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Message From the President

Lee Whittington,
Prairie Swine Centre

If Change is a good thing – 2008/09 may be remembered as having too much of a good thing!

Change was the watchword of the day in 2008; personnel changes topped the list with the career change of Dr. John Patience, first President/CEO of Prairie Swine Centre, taking a position with Iowa State University. Seeking a replacement became an important function of the Prairie Swine Centre Board of Directors in 2008. I am pleased to be writing this article today as the Centres new President/CEO.

The year saw the opening of the new Sow Research Unit at our Floral, Saskatchewan location. Every part of the 300 sow F-F operation facility has now been completely rebuilt over the past 17 years, providing very good quality, flexible research facilities and at the same time emulating typical commercial barns in Canada. Production staff are very pleased with the loose-housing system selected and both behaviour and nutrition studies currently have nearly 100% of the sows on trial in the new Sow Research Unit. The year was also marked with the disappointment of closing the PSC Elstow Research Farm. The 600 sow F-F farm had been operated since 2000 and contributed greatly to the development of knowledge in nutrition, engineering and behaviour through its ability to provide large numbers of pigs for experiments. The ability to simulate a typical larger production operation was essential in work such as sow management with electronic sow feeders, the use of alternative strategies in auto-sort grow-finish management and investigation of variability in piglet growth rate across thousands of piglets. This facility is certainly missed and alternative arrangements have been made to locate these larger group-size related trials at commercial pig farms. We recently completed a sale of this farm to JSR Genetics of the United Kingdom. This Arrangement will allow PSC Researchers some access to the barn and JSR Genetics has generously offered to have the Pork Interpretive Gallery remain open for industry and public tours.

In fall 2008 we embarked on a revision to our strategic plan. So many changes had overtaken the industry in the past 5 years that certain aspects of how and what was needed, and whom we served were all up for discussion. In all the books on the subject of strategic planning one quote bears repeating here:

"In today's marketplace it is organizational capability to adapt that is the only sustainable competitive advantage" Willie Pietersen, in Reinventing Strategy

Change is invigorating

Where to start? Prairie Swine Centre had a business and research funding model that worked well for 17 years. That success of course affects your thinking and colours your outlook to the future, as does the success enjoyed by the Centre locally and internationally in recognition of its contribution to the various members of the pork value chain. Our emphasis on the pork producer has allowed our technology transfer and research efforts to succeed in speeding adoption of change

(continued on page 3)

Publication # 40010021

Evaluating Energy Usage and Various Energy Conservation Strategies for Swine Barns

B. Predicala, E. Navia

SUMMARY

Energy usage in swine barns and potential energy conservation measures were evaluated in this study. A survey of 28 swine facilities showed large variability in energy used per hog produced. Energy audits conducted in four selected barns identified the various areas, equipment, and practices in the barn that contributed significantly to the total overall energy consumption, thereby aiding in prioritizing areas for intervention. Using computer simulation, various potential strategies that can be applied in a barn in terms of lighting, creep and space heating, fans, feed motor, and heat recovery were examined. Simulation results for a typical 600-sow operation showed that potential annual savings up to 47,391 kWh electricity (79 kWh/sow) or 88,404 m3 natural gas (147 m3/sow) can be attained.

INTRODUCTION

Swine production in temperate regions like Canada requires substantial energy input. With the recent upward trends in energy prices, the cost of energy input to swine operations have been steadily rising such that for many operations, utilities now represent the third largest variable cost component of the total cost of production. The goal of this work is to assess the current energy usage and examine energy conservation measures that can improve the energy use efficiency in swine production operations, thereby reducing overall energy costs.

EXPERIMENTAL PROCEDURES

A survey questionnaire was developed and sent out to various swine producers to collect pertinent data from each operation over the past 3-year period to be able to calculate the average monthly utility cost per animal marketed ($/pig marketed) for each operation.

Based on the survey results, two barns which used the most energy per hog produced and two which used the least energy were selected for energy audits and monitoring of actual energy consumption during winter and summer seasons.

Following the barn monitoring, a mathematical model which simulated the energy use in a typical barn operation was developed based on fundamental principles of heat transfer, thermodynamics, and other engineering concepts. The model was applied to a typical 600-sow operation to simulate the theoretical energy consumption in the barn based on the building properties, climatic factors, barn management and practices, number and growth stage of animals, and equipment used in the barn. The baseline model was validated by comparing the predicted energy consumption in different operations within the barn with actual values obtained from barn monitoring. Finally, a number of potential energy conservation strategies were incorporated into the model and the projected energy savings resulting from each measure were calculated.

RESULTS AND DISCUSSION

Benchmarking results

Table 1 shows the range and average values of utility cost per animal marketed ($/head) based on the three-year information obtained from the survey. The average utility cost between types of barns were significantly different ($P<0.05$) for all comparisons except between grow-finish and farrow-wean barns ($P>0.05$). The survey results also showed almost 4x difference in energy consumption (per head) between the lowest and highest energy user barns. This indicated significant opportunities for improving energy use practices in some barns in order to reduce overall energy costs.

Monitoring of energy use in the four selected barns showed that the grow-finish rooms had the highest contribution to electrical energy consumption in the barn during summer months followed by farrowing, nursery, and gestation. The high energy consumption in the grow-finish area can be explained partly by the relatively larger footprint of this part of the barn compared to the other production stages in a typical farrow-to-finish operation and to the lower temperature set-point in grow-finish rooms (which meant all fan stages were operating almost continuously at full capacity during warm months). During winter, the highest natural/propane gas consumption was observed in nursery rooms followed by the grow-finish and farrowing rooms. This can be attributed to the high temperature set-point in nursery rooms relative to other production rooms. The gestation room had the lowest gas energy consumption because the heat generated by the sows was adequate to maintain the room at its set-point temperature.

Table 1. Results of benchmark survey of utility cost per animal marketed in different types of barns.

Type of barns	Size range	No. of barns, n	Utility cost per animal marketed			
			$/head pig sold		$/100-kg pig sold	
			Range (min – max)	Average (SD)	Range (min – max)	Average (SD)
Farrow-Finish	300 to 1,500 sow	9	3.0 -12.0	6.8 (3.41)	3.5-12.0	6.56 (3.05)
Farrow-Finish (excluding feedmill)	300 to 2,000 sow	7	3.8-13.0	6.5 (2.98)	6.0-11.5	6.75 (2.31)
Grow-Finish	10,000 to 40,000 feeders/weanlings	6	1.3-2.1	1.7 (0.58)	1.2-2.6	1.7 (0.74)
Nursery	130,000 to 140,000 feeders/weanlings	2	0.5-0.7	0.6 (0.12)	1.7-2.2	2.0 (0.41)
Farrow-wean	150 to 1,200 sow	4	0.8-4.3	1.9 (1.64)	8.2-17.8	12.2 (4.67)

Table 2. Average annual energy savings associated with different energy-saving strategies.

Areas	Average energy savings	
	kWh/yr	kWh/yr/sow
1. Lighting (from T12 to T5 fluorescent)	25, 957	43
2. Creep Heating (Heat lamps to Heat pads)	47, 391	79
3. Recirculation fan (High efficiency motor)	9,872	16.4
4. Exhaust fan (High efficiency motor)	42, 501	71
5. Feed motor (High efficiency motor)	1,846	3.1
6. Heat recovery (air-air heat exchanger)	88, 404 m3/yr	147 m3/yr/sow
7. Radiant heater (propane gas-fired)	52, 707 m3/yr	87.8 m3/yr/sow

Ventilation plays an important role in keeping the environment of the pigs at a level where production performance is optimized. The results of this study showed a medium to high negative correlation (i.e. -0.6 to -0.9) between the fan energy consumption and concentrations of NH_3, H_2S and CO_2 gases which are indicators of indoor air quality. This correlation indicated the need for careful consideration of conservation measures to reduce energy cost so as not to compromise the health of workers and animals the barn.

Simulation results

Simulation of the baseline case and the cases in which energy-conservation strategies were applied showed that significant energy savings can be attained in the areas of ventilation and heating as shown in Table 2. Using higher efficiency fans can reduce electrical energy consumption by 21% while the natural/propane gas consumption can be reduced by 70% using a heat recovery system (i.e. air-to-air heat exchanger). Furthermore, replacing conventional space heaters with gas-fired radiant heaters can reduce the gas consumption by 40%. Applying conservation strategies to other areas such as recirculation fans, feed motors, lighting, and creep heaters can reduce energy consumption by 12% and 20%, 26%, and 39%, respectively.

Piglets using heat pads

The Bottom Line

Benchmarking showed that the average utility cost (electricity and gas) per animal marketed is about $6.80/head, but can be as high as $12.0/head for some types of operations. Energy audits identified areas and operations in the barn such as ventilation and space heating in the grow-finish and nursery rooms as significant contributors to the overall energy consumption in the barn. Examination of a number of energy conservation strategies using computer simulation quantified the potential impact of the application of each measure on the overall energy use. Simulation results also identified the most promising measures that would merit further evaluation under actual swine barn conditions. Overall, the findings from this study would aid pork producers in focusing on specific areas and practices in the barn and in prioritizing conservation strategies to be considered for implementation, which would result in the most significant energy savings.

Acknowledgements: Project funding provided by the Advancing Canadian Agriculture and Agri-Food Saskatchewan (ACAAFS) is acknowledged. Thanks must also be given to the participating swine producers for providing access to their swine facilities and business information. Strategic funding was provided by Sask Pork, Alberta Pork, Manitoba Pork Council, and Saskatchewan Agriculture to the research programs at PSCI.

(continued from page 1 . . . President)

at the farm. For example, the selection of feeder types, to the level of feed in the pan to maximize intake and reduce waste and the Net Energy value of that feed – all of these developments over the past decade and a half can be traced to a study, a report and countless producer and supplier meetings initiated by Prairie Swine Centre. There is no question the old formula worked to instil a competitive advantage for the Canadian pork producer. But times have changed and the current income crisis within the industry challenges us all first to survive and secondly to predict what the new industry that rises from this period will look like.

The 'future' makes a mockery of our attempt to predict its coming, but we are obliged to try. So this coming year we are on a path to reinvent our company, and its service to our stakeholders. Firstly, by broadening the definition of stakeholders to aggressively seek solutions for the many players within the pork value chain. This is a natural extension of the base of knowledge and expertise PSC personnel have within the barn and extend that up the value chain to include the transportation and packer components and down the chain in the opposite direction to the cereal breeder and genetics supplier for example. What about something more novel? How can we demonstrate a greater value to the broader Canadian population? The pig as a model for human or pet health and nutrition for example is an area where our in-depth knowledge of the pig would allow us to provide greater value to a greater portion of society.

At Prairie Swine Centre we believe in the Canadian pork producer's ability to be internationally competitive and we will do our part to ensure that you have the research expertise needed to sustain your competitive edge in the future.

Net Energy Content of Canola Meal and Full-Fat Canola Seeds in Swine

Carlos A. Montoya, Kathryn Neufeld, Pam Kish & Pascal Leterme

Abstract

The project aimed to estimate the net energy (NE) content of canola meal (CM) and full-fat canola seeds (FFCS) in swine and to validate these values, through growth studies using diets containing graded levels of CM or FFCS. No difference in average daily gain and feed conversion ratio was observed between the treatments. This confirms that the estimation of the NE content (CM 2.41 and FFCS 3.53 Mcal/kg DM) was correct and that it is possible to formulate balanced diets for growing pigs that contain up to 15% FFCS and 22.5% CM.

Introduction

Canola meal (CM) is used in animal nutrition but has to compete with other protein sources such as soybean meal and peas. Currently, CM is not used to its full potential in swine nutrition, due in part to a lack of confidence in its nutritional quality. It is perceived as a poor energy source, due to its low starch and oil content and high protein and fibre content.

Thanks to their high oil content, full-fat canola seeds (FFCS) could partly contribute to correct the low energy content of CM. However, the seeds must be crushed to liberate the drops of oil entrapped within the cell walls and little information is available on the efficiency of the process.

The NE system is the best estimative to predict pig growth and its ability to convert feed into lean meat. However, it is often estimated by means of prediction equations because the direct determination is time-consuming and expensive. It is possible to confirm the validity of the NE content of CM or FFCS by measuring the feed conversion ratio of pigs fed with canola-based-diets. If the growth rate does not correspond to the predicted value, it means that the current values of NE over- or underestimate the real energy potential of these canola products.

The present project aimed to estimate the NE content of CM and FFCS and validate them through a growth trial using different graded levels of both ingredients in growing pigs.

Material & Methods

A total of 18 growing pigs (36 kg on average) were used for the digestibility study. Three experimental diets were prepared: a control diet (composed of barley, soybean meal and a mineral/vitamin premix) and two diets composed of 2/3 of the control diet and 1/3 of CM or FFCS. Each diet was tested on 6 growing pigs. After an adaptation period to the diet of 10 days, the faeces were quantitatively collected for 10 days. The samples were then pooled per animal, freeze-dried and analysed at the University of Saskatchewan. The digestible and net energy (DE and NE) content of the diets were calculated. The same parameters were calculated for the CM or FFCS alone (Table 1).

Based on the results of NE content of both CM and FFCS, two separate growth studies were conducted with graded levels of CM or FFCS. In each study, 72 growing pigs were used and four diets containing graded levels of FFCS (0, 5, 10 and 15 %) or CM (0, 7.5, 15 and 22.5 %) were formulated in order to meet the pig's nutritional requirements. Each diet was tested on 18 growing pigs (9 females and 9 males) for 35 d.

Table 1. Digestibility values and energy content of canola meal (CM) and full-fat canola seeds (FFCS) in growing pigs.

	CM	FFCS
Digestibility (%)		
Dry matter	74	75
Nitrogen	79	74
Energy	74	73
Digestible Energy (Mcal/kg DM)	3.51	4.99
Net Energy (Mcal/kg)	2.41	3.53

Results

The DE content was 3.51 and 4.99 Mcal/kg DM and the NE 2.41 and 3.53 Mcal/kg DM for CM and FFCS, respectively. The DM and nitrogen digestibility for CM was 74 and 79 % and for FFCS 75 and 74 %, respectively (Table 1). The results of growth performance are detailed in Table 2 and Figure 1. No difference in average daily gain (ADG) and feed conversion ratio (FCR) was observed when CM (ADG, 1.07 ± 0.29 kg/d and FCR, 1.99 ± 0.56) or FFCS (0.97 ± 0.24 kg/d and 2.27 ± 0.56) were included at different levels in the diets ($P > 0.05$).

The Bottom Line

The validity of the values of NE obtained for CM (2.41 Mcal/kg DM) and FFCS (3.53 Mcal/kg DM) was confirmed through growth experiments. The latter also showed that inclusion rates up to 22% canola meal and 15% full-fat canola seeds in rations have no detrimental effect on the performances of growing pigs.

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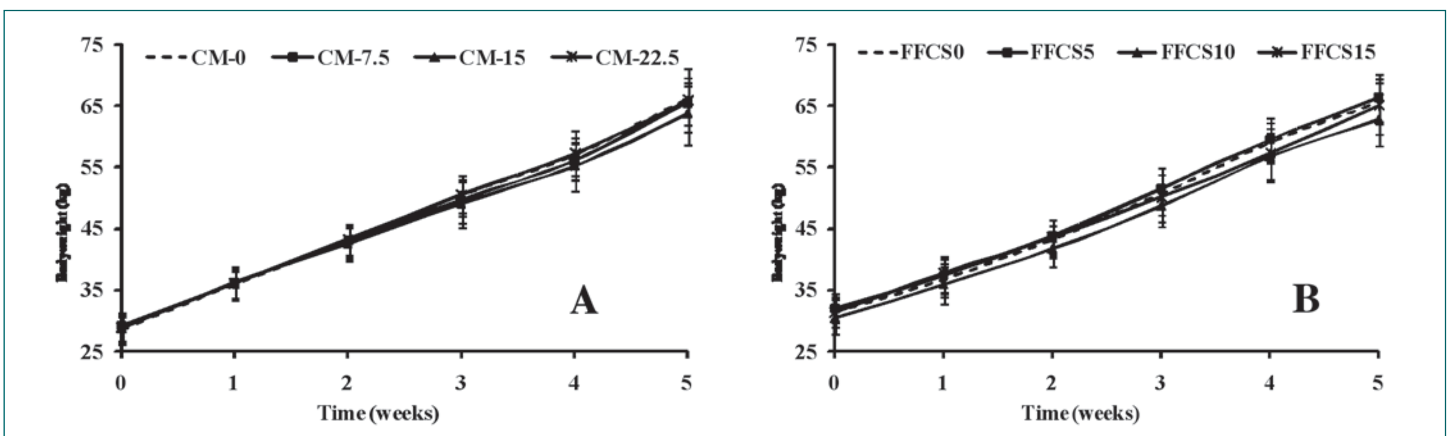
Table 2. Feed intake and growth in growing pigs fed with different levels of canola meals (CM) or full-fat canola seeds (FFCS) in the diets.

	Inclusion level	(%)			RSD[1]	P			
CM	**0**	**7.5**	**15**	**22.5**		**Diet**	**Time**	**D*T**	**Gender**
FFCS	**0**	**5**	**10**	**15**					
Average daily feed intake (kg)									
CM	2.03	2.02	2.01	2.09	0.55	0.664	0.001	0.122	0.023
FFCS	1.97[a]	1.99[a]	1.84[ab]	1.75[b]	0.45	0.001	0.001	0.651	0.002
Average daily gain (kg)									
CM	1.08	1.09	1.03	1.08	0.25	0.483	0.001	0.925	0.360
FFCS	0.98	1.00	0.94	0.95	0.24	0.070	0.001	0.437	0.018
Feed conversion									
CM	1.94	1.95	2.06	2.00	0.63	0.190	0.001	0.694	0.814
FFCS	2.07	2.05	2.03	1.92	0.56	0.068	0.002	0.056	0.245

[1] RSD: residual standard deviation.
[a,b] Values with different letters in the same row differ significantly at $P < 0.05$.

Figure 1. Growth curve of growing pigs fed with diets containing graded levels of canola meal (A) or full-fat canola seeds (B). Values are means and SD for 18 pigs (9 females and 9 males).



Transportation of Pigs in Western Canada: Temperatures Within Trucks During Winter and Summer Months

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Herold Gonyou

Transportation, without any doubt, is a major stressor to pigs and is one of the most critical periods in pig handling before slaughter. It involves separation from a familiar environment, physical exertion and psychological stress during loading, an unfamiliar social environment, and a challenging environment on the vehicle. Death losses during transportation in Canada are reported to range from 0.05 to 0.17%, with an additional 0.10 to 0.20% becoming non-ambulatory. Losses are higher in the summer and vary among compartments within a truck, and are also affected by method of handling, facility design and farm of origin. Little is known about micro-environmental conditions that develop within compartments during transportation and its effect on welfare and meat quality of pigs. As part of a larger project on handling and transport of pigs, we examined the temperature conditions in trucks to determine if differences exist among compartments. The study was conducted in both summer and winter to assess the seasonal variability in temperatures.

All animals used in the study were market animals (approx. 115 kg), including both males and females, and were assembled from multiple pens. The pigs were transported from the PSC Elstow Research Farm, and involved approximately 8 hours of travel to the Maple Leaf plant in Brandon. Pigs were loaded in the evening and transported overnight to arrive at the packing plant at 6 am. Trials were conducted in both winter and summer. The range of outdoor temperatures encountered were 7.7 to 22.9°C for summer and -24.5 to -3.8°C for winter. The truck used for transportation was a three-deck dual (cattle and pigs) purpose, pot-belly trailer. Compartments in the upper deck were numbered from 1, at the front, to 4, at the back and in the middle deck it was numbered from 5, at the front, to 8, at the back. The bottom (pot-belly) was numbered from 9 at the front, to 10, at the back. Compartment 6 was not used due to load limitations. Loading density was 0.41 m^2/pig, equivalent to a k value of 0.017 $m^2/kg0.667$. The trailer included 5 internal ramps with slopes ranging from 22 to 30°C. Eleven loads of 195 pigs (six loads in the summer and five loads in the winter) were used in the study.

We measured the temperature and humidity within each compartment using temperature and humidity sensors (iButtons). Five iButtons per compartment were mounted 5-6 cm below the ceiling. These were positioned in the centre of the compartment, and 15 cm in from the centre of each wall of the compartment. The values of temperature and humidity were recorded at 5 minute intervals. Temperatures reported here represent the mean of all five sensors within each compartment. Temperatures were determined at the time each compartment was filled with pigs (loading), at the time the vehicle left the farm (departure), at arrival at the packing plant (arrival), and at the time of unloading of each compartment (unloading).

The average temperatures at loading, departure from the farm, at arrival at the plant, and at unloading are given in Table 1. There were significant differences between summer and winter for all time points assessed. The temperatures were highest during loading and at departure from the farm, and then cooled during transport. In the summer temperatures tended to increase while waiting to unload, but they decreased in the winter.

The temperatures within each compartment of the truck during summer and winter trials are presented in Figures 1-4. At the time of loading, during the winter, compartment 5 was considerably colder than the rest, with the pot-belly compartments intermediate. Compartment 5 is at the front of the truck and its divider is relatively solid. Warm barn air being ventilated through the truck 30 minutes prior to loading in winter does not effectively reach this compartment. The compartment is generally the first to be loaded, and is considered to be difficult to fill. The very cold temperatures that exist here in the winter

may add to the difficulty. Compartments 9 and 10 are also likely to be poorly ventilated during the warming period, but they are not loaded until the entire upper deck has been filled. By this time the heat from the pigs has warmed the trailer considerably.

By the time of departure, the compartments in the middle deck and compartment 10 were the warmest in both summer and winter. All of these compartments have pigs immediately above them, and compartments 7 and 10 have low ceilings.

Table 1. Average temperatures at the time of loading, departure from the farm, arrival at the packing plant, and unloading for summer (6 loads) and winter (5 loads) months

Season	Loading	Departure	Arrival	Unloading
Summer	20.3*	21.7*	15.0*	19.1*
Winter	11.8	12.3	1.6	-1.8

** indicates a significant difference between summer and winter ($P < 0.05$).*

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[4]University of Guelph, Guelph, ON
[5]University of Manitoba, Winnipeg, MN

These factors would contribute to their warming from the heat of the pigs.

By the end of the journey, temperatures in all compartments had decreased significantly. In both seasons the middle deck and the pot remained the warmest. The temperatures in the top deck fell below freezing during the winter. These decks had no pigs above them to warm the ceiling and heat loss through the roof was likely considerable.

Between arrival at the plant and unloading, approximately 30 minutes in these trials, the truck is stationary and the compartments warm up in the summer. The hottest temperatures are seen in compartments 5 and 10. Compartment 5 has relatively poor ventilation as the front of the compartment is solid. It also is immediately above the tractor drive wheels and transmission which will be dissipating heat. Compartment 10 is also poorly ventilated and has a low ceiling.

During the winter the temperature in the warmer compartments decreases during the waiting period prior to unloading. This is surprising as we could assume that heat loss would be greater while the truck was in motion. It may be that pigs begin to arouse themselves during this stationary period and this facilitates heat loss from the compartment.

The pattern of temperatures in each compartment during the first 90 minutes of travel is shown for warmest summer and coolest winter days in Figures 5 and 6. Within 30 minutes of travel, if not sooner, the pattern of temperatures seen at the time of arrival at the packing plant has become evident. The compartments in the upper deck and compartment 8 (rear, middle deck) are the coolest. All the compartments cool somewhat, although this amounts to less than 5ºC in the summer, and as much as 20ºC in the winter. During the coolest day of travel, temperatures in the 'cool' compartments averaged -10ºC, with that in compartment 3 going below -15ºC.

During all of the trips temperatures within compartments cooled, then increased slightly and fell again. The reasons for these shifts in temperature of a degree or more are unclear. It may relate to road conditions that favour increased speed or require slowing down, or to shifts in wind speed or direction. The pattern for the warm, summer day approximately 70 minutes into the trip suggests that this shifting may be greater in the upper deck than elsewhere. It may be that this period represents a time of behavioural adjustment of the pigs, from standing to resting or vice versa. Transport lengths of more than 90 minutes have been shown to improve meat quality in pigs, and the reason for this is believed to be recovery from the stress of handling at loading.

The Bottom Line

The temperature conditions pigs are exposed to during transport vary considerably between seasons and among compartments within a vehicle. It may be possible to better standardize these temperature variations by changing ventilation and insulation values in each section/compartment of the trailer. The results found in this study will provide direction for important studies in the future.

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Figure 1. Temperatures at Loading

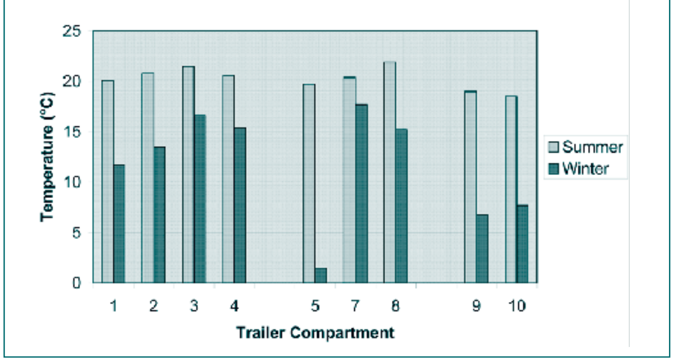


Figure 2. Temperatures at Departure

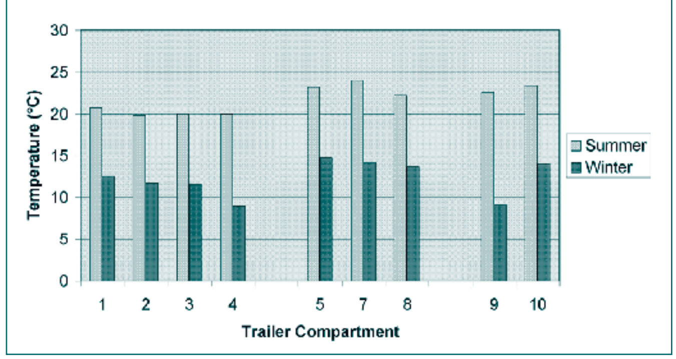


Figure 3. Temperatures at Arrival

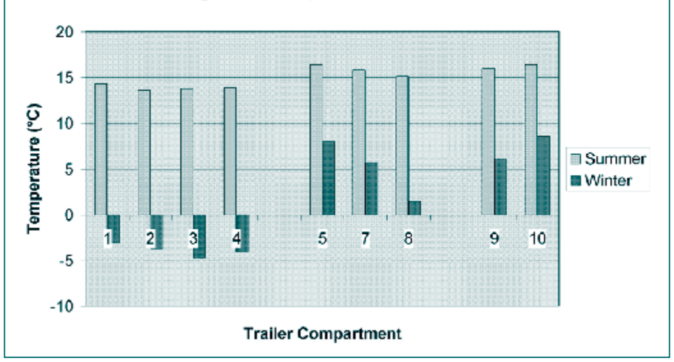
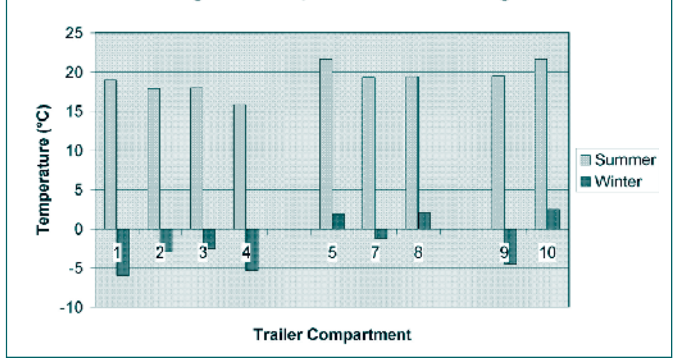


Figure 4. Temperatures at Unloading



Ractopamine hydrochloride and the environmental sustainability of pork production

Denise Beaulieu

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Summary

We (Patience et al. 2006) and others have shown improvements in lean growth and feed efficiency when ractopamine (Paylean®) was fed to finishing pigs. The objective of the following experiment was to determine if the improvements in nutrient utilization with Paylean can lead to a demonstrable reduction in the environmental footprint of pork production.

A metabolism experiment was conducted to measure the effect of 5 or 10 mg/kg ractopamine (RAC) from Paylean on N and water balance in finishing swine. Paylean improved ADG, N retention in the carcass and feed efficiency and decreased water intake and urine output. Because of the improvement in N and water utilization in finishing pigs, we concluded that Paylean can reduce the environmental impact of pork production.

INTRODUCTION

The excretion of nitrogen (N) in the manure of swine is problematic because it is in the form of NH_3 which has odour and other environmental implications. Ractopamine hydrochloride (RAC), or Paylean (Elanco Animal Health, Guelph, ON) is a ß-adrenergic agonist which, when added to the diet of finishing swine, improves ADG, feed efficiency, and carcass lean growth. These growth performance and carcass improvements are well noted in the literature but there is limited research on other potential benefits of Paylean.

A small number of studies have looked at RAC's impact on reducing nutrient excretion; however inclusion levels of 18 to 20 mg/kg were used. Currently, the Canadian Food Inspection Agency approves RAC at inclusion levels of 5 and 10 mg/kg, thus, these were the levels used in the following study.

The overall objective of this experiment was to define the impact of RAC on the efficiency of pork production with a view to reducing the environmental impact of pork production. Specifically we wanted to determine the effect of RAC on the efficiency of N utilization, and to evaluate the effect of RAC on the efficiency of animal performance, including carcass quality and water and feed requirements for growth.

MATERIALS AND METHODS

The experiment utilized 54 barrows assigned to one of 9 treatments when they reached 95 (± 3) kg bodyweight. Treatments were 3 levels of RAC (0, 5 or 10 mg/kg) x 3 lysine:DE ratios (1.75, 2.25 or 2.75 g ileal digestible lysine:kcal DE). Barrows were on test for 15 days and maintained in pens which allowed the collection of faeces and urine. Collection of urine and faeces occurred on days 6 to 8 and 13 to 15 of the experiment allowing us to determine if the response to RAC changed over time.

Diets were based on wheat, barley, and soybean meal and also contained canola oil, vitamin/mineral premix, and synthetic amino acids. All diets were formulated to contain 3,300 kcal DE/kg and formulated to meet or exceed the nutrient requirements of the finisher pig (NRC, 1998).

RESULTS AND DISCUSSION

Final BW, ADG, ADFI and G:F ($P < 0.05$) increased as RAC concentration in the diet increased. Final BW, ADG ($P < 0.05$), and G:F

Table 1. The effects of RAC and lysine on final body weight, growth rate, feed intake, feed efficiency and water intake in finishing barrows[1]

	Body Weight, kg		ADG,	ADFI,	G:F
Item	Initial	Final	kg/d[2]	kg/d[2,3]	kg/kg[2,3]
RAC (ppm)					
0	93.8	110.2	1.1	3.2	0.34
5	93.8	112.9	1.3	3.2	0.39
10	94.1	112.7	1.3	3.0	0.41
SEM	0.65	0.54	0.04	0.06	0.01
Lysine (g/Mcal)					
1.75	93.5	110.9	1.1	3.3	0.35
2.25	94.2	112.9	1.3	3.1	0.40
2.75	94.0	112.0	1.2	3.0	0.40
SEM	0.65	0.54	0.04	0.06	0.01
Statistics			P-value		
RAC	-[4]	0.002	0.002	0.051	<0.001
Lysine	-	0.039	0.039	0.027	<0.001
RAC x Lysine	-	0.654	0.650	0.918	0.579

[1] Data expressed as least square means. Data analyzed with initial body weight as a covariate
[2] Calculated based on 15 d experimental period.
[3] As-fed basis.
[4] (–) indicates no statistics were calculated on that parameter

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[2] Dept. Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK Canada S7N 5N8
[3] Elanco Animal Health, Guelph, ON Canada
[4] Department of Animal Science, Iowa State University, Ames, IA. USA

increased (P < 0.001) and ADFI decreased (P < 0.001) with increasing Lys levels (Table 1). Pigs fed no RAC averaged 19 d to reach market and RAC fed pigs required 17 d.

Table 2 describes water balance and fecal ouput. A decrease in water intake and excretion (urine output and fecal moisture) (P < 0.05) was observed with increased RAC. Apparent water retention tended to decrease with RAC inclusion (P = 0.10). Fecal output (dry basis) was greatest for the 5 mg/kg RAC-fed pigs when compared to the 0 and 10 mg/kg treatments (P < 0.05). Greater Lys concentrations tended to decrease fecal output (P < 0.10) but Lys had no effect on water intake, excretion, and apparent water retention (P > 0.10).

Nitrogen intake, N digestibility, urinary N excretion, fecal N excretion, and total N excretion decreased and N retention increased (P < 0.05) with increased RAC (Table 3). Nitrogen intake, N digestibility, urinary N excretion, total N excretion, and N retention increased with greater dietary Lys concentration (Table 3, P < 0.05) but fecal N excretion was unaffected (P > 0.10; Table 3).

Calculations based on the present data were applied to a commercial situation to define the potential impact of RAC on the environment. The values obtained in the metabolism study were utilized to calculate nutrient balance in a 1,000 head finishing barn (Table 4). In these calculations, we assumed that pigs started on treatment diets at 95-kg and finished at 120-kg.

Our calculations indicated that 10 mg/kg Paylean supplemented at 95-kg and fed for 17 days would reduce feed intake and water consumption by 7.5 kg and 33.1 liters per pig, respectively. Water and faecal excretion would be reduced by 18.6 liters and 0.9 kg per pig, respectively. N intake was reduced by 0.2 kg per pig, and N excretion declined by 0.2 kg per pig.

Table 2. The effect of RAC and lysine on feed and water intake, faecal and urine output, water excretion and retention in finishing barrows[1]

Item	ADFI (dry basis), kg/d	Water Intake, l/d[2]	Faecal Output (dry basis), kg/d	Urine Output, l/d	Water Excretion, l/d[3]	Apparent Water Retention, l/d[4]
RAC (ppm)						
0	2.8	8.3	0.4	3.5	3.9	4.4
5	2.9	7.9	0.5	3.2	3.6	4.4
10	2.7	7.3	0.4	2.9	3.2	4.1
SEM	0.05	0.25	0.01	0.18	0.18	0.12
Lysine (g/Mcal)						
1.75	2.9	7.9	0.5	3.2	3.6	4.4
2.25	2.8	7.5	0.5	3.0	3.3	4.2
2.75	2.7	8.1	0.4	3.4	3.7	4.4
SEM	0.05	0.25	0.01	0.18	0.18	0.12
Sample Period (days)						
d 6-8	2.7	7.7	0.4	3.0	3.4	4.3
d 13-15	2.9	8.0	0.5	3.3	3.7	4.3
SEM	0.04	0.15	0.01	0.12	0.12	0.09
Statistics	P values					
RAC	0.057	0.017	0.018	0.031	0.033	0.102
Lysine	0.053	0.186	<0.001	0.221	0.276	0.337
RAC x Lysine	0.846	0.994	0.060	0.840	0.769	0.125
Sample Period	<0.001	0.051	0.025	0.022	0.014	0.828

[1] *Data expressed as least square means. Data analyzed as repeated measures with sampling periods and the Toeplitz model used for the covariance structure.*

[2] *Includes water consumption and diet moisture.*

[3] *Sum of faecal water output and urine output.*

[4] *Calculated as the difference between water intake and urine and faecal excretion. Other moisture losses (ie. respiration) were not accounted for.*

When comparing the 5 mg/kg Paylean level to the 10 mg/kg level, the 10 mg/kg Paylean-fed pigs had the most substantial reduction in intake and excretion of both water and nitrogen. Utilizing the results obtained in this experiment and applying them to a commercial situation demonstrates that Paylean can have a significant impact on reducing the environmental footprint from pork production. Therefore, feeding either 5 or 10 mg/kg RAC can improve environmental sustainability of market hogs by reducing feed requirements, decreasing water consumption and excretion, and improve utilization of dietary N.

The Bottom Line

RAC feeding has the potential to improve the environmental footprint associated with marketing hogs. Results from these experiments indicate that supplementing either 5 or 10 mg/kg RAC in finishing swine diets can improve N utilization. A decrease in urinary N excretion from 35.1 % to 29.8 % and improvement in N retention from 49.3 to 54.0 % in control and 10 mg/kg RAC-fed pigs, respectively, can reduce excess N being released in soil and water when manure is spread on land. RAC also improved protein deposition rates to 189.2 g/d in the 10 mg/kg RAC-fed pigs, whereas lipid deposition rates decreased to 542.3 g/d. Supplementing RAC produced a leaner carcass with improved nutrient utilization. As well, RAC-feeding reduced water intake by 1 l/d and water excretion was reduced by 0.7 l/d with 10 mg/kg RAC–feeding, which can decrease water consumption requirements for finishing hogs.

(continued on page 11)

Feeding the 2009 Crop

Dr. Denise Beaulieu

A cold and wet spring which delayed seeding and sprouting has resulted in a late harvest throughout most of the Western Canadian Prairies. The early September Saskatchewan crop report confirmed a harvest that is well behind the 5 year average. Although, a long, dry and sunny fall could significantly improve the outcome, it is reasonable to predict that the 2009 harvest will result in significant amounts of grain that is immature, frozen and or sprouted. Because these grains will be discounted, even relative to feed-grade grains, they represent an opportunity for lowering the overall cost of feed for swine producers.

Barley and Wheat

Grains are primarily incorporated into swine rations to provide energy; protein and amino acids can be supplemented with specific ingredients. The digestible energy (DE) content of a grain is due to the total amount of energy (gross energy, GE) in the kernel (derived from fat, starch and protein) and the digestibility of this energy by the animal. Unfortunately energy digestibility can't be measure directly in an analytical lab. The best we can do is to determine nutrient digestibility experimentally and correlate these measurements to the chemical composition. Prediction equations can then be developed. This has been done in a series of experiments with barley and wheat. An equation developed for barley samples collected in 2002 explained 86 % of the variability in DE. It requires the measurement of acid-detergent fibre (ADF) and crude protein (Clowes et al. 2003) while the best equation for wheat uses neutral detergent fibre (NDF) and crude protein (Zijlstra et al. 2003). The R2 of 0.75 for the wheat equation indicates that 75 % of the variation in DE content can be explained using this equation, or conversely 25 % of the variation in DE content is unexplained (Table 1). This data set is particularly relevant for the current year because 14 of the 16 samples used in this data-set were frost damaged.

Table 1. Equations to predict DE (Kcal/kg) content of barley and wheat.[1]

		R2
Barley[2] :	DE = 3,542 – 138.8 ¥ ADF + 39.3 ¥ CP	0.86
	DE = 4,054 – 135.2 ¥ ADF	0.80
Wheat[3]	DE = 3,584 + 38.3 ¥ CP – 16.0 ¥ NDF	0.75

1. *DE (kcal/kg DM), ADF, ADF and NDF (% DM)*
2. *Clowes et al. 2003*
3. *Zijlstra et al. 1999*

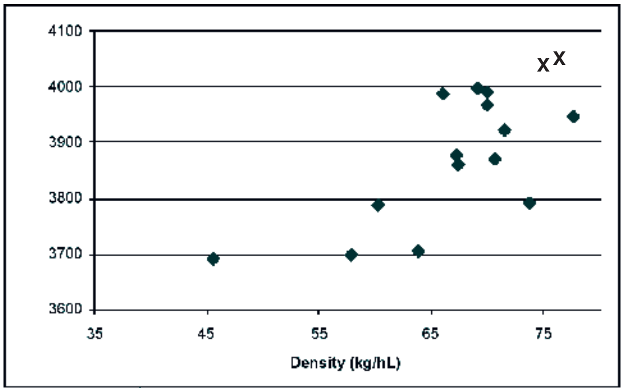
Density or bushel weight is commonly used to estimate grain quality. Bushel weight is easy, low-cost and fast, ADF and NDF are none of these. Research over the past 20 years, however, has been unable to demonstrate a good relationship between bushel weight and feeding quality of grains for swine. Frost damaged grains often have a low bushel weight, primarily because of an increased fibre and lower starch content. The degree of damage depends on maturity of the crop and when the frost damage occurred. The following table (adapted from a 1980 Agriculture and Agri-Food publication) and graph (adapted from work conducted at the Prairie Swine Centre in 1993) demonstrate why there is some confusion regarding the use of bushel weight as an indication of grain quality.

Table 2. Relative feed value of damaged cereal grains.

Grain		Density kg/hL	(lbs/bushel)	Composition (%) Protein	Fat	Fibre	Ash	Feed value[2]
Wheat	Not damaged	78	(62)	14.8	1.8	2.6	1.5	105
Wheat	Slightly frozen	70	(56)	14.3	1.9	3.5	1.7	104
Wheat	Frozen or sprouted	63	(50)	14.7	2.1	4.0	1.9	102
Wheat	Frozen or sprouted	50	(40)	14.9	2.6	4.6	2.0	90
Wheat	Burnt (20% charred)	68	(54)	12.1	1.9	4.5	2.1	92
Barley	No damage	63	(50)	11.9	2.1	6.0	2.6	100
Barley	Frozen or sprouted	55	(44)	11.8	2.1	6.6	2.5	94
Barley	Frozen or sprouted	45	(36)	11.8	1.9	7.8	3.0	86
Oats	Frozen or sprouted	40	(32)	13.8	5.1	11.1	2.9	89
Oats	Frozen or sprouted	35	(28)	13.4	4.6	13.9	2.9	85

1. *Adapted from "Feeding Frost-Damaged and Sprouted Grain to Livestock" Fact Sheet, Sask. Ministry of Ag. (citing Ag and Agri-Food Canada publ # 1277; 1980)*
2. *Relative to #1 Feed barley*

*Figure 1. Correlation of grain density with digestible energy content in 16 wheat samples. Samples indicated by **X** had optimal growing and harvesting conditions while ◆ samples had some degree of frost damage. Note (To convert kg/hL to lbs per bushel, divide by 1.25 or for example a density of 60 kg/hL is a bushel weight of 48).*



It is clear from both of these data sets that a decline in density due to frost –damage correlates with decreased DE content of the grain. However, upon closer examination we can see that this relationship is only valid when comparing extremes, for example when comparing undamaged wheat with a bushel weight of 62 to damaged wheat with a bushel weight of 40 (Table 2) but above a bushel weight of about 40 for wheat or 45 for barley, bushel weight does a poor job of predicting DE.

Additional information on canola, ergot, molds and mycotoxins can be found on the Prairie Swine Centre website at www.prairieswine.ca

(continued from page 9 Ractopamine ...)

Table.3 The effect of RAC and lysine concentration on nitrogen balance in finishing barrows[1]

Item	N Intake, g/d	N Digestibility, %	Urinary N Excretion, g/d	Faecal N Excretion, g/d	Total N Excretion, g/d	N Retention, g/d
RAC (ppm)						
0	80.5	84.4	28.5	12.6	41.1	39.4
5	84.1	83.2	25.5	14.1	39.6	44.5
10	77.0	83.8	23.3	12.6	35.9	41.1
SEM	1.43	0.26	0.95	0.37	1.12	1.03
Lysine (g/Mcal)						
1.75	76.0	83.0	24.6	13.0	37.6	38.4
2.25	80.4	83.7	24.1	13.2	37.3	43.0
2.75	85.2	84.8	28.6	13.1	41.7	43.6
SEM	1.44	0.26	0.96	0.37	1.13	1.07
Sample Period (days)						
d 6-8	77.1	83.7	24.1	12.7	36.8	40.3
d 13-15	89.0	83.9	27.4	13.5	41.0	43.0
SEM	1.10	0.20	0.74	0.27	0.84	0.79
Statistics			P values			
RAC	0.057	0.017	0.018	0.031	0.033	0.102
Lysine	0.053	0.186	<0.001	0.221	0.276	0.337
RAC x Lysine	0.846	0.994	0.060	0.840	0.769	0.125
Sample Period	<0.001	0.051	0.025	0.022	0.014	0.828

[1] *Data expressed as least square means. Data analyzed as repeated measures.*

Table 4. Calculated water and nutrient balance for the finishing period (95-120-kg BW)[1]

	RAC (mg/kg)		
Item	02	52	102
Feed Intake (as-fed), kg	60.8	54.4	51.0
N Intake, kg	1.5	1.4	1.3
Water Intake, liters	157.5	134.8	124.4
Water Excretion, liters3	73.2	60.4	54.6
Urine Output, liters	66.9	54.1	48.8
Fecal Output (dry basis), kg	8.4	8.3	7.5
N excreted, kg	0.8	0.7	0.6
N retained, kg	0.8	0.8	0.7

[1] *Except days to market, which were obtained from the growth experiment, calculations were based on results obtained in the metabolism experiment.*

[2] *Pigs fed ractopamine were considered to reach market weight (120-kg) in 17 days from 95-kg and pigs fed no ractopamine were considered to reach market weight in 19 days from 95-kg*

[3] *Water excretion is the sum of urine output and fecal moisture*

Acknowledgements:
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The plant extract Micro-Aid, has unexpected effects on litter size.

Micro-Aid® (DPI Global) is an all-natural product, produced from a plant extract which has been marketed primarily as an aid to reduce the emission of ammonia and odours from livestock production facilities. However, due to reports that colostrum from sows fed Micro-Aid® had increased levels of immunoglobulins a study was conducted at PSCI to determine the impact of Micro-Aid, on weight gain in piglets.

A total of 196 parity 2 to 7 sows were randomly assigned to one of 3 treatments; 1) Control, no Micro-Aid; or Micro-Aid, included in the gestation diet at 125 ppm for either 2) 5 or 3) 30 days pre-farrowing. In this study the inclusion of Micro-Aid had no effect on colostrum IgG levels or on serum IgG measured at birth in the piglets. Micro-Aid in the sow's diet for 30 days pre-farrowing resulted in one additional piglet born alive per litter ($P < 0.01$ Chi-square analysis). The increase in litter size appears to be primarily due to a decrease in stillborns rather than through increased IgG delivered to the pigs prenatally.

There was no effect of Micro-Aid, on colostrum IgG levels or on serum IgG measured at birth in the piglets. Moreover, there was no beneficial effect of Micro-Aid inclusion on piglet growth from birth until weaning (day 19).

One additional piglet per litter or more than two additional piglets per sow per year is a significant improvement in the reproductive efficiency of sows and the mechanism responsible for this warrants further research.

Funding for this study from DPI Global is appreciated.

Table 1. The effect of Micro-Aid in the diet on either 5 or 30 days prefarrowing on litter size and body weights of piglets.

			Treatment			P value	P values, comparisons		
Parameter		Control	MicroAid5	MicroAid30	SEM	Trt	Trt 1 vs 3	Trt 1 vs 2	Trt 2 vs 3
Number of litters	n	65	66	65					
Total pigs born live	n	745	751	811					
Stillborns	n	65	40	44					
Mummies	n	7	13	8					
Live pigs/litter, n	Day 0	11.4	11.7	12.4	0.4	0.14	0.05	0.58	0.17
Avg BW, kg	Day 0	1.58	1.55	1.55	0.03	0.59	0.40	0.35	0.93
	Day 5	2.40	2.37	2.30	0.05	0.25	0.11	0.64	0.25
	Day 12	4.38	4.21	4.13	0.08	0.07	0.03	0.11	0.49
	Weaning	7.01	6.81	6.73	0.12	0.22	0.09	0.22	0.64
Total litter wt, kg	Day 0	17.66	17.73	18.88	0.53	0.19	0.11	0.93	0.13

Personal Profile

Thomas Sebastian

Thomas was born as the youngest son of a rural farmer in Kerala province in India and his life has always been associated with animals. In 1996, after graduating with a degree in Veterinary Medicine from the Veterinary College Mannuthy in Kerala, India, he went into practice and worked for 8 years as a Veterinary Surgeon in the department of Animal Husbandry in Kerala. Thomas came to Canada in 2005 and worked under Dr. Joseph Stookey in the Western College of Veterinary Medicine and earned his Masters in Animal Behaviour. He then worked for BigSky Farms as a Breeding Technician for 18 months. He is currently working for the Prairie Swine Centre as a Research Assistant for Contract Research Services. He spends his free time with his wife Jabina and his two year old wonderful son, Joel Thomas.

Coming Events

Swine Technology Conference
Red Deer, Alberta.
November 4, 2009

Saskatchewan Pork Industry Symposium
November 17 & 18, 2009

Banff Pork Seminar
January 20-22, 2010

Manitoba Swine Seminar
February 3 & 4, 2010

Alberta Pork Congress
March 17 & 18, 2010

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