| Item | CONT | MSe | OSe |
|---|---|---|---|
| Average embryo Se content (ng) | 208.4 | 196.5 | 298.1 |
| Litter total Se content (g) | 2.9 | 2.7 | 4.5 |
| Within-litter Se content variation (%) | 20.5 | 15.6 | 14.7 |
| Average embryo Se-GPX activity | 53.5 | 54.6 | 54.8 |
| Within-litter Se-GPX activity variation | 23.1 | 20.0 | 18.9 |
| Number of viable embryos (n) | 14.3 | 14.3 | 15.2 |
| Embryo survival (%) | 61.4 | 63.2 | 64.2 |
| Average embryo weight (g) | 1,4 | 1.3 | 1.5 |
| Litter weight (g) | 19.2 | 18.8 | 22.3 |
| Within-litter weight variation (%) | 9.6 | 9.4 | 9.3 |

Adapted from Fortier et al. (2012)

nancy along with uniformity of embryo development during gestation, as shown by Fortier et al. and Dalto et al. using organic Se supplements. This "Se connection" could become an additional advantage for incorporating higher proportions of canola meal in diets for pigs. ■

**Table 2. Development of embryos at 5 days of gestation in gilts unsupplemented with selenium (CONT) or supplemented (0.3 mg/kg diet) with organic (OSe) or inorganic (MSe) selenium.**

| Item | CONT | MSe | OSe |
|---|---|---|---|
| Viable embryos (n) | 14.17 | 13.50 | 18.17 |
| Degenerated embryos (n) | 0.50 | 2.00 | 0.00 |
| Early-stage embryos (n) | 3.33 | 4.30 | 3.67 |
| Advanced-stage embryos (n) | 10.83 | 9.17 | 14.50 |
| Total embryos (n) | 14.67 | 15.50 | 18.17 |

Adapted from Dalto et al. (2015)

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# Group sow housing – what about precision feeding for gestating sows?

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**Are you soon planning to modify your farm buildings for sow group housing? Do you have questions about which feeding system is the most appropriate? Are you wondering what advantages precision feeding may have? If so, read below to learn about our initial findings on this subject.**

The team at CDPQ is currently carrying out a project to evaluate the impact that precision feeding for gestating group-housed sows may have on feed cost and sow performance. A first evaluation was performed by simulation and is now being validated in a commercial setting. The results presented in this article are those delivered from the simulation phase, while results from the commercial trials will be published next winter.

## What is involved exactly in precision feeding for gestating group-housed sows?

Precision feeding for gestating sows involves using two different feed ingredients (one rich in nutrients, while the other is low) that are mixed in different proportions in order to meet the individual needs of each sow. The application of precision feeding for gestating sows housed in groups requires the use of an electronic sow feeder-type (ESF) feeding system or a free-access ESF stall, which allows the sows to be monitored individually as well as 2 feeds to be used simultaneously. The period of applying this feeding strategy covers the interval of time where the sows are housed in groups. This period begins when sows are transferred from the breeding room to the

gestation area (between the 28th and 35th day of gestation). The period ends when these same sows are transferred to the farrowing rooms (around the 110th day of gestation).

The simulations in this project were carried out with the help of a database that analyzed performance data of more than 2000 gestating sows. The types of data that were analyzed include body weight and backfat thickness at breeding time and at farrowing, the total number of births, litter weight, etc. This allowed us to evaluate the potential impact that a precision feeding strategy may have on feed costs as well as the ability of this strategy to better feed gestating sows.

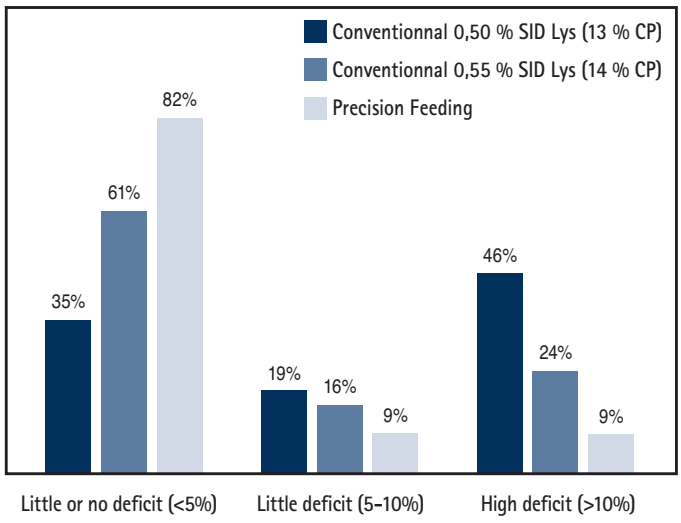
## What are the benefits?

The results of the simulations indicate that precision feeding allows lysine requirements in sows to be better targeted. This is especially true at the end of gestation and for gilts in

*CONTINUED ON PAGE 50*

particular. In fact, considering that gilts are still growing and the needs of the fetus is more significant towards the end of gestation, conventional feeding strategies do not completely fulfill the gilt's or the fetus' requirements at this stage of gestation (Figure 1).

**Figure 1 : Proportion of gilts according to 1) accumulated deficits in daily SID Lys at the end of gestation (days 91 to 110) and 2) according to feeding strategy used.**

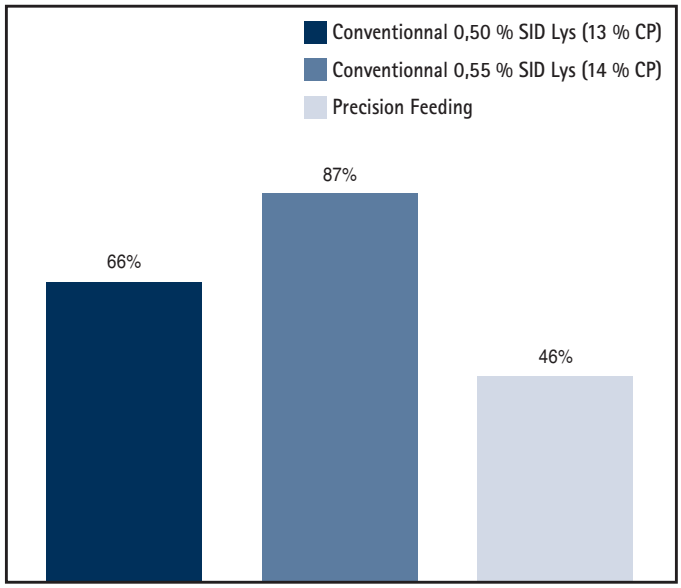





Conventional feed that has 0.50 % and 0.55 % of standardized ileal digestible (SID) lysine (Lys) corresponds respectively to feed containing approximately 13 % and 14 % of crude protein.

Figure 1 shows that precision feeding better meets gilts' requirements for SID Lys at the end of gestation. This is especially true when compared to conventional feeding strategies where a single feed ingredient is used during the gestation period. The proportion of sows presenting little or no deficit in SID Lys is significantly higher for sows being fed more precisely compared to sows conventionally fed. In fact, 82 % of sows have shown less than a 5 % deficit in Lys with precision feeding, compared to 35 % of sows fed with a conventionally 0.50 % SID Lys feeding. This means that precision feeding allows Lys requirements to be met in 47 % more sows in the herd. This strategy equally allows the proportion of gilts receiving a surplus of SID Lys to be reduced (Figure 2).

**Figure 2: Proportion of gilts whose daily SID Lys surplus accumulated during the group gestation period (days 35 to 110) exceeds more than 10 % of necessary requirements, according to feeding strategy**




## And what about multiparous sows?

For multiparous sows, the principal advantage of precision feeding is the ability to reduce the overfeeding of sows as well as to better feed them at the end of gestation. The potential of this strategy for reducing feed costs depends on the efficiency to reduce any excess Lys ingested by multiparous sows, particularly during the two first trimesters of gestation. The effects on sow performance, as much for multiparous sows as for gilts, still needs to be verified.

## Are there any economic benefits?

An evaluation of the effect that this feeding strategy may have on sow performance has not yet been completed. There-

fore, the economic benefits associated with precision feeding is focused on feed costs for the moment. The precision feeding strategy has been compared to two concentrations of SID Lys conventionally used by different feeding companies to feed gestating sows, being 0.50 % (feed $C_{0,50}$) and 0.55 % (feed $C_{0,55}$). Regarding the feed used in precision feeding, concentrations in SID Lys for Feed A et B were at 0.65 % et 0.35 % respectively. Results are shown in Table 1.

**Table 1: Feed cost savings in precision feeding compared to conventional feeding (C0,50 et C0,55) for the period when sows are housed in groups (35th to 110th day of gestation).**

| Annual criteria basis | | $C_{0,50}$ | $C_{0,55}$ |
|---|---|---|---|
| Average feed price (2016) | $/mT | -5,40 | -7,10 |
| Feed cost | $/sow | -2,62 | -3,42 |

Based on average prices in 2016, annual feed cost is reduced by **2.62 $/sow** and **3.42 $/sow** respectively when comparing precision feeding strategies to conventional feeding $C_{0,50}$ et $_{C0,55}$.

## Savings over time

As feed prices vary over time, a sensitivity analysis was conducted on the price of maize and soybean meal, two major feed components. Thus, considering the minimum and maximum prices ($/ton) observed between January 2012 and January 2017, the precision feeding strategy holds an absolute economic advantage over conventional feeding, with annual savings ranging from $0.60 to $5.00/sow.

## And what about the time spent in the breeding rooms (day 1 to 35 of gestation)?

Knowing that sows' requirements for Lys are lower in early gestation, there would be an economic benefit in applying the precision feeding strategy on Day 1 of gestation or, at least, a feed could be formulated that is poorer than the conventional feed normally distributed during this period. Applying a precision feeding strategy during the first 35 days (in the breeding room) would save an additional $2.10 to $2.45 per sow per year when compared to conventional feeding $C_{0,50}$ et $C_{0,55}$ respectively.

## Conclusion

Precision feeding for gestating sows would be particularly **beneficial for sows in late gestation and for young sows still growing**, as the requirement for lysine is significant during these times of the reproductive cycle of sows and that it is difficult to meet these sows' requirement with conventional feeding methods. Precision feeding would therefore make it possible to better feed the sows while **minimizing overfeeding**. By reducing excess nutrients given to sows, there is a reduction in the cost of feed that fluctuates around **$3 per sow per year**.

*The commercial field trial of this project is currently underway at the Ferme Ste-Catherine Nord of La Coop Seigneurie in Quebec and will validate the effects of precision feeding on the performance of more than 300 gestating sows during two gestation cycles and lactation. Results will be available in the winter of 2018.*

## Financial partners

The project was funded by the Agri-Innovation Program of Agriculture and Agri-Food Canada, in partnership with La Coop Seigneurie, Jyga Technologies and Les Éleveurs de porcs du Québec. ■

# Turning your farmyard into a CAZ

**Submitted by Mark Fynn, Manitoba Pork**

A Controlled Access Zone (CAZ) is often assumed to begin at the end of the driveway and surround a farm's yard. But if you have no way to prevent vehicles from entering the yard, what are you controlling?

A true CAZ must control access down the driveway and into the yard. For that, a physical barrier is imperative. An open gate or no gate at all is not a physical barrier. On the other hand, expecting barn personnel to exit the barn to open a gate every time a feed truck or transport trailer arrives is not practical and provides another chance for a biosecurity breach to happen at the barn door.

One option we could consider is installing automated barrier arm gates with PIN codes, key fob entry, or intercoms to the barn. In that sense, only authorized personnel are able to enter the yard and the CAZ is truly controlled. (Plus, there's the added bonus of having a good visitor log of site visitors.)

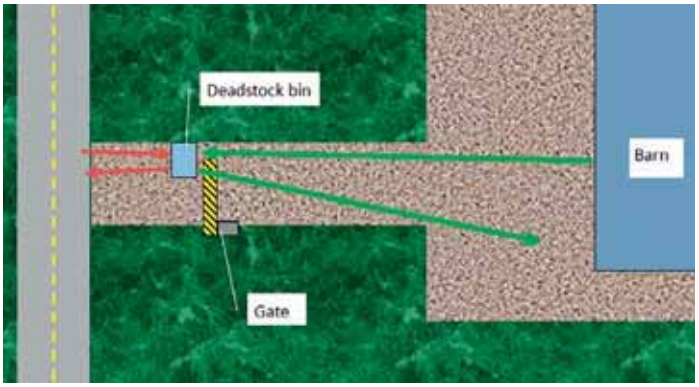
Figure 1. Automated barrier arm gate.

With this type of system in place, barn managers can make real-time decisions about who enters the yard by asking the questions:

- Can the service, supplies or equipment be provided off-site?
- Can the service be performed outside the CAZ?
- Can the vehicle be left outside the CAZ and the service person walk in?
- How far away from the barn can the service be performed?
- Can they perform the service without entering the barn or bringing equipment into the barn?

Performing services off-site is obviously the most preferable, and services such as deadstock and garbage removal should always be performed outside the CAZ. If a lift gate system is used, deadstock could be moved from the barn by farm-dedicated equipment to a bin placed just outside the gate; this acts to prevent the farm-dedicated equipment from ever having to drive over the same ground as the deadstock removal company's vehicle. To further improve the system, can the farm have a separate access way – also gated – specifically for high-risk service providers such as deadstock removers and manure applicators? This could eliminate the need for staff vehicles, feed trucks and livestock trailers ever having to cross paths with these high-risk vehicles on-site.

Figure 2. Deadstock disposal flows and bin locations.




But what should we do on the other side of the gate? Vehicles that have been offsite still have to enter the CAZ; we have staff vehicles, feed trucks, livestock trailers, and some service vehicles that are unable to park outside the CAZ. How do we reduce the risk that these vehicles present? Reducing the number of movements into the CAZ would be a definite improvement; for example, reducing the frequency of feed deliveries by optimizing feed bin capacity and usage. A tire disinfection step just past the entry to the CAZ, preferably where the driver is not required to get out of the vehicle, could further reduce the risk of pathogens being dragged into the yard.

The use of dry, hydrated lime in a depression might work, but there are some things to know about hydrated lime:

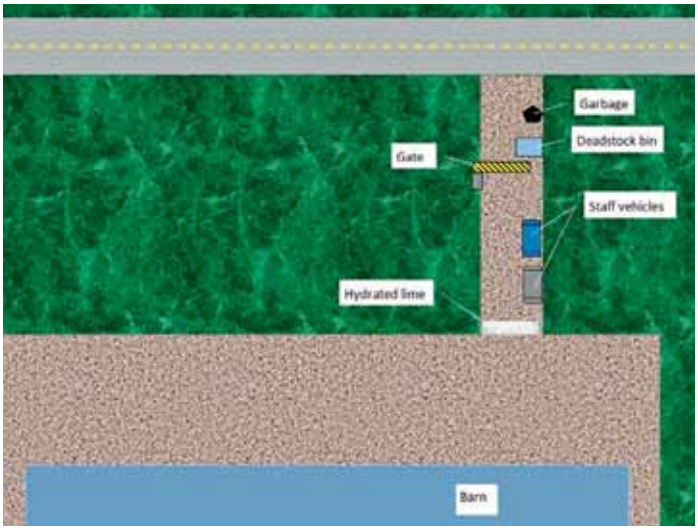
- It is corrosive and an irritant, and personal protective equipment (PPE) should be worn when handling it;
- It reacts quickly when introduced to moisture, so barn personnel would have to replace it after every rain and every few days; and
- It needs to fully coat a surface to be effective, so it should be provided in ample quantity and fully distributed over a reasonable area that would allow for full coverage of at least one full rotation of a tire.

As for liquid disinfectants, they must be applied in ample concentration to a clean surface for a certain amount of time (usually over five minutes) without being removed to be effective. This requirement is unlikely to occur if we apply them to vehicle tires as they enter a yard.

Other than what the tires are bringing into the yard, we must be concerned about what is on people's shoes as well. Barn personnel should wear dedicated yard boots or disposable booties, and visitors should wear disposable booties, outside their vehicles while in the CAZ. It is a two-way street:

- Keep pathogens from inside the vehicles from getting into the yard and barn;
- Keep pathogens from the barn and yard from getting into the vehicle; and

Figure 3. Example of a farm yard that truly is a Controlled Access Zone.




- Don't forget: keeping pathogens from the yard from getting in the barn.

Barn door biosecurity – entry into the Restricted Access Zone (RAZ) – is another story for another time, a story that hopefully includes changing clothing and footwear and having a shower. Talk to your herd veterinarian for immediate advice. ■

# Ad Index

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