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Evaluating the impact of early life management of piglets on lifetime welfare and performance

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Introduction

It is widely known that getting newborn piglets off to a successful start in life is key for increasing the chances of lifelong health and productivity, and the early life management of the pig is focussed on ensuring good nutrition, accommodating temperature requirements to avoid chilling and maintaining good health. But how much consideration is given to how the physical and sensory environment and experiences in the weeks of early life could impact the behavioural development of the pig, transition at weaning and their overall resilience to stressors and animal welfare?

The first 12 weeks of a pig's life is a period where rapid brain development occurs, with the greatest increase occurring from the period of birth to four weeks of life (Conrad et al. 2012). This rapid growth suggests a critical period of development, and what a pig experiences during this period of time will shape how an individual responds to subsequent life events, leading to consequences for the overall health and resilience of the pig, welfare and productivity. Management strategies that provide targeted inputs during this sensitive period of development could lead to improvements in the behavioural development, affective state, and the subsequent response of the pig to stressors which could result in a more resilient animal, with better health and welfare outcomes.

Evaluating the effect of management strategies early in life to impact the long-term welfare and resilience of the pig in fully slatted systems is the objective of one of the four research goals that constitute the Natural Sciences and Engineering Research Council (NSERC) industrial research Chair research program in swine welfare. Led by Dr. Yolande Seddon and developed in

(Evaluating the impact of early life... cont'd on page 2)

Inside This Edition

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(Evaluating the impact of early life... cont'd from page 1)

collaboration with 14 industry partners representing Canadian producers, processors and a swine genetics company, the program contains four overarching research goals which focus on emerging questions in swine welfare. Over a series of experiments, the research of Goal 1 is to determine the contribution of early life management to resilience, sociability and welfare outcomes in the growing pig. Broadly, this work will determine if there are beneficial and additive effects to targeted management of the pig within the first four to 12 weeks of life to shape the behavioural and stress resilience of the pig, and the consequences for lifetime pig welfare and performance. This work is important to uncover ways to optimize welfare and performance in the fully-slatted system, and could contribute to supporting other industry goals such as reducing antibiotic use, to which the fundamental resilience of the pig is important for success.

As part of our study design, we will follow the pigs from birth to slaughter. Provided that a marked improvement on the stress resilience, performance, or welfare of the pig is seen, the treatments implemented in the study could potentially serve as functional modifications to swine housing in production settings.

What we did:

One longitudinal trial has been run to evaluate the interactive effects of specific early life management strategies designed to target specific areas of pig development that will support improved welfare and productivity outcomes. Before implementing any enrichments and management strategies in production systems, it is imperative to know if these enrichments will make a worthwhile improvement to both yield and pig welfare. Trying to pinpoint the best period in development between the two critical windows in the pig's life is important so that the approach can be most effective. Thus, we aimed to determine if targeted management between birth to four weeks or four to twelve weeks will generate the most profound effects on the pigs' welfare and growth, or if both periods combined will create an additive effect. Following pigs from birth to slaughter, the long-term effects on the pig can be determined, also enabling a cost benefit analysis to be conducted to determine if there are worthwhile benefits for production.

Forty litters of pigs have been studied originating from four farrowing batches. In the farrowing room, 50% of pens were reared as standard, with no additional management inputs, and treatment litters receive three management changes. Three management changes that have been shown to improve welfare and decrease adverse behaviours are manipulable physical enrichments, provision of extra space pre-weaning, and positive human contact. An interactive approach of providing the combination of these adjustments was taken to determine if we can understand the maximum benefits to be had from this approach, which could lead to later questions on what could be the most pertinent management adjustments to make.

1) Chewable enrichments: in the form of cotton rope and burlap strips hung in several locations in the farrowing pen, serve to satisfy and develop their innate foraging motivation, support the development of chewing (mastication) ahead of solid food intake, and provide an outlet for expression of oral behaviours towards the enrichment, instead of towards the sow or littermates. Rope and burlap are also added to the creep feeders to entice the piglets and bring their attention to the

creep, a simple approach to add functional enrichment which has previously been shown to stimulate exploration at the creep feeder pre-weaning, increasing feed intake and weight gain post weaning (Middelkoop et al. 2019).

2) Extra space per pig: farrowing pen space increased from 4.32m^2 to 6m^2, increasing the room for the expression of social behaviours and play. Room to express these behaviours pre-weaning when they start to develop has been shown to reduce aggression post-weaning, and also helps to reduce overcrowding for large litters.

3) Neutral human contact: Specific handlers caring for the pigs took time on three occasions per week when checking pens and changing enrichment to enable piglets to sniff and interact with the human handler. This neutral human interaction is given to acclimate the pigs to human presence, reducing fear of humans and reduce the negative associations that may have arisen from previous handling and processing.

> "early life experience of piglets before and around weaning can influence their behavioural adaptation and the development of positive or negative behavioural characteristics"

These manipulations can prepare the pig for close human contact during handling, shape the development of oral-nasal-facial behaviours, reducing negative behaviour to pen mates, and improve social behaviours.

Piglets were weaning at 26-28 days of age and new pen groups formed with litters mixed within treatment. In the nursery both treatment pigs and the control pigs were further divided into two more groups with 50% of pens received a management switch (Fig. 1). This resulted in 50% of treatment pens receiving no further interventions post weaning, and 50% receiving continued management interventions until 12 weeks of age. Simultaneously, 50% of control pens remained as control post weaning, and 50% of control pens started to receive the

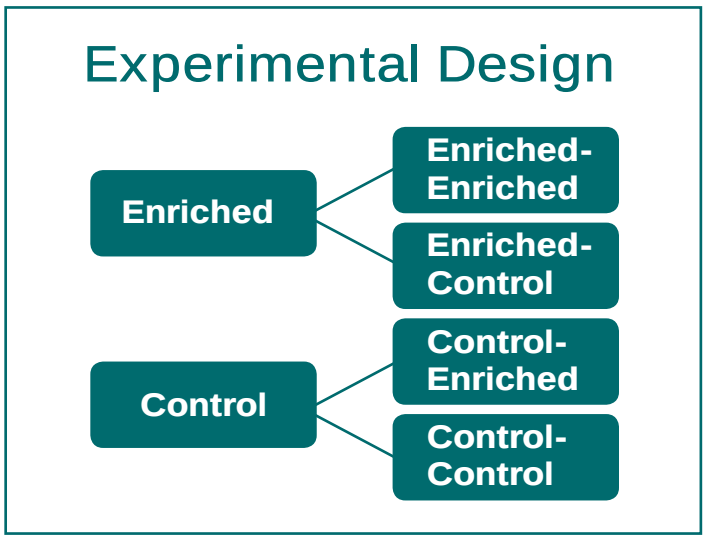
management interventions from weaning until 12 weeks of age. This experimental design enables the effect of delivering management interventions separately at each of the sensitive periods of development (birth to four weeks, and four to 12 weeks), or to explore an consistent management across both periods. After week 12 of age, all enrichment management interventions were stopped, and pigs were reared to slaughter in standard husbandry conditions, with the provision of standard enrichment of rope changed once weekly. Pigs remained in the same pen groups after weaning until slaughter.

This longitudinal study is being purposefully used to answer several key research questions by layering measures across the pigs, building up a solid body of information that can support greater understanding of the separate and interactive effects, and the development of common welfare challenges:
A first research question is how the early life management influences the behaviour development, and subsequent indicators of welfare outcomes and performance.

For this, repeated measurements are taken from the pigs throughout their life from birth to slaughter at each stage of growth to provide information on how the early life management has influenced various aspects of pig development of important to welfare and performance. Specific measures include: the development of oral-nasal-facial behaviour and its relationship to tail-biting in the pigs later in life; skin lesions as a measure of acute and chronic social aggression; fear of humans and handleability during moving and a weigh crate handleability test. Productivity measures include growth rate, feed conversion efficiency, carcass composition data from slaughter records. The repeated nature of these measures will provide a timeline of the magnitude and length of effects, if any, throughout the pigs' life in the production system.

A second research question is how the early life management has influenced the resilience of pigs to production relevant stressors. For this the transition of piglets at weaning has been studied, utilising specialised IVOG feeders (Hoko Farm Group, NL), the individual feed intake of piglets at weaning has been recorded and is used as a measure of the speed of transition onto solid food at weaning. At 17 weeks of age, pigs underwent an out of feed event stress test, designed to induce both acute and chronic forms of stress (O'Driscoll et al. 2013) and potentially stimulate a tail biting outbreak. Pigs were observed for behaviour before, during and after the out of feed event at refeeding, created by removing feed from feeders for a period of 18 hours. Saliva was also collected from pigs to measure physiological responses to the stressor, and the recovery.
Oral behaviours and early life stress are also intimately tied with gut health and the gut-brain access. Studies have shown a possible link between abnormal gut development and behaviours like tail biting. Promoting early feed intake, such as from creep in the farrowing phase to help the transition onto solid feed is important. A third objective is to determine the relationship between the early-life environment, creep-feed intake pre-weaning, gut inflammation at weaning, and subsequent development of oral-nasal facial behaviour and tail biting later in life. A sub-sample of litters had blue dye added to the creep feed pre-weaning and were but swabbed to identify the number of piglets in the litter that have and have not eaten creep pre-weaning. The individual animals are tracked post-weaning, with fecal samples collected in the days following weaning for measures of gut inflammation, and the animals followed to slaughter with regular observations for the development of tail biting; being both a bitten victim and becoming a biter.

Implications:
The early life experience of piglets before and around weaning can influence their behavioural adaptation and the development of positive or negative behavioural characteristics that have significant, and likely lasting, implications for welfare, stress resilience and production performance. This research will determine whether providing targeted adjustments to management at specific sensitive periods in the piglets' development, could offer a simple and effective method of benefitting the welfare, health and productivity of pigs. Working within the context of the pig's development and physiology could potentially provide an avenue for optimizing cost effectiveness and benefits of enrichments and can identify management strategies to help optimize welfare within modern fully-slatted systems of production. Supporting the overall resilience of the pig will simultaneously help to support goals to help reduce antibiotic use and support production in the face of common stressors experienced in the production system. The longitudinal approach offered by this work will also contribute knowledge towards uncovering the cost benefit of such approaches and also contribute knowledge towards understanding the development of complex welfare challenges, such as tail biting.



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Investigating novel biomarkers of welfare in swine

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Introduction

There remains increasing concern and debate over the welfare of animals used by humans, particularly those raised for consumption. Consequently, robust measures are required to evaluate the welfare of animals in our care. However, many welfare measures are subjective and relate to what we as humans think is positive or negative for the animal. Within livestock production, identifying objective biomarkers that can inform on animal welfare is important to help support the correct and accurate assessment of welfare with data that can inform public debate and guide management decisions. Biomarkers are objective and quantifiable characteristics of biological processes. Whilst there are many measures taken to evaluate acute experiences that influence animal welfare, such as measurement of cortisol, a hormone that increases in acute stress after aggression. There is currently a lack of reliable biomarkers that can provide information on longer-term welfare in farmed animals. However, the assessment of welfare over a longer period of time is important in the evaluation of husbandry procedures and management practices on animals, such as for example, how different gestation systems influence the welfare of sows, with the stalls vs group-housing debate being one key example: a debate that would have benefitted from improved chronic measures of welfare and stress. Identifying biomarkers in swine could assist in the objective identification and quantification of factors that positively and negatively contribute to an animal's welfare, advance our understanding of animal wellbeing, and provide guidance to improve production systems.

Hair as a medium for evaluating welfare

Cortisol is a hormone of the hypothalamic pituitary adrenal (HPA) axis released in times of stress.. Increased levels of cortisol in saliva and blood have been shown to relate to acute stress in situations such as following weaning, (Erp-van der Kooij et al., 2003) castration (Prunier et al., 2005), transportation (Smiecinska et al., 2011) and mixing with unfamiliar pigs (Erp-van der Kooij et al., 2003). While valuable in certain situation these mediums are unable to inform on long-term stress or support assessments of their overall quality of life. Measurement of hormones within hair has been proposed as a method to evaluate stress over a longer-term. In addition, hair has the benefits of being easily and quickly collected in a non-invasive manner (Fig. 1) compared to other matrices such as blood, and, if properly stored can be saved for months to years for analysis. Hormones are incorporated into the shaft as hair grows and can reflect hormone concentrations over longer periods of time and thus could serve to inform on evaluating emerging issues in the swine industry such as whether group or stall-housed are less stressful for sows. Another hormone of the HPA axis is dehydroepian-drosterone (DHEA). While less researched, DHEA is thought to have roles largely opposing those to cortisol. Studies in humans (Wolkowitz et al., 2001; Rutkowski et al., 2014) and other animals such as cows (Almeida et al., 2008) and mice (Rutkowski et al., 2014) have shown lower levels of DHEA relate to illnesses and disease such as lameness and inflammatory conditions as well as depression and chronic stress. In contrast, higher levels of DHEA have been found to correlate to physical and psychological

Figure 1. Collection of hair from a pig restrained in a weigh crate. Hair is shaved from a consistent area on the rump, and collected on aluminum foil. Collected hair is transferred to a paper envelope for storage.

resilience as well as faster and more successful recovery times in a variety of illness and injuries (Mills et al., 2005; Rutkoswki et al., 2014). Due to the opposing roles of cortisol and DHEA, their ratio has been suggested to be a superior biomarker compared to either analyte separately (Kamin and Kertes, 2016), but studies in this area are extremely limited.

The NSERC Industrial Research Chair program in swine welfare, led by Dr. Yolande Seddon and developed in collaboration with 14 industry partners representing Canadian producers, processors and swine genetics company contains four overarching research goals which focus on emerging questions in swine welfare. The broad objective of Goal 3 is to identify and validate objective biomarkers able to inform on swine welfare, providing monitoring tools that can be used by both the industry and research. Research has been carried out at the Prairie Swine Centre.

One specific objective is to evaluate the use of measuring hormones in swine hair. Over a series of three experiments, the objectives of this goal will evaluate and validate the value of measuring cortisol and DHEA in swine hair as a measure of chronic stress, animal welfare, and of individual stress reactivity in pigs. The results of this work will help to conclude whether hair analysis is a useful tool for use by researchers and industry alike.

Work started (experiment 1) to first refine the laboratory procedures for analysis of hair cortisol and DHEA by evaluating the optimal washing protocol of hair prior and to determine if DHEA could be reliably measured in swine hair. Pig hair varies in cleanliness ranging from visibly clean to hair covered in feces and urine. As feces and urine also contain hormones, external contamination with such matter may influence the hormone concentrations in hair. It is therefore crucial to ensure an effective washing protocol is in place before analysis begins. This study which was published in the fall of 2021 and is available for viewing online (Pollock et al. 2021), showed that DHEA can be measured in swine hair, and a commercially available assay for analysis of DHEA was validated for use in swine. Results also determined that external fecal and urinary contamination influenced the hair cortisol concentrations. Recommendations for the lab analysis of cortisol and DHEA in swine hair were i) to avoid using contaminated hair when possible, and ii) to wash swine hair (visibly contaminated or not) for five three-minute washes using the solvent methanol prior to analysis. This project allowed us to be confident with the laboratory procedure and to proceed to evaluate these hormones as biomarkers of welfare on farm in further studies.

A second experiment explored whether husbandry system could influence the levels of hormones in swine hair. For hormones in hair to be used as a measure of swine welfare, it is important to understand what factors could affect levels. A pig's rearing environment has been shown to influence the release of hormones through HPA activity. One study showed that pigs raised in a conventional fully slatted system had a higher likelihood of developing a blunted circadian rhythm (a natural 24-hour cycle of rising and falling levels of hormones) of cortisol compared to those raised with straw who had a higher likelihood of developing a typical rhythm. However, it is unclear if these changes in the circadian rhythm of cortisol relate to hormone concentrations within the hair and what these changes in the rhythm may mean for the pig. Few studies have investigated the effect of rearing environment on hair cortisol concentrations, with conflicting results. Studies evaluating DHEA are extremely limited, with no studies evaluating the circadian rhythm of DHEA in pigs. To understand if hormones within the hair can inform on swine welfare, it is important to know if there are factors influencing the hormones within the hair. Thus, the objective of this study was to determine if hair cortisol and dehydroepiandrosterone, and their ratios as well as their circadian rhythms differ in pigs raised with straw (Fig. 2) versus those raised in a conventional system. The results of this work will provide useful information to support the correct interpretation of data when measuring hormones in hair from growing swine. This is especially important when considering that husbandry system comparisons are a regularly made with regards to animal welfare.

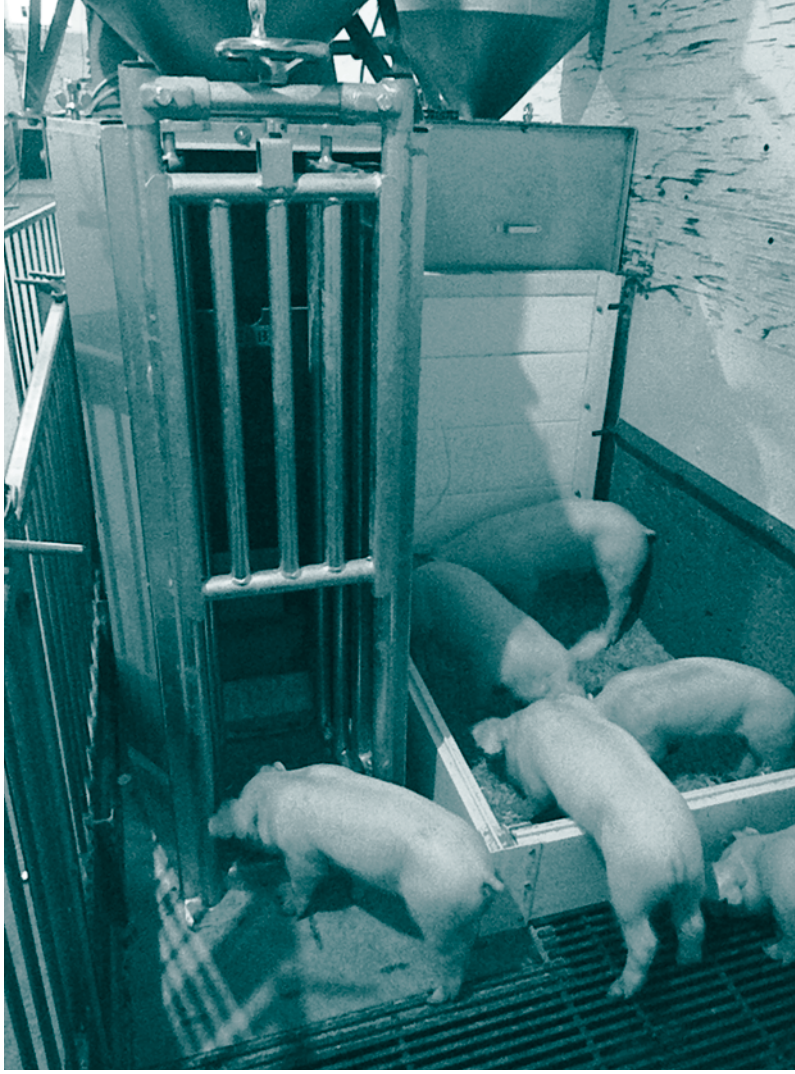

Figure 2. Piglets reared with the provision of straw influenced their levels of hair cortisol and DHEA.

A third study is underway and connects to another research goal within the NSERC IRC in swine welfare (Goal 1) and will determine if targeted management in the early life of the pig that can influence welfare outcomes and stress resilience in the fully-slatted pig resulting in changes in levels of hair cortisol and DHEA. This project provides a platform to further understand how levels of the hormones alter in hair based on welfare

(Investigating novel biomarkers... cont'd on page 7)

Can hybrid rye replace wheat in swine diets?

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Take home messages

- In a commercial scale growout trial, hybrid rye completely replaced wheat in diets without affecting feed efficiency, carcass traits, feed cost per hog or feed cost per kg of body weight gain, and profit per hog.
- Including feed NSP enzymes tended to improve weight gain over the entire trial.
- NSP enzyme inclusion improved feed efficiency, but only for hogs fed the all-rye replacing wheat diet.
- Assuming 2700 kg greater hybrid fall rye yield than wheat grain, an additional 13 hogs more (30 to 130kg live) could be fed per hectare (5 more hogs per acre) at ~200 kg (440 lb) cereal grain intake per hog.

Why hybrid rye?

Rye is a cereal crop similar to wheat. It is popular in northern and eastern European countries for the production of dark bread and food products. In Canada, rye is best known for the production of whisky and spirits. Its winter hardiness allows efficient use of spring runoff and extends the 'work season' vs. spring cereals for grain producers. Of ~324,000 hectares planted to rye in Canada, about 80% grows in the Prairie provinces. Rye has other uses in Europe including as grain stock for ethanol production, as forage/silage crop for ruminants and grain for pigs. What's new with rye in Canada is that novel European hybrid cultivars yield >30% more over conventional rye, 15-20% over barley and 20-40% over wheat grain. Modern rye hybrids produce vast amounts of pollen that overwhelm the stigma. With the stigma oversaturated by pollen, mold spores have a lesser chance of infecting the ear before the stigma closes. Fall planted rye flowers earlier than spring planted cereals so ergot and fusarium contamination risk is lower. Not much rye is fed to pigs in Canada compared with corn, wheat and barley, even triticale. But greater grain yield compared with wheat grain (80-120 vs. 40 – 80 bu/acre) was an attractive incentive for us to evaluate feeding hybrid fall rye to hogs even if that resulted in somewhat lower pig performance. Rye is known to have greater fibre content than wheat grain. But the fibre in rye grain is mostly complex gummy sugars, not bulky, woody hulls (bran). These complex soluble sugars could be made more digestible/fermentable to pigs by the inclusion of feed NSP enzymes. As Prairie hog producers typically stock two cereal grains (barley, wheat), but not likely three, we decided to evaluate feeding increasing hybrid rye inclusions replacing wheat grain. And test whether or not NSP enzymes would make the hybrid rye grain more digestible to hogs.

> "Hybrid rye can successfully replace wheat in growing and finishing diets."

Commercial scale hog trial setup

We conducted this growout trial at a contract finishing barn located at Lougheed, AB that is part of the Sunhaven system. In total, 504 barrows and 504 gilts (Camborough Large White/Landrace ♂ x 380 ♀ (PIC Canada) were involved. As pigs arrived at the barn (~30 kg or 66 lb), they were herded into 48 pens by sex, 21 pigs per pen. Pens with slatted concrete flooring measured 20 × 8' providing 0.7 m2/pig. Pens were equipped with one wet-dry feeder (Crystal Spring Hog Equipment, St. Agathe, MB, Canada) with two opposing feeding places located halfway along a dividing wall between pens. An additional water bowl drinker was located at the back of the pen. Pigs were initially fed a common Grower 1 diet. At ~44 kg (96 lb), pens were blocked by area of the rectangular room. Within area block, pens of barrows or gilts were randomly allocated to be fed diets with one of three hybrid rye levels replacing soft wheat grain: low rye (1/3rd of wheat replaced), medium rye (2/3rd of wheat replaced), or high rye (all wheat replaced). The

(Hybrid rye replacing wheat grain... cont'd on page 8)

(Investigating novel biomarkers... cont'd from page 5)

outcomes and stress resilience of pigs, which is being directly influenced by the experimental treatments. Pigs may experience numerous events throughout their life, many of which occur at a young age, such as processing, castration, weaning and mixing from unfamiliar piglets which may contribute to stress. It may be possible to lessen the overall stress early in life, and in fact positively influence stress resilience and appropriate behaviour development by the addition of positive manipulations such as providing enrichment, increasing space during the pre-weaning period, and providing increased neutral or positive human contact. Early life is also a crucial time for HPA axis development and events early in life may have long term effects on HPA axis development which may affect behaviour and productivity long term. While these manipulations are considered to improve welfare, it is not known if this can be detected within the hair. The results of this study will 1) contribute to understand the ability of measuring cortisol and DHEA in swine hair as a biomarkers of welfare in swine and will be compared to behavioural and productivity measures which is limited in other studies, 2) determine if hair cortisol and DHEA is a reliable and sensitive biomarker of welfare and 3) allow the industry to determine potential benefits of providing early life management strategies such as through the provision of targeted enrichment at different life stages. While enrichment can be difficult to provide in certain barns, providing it early in life may be more feasible.

Finally, we will determine how individual pig traits, stress reactivity, welfare outcomes and productivity measures relate to the levels of cortisol, DHEA and their ratio in the hair of growing swine. The levels of hormones in hair can be highly variable between individuals in a study population, suggesting the reflection of individual differences, which may relate to individual characteristics, like age, stage of growth, stress reactivity, welfare and production performance. Utilizing a database of information accumulated from pigs studied under the experiments of the NSERC IRC in swine welfare, analysis will determine relationships between individual productivity traits (individual growth performance and feed efficiency), welfare outcomes (i.e. was pig tail bitten, lame, in good health), behavioural stress reactivity as quantified through behavioural tests. If successful, this would provide the scientific community and swine industry with an objective measure informing on individual welfare and could aid in genetic selection of resilient pigs.

Implications

If successful, this project will provide the industry and scientific community with a useful, reliable and objective measures of welfare in swine, which could provide information on long-term states, and may also provide information on individual pig stress resilience and performance. The measurement of hormones in hair could in turn can assist in comparing different management systems, individual welfare assessments and genetic selection of stress resilient pigs. Results of ongoing work are expected to be complete by the spring of 2023.

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(Hybrid rye replacing wheat grain... cont'd from page 6)

fall rye was a hybrid cultivar named Bono (Figure 1) developed by KWS LOCHOW GMBH (Bergen, Germany) grown at Kalco Farms near Gibbons, AB. Diets were fed either with or without NSP enzyme (Endofeed WDC, 200 mg/kg) providing 1400 units/g β-glucanase and 4500 units/g xylanase donated by GNC Bioferm, Bradwell, SK. Test diets were fed to slaughter weight (133 kg or 293 lb) over 4 growth phases (Grower 2 d 0-22, Grower 3 d 23-42, Finisher 1 d 43-63, Finisher 2 d 63 – slaughter). Pigs were slaughtered at Maple Leaf, Brandon, MB.

What we found

Body weight of hogs throughout the trial was not affected by either feeding increasing hybrid rye level replacing wheat grain or enzyme inclusion (Figure 2). For the entire trial (d 0-76), feeding increasing rye level replacing wheat grain reduced hog feed intake and weight gain, but feed efficiency was not affected (Figure 3). Enzyme inclusion did not affect feed intake and feed efficiency, but tended to increase overall weight gain by 20 g/d. Enzyme inclusion improved feed efficiency only for hogs fed the high rye level whereas it did not affect feed efficiency for hogs fed low or medium rye levels. Days on test to 130 kg slaughter weight or carcass traits were also not affected by feeding increasing rye level replacing wheat grain or enzyme inclusion (Figure 4). Feeding increasing rye level replacing wheat grain increased cost per tonne of feed, but did not affect feed cost per hog or per kg of body weight (Figure 5). Feed enzyme inclusion reduced feed cost per hog and per kg of body weight gain by CDN$1.70 and $0.02, respectively.

Figure 1. Field of hybrid fall rye Bono growing in Western Canada. Photo courtesy FPGenetics, Regina, SK.

What these results mean

Because of the decrease in feed intake with increasing rye level replacing wheat grain, we first suspected mycotoxins or ergot alkaloids. Two labs tested both the hybrid rye and wheat grain and confirmed that these were no factors in reducing feed intake. We therefore believe that the decreased feed intake observed was possibly caused by the more complex sugars found in rye. Increasing gummy sugars content made the digesta somewhat more viscous (held more water), slowing down passage rate

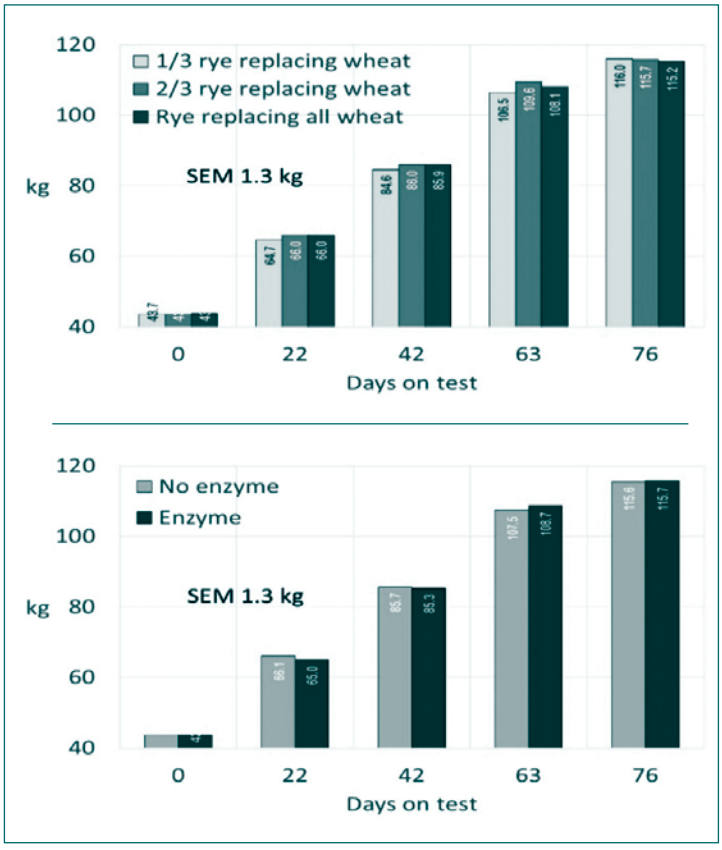

Figure 2. Body weight of hogs on test days throughout the trial fed increasing hybrid rye level replacing wheat grain with or without enzyme.

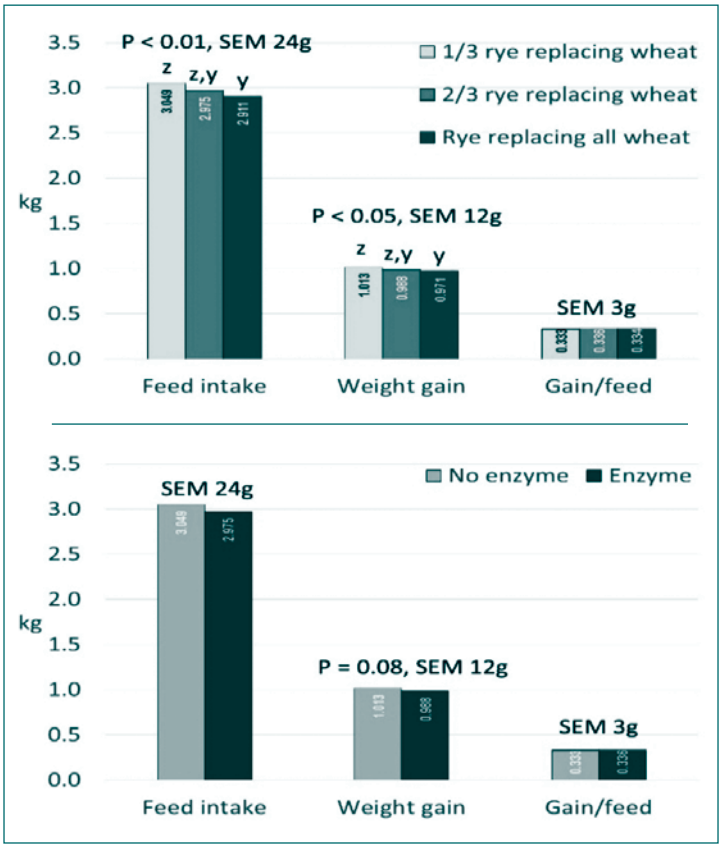

Figure 3. Daily growth performance (0 – 76d) of hogs fed increasing hybrid rye level replacing wheat grain with or without enzyme.

through the gut. Hogs fed these less digestible complex sugars therefore felt more full and satisfied with slightly less feed thus reduced their weight gain. Because both feed intake and weight gain were reduced in parallel, feed efficiency was not affected. Feed NSP enzyme inclusion increased the digestibility/fermentability of the rye complex sugars, but that only showed up at the high rye level replacing wheat grain. The all-rye grain diet likely moved slower along the gut, staying longer and held the most water giving feed enzymes more time to breakdown the rye complex sugars. Carcass dressing was not reduced because the rye complex sugars were mostly soluble instead of bulky, insoluble cereal hulls (bran) so that did not increase gut weight or thickness. Backfat did not increase or decrease because we accounted for the greater rye complex sugars content as a lower net energy value for rye compared with wheat grain. Loin depth was also not affected because we correctly accounted for differences in amino acid (the chain links of protein) digestibility between rye and wheat grain at formulating the diets. Diets with increasing rye level were more costly than wheat grain diets because oil was added to compensate for the lower net energy value of rye. Hybrid fall rye was sourced at $170 vs. $180 for wheat grain. Assuming hybrid fall rye yields 2700 more kg/ha (40 more bu/acre) than wheat grain, using our trial results that would imply 691 more kg of lean pork/ha (617 more lb/acre) feeding 60% rye inclusion replacing wheat grain from 43.7 to 132.7 kg slaughter weight (96 to 292 lb).

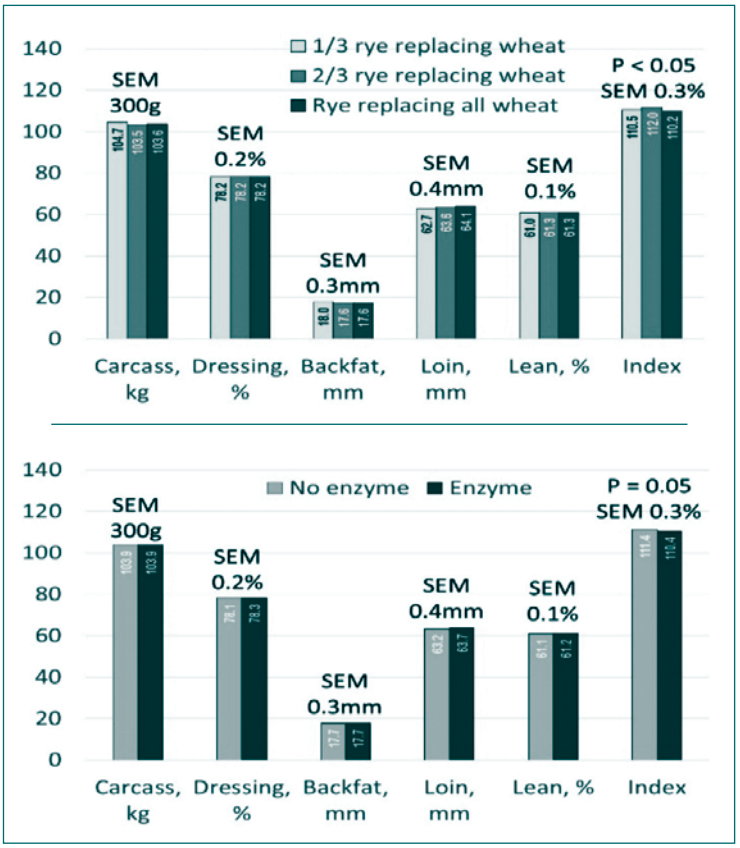

Figure 4. Carcass traits of hogs fed increasing hybrid rye level replacing wheat grain with or without enzyme.

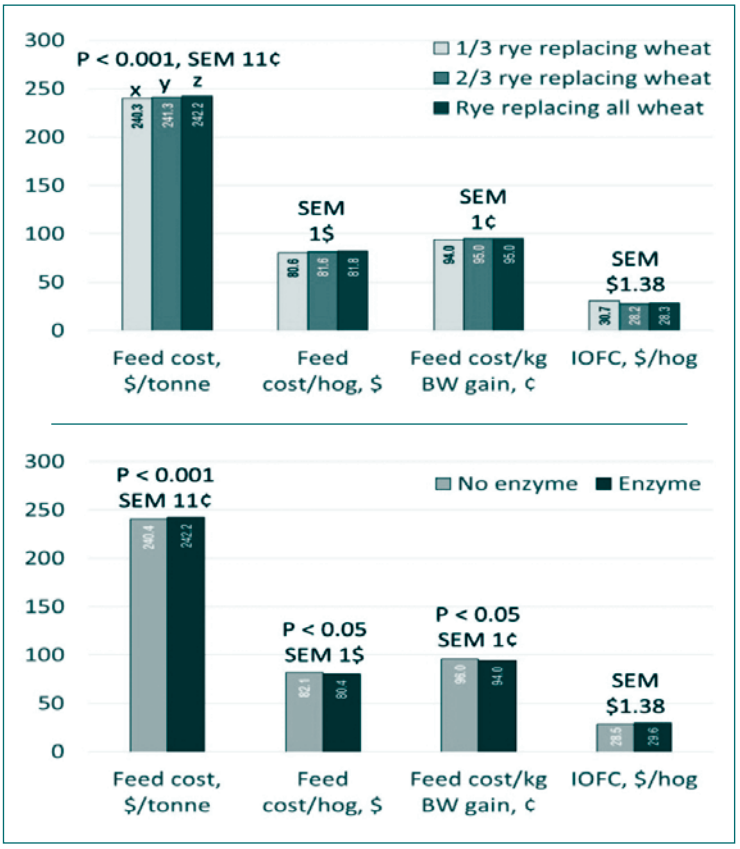

Figure 5. Overall cost vs. benefit of feeding increasing hybrid rye level replacing wheat grain with or without enzyme to hogs. Income over feed cost (IOFC) calculated as gross carcass revenue minus feed cost.

> "Inclusion of NSP enzymes is recommended for diets containing high rye inclusion levels."

In conclusion, hybrid rye can completely replace wheat grain in growout hog diets without affecting feed efficiency, feed cost/hog or feed cost/kg of body weight gain. Inclusion of feed NSP enzymes would be recommended for diets containing high rye inclusion levels (45 – 65% of the diet) to improve feed efficiency and weight gain. Assuming 2700 kg greater hybrid fall rye yield than wheat grain, an additional 13 hogs more (30 to 130kg live) could be fed per hectare (5 more hogs fed per acre) at ~200 kg (441 lb) cereal grain intake per hog.

Thank you

We thank Tanya Hollinger, Neil and John Burden at the Dumloche test barn for care of the animals and smooth running of the trial. Thanks also to Lewisville Pork Farm for the use of their animals and Sunhaven Farms Milling for mixing and supplying the feed.

A new method for improving animal welfare oversight: routine monitoring of pig carcasses

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Introduction

In an age of increasing consumer concern over the welfare of animals raised for consumption, collecting data that can provide insight on the welfare of animals raised in production systems is valuable for an industry to demonstrate and assure customers that specific standards are maintained, and to monitor progress in animal care for continual improvement of practices. Animal care verification requires the accurate evaluation and quantification of animal welfare. Assurance schemes typically rely on farm audits for animal care verification, which are time consuming, incur cost for the producer and can pose a biosecurity risk. Consequently, animal care audits are performed infrequently and commonly by the herd veterinarian, which can make the audit less credible if there is a conflict of interest. A strong, credible system for animal care evaluation is important to support transparency and public trust in practices. One approach to increase the consistency and accuracy of monitoring animal welfare standards could be the monitoring of pig carcasses at slaughter for indicators of importance to animal welfare.

Animal-based indicators of welfare are quantifiable characteristics directly measured on the animals, such as behaviour, body condition, health (EFSA, 2012), and are reflective of what the animal has experienced. Animal-based indicators are scientifically validated to provide meaningful information on animal welfare (EFSA, 2012) and provide a powerful and consistent method of evaluating the wellbeing of groups and individual animals, regardless of the production system (Whay et al. 2003). The evaluation of animal welfare indicators on swine carcasses at slaughter could offer a cost-effective method for the routine evaluation of swine welfare on farms supplying pigs to abattoirs within Canada.

The NSERC Industrial Research Chair program in swine welfare, led by Dr. Yolande Seddon and developed in collaboration with 14 industry partners representing Canadian producers, processors and swine genetics company contains four overarching research goals which focus on emerging questions in swine welfare. The broad objective of Goal 4 is to evaluate the value of measuring animal-based indicators of welfare at slaughter to determine if this could be a viable method for a routine animal welfare monitoring system (Fig. 1). Specific objectives of this research are to determine:

i) Whether measuring animal-based indicators of welfare on swine carcasses can accurately inform about the welfare of swine on-farm and during pre-slaughter handling.
ii) The relationship between animal-based indicators on carcasses and economic loss to understand the economic consequence of these lesions to the producer and meat packing industry.

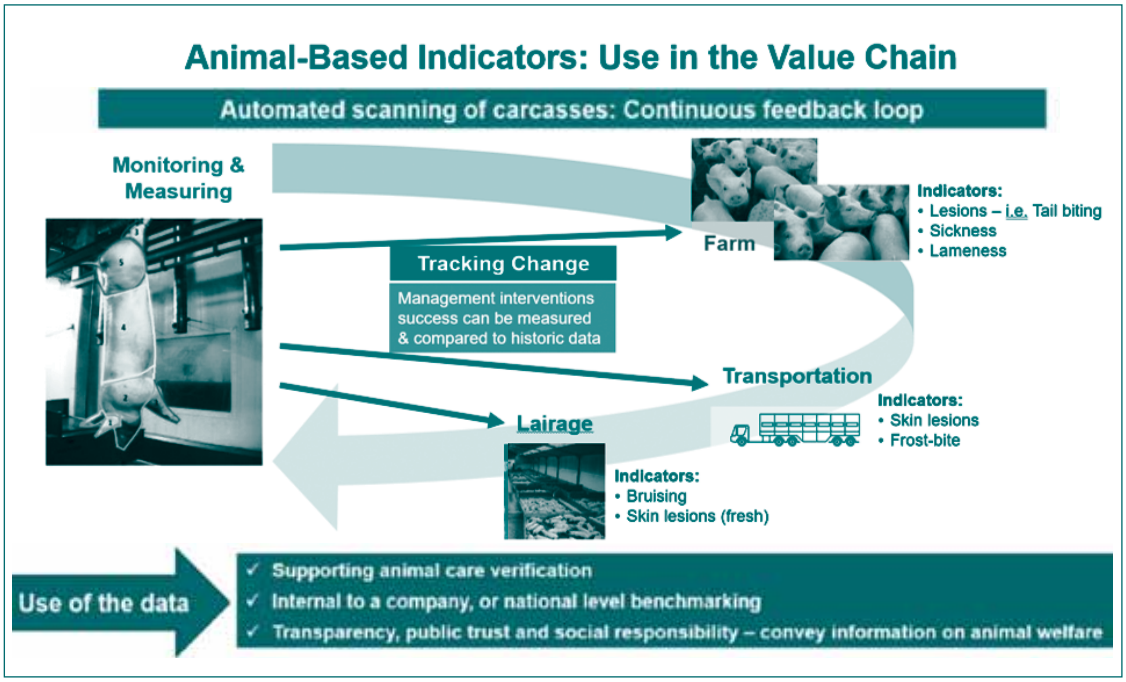

Figure 1. Overview of monitoring animal-based indicators of welfare on carcasses at slaughter, linking measures to stages of production to support routine monitoring. Schematic author: G. Miguel-Pacheco.

Due to the large number of pigs slaughtered within Canada, the routine monitoring of indicators on carcasses would need to be automated to be viable tool for the industry. Researchers Giuliana Miguel-Pacheco, Yunayue Wang and Yolande Seddon from the Western College of Veterinary Medicine have collaborated with Prof. Seokbum Ko and Postdoctoral research assistant Juan Yepez from the Department of Electrical and Computer Engineering to determine:

iii) The ability to automate the evaluation of swine carcasses through training computer-based models to detect, identify and quantify animal-based indicators of welfare on carcasses.

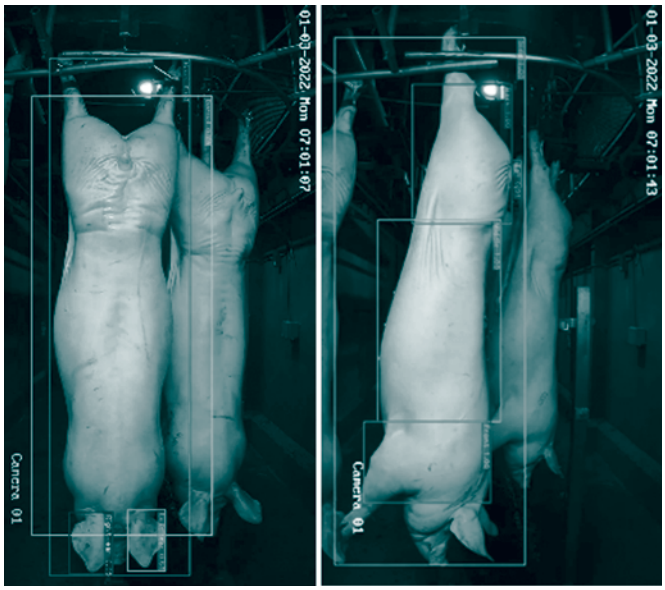

Figure 2. Computer-based system identifying different body regions on pig carcasses passing by a camera in the abattoir. Body regions of interest for animal welfare assessment: Dorsal side: ears and back; lateral side: shoulder, side, hindquarters, tail.

Research progress

Over a period of five months five maternity, 10 nursery and 10 finisher barns in Western Canada were each visited three times to perform repeat animal care assessments. At each visit a defined number of animals at each stage of production were randomly sampled and assessed for 43 animal-based indicators (i.e. tail-biting, skin lesions, hernias), and farms were assessed for five environmental (i.e. ventilation, dust level), and six resource-based indicators (i.e. floor type, enrichment). On-farm data collection utilised a sample size designed to pick up indicators if they were present in the population at 1% prevalence. Per finisher barn, at least one transport load of pigs originating from a batch of pigs assessed on farm, was followed to slaughter. At each finisher barn, the loading of the pigs onto the transport trailer was observed for animal-based and human-animal interaction indicators (i.e. prod use, the pig's reaction to handling). Each load of pigs followed from the finisher barn was tracked to slaughter where the assessment continued through the unloading, lairage and pre-slaughter management, utilising the abattoir video footage for observations. A video camera located on the slaughter line collected footage of the pig carcasses as they pass the camera after scolding and dehairing. Images of the carcasses are assessed for 10 animal-based indicators of welfare that relate to animal-based injury (i.e. tail biting), environmental (i.e. injury, frostbite) and human-handler (i.e. bruising from tool use). Carcass data per load sent to slaughter, including cut outs is being collected.

Training computer models for automated assessment of indicators

A camera was set up in one Western and one Eastern abattoir to collect images of pig carcasses on the slaughter line after the process of scalding and dehairing. Images of pigs passing by the camera during abattoir hours of operation are sent to the University of Saskatchewan every six weeks, allowing the collection of a bank of images spanning all four seasons. Images of the pigs are reviewed through a collaborative effort by researchers at the Western College of Veterinary Medicine and the Department of Computer Engineering and the images marked up to identify specific criteria: one lateral and the dorsal side of each pig, different body parts of the pig (Fig. 2) and then to identify specific lesions of interest.

On-farm data collection concluded in summer 2022, and data processing continues into fall and winter 2022/2023. Results will be available in early to mid 2023.

Industry implications

The scientific knowledge delivered from this research project will enable the Canadian swine industry to determine whether the assessment of animal-based indicators of welfare on swine carcasses at slaughter can be a tool to monitor pig welfare at different parts of the production chain. Evaluating the ability to conduct camera-based assessment of animals at slaughter, paves the way for the development of automated animal welfare monitoring as a tool for the Canadian swine industry. Regular and automated assessment of animal welfare at slaughter from reviewing carcasses will help to improve the robustness and reliability of the Canadian swine industry's animal care program, may help to reduce the number of on farm audits and can also provide a mechanism routine data collection and feedback on findings at different levels of the production chain for continual improvement.

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The Prairie Swine Centre for facility use.
Academic: University of Saskatchewan

Personal Profile

Olufemi ‘Femi’

Olufemi ‘Femi’ is from a small city (Ibadan) in Nigeria and completed his bachelor’s degree in Animal Science from the prestigious University of Ibadan. He undergrad thesis investigated the phosphorus and calcium utilization of groundnut cake meal supplemented with lysine and methionine and fed to broiler chickens. Femi then went on to complete his master’s and Ph.D degrees in Monogastric Nutrition at Purdue University, USA in 2018 and 2022 respectively, under the tutelage of Dr. Layi Adeola. He specialized in minerals, enzymology, and nutrient value of feedstuffs for broiler chickens and pigs. His graduate work investigated the utilization of phosphorus and phytase efficacy in broiler chickens and well as the time-related utilization of phosphorus and calcium in growing and finishing pigs. With 12 publications to his name, most of his findings from his graduate work have been published in reputable journals including Poultry Science, Journal of Animal Science, British Poultry Science, and Canadian Journal of Animal Science.

Currently, Femi works as a postdoctoral fellow with Dan Columbus at the Prairie Swine Centre, Canada where he investigates the role of indigestible protein on performance and gut health of weanling pigs. His future goals are to further connect the dots between nutrition, intestinal health, and physiology of Monogastric Animals to ensure a sustainable production of food for generations to come. In his free time, Femi loves to sing, cook, read fiction and travel with his wife Mo.

Coming Events

Alberta Pork Congress
Red Deer, Alberta
June 14 – 15, 2023

Ontario Pork Congress
Stratford, Ontario
June 21 – 22, 2023

Red Deer Swine Technology Workshop
Red Deer, Alberta
October 18, 2023

Sask Pork Symposium
Sasktoon, Saskatcheewan
November 7 – 8, 2023

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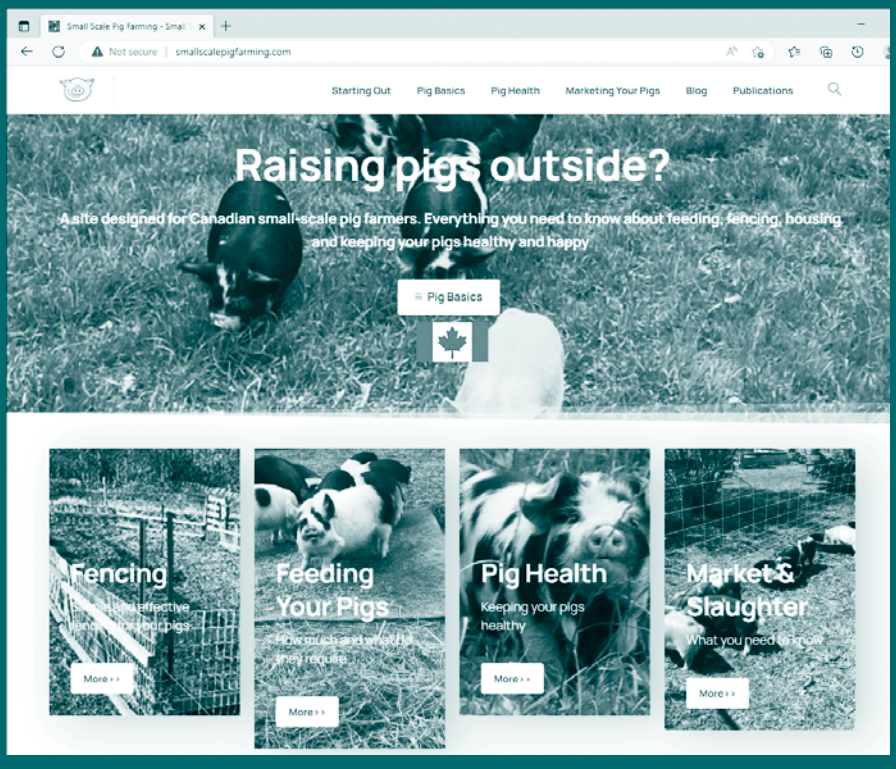

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